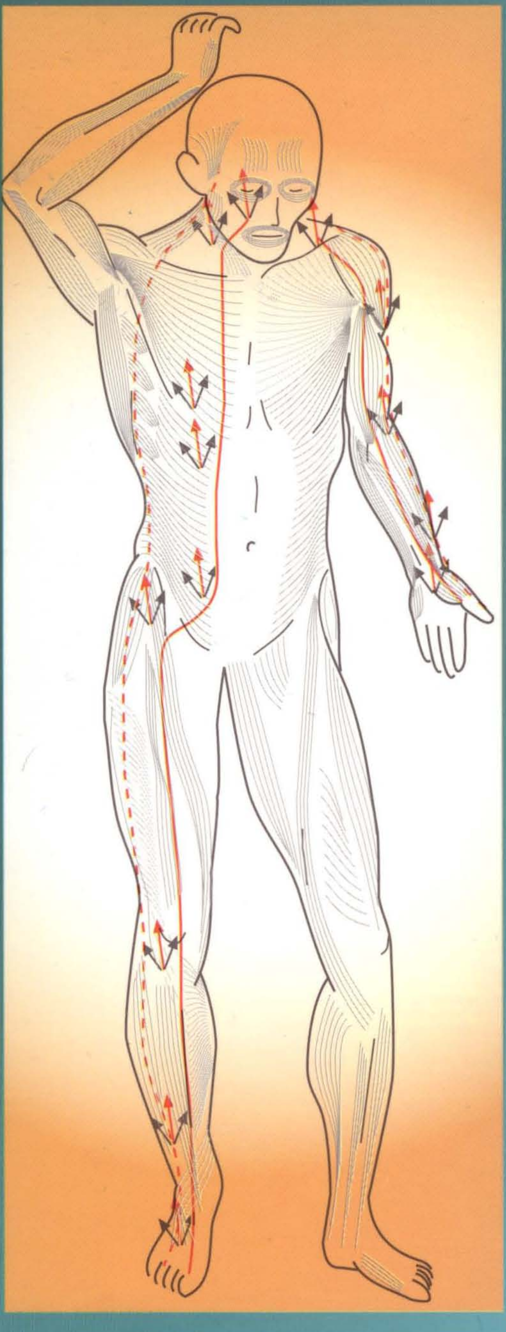
FASCIAL MANIPULATION

for Musculoskeletal Pain



LUIGI STECCO

Foreword by
JOHN V. BASMAJIAN

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Few books achieve the fond hopes of their authors and their admirers. This is just one that succeeds, making a genuine and profound contribution to the fields of biomechanics, orthopedics and rehabilitation. It moves with easy grace from any topic to its neighbor, shedding warmth and life to them all.
As one who has experienced both the high and low points of medical writing and editing over several decades, I see in these pages a true work of genius. It deserves a very wide readership and enthusiastic application of its lessons.

John V. Basmajian
Professor Emeritus in Medicine, McMaster University
Hamilton, Ontario, Canada

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Foreword by
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Hamilton, Ontario, Canada

English Edition by
Julie Ann Day

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Foreword

In spite of my amateurish command of the Italian language, several years ago I recognized immediately that Luigi Stecco had produced an Italian masterpiece with the help of Piccin Nuova Libraria. Reproduction in an English edition seemed a mandatory next step and I urged it to be done. Now my pleasure is redoubled as I read through the excellent translation that captures the true essence of my esteemed colleague's ideas and recommendations.

Few books achieve the fond hopes of their authors and their admirers. This is just one that succeeds, making a genuine and profound contribution to the fields of biomechanics, orthopedics and rehabilitation. It moves with easy grace from any topic to its neighbor, shedding warmth and life to them all.

As one who has experienced both the high and low points of medical writing and editing over several decades, I see in these pages a true work of genius. It deserves a very wide readership and enthusiastic application of its lessons.

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With regards to the original version in Italian this edition has been enriched with a number of photographs concerning the histology of the fascia. I am most grateful to my daughter, Dr. Carla Stecco, who is currently specialising in Orthopaedics at the University of Padova, for this scientific contribution.

I wish to acknowledge my colleague and teacher of this method, Julie Ann Day, who has not limited herself to the translation of this book but has often contributed valuable advice.

I wish to express my gratitude to Prof. J.V. Basmajian for having suggested the translation of this book into English, for his encouragement concerning all of my previous works and for having accepted to preface this edition.

I wish to thank all of my readers and I only hope that all of you will share the thoughts of Dr. Nicholas Padfield, Consultant in Pain Management at St. Thomas’ Hospital, London who kindly wrote: “After having read this book I now understand the importance of the myofascial system in the origin of pain”.

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ABBREVIATIONS

***	Maximum intensity of the symptom
+++	Maximum benefit obtainable
1 x m	Once a month the symptom aggravates
An	Ante, antemotion
An-la-	Motor scheme of ante-latero-…
An-ta	Antemotion talus, dorsiflexion
bi	Bilateral, both right and left
BL	Bladder Meridian
Ca	Carpus, wrist
cc	Centre of coordination of a mf unit
Cl	Collum, cervical region
Cont.	Continuous, persistent pain
Cp	Caput, face and cranium (head)
cp	Centre of perception of a mf unit
Cu	Cubitus, elbow
CV	Conception V. Meridian.
Cx	Coxa, thigh-hip
d	Day, 1 or more days since trauma
Di	Digiti, II°-III°-IV°-V° (hand)
dist.	Distal, away from the centre of body
Er	Extra, extrarotation, eversion
Er-ta	Extrarotation talus, eversion, supinat.
Fne	Free nerve ending
GB	Gallbladder Meridian
Ge	Genu, knee
Gto	Golgi tendon organ
GV	Governor Vessel Meridian.
HT	Heart Meridian
Hu	Humerus, distal part of the shoulder
Ir	Intra, intrarotation, inversion
Ir-ta	Intrarotation talus, inversion, pronat.
KI	Kidney Meridian
lt	Left, limb or one side of the body
La	Latero, lateromotion, lateral flexion
La-ta	Lateromotion talus, lateral deviation
LI	Large Intestine Meridian
Lower	Refers to the lower limb
LR	Liver Meridian
lu	Lumbi, lumbar
LU	Lung Meridian
m	Month, period of time since pain onset
Me	Medio, mediomotion, medial
Me-ta	Mediomotion talus, medial deviation
Mf	Myofascial: unit, sequence, spiral
mn	Morning, morning pain and/or stiffness
nt	Night, period in 24 hr. when pain is worst
p	Posterior
PaMo	Painful Movement
Par.	Paraesthesia, pins and needles
PC	Pericardium Meridian
Pes	Foot, tarsus, metatarsus and toes
pm	Afternoon, time period when pain is worst
Po	Pollicis, pollex, I° finger
Prev.	Pain(s) previous to present pain
prox.	Proximal, nearer to the centre of the body
Pv	Pelvis, pelvic girdle
rt	Right, limb or one side of the body
Re	Retro, retromotion, backwards
Rel.	Relapse, pain which recurs
Re-la-	Motor scheme of retro-latero-…
Re-ta	Retromotion talus, plantarflexion
Sc	Scapula, proximal part of the shoulder
SI	Small Intestine Meridian.
SiPa	Site of pain as indicated by patient
SP	Spleen Meridian
ST	Stomach Meridian
Ta	Talus
TE	Triple energiser Meridian
Th	Thorax
TMM	Tendinomuscular Meridian
TP	Trigger Point
Upper	Refers to upper limb
y, 10y	Year, 10 years since pain began

In the above list of abbreviations the first letter has been written in upper case and the second is in lower case. However, they can be written either like this or all in capitals or all in lower case. The meridians are normally written in capital letters. All of the abbreviations of each of the segmentary mf units and the mf units of fusion have not been included because the various combinations can be inferred from the examples given.

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INTRODUCTION

Fascial Manipulation[1] was first known as neuroconnective manipulation or "segmentary treatment". Pathologies of the locomotor apparatus were then considered as an isolated dysfunction of a single body segment.

The term Manipulation of the Fascia, introduced several years ago, was based on the idea of the fascia as the unifying element of the body.

Fascia is the only tissue that modifies its consistency when under stress (plasticity) and which is capable of regaining its elasticity when subjected to manipulation (malleability).

In this book fascia is not simply presented as a uniform membrane but is rather seen in its role of a:

- coordinating component of motor units (these are grouped together in the myofascial unit (*mf*);
- uniting element between unidirectional muscle chains (*mf sequence*);
- connecting element between body joints by means of the retinacula (*mf spirals*).

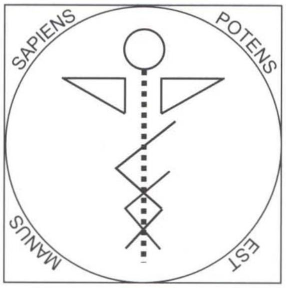
These myofascial structures (mf) can explain many aspects of the organisation of the motor system previously attributed to the Central Nervous System. These innovative hypotheses are supported by numerous quotes from texts of anatomy and physiology. Moreover, the insertions of some muscles into the fascia, as normally described by anatomists, are analysed here from the viewpoint of the physiology of the motor system

To make consultation of these research texts easier, you will find references in the footnotes to the authors' names as well as year of publication.

Fascial Manipulation is a manual therapy that requires a good working knowledge of anatomy and physiology. Only by comprehending the origin of a problem can one resolve it rapidly and efficiently (*Manus sapiens potens est*). The wellbeing of any organ or apparatus depends on the balance that exists between its components. A harmoniously balanced posture is indicative of a healthy musculoskeletal apparatus.

In the logo of Fascial Manipulation (see below) a correct posture is represented by the alignment of the head and the scapulae with the vertebrae.

The fascia and the muscles act as the rigging that guarantees the verticality of our body. If the fasciae were only arranged parallel to the vertebral column (static longitudinal sequence), stability would be achieved but movement would be definitely impeded. The spiral arrangement of the endofascial collagen fibres (e.g. the abdominal fascia is arranged in a S) allows for movement without loss of stability.



Logo of Fascial Manipulation

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[1] The term "manipulative treatment" or "manipulation" used by United States Osteopaths covers a variety of manual techniques collectively known as "osteopathic manipulative treatments (OMT)". Osteopathic manipulative treatments include:
- thrust techniques
- joint mobilisation techniques
- soft tissue techniques, muscle energy techniques, myofascial treatments, strain and counterstrain...(Teyssandier MJ, 2000)

Basic principles

The basic principles underlying the technique of Fascial Manipulation will now be examined before proceeding with any study of the actual technique. In living bodies all muscular tissues glide freely over one another[2]. Muscle fibres within the muscle itself do not all contract simultaneously but in succession and movement is only possible when the gliding component is unimpeded. Through analysis of anatomy from this viewpoint it is clear how the fascia, with all its ramifications, is the buffer that allows for this gliding to occur. The macroscopic structure of the fascia will now be analysed followed by the microscopic structure.

Macroscopic structure of the fascia

The fascia is formed by three fundamental structures: the superficial fascia, the deep fascia, and the epimysium (see Figures on book cover: anterior abdominal wall).

1) Superficial fascia is comprised of the subcutaneous loose connective tissue containing a web of collagen, as well as mostly elastic fibres. It is absent in the soles of the feet, the palms of the hand and in the face.

In the urogenital region it forms the superficial fascia of the perineum (Colles' fascia) attaching posteriorly to the border of the urogenital diaphragm, to the ischiopubic rami laterally and continues anteriorly onto the abdominal wall. The superficial fascia blends with the deep fascia at the retinacula of the wrist and ankle and continues with the galea aponeurotica over the scalp. It acts as both a mechanical and thermal cushion and facilitates the gliding of the skin above the deep fascia (Figure 1). This gliding movement hides the tensioning, which takes place in the deep fascia, to the naked eye. Within its meshes the superficial fascia contains fat (panniculus adiposus) or fasciculi of muscular tissue (panniculus carnosus). Cutaneous vessels and nerves also lie within the superficial fascia and its inner surface relates with the deep fascia.

The superficial fascia is named differently by different authors: tela subcutanea, hypoderm, stratum subcutaneum and subcutis

2) Deep fascia is formed by a connective membrane that sheaths all muscles (Figure 2, 3). The deep fascia, devoid of fat, forms sheaths for the nerves and vessels, becomes specialised around the joints to form or strengthen ligaments, envelops various organs and glands and binds all of the structures together into a firm, compact mass.

The deep fascia has been called *fascia profunda* or aponeurosis by some authors. It is worthwhile noting that the thoracolumbar fascia is not the same structure as the thoracolumbar aponeurosis. In fact, the term "fascia" refers to the undulated collagen fibres that are positioned in parallel to tendons and muscles. The term "aponeurosis" (or flat tendon) refers to the inextensible collagen fibres that are positioned in series with muscle fibres because they transmit the force of the large muscles (latissimus dorsi).

In some areas of the limbs and the trunk the deep fascia duplicates itself to form a deep lamina. In the neck and trunk there is also an intermediate lamina[3].

The superficial lamina of the deep fascia of the neck doubles itself to surround the trapezius and

---

[2] There is no specialised lining of this surface of the fascia to account for its gliding properties. The post-surgical specimens demonstrated preservation of the structure of the interface between fascia and muscle, including the retention of the hyaluronic acid lining, if the epimysium was intact. However, if the epimysium was disrupted, the structure of the interface was obliterated. (McCombe D, 2001)

[3] The dorso-lumbar fascia and cervical fascia can be conveniently divided into three layers: outer layer, middle layer, inner layer; the outer layer of cervical fascia forms a complete hollow cylinder; It splits twice to form strong sheaths for trapezius and sternocleidomastoid. (Ebner M, 1985)
(In this book: layer = lamina)

Figure 1. Superficial fascia of a rabbit; this fascia can only be stretched like this immediately after slaughtering because it dries quickly and adheres to the underlying deep fascia. The superficial fascia in rabbits is extremely elastic and contains very little adipose tissue because the animal's fur provides thermal insulation.

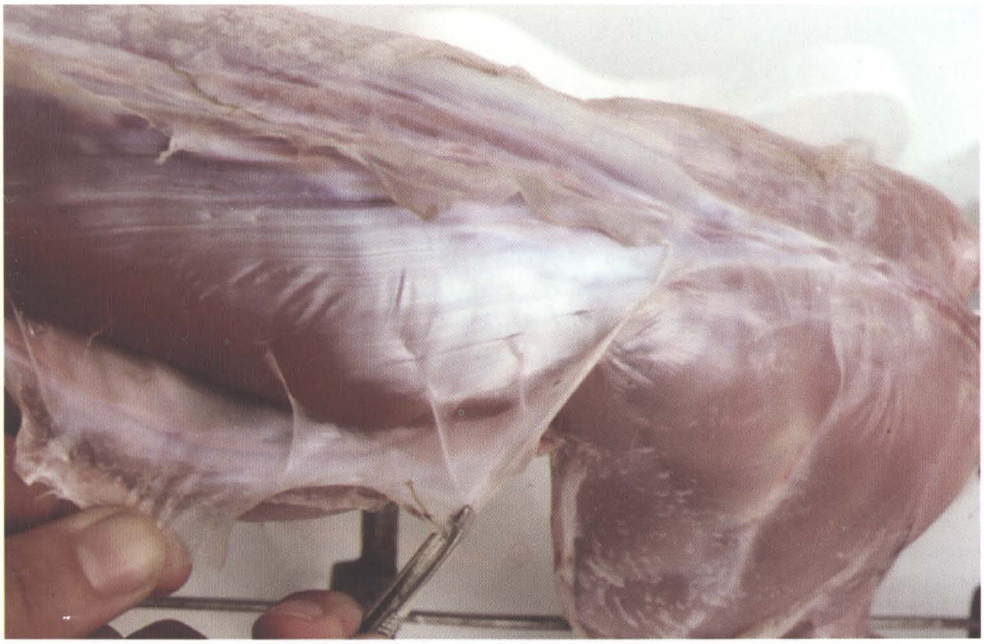

Figure 2. Section of the deep fascia on the left, demonstrating the mass of the erector spinae enclosed by its own epimysial fascia. The superficial lamina of the deep fascia is tensioned in a cephalic direction by the latissimus dorsi, caudally by the glutei and in a ventral direction by the oblique muscles.

Figure 3. Here the muscles of a calf's leg have been manually parted in order to highlight the septa and the band-like extensions of the deep fascia. These collagen bands act as transmission belts, which link the sequences and the spirals, rather than packing or confining elements. Manipulation initially identifies blockages and then restores gliding between these bands of collagen fibres.

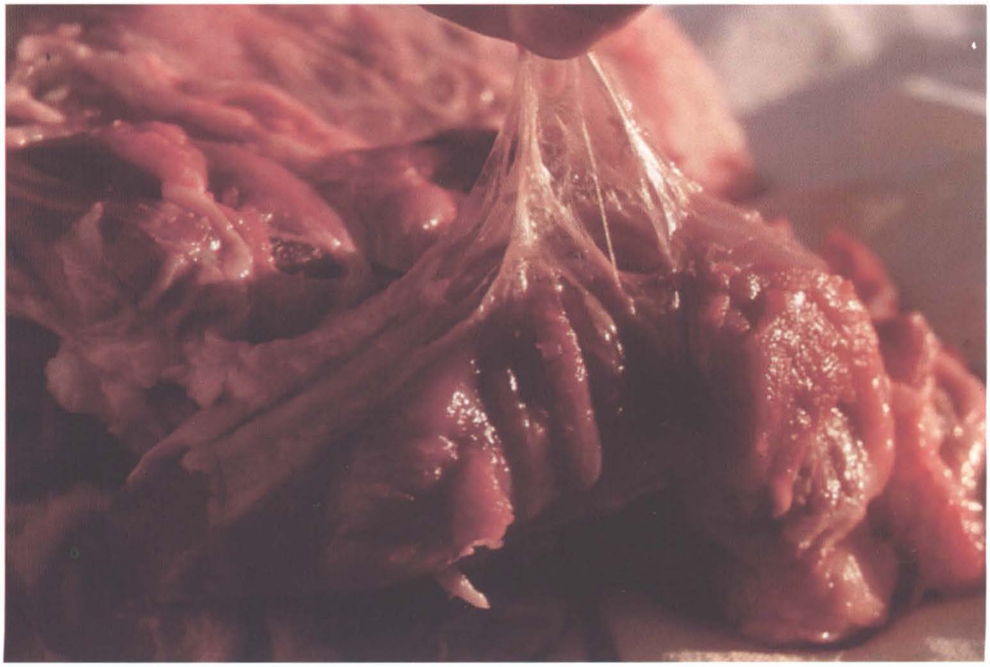

Figure 4. The macroscopic structure of the epimysial fascia is demonstrated in this specimen of muscle which was removed from a pig. The grooves, formed in the transverse section of the muscle following manual traction of the epimysium, are to be noted. This demonstrates the transference of traction from the fascial framework to the muscular fibres and visa versa.

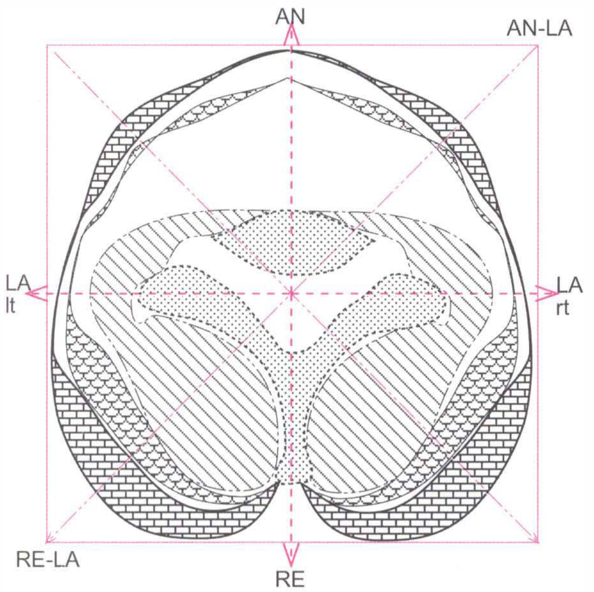

Figure 5. A schematic representation of Figure 7 with three laminae of cervical fascia. To be noted how the macroscopic structure of the fascia reproduces a ball-bearing or buffer effect.

the sternocleidomastoid muscles (Figure 7, Figure 5). Anteriorly, the intermediate lamina ensheaths the omohyoid muscle and posteriorly, the splenius capitis muscle. Anteriorly, the deep lamina surrounds the prevertebral muscles and posteriorly, the erector spinae muscles. These fasciae can be stretched either according to precise spatial planes (ante, retro = sagittal plane) or according to transitional motor schemes (e.g. ante-lateral, retro-lateral = diagonals) (Figure 5).

The deep fibres of the trapezius muscle are clearly surrounded by the perimysium and the endomysium. This connective tissue sheath allows each single muscle fibre to contract independently. In fact, a motor unit is formed from muscular fibres that can even be located at a distance from one another, within the same muscle. Therefore they can only contract if the endomysium allows them to move while other fibres remain immobile.

3) The epimysium comprises the fascia that encloses each single muscle and it is continuous with the perimysium and the endomysium (Figure 4). These fascial structures subdivide the muscle into various bundles: on the inside of the bundles the endomysium contains few elastic fibres and no adipose cells, on the outside of the bundles the perimysium contains many elastic fibres as well as adipose cells. The epimysium continues beyond the extremities of the muscle with the epitendineum and the peritendineum. The epimysium is directly involved in the play of tension between the muscle spindles and the

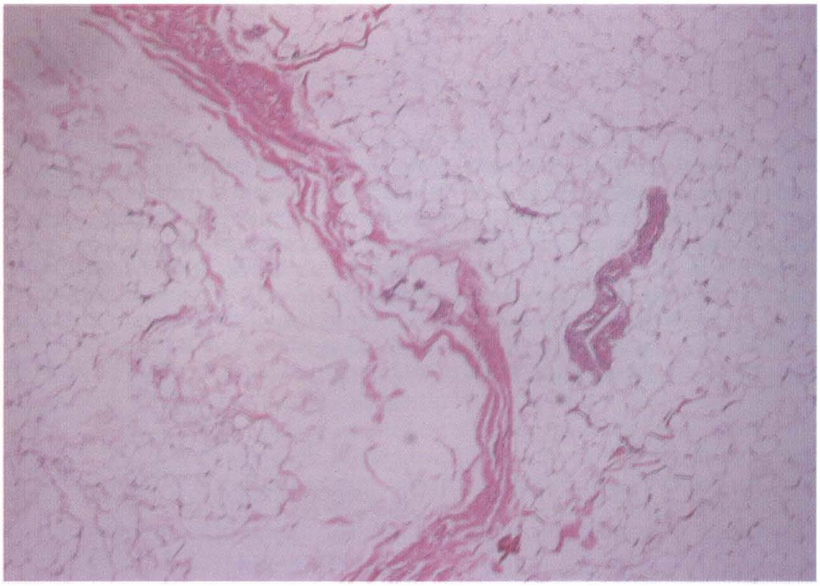

Figure 6. Superficial fascia (EE x 120). In this photo numerous adipocytes distributed in the loose connective tissue can be identified. In the centre an intertwining of collagen fibres that forms a lamellar layer is evident.

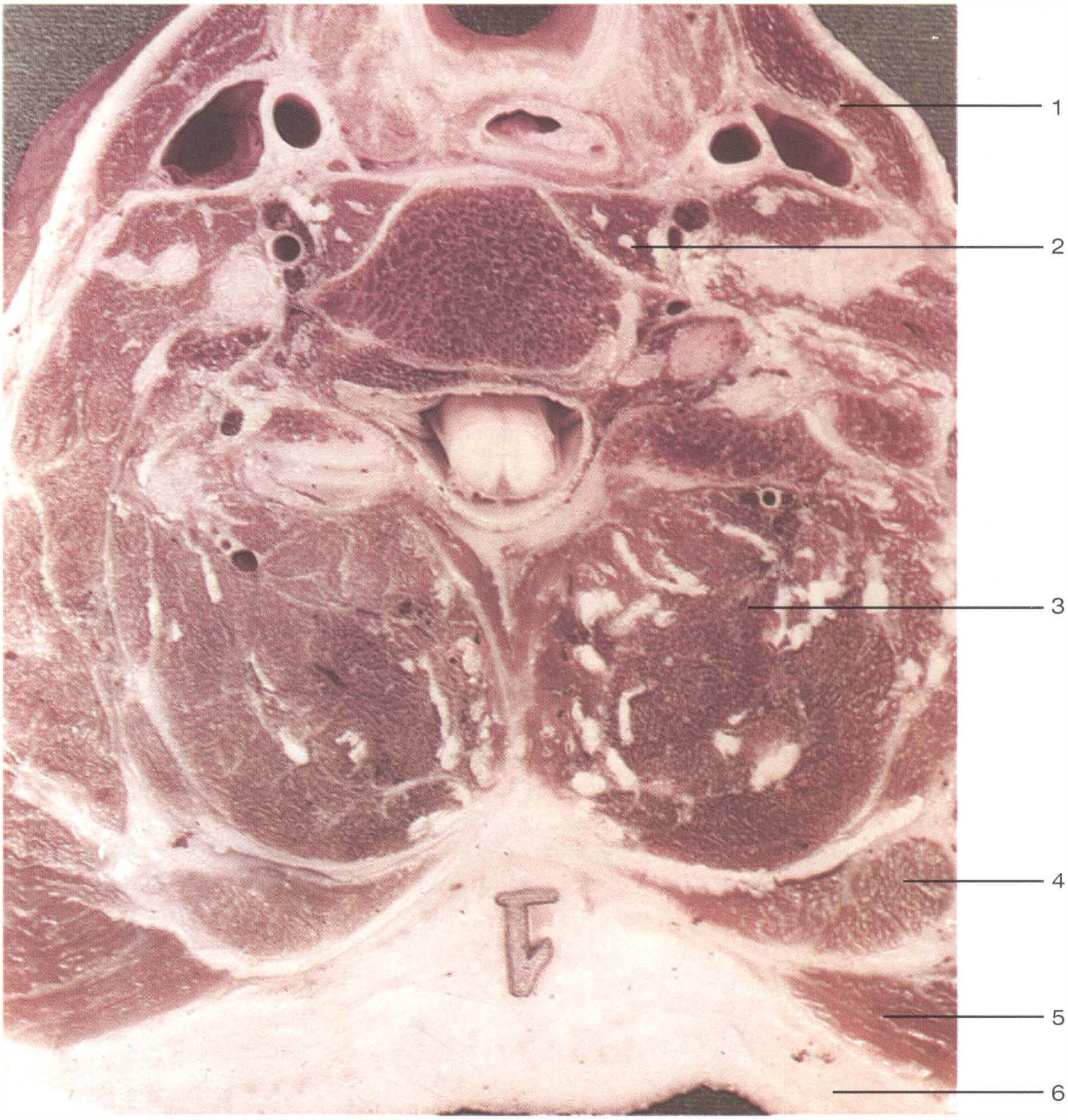

Figure 7. Horizontal section of the neck at C6 level (Fumagalli – Colour photographic atlas of macroscopic human anatomy - Publisher: *Dr. Francesco Vallardi/Piccin, Nuova Libraria*). 1) Sternocleidomastoid m. surrounded by the superficial lamina of the deep cervical fascia. 2) Prevertebral mm. surrounded by the deep lamina of the cervical fascia. 3) Fascial compartment of the erector spinae mm. (semispinalis, multifidus mm.); the muscle fibres are subdivided by the perimysium which connects to the various aponeurotic insertions (white collagen fibres). 4) Splenius m. surrounded by the middle lamina of the deep cervical fascia. 5)Trapezius muscle within the doubled superficial layer of the deep cervical fascia. The muscle fibres of the trapezius m. run horizontally at this level (these are involved in lateral flexion of the neck) whereas the fibres of the erector spinae run in a longitudinal sense and are thus seen here as a horizontal section (involved in retromotion of the neck). 6) In the superficial cervical fascia there is an intermediate layer of fibres between two layers of fatty connective tissue.

Golgi tendon organs. It unites with deep fascia by way of the intermuscular septa (n.b. see formation of segmentary cc(s)), the aponeuroses and the tendons (n.b. the tensional fibres that are involved in the myofascial sequences and the myofascial spirals).

Microscopic structure of the fascia

Figure 8, enlarges the three layers of the fascia in order to analyse its various components.

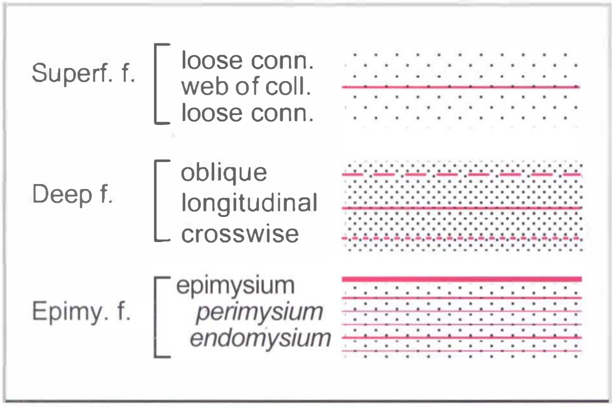

Figura 8. Three layers of the fascia; in superficial fascia: collagen fibres (red) within loose connective tissue; in deep fascia: three distinct directions of collagen fibres within ground substance; in epimysial fascia: collagen fibres within muscular tissue.

The tissues illustrated in the above scheme will now be examined in photographs taken from the microscope.

These histological photographs have been obtained thanks to the collaboration of the Institute of Anatomy Pathological and the Orthopaedic-Traumatology Clinic of the University of Padova, Italy.

A segment of dermis with relative underlying soft tissues has been sectioned from the left, anterior part of the neck, close to the median line in each cadaver. The diverse fascial structures were then isolated, with particular attention having been paid to the removal of muscle tissue from the prepared section. In this way small parts of the superficial fascia, the deep fascia (superficial lamina) and the epimysial fascia of the sternocleidomastoid were obtained. These preparations were immediately fixated in neutral formalin 10% dilution, then enclosed in paraffin and lastly, stained with the following substances:

- Haematoxylin-eosin
- Weigert's Fuchsine-resorcinol to highlight the elastic fibres;
- Van Gieson to highlight the collagen fibres;
- S 100, the immuno-histochemical stain specific for nerve structures

In this way the histology of the different fasciae could be evaluated, with the possibility to identify both structural and innervative diversities.

In the superficial fascia (Figure 6) numerous adipose cells are present together with a web of collagen fibres and a central lamina[4].

Within the ground substance of the deep fascia elastic fibres and, above all, undulating collagen fibres are found (Figure 9). These fibres can be aligned, within the same fascia, on different planes and in three distinct directions: a) crosswise, according to the traction of the segmentary myofascial units; b) longitudinal, conforming to the traction of the myofascial sequences; c) obliquely, in a spiral formation (Figure 10).

When nerves pass through the deep fascia they are surrounded by loose connective tissue in such a way as to not be subjected to traction when the fascia lengthens. However, when these nerves terminate in the neuroreceptors (e.g. free nerve endings) then they are directly inserted into the collagen fibres (Figure 11)

The epimysium lies beneath the deep fascia and in some areas it glides freely and in others it unites to the deep fascia itself[5]. It is preferable to call this tissue "epimysial fascia" in as much as it is formed by undulated collagen fibres and elastic fibres, similar to those of the deep fascia[6] (Figure 12).

---

[4] The subcutaneous zone can be divided into two layers: superficial layer, hypodermis, and a deep layer. In the first the bundles of collagen fibres form a loose web and its trabeculae , retinaculae, are more or less perpendicular to the skin. The retinaculae of the deep layer are mostly in parallel with the skin. Between the two layers the retinaculae densify to form a true lamellar fascia, fascia superficialis, which in certain regions separate the two layers and in other regions lacks altogether and the two layers are thereby continuous. (Fazzari, 1972)

[5] Fascial Sheaths. Since the attachment of many muscles is from the deep surface of the fascia, and since each muscle is invested by a fascial sheath, the fascia and the muscles are treated together. (Basmajian JV, 1993)

[6] Muscle is invested by a dense connective tissue sheath, the epimysium. Connective tissue septa, or perimysium, detach from the epimysium penetrating between the muscle parts, subdividing it into bundles. Fine connective tissue septa detach from the perimysium to surround the single muscle fibres. (Monesi, 1997)

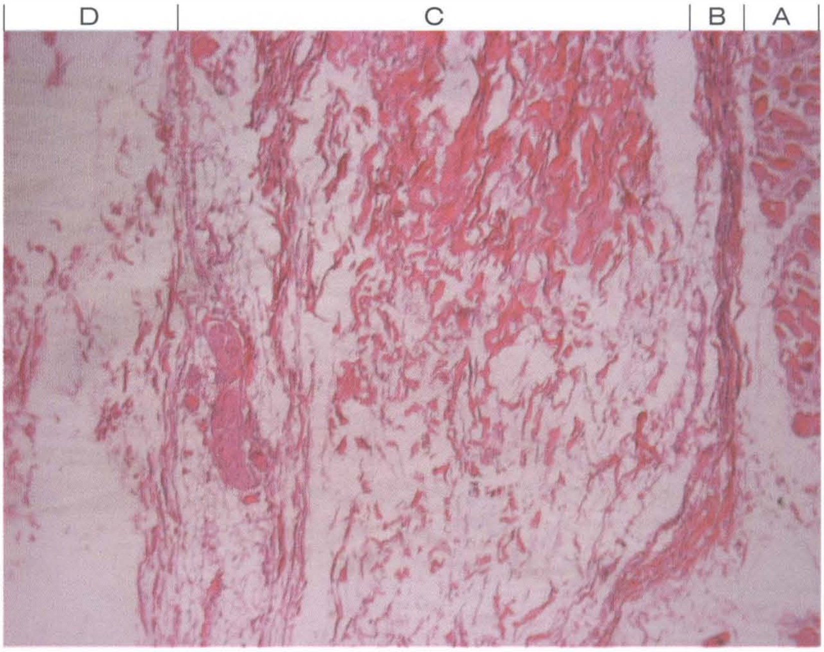

Figure 9. Deep fascia (EE x 120). Proceeding from right to left in this image the following structures can be identified: a small layer of muscle tissue (A), the epimysial fascia (B), a large layer of deep fascia with collagen fibres (C), lastly a portion of superficial fascia with numerous adipose cells (D).

Figure 10. An enlargement of a portion of the deep fascia highlighting the arrangement of the collagen fibres (Van Gieson and Weigert x 300). The collagen fibres are seen as brick red whereas the elastic fibres are black. The collagen fibres are grouped together in bundles arranged in longitudinal, oblique and transverse directions. The fibres in all of the bundles are undulated so that they can be stretched within physiological limits. The elastic fibres are very fine.

The difference between the two fascia is, above all, in their thickness. The epimysial fascia must be very fine in order to allow it to adapt to the stretch of the endomysium and of the muscle spindles.

The cell from which the collagen fibre originates, that is the fibroblast, will now be taken into examination.

In Figure 13, the complexity of a single bundle of collagen fibres of the deep fascia is highlighted. A collagen fibre is formed from collagen fibrils united by reversible and irreversible links[7]. Each

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[7] By using enzymatic digestion, it was found that the proteoglycan filaments contribute to the viscoelasticity of the ligaments. They provide transverse reversible links between the collagen fibrils. (Yahia, 1988)

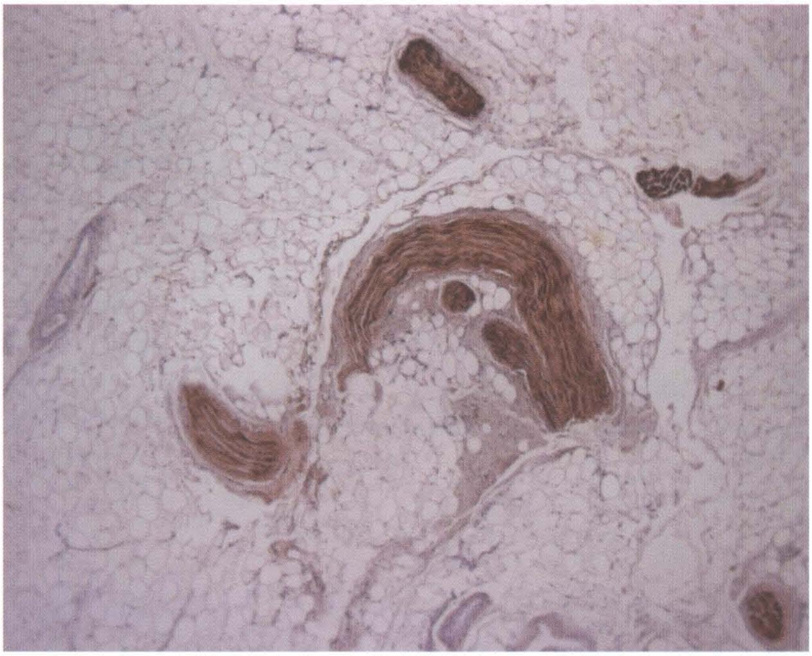

Figure 11. A nerve within the fascia (S 100 x 120). In this photo an axon encircled by a layer of adipose cells can be seen. The other three nerve fibrils are less insulated and are in close contact with the collagen fibres.

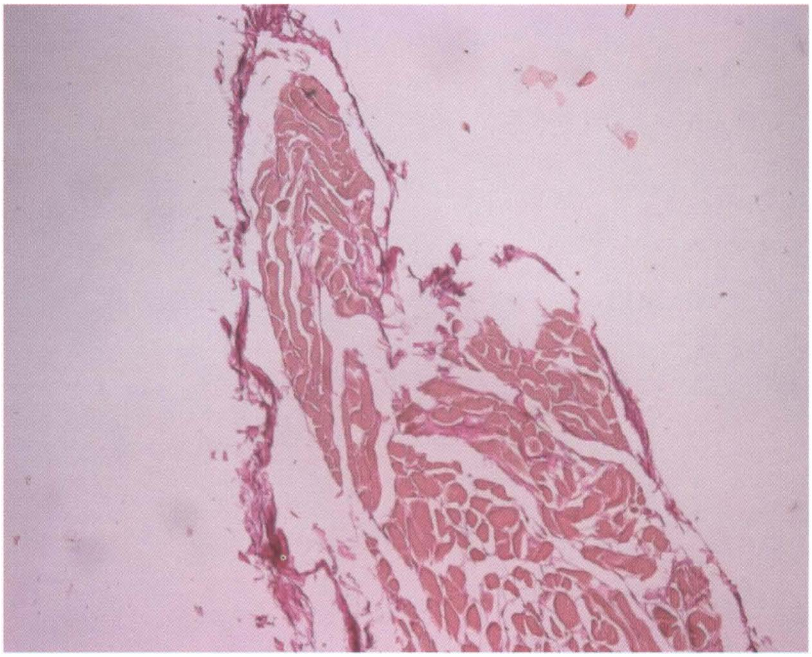

Figure 12. Section of muscle invested by its epimysium (Van Gieson and Weigert x120). The muscle fibres (pale red) encircled by endomysium are visible. Groups of muscle fibres are surrounded by perimysium, which in turn connects with the most external layer or epimysial fascia. Within this fascia collagen fibres (brick red) and elastic fibres (black) can be noted.

fibril is formed from molecules of tropocollagen united by intermolecular cross-links. These molecules are secreted into the ground substance after being formed by the fibroblasts. Within the fibroblasts these molecules are called procollagen and are formed by several amino acids in a polypeptide chain.

Manipulation does not act at this microscopic level, whereas it can intervene in maintaining the fluidity of the ground substance of the deep fascia, in such a way that the bundles of collagen fibres glide independently. It also intervenes in maintaining the fluidity of the epimysium and perimysium so that the various fascicles of muscle fibres can contract at different times.

Fascia is the connecting tissue that unites all

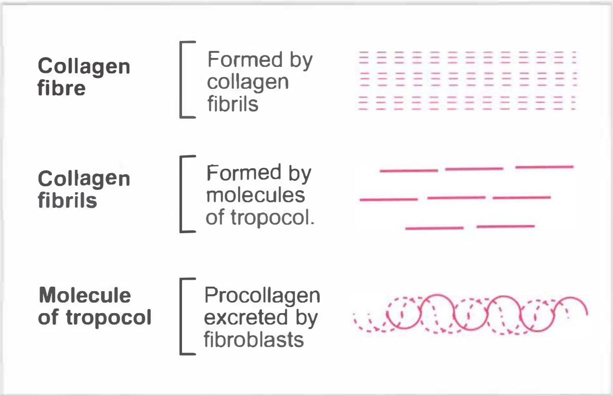

Figure 13. Complexity of a single bundle of collagen fibres.

parts of the musculoskeletal system. It is continuous with ligaments[8], joint capsules and the outer layer of the periosteum. Whilst these structures vary in their denomination and composition (percentage of collagen or elastic fibres), together they form the so-called soft tissues.

It is more precise, therefore, to use the term *fascial system*, to be considered as a system of fibrous connective tissues that influence one another reciprocally throughout the whole body. In Fascial Manipulation it is this interaction of the fascial system that provides the basic principles for the global treatment of the musculoskeletal apparatus.

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[8] Although ligaments in general have traditionally been viewed simply as mechanical structures, there is much evidence to show that they are well innervated with both simple free nerve endings and encapsulated mechanoreceptors. It is thought that this innervation provides proprioceptive information, which ultimately contributes to muscle coordination around joints, designed to increase stability and prevent damage. The sensory input influences gamma motor neurone output and subsequently affects spindle afferent discharge. (Jiang H, 1996)

PART I

THE MYOFASCIAL UNIT

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Chapter 1
THE ANATOMY OF THE MYOFASCIAL UNIT

A myofascial unit (mf) is composed of a group of motor units that move a body segment in a specific direction, together with the fascia that connects these forces or vectors. The myofascial unit (mf) is, after the motor unit, the structural basis of the locomotor system.

The nervous component of these two base elements (mf unit and motor unit) will be studied later in this book, together with the physiology of the neuro-myofascial unit (nmf). A centre of coordination (cc) that synchronises the motor vectors and a centre of perception (cp), which perceives the joint's movement, can be found in the fascia of each mf unit.

These two focal points (cc and cp) act as peripheral references for the nervous system: the first interacts with the muscle spindles and the second provides information to the various joint receptors about the directional significance of each movement.

The structure of the myofascial unit

Movement at each joint of the body is coordinated by six unidirectional mf units (Figure 15). The following components are found in each mf unit:

- monoarticular and biarticular muscle fibres that are partially free to slide in their fascial sheaths;
- deep muscle fibres that transfer their tension to the superficial fascial layers via the endomysium, the perimysium and the epimysium;
- some muscle fibres of the agonist mf unit that are attached to the fascia of the antagonist mf unit.

These components will now be examined in more detail:

Mono and biarticular fibres

Muscle physiology cannot be understood only by studying the external appearance of each muscle (i.e. biceps brachii muscle has two heads and triceps three heads etc.) without taking into consideration their fascial connections.

Biceps brachii, for example, is a biarticular muscle that participates in flexion of the humerus (shoulder) and the cubitus (elbow). The brachialis muscle is a monoarticular muscle that participates in flexion of the cubitus (elbow) (Figure 14).

The posterior part of the upper arm has a similar structure: the long head of the triceps muscle is

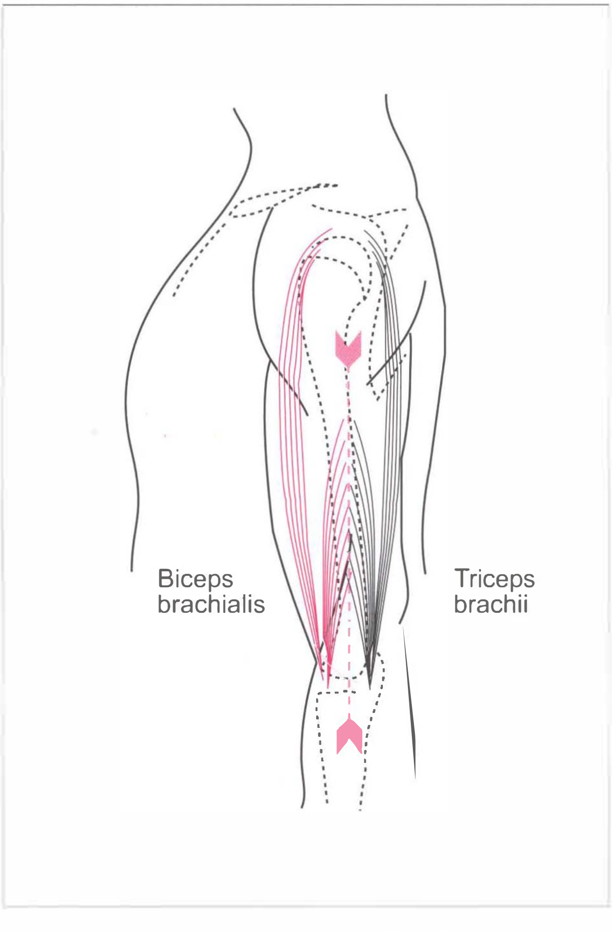
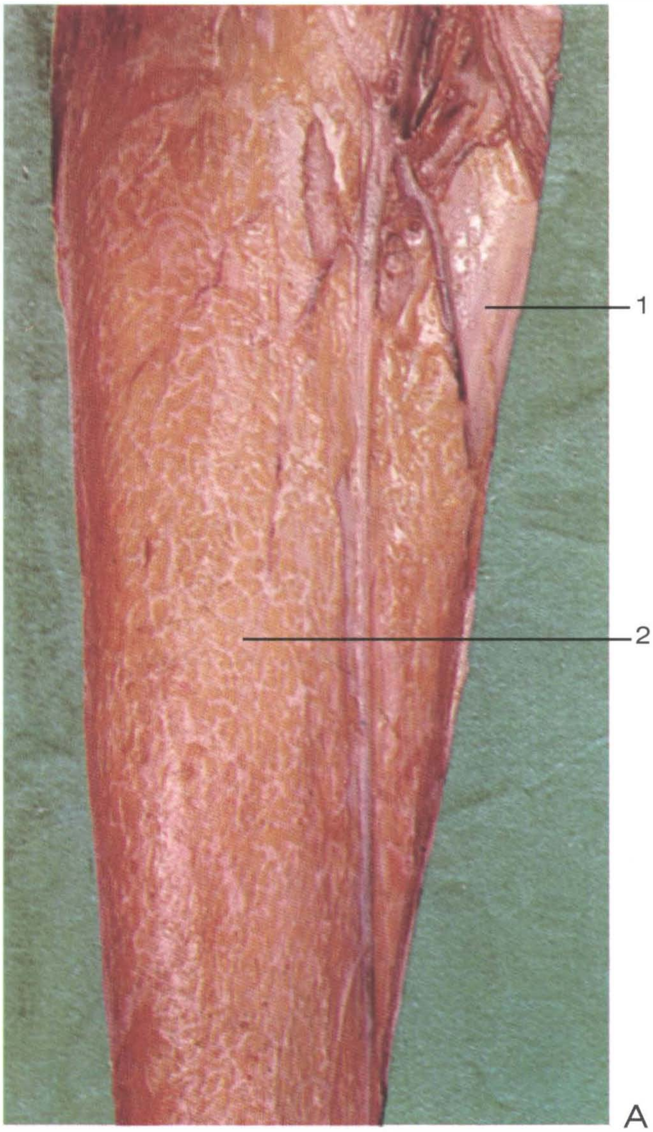


Figure 14. Monoarticular and biarticular fibres.



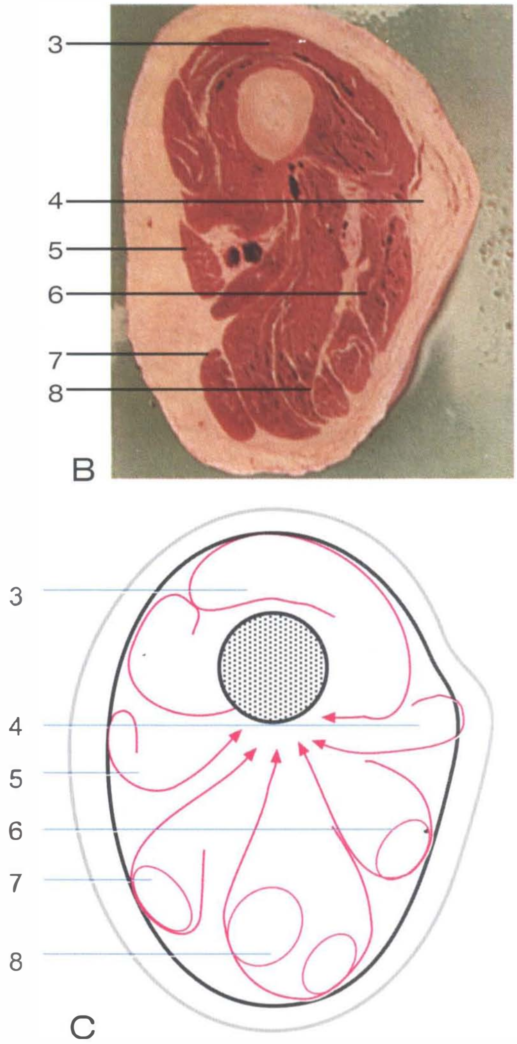
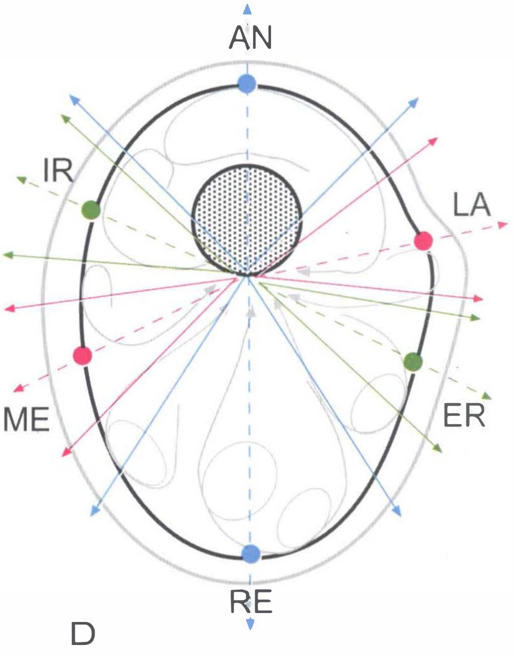


Figure 15. A - Subcutaneous layer of anterior thigh region; B - horizontal section of the thigh (Fumagalli - Colour photographic atlas of macroscopic human anatomy - Published by Dr. Francesco Vallardi/Piccin Nuova Libraria); C - Schematic diagram of fascial compartments of the thigh
A - 1, Fascia lata or deep fascia; 2, subcutaneous adipose tissue or superficial fascia. When the fascia is left intact the muscles are not visible but, without the deep fascia and the epimysium, the motor physiology is not comprehensible. **B, C** - In this section one can see how from the internal layer of the fascia many septa and fascial compartments originate and invest muscular groups that collaborate in the same motor direction. 3, fascial compartment of the quadriceps femoris; 4, compartment of the iliotibial tract of the tensor fascia latae; 5, compartment of sartorius; 6, long head and short head of biceps femoris m.; 7, compartment of gracilis and the other adductors; 8, compartment of semitendinosus and semimembranosus mm. **D**, in this illustration it is evident how the cc's of the mf units of antemotion (AN), retro (RE), latero (LA), medio (ME), intra (IN), and extra (ER) are positioned along the resultant of two vectors.



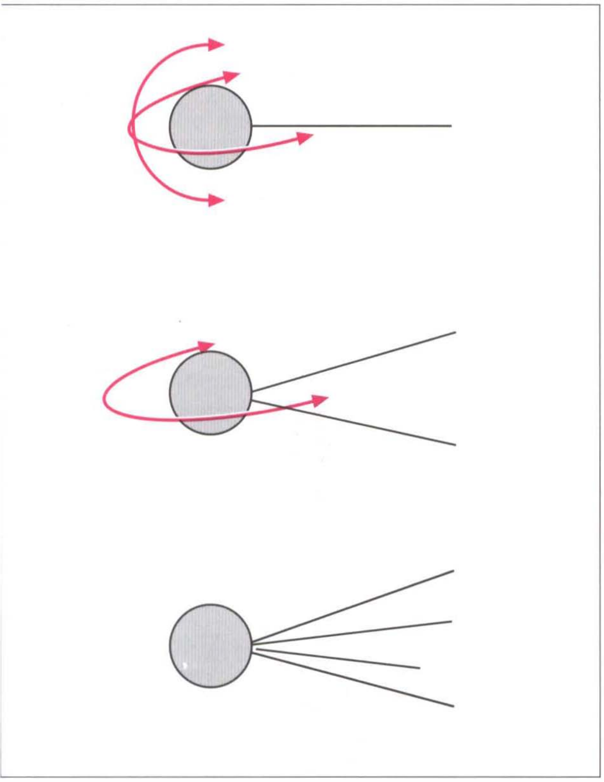


Figure 16. The more fixed the balloon the less it oscillates.

biarticular and it participates in the extension of the humerus (shoulder) and the cubitus (elbow). The lateral and medial heads of triceps are monoarticular and they are active in cubitus (elbow) extension. The short heads of triceps insert into the opposite side of the intermuscular septum from their antagonist, the brachialis muscle.

If this type of anatomical structure were to be found only in the arm then one could assume that it was just a casual phenomenon. However, the same type of anatomical structure is actually repeated in all of the body's 84 mf units.

The movement of the various body segments is well controlled due to the presence of a short vector (monoarticular fibres) and a long vector (biarticular fibres).

To understand this better the example of a balloon tied behind a moving car can be considered. If the balloon is tied with a single piece of string it will move in all directions; if it is tied with two strings it will oscillate in two directions; whereas if it is tied with four strings it will not oscillate at all (Figure 16).

Between the two principal vectors of every mf unit, there are other smaller vectors formed by single muscle fibres that are situated some distance apart[9].This multiplication of vectors allows the mf unit to exert a finer control over the body segment during movement. It is due to the continuity of the endomysium with the perimysium and the epimysium that all these vectors manage to synchronise their actions harmoniously.

Endomysium, perimysium and epimysium

Single muscle fibres are embedded in a delicate connective tissue called endomysium and these fibres are grouped together in fascicles. Fascicles are enclosed by a connective tissue sheath called perimysium[10]. The majority of muscles are made up of many fascicles grouped together and in turn, surrounded by a dense connective tissue, the epimysium.

The connective tissue component in each muscle contains both collagen and elastic fibres and acts as a flexible skeleton or framework that anchors muscle fibres and muscle spindles. This connective tissue is continuous with tendons and its function is to direct and distribute the force of muscular activity.

The continuity of the fasciae from the endomysium surrounding a single muscle fibre, to the epimysial fascia or epimysium, allows for the transmission of muscle spindle contractions from the deeper to the more superficial layers. Likewise, this mf continuity allows for the transmission of passive

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[9] A single motor neurone innervates many muscle fibres that are distributed diffusely throughout the muscle. The location of the single muscle fibres that belong to a motor unit has been determined by prolonged stimulation of a single motor neurone. In this way all the muscle fibres connected to that specific motor-neurone contract. It has been determined that the motor units are recruited in a stereotypical order. This has been confirmed in experiments with animals as well as humans and verified during both reflex and voluntary contractions. (Kandel E, 1994)

[10] The aponeurotic fasciae are part of the interstitial connective tissue of the musculoskeletal apparatus. From their deepest surface they extend septum down between the muscle groups dividing them from one another and finally ending in the perimysium, which covers single muscles. This sheath is intimately connected with the endomysium, which, in turn, surrounds the sarcolemma of the single fibres". (Chiarugi G, 1975) Voluntary muscles are contained within a connective lamina, which has the same structure as the external layer of joint capsules and it also determines the muscle's shape. The underlying muscles slide on this connective tissue surface that is formed mostly by collagen fibres and is called the muscular fascia or epimysium. (Wirhed R, 1992)

stretching of the fascia from the superficial layers to the muscle spindles.

In other words there can be:

- An internal stretch: when a person actively extends his/her arm, the muscle spindles are activated before the actual gesture occurs. Muscle spindles are inserted into endomysium and perimysium therefore these connective tissues are stretched when the spindles contract.
- An external stretch: when a person is pushed from behind the muscle spindles of the erector spinae muscles are stretched. This activates the stretch reflex mechanism causing a muscular contraction[11] that prevents the person from falling.

It is important that this stretch does not become generalised. In effect it requires coordination by means of a specific centre of coordination (*cc*).

In order that this myofascial stretch converges at a specific point of the fascia (*cc*) it is necessary that:

- part of the epimysial fascia is free to slide over the underlying muscle fibres;
- another part of the fascia is anchored to the bone so that the stretches converge in one point;
- another part of the fascia is inserted onto the bone in order to separate the tensioning of one myofascial unit from the successive.

Take for example a tablecloth laid out on a table:

– if the tablecloth is glued to the table then it does not form any creases when pulled;
– if it is fixed at all four angles then the creases converge to the point where the pull is applied;
– if it were not fixed at any point then it would be pulled away completely;
– if it were blocked across the middle of the table then the stretch would be propagated to the middle of the tablecloth.

The three orthogonal projections of the anterior compartment of the arm (see Figure 17) will now be examined in order to explain myofascial anatomy and the fascial attachments to the bone[12].

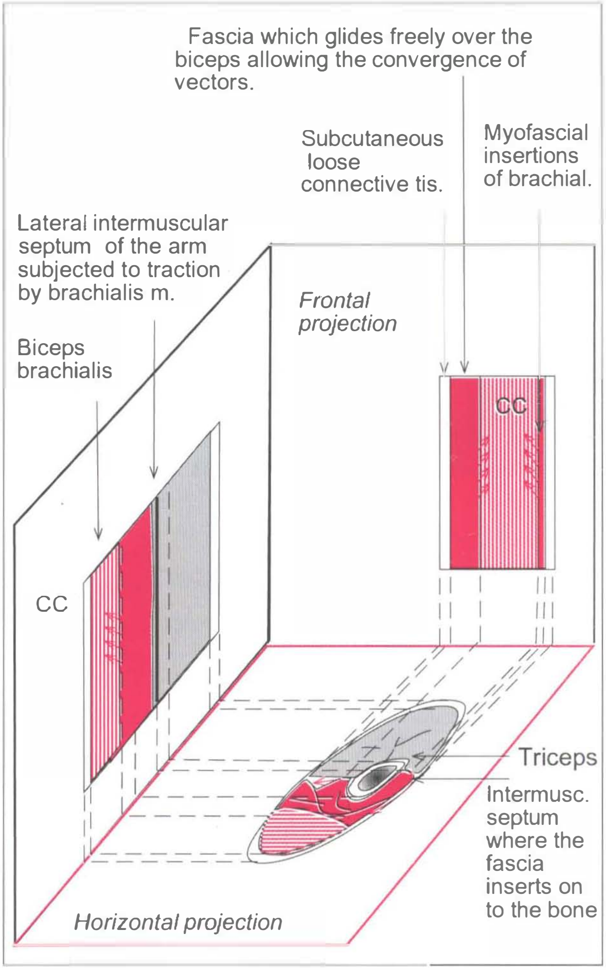

Figure 17. Orthogonal projection of the arm.

The anterior fascial compartment of the arm, as seen in the horizontal projection, surrounds the biceps brachii and the brachialis muscles. The brachialis is partially inserted onto the intermuscular septum whereas the biceps, a biarticular muscle, slides freely within the fascial compartment. In this horizontal projection it is important to note the fascial membrane that separates the biceps from the brachialis.

This membrane allows for differentiated timing in the contractions of the superficial, biarticular fibres with regards to the deeper, monoarticular fibres. The posterior fascial compartment contains the mf antagonist, the triceps muscle (grey part). The lateral and medial heads of triceps are inserted into the posterior part of the respective intermuscular septum.

The most external layer, as seen in the frontal projection, is the subcutaneous loose connective

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[11] Motor unit contractions are not only caused by impulses from the pyramidal and extrapyramidal pathways, which stimulate motorneurones, but also via efferent gamma impulses resulting from the stretch reflex mechanism. (Licht s, 1971)

[12] The inner surface of the epimysial fascia of the arm rests on the underlying muscles and extends a rather insignificant connective sheath to each of them. Apart from these extensions to the muscles the inner surface of the fascia gives rise to two strong, fibrous septa known as the medial and lateral intermuscular septum, which insert onto the humerus. In this way the cylindrical cavity formed by the fascia of the arm is divided into two compartments. (Testut L, 1987).

tissue, which tends to hide the tensional play of the muscles on the fascia to the naked eye (Figure 15). The next layer represents the insertions of the brachialis on the intermuscular septum. When the brachialis contracts tensional vectors form and these are represented by the small arrows. It is the fascia that synchronises muscular activity, ensuring that the fibres inserted onto the medial septum are coordinated with the fibres inserted onto the lateral septum. The middle layer represents the part of the fascia that slides freely over the biceps, allowing for the previously mentioned vectors to converge at the centre of coordination (*cc*).

In the sagittal projection, the insertions of the brachialis onto the intermuscular septum are highlighted, as well as the formation of fascial vectors from the fibres of the flexor muscles of the elbow. In the posterior part of the septum, the lateral and medial heads of the triceps muscle have the same insertions on to the septa, only in the opposite direction.

Table 1. Old/new terminology used for movement

Upper limb movem.	Trunk move-ments	Lower limb move-ments	New FM Terms
Flexion	Flexion	Ankle dorsiflexion	Ante-motion
Extension	Extension	plantar flexion.	Retro-motion
Adduction		Ankle inversion	Medio-motion
Abduction	Lateral flexion	eversion	Latero-motion
Radio-ulnar Supination	Rotation	Hip external/ Internal rotation	Extra-rotation
Pronation			Intra-rotation

Table 2. Spatial planes and directions of movement

Sagittal plane		*Frontal Plane*		*Horizontal Plane*	
Ante	**AN**	**Medio**	**ME**	**Intra**	**IR**
Retro	**RE**	**Latero**	**LA**	**Extra**	**ER**

Terminology of the myofascial unit

Each mf unit is comprised of several motor units in one, or more, muscles, the overlying fascia and the corresponding joint that is moved by this structure. Obviously this group could not be named according to the muscles involved and hence a new, innovative terminology has been applied. *The name of each mf unit is formed by the initials of the movement that it performs and from the initials of the body part it moves.* For example, the mf unit of antemotion of the foot is abbreviated into an-pe (pe=pes=foot). This unit comprises the muscles that carry out the movement of antemotion, the relative fascial part and the joints of the foot involved in the forward movement. Normally, in anatomy, this movement is defined as dorsiflexion of the foot however the same direction of movement when referring to the knee is called extension and flexion when referring to the shoulder. The numerous terms used to define the movement of body parts have been simplified into a common terminology. These terms are not related to the joint movement itself but to the movement of the body part in the three planes (Table 1).

In the second table you will find the abbreviations used both for the direction of movement of the body part as well as for the localisation of any pain (Table 2).

This change has two positive aspects with regards to the practice of FM:

- the continuity between the unidirectional sequences becomes immediately comprehensible;
- when we note the site of pain then the mf unit requiring treatment is instantly apparent e.g. a pain in the anterior part of the foot is noted as "pe an".

On the sagittal plane the forward movements of all body parts are called *ante* and are abbreviated as *an*. Any movement of a body part in a backwards direction is called *retro* (*re*). On the frontal plane medially directed movements are called *medio* (*me*) and laterally directed movements are called *latero (la)*. On the horizontal plane, the combination of movement towards the ante-medial part of the body is called *intra* or intrarotation (*ir)* whereas movement towards a retro-lateral direction on the horizontal plane is called *extra* (*er*).

The initials of the body segment/articulation involved in each mf unit make up the remaining part of the unit's name. Once again Latin terms have been chosen as they are used internationally (Table 3). When used alone these terms mean a joint or bone but when associated with a motor direction they mean an arthro-myo-fascial functional unit. In Table 3, the third column describes the

Table 3. Names of the body parts

Abbr.	*Latin Term*	*Corresponding to*
SC	Scapula	Scapula-thoracic and clavicular joints + trapezius, serratus ant., rhomboids
HU	Humerus	Glenohumeral joint + deltoid, biceps, supraspinatus mm.
CU	Cubitus	Elbow joint + brachialis fascia + biceps, triceps, brachioradialis
CA	Carpus	Radio-carpal joint, + extensor carpi radialis and ulnaris mm.
DI PO	Digiti Pollex	Intercarpal and interphalangeal joints + interossei of the hand
CP	Caput	Cranial bones and TMJ + Recti mm. of eye, temporalis muscle
CL	Collum	Cervical vertebrae + cervical fasciae + ileocostalis cervicis...
TH	Thorax	Thoracic and sternocostal joints + Ileocostalis thoracis, pectoralis m.
LU	Lumbi	Lumbar vertebrae + fascia + ileocostalis lumborum, rectus abdominis
PV	Pelvis	Sacroiliac, pubic joints + glutei, oblique, rectus abdominis mm
CX	Coxa	Hip joint, thigh + obturator internus, pectineus, piriformis.
GE	Genu	Knee joint + fascia lata + quadriceps femoris, biceps femoris mm.
TA	Talus	Ankle joint (talotibial), fascia of the lower leg, gastrocnemius, tibialis mm.
PE	Pes	Inter tarsal, Phalangeal joints .+ fascia + interossei mm of the foot

overall significance of each segment. By associating these initials with a direction then the specific zone of each mf unit is further defined.

The term ante-cubitus (an-cu), for example, refers to all of the muscles of the arm and the forearm that move the elbow joint forward.

The combination of a body segment together with a motor direction, not only defines the name of the mf unit but also assists in the precise definition of the location of pain, hence the selection of the mf unit(s) involved in a specific dysfunction. The schematic diagrams of the anterior and posterior mf units (Figure 18, Figure.19) contain several circles each of which outlines a specific mf unit whose name is indicated by the initials placed nearby. For example, the circle around the foot (pe) includes the joints and the various bones of the foot, as well as the intrinsic muscles, all of which move as a functional unit rather than independently from each other. During antemotion or retromotion of the foot (pe) there is a reciprocal adaptation occurring between the heel and the toes. The same occurs with the small muscles of the foot as they do not intervene singularly, but act together in groups. During ante or retromotion of the foot the extensor brevii mm. and the flexor brevii mm. act together as a functional unit.

Each muscle group of the hand and the foot, as well as each group of motor units of the greater muscular masses, is coordinated by a specific centre of coordination (*cc*), which determines the harmonious execution of all movements. Each circle designed on the anterior of the body encompasses the *cc* of the mf units of ante (an), medio (me) and intra (ir). Each circle designed on the posterior of the body encompasses the mf units of retro (re), latero (la) and extra (er).

The circle around the tarsus indicates the mf unit (ta) and comprises the ankle (talotibial) joint, the two malleoli and all of the muscles that move the tarsus in the three spatial planes. The mf units that move the knee (ge) extend from the proximal third of the thigh to the proximal third of the lower leg. They include the two heads of the gastrocnemius muscle, which intervene in the retromotion of this joint. The mf unit of the hip (cx) extends from the inguinal ligament anteriorly to the sacrotuberous ligament posteriorly and includes the proximal third of the thigh.

The mf unit of the pelvis (pv) extends from below the umbilicus to the pubis anteriorly and from the iliolumbar ligament to the urogenital diaphragm posteriorly.

The lumbar mf unit (lu) extends from the inferior thoracic outlet to the umbilicus and from the first lumbar vertebra to the fifth.

The thorax (th) comprises the rib cage and the thoracic vertebra with the exception of the muscles that move the scapula and the humerus.

The mf unit of the neck (cl = collum) extends from the seventh cervical vertebra up to the occipital area posteriorly and anteriorly up to the chin, together with the corresponding voluntary muscles.

The posterior circle around the mf unit of the scapula (sc) encloses the medial border of the scapula together with the muscles (trapezius, levator scapula, rhomboids), which move it backwards (re), upwards (la) and in extrarotation (er); the anterior circle encloses the clavicle with the muscles (pectoralis maximus and minimus, subclavius) that move the shoulder girdle forwards (an), downwards (me) and in intrarotation (ir).

The mf unit of the humerus (hu) comprises the glenohumeral joint and the muscles from the scapula, the thorax and the proximal third of the arm that move this body part in the three spatial planes.

The circles around the cubitus (cu) enclose most of the biceps (an) and the triceps (re); part of the

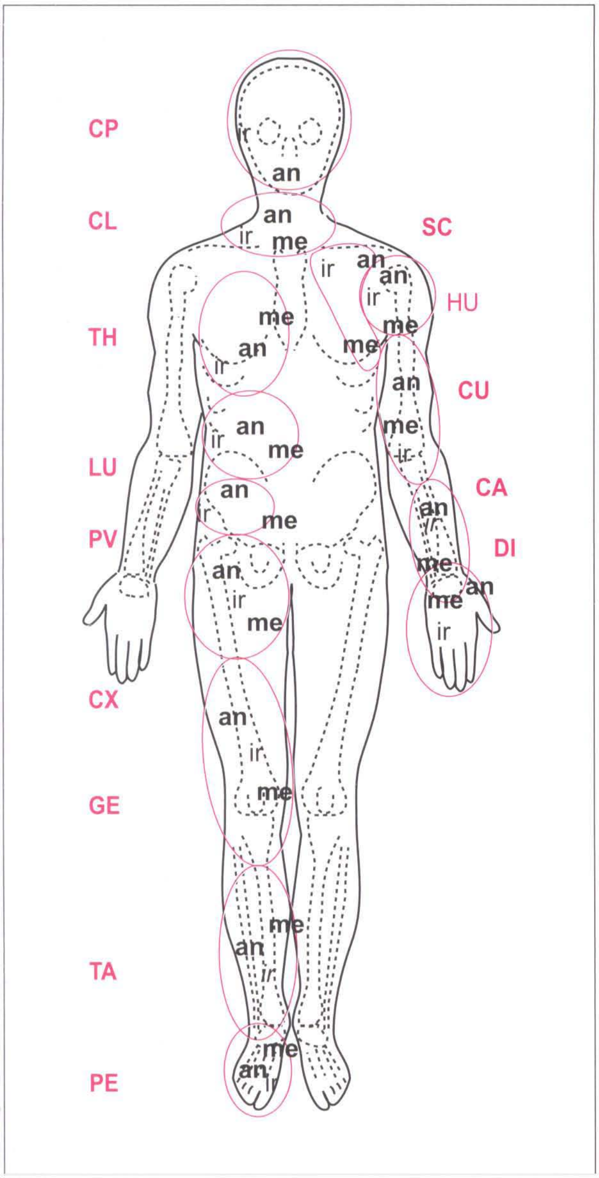

Figure 18. Mf unit of the anterior part of the body.

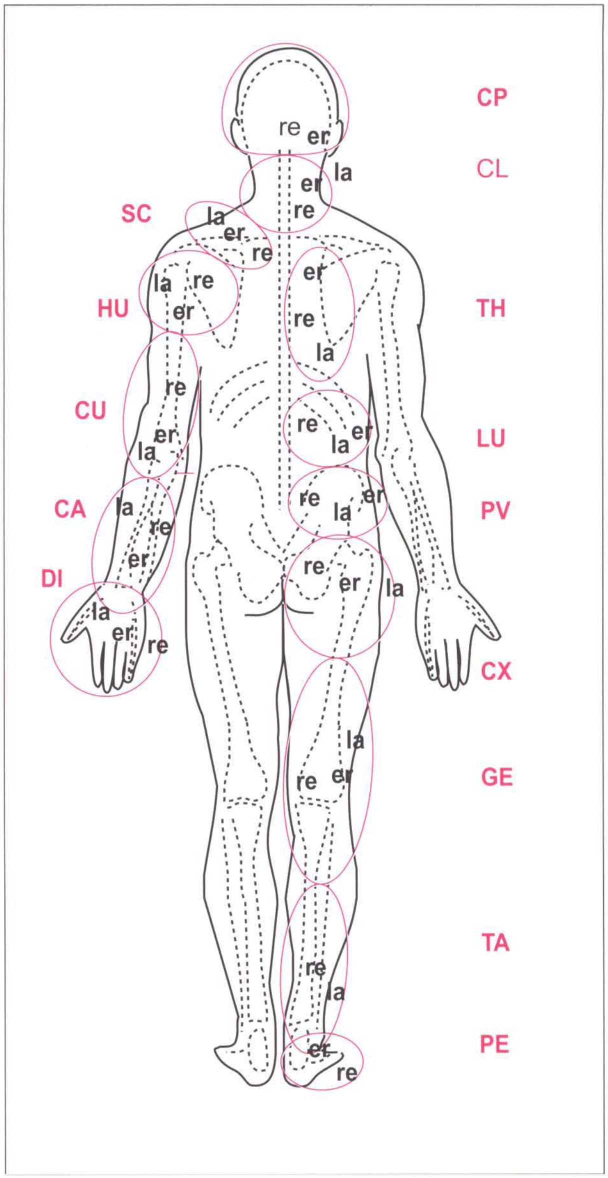

Figure 19. Mf unit of the posterior part of the body.

forearm, with the muscles that fixate the elbow during latero (la) and mediomotion (me), is included.

The mf unit of the wrist (ca) includes the wrist joint and the portion of forearm muscles that act upon this joint.

The mf unit of the hand includes the fingers (di) and the thumb (po): this distinction is required due to the independence of movement of the thumb in relation to the fingers. Whilst voluntarily we are capable of individual finger movements, during reflex gestures the fingers always move together. The mediomotion, or adduction, of the last four fingers is carried out by the palmar interosseous muscles, which are united by the deep palmar fascia. Lateromotion, or abduction, of the same fingers is carried out by the dorsal interosseous muscles, which are united by the deep dorsal fascia. Both of these fasciae have a centre of coordination for these two motor directions.

The myofascial unit: agonists and antagonists

The group of muscles that contract to provide the force required to produce movement are called ago-

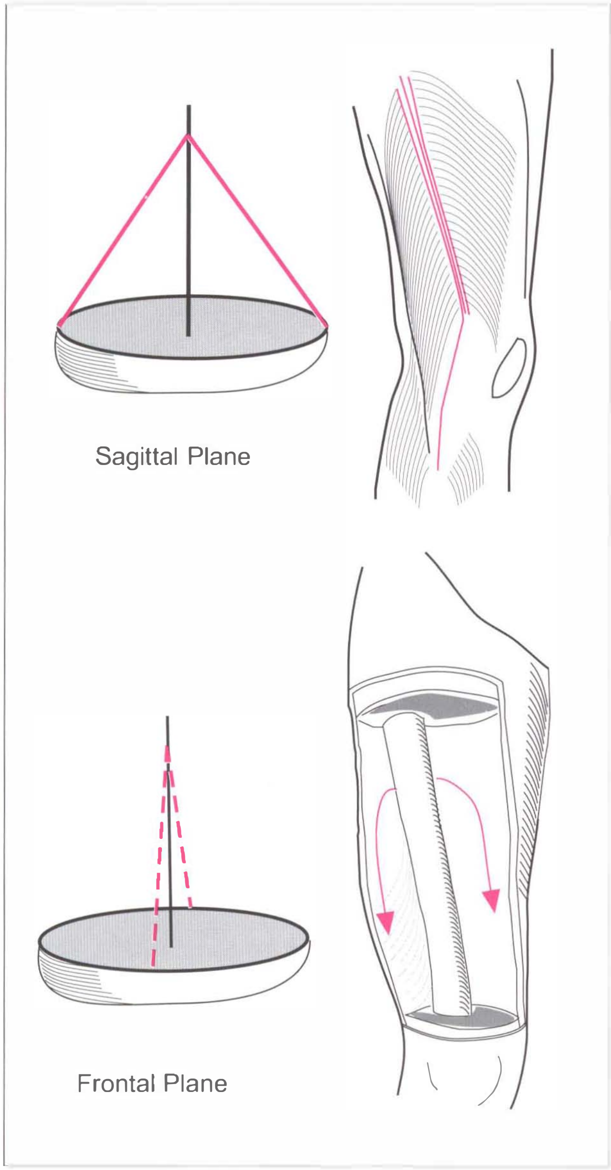

Figure 20. Sailing boat rigging and fasciae of the thigh.

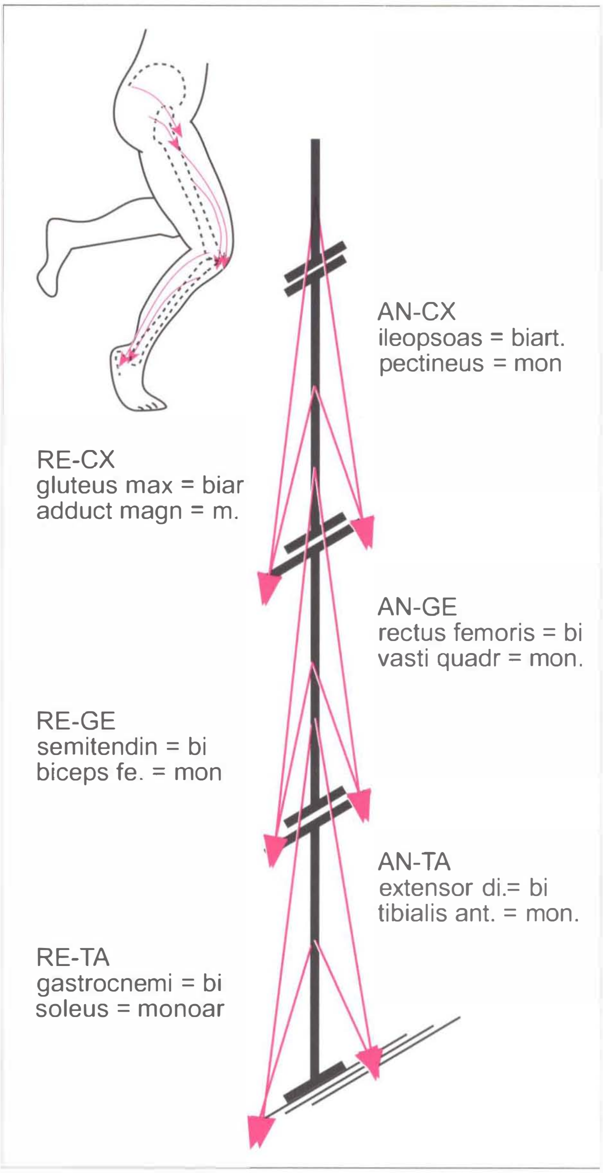

Figure 21. Vertically placed segments stabilised on the sagittal plane.

nists. The muscles whose action opposes that of the agonists are called antagonists.

This anatomical arrangement is found, even more precisely, between the mf units. Every mf unit that moves a body part towards a given direction on any plane has a corresponding mf unit that moves that part in the opposite direction on the same plane.

A mf unit is only capable of contraction therefore the antagonist mf unit must intervene actively to bring a body part to its neutral position or starting point. Through the study of the physiology of the mf unit it will be demonstrated how the fascia is involved in reciprocal inhibition. In this first part, the fascial connections between all of the agonist and antagonist mf units, from an anatomical viewpoint, will be verified.

If the mast of a sailing boat is compared to the femur in a thigh the following similarities can be noted (Figure 20):

- on the sagittal plane the mast is held in a vertical position by the cords from the stern and the bow; in the same plane the femur is held in a vertical position by the vasti of the quadriceps and the biceps femoris;

- on the frontal plane the mast is held vertically by the lateral cordage and the femur by the lateral and medial intermuscular septa.

The intermuscular septa and the epimysial sheaths probably play a direct role in the regulation of the muscular fibres of the two mf units. In fact, whilst the mast of a sailing boat remains in one position, a thigh actually moves through space. The agonist mf unit is activated during movement (albeit forwards, backwards or sideways) and the antagonist mf unit adapts (reciprocal inhibition) according to the angle of inclination of the body part.

In the human body not only one part is held vertically but a combination of many bones to be maintained in position, in different planes. At this point the necessity for biarticular fibres in every mf unit becomes evident (Figure 21). The monoarticular fibres stabilise the body segment whilst the biarticular fibres modify the position of the upper part in relation to the underlying part.

Neither the single muscle fibres nor the CNS alone would be capable of coordinating this type of adjustment. The muscle fibres do not have a fixed dimension and as far as the CNS is concerned, there are too many variables that would need to be controlled. The fascia has a fixed dimension but one that is adaptable to joint range hence it is the only structure truly suitable for this type of coordination and control.

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Chapter 2
THE EVOLUTION OF THE MF UNIT

In the previous chapter it was explained how each joint is controlled by six myofascial units, two for each plane of movement. In this chapter we will examine how this structure of the musculoskeletal apparatus has formed throughout evolution.

The evolution of movement on the three planes

According to the theory of evolution the frontal plane was the first plane of movement to be mastered[13], lateral flexion being the most suitable type of motion for aquatic environments.

Coelenterates (polyp, jelly fish) move through water by means of contractions of their myoepithelial cells. They generate an adduction/abduction movement of the whole body, which is useful for filtering water and capturing nutrients as they move.

The body parts of these animals are all identical[14] and their movements have no specific direction (Figure 22).

The body of the annelid has a posterior and an anterior part and it also possesses a cerebral ganglion which controls all its identical metameres. Whilst the contraction of the annelid's body is still that of adduction/abduction, its motion follows a trajectory determined by the head of the animal.

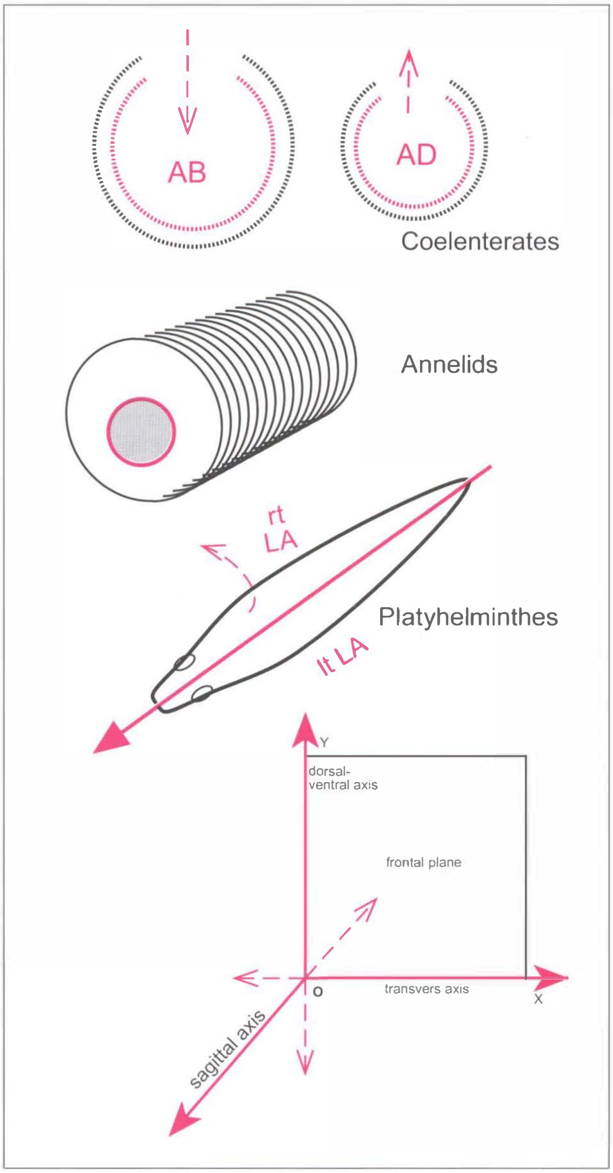

Figure 22. Annelids and platyhelminthes move along a sagittal axis.

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[13] In the myotome the first voluntary muscle fibres to differentiate themselves are those parallel to the notochord, hence, when they contract they flex the same side. This alternation between the two sides gives rise to an undulating motion, which is the first type of movement that an embryo performs. (Chiarugi G, 1975)

[14] Coelenterates are formed by two layers of cells, external (ectoderm) and internal (endoderm), divided by a gelatinous layer called mesogla. Coelenterates have a nervous system but there are no signs of any central control. Regardless of the area dissected, a coelenterate always maintains the same characteristics. This type of body structure is called radial symmetry. In water these animals are sessile, or fluctuating". (Stefanelli A, 1968)

The platyhelminthes[15] and the metazoan (arthropods) possess a bilateral symmetry and a musculature derived from mesoderm. These animals exploit their body's symmetry by using alternating contractions to move through their environment. They move in a posterior-anterior direction along a sagittal axis due to lateral flexion movements executed on a frontal plane.

The cephalochordata and the cyclostomes[16] or petromyzons (lamprey), are primitive chordates that possess a notochord or sustaining, connective apparatus.

Whilst their principal motion continues to be that of lateral flexion, their movements are more potent due to fact that:

- the notochord provides a point of leverage of a certain consistency for the muscles, allowing them to develop strength;
- the two muscular masses on the left and right sides are divided from each other by a longitudinal septum.

The formation of dorsal fins as a prolongation of this septum adds ulterior stabilisation. This longitudinal septum is stretched to the left, or the right, according to whichever muscular mass is active (Figure 23).

The cephalochordata possess two myofascial (mf) units of lateromotion, which are antagonists to one another. The intermuscular septum acts as the mediator between the opposing forces on the two sides of the body. The fascial myosepta[17], situated between the myomeres, are the elements that unify the synchronised contractions of the unilateral muscle fibres. All of the muscles on one side of the cephalochordata's body act as a mf unit of lateromotion but the resulting movement is imprecise, due to the fact that it is produced by only one vector.

The formation of a transverse septum in some vertebrates (chondrichthyes, selachii), divides the unilateral muscular masses in two, improving the precision of lateromotion[18]. This is an example of how the resultant of two vectors provides for better control of movement (Figure 24, 25). The same principle is found in the combination of forces in each mf unit of the body (monoarticular and biarticular fibres).

The muscles of retromotion of the head (caput) developed from the two dorsal muscular masses, whilst the muscles for antemotion of the head (caput) formed from the ventral musculature. Gradually, as movement on the sagittal plane extended to the whole trunk, the lateral septum divided into two sheets. One sheet connected with the epaxial muscles involved in retromotion and the other to the hypaxial muscles involved in antemotion. The epaxial muscles were enveloped by the compartment of the thoracolumbar fascia and the hypaxial muscles by the compartment of the abdominal fascia[19].

The study of the evolution of movement on the horizontal plane will be considered in another chapter dealing with movement schemes.

The importance of the intermuscular septa with regards to the organisation of the antagonists will now be analysed.

In coelenterates and red sea squirt, or red bait, movement consists of a massive, singular contraction of all of the cells of the body, immediately followed by a complete relaxation, which allows for the body to return to its starting position under the influence of gravity. As this motor strategy is slow the body organised itself into two antagonist mf

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[15] Animals that impart a specific direction to their movements exhibit a bilateral symmetry consisting of a single division running from head to tail, which effectively divides them into identical halves. The platyhelminthes (flat worms) have a body formed by three layers: an ectoderm, an endoderm and a mesoderm. The muscles are derived from the mesoderm. (Stefanelli A, 1968)

[16] In the cyclostomes (agnatha) we find not only septa that divide the body into metameres on the horizontal plane but also a dorsal sagittal medial septum, which joins in the tail with a ventral sagittal medial septum and divides the body into a left and a right half. Thus, the myomeres, which develop between the fascial septa, appear to be continuous from the ventrum to the dorsum. In the lamprey we find two semicircular canals." (Stefanelli A, 1968)

[17] Metamerism consists of the formation of sequential segments – the myomeres down each side of the body correspond to the number of vertebrae. The muscle fibres in each myomere are oriented in an anterior-posterior direction. Only some are connected to the skeleton. Robust laminae of connective tissue called myoseptum are interposed between adjacent myomeres Most of the muscular tissue is inserted into these septa, which work their way internally until they join to the vertebral column. The ribs originate within these septum as well as the intermuscular bones of the teleostei, which provide added support. (Romer P, 1996)

[18] In the gnathostoma a horizontal or frontal septum divides the myomeres into a dorsal epimere and a ventral hypomere. The epimere gives rise to the dorsal, or epaxial, muscles and the hypomere to the ventral, or hypaxial, muscles. The epaxial muscles are innervated by the dorsal branch of the spinal nerves and the hypaxial muscles by the ventral branch. (Stefanelli A, 1968)

[19] The function of the epaxial muscles is to extend or to straighten up the vertebral column and to laterally flex the body. The epaxial muscles are divided into four groups: the intervertebrals, the longissimi, the spinals and the iliocostalis. The epaxial muscles continue on into the cranium as epibranchial muscles. The hypaxial muscles continue on into the mandible as hypobranchial muscles. (Kent GC, 1997)

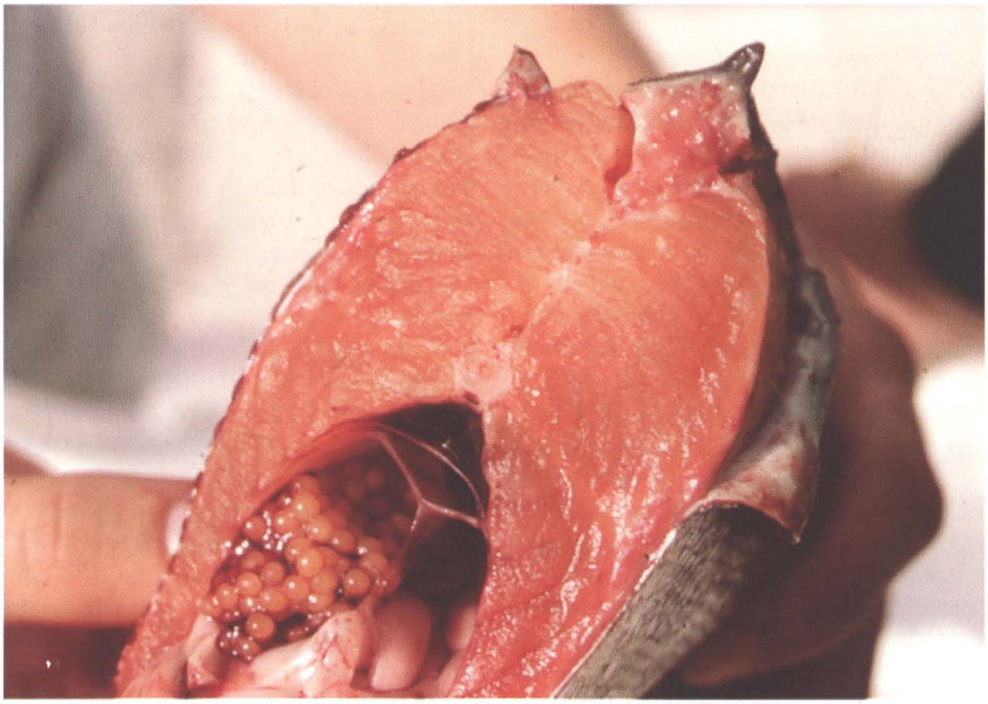

Figure 23. In this transverse section of a trout the longitudinal septum that extends from the vertebra to the dorsal fin is visible. This septum separates the muscular mass into two symmetrical and specular halves. Muscular fibres insert onto this septum; insertion onto an elastic structure allows for the transmission of the contraction of fibres on one side to the antagonist fibres on the opposite side.

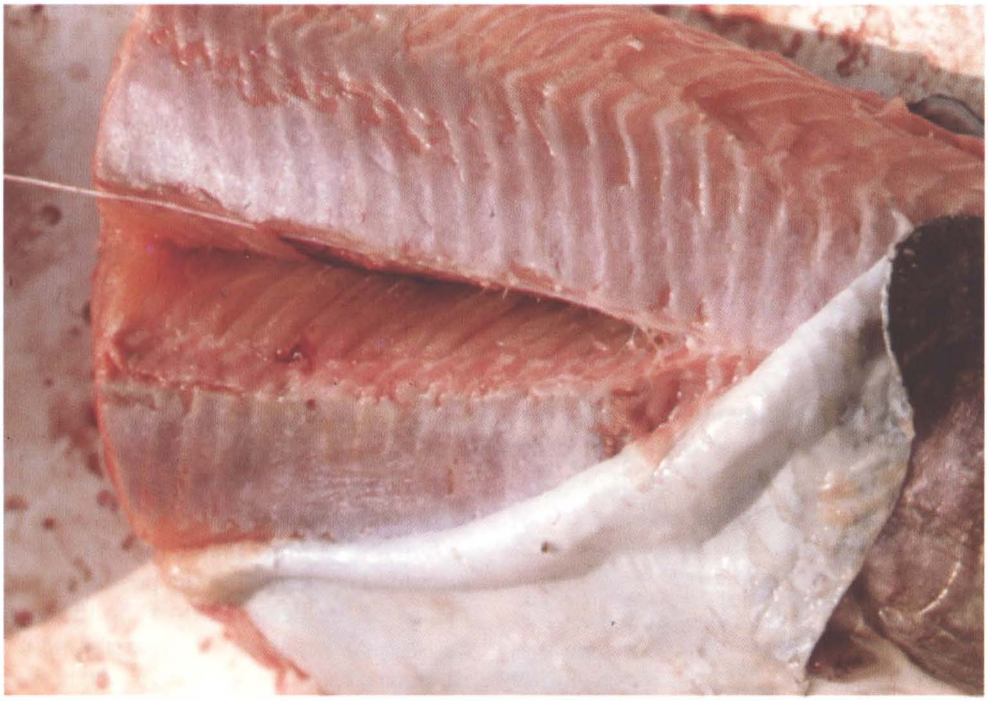

Figure 24. The lateral view of the trout demonstrates: the myosepta interposed between the myomeres and inclined in a cephalic direction; the transverse septum that separates the dorsal musculature (epaxial) from the ventral (hypaxial); the presence of a thin fascial layer that adheres to the muscle fibres.

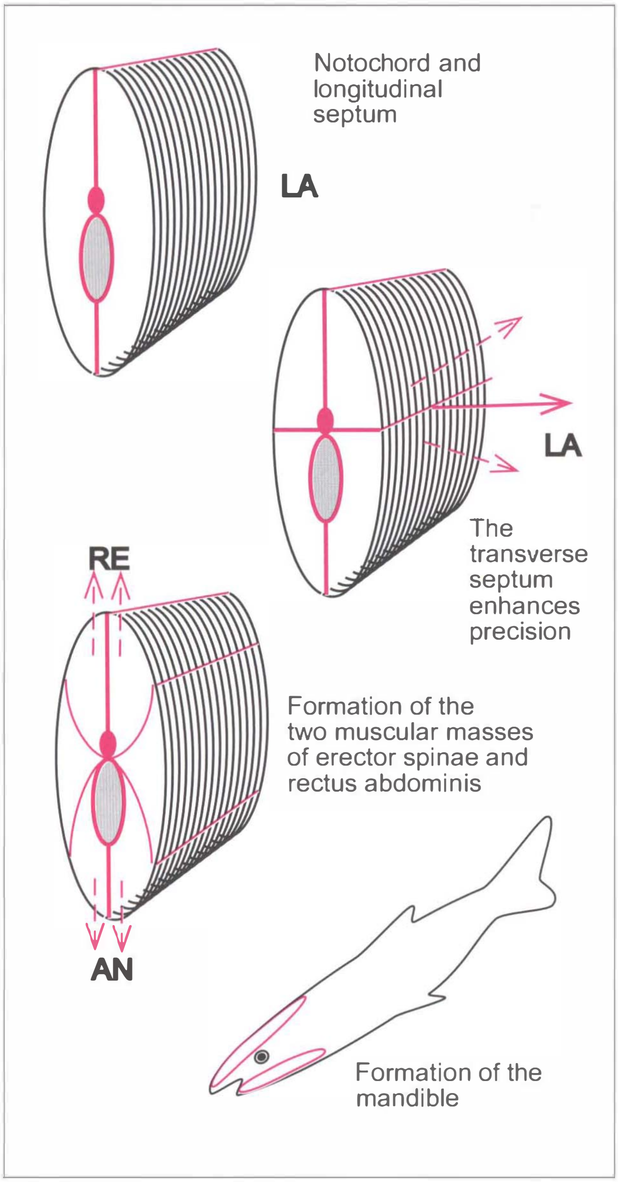

Figure 25. Notochord and longitudinal septum of cephalochordates and transverse septum of chondrichthyes.

units in order to accelerate movement. In this way the identical metamerism of the anellida became divided into two perfectly symmetrical halves, as already found in the cephalochordates[20].

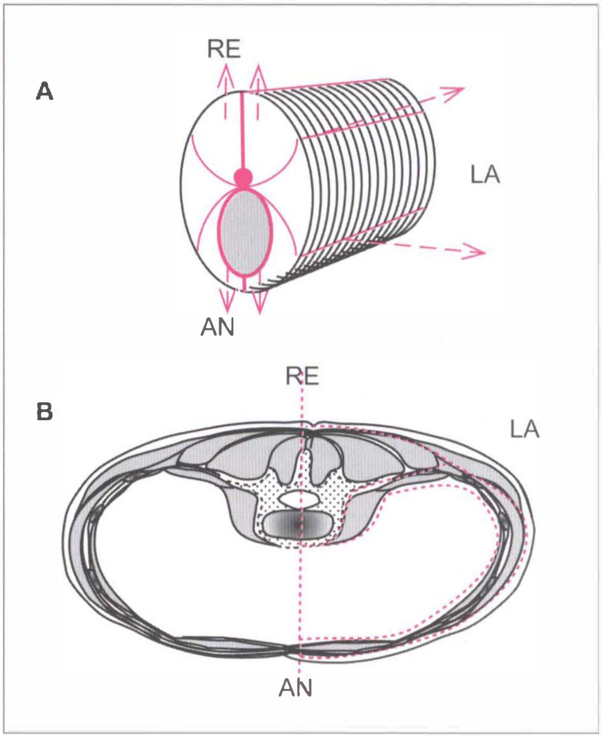

Figure 26. Antagonist activity around the trunk.

The longitudinal septum that divides the two muscular masses for lateromotion in fish, persists in humans as the linea alba in the abdomen and the supraspinous ligament between the spinous processes of the vertebrae. These fascial septa divide the body in two symmetrical halves, which work as antagonists during lateromotion (Figure 26 A).

During evolution of the amphibians, reptiles and mammals, the lateral flexion sequences in question have been subjected to the following changes:

- The use of lateral flexion progressively diminished whilst movement on the sagittal plane increased.
- Progressive atrophy of the lateral flexion musculature ensued as it migrated, mostly dorsally, to become the ileocostalis muscles.

On the sagittal plane the anterior musculature remained connected to the posterior musculature by means of the deep sheet of the thoracolumbar fascia, which separates the erector spinae from the iliopsoas muscle. A second sheet, the transverse fascia, connects the rectus abdominalis to the embryonic hypaxial muscular mass, the iliopsoas (Figure 26 B).

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[20] There is a sagittal connective tissue septum, as well as a connective tissue dermal covering in cyclostomes and cephalochordates. This connective tissue septum dilates centrally to embrace the axis of the skeleton, with the spinal cord dorsally and the main blood vessels ventrally. The transverse connective tissue septa, that form between the myotomes, also insert into this sagittal septum. (Stefanelli A, 1968)

The evolution of segmentary independence

Cyclostomes (lamprey) do not have a mandible. The whole body is an uninterrupted series of identical metameres. In order to achieve independent movement of one segment in relation to another and to interrupt the synergy between all of the metameres, the body has undergone a slow transformation. The mandible was the first segment to become independent from the movement of the rest of the body[21]. Its muscles developed from the first branchial or pharyngeal arch. The masseter, the temporalis and the pterygoid muscles in mammals originated from the adductor of the mandible in the selachian (Table 4). The intermandibular muscle, found at the opening of the mandible, transformed into the anterior digastric muscles in mammals.

The mandible of the shark only moves on the sagittal plane and closes in a jack-knife fashion. Furthermore, to catch its prey, the shark has to move its whole trunk. To economise energy and to get to its food faster it would have been much more advantageous to be able to move its neck separately. For these reason the cervical region was the second segment to achieve independent mobility.

Table 4. Formation of the muscles of the segments

Segments	*Chondrichthyes*	*Humans*
Mandible		
1st. Pharyngeal Branchial Arch	Adductor of mandible	Masseter, temporalis
	Intermandibular m.	Anterior digastric
Neck		
2nd. Pharyngeal Arch (Hyoid)	Elevator Neck Sphincter	Stylohyoid, Stapedius Platysma, Facial mm.
3rd.,4th. Pharyngeal arch	Branchial Constrictor	Cricothyroid Trapezio, scm
Branchial	Branchial Elevator	Trapezius, SCM
Somatic muscles	Epaxial	Longissimus
Myotomes	Hypaxial	Long. cervicis
Shoulder girdle		
Pharyngeal mm	Early Trapezius	Trapezius
Somatic mm.	Epaxial	Rhomboids
	Hypaxial	Pectoralis min.

This group of vertebrates potentiated some muscle fibres of the second, third and fourth branchial arches in order to have more liberty of movement with respect to the trunk[22]. As the neck not only moves on the sagittal plane, but also on the other two planes, some muscle fibres have their origins in the somatic muscles (epaxial and hypaxial), whilst some have their origins from the third branchial arch (cricothyroid) and others from the fourth branchial arch (trapezius, sternocleidomastoid).

The formation of the shoulder and pelvic girdles[23], followed by limb development, will be studied together with the development of the myofascial sequences.

A certain freedom in movement of the thorax, in relation to the lumbar area, was determined by the presence of the limbs. This motor independence interrupted the continuity of the epaxial musculature and led to the formation of the longissimus thoracis, cervicis and lumborum muscles.

From the myosepta to the myofascial unit

The independence of the various segments meant that the myomeres and myosepta were required to align themselves according to new lines of force, thus abandoning metamerism altogether. Previously the entire musculature of a body intervened every time it was moved in any direction or plane, but at this stage each part of the body required its own musculature[24]. In this way six myofascial units, formed by mono and biarticular fibres as well as

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[21] The muscles of the first arch in all vertebrates are principally those that move the maxilla and the mandible. The adductor of the mandible is the strongest muscle of the first pharangeal arch. In mammals this muscle is divided into three separate muscles: the masseter, the temporalis and the pterygoids. (Kent GC, 1997)

[22] In the inferior tetrapods a thin neck sphincter, in the form of a collar, covers the origin of the second branchial arch and adheres to the skin of the neck. In reptiles and birds, this membrane called the platysma, extends dorsally to insert itself under the skin of the cranium. In mammals the platysma expands over the facial area to form the muscles of facial expression. (Kent GC, 1997)

[23] In fish, the muscles of the arches following those of the hyoid are constrictors (dorsal and ventral), levators and adductors that narrow or widen the pharyngeal cavity and the branchial slits. The elevators of the arches form a muscular lamina, which later gives rise to the trapezius and the sternocleidomastoid muscles. (Kent GC, 1997)

[24] A further improvement in the development of the muscular apparatus was determined by the autonomy of movement of the different parts of the skeleton and by the division between the various bundles of fibres that constituted a muscular mass. Muscles, therefore, do not have an individual origin but are rather the end product of the differentiation of a uniform mass. (Chiarugi G, 1975)

muscle spindles, were created for each segment.

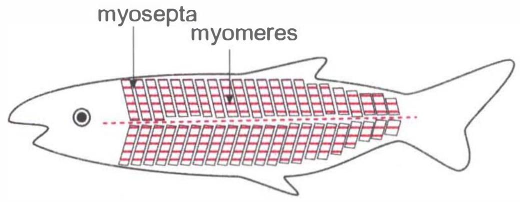
The evolutionary process proceeded in the following manner:

- at first metameres lengthened according to the lines of tension;
- then the myosepta, or metameric septa, in part joined with the unidirectional muscle fibres to form the muscle spindles and, in part, surrounded the entire muscular mass to form the epimysium[25].

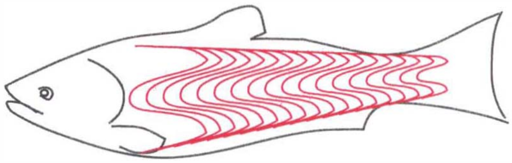
From the observation of this process in bony fishes[26] we find that lateral flexion of the trunk stimulated the myomeres to elongate in a cephalo-caudal sense[27], which in turn induced the myosepta-fasciae to align parallel to the traction.

Hence, these fibres lengthened and they connected to a number of segments. As a consequence, the myosepta-fasciae, which were no longer metameric, lengthened between the muscle fibres to form the perimysium (Figure 27, A, B).

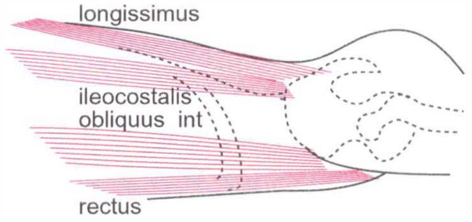
The deep muscles maintained parallel fibres between one vertebra and the next, somewhat similar to the first metameric stage. The more superficial muscles however formed links between the various segments. In humans, the deep paravertebral muscles are metameric and the more superficial ones like the ileocostalis and the longissimi (lumborum, thoracis and cervicis) extend over a number of metameres[28] (Figure 27, C). The vertebrae and the ribs are derived from the myosepta and they remain the reference point for the metameric muscle fibres, which are in series with them. The multisegmentary muscular fibres have the muscle spindles, which are placed in parallel to them, as their point of reference.



A - A selacus body is formed by many myomers tensioned between myosepta



B - In osteichthyes the inclination of the myomeres forms two muscular layers.



C - Within the large trunk muscles in humans the myosepta have been transformed into muscle spindles and arranged in parallel to the muscular fibres.

Figure 27. From myosepta to longitudinal muscles.

Innervation[29] also transformed simultaneously along with changes in the musculature: the deep intervertebral muscle fibres possess few muscle spindles whereas the long superficial muscle fibres

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[25] It seems that the muscular fasciae, in particular those of the back, are formed from the myosepta, the mesenchymal septa placed between the myotomes. (Chiarugi G, 1975)

[26] In bony fishes the myomeres tend to increase their insertable surface on the myosepta. The surfaces become conical and in this way the contraction of a myomere does not only act on the two adjacent vertebrae but also on vertebrae at a distance. The retrorse (backwards) inclination of the myomeres creates a distinction between the deep and the superficial part of the musculature of the trunk. This division forms the internal and external oblique muscles of the trunk. The transverse septa in the trunks of amniota disappear at different points and the myotomes fuse to form longitudinal muscles. (Stefanelli A, 1968)

[27] Notably, hypaxial intercostal muscles also contained pioneer myofibers (first wave) showing for the first time that lateral myotome-derived muscles contain a fundamental component of fibers generated in the medial domain of the somite. In addition, we show that during myotome growth and evolution into muscle, second wave myofibers progressively intercalate between the pioneer fibers, suggesting a constant mode of myotomal expansion in its dorsomedial to ventrolateral extent. (Cinnamon Y, 1999)

[28] The majority of muscles originate from the fusion of several myotomes within single muscles. These muscles are to be considered multisegmentary, as opposed to unisegmentary, meaning derived from a single myotome. (Chiarugi G, 1975)

[29] The available evidence suggests that a topographically organized motor column was absent in early vertebrates. A motor column/myotome map appears to have arisen just prior to, or in conjunction with, the origin of amniotic vertebrates. (Fetcho JR, 1987)

have many muscle spindles[30]. In lamprey only the myomere and not the myosepta are innervated however, in mammals, both muscle spindles as well as muscular fibres are innervated[31]. The muscles of cartilaginous fish do not have muscle spindles[32] because each muscular fibre receives feedback from the myoseptum-fascia into which it is inserted. As the muscles lengthened, becoming gradually longitudinal, the different fibres drew with them a part of the myoseptum, which was destined to be slowly transformed into a muscle spindle[33].

One can deduce that muscles spindles are a substitute for feedback from the fascia by the fact that, in humans, the muscles inserted directly into the fascia, such as the facial muscles of expression, do not possess muscle spindles[34].

The muscular fibre is a contractile element without a precise dimension. At first, it was connected to the myosepta but, due to the evolutionary process, it now connects to the collagen structure of the muscle spindle.

This location of muscle spindles within the muscle serves the following purposes:

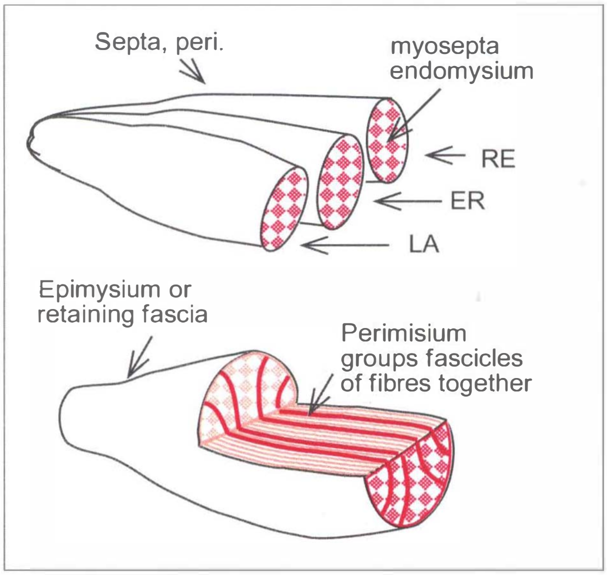

Figure 28. Endomysial, perimysial and epimysial fascia.

- to direct the unidirectional fibres in the realisation of a motor gesture
- to ensure successive contractions of the unidirectional fibres that move a body part on one plane.

The muscle spindle is the connection between the unidirectional muscular fibres and the relative portion of the primordial fascia.

Every muscle of the body contains muscular fibres that activate latero or mediomotion, retro and antemotion, as well as fibres that activate intra and extrarotation (Figure 28). These fibres were initially separated by specific intermuscular septa however, with the formation of the muscles, these septa underwent a process of invagination to form the perimysium.

The perimysium is continuous with the epimysium and the deep fascia[35]. This continuity means that single muscle fibres connect to one structure

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[30] Comparison of segmental distribution of spindles in relation to the areas of muscle show that the lateral column (iliocostalis) has a relatively higher density than the intermediate column at all levels, whilst the medial column (semispinalis, multifidus, rotatores) has the lowest spindle densities. (Amonoo-Kuofi A, 1982)

[31] In the Lampetra japonica the lateral aspect of the myotome is covered by a layer of flattened cells, and the other aspect is covered by an external lamina, which does not extend into the intercellular space between adjacent cells within a myotome. A bundle of thin axons was found in a depression at the middle of the medial edge of each muscle lamella of the myotome and a neuromuscular junction was formed here. No nerve endings were found at the ends of the myosepta or at the lateral borders of the muscle lamellae. (Nakao T, 1976)

[32] In many groups of vertebrates, the muscle spindle is a specialised sensory organ for the detection of muscle stretching; the structure of the spindle varies among vertebrate classes. Moreover, Barker has asserted that Amphibians are the most primitive vertebrates to possess muscle spindles. (Maeda N, 1983)

[33] Muscle spindles are a characteristic of muscles. In the Reptile group they appear as spiral expansions that form a ring around the single muscle fibres. In mammals the muscle spindle consists of a small group of muscle fibres enclosed within a connective tissue sheath. Each fibre is encircled either by a spiral ring or an inflorescent expansion. The muscle spindles are more numerous in the muscles of the limbs than those of the trunk. They are connected to the proprioceptive pathways. (Stefanelli A, 1968)

[34] Anatomically the muscle spindles consist of special muscular fibres situated in almost all human muscles. They do not exist in the infra hyoid muscles and the muscles of facial expression. (Pirola V, 1996)

[35] In every muscle there are fibres with different functions and innervations (fast white fibres, slow red fibres) therefore they cannot all intervene simultaneously in a motor gesture. The endomysium allows for the active fibres to slide against the inactive fibres, whilst the perimysium connects the active unidirectional fibres. In every muscle the connective tissue component contains collagen fibres as well as elastic fibres; these act as a flexible skeleton to which anchor the muscular fibres and the fascicles. This connective tissue is continuous with that of the tendons and the muscle insertions. Its function is to distribute and direct the muscle's force of movement to the bone in an appropriate manner. (Wheater P, 1994)

and to one centre of coordination, which together will guide them towards their final, specific task. The corresponding centres of coordination for each group of unidirectional muscle fibres are to be found in specific points on the epimysial fascia.

A motor unit has thousands of muscle spindles, which can be distributed in many muscles. It is not possible that the Central Nervous System synchronises this activity alone. There needs to be a vectorial centre in the periphery that coordinates this activity. Nervous impulses provoke an "all or nothing" contraction of muscle fibres. The shark, for example, opens and closes its mouth in a jack-knife fashion and is unable to select jaw closure to any specific intermediate angle. Only the presence of the muscle spindles, plus the activation of the muscular fibres in succession, allows for the arrest of movement at any angle of the entire joint range.

Due to the muscle spindles and the Golgi tendon organs, the unidirectional fibres intervene in succession during the movement of a body part in one plane.

Every joint can be moved for numerous degrees in each plane (Figure 29). The muscular fibres of each mf unit are activated in succession during each movement, just as if they were a series of rheostats. In fact, observation of anatomy reveals how the formation of every muscle is similar to a rheostat.

Pectoralis major, latissimus dorsi, gluteus maximus, the deltoid muscle and all the other muscles are formed by a series of fibres[36] that are activated in succession according to the degree of joint range.

The examination of the latissimus dorsi muscle in a freshly butchered rabbit[37] demonstrated the presence of a number of muscular fibre layers that slid independently one upon the other.

At the tendon level, it was observed that fibres were activated at different moments according to the degree of joint range.

The Central Nervous System sends impulses to the various fibres but is unable to determine[38] when to diminish the activity of the more distal fibres and to increase that of the proximal fibres, in relation to the changing positions of the limb. The CNS is not able to modulate the activity of the various fibres in relation to the variations of the required forces. Only an elastic structure sensitive to stretch, such as the fascia, can recruit or inhibit the various muscle spindles and the corresponding muscle fibres.

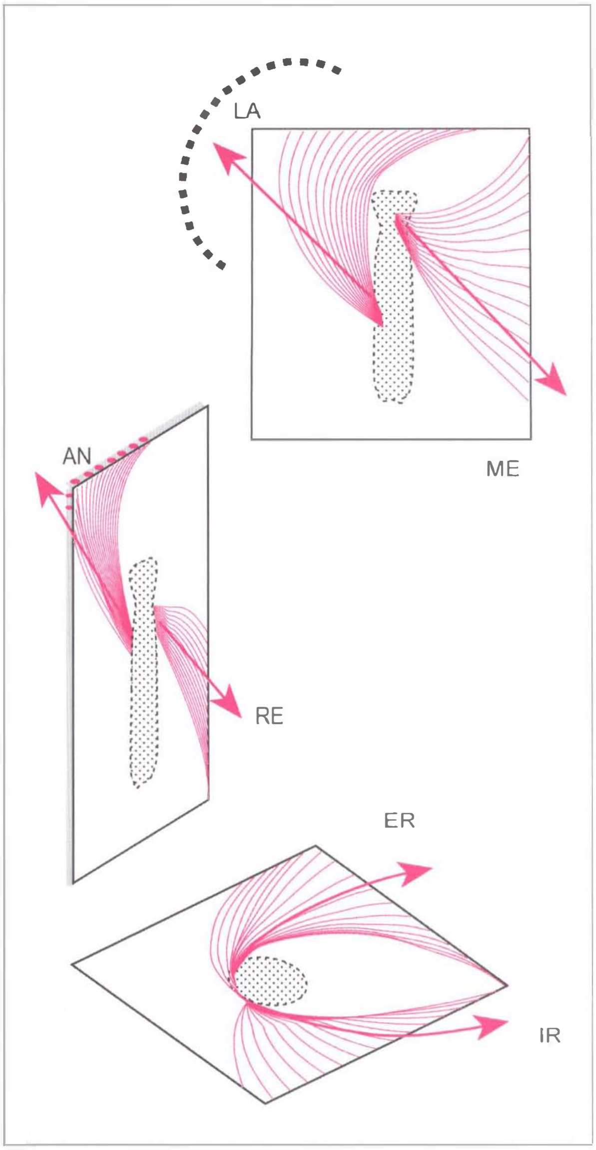

Figure 29. In each mf unit the fibres are activated in succession.

Exactly how this regulatory mechanism of the periphery works will be explained in the following chapter dealing with physiology.

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[36] Muscles do not represent a functional unit as the single fibres can contract independently from one another. (Chiarugi G, 1975)

[37] To verify the above, the cadavers of 5 rabbits were examined. The skin of the first rabbit was removed immediately after butchery in order to study the various layers of connective tissue. To observe the sliding and the separation between the fascial layers it is important that the tissues are still warm. (Stecco L, 1997)

[38] The cerebral cortex is unaware of what effectively occurs as a consequence of its commands. Unfortunately for the cortex its orders intervene in a context – against a background of changing conditions – and their final result is necessarily modified by those conditions. There is no way of modifying commands whilst taking into account the changing circumstances within which these commands will be sent. (Turvey M, 1992)

Chapter 3
THE PHYSIOLOGY OF THE MYOFASCIAL UNIT

With regards to the organisation of movement, the brain is only capable of programming peripheral movements whereas muscular fibres are only capable of contracting. Stimulation of the myofascial unit by a specific nervous impulse is essential to bring about movement of a specific body part. Muscular fibres effectuate movements only within their own particular context and it is the fascia that determines the form as well as the direction of a muscle. If the consistency of the centre of coordination of the fascia varies, then the muscular fibre's "frame of reference" is changed and the resulting motion will be different.

Centres of coordination and centres of perception

Thousands of years of experience have shown that there are points in the human body which, when stimulated, radiate pain more than surrounding areas. When treated appropriately these same points can have a beneficial effect. These points have been named differently by the various schools or traditions, but their location is always the same.

Why do these points have the same location in all human beings? It is important to understand in which tissues these points are found as each school, or tradition, tends to assign them to different tissues (e.g. muscle, loose connective tissue, periosteum, ligament, vessels, nerves etc.).

However, the fascia is the only tissue that modifies its consistency when under stress. It is plastic but also malleable and it changes its consistency when manipulated. Whilst this premise would be sufficient to justify the choice of the fascia as the ideal location for these points, the physiology of the myofascial unit confirms this hypothesis.

In every mf unit there is a centre of coordination that directs the muscular forces (centre of coordination = cc) and a centre of perception that perceives movement occurring at the joint (centre of percep-

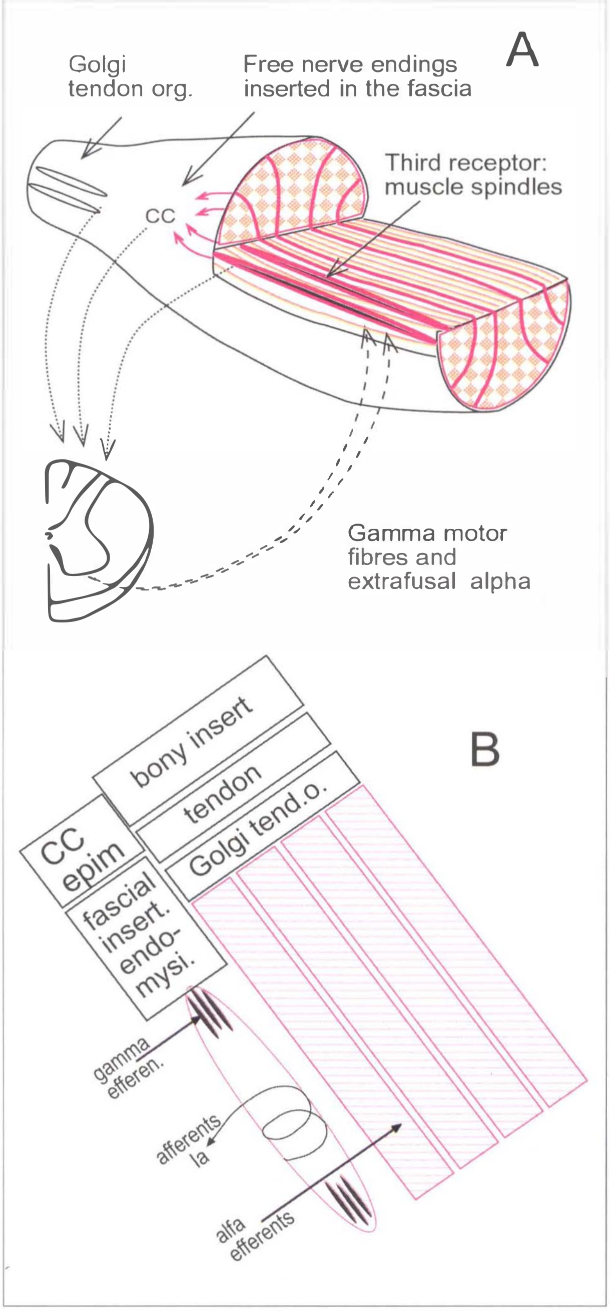

Figure 30. Traction of muscle spindles on the fascia and the formation of the CC.

tion = cp). The coordination of these tensile forces in the mf unit is determined by the continuity of the fascia.

In fact, the transmission of forces from the deep layers of a muscle towards a superficial point is due to the continuity of the endomysium with the perimysium and the epimysium.

All traction that the muscle spindles exert on the endomysium converges together at the epimysium (Figure 30, A). In the simplest mf units (for example, the extension of the cubitus which is formed entirely by the triceps brachialis) the traction converges at a point halfway along this same muscle. However, even in the more complex mf units, such as those formed by motor units situated in a number of different muscles, these forces always converge at a unifying point. The fascia has to be able to slide freely over the single muscular fascicles[39] so that this convergence at a single point or cc can occur. Fascia also needs to have some points of anchorage to bone so that it can be stretched without being dislodged. In fish, the fascial myosepta unify the action of the single myomeres to bring about the movement of lateral flexion. In humans, the cc of each mf unit unifies the action of the single motor units towards a specific movement. The cc coordinates these muscular fibres due to its capacity to adapt to the traction of the muscle spindles[40], rather than through the afferents of the free nerve endings. Muscle spindles are inserted into the endomysium and whenever a gamma impulse causes them to contract (Figure 30, B) they stretch the entire fascial framework[41,42]. This stretch is not random but converges towards a precise point or cc that, because of the intrinsic elasticity of the fascia, adapts itself to the stretch. When the muscle spindles contract they shorten, the central part enlarges and the annulospiral endings are activated[43]. Afferents of 1a and 1b fibres, originating from these annulospiral endings, convey impulses to the spinal cord. Only when these afferents arrive at the spinal cord can the second contractile phase be generated via the alpha fibres. Normally this neuro-myo-fascial activity is not perceptible but when it does not function correctly we are aware of the resulting joint pain. If a densification of a cc occurs then it will not adapt correctly to the muscle spindles' stretch. This means that not all of the 1a afferent fibres and, consequently, not all of the necessary alpha fibres will be activated. Hence, only some of the muscular fibres within the mf unit contract resulting in a distorted traction on the joint.

The cp of the mf unit is situated in the joint[44]. It is connected to the voluntary muscles and shares a common innervation with them[45]. The cp is also the sum of all the afferents of the articular components, namely the tendons, the ligaments and the joint capsule. The fascia is connected to all of these soft tissue components and it interprets these afferents assigning them a directional significance. The con-

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[39] The inner surface of the fascia is covered by a loose sliding tissue that separates it from the muscles. Layers of epimysial fascia are found between the fascia and the subcutaneous tissue. The fascia is also anchored to bone by means of the intermuscular septa and these deep insertions have a marked influence on the directions of the fascial fibres. The direction of these collagen fibres can be longitudinal, transverse or oblique. The fascia represents an essential component of the motor apparatus. (Lang J, 1991)

[40] The muscle spindle is made up of a bundle of 4-10 voluntary muscle fibres surrounded by a collagen sheath. The gamma motorneurones produce impulses that induce the contraction of these fibres, which are inserted in the endomysium and the collagen sheath. (Mazzocchi G, 1996)

[41] The gamma circuit is essential for voluntary muscle contractions because it maintains an optimum muscle tone which allows for an efficient phasic contraction. It has been demonstrated that every voluntary movement is preceded by a slight increase in tone of the voluntary muscles involved. (Mazzocchi G, 1996)

[42] Each muscle spindle is enclosed within fascia that limits elongation and is thus involved in neuromuscular function. (Warren IH, 1998)

[43] The intrafusal fibres are inserted into the connective tissue that surrounds the muscle fibres. They shorten when they are stimulated by the gamma motorneurones and, as the muscle contracts, they adjust their length to those of the extrafusal muscle fibres. (Baldissera F, 1996)

[44] We would like to show that groups of muscles, with relative fascia and innervation, form the following neuromyofascial units: flexor, extensor, adductor, abductor, intra and extrarotatory. While the muscles carry out the movement, they stretch the joint capsules and the fascia and in this way the mechanoreceptors are put into action. Consequently the fascia provides the feedback for the overall motor image. (Stecco, 1989)

[45] Static and dynamic receptors, found abundantly in ligaments and joint capsules, are distributed in such a way that the sensitive innervation of one part of a capsule originates from the same nerve trunk that innervates the muscles protecting that part of the capsule. (Viel E, 1991)

viction that the fascia is responsible for kinaesthetic sense, rather than the joint capsule[46], has been suggested by the experience accumulated from joint replacement surgery.

The structure of the fascia is such that it stimulates the free nerve endings with precision, ensuring the transmission of the exact afferents of the programmed movement back to the cerebral cortex. Without this feedback there would be chaos between the movement and the afferents. For example, the mf units of ante-humerus, cubitus and carpus are found anteriorly to the intermuscular septa and the fascial compartments surrounding these upper limb flexor muscles are anchored at the epicondyles and the styloid processes. Due to these fixed points the nerve endings embedded along these fascial sequences are *actively* stretched only during flexion[47].

The receptors embedded in the joint capsules, in the ligaments and the fasciae are the same throughout the entire body. However, the afferents they transmit convey information about specific motor directions (i.e. flexion, abduction, extension etc.) because they are located within structures that are strictly connected to specific motor directions[48]. Without this fascial map the cerebral cortex would always receive the same type of nervous impulses from these receptors, which would be impossible to interpret.

If the soft tissues surrounding a joint (centre of perception) do not stretch according to physiological lines then the receptors embedded in these tissues signal the dysfunction as pain. Any therapeutic intervention, therefore, is not to be focused at the site of pain or the centre of perception as they are mere consequences of the dysfunction. The focus should be on the cause or, more precisely, the densification of the cc, which results in uncoordinated activity of the muscular fibres.

Densification can occur in many parts of the fascia but it is only when the cc is involved does uncoordinated activity of the mf unit ensue. Densification forms most frequently at the cc because it is the part of the fascia most subjected to strain.

CC and referred pain

Referred pain has been described by various authors[49,50,51] as a shooting pain that occurs when precise points of the body are compressed. In Fascial Manipulation these points are considered to be the centres of coordination. In normal conditions these cc are not hypersensitive nor do they produce referred pain when stimulated. They become sensitive, even to light stimulation (hyperalgesia or allodynia)[52], when the fascia within which they are located densifies. Under normal physiological conditions, the elasticity of the fascia allows it to adapt to compression without straining the free nerve endings. Normally the free nerve endings are

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[46] Clinical experience seems to testify to the limited relevance of joint afferents given that a person's kinaesthetic sense remains essentially intact following the substitution of an articulation with a prosthesis. At the same time, local anaesthesia of the skin and joint capsule of the metacarpophalangeal or interphalangeal joints provokes a reduction in the sense of position in the fingers, when testing is done with the hand muscles in a relaxed state. (Baldissera F, 1996)

[47] Each mechanoreceptor is activated through only a part of the range of movement of a joint. A map of all the mechanoreceptors would be required to be able to determine the total angle of joint excursion. The majority of receptors react only when the ligaments are under maximum stretch, at the two extremes of joint excursion. (Baldissera F, 1996)

[48] Vertebrate sensitivity depends upon: 1) free intraepithelial terminations or expansions 2) free terminations or expansions within connective tissue 3) terminations protected by connective tissue sheaths... It is not always possible to assign specific sensations to these peripheral receptors. Thus, for example, the Pacini corpuscles, whilst always functioning as pressure receptors can become proprioceptors or nociceptors according to where they are located. (Stefanelli A, 1968)

[49] Each single muscle can develop myofascial trigger points (MTrP) that can produce referred pain, along with other disturbing symptoms, at a distance. (Travell J, 1998)

[50] Researchers in the field of pain have given us an understanding of the basis for hyperalgesia, allodynia and the previously difficult-to-understand finding of referred pain zones that we see daily in our patients. Finally the interesting initial observations of Hubbard and Berkoff (1993), suggesting that the muscle spindle may be associated with the trigger point, open yet another door in our understanding of the nature of MPS. (Gerwin RD, 1994)

[51] Pain referred from a muscle can mimic both pain from a joint and radicular pain associated with disease of spinal joints, leading to mistakes in diagnosis and in treatment. When articular disease is present, it predisposes to myofascial trigger point (TP) syndromes. It has been proposed, on theoretical and clinical grounds, that muscular TPs can cause joint disease. (Reynolds MD, 1981)

[52] The term hyperalgesia used to describe this sensation is often replaced by the term allodynia, conceived to describe the transformation of a light signal to a painful signal. Analogous painful sensations are frequently produced spontaneously even in the absence of any stimulation. Little is known of the mechanism of allodynia. (Albe D, 1997)

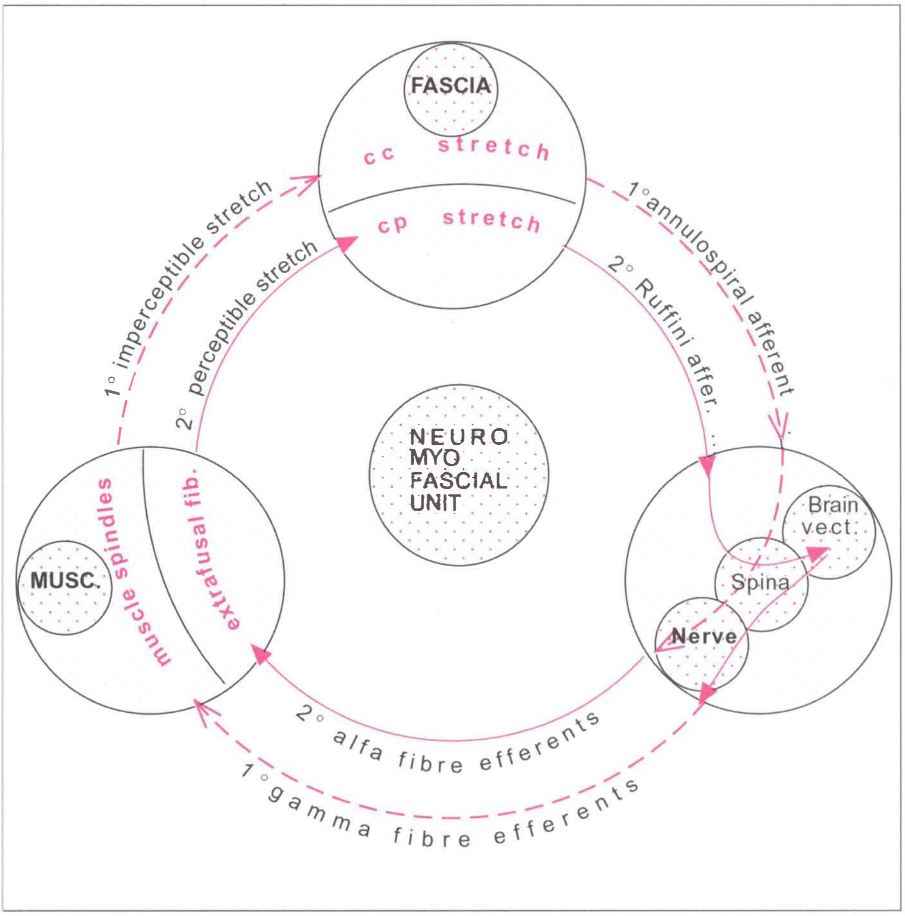

Figure 31. Circuit of the myofascial unit.

involved in deep somaesthetic activity or the perception of the body's position and movement in space. In pathological conditions, such as in the presence of a densification of the fascia, these free nerve endings are under tension which tends to lower their pain threshold. In such a situation even a minimal compression can be sufficient to override this threshold, setting off local pain as well as referred pain. At times the densification of a cc provokes a reflex contraction of the tensor muscles of the fascia[53]. This determines a continuous tension on the free nerve endings, with a persistent pain that irradiates along the entire sequence (e.g. sciatica).

The localisation of the reflex area, or the referred pain, is not always clear-cut. In fact near the main zones of referred pain there are almost always secondary zones. However, this confusion is due to the variety of directions that a radiation can take in the fascia. The radiation elicited from a densified cc can involve either: the centre of perception of the mf unit of which it is a part; or the cp of the antagonist mf unit; or the entire mf sequence, or the spiral which passes through that specific cc.

Implication of either the longitudinal fibres or the spiral fibres depends on the particular elements of tensional stress that have caused the densification. Initially these stresses can be compensated and therefore, for example, sciatica can apparently resolve itself spontaneously. What often occurs is that the densified cc then becomes silent (latent trigger points) because the body has developed a compensation along the sequence. When the body is no longer capable of balancing such a stress the alteration of the fascia becomes chronic and the pain returns (e.g. chronic sciatica).

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[53] Kellgren studied many of the principal muscles of the body and in 1938 noted that when a muscle belly is infiltrated with a saline solution referred pain emanated from the point of stimulation at a distance from each muscle. (Travell J, 1998)

The densification of cc(s) is associated with pathologies that until recently were thought to have quite different origins. A form of sciatica has already been mentioned but fibromyalgia[54], fasciitis, tenosinovitis, tendinitis, bursitis, frozen shoulder and so forth can also be considered. These ailments manifest themselves in the joints or in tendons, but they originate from the densification of the cc(s) within the mf units that move these structures.

The circuit of the myofascial unit

The physiology of the myofascial unit can be summarised by the following diagram (Figure 31).

An impulse for a motor direction and not for a specific muscle is generated in the brain, descends the spinal cord and arrives at the muscle by passing along the motor nerves via the gamma fibres. The gamma circuit excites the intrafusal contractile fibres of the muscle spindles. When these fibres contract they stretch the annulospiral terminations, which are coiled around them, as well as the connective tissue in which they are inserted[55]. The contraction of these fibres is insufficient to exert a force on the tendons but it does propagate a stretch along the connective tissue structure. Due to the conformation of the muscle, a part of this stretch propagates towards the inelastic tendon and a part goes towards the centre of coordination, which is elastic and adapts to the stretch.

The adaptation of the cc to this stretch allows the muscle spindle to shorten and in this way the primary spindle afferents are excited. These convey impulses via Ia fibres to the motor-neurone pool and, from here, secondary motor efferents part via the alpha fibres in the direction of the muscle.

This secondary efferent stimulus activates the extrafusal fibres, or the voluntary muscle fibres.

The contraction of the voluntary muscle fibres causes articular movement, which stretches the joint capsule and the receptors. A second afference then parts from the centre of perception, arrives at the spinal cord and ascends to the brain, conveying information that the programmed movement has taken place in the periphery.

Regulation of movement would not be possible without these circuits especially considering all of the possible variables at any given moment and in any given situation. These reflex adaptations are organised within the mf unit according to tensional adjustments. It is for these reasons that muscle spindles as well as Ruffini corpuscles and Golgi tendon organs are sensitive to stretch.

Agonists and antagonists: the role of the fascia

All neurophysiologists are in agreement about the existence of a peripheral system of motor coordination. Having examined how the fascia and the muscle spindles intervene in the organisation of the motor units within the mf units, the role of the fascia and the Golgi tendon organs in the peripheral coordination between agonist and antagonist mf units will now be analysed.

It is necessary to study the structure of the Golgi tendon organs to be able to understand their function. Each Golgi tendon organ consists of a mesh of collagen fibres entwined around a nerve fibre and it is situated in series with 10-20 muscle fibres. The axon of this nerve fibre is activated when compressed by the collagen fibres. These collagen fibres and a part of the axon[56] are arranged in a spi-

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[54] Myofascial syndromes could represent incomplete, regional or initial cases of fibromyalgic syndrome. The diagnosis of fibromyalgia requires the demonstration of the presence of tender points i.e. deep painful points with-in muscles or thickened areas of soft tissue. Tender points are characteristically painful points, which, unlike trigger points, do not provoke referred pain but are painful only at the site of stimulation. More than 50 tender points have been identified. The simplest technique for testing such points is by means of digital compression around joints or over tendon insertions. (Todesco S, 1998)

[55] The impulse that originates from the gamma motorneurones induces contraction of the polar contractile portions of the intrafusal muscular fibres. Given that these are connected at both extremes either with the internal surface of the fusal capsule or with the endomysium, it is obvious that the shortening of the contractile portion of the intrafusal fibres provokes stretching of the central portion of the fibre. This activates the afferent terminations just like lengthening of the entire muscle does... The discharge of the primary afferent neurone excites the motor unit of the muscle in which the spindle itself is located. (Mazzocchi G, 1996)

[56] The Golgi tendon organs were divided into three small compartments by septal cells: the neuronal compartment containing myelinated nerve fibres, the terminal compartment having axon terminals, and the fibrous compartment containing only collagen fibrils. The three dimensional reconstruction demonstrated that myelinated fibres rotated spirally before losing their myelin sheaths, and ended as unmyelinated axons in the terminal compartment. (Nitatori T, 1988)

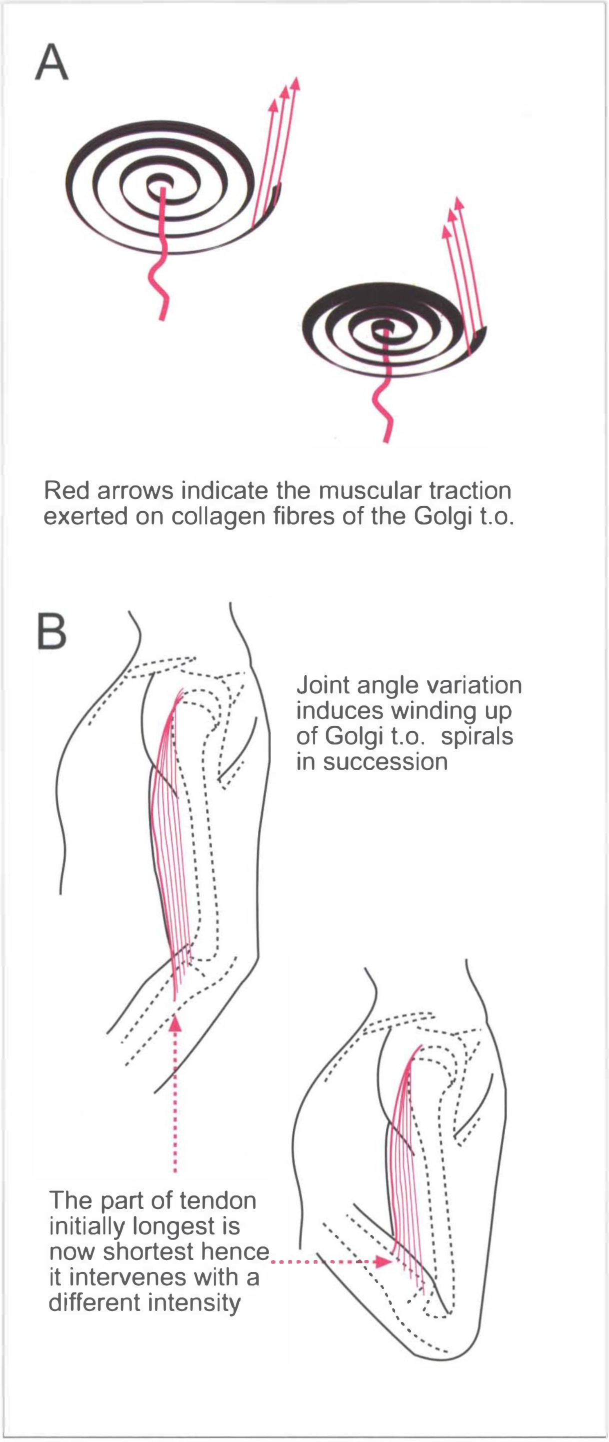

Figure 32. Active stretch of the Golgi tendon organs.

ral form (Figure 32, A). According to the direction of the muscular traction these spirals rotate around themselves compressing the nerve or they open themselves out and, therefore, do not provoke any nerve discharge. According to the lines of traction[57], which vary with joint range in each mf unit, specific motor units are inhibited. Inhibition comes about due to the compression of the axon that occurs during active or passive stretching of the muscle fibres[58].

The Golgi tendon organ acts in three modes:

1) by the inhibition of the monoarticular antagonist muscle fibres
2) by the progressive inhibition of the biarticular agonist fibres (active stretch)
3) by the inhibition of the biarticular antagonist fibres in succession (passive stretch)

Direct inhibition of the mono-articular fibres

Muscle spindles can activate the alpha fibres either as a consequence of a direct nerve impulse resulting in movement or by means of a passive stretch. For example, when a person wants to flex their elbow, an impulse is generated in the brain which results in the contraction of the ante-cubitus mf unit. The flexion of the elbow determines a stretch of the antagonist mf unit (retro-cubitus) and hence the muscle spindles of the triceps brachii muscle are activated through passive stretching (Figure 33).

Co-contraction of the agonist mf unit and the antagonist mf unit would impede movement.

To allow movement to occur it is necessary that, in order to fixate the joint, only a part of the antagonist fibres contract and a part are inhibited. The antagonist biarticular fibres (long head of triceps) can contract, fixating both the elbow and the shoulder joints, because its fibres are aligned perpendicularly to the Gto. Therefore when they contract they release the spiral fibres of the Gto.

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[57] Tendon organs are sensitive to activity...Using the method of distributed stimulation it has been possible to grade motor unit tension over a wide range and record the corresponding firing rates of the receptor. The plot of firing rate against tension was found to be highly non-linear and did not conform to the simple power function previously attributed to the relation. (Proske U, 1980)

[58] The Golgi tendon organs are situated in proximity of the junction of between tendons and muscular fibres. These receptors consist of tendinous fascicles, originating from ten or more muscle fibres, surrounded by a connective tissue capsule and innervated by 1 or 2 large myelinated nerve fibres. Each tendinous fascicle is formed by a mesh of finer filaments. As with the Ruffini corpuscles, the termination of the nerve axon of the GTO is interwoven with the spirals formed by these filaments. If the tendon is stretched, the space between the filaments decreases and the nerve termination is compressed. This generates an impulse from the receptor. (Baldissera F, 1996)

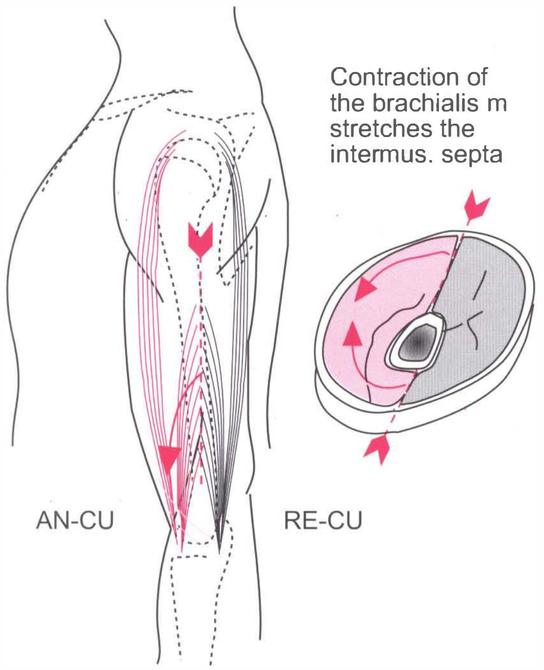

Figure 33. Passive stretch of the Gto's.

The antagonist monoarticular fibres (short heads of triceps) are inhibited because their fibres and their Gto's are placed obliquely with respect to the lateral and medial intermuscular septa. When the brachialis muscle, which is inserted onto these intermuscular septa, contracts then the oblique fibres of the short heads of triceps are stretched forward, activating their Gto's and thereby inhibiting their contraction.

This hypothesis is supported by the following facts: the Ruffini endings, the Ruffini corpuscles of the Golgi tendon organ-like type[59] and the real Golgi tendon organs are formed by collagen fibres arranged around an axon. The difference between them is that, in the first two these collagen fibres are parallel to each other, whereas in the Golgi tendon organs these fibres are arranged in a spiral formation. From a mechanical viewpoint the parallel fibres will always compress the axon of the nerve whenever they are stretched. The spiral fibres of the Gto, however, will only compress the axon when traction causes them to wind themselves up like the mainspring of a watch.

In all the mf units of the body there are mono and biarticular fibres arranged according to this same structural pattern. In the next three chapters this aspect of the mf units will be highlighted.

Inhibition by active stretch

Up to this point the role of the Golgi tendon organs in the reciprocal inhibition of agonist and antagonist mf units has been discussed. How these Gto's are involved in the regulation of the succession of muscular fibre contractions of the agonist mf unit will now be examined.

The spiral of the Gto's collagen fibres is connected not just to one muscle fibre but to approximately ten fibres. This means that this spiral of collagen fibres, depending on the stretching action of these muscle fibres, will wind itself up to a variable degree. The hundreds of muscle fibres that make up a motor unit are all activated simultaneously[60]. However, this mass contraction would not allow for a harmonious passage from one position to the next. The flexor fibres of the cubitus (elbow) that, for example, intervene when the arm is extended cannot be the same as those that act when the arm is almost fully flexed[61]. As the joint angle changes so does the activation of the hundreds of muscle fibres that make up a motor unit (Figure 32, B). This is made possible due to the fact that the Gto spiral connected to some muscle fibres winds up while the Gto collagen spiral of other muscle fibres unwinds. This determines the inhibition of some muscle fibres whilst allowing other muscle fibres of the same motor unit to contract.

This hypothesis is supported by the following facts: insertions of muscle fibres into tendons are

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[59] Ten anterior and posterior cruciate ligaments were investigated... Three distinct neural structures could be identified: Ruffini endings, Ruffini corpuscles of the Golgi tendon organ-like type and Pacinian corpuscles. Golgi tendon organs were not found. (Raunest J, 1998)

[60] A motor unit represents a group of muscle fibres whose function is indivisible and which responds to the law of "all or nothing". It is estimated that a motor unit contains between 100 and 200 muscle fibres. (Licht S, 1971)

[61] In fact tendons have fan shaped insertions onto bone and, in succession as the joint angle varies, the extreme portions of the tendon support the traction force of the muscle. (Basmajian J, 1984)

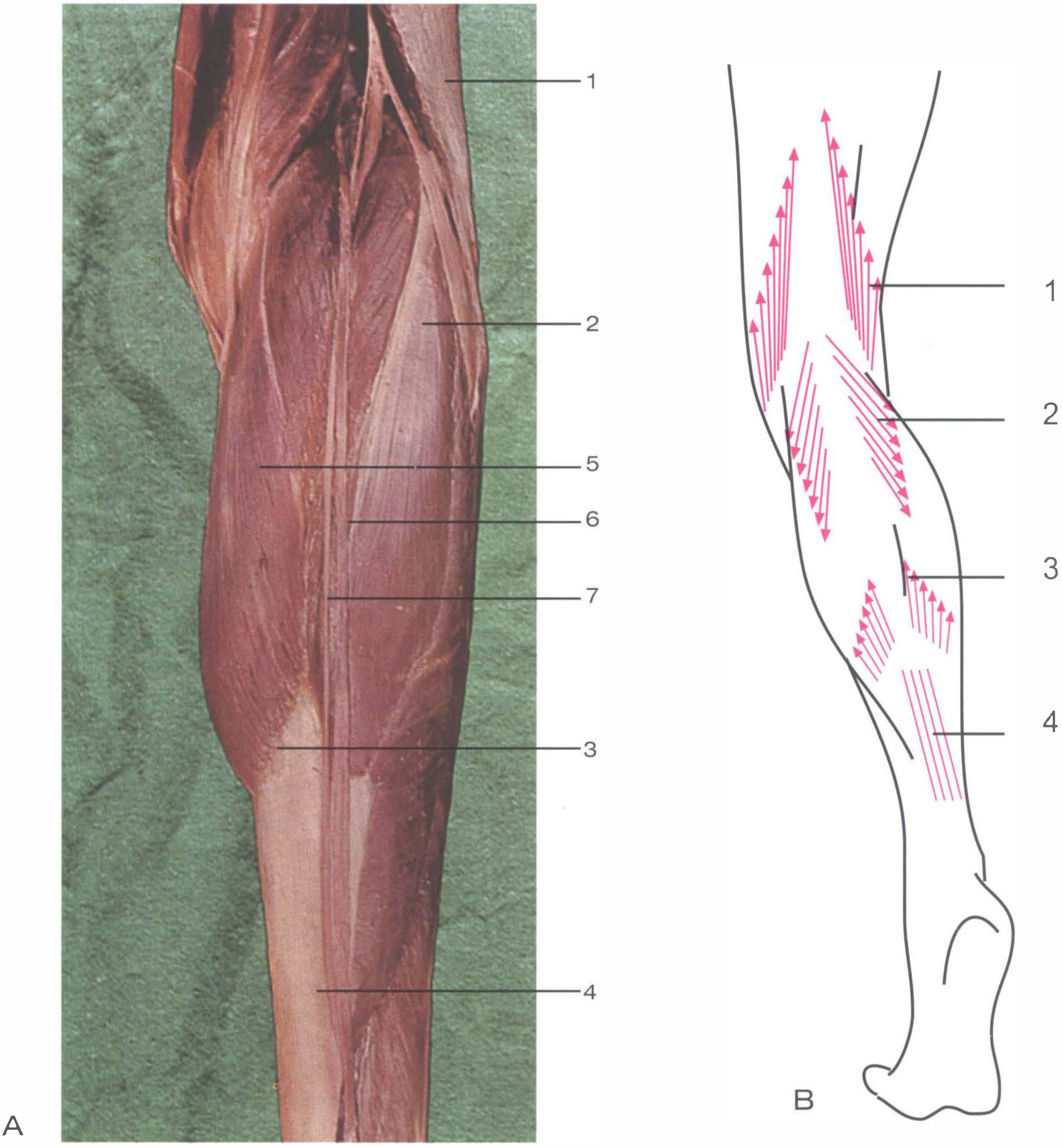

Figure 34. A - Posterior compartment of the leg (from Fumagalli - Colour photographic atlas of macroscopic human anatomy. - Published by Dr. Francesco Vallardi/Piccin Nuova Libraria); B - Scheme of the aponeurotic vectors of the epimysial fascia.

1, Teno-aponeurotic fibres that stimulate the myotendinous organs of the biceps femoris muscle. These organs are arranged in succession such that their spirals are activated at different degrees of joint range. 2. Collagenous aponeurotic fibres that blend into the proximal tendon of the lateral head of gastrocnemius; these collagen fibres are arranged in such a way that they interact with all the Golgi tendon organs of the motor units involved in retromotion of the knee.

3. The muscle fibres of the triceps surae insert into the Achilles tendon in a fan shaped distribution so that the Golgi tendon organs are stimulated in succession according to the degree of joint range. The joint range of the talus is less than that of the knee hence the extension of the insertion of the muscle fibres onto the tendon is less than that of the biceps femoris. 4. Inextensible, parallel collagen fibres of the triceps surae tendon. 5. Medial head of gastrocnemius m. 6. Small saphenous vein. 7. Sural nerve

always arranged along an oblique line rather than onto a horizontal surface (Figure 34). By observing, for example, the proximal part of the two gatrocnemii muscles it can be seen that part of the epimysial fascia transforms into an aponeurosis and continues with the tendon which inserts into the femur. Within this aponeurosis a series of collagen fibres, aligned according to the lines of force of the underlying muscles, are visible. According to the angle of the knee joint these teno-aponeurotic fibres are more or less in tension and, therefore, their affect on the Gto varies.

Inhibition by passive stretch

An analogous process to that which was discussed in the previous section, takes place in the antagonist mf unit, with the only difference being that the activation and inhibition of the fibres occurs due a passive stretch. The contraction of the agonist mf unit stretches the antagonist mf unit. The stretch of its muscle spindles causes the fibres of the antagonist mf unit to contract.

In the specific case of the forearm, the contraction of the mf unit of ante-cubitus (an-cu) stretches the mf unit of retro-cubitus (re-cu) resulting in the contraction of this mf unit. The only fibres remaining active in this mf unit will be those muscle fibres that are perpendicular to the Golgi tendon organ (Figure 33).

The perpendicularity between the muscle fibres and the Gto varies according to the elbow joint's angle. This determines the activation of the antagonist muscle fibres required for joint stability in each specific position of the joint.

This hypothesis has been suggested by the following experience of clinical work: many patients complain of joint instability or rigidity even in the absence of pain or any anatomical damage. In both cases the symptoms disappear immediately once the fascial tensions are normalised. The joint stability or mobility is re-established presumably because the Golgi tendon organs of the antagonist are activated, or inhibited, only at the appropriate moment.

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Chapter 4
THE MF UNITS OF THE UPPER LIMB

In the upper limb there are six mf units for each major articulation; a total of thirty mf units in all. For each articulation there are two mf units for the sagittal plane (ante and retro), two for the frontal plane (medio and latero) and two for the horizontal plane (intra and extra). All mf units have a centre of coordination and a centre of perception.

In this chapter the following aspects will be explained for each mf unit: a) the mono and biarticular muscle fibres; b) the point where the myofascial tractions converge, the vectorial centre of coordination (cc); c) the superimposition of these cc(s) over or near points used in other methods.

The shoulder is a complex motor system composed essentially of two different segments: the scapula and clavicle (sc) and the humerus (hu). Whilst these two segments often work together they nevertheless have specific muscles for independent movements. Mf units which perform tasks requiring considerable strength, such as ante-cubitus (an-cu), are equipped with a large muscular mass; mf units involved in stabilising joints, such as latero-cubitus (la-cu), are composed mostly of fasciae and ligaments, with a small percentage of muscular fibres that tension the fascia. Often the cubitus (elbow joint) is only studied for its movement on the sagittal plane (ante and retro) whereas it also has a stabilising component (latero and medio), as well as a rotary component at the head of the radius.

Intrarotation of the carpus (wrist) is considered the component of pronation involving the distal part of the radius and ulna and it is carried out by the pronator quadratus muscle. The movement of latero-carpus is similar to radial deviation but when the forearm is in the anatomical position, the action of the extensor carpi radialis prevails; the movement of medio-carpus is similar to ulna deviation but in the anatomical position the action of flexor ulnaris carpus prevails. When a person is walking, for example, the forearm is in the physiological position and radial and ulna deviation become part of a movement scheme rather than a purely directional movement. The same argument can be made for ante-carpus and retro-carpus: with the forearm in the anatomical position the action of extensor carpi ulnaris and flexor carpi radialis prevails however, in daily use, the action of the extensor digitorum and flexor digitorum muscles prevails.

All of the small joints of the hand can be grouped into two functional units, namely that of the thumb (pollex) and the other four fingers (digiti). The thumb does have a pure movement of antemotion whereas all its other movements are part of movement schemes (e.g. opposition and abduction). The other four fingers move away from the median line (latero) and return to the median line (medio); the movements of opening and closing of the fingers have both a rotational component (intra and extra) and a component on the sagittal plane (ante and retro) which determines a movement scheme. In this chapter, which deals with segmentary movements, the cc(s) of the mf units of retro, intra and extra of the hand only coordinate unidirectional movements.

Localisation of the centres of coordination

The centre of coordination of each mf unit is formed by various myofascial vectors. It is possible to delineate the exact anchorage points of the fascia of each mf unit, along with the insertions of the superficial and deeper muscular fibres onto the perimysium and the epimysium. However, clinical experience has shown that it is preferable to describe the anatomical points of reference of each mf unit, in order to assist the therapist in the practical examination of fascial densifications.

The localisation of the centre of perception (cp) of a mf unit is easily deduced from its name. The centre of perception of the mf unit of ante humerus (an-hu), for example, is situated in the anterior part of the shoulder; the centre of perception of ante-cubitus (an-cu) is situated in the anterior part of the elbow (n.b. with the arm held in the anatomical position) and so forth. In Chapter 7, three Tables (Table 7, 8, 9) describe the sites of pain as referred to by the patient. These areas correspond to the centres of perception of the mf units. Once it is accepted that pain is the warning signal that the body uses to indicate a dysfunction of a mf unit then, in the presence of joint pain, the centre of coordination concerned is easily traced. If a patient, for example, complains of a pain in the anterior part of the elbow, treatment by a fascial therapist will be oriented towards the cc of the mf unit of ante-cubitus. Centres of coordination themselves are always found in areas that are not spontaneously painful, such as over muscle bellies where the nociceptors are not stretched and irritated by movement.

Comparison of centres of coordination (cc) with points from other methods.

The choice to illustrate the parallels that exist between cc(s), acupuncture points[62] and trigger points has been made to facilitate practitioners of these methods. Furthermore, the intention is to demonstrate how these same points, as used in the practice of Fascial Manipulation, have been successfully manipulated for thousands of years. Later on, with the study of the cc(s) of fusion, parallels will also be drawn with treatment zones recommended by Cyriax and Maigne. At times acupuncture points and trigger points (Table 5) coincide exactly with cc(s) and at other times not. Similar disagreement is often found when studying texts that deal with these disciplines. In acupuncture new points are often prefixed with *ex* because they are located outside of the traditional meridian line.

- Acupuncture points have precise positions but their position can vary from one person to another[63] as a consequence of trauma, incorrect posture etc.
- Acupuncture points do not all have the same function nor are they located at the same depth within tissues[64]. Those situated over muscle bellies correspond to segmentary cc(s) whilst those over tendons correspond to cc(s) of fusion.
- Segmentary cc(s) are situated either near the motor point of the muscle (where the nerve enters the muscle) or near the terminal plate of the neuromuscular junction. Neuromuscular plates in polyarticular muscles can be numerous[65].
- Sometimes it is necessary to treat cc(s) at a dermal level before proceeding onto treatment at the fascial level. The deep, fibrotic process can extend collagen fibrils up towards the dermal layer.
- The cc(s) of fusion in Fascial Manipulation correspond to the areas used by Cyriax in the treatment of tendons and ligaments. These cc organise motion via retinacula and Golgi tendon organs.
- Periosteal points of stimulation[66] have their own effectiveness and referred pain patterns because the periosteum (the superficial layer) is continuous with the fascia.
- When a mf unit governs complex joints (e.g. fingers) or multiple articulations (e.g. thoracic vertebrae, cervical vertebrae etc.) its cc often correspond to two or three acupuncture points. In such cases the cc is no longer a singular point but extends over a small, elongated area (Figures 183-188).

Table 5. Parallels between CC(s) and other points.

Segmentary CC(s) Monoarticular Unidirectional	**CC of fusion** Multiarticular Multidirectional
mf Sequences	mf Spirals
Acupuncture points on the muscle	**Acupuncture points on the joint**
Main Meridians	Tendinomuscular Mer.
Muscular trigger point	**Tendon/liga. Treatments**

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[62] Melzack and others examined the correlation between the localisation of acupuncture points related to pain, as published by an acupuncturist, and myofascial trigger points. Allowing for a mean difference of 3cm, they found a general correspondence of 71%. (Travell J, 1998)

[63] The points that are treated with acupuncture consist of very small areas of the body each with a precise location. In my experience I have found that the areas to treat can actually be quite extensive and of variable locations. (Mann F, 1995)

[64] Gunn identified 4 types of acupuncture points based on the type of nervous structure penetrated by the needle. Two types of points were found to be specific for muscular motor points and two types for Golgi tendon organs. (Travell J, 1998)

[65] The sartorius muscle and the gracilis have multiple terminal plates. (Travell J, 1998)

[66] In periosteal acupuncture the needle is inserted in the same way as in normal acupuncture. The difference consists in penetrating further until contact with the periosteum has been made. I have heard that in Germany some doctors practice periosteal massage. (Mann F, 1995)

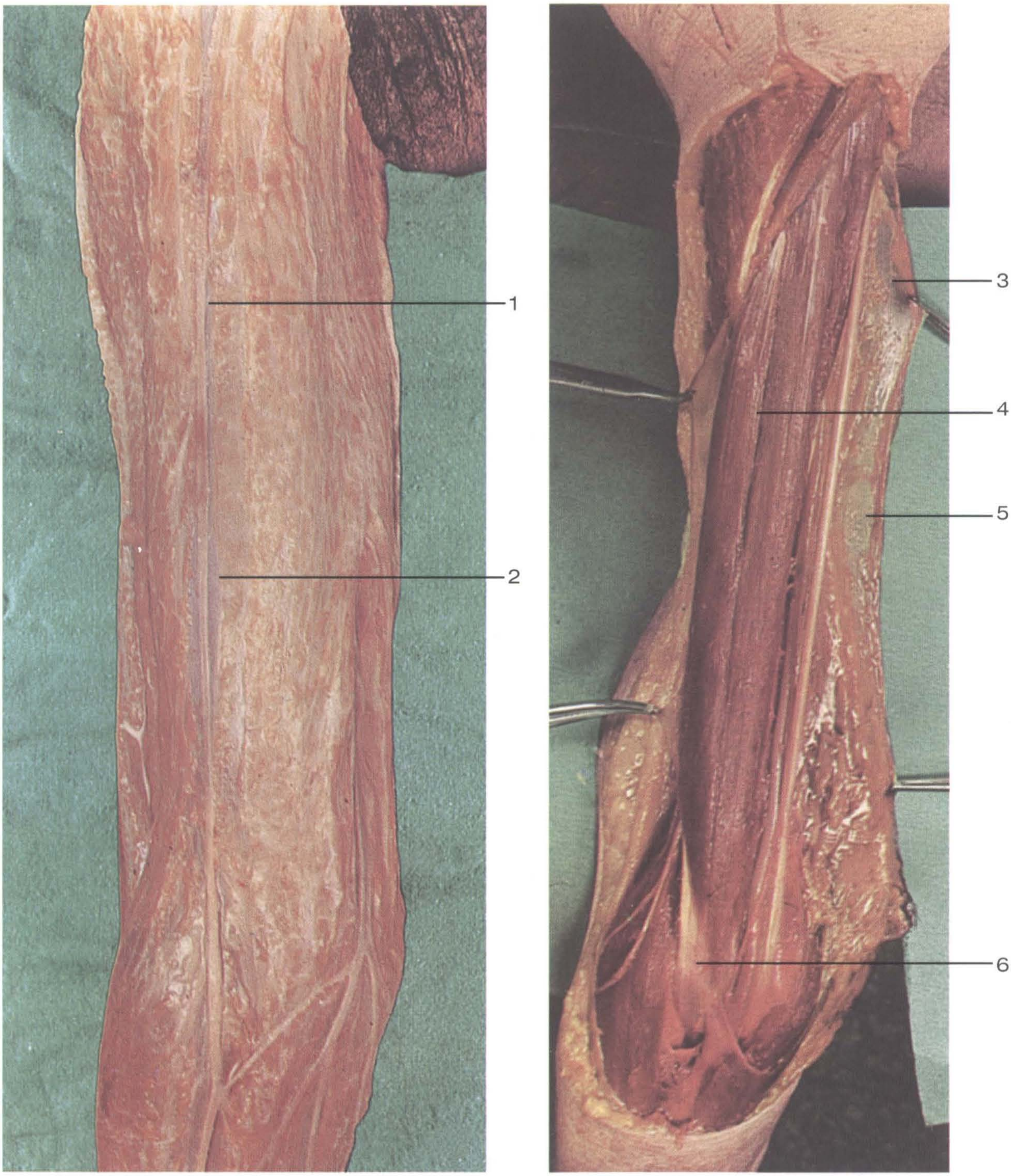

Figure 35. A - Superficial and deep fascia of the anterior part of the arm; B - Dissection of the anterior compartment of the arm (from Fumagalli - Colour photographic atlas of macroscopic human anatomy. - Published by Dr. Francesco Vallardi/Piccin Nuova Libraria).

1, Cephalic vein surrounded by the loose connective tissue of the superficial fascia of the arm; 2, Partial view of the deep fascia of the anterior part of the arm; 3, Deep fascia sectioned and tensioned; 4, location of cc of ante-cubitus; traction exerted on the epimysium of the biceps (biarticular fibres) and traction of the muscular fibres of brachialis m. (monoarticular fibres) inserted into the intermuscular septa, converge at this point; 5, deep fascia that continues on with the medial intermuscular septum and the epimysium of the brachialis m.; 6, distal tendon of biceps, where it is evident the progressive insertion of the muscular fibres at graduated levels (for recruitment of Gto's in succession).

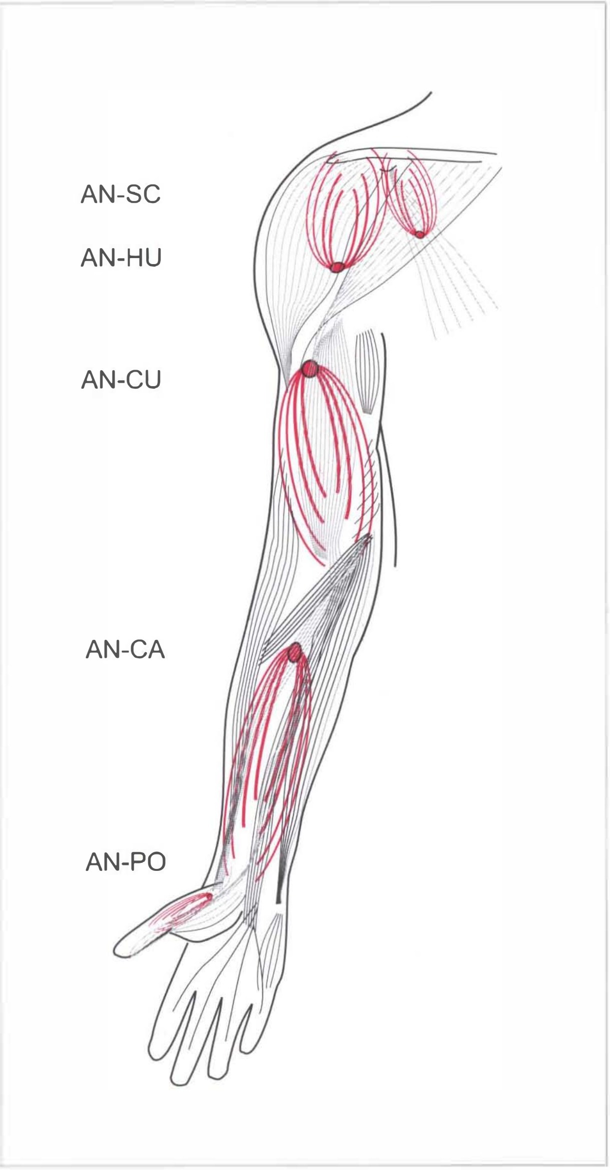

Figure 36. Myofascial unit of antemotion of the upper limb.

Mf unit of antemotion of the upper limb

Mf unit of ante-scapula (an-sc).

Antemotion of the scapula (to bring forward and lower the scapula) is effectuated by monoarticular (pectoralis minor) and biarticular fibres (pectoralis major).

The centre of coordination of these vectorial forces is over the belly of the pectoralis minor, beneath the coracoid process (Figure 36).

This cc corresponds to the acupuncture point LU 1 and to the trigger point of pectoralis minor.

Mf unit of ante-humerus (an-hu)

Antemotion of the humerus (to bring the arm forward to a maximum of 90°) is effectuated by monoarticular (coracobrachialis, deltoid) and biarticular fibres (clavicular part of pectoralis major, biceps).

The centre of coordination of these forces is in the groove between deltoid and pectoralis major, over the short head of biceps.

This cc corresponds to the acupuncture point LU 2 or EX 91 and to the trigger point of anterior deltoid.

Mf unit of ante-cubitus (an-cu)

Antemotion cubitus (to bend the elbow) is effectuated by monoarticular (brachialis) and biarticular fibres (biceps).

The centre of coordination of these forces is over, or slightly lateral to, the muscle belly of biceps.

This cc corresponds to the acupuncture point LU 4 (with reference to the atlas of acupuncture of Souliè de Morant) and to the lateral trigger point of biceps.

Mf unit of ante-carpus (an-ca)

Antemotion of the carpus (to bring the wrist forward and outwards) is effectuated by monoarticular (flexor pollicis longus) and biarticular fibres (flexor carpi radialis).

The centre of coordination of these vectorial forces is over the flexor pollicis longus, laterally to the flexor carpi radialis.

This cc corresponds to the acupuncture point LU 6 and to the trigger point of flexor carpi radialis.

Mf unit of ante-pollex

Antemotion of the pollex (to bring the thumb forward on the sagittal plane) is effectuated by monoarticular (flexor and abductor pollicis brevi) and biarticular fibres (flexor pollicis longus).

The centre of coordination of these forces is over the external and proximal part of the thenar eminence.

This cc corresponds to the acupuncture point LU 10 and to the trigger point of the opponens pollicis (Note: it is more likely that manipulation of this point involves the fascia of the abductor pollicis brevis, which lies over the opponens pollicis. Abductor pollicis brevis moves the thumb anteriorly and not laterally).

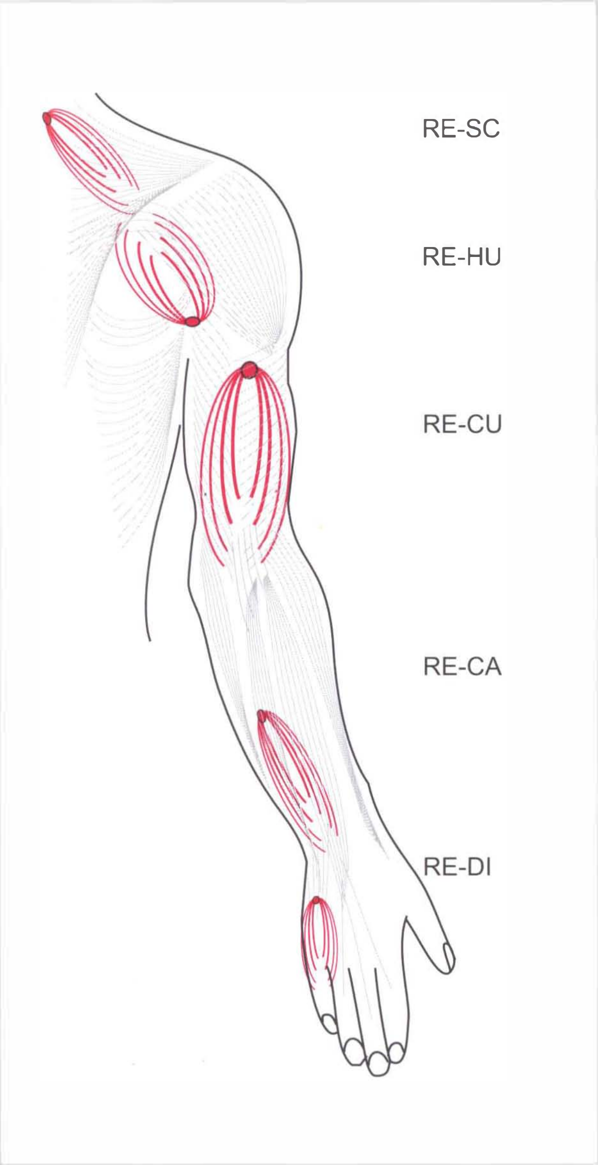

Figure 37. Myofascial unit of retromotion of the upper limb.

Mf unit of retromotion of the upper limb

Mf unit of retro-scapula (re-sc).

Retromotion of the scapula (to move the scapula posteriorly on the sagittal plane) is effectuated by monoarticular (rhomboid major and minor) and biarticular fibres (trapezius).

The centre of coordination of these forces is over the muscle belly of the rhomboids near the division, if any, between the two muscles (Figure 37).

This cc corresponds to the acupuncture point SI 15 and to the trigger point of rhomboid minor.

Mf unit of retro-humerus (re-hu).

Retromotion humerus (posterior movement of the arm on the sagittal plane) is effectuated by monoarticular (teres major, part of the deltoid attached to the scapular spine) and biarticular fibres (latissimus dorsi, long head of triceps).

The centre of coordination of these forces is over the muscle belly of teres major, behind the posterior axillary wall.

This cc corresponds to the acupuncture SI 9 and to the lateral trigger of teres major.

Mf unit of retro-cubitus (re-cu).

Retromotion cubitus (to straighten or extend the elbow) is effectuated by monoarticular (lateral and medial heads of triceps and anconeus) and biarticular fibres (long head of triceps).

The centre of coordination of these forces is at the level of the deltoid insertion, between the long head and the lateral head of triceps.

This cc corresponds to the acupuncture point TE 12 and to the 1° trigger point of triceps.

Mf unit of retro-carpus (re-ca).

Retromotion carpus (dorsiflexion of the wrist) is effectuated by monoarticular (fibres of extensor carpi ulnaris that have their origin from the ulna) and biarticular fibres (fibres of the same muscle and of extensor digitorum, which all originate from the humerus).

The centre of coordination of these vectorial forces is over the muscle belly of the extensor carpi ulnaris, where the fibres that originate from the ulna unite with those from the humerus.

This cc corresponds to the acupuncture point SI 7 and to the trigger point of extensor carpi ulnaris.

Mf unit of retro-digiti (re-di).

Retromotion of the digiti (to extend the fingers with ulna deviation) is effectuated by monoarticular (abductor digiti minimi) and biarticular fibres (extensor digiti minimi).

The centre of coordination of these vectors is over the abductor digiti minimi, at the base of the V° metacarpal (the insertion of the extensor carpi ulnaris m.).

This cc corresponds to the acupuncture point SI 4 and to the trigger point of abductor digiti minimi.

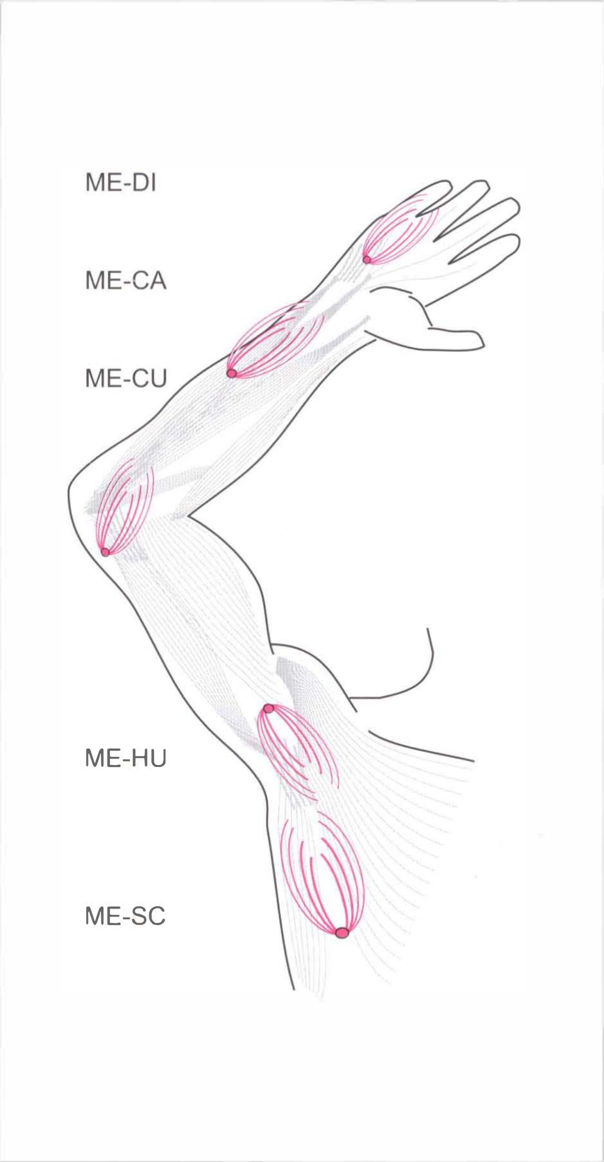

Figure 38. Myofascial unit of mediomotion of the upper limb.

Mf unit of mediomotion of the upper limb

Mf unit of medio-scapula (me-sc).

Mediomotion scapula (active fixation of the scapula to the thorax) is effectuated by monoarticular (serratus anterior) and biarticular fibres (latissimus dorsi)).

The centre of coordination of these vectorial forces is over the serratus anterior muscle, in the sixth intercostal space, along the midline of the axilla (Figure 38).

This cc corresponds to the acupuncture point of SP 21 and the trigger point of the serratus anterior.

Mf unit of medio-humerus (me-hu).

Mediomotion humerus (to hold the arm to thorax) is effectuated by monoarticular fibres (short head of biceps, coracobrachialis) and biarticular fibres (pectoralis major and latissimus dorsi).

The centre of coordination of these forces is behind the coracobrachialis on the lateral wall of the axillary cavity (convergence of vectors which tension the axillary fascia).

This cc corresponds to the acupuncture point HT 1 and the trigger point of the coracobrachialis.

Mf unit of medio-cubitus (me-cu).

Mediomotion cubitus (stabilisation of the elbow during adduction) is effectuated by monoarticular (flexor carpi ulnaris fibres that connect humerus and ulna) and biarticular fibres (flexor carpi ulnaris fibres that connect humerus and carpal bones).

The centre of coordination of these forces is over the medial intermuscular septum where the flexor carpi ulnaris m. begins.

This cc corresponds to the acupuncture point of HT 2.

Mf unit of medio-carpus (me-ca).

Mediomotion of the carpus (ulna deviation of the hand, from the anatomical position) is effectuated by monoarticular (flexor carpi ulnaris fibre that have their origin from the ulna) and biarticular fibres (flexor ulnaris fibres and flexor fibres of the fifth finger that originate from the humerus).

The centre of coordination of these forces is over the flexor carpi ulnaris.

This cc corresponds to the acupuncture point of HT 4 and to the trigger point of flexor carpi ulnaris.

Mf unit of medio-digiti (me-di).

Mediomotion digiti (to adduct the fingers towards the median line) is effectuated by monoarticular (palmar interossei, opponens minimi digiti) and biarticular fibres (palmaris longus - n.b. hypothenar and thenar eminence muscles are inserted onto the aponeurosis of this muscle).

The centre of coordination of these forces is over the palmaris brevis m. and flexor minimi digiti.

This cc corresponds to the acupuncture point HT 8 and the trigger point of the palmar interossei.

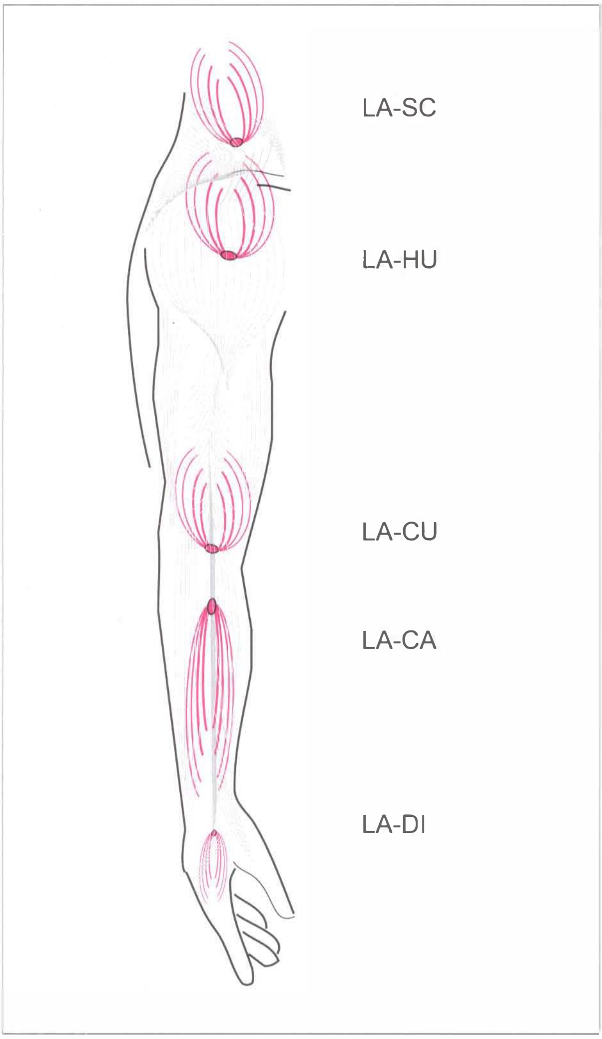

Figure 39. Myofascial unit of lateromotion of the upper limb.

Mf unit of lateromotion of the upper limb

Mf unit of latero-scapula (la-sc).

Lateromotion scapula (to raise the shoulder girdle – humerus abduction above 90°) is effectuated by monoarticular (inferior belly of the omohyoid and scalenus m.) and biarticular fibres (ascending fibres of trapezius and fibres of the SCOM inserted onto the clavicle).

The centre of coordination of these vectors is over the scalenus lateralis between the trapezius and the SCOM (Figure 39).

This cc corresponds to the acupuncture point of LI 17 and the trigger point of the scalenus lateralis.

Mf unit of latero-humerus (la-hu).

Lateromotion humerus (abduct the arm to 90° elevation) is effectuated by monoarticular (middle deltoid, supraspinatus) and biarticular fibres (long head of biceps).

The centre of coordination of these vectors is over the deltoid muscle, in front of the greater tubercle (where supraspinatus m. inserts).

This cc corresponds to the acupuncture point LI 15 and to the trigger point of the deltoid muscle.

Mf unit of latero-cubitus (la-cu).

Lateromotion cubitus (fixation or stabilisation of the elbow during abduction of the arm) is effectuated by monoarticular (brachioradialis) and biarticular fibres (extensor carpi radialis longus).

The centre of coordination of these vectors is over the brachioradialis m. at the level of the head of the radius and in the groove that separates it from the extensor carpi radialis longus.

This cc corresponds to the acupuncture point LI 11 and to the trigger point of the brachioradialis.

Mf unit of latero-carpus (la-ca).

Lateromotion carpus (abduction + extension of the wrist) is effectuated by monoarticular (extensor carpi radialis fibres inserted onto the ligaments of the radius) and biarticular fibres (fibres of the two extensor carpi radialis muscles that are inserted onto the humerus).

The centre of coordination of these vectors is over the muscle belly of the two extensor carpi radialis muscles.

This cc corresponds to the acupuncture point of LI 9 and to the trigger point of the extensor carpi radialis brevis.

Mf unit of latero-digiti (la-di).

Lateromotion of the digiti (to spread the fingers) is effectuated by monoarticular (dorsal interossei) and biarticular fibres (abductor pollicis longus).

The centre of coordination of these forces is over the first dorsal interosseus, precisely where the fascia connects the tendon of the abductor pollicis longus and the interossei of the other fingers.

This cc corresponds to the acupuncture point LI 4 and to the trigger point of the first dorsal interosseus.

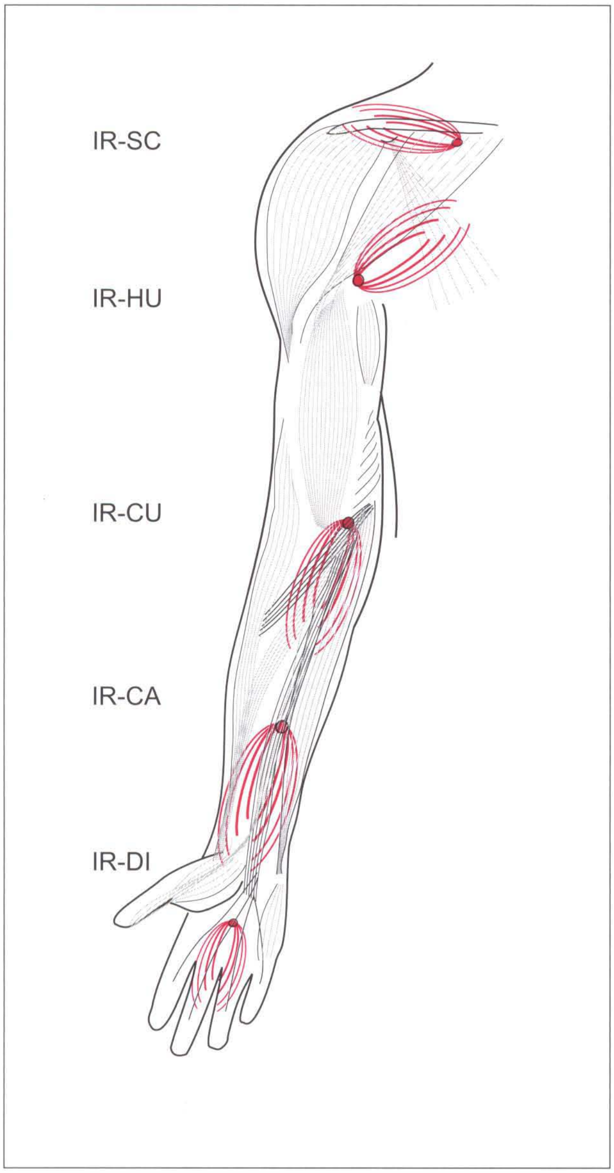

Figure 40. Myofascial unit of intrarotation of the upper limb.

Mf unit of intrarotation of the upper limb

Mf unit of intra-scapula (ir-sc).

Intrarotation scapula (to bring the glenoid cavity to face forwards and downward) is effectuated by monoarticular (subclavius) and biarticular fibres (pectoralis major) (Figure 40).

The centre of coordination of these vectorial forces is beneath the clavicle over the muscle belly of the subclavius.

This cc corresponds to the acupuncture point of ST 13 and the trigger point of the subclavius.

Mf unit of intra-humerus (ir-hu).

Intrarotation of the humerus (internal rotation of the shoulder) is effectuated by monoarticular (subscapularis) and biarticular fibres (pectoralis major and latissimus dorsi).

The centre of coordination of these forces is beneath the pectoralis major tendon over the coracoclavicular fascia, which is continuous with the subscapularis m. (this muscle not directly accessible for manipulation).

This cc corresponds to the acupuncture point of PC 2.

Mf unit of intra-cubitus (ir-cu).

Intrarotation of the cubitus (pronation of the head of the radius) is effectuated by monoarticular (pronator teres) and by biarticular fibre (flexor carpi radialis, palmaris longus).

The centre of coordination of these forces is over pronator teres on the medial border of the cubital fossa.

This cc corresponds to the acupuncture point PC 3 and to the trigger point of pronator teres.

Mf unit of intra-carpus (ir-ca).

Intrarotation carpus (pronation of the distal radio-ulna articulation) is effectuated by monoarticular (pronator quadratus) and by biarticular fibres (brachioradialis, flexor carpi radialis and palmaris longus).

The centre of coordination of these vectorial forces is over the proximal part of pronator quadratus (between the tendons of palmaris longus and flexor carpi radialis).

This cc corresponds to the acupuncture point PC 4 and to the trigger point of pronator quadratus.

Mf unit of intra-digiti (ir-di).

Intrarotation digiti (flexion of the fingers involves intrarotation; this component is considered here whereas the grip, as such, will be analysed in the chapter that deals with motor schemes) is effectuated by monoarticular (lumbricals) and biarticular fibres (flexor digitorum profundus and superficialis).

The centre of coordination of these forces is over the palmar aponeurosis and the tendons of the flexors of the fingers.

This cc corresponds to the acupuncture point PC 8.

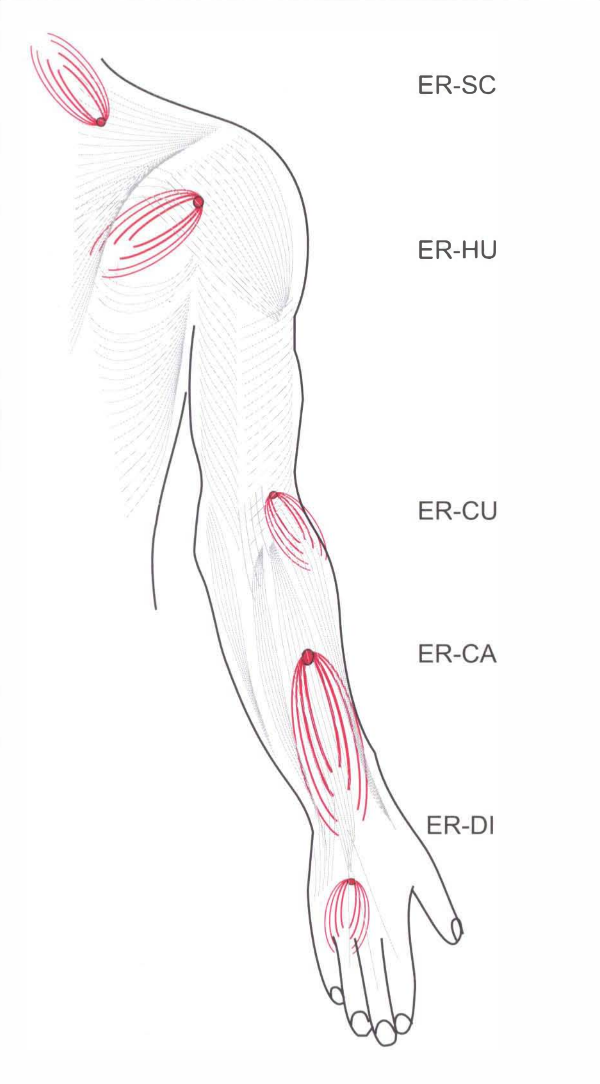

Figure 41. Myofascial unit of extrarotation of the upper limb.

Mf unit of extrarotation of the upper limb

Mf unit of extra-scapula (er-sc).

Extrarotation of the scapula (elevation of the glenoid cavity together with external rotation) is effectuated by monoarticular (serratus anterior inferior) and biarticular fibres (superior fibres of trapezius).

The centre of coordination of these vectorial forces is located above the angle of the scapula, where the fascia of the serratus anterior joins with the fascia of the levator scapulae (also involved in er-cl) and the superior fibres of the trapezius (Figure 41).

This cc corresponds to the acupuncture point TE 15 and the distal trigger point of levator scapulae.

Mf unit of extra-humerus (er-hu).

Extrarotation humerus (external rotation of the arm) is effectuated by monoarticular (teres minor, infraspinatus) and biarticular fibres (posterior deltoid).

The centre of coordination of these forces is over the muscle belly of the infraspinatus and teres minor, below the scapular spine.

This cc corresponds to the acupuncture point TE 14 and to the trigger point of posterior deltoid or that of teres minor.

Mf unit of extra-cubitus (er-cu).

Extrarotation cubitus (supination at the level of the head of the radius) is effectuated by monoarticular (supinator) and biarticular fibres (biceps brachialis, which inserts onto the tuberosity of the radius, brachioradialis).

The centre of coordination of these forces is over the origin of the supinator from the lateral intermuscular septum.

This cc corresponds to the acupuncture point TE 10 and the trigger point of the supinator.

Mf unit of extra-carpus (er-ca).

Extrarotation of the carpus (supination at the distal radio-ulnar articulation) is effectuated by monoarticular (fibres of the extensor pollicis brevis and abductor pollicis longus that, like pronator quadratus, insert onto the interosseous membrane and extend between the radius and the ulna) and biarticular fibres (extensor pollicis longus and extensor digitorum – these muscles have developed the fibres involved in the gesture of opening the hand, in part abandoning their activity on the horizontal plane).

The centre of coordination of these forces is over the extensor pollicis longus and extensor digitorum.

This cc corresponds to the acupuncture point TE 8 and to the trigger point of extensor pollicis longus.

Mf unit of extra digiti (er-di).

Extrarotation digiti (fingers) is effectuated by monoarticular (lumbricals) and biarticular fibres (extensor digitorum).

The centre of coordination of these forces is over the lumbricals and the dorsal interossei. The dorsal fascia coordinates the fine finger movements while the cc of the carpus is involved in coordination of their strength.

This cc corresponds to the acupuncture point TE 3.

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Chapter 5
THE MF UNITS OF THE TRUNK

The motor organisation of the trunk presents several aspects that differ from those already seen in the upper limb.

Sagittal plane

Movements of the trunk on the three planes are usually described in quite confusing terms. For example, the movement of "trunk flexion" is used to describe the action of bending forwards. However this movement is effectuated by the eccentric activity of the erector spinae muscles and therefore it is controlled by the mf units of retromotion of the neck, thorax and the lumbar region. To test the antemotion muscles, or "flexors" of the trunk, the person needs to be positioned supine and asked to raise their head and thorax.

Frontal plane

Mediomotion in the trunk as such is non-existent but ligaments along the median line are active in the perception of the alignment of the body. On both sides of the body the mf units of lateromotion work as antagonists. Thus, as opposed to the limbs where a mf unit of lateromotion has a mf unit of mediomotion as an antagonist, in the trunk it is the mf unit of lateromotion on the opposite side that realigns the body segment to the median line.

Horizontal plane

Movement of a limb on the horizontal plane is carried out by the contraction of a single mf unit, which takes its leverage from a fixed bone. For example, extrarotation of the humerus is effectuated by the single mf unit of er-hu (Figure 42).

In the trunk, due to the fact that its rotary movements take place on a mobile body, coupled forces are required. The vertebrae act as the pivot around which coupled forces of extra and intrarotation act.

Quite commonly the study of trunk movement only takes into consideration the dorsal muscles which rotate the trunk posteriorly, ignoring altogether that there is always a simultaneous force generated by the anterior part of the trunk on the opposite side of the body. Even though these differences exist the brain interprets extrarotation, both of the trunk and the limbs, as an outward movement whereas intrarotation is considered as an inward movement.

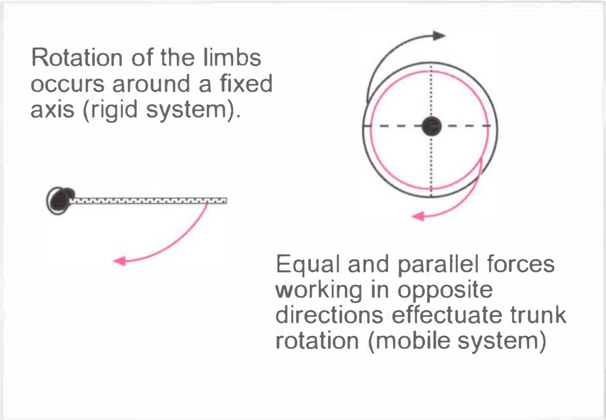

Figure 42. Coupled forces acting on horizontal plane in the trunk.

Mf unit of the caput (head)

Whilst the caput (head) is considered as one segment it comprises three main articulations: the eye, with the rotation of the eyeball within its bony orbit, the temporomandibular joint and the middle ear with its auditory ossicles. Each of these articulations has its own muscles and its own mf units.

The eye is a spherical articulation (enarthrosis) with six muscles that move the eyeball in the three planes.

The mandible moves forwards, laterally and in circumduction[67]. The mf units of intra, ante and latero govern these motor trajectories.

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[67] The inferior articulation rotates and the superior part slides forward when the mouth is opened. Mostly it is the lateral pterygoid m. that controls this movement. Along with the opening of the mouth lateral movement also occurs. (Platzer W, 1979)

The chain of auditory ossicles[68] is subjected to the action of two muscles that are antagonists to one another: the tensor tympani muscle and the stapedius muscle. The muscle of the stapes (stapedius) releases the tympanic membrane[69]. Tension in this membrane is also regulated according to traction of the neck fasciae.

The tongue is also situated in the head but, because it originates from infra pharyngeal musculature[70], its centres of coordination are found in the neck.

The musculature of the caput (head) originates from the first three pharyngeal arches and three cephalic somites[71], which are continuous with the somites of the trunk. The myofascial sequences are a sort of enduring testimony to these origins. The superior rectus muscle of the eye, for example, elevates the gaze and its action is always synchronised with the erector spinae muscles. The intra ocular fascia is continuous with the nuchal fascia via the longitudinal fibres of the epicranial fascia. This fascia is tensioned longitudinally by the occipitalis and frontalis muscles. Together these structures form the mf unit of retro-caput (re-cp), which is divided into three minor mf units. Each minor mf unit is specific for the coordination of the fibres of the following muscles: re-cp 1 for the superior rectus of the eye; re-cp 2 for the frontalis; re-cp 3 for the occipitalis.

The antagonist of this mf unit is ante-caput (an-cp). An-cp is also divided into three minor mf units: an-cp 1 for the inferior rectus of the eye; an-cp 2 for the zygomaticus muscles and the levator angoli oris; an-cp 3 for the depressor angoli oris and the anterior belly of digastric. These muscles are all connected[72] and, as they originate from the inferior margin of the orbit[73], they tension the orbital and facial fasciae in the opposite direction to that of the mf unit of re-cp. This continuity facilitates the synergy that exists between eye, head and neck movements. This synergy is so well established that it is quite difficult to raise the eyes whilst simultaneously lowering one's head or vice versa.

The levator anguli oris muscle is the medial portion of the levator labii superioris. In fact the first[74] is a part of the mf unit of medio-caput (me-cp) while the second is part of the mf unit of ante-caput (an-cp).

The mf unit of me-cp 1 originates from the medial palpebral ligament; the mf unit of la-cp 1 originates from the lateral palpebral ligament. These two ligaments are situated at the opposite extremes of the orbicularis oculi muscle; the first is in close relationship with the lachrymal sac and the second does not end at the lateral angle of the eye but is continuous with the temporal fascia[75]. The cc of la-cp 2 is located over this fascia, whereas la-cp 3 is located in the masseteric fascia, which is continuous with the temporal fascia.

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[68] The formation of the ossicles of the ear is linked to the transformation of the mandibular joint: the second pharyngeal arch transforms into the stapes. In mammals the two endochondral bones, which separated from the primary articulation of the maxillary arch, are incorporated into the middle ear: the quadrate becomes the incus and Meckel's cartilage becomes the malleus. (Stefanelli A, 1968)

[69] The muscle of the malleus is innervated by the mandibular branch of the trigeminal nerve whilst its antagonist, the stapedius muscle, relaxes the tympanic membrane and is innervated by the facial nerve. (Testut L, 1987)

[70] The muscles of the diaphragm originate from infra branchial musculature. Consequently from this area there is a caudal migration, with the formation of muscles that develop in the trunk (diaphragm) and a cephalic migration of muscles towards the head (tongue). (Stefanelli A, 1968)

[71] The musculature of the head originates from the pharyngeal arches but there is also a part of its musculature that is derived from the cephalic somites. (Stefanelli A, 1968)

[72] The triangular muscle or depressor anguli oris fuses with the zygomaticus muscle above and laterally with some fascicles of the platysma. This same muscle is said to receive some muscular slips originating from the masseteric fascia, which after passing via the depressor anguli oris converge towards the corners of the lips. Often slips that are placed deeply to the triangular muscle pass below the chin to unite with other slips from the opposite side. (Chiarugi G, 1975)

[73] The infraorbital portion of the zygomaticus minor and the levator anguli oris originate from above the infra-orbital foramen on the infra-orbital margin and insert below into the upper lip. (Chiarugi G, 1975)

[74] The levator anguli oris originates from the frontal process of the maxilla near the medial palpebral ligament, descends vertically and laterally to insert partially into the skin near the nostrils and partially into the skin of the upper lip. (Chiarugi G, 1975)

[75] Some fascicles of the orbicularis are connected via dense connective tissue to the temporalis fascia and thus do not end at the lateral angle of the eye. (Chiarugi G, 1975)

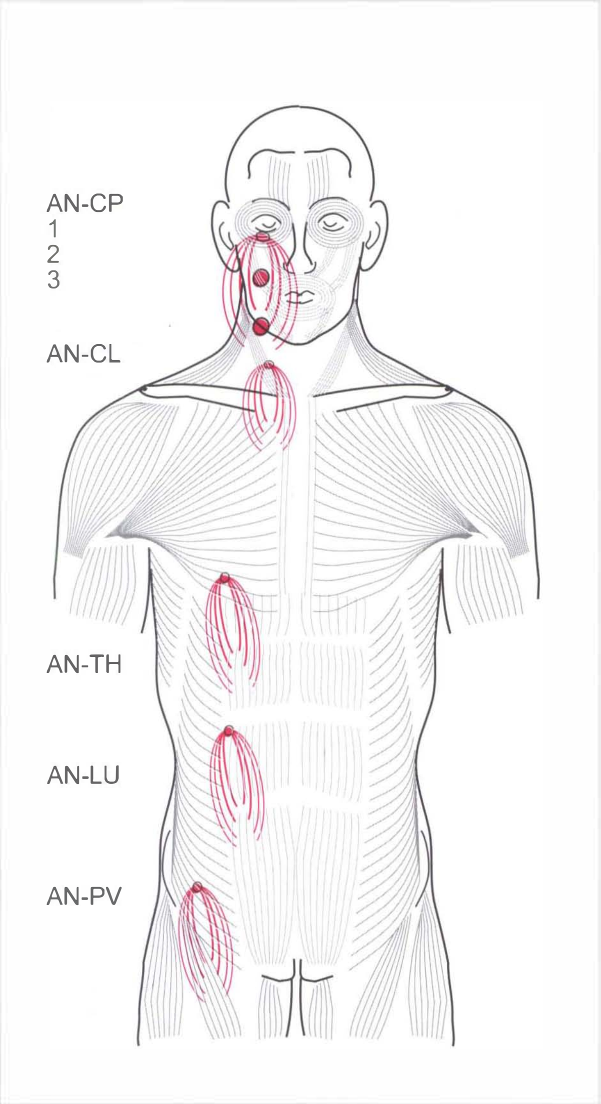

Figure 43. Myofascial unit of antemotion of the trunk.

Mf unit of antemotion of the trunk

Mf unit of ante-caput (an-cp).

Antemotion caput (head) is formed by three minor units (Figure 43): 1 = inferior rectus muscle of the eye; the cc is located between the eyeball and the median point of the infraorbital margin; 2 = zygomaticus muscle; the cc is lateral to the ala of the nostril; 3 = anterior belly of digastric; the cc is over the inferior border of the body of the mandible. The unifying element is the facial fascia, which is tensioned by the platysma.

These cc(s) correspond to the acupuncture points ST 1, 3, 5 and to the trigger point of the zygomaticus muscle and that of the anterior belly of the digastric (Figure 44).

Mf unit of ante-collum (an-cl).

Antemotion collum (to lift the head from supine, bringing the neck forward) is effectuated by monoarticular (longus colli) and biarticular fibres (sternocleidomastoid).

The centre of coordination of these vectorial forces is over the anterior border of the sternocleidomastoid laterally to the thyroid cartilage.

This cc corresponds to the acupuncture point ST 9 and to the anterior trigger point of the sternocleidomastoid.

Mf unit of ante-thorax (an-th).

Antemotion thorax (to lift the thorax from the supine position) is effectuated by monoarticular (sternalis) and biarticular fibres (pectoralis major and rectus abdominis).

The centre of coordination of these forces is immediately below the inferior costal margin.

This cc corresponds to the acupuncture point ST 19 and to the trigger point of the descending fibres of the pectoralis major and not to that of the sternalis muscle, which is only occasionally present.

Mf unit of ante-lumbi (an-lu).

Antemotion of the lumbi (to raise oneself up from the supine position) is effectuated by monoarticular (those fibres of rectus abdominis that extend from one tendinous intersection to another) and biarticular fibres (obliques and transversus abdominis).

The centre of coordination of these forces is over the rectus abdominis muscle, lateral to the umbilicus.

The cc corresponds to the acupuncture point ST 25 and to the trigger point of the rectus abdominis.

Mf unit of ante-pelvi (an-pv).

Antemotion pelvis (to lift the pelvis upwards from supine) is effectuated by monoarticular (iliopsoas, which rotates the pelvis forward if the femur is fixated) and by biarticular fibres (rectus abdominis).

The centre of coordination of these forces is over the iliacus, which is the most accessible point to be able to act upon the fascia of the iliopsoas muscle.

This cc corresponds to the acupuncture point SP 14 and to the trigger point of the external obliques of the inferior quadrant.

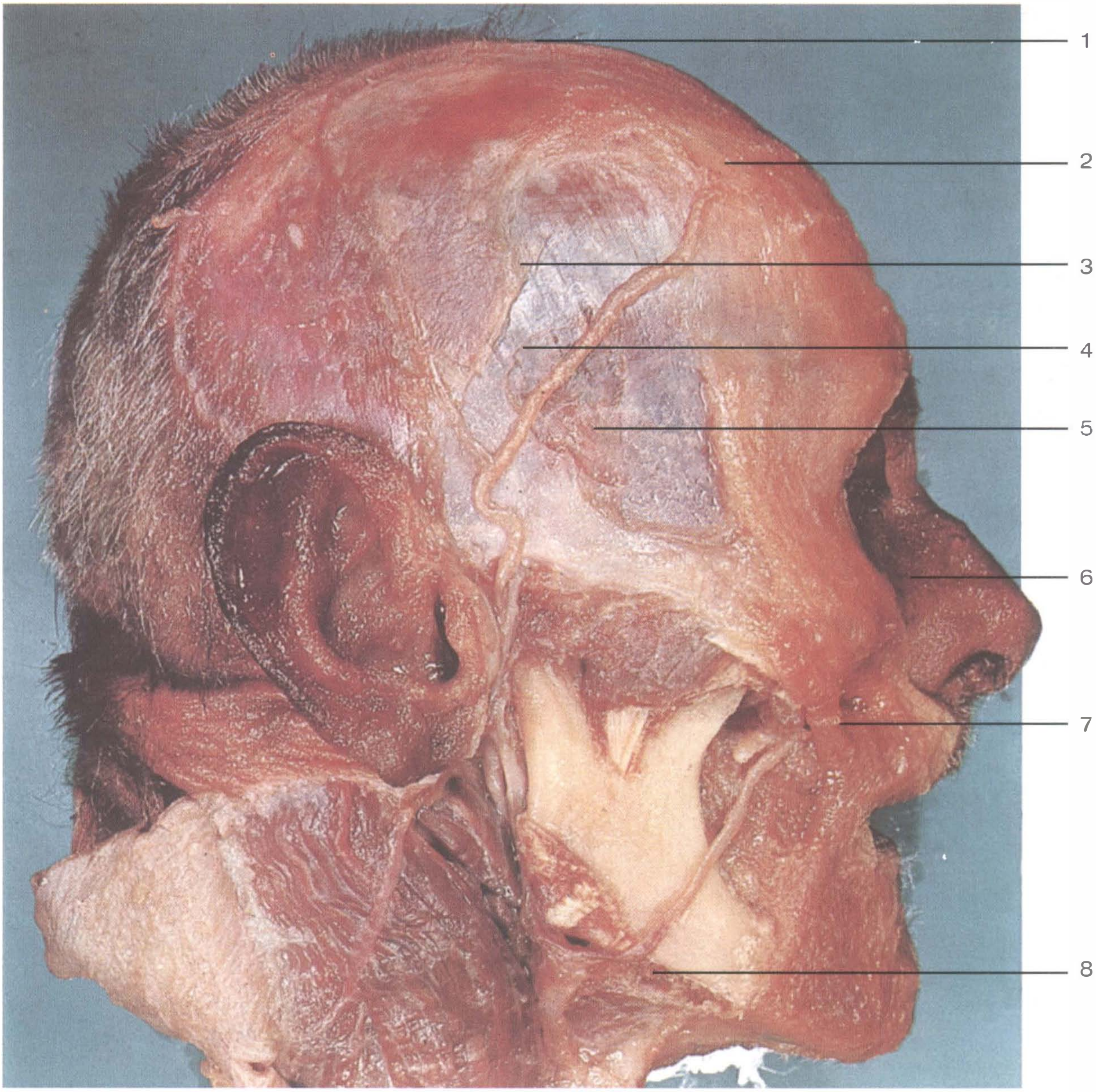

Figura 44. Temporal region of the head with the galea aponeurotica and epicranial fascia. (from Fumagalli - Colour photographic atlas of macroscopic human anatomy. - Published by Dr Francesco Vallardi/Piccin Nuova Libraria).

1, Scalp; 2, subcutaneous connective tissue or superficial fascia or galea aponeurotica. This is called aponeurosis because it provides insertions: in front to the frontalis m. (re-cp 2) and behind to the occipitalis muscle (re-cp 3) and laterally to the temporal and auricularis muscles. 3, Layer of loose sliding connective tissue or unnamed fascia or subaponeurotic layer; 4, deep fascia, this epicranial fascia continues over the whole cranium beneath the galea from which it is separated by the previous layer of loose connective tissue; this independent sliding movement allows it to perceive the movements of the head in the three planes; 5, temporal muscle whose fascia is continuous above with the epicranial fascia and below with the masseteric fascia; 6, cc of an-ca 1, in relation to the rectus inferioris; 7, an-cp 2, situated over the zygomaticus muscle; 8, an-cp 3, over the anterior belly of digastric; the posterior belly of digastric inserts onto the mastoid process (re-cl, sagittal plane).

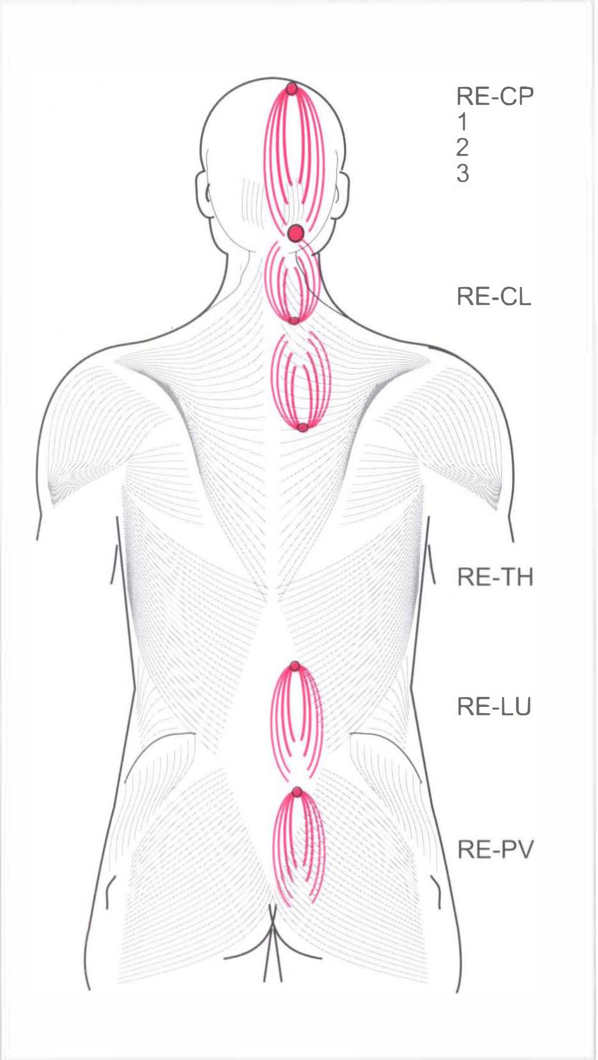

Figure 45. Myofascial unit of retromotion of the trunk.

Mf unit of retromotion of the trunk

Mf unit of retro-caput (re-cp).

Retromotion of the caput (head) is formed by three minor units (Figure 45): 1 = superior rectus of the eye; the cc is on the internal edge of the eyebrow. 2 = frontalis muscle; the cc is in the centre of the frontalis muscle (Figure 44). 3 = occipitalis muscle; the cc is in the area between this muscle and the erector spinae.

The unifying element is the epicranial fascia, which is tensioned by the previously mentioned muscles.

These cc's correspond to the acupuncture points of BL 2, 4, 9 and to the trigger point 3 of the semispinalis capitis and to the TP of occipitalis and frontalis muscles.

Mf unit of retro-collum (re-cl).

Retromotion collum (to move the neck backwards) is effectuated by monoarticular (multifidus of the neck) and biarticular fibres (semispinalis cervicis, longissimus cervicis).

The centre of coordination of these forces is over the muscular mass of the erector spinae at the level of the sixth cervical vertebra.

This cc corresponds to the acupuncture point of SI 16 and to the 1st. trigger point of the multifidus.

Mf unit of retro-thorax (re-th).

Retromotion of the thorax (to hyperextend the thorax) is effectuated by monoarticular (multifidus of the thorax) and biarticular fibres (longissimus thoracis).

The centre of coordination of these vectorial forces is over the muscular mass of the erector spinae at the level of the fourth thoracic vertebra. Referred pain and tension from this cc manifest themselves most frequently at the level of the seventh cervical vertebra as indicated by the diagram Figure 45.

This cc corresponds to the acupuncture point of BL 14 and to the trigger point of the erector spinae.

Mf unit of retro-lumbi (re-lu).

Retromotion lumbi (to straighten up) is effectuated by monoarticular (multifidus) and by biarticular fibres (longissimus lumborum).

The centre of coordination of these forces is over the muscular mass of the erector spinae at the level of the first lumbar vertebra.

This cc corresponds to the acupuncture point BL 22 and the trigger point of longissimus and multifidus.

Mf unit of retro-pelvis (re-pv).

Retromotion pelvis (hyperextension) is effectuated by monoarticular (multifidus) and biarticular fibres (longissimus lumborum, quadratus lumborum).

The centre of coordination of these vectorial forces is over the origin of quadratus lumborum from the iliolumbar ligament.

This cc corresponds to the acupuncture point BL 26 and to the trigger point of the multifidus at the level of the first sacral vertebra.

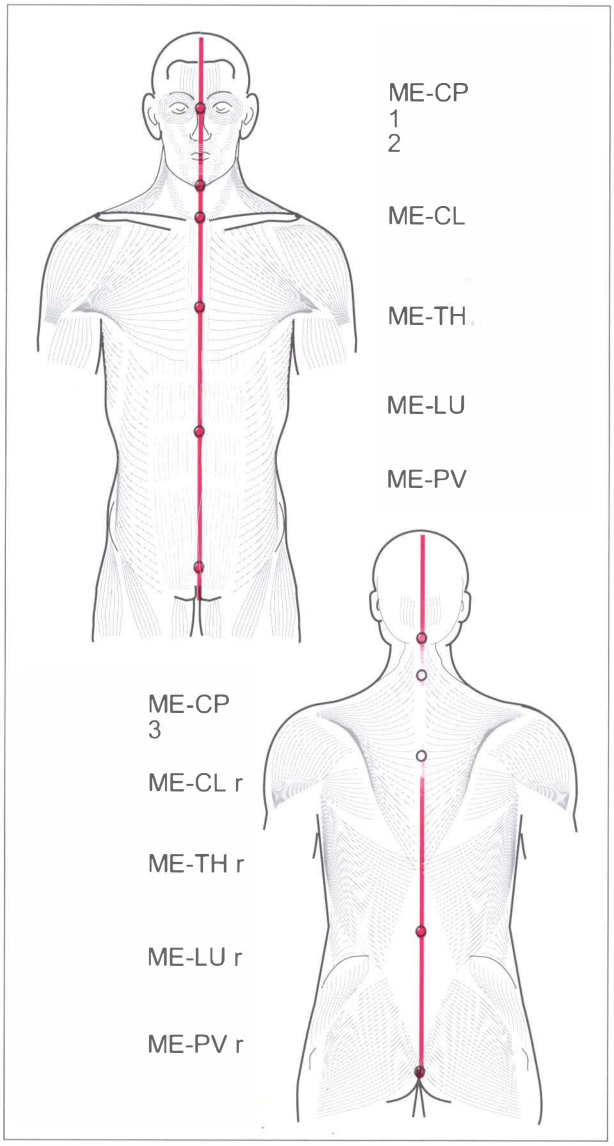

Figure 46. Myofascial unit of mediomotion of the trunk.

Mf unit of mediomotion of the trunk

Mf unit of medio-caput (me-cp).

Mediomotion caput (to position the head on the medial plane) is divided into three minor units: 1 = medial rectus muscle of the eye; the cc is over the medial angle of the eye. 2 = raphe of the mylohoid muscle, which centres the mandible; the cc is under the chin. 3 = occipital insertion of the ligamentum nuchae; the cc is beneath the occipital protuberance (Figure 46).

This cc corresponds to the acupuncture points BL 1, VC 23, VG 16.

Mf unit of medio-collum ante (me-cl).

Mediomotion collum (alignment of the neck with the line of gravity) is co-ordinated anteriorly by the cervical linea alba or median raphe of the anterior cervical fascia. The centre of coordination of this linea is over the suprasternal notch.

This cc corresponds to the acupuncture point CV 22.

Mf unit of medio-collum retro (me-cl r).

Mediomotion of the collum is co-ordinated posteriorly by the ligamentum nuchae.

The centre of coordination is over the ligament itself as it has a role in perceiving the position of the neck in space. This cc corresponds to the acupuncture point GV 14.

Mf unit of medio-thorax ante (me-th)

Mediomotion of the anterior thorax refers to the sternal fascia tensioned between the two muscular masses of the pectoralis major. The centre of coordination of these forces is over the sternum. This cc corresponds to the acupuncture point VC 16.

Mf unit of medio-thorax retro (me-th r).

The centre of coordination of these vectorial forces is over the supraspinous and interspinous ligaments of the fourth thoracic vertebra. (It is to be noted that all cc(s) of the trunk have a maximal point, with secondary points situated slightly proximally or slightly distally).This cc corresponds to the point GV 12.

Mf unit of medio-lumbi ante (me-lu).

The centre of coordination of these forces is over the abdominal part of the linea alba extending between the umbilicus and the xiphoid process.

This cc corresponds to the ac. point CV 9.

Mf unit of medio-lumbi retro (me-lu r).

The centre of coordination of these forces is over the lumbar interspinous ligaments.

This cc corresponds to the acupuncture point GV 4.

Mf unit of medio-pelvi ante (me-pe).

The centre of coordination of these forces is between the two muscles which tension the linea alba, the pyramidalis muscles.

This cc corresponds to the ac. point CV 3.

Mf unit of medio-pelvis retro (me-pv r).

The centre of coordination of these forces is over the raphe of the pubococcygeus fascia between the sacrum and the coccygeus.

This cc corresponds to the acupuncture point GV 2.

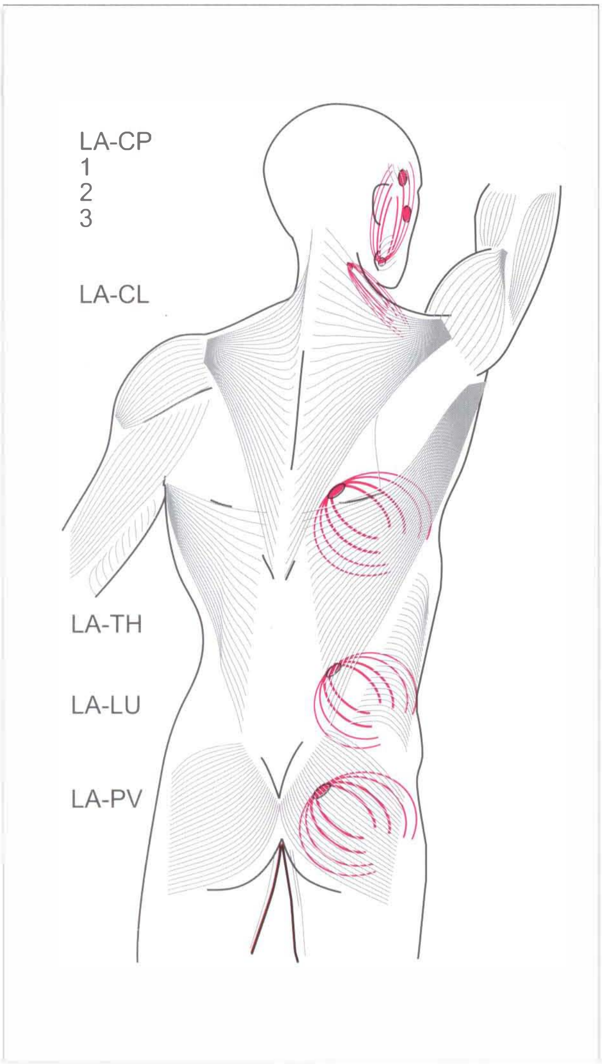

Figure 47. Myofascial unit of lateromotion of the trunk.

Mf unit of lateromotion of the trunk

Mf unit latero-caput (la-cp).

Lateromotion caput is divided into three minor units (Figure 47): 1 = lateral rectus muscle of the eye; the cc is over the lateral angle of the eye. 2 = temporalis muscle; the cc is at the centre of this muscle. 3 = masseter muscle; the cc is at the centre of this muscle. The temporalis and masseteric fascia, which extends over the two muscles mentioned above, unifies their action during the closure of the mandible.

These cc correspond to the acupuncture points of GB 1, ST 8, ST 6 and to the trigger points of the temporalis muscle (1, 2, 3 – according to where the fascial densification is found) and the masseter muscle.

Mf unit of latero-collum (la-cl).

Lateromotion collum (lateral flexion of the neck) is effectuated by monoarticular (scalenus medius) and biarticular fibres (sternocleidomastoid).

The centre of coordination of these vectorial forces is over the lateral part of the sternocleidomastoid at the level of the thyroid cartilage.

This cc corresponds to the acupuncture point LI 18 and to the trigger point of the sternocleidomastoid, the sternal and clavicular part. There are several trigger points for this muscle as it participates in several different movements.

Mf unit of latero-thorax (la-th).

Lateromotion thorax (lateral flexion) is effectuated by monoarticular (interspinales, intertrasversarii, intercostals) and biarticular fibres (iliocostalis, trapezius).

The centre of coordination of these forces is over the iliocostalis thoracis, below the inferior border of the trapezius muscle.

This cc corresponds to the acupuncture point BL 46 and to the trigger point of the iliocostalis muscle.

Mf unit of latero-lumbi (la-lu).

Lateromotion lumbi (to bend to one side) is effectuated by monoarticular (quadratus lumborum) and biarticular fibres (iliocostalis, obliques).

The centre of coordination for these forces is over the quadratus lumborum muscle.

This cc corresponds to the acupuncture point BL 52 and to the trigger point of quadratus lumborum.

Mf unit of latero-pelvis (la-pv).

Lateromotion of the pelvis (to stabilise the pelvis on weight bearing) is effectuated by monoarticular (gluteus medius) and biarticular fibres (gluteus maximus).

The centre of coordination of these forces is over the gluteal muscles, both medius and maximus, at the level of the fourth sacral foramen.

This cc corresponds to the acupuncture point BL 54 and to the trigger point of the above-mentioned muscles.

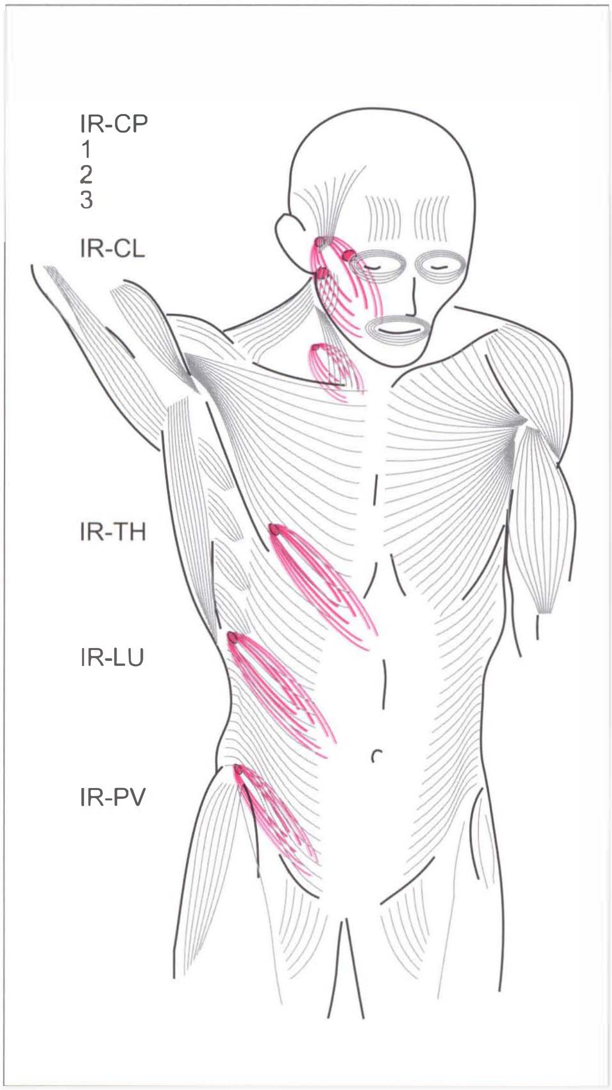

Figure 48. Myofascial unit of intrarotation of the trunk.

Mf unit of intrarotation of the trunk

Mf unit of intrarotation of the caput (ir-cp).

Intrarotation caput is divided into three minor units: 1 = inferior oblique muscle of the eye; the cc is at the lateral tip of the eyebrow. 2 = lateral pterygoid muscle inserted into the articular disc of the TMJ; the cc is between the tragus and the head of the mandible; 3 = medial pterygoid; the cc is between the lobe of the ear and the neck of the mandible. The fascia of the pterygoid muscles is the unifying element for these three minor units (Figure 48).

These cc correspond to the acupuncture points TE 23, TE 21, GB 2 and to the trigger point of the pterygoid muscles.

Mf unit of intra-collum (ir-cl).

Intrarotation collum (to return the neck to the median line from extrarotation) is effectuated by monoarticular (scalenus anterior) and biarticular fibres (sternocleidomastoid).

The centre of coordination of these forces is over the scalenus anterior between the two heads of the SCM.

This cc corresponds to the acupuncture point ST 11 and to the trigger point of the previously mentioned muscles.

Mf unit of intra-thorax (ir-th).

Intrarotation thorax (to bring forward one side of the thorax) is effectuated by monoarticular (intercostals) and biarticular fibres (pectoralis major, latissimus dorsi, obliques).

The centre of coordination of these forces is on the midclavicular line over the intercostal muscle of the fifth/sixth intercostal space.

This cc corresponds to the acupuncture point LR 14.

Mf unit of intra-lumbi (ir-lu).

Intrarotation of the lumbi (to bring forward the costal margin on the same side) is effectuated by monoarticular (transversus abdominis, which maintains a certain metamerism and terminates at the linea alba) and biarticular fibres (the oblique muscles have fibres that cross many metameres, with the external fibres continuing on without interruption with the internal fibres of the opposite side).

The centre of coordination of these forces is beneath the eleventh rib.

This cc corresponds to the acupuncture point LR 13 and to the lateral trigger point of the external obliques.

Mf unit of intra-pelvis (ir-pv).

Intrarotation of the pelvis (to bring the iliac crest forward) is effectuated by monoarticular (gluteus minimus) and biarticular fibres (obliques, tensor fascia lata and sartorius).

The centre of coordination of these forces is over gluteus minimus muscle immediately below the anterior superior iliac spine.

This cc corresponds to the acupuncture point GB 27 and to the trigger point of the gluteus minimus (this muscle rotates the hip internally when the femur is not fixated and rotates the pelvis internally when the femur is fixated).

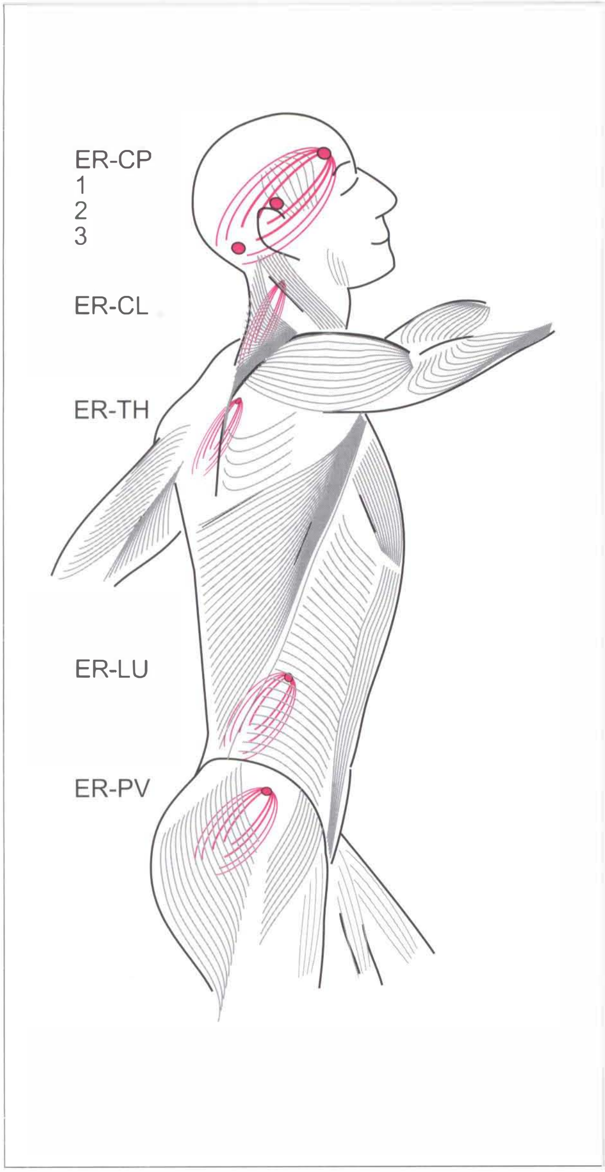

Figure 49. Myofascial unit of extrarotation of the trunk

Mf unit of extrarotation of the trunk

Mf unit of extra-caput (er-cp).

Extrarotation caput is divided into three minor units: 1 = superior oblique muscle of the eye; the cc is above the middle of the eyebrow; 2 = superior auricularis m.; the cc is above the helix of the ear; 3 = posterior auricularis m.; the cc is located where the post. auricularis m. originates from the nuchal line and the mastoid part of the temporal bone (Figure 49). The fascia temporoparietal, which extends from the orbit to the galea aponeurotica, the epicranial fascia and to the occiput, is the unifying element for these three minor units. These cc correspond to the acupuncture points of GB 14, 8, and 12.

Mf unit of extra-collum (er-cl).

Extrarotation collum (to look back) is effectuated by monoarticular (rotatores cervicis - deep layer of multifidus) and biarticular fibres (splenius capitis, levator scapulae).

The centre of coordination of these vectorial forces is over the splenius and the rotatores, at the level of the transverse process of the second and third cervical vertebrae.

This cc corresponds to the acupuncture point TE 16 and to the trigger point of the splenius.

Mf unit of extra-thorax (er-th).

Extrarotation thorax (to rotate backwards one side of the thorax) is effectuated by monoarticular (serratus posterior superior) and biarticular fibres (latissimus dorsi).

The centre of coordination of these forces is over the origin of the serratus posterior superior near the spine of the scapula.

This cc corresponds to the acupuncture point BL 42 and to the trigger point of the serratus posterior superior.

Mf unit of extra-lumbi

Extrarotation of the lumbi (to rotate the costal margin posteriorly) is effectuated by monoarticular (serratus posterior inferior) and biarticular fibres (latissimus dorsi).

The centre of coordination of these forces is over the origin of the serratus posterior inferior from the twelfth rib.

This cc corresponds to the acupuncture point GB 25 and to the trigger point of the serratus posterior inferior.

Mf unit of extra-pelvis (er-pv).

Extrarotation pelvis (er-pv) is effectuated by monoarticular (gluteus medius) and biarticular fibres (gluteus maximus).

The centre of coordination of these forces is over the gluteus medius muscle immediately below the highest point of the iliac crest; at this point the gluteal fascia provides insertions for many muscle fibres. Many connective tissue laminae extend posteriorly from here, either intertwining between the muscular fibres or connecting up with the sacrotuberous ligament.

This cc corresponds to the acupuncture point GB 29 and to the trigger point of the gluteus medius.

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Chapter 6
THE MF UNITS OF THE LOWER LIMB

The lower limb is comprised of only four segments because the pelvic girdle, which acts mostly in synchrony with the trunk, has been included in the previous chapter. In this chapter the variations in terminology used for motor trajectories in the lower limb, as well as the differences in the parallels drawn between acupuncture meridians and the mf sequences are considered, followed by the description of the singular mf units.

Differences in movement terminology

The brain does not interpret movement in terms of individual muscle action but as motion occurring on spatial planes[76]. When a person walks, for example, the brain is intent on bringing the lower limb forward hence antemotion of the thigh, knee and foot occurs. In anatomy the term flexion means closure of a joint and extension means the opening out of a joint. When applying these terms to the previous example of antemotion of the lower limb, the description becomes: flexion of the hip, extension of the knee and dorsiflexion of the foot. This way of naming the same motor trajectory does not mirror the neuromuscular organisation. Contradiction between how the brain organises movement and how movements of the lower limb are commonly named can also be found in the antagonist movement. Retromotion of the hip, knee, tarsus and foot, which takes place with normal gait, corresponds in canonical terms to: hip extension, knee flexion and plantar flexion of the foot. Furthermore, the terms inversion and eversion of the foot are often used differently by different authors and confusion is made when comparing these to the movements of pronation and supination of the forearm. The terms proposed in this book are valid alternatives that respect neuromuscular organisation and simplify the analytical process of the study of movement.

Differences with acupuncture meridians

When tracing acupuncture meridians the ancient Chinese followed the distribution of referred pain in consequence to compression of certain precise points. Referred pain can follow different fascial distributions, the most frequent being along the endofascial collagen fibres that run parallel to the unidirectional myofascial unit sequences. Knowledge of the anatomical structures that underlie these radiations has led to the application of the following modifications:

- The meridian of the Gall Bladder (GB) as represented by the Chinese presents a zigzag pathway, referred pain being distributed between the anterior and posterior parts of the femur and the fibula. From an anatomical viewpoint, however, the points that are anterior to these two bones lie over muscles involved in lateromotion, whilst the points located posteriorly lie over muscles involved in extrarotation of the knee and the ankle.
- The meridian of the Stomach (ST) corresponds to the mf unit of antemotion; in the trunk this meridian runs parallel to the meridian of the Spleen whereas in the lower limb these two meridians separate from each other. The crossing over of the two meridians at the inguinal level appears to have been decided upon more for theoretical or philosophical reasons than from an anatomical truth.
- The meridian of the Liver (intrarotation) has an antagonistic function with regards to the meridian of the Gall Bladder (extrarotation). In order to coordinate movements of the foot on the horizontal plane, the LR meridian passes above the abductor hallucis muscle.

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[76] It has been demonstrated that stimulation at a single point of the motor cortex produced contractions in many muscles according to a specific scheme of radiation, rather than contraction of a single muscle. (Light S, 1971)

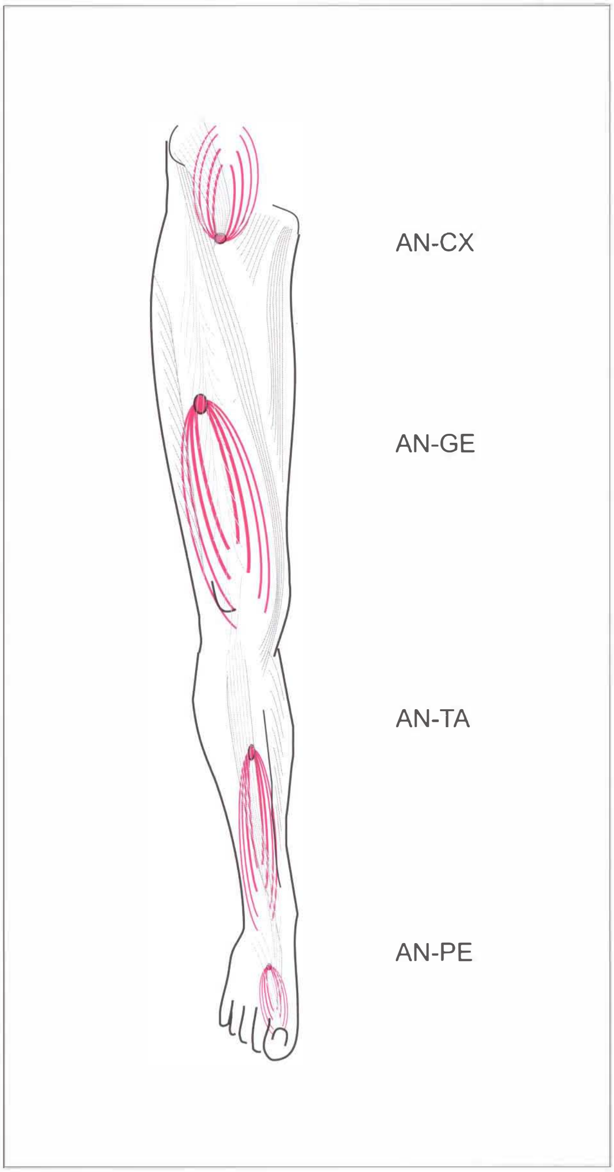

Figure 50. Myofascial unit of antemotion of the lower limb.

Mf unit of antemotion of the lower limb

Mf unit of ante-coxa (an-cx).

Antemotion of the coxa (hip)(to bring the thigh forward) is effectuated by monoarticular (pectineus, adductor longus) and biarticular fibres (iliopsoas, tensor fascia lata, sartorius, gracilis).

The centre of coordination of these vectorial forces is over the lateral pectineus[77] and iliopsoas, beneath the inguinal ligament (Figure 50).

This cc corresponds to the acupuncture point SP 12 and to the trigger point of the pectineus muscle.

Mf unit of ante-genu (an-ge).

Antemotion of the genu (knee)(to bring the knee forward) is effectuated by monoarticular (vastus medialis, intermedius and lateralis) and biarticular fibres (rectus femoralis) (Figure 51).

The centre of coordination of these forces is over the vastus intermedius muscle, midway on the thigh.

This cc corresponds to the acupuncture point ST 32 and to the trigger point of the quadriceps femoris[78].

Mf unit of ante-talus (an-ta)

Antemotion talus (dorsiflexion of the foot) is effectuated by monoarticular (tibialis anterior[79] and biarticular fibres (extensor hallucis longus and extensor digitorum longus).

The centre of coordination of these forces is over the tibialis anterior, midway on the leg.

This cc corresponds to the acupuncture point ST 37 and to the trigger point of tibialis anterior.

Mf unit of ante-pes (an-pe).

Antemotion pes (to raise the foot/big toe upward and forward) is effectuated by monoarticular (extensor hallucis brevis) and biarticular fibre (extensor hallucis longus and extensor digitorum longus).

The centre of coordination of these forces is over the extensor hallucis brevis between the first and second metatarsal.

This cc corresponds to the acupuncture point LR 3 and to the trigger point of the extensor hallucis brevis.

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[77] The pectineus muscle can present a number of variations. It can be divided into superficial and deep or medial and lateral. In this latter case the lateral portion is innervated either by a branch from the femoral nerve or one from the accessory obturator, whilst the medial portion is innervated by the obturator. (Travell J, 1998)

[78] The vastus intermedius contains numerous deep TP that are often difficult to localise by palpation. The series of deep TP in the central part vastus lateralis are usually numerous and require deep palpation. (Travell J, 1998)

[79] On the non-weight bearing limb, the tibialis anterior dorsiflexes the foot at the talotibial joint raising it upwards, acting upon the intertarsal joints inferior to the talus. (Travell J, 1998)

Figura 51. Antero-medial compartment of the thigh and the femoral triangle. (from Fumagalli - Photographic colour atlas of human macroscopic anatomy. - published by Dr. Francesco Vallardi Piccin, Nuova Libraria).
1, cc of fusion of an-la-cx, at this point the ante (sartorius inserted onto the inguinal ligament) and latero (tensor fascia lata) vectors converge; 2, cc of an-cx over the iliopsoas; 3, cc of la-cx over the muscle belly of tensor fascia lata; 4, cc of fusion of an-me-cx, at this point the ante (pectineus) and medio (adductors) vectors converge; 5, cc of ir-cx at the apex of the femoral triangle; 6, cc of me-cx, at this point the epimysial fascia of the gracilis is continuous with that of adductor longus; 7, cc of la-ge, from midway on the thigh the muscular fibres act on the knee; 8, cc of an-ge, over the rectus femoris muscle (biarticular fibres), these fibres are on the resultant of the two vectors formed by vastus medialis and vastus lateralis of the quadriceps.

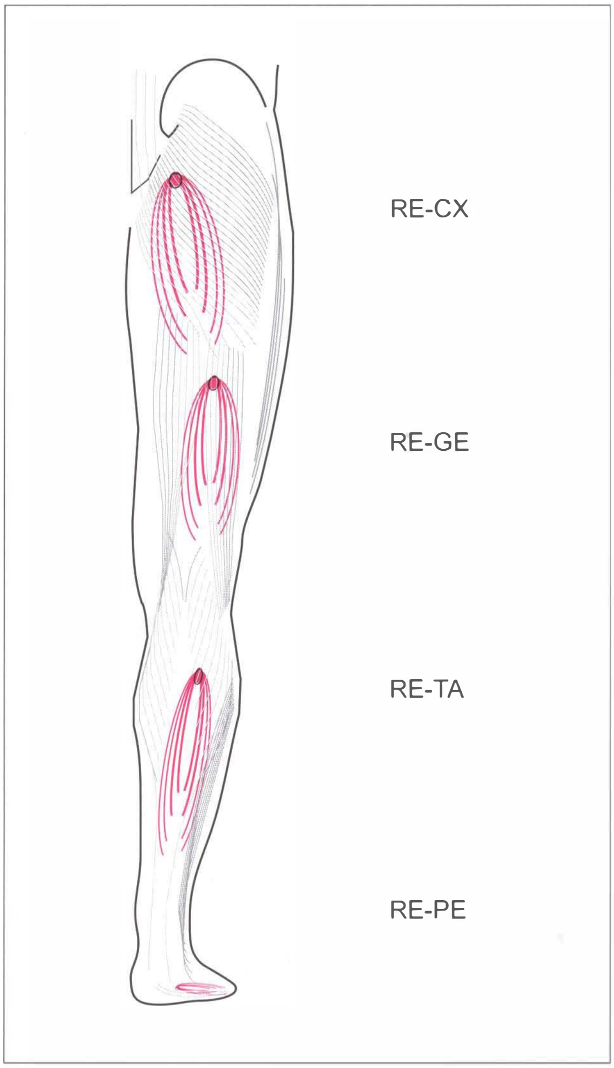

Figure 52. Myofascial unit of retromotion of the lower limb.

Mf unit of retromotion of the lower limb

Mf unit of retro-coxa (re-cx).

Retromotion coxa (to move the thigh backwards) is effectuated by monoarticular (sacrotuberous fibres of the gluteus maximus) and biarticular fibres (semitendinosus[80], biceps femoris-which in part takes origin from the sacrotuberous ligament, semimembranosus).

The centre of coordination of these vectorial forces is over the gluteus maximus above the sacrotuberous ligament (Figure 52).

This cc corresponds to the acupuncture point BL 30 and to the inferior trigger point of the gluteus maximus.

Mf unit of retro-genu (re-ge).

Retromotion genu (to move the leg backwards) is effectuated by monoarticular (short head of biceps femoris) and biarticular fibres (long head of biceps femoris, semitendinosus, semimembranosus and the proximal part of gastrocnemius).

The centre of coordination for these forces is midway on the thigh, medial to the biceps femoris.

This cc corresponds to the acupuncture point BL 37 and to the trigger point of the posterior muscles of the thigh[81].

Mf unit of retro-talus (re-ta).

Retromotion talus (to rise up on ones toes) is effectuated by monoarticular (soleus) and biarticular fibres (gastrocnemius, flexor digitorum longus and peroneus muscles).

The centre of coordination of these forces is over the triceps surae, halfway on the leg and slightly towards the peroneus muscles.

This cc corresponds to the acupuncture point BL 58 and to TP 3 of the soleus[82].

Mf unit of retro-pes (re-pe).

Retromotion pes (foot) (push-off with the lateral part of the foot – this fascial compartment is continuous with that of the triceps surae) is effectuated by monoarticular (abductor digiti minimi, flexor digiti minimi brevis of the foot) and biarticular fibres (peroneus brevis which inserts into the base of the fifth metatarsal from where flexor brevis originates).

The centre of coordination of these forces is over the flexor brevis and abductor digiti minimi muscles.

This cc corresponds to the acupuncture point of BL 64 and to the trigger point of abductor digiti minimi.

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[80] The semitendinosus shares a common origin with the long head of biceps femoris from the posterior face of the ischial tuberosity. Midway on the thigh the central part of the belly of the semitendinosus is divided by a tendinous indentation. (Travell J, 1998)

[81] The examination of trigger points: Pincer palpation is commonly used for the posterior muscles of the medial thigh whilst flat palpation is usual for the biceps femoris. (Travell J, 1998)

[82] In one patient the trigger point 3 of the soleus referred an intense pain to the jaw with an associated blocked joint. Infiltration of TP 3 of the soleus eliminated the pain and the contraction of the jaw. (Travell J, 1998)

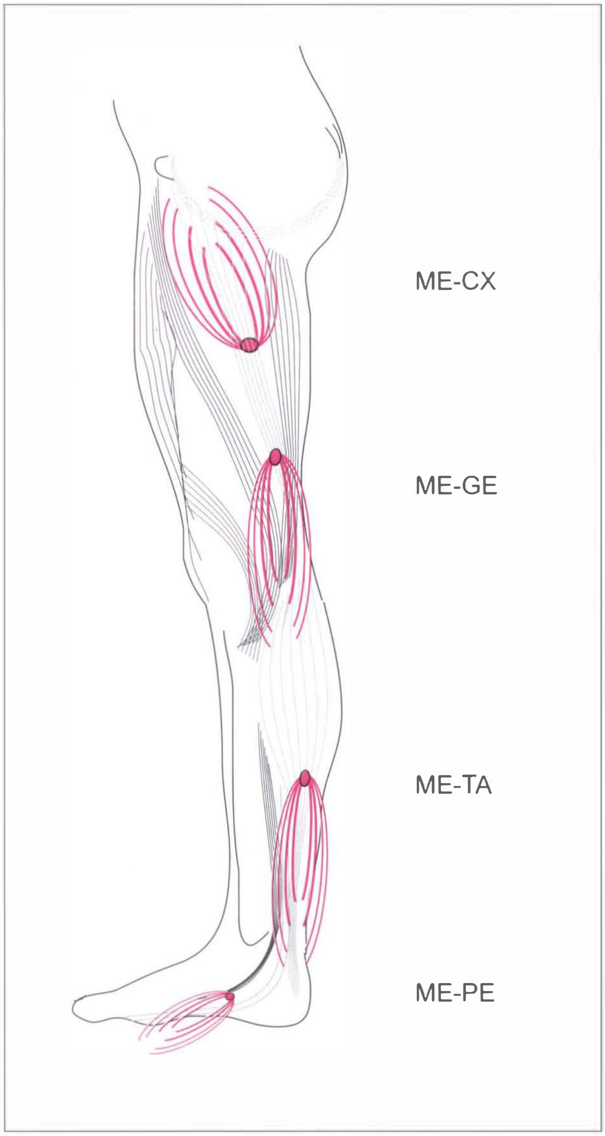

Figure 53. Myofascial unit of mediomotion of the lower limb.

Mf unit of mediomotion of the lower limb

Mf unit of medio-coxa (me-cx).

Mediomotion coxa (to adduct the thigh) is effectuated by monoarticular (adductor longus, brevis and magnus) and biarticular fibres (gracilis).

The centre of coordination of these forces is located anteriorly to and at the level of the proximal third of gracilis (Figure 53).

This cc corresponds to the acupuncture point LR 10 and to the trigger point of the adductor muscles[83].

Mf unit of medio-genu (me-ge).

Mediomotion genu (medial stability of the knee) is effectuated by monoarticular (distal portion beneath the tendinous indentation of the semitendinosus; the tendon of this muscle, which inserts into the medial tibia, stabilises the knee impeding medial deviation) and biarticular fibres (distal part of the gracilis, which is innervated by its own neuromuscular plate independently from the proximal part of the same muscle).

The centre of coordination of these forces is over gracilis and the distal part of sartorius.

This cc corresponds to the acupuncture point SP 11 and the distal trigger point of sartorius and gracilis.

Mf unit of medio-talus (me-ta).

Mediomotion talus (to move the ankle inwards) is effectuated by monoarticular (tibialis posterior) and biarticular fibres (triceps surae, flexor digitorum longus).

The centre of coordination of these forces is over the triceps surae where the soleus and gastrocnemius medialis unite.

This cc corresponds to the acupuncture point KI 9 and to the medial trigger point of the triceps surae.

Mf unit of medio-pes (me-pe).

Mediomotion pes (foot) (adduction of the foot with an increase in both the longitudinal and transverse plantar arches) is effectuated by monoarticular (plantar interossei, flexor hallucis brevis, oblique head of adductor hallucis which takes origin from the long plantar ligament) and biarticular fibres (flexor digitorum longus, flexor hallucis longus).

The centre of coordination of these forces is over the insertion of the tibialis posterior on the navicular bone; from this tendon the flexor hallucis brevis originates.

This cc corresponds to the acupuncture point KI 2 and to the trigger points of the flexor digitorum brevis and flexor hallucis brevis.

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[83] Referred pain from the myofascial trigger points of the adductor longus and brevis of the thigh irradiates deeply to the inguinal area and inferiorly to the knee. The TP of the gracilis can project superficial pain all over the medial thigh. (Travell J, 1998)

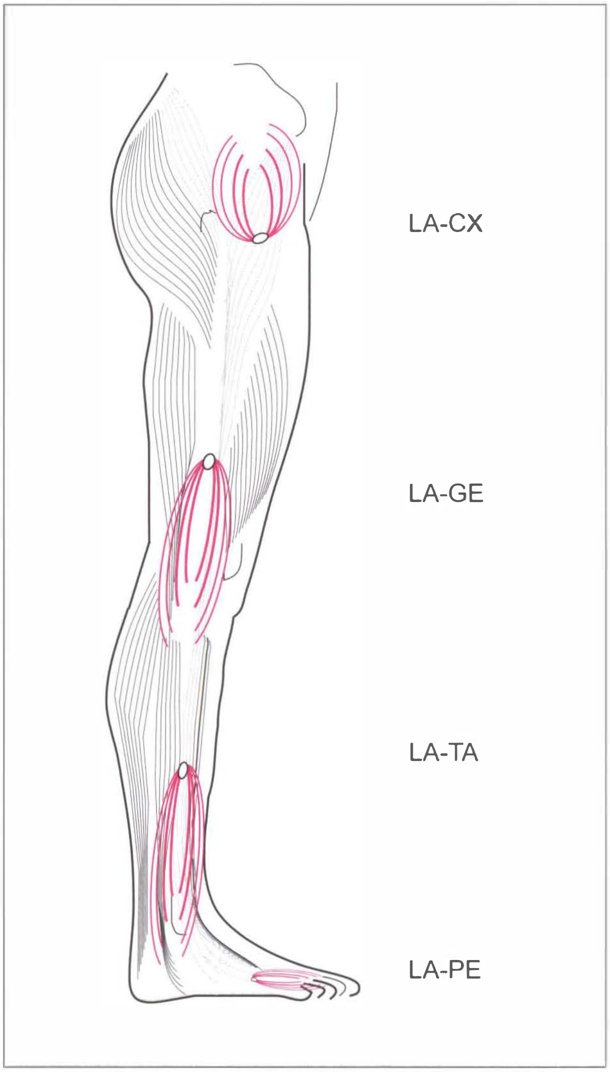

Figure 54. Myofascial unit of lateromotion of the lower limb.

Mf unit of lateromotion of the lower limb

Mf unit of latero-coxa (la-cx).

Lateromotion coxa (to abduct the thigh) is effectuated by monoarticular (gluteus minimus and medius) and biarticular fibres (tensor fascia lata and gluteus maximus).

The centre of coordination of these forces is over the tensor fascia lata (Figure 54).

This cc corresponds to the acupuncture point ST 31 and to the trigger point of the tensor fascia lata.

Mf unit of latero-genu (la-ge).

Lateromotion genu (to impede the lateral deviation of the knee) is effectuated by monoarticular (short head of biceps femoris) and biarticular fibres (long head of biceps femoris and iliotibial tract of the tensor fascia lata[84]; the tendons of these muscles insert onto the fibula and the tibia).

The centre of coordination of these forces is over the iliotibial tract near the origin of the short head of biceps femoris[85].

This cc corresponds to the acupuncture point GB 31 and to the trigger point of biceps femoris.

Mf unit of latero-talus (la-ta).

Lateromotion talus (to move the ankle outwards and, above all, to stabilise the joint against medially directed distortions) is effectuated by monoarticular (peroneus tertius) and biarticular fibres (extensor digitorum longus).

The centre of coordination of these forces is over the extensor digitorum longus at the point where peroneus tertius originates.

This cc corresponds to the acupuncture point ST 40 and to the trigger point of the extensor digitorum longus[86].

Mf unit of latero-pes (la-pe).

Lateromotion pes (foot)(opening out the toes, away from the median line) is effectuated by monoarticular (dorsal interossei) and biarticular fibres (extensor digitorum longus).

The centre of coordination of these forces is over the III° and IV° dorsal interossei.

This cc corresponds to the acupuncture point ST 43 and to the trigger point of the dorsal interossei muscles.

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[84] The tensor fascia lata assists the gluteus medius in stabilising the pelvis. The distal fibres are involved in the stabilisation of the knee. (Travell J, 1998)

[85] The long head of biceps can take origin from the sacrum, the coccygeus and from the sacrotuberous ligament. It can have a tendinous indentation like that of the semitendinosus. In the distal part of the thigh, the long head of biceps unites with the short head inserting into the lateral side of the head of the fibula via a single tendon that divides into three parts. In children the posterior muscles of the thigh present myofascial TP but the pain is often diagnosed (or simply ignored) as "growing pains". (Travell J, 1998)

[86] Electrical stimulation of the extensor digitorum longus provokes extension of the proximal phalanges of the last four toes, abduction of the foot and elevation of its lateral edge (eversion). (Travell J, 1998)

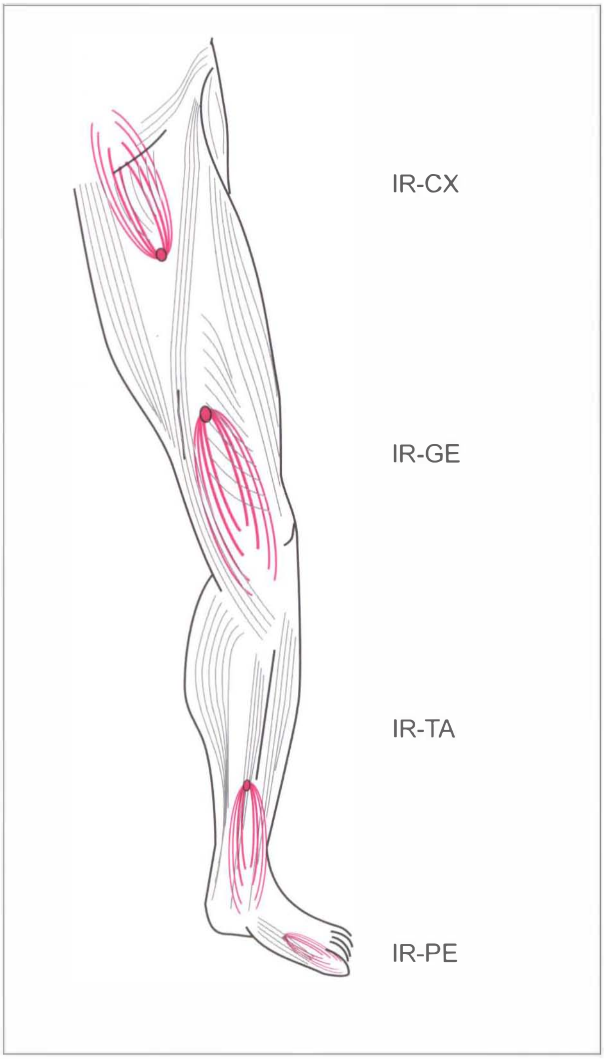

Figure 55. Myofascial unit of intrarotation of the lower limb.

Mf unit of intrarotation of the lower limb

Mf unit of intra coxa (ir-cx).

Intrarotation coxa (internal rotation of the hip) is effectuated by monoarticular (pectineus[87]) and biarticular fibres (tensor fascia lata, adductor magnus, gluteus minimus).

The centre of coordination of these forces is over the apex of the femoral triangle (Figure 55).

This cc corresponds to the acupuncture point LR 11 (Souliè) and to the trigger point of pectineus.

Mf unit of intra-genu (ir-ge).

Intrarotation knee (internal rotation of the medial condyle of the tibia) is effectuated by monoarticular (popliteus) and biarticular fibres (semimembranosus, sartorius, semitendinosus, gracilis).

The centre of coordination of these forces is over the distal part of sartorius and over the subsartorial fascia.

This cc corresponds to the acupuncture point of LR 9 and to the TP of the sartorius[88].

Mf unit of intra-talus (ir-ta).

Intrarotation talus (not of the ankle as the malleoli remain horizontal) is effectuated by monoarticular (tibialis posterior) and biarticular fibres (flexor digitorum longus) (Figure 55).

The centre of coordination of these forces is over the tibialis posterior muscle or, more precisely, the medial part of the deep transverse fascia onto which this muscle inserts.

This cc corresponds to the acupuncture point of LR 5 and to the trigger point of the flexor hallucis longus.

Mf unit of intra-pes (ir-pe).

Intrarotation pes (medial or internal deviation of the forefoot and, in particular, of the big toe) is effectuated by monoarticular (abductor hallucis) and biarticular fibres (flexor hallucis longus[89]).

The centre of coordination of these vectorial forces is over the anterior part of the abductor hallucis.

This cc corresponds to the acupuncture point SP 3 and to the TP of the abductor hallucis.

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[87] There has been a general indecision or disagreement as regards to whether the pectineus rotates the thigh medially or laterally. When the pectineus is stretched passively the position of the thigh in extra or intrarotation seems to be unimportant. (Travell J, 1998)

[88] The tendinous intersections of the sartorius are not aligned and they do not form definite strips such as the intersections of the rectus abdominis. The sartorius has additional connections with the inguinal ligament, the iliopectineal line, the ligamentum patellae and the tendon of the semitendinosus. (Travell J, 1998)

[89] In the non weight bearing foot the flexor hallucis longus assists plantar flexion and inversion. The abductor hallucis inserts proximally onto the tuber calcanei, the flexor retinaculum, the plantar aponeurosis and the intermuscular septum of the flexor digitorum brevis. The accessory abductor hallucis can extend from the superficial fascia over the tibialis posterior nerve, above the medial malleolus, to insert on the centre of the abductor hallucis muscle. (Travell J, 1998)

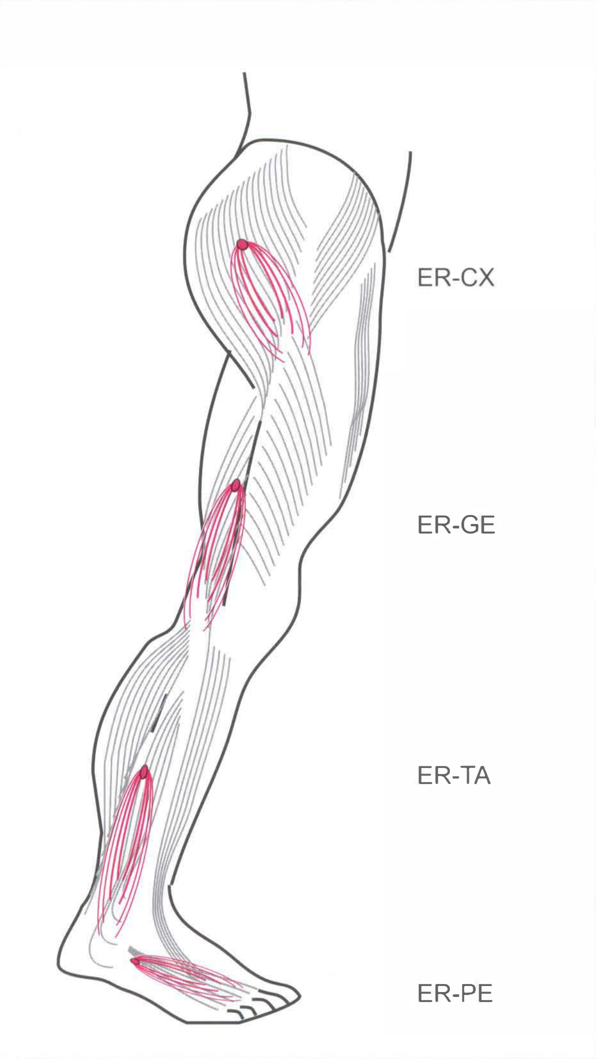

Figure 56. Myofascial unit of extrarotation of the lower limb.

Mf unit of extrarotation of the lower limb

Mf unit of extra-coxa (er-cx).

Extrarotation coxa (external rotation of the hip) is effectuated by monoarticular (piriformis, gemelli, quadratus femoris, obturator internus) and biarticular fibres (gluteus maximus, sartorius, iliopsoas).

The centre of coordination of these vectorial forces is over the piriformis muscle, midway over the gluteus maximus (Figure 56).

This cc corresponds to the acupuncture point GB 30 and to the trigger point of piriformis[90].

Mf unit of extra-genu (er-ge).

Extrarotation genu (external rotation of the lateral tibial condyle of the knee) is effectuated by monoarticular (short head of biceps femoris) and biarticular fibres (long head of biceps femoris).

The centre of coordination of these forces is over the origin of the short head of biceps femoris from the lateral intermuscular septum.

This cc corresponds to the acupuncture point GB 32 and to the trigger point of biceps femoris[91].

Mf unit of extra-talus (er-ta).

Extrarotation talus (outward movement of the foot on the horizontal plane) is effectuated by monoarticular (peroneus brevis) and biarticular fibres (peroneus longus).

The centre of coordination of these forces is over the peroneus longus and brevis muscles, midway on the leg.

This cc corresponds to the acupuncture point GB 35 and to the TP of peroneus longus[92].

Mf unit of extra-pes (er-pe).

Extrarotation pes (outward movement of the forefoot) is effectuated by monoarticular (extensor digitorum brevis) and biarticular fibres (peroneus longus).

The centre of coordination of these forces is over the extensor digitorum brevis beneath the lateral malleolus.

This cc corresponds to the acupuncture point GB 40 and to the trigger point of the extensor digitorum brevis[93].

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[90] Referred pain of a TP of the piriformis muscle can irradiate to the sacroiliac region, the lateral part of the buttocks, over the posterior part of the hip and the proximal two thirds of the thigh. The distribution of referred pain from the other five external rotator muscles of the thigh is identical to that of the piriformis muscle. (Travell J, 1998)

[91] The fibrotic taut bands associated with the syndrome of the posterior thigh muscles should be distinguished from the taut bands of a TP because they are not formed by muscular tissue but from connective tissue. A clicking hip is mostly due to the dislocation of the tendon of biceps femoris at its ischial tuberosity insertion. (Travell J, 1998)

[92] The peroneus longus and brevis form the lateral compartment of the leg whereas peroneus tertius is part of the anterior compartment. Weakness in these muscles can cause corns to appear under the II and III metatarsal heads. (Travell J, 1998)

[93] The long and short flexors and extensors of the toes work in synergy with the lumbricals and the interossei as a single functional unit (myotactical unit). (Travell J, 1998)

Chapter 7
MANIPULATION OF THE MF UNIT

Having studied the anatomy and the physiology of myofascial units, their dysfunctions and consequent treatment will now be taken into examination. The pathological manifestation of a dysfunction in a myofascial unit differs from individual to individual, however, there is only one aetiology: the densification of the cc. For densification it is intended the incapacity of the fascia to elongate and to accommodate to tension that originates from underlying muscle fibres.

Just as the cause of fascial dysfunction is unique (densification) so too is the treatment (manipulation). The difficulty lies in individuating the correct point to treat as well as the most appropriate dosage to apply in order to restore elasticity. An individual assessment chart for each patient is useful because from the analysis of the symptoms, the cause of the dysfunction and hence the densified point(s) can be identified. Fascial Manipulation is efficient when it is graded in its intensity, duration and depth according to the patient and to the type of tissue.

Plasticity and malleability of the fascia

Numerous authors[94] speak of overuse syndrome, repetitive stress injuries, soft tissue or extra-articular rheumatism and then proceed in treating tissues that cannot actually be responsible for these dysfunctions. Good results are often achieved by operating on endoarticular tissues, however, some recent research demonstrates that benefits from these operations are due to the incision of the fascia rather than, for example, the removal of a disc hernia[95]. In some hospitals (Houston, Alexandria) operations on knee arthritis involving incision of the fascia alone have produced better results than those obtained from endoarticular operations.

Therefore the fascia and not other tissues is often responsible for pain in RSI:

- It cannot be muscular tissue because when overused it hypertrophies.
- It cannot be bone tissue, or even less so cartilage, in as much as they are almost devoid of nociceptors.
- It cannot be the nerve trunk because it conveys the nociceptive afferents detected in peripheral tissues.
- It cannot be vascular tissue[96] in as much as no difference is detectable in the capillarity of painful areas.
- It can only be the fascia because it is the tissue that has the greatest innervation[97].
  - The fascia[98] is an elastic tissue that is able to

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[94] There are professional categories that are exposed to functional overuse due to the execution of movements carried out in a repetitive and prolonged manner, which are at the origin of pathologies defined by American authors as Cumulative Trauma Disorders (CTD). Such terminology refers substantially to pathological cases that involve nerves, muscles, tendons, ligaments, arteries, veins, connective tissue and occasionally bony structures (epicondylitis, carpal tunnel syndrome, trigger finger, de Quervain's tenosynovitis etc.). (Cossu M, 2000)

[95] The hernia appears through a defect of the overlying lumbar dorsal fascia. Increased physical activity in young women seems to be the causative factor. Nineteen of the 20 hernias were treated with surgical excision and repair of the lumbar dorsal fascia defect. Results of the treatment were good. (Light HG, 1983)

[96] Patients with impingement syndrome, when compared with the control group, were found to have more connective tissue between the fibres of the deltoid but no difference in the capillarity. (Kromberg M, 1997)

[97] Two anatomical researchers from the University of Fribourg took some electronic microphotographs of the crural fascia in 51 people. To their surprise they found many unmyelinated nerve fibres and many sensitive nerve endings between the collagen fibres of this fascia. Manual therapists who treat painful myofascial syndromes – often successfully – with mechanical and/or thermal stimulation now have new pretexts to justify their procedures. (Straubesand J, 1996)

[98] Electron microscope research has revealed that numerous types of sensitive nerve endings connected to small diameter afferent fibres are free nerve endings. The typical collocation of these endings is in the connective tissue that surrounds muscles. (Mense S, 1993)

stimulate neuroreceptors.
  - The fascia is an elastic tissue but it has established limits and this allows it to effectuate motor coordination, the perception of motion and to signal postural variations[99].
  - Within the fascia there are areas that are more densely innervated and these are the centres of coordination[100] and perception of each mf unit.
- It can only be the fascia because when it is subjected to repeated, incongruous and inappropriate stimulation it modifies the mesh of its fibres:
  - Plasticity is the property of matter to experience a permanent deformation due to an external stress.
  - Within fascia there are areas that are highly subjected to muscular traction and these areas are the cc(s) of each mf unit.
  - Diverse factors intervening simultaneously cause the modification of the ground substance of these points.

Such factors are repeated mechanical stimuli, thermal stresses and chemical/metabolic dysfunctions (Table 6). In one person mechanical stress might be prevalent whilst in another thermal stress and in yet another hereditary factors prevail[101], however, they all share metabolic and autonomic nervous system dysfunctions[102,103].

Table 6. Reaction of fascia to stress

Repeated mechanical Stimuli
Thermal and SNS Stress
Metabolic dysfunctions

Inflammation	Repeated inflammation
↓	↓
Repair	Collagen fibre hyperplasia
↓	↓
Reorganisation of Collagen fibres	Collagen fibre dysplasia
↓	↓
Healing	Ground substance densification

Thus the modification of the ground substance of connective tissue or densification of the fascia is due to a combination of factors, which vary from one individual to the next.

Normally all stressful or traumatic stimuli, such as a sudden sprains with laceration of the fascia, provoke local inflammation with oedema. Rest favours fibroblast activity and repair of the lesion. Physiological movement then induces the collagen fibres, which are produced by fibroblasts, to realign themselves along the lines of traction. In the end the damaged area heals perfectly. If fascia is tensioned along physiological lines and the tension is balanced between the two sides of the body, then fascial hypertrophy occurs rather than compensations. The fascia is without doubt an integral part in the maintenance of bodily proportions.

If human beings were still able to perceive the fascia they would feel the itching sensation that emanates from an area impregnated with catabolites. The human hand would then reach for that area, as animals still do, unconsciously restoring fluidity to the ground substance of the connective tissue. Unfortunately the brain is occupied by too many external distractions and therefore it notices fascial dysfunctions only when the initial oedema has been transformed into acidosis, fibrosis and sclerosis... with consequent pain.

Generally these fascial densifications develop due to repeated inflammation (overuse, repeated strain) that provokes an increase in the number of collagen fibres[104]. Often these fibres do not align

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[99] In connective tissue there are nerve endings of various types that provide sensory innervation for the detection of mechanical effort, painful stimuli and thermal variations. (Gray H, 1993)

[100] On the other hand Heine, on the basis off macroscopic and histological exams, has demonstrated that acupuncture points are situated over perforations in the fascia corporis. Neuro-vascular bundles cross these perforations before proceeding more deeply. (Heine H, 1988)

[101] Inguinal hernia and all weakening of the transverse fascia is a frequent pathology whose cause remains unknown. Persistent changes in the level of MMP-2 in cellular cultures suggest that a genetic defect, rather than an environmental factor, could be at the origin of this pathology. (Bellon J, 2001)

[102] According to our previous biomechanical and histological studies suggesting that a connective tissue pathology could play a role in the genesis of groin hernias, we performed a biochemical investigation of the collagen in the transversalis fascia and rectus sheath. The significant increase of collagen extractability... suggests that molecular alterations of collagen could be involved in the genesis of groin hernias. (Pans A, 2001)

[103] The connective tissues may profitably be regarded as comprised of two distinct but interrelated populations of cells, namely the resident cells with a slow turnover and those cells that are constantly "cascading" from the blood through the tissues. This dynamic approach is outlined in relation to the histogenesis and cytogenesis of inflammation, immune responses and fibrotic processes, both localised and diffuse. (Bernard SG, 1968)

[104] Collagen fibre resistance to mechanical stress is only possible due to the formation of a series of intra and intermolecular connections. Inadequate regulation of the synthesis and deposition of collagen provokes hypertrophic scarring, fibrosis and organ dysfunction. In adult tissues, collagen has a slow turnover (catabolism) of more or less months. Collagen should not be simply considered as a passive, inert packing material.

themselves along physiological lines, either because pain imposes abnormal postures or because the trauma itself necessitates immobilisation[105] of the part.

Densification of the ground substance[106] cannot be eliminated spontaneously, as the body is incapable of distinguishing excess collagen fibres from normal physiological fibres; only an accurate, external intervention can modify the consistency of connective tissue.

The fascia is plastic but also malleable[107], that is to say it modifies its consistency when acted upon by external stimuli. Manipulation has an effect on fascia because it is a tissue that is easily accessible and it possesses a strong capacity for repairing and regenerating itself.

The alteration of a cc causes joint pain (cp) as well as a possible joint blockage. If it is a recent lesion then it is possible to intervene directly with joint mobilisations. By freeing the articulation the painful afference is reduced and the excess tone of the mf unit disappears. However, if the chronicity of the problem has created a densification of the cc then a manipulation applied directly to the cc is required.

The manipulation must act on the densified cc for a sufficient amount of time for the friction against the fascia to produce heat. This heat modifies the consistency of the ground substance and initiates the inflammatory process[108] required for healing. In this way the fascial therapist removes the mesh of fibronectin, which impedes the functionality of the cc, and consequently the healing process[109] restores physiological elasticity. The new collagen fibres will align themselves along the normal lines of force only if there is a tensional balance in the fascia. It is therefore important not to limit a therapeutic intervention to a single point but to consider all of the eventual postural compensations.

Compilation of the assessment chart

Treatment of the exact cc that is responsible for an imbalance is the only way to achieve immediate functional recovery. The localisation of this cc by palpation alone or the mere identification of a hypersensitive point is not sufficient, because when a limb is inflamed then the entire fascia is often hypersensitive. Therefore it is essential to have established which point requires treatment prior to commencing. Accurate compilation of the assess-

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This protein in fact fuses to the superficial cells and modulates the morphogenesis, the chemotaxis, platelet aggregation and cellular cohesion. (Rubin E, 1993)

[105] The activation and perpetuation of trigger points can result from prolonged immobilisation in plaster of the part or segment. (Travell J, 1998)

[106] All connective tissues consist of two major components, namely cells and extracellular matter. The extracellular matter is the constituent that determines the physical properties of each connective tissue type. The ground substance of the fascia has a semi-fluid, gel-like consistency. It contains seven types of polysaccharide chains and fibrous protein... Fibronectin is a glycoprotein that controls the deposition and the orientation of collagen in the extracellular matrix. (Wheater P, 1994)

[107] The elastic recoil of the connective tissue arises from the arrangement of fibers within the connective tissue matrix. Collagen fibers themselves are not elastic, but they are coiled and their interweaving allows for elastic displacement and return. When these fibers are densely matted or not aligned in the direction of movement, their elastic potential is dispersed.....The intercellular matrix is a protein solution. One of the chief properties of protein solutions is their response to changes in temperature – they will be fluid (sol) in warmer temperatures, thick (gel) in colder temperatures. ....Blood circulation normally provides heat as well as nutrients and waste removal. As capillary circulation decreases, the colloid matrix changes state from sol to gel, and its consistency becomes more glue like, trapping connective tissue fibers into a non-moving matted mass. Fibers proliferate wherever there is tissue stress. The resulting mass of thickened matrix and increased fibre mass can be palpated as an unmoving, painful thickening. This kind of build-up can be reversed by the intervention of manipulative or movement therapy. The immediate effect is to modify the physical nature of the matrix. (Schultz R, 1996)

[108] The inflammatory response is the initial step for the body's healing cascade and immune/reparative system. This process appears to stimulate connective tissue remodelling through reabsorption of excessive fibrosis. (Stover SA, 1998)

[109] After the inflammatory phase the healing process is completed by repair or substitution of dead tissue with granulation tissue, which matures into scar tissue due to fibroblast activity. These cells secrete the components of the extracellular matrix (collagen, proteoglycans). An excessive quantity of myofibroblasts provokes retractile sclerosis with tissue deformation. Many pathological states such as Dupuytrens (retractile palmar sclerosis) are characterised by retractile sclerosis and irreversible fibrosis of the superficial fasciae, their basis process being similar to that of wounds.
In mammals granulation tissue, which is involved in inflammation, is a remainder of the blastema of the amphibians. Anyway, granulation tissue does not bring about the formation of a limb but only matures into dense connective tissue and finally a scar. The extracellular matrix and the cells are the two major components of the process of repair. Only a matrix that contains information can direct migration, cohesion and cellular organisation. (Rubin E, 1993)

ment chart assists in the selection of the correct point and provides concise documentation of treatment sessions. The assessment chart contains the patient's personal data and history (Figure 189), an abbreviated description of their initial symptom and the points treated. Therapists commencing the practice of Fascial Manipulation use an assessment chart which contain a section for the hypothesis of the points to be treated as well as sections for the movement and palpation assessments.

The assessment chart needs to be:

- readable: this first requisite might appear to have been ignored when one first sees a FM assessment but, once the terminology has been learnt, it will become clear that the abbreviations are comprehensible in all languages;
- simple: the data, as referred by the patient, is recorded on the assessment chart (Table 11). Site of the pain (SiPa) "The outer part (la) of my upper arm (hu) has been painful for six months (6m)". Painful movement (PaMo): "This pain increases when I raise my arm outwards (la)"; often this particular information is not one simple direction because patients often demonstrate motor gestures, or schemes. The most painful movement will, in these cases, be identified during the movement assessment;
- functional: the two previous data indicate which mf unit is directly involved in the problem (la-hu).
- reproducible: with the same data any fascial therapist should be able to record the same site of pain and the same painful movement;
- accurate: the recorded data is not generic (e.g. periarthritis) but outlines precisely the site of pain (lateral part of the humerus = la-hu) and the movement that provokes the pain (lateromotion - la). If there is any limitation in joint range then it should be recorded in degrees (e.g. if the humerus only abducts twenty degrees = la hu 20°).

An accurate assessment chart is always faithful to the patient's history and to any deductions drawn from formulated hypotheses. Therapists should avoid interpreting the data according to one's own convictions, and a therapist also needs to avoid the error of formulating a manual of points that are apparently useful for similar dysfunctions.

Data

Site of the pain (SiPa)

When referring to his/her pain a patient will indicate the centre of perception of the mf unit involved. In the following tables some of the more common sites of pain in the upper limb (Table 7), the trunk (Table 8), and in the lower limb (Table 9) are listed, along with the way to record them on the assessment chart.

For example if "la hu" is written on an assessment chart it means that the patient is suffering from pain in the lateral part of the humerus. If instead "me hu" is written then this means that the patient is suffering from a pain in the axillary cavity. Details of the pathology can be noted in the section that deals with symptoms. At this stage it is necessary to be concise in order to collect the data that can guide the therapist to the dysfunctional mf unit.

Table 7. Common sites of pain in the upper limb

SC	la	Superior border of trapezius
	me	Below scapula over serratus anterior
	re	Medial border of the scapula
	an	Zone of pectoralis minor
	er	Superior angle of the scapula
	ir	Sternoclavicular joint
HU	la	Lateral part of deltoid
	me	Axillary cavity
	re	Posterior glenohumeral joint
	an	Anterior glenohumeral joint
	er	Above the rotator cuff tendons
	ir	Over insertion of intrarotator mm
CU	la	Lateral epicondyle
	me	Medial epicondyle
	re	Distal tendon of triceps
	an	Cubital fossa
	er	Sensitive olecranon
	ir	Sheath of median nerve
CA	la	Lateral radio-carpal joint
	me	Sensitivity of pisiform bone
	re	Tendinitis of extensor ulnaris
	an	Tendinitis of flexor radialis
	er	Tendinitis of extensor digitorum
	ir	Tendinitis of flexor digitorum
DI	la	Dysfunction of dorsal interossei
	me	Dysfunction of palmar interossei
	re	Difficulties with little finger
	an	Thumb pain
	er	Disturbance in ring finger
	ir	Disturbance in middle finger

Table 8. Common sites of pain in the trunk

CP	la	Cephalalgia: temporal, mandible
	me	Nose, mouth, medial eye
	re	Occipital-frontal cephalalgia
	an	Temporomandibular joint
	er	Cephalalgia all around ear
	ir	Pain anterior to the ear
CL	la	Unilateral neck pain
	me	Anterior and posterior neck pain
	re	Rigidity paravertebral muscles
	an	Bilateral anterior neck and throat
	er	Ipsilateral torcicollis
	ir	Torcicollis on turning to opp. side
TH	la	Lateral intercostal pain
	me	Sternal pain, sense of oppression
	re	Dorsal pain
	an	Rigidity of anterior chest wall
	er	Ipsilateral cervicodorsal pain
	ir	Anterior intercostal shooting pain
LU	la	Unable to bend to one side
	me	Visceral problems above umbilicus
	re	Low-back pain on straightening up
	an	Pain in rectus abdominis
	er	Pain in side on twisting
	ir	Shooting pain in hypochondrium
PV	la	Pain in glutei when weight bearing
	me	Groin strain, coccygodynia (r)
	re	Rigidity of the sacroiliac joints
	an	Shooting pain in the fossa iliac
	er	Sensitivity around gr. trochanter
	ir	Tension in inguinal ligament

Table 9. Common sites of pain in the lower limb

CX	la	Cramps in the tensor fascia lata
	me	Contractures in the adductor mm;
	re	Sensitivity of ischial tuberosity
	an	Enthesitis of the ASIS
	er	Posterior Coxalgia
	ir	Pain in the femoral triangle
GE	la	Iliotibial tract tense
	me	Pain in medial knee
	re	Swelling of popliteal fossa
	an	Patellar tendon
	er	Tendinitis of biceps femoris
	ir	Sensitivity below med. tib. condyle
TA	la	Lateral malleolus
	me	Medial malleolus
	re	Achilles tendon
	an	Tendinitis of extensor digitorum
	er	Passage of peronei tendons
	ir	Tendons of flexor digitorum
PE	la	Dorsal interossei
	me	Plantar interossei
	re	Lateral compartment of the foot
	an	Extensor hallucis brevis
	er	Extensor digitorum brevis
	ir	Abductor hallucis

When the site of pain is lateral (la) or medial (me) it indicates a problem connected to the frontal plane. The assessment of movement highlights exactly which movement sets off the pain. In the trunk mediomotion is regulated by the anterior ligaments (lines alba) and the medial posterior ligaments (interspinous). If the pain is located medially and anteriorly it is sufficient to record (me th) whereas, if it is localised over the interspinous or ligamentum nuchae then an r is added to indicate that it is the rear or retro point (me th r).

When a patient indicates a specific point of an articulation as the site of their pain (SiPa) a fascial therapist is aware that this is the point where movement occurs (cp). It is at this point that incoordination which originates from the densification of the centre of coordination (cc), manifests itself. The cc itself does not cause pain unless it is touched because it is located where there is no great displacement that pinches or distracts the nociceptors. Knowledge of the mf unit's structure allows the therapist to trace back to the cc of a specific mf unit from the centre of perception, or cp.

The subjective evaluation of the intensity of pain should be recorded on the assessment chart. This information is recorded using asterisks. Table 10, summarises and compares other commonly used scales (the international classification used for handicap, the visual analogous scale, activities of daily living scale and the Kinesiological scale) with the asterisk scale used in FM. With this scale, pain provoked during movement, joint limitation and any muscular weakness in the segment, as compared with the opposite side, is taken into consideration. If a mf unit presents a weakness it is record-

Table 10. Pain evaluation (Pa)

	Light Pain	*Medium Pain*	*Strong Pain*
Fascial Manipul.	*	**	***
ADL	No sport	No work	No life
Internat. Classific.	Deficit	Inability	Handicap
Kinesiology	Force	Articular	Pain
Analogous scale	– 50%	50%	+ 50%

ed with one asterisk; if there is also joint limitation a second asterisk is added; if there is also pain then a third asterisk is used. At times there is only pain, without weakness or loss of ROM, but it is so intense that a normal life style is not possible. A similar situation would be noted with three asterisks.

Supplementary data can further define and quantify the pain.

- Recording the chronology of pain aids in deciding between a predominant pain and a compensatory or secondary pain. The following abbreviations are brief and of immediate comprehension: day (d), month (m), year (y). If for example a patient has been suffering for six months from a particular disturbance then one records: *6m*.
- Sometimes the pain is continuous (cont) or at times it is a relapse (rel) and the relapse is fairly regular. If, for example, a periarthritis worsens once a month and this has been happening for the last six months then one records: *6m rel 1xm*. Sometimes headaches present themselves daily (*1xd*) or once a week (*4xm*).
- Some characteristics of pain can be determined by the pattern of aggravation that manifests itself over a 24-hour period. Pain that worsens at night (nt) signals a stretch of pain terminations due to relaxation of compensatory contractions; a pain that is worse in the morning (am) indicates a certain rigidity of the fascia, or an inability to adapt to changes of position; a pain that accentuates in the afternoon (pm) is indicative of inflammation caused by friction from overuse.

On the assessment chart all this data can be recorded in its abbreviated form (Table 11). In one line it is possible to understand that the patient has a pain in the lateral part of the right shoulder (right = rt; left = lt; bilateral = bi); this pain accentuates (^) during the night (nt); it all started six months ago, it is not continuous but reappears, or relapses, once a month. When pain is acute, the patient is unable to conduct a normal life style (unable to work, dress). In a week, or even a months time, it will be possible to compare all this data with the ongoing situation for a more accurate evaluation of the outcome of one's treatment.

Table 11. The way to record patient's data

SiPa	HU LA rt ^nt 6m rel 1xm ***

Hypothesis

From the previous data it is evident that the patient's periarthritis is localised in the lateral part of the humerus, which might lead one to deduce a densification of the cc of the mf unit of la-hu. It would then be possible to proceed with treatment, not of the painful articulation or cp, but of this cc. Treatment of the fascia is, however, painful therefore it is preferable to formulate all possible hypotheses before immediately concentrating on a single mf unit. Taking into consideration only the compromised segment, pain in the lateral part of the shoulder could also be due to an incoordination in the antagonist mf unit (me-hu) or otherwise in the mf unit of extrarotation (er-hu). Even though this last mf unit is situated over the posterior and external part of the shoulder its symptoms can overlap with those of the mf unit of lateromotion. Often a patient will refer to unlikely symptoms, all of which need to be verified. For example, a patient might complain of pain during abduction but it could be the trajectory of extrarotation which is really the most painful and which the patient unconsciously avoids altogether.

It is not necessary to reduce the data to a single hypothesis but rather to analyse all the possible hypotheses. Shoulder pain, for example, can be the basis for formulating four different hypotheses:

1. Diffuse pain in the glenohumeral (hu) articulation: it is possible to hypothesise the involvement of all six mf units that move this joint. The movement assessment will indicate which specific mf unit (s) provokes pain and to what degree.
2. Pain concentrated in the lateral part of the humerus accentuated by lateromotion (la-hu): it is possible to hypothesise the centre of coordination of the agonist mf unit. Movement and palpation assessments will substantiate or not.
3. Pain concentrated in the lateral part of the

humerus accentuated by mediomotion (me-hu): it is possible to hypothesise the centre of coordination of the antagonist mf unit and, once again, it will be the movement assessment to determine the validity of this hypothesis.

4. Pain concentrated in the lateral part of the humerus accentuated both by lateromotion and mediomotion: it is possible to hypothesise the cc of both the agonist and the antagonist mf units.

An open mind will help to develop objectivity and to avoid leaping to conclusions. It should not be forgotten that when there is inflammation the surrounding fascia is usually sensitive. If one passes straight on to a palpation assessment as, for example, in the case of the cc of la-hu, the zone could easily be hypersensitive. By comparing various points prior to commencing treatment the final choice will definitely be more objective.

Verification

Verification is divided into two sections: the movement assessment and the palpation assessment.

The **movement assessment** is comprised of:

- active movement assessment; the patient is asked to move the painful segment in the three spatial planes and any articular limitation is recorded.
- passive movement assessment; the painful segment is moved in the three planes in order to highlight any compensatory movements adopted by the patient to avoid pain from joint impingement.
- resisted movement assessment; maximum resistance is applied to the patient's movement in order to test muscle strength and, where possible, a comparison with the opposite side is carried out.

The object of these movement assessments is to select the mf unit responsible for the articular irregularity. In order to choose this specific unit a grid (Table 12) is used to compare all of the six mf units involved in moving the segment.

From the movement assessment of the segment of the humerus (hu), as recorded below, lateromotion is effectively the most painful (**). Asterisks are also used here to indicate the intensity of the pain: one asterisk is indicative of a slight pain during movement, two asterisks a strong pain and three of a very intense pain. Even in the event of slight pain but in the presence of severe muscle weakness preventing elevation of the arm, three asterisks can be used. In the above grid it also emerges that a slight pain is felt during activity of the mf units of mediomotion and antemotion humerus.

Table 12. Movement assessment grid

Frontal plane	*Sagittal plane*	*Horiz. plane.*
LA-HU **	RE-HU	ER-HU
ME-HU *	AN-HU *	IR-HU

The next step is the palpation assessment in order to compare the relative densification of the cc's of these three mf units.

The **palpation assessment** should reveal

- pain; sometimes even light touch over a cc can be painful. However this parameter alone is not sufficient because painfulness of an inflamed segment can be quite extensive. Palpation should proceed from the superficial to the deeper layers using the minimum amount of pressure required to reach the fascia.
- densification; with practice the site of a cc can be easily identified and, in the case of densification, then a type of granulation tissue or nodosity can be felt.
- referred pain; often referred pain, which can extend from the cc to the centre of perception, does not appear immediately but only after a pressure has been applied for some time. In any case the patient should report a needle like or cutting sensation and not only a sensation of pressure.

In conclusion the cc that is painful, densified and from which a referred pain expands towards the centre of perception is the most likely candidate for treatment.

There should be a certain conformity between what the therapist detects manually and the patient's description or experience.

Noting the conditions of the centre of perception (cp), or site of pain, can enhance the documentation. The following information should also be recorded on the assessment sheet:

- any joint swelling/oedema (circumference of the segment)
- sensitivity of the cp using a pressure algometer
- any redness, thermal differences and any other parameters pertinent to the dysfunction.

Treatment

Treatment commences once verification has defined the cc to be treated. Treatment can vary in its intensity or depth for the following reasons:

- superficial friction is used whenever the disturbance of the deep fascia has extended itself to the subcutaneous loose connective tissue (Jarricot's dermatographism, Valleix's inflamed membrane, Dicke's dermatographism);
- static compression or stretch is used when there is a serous swelling of the ground substance (Kellgren's tender point, Strauss' tender nodules);
- deep friction is used when granulation tissue or densification of the fascial tissue is present (Travell's trigger points, Froriep's muscular hardening, Good's myalgic spots, Maigne's cellulagic zones).

The majority of patients referred to a fascial therapist have chronic dysfunctions with densification of the ground substance. To economise the therapist's energy, the elbow and knuckles are used for treatment. The elbow or knuckle is placed over the cc to be treated for the length of time required for the initial pain reaction to diminish[110]. This hypersensitivity is due to the fact that the free nerve endings, located within a hardened tissue that does not adapt to any stretch, are tensioned in a non-physiological manner. It is rare that light pressure alone can modify the ground substance's state[111] unless it has only recently formed or it is still in the phase of being structured (oedema). Fascial Manipulation creates friction or stretching of the densification of the fascia. The skin of the therapist's elbow adheres to the skin of the patient, in this way the loose subcutaneous tissue moves together with the elbow and friction is transmitted directly to the fascia (Figure 58). During treatment the pressure used should always be bearable for the patient therefore a constant feedback between patient and therapist is advisable.

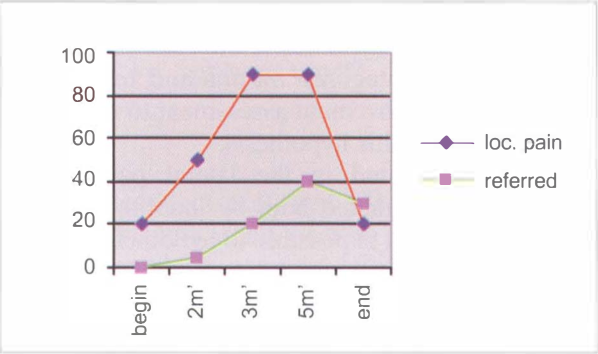

Figure 57. Reactions during treatment

During treatment it is useful to ask the patient:
- if the cc being treated refers pain into the cp, accentuating his/her symptoms;
- if the cc being treated provokes a sharp needle-like pain (correct) or only a strong pressure;
- if the patient requires a short rest (meanwhile the fascia develops more heat, which favours the modification of the ground substance);
- if the therapist's perception of the fluidity of the cc is also confirmed by a sudden disappearance of the pain.

An appropriate distribution of the therapist's body weight, rather than pure muscular strength, is to be used when applying this technique. This requires correct positioning of the therapist in the direction of the pressure to be applied; initially a light pressure is applied, this is gradually increased whilst, simultaneously, the area of contact is expanded until contact is made with the densified cc. A further increase in force is not necessary but rather a persistent friction, until the temperature required to modify tissue consistency is obtained.

When the temperature increases to the gel-to-sol point, modifying the ground substance of the fascia, then there is a sudden decrease in localised (free nerve endings are released) and referred pain (due to improved motor coordination and normalised trajectory of the articulation)[112].

A transformation in the consistency of the densification is normally obtained within a few minutes. At times a point that is painful but not densified may be chosen but, in this case, the tissue is elastic and adapts to the movement of the elbow. This lack

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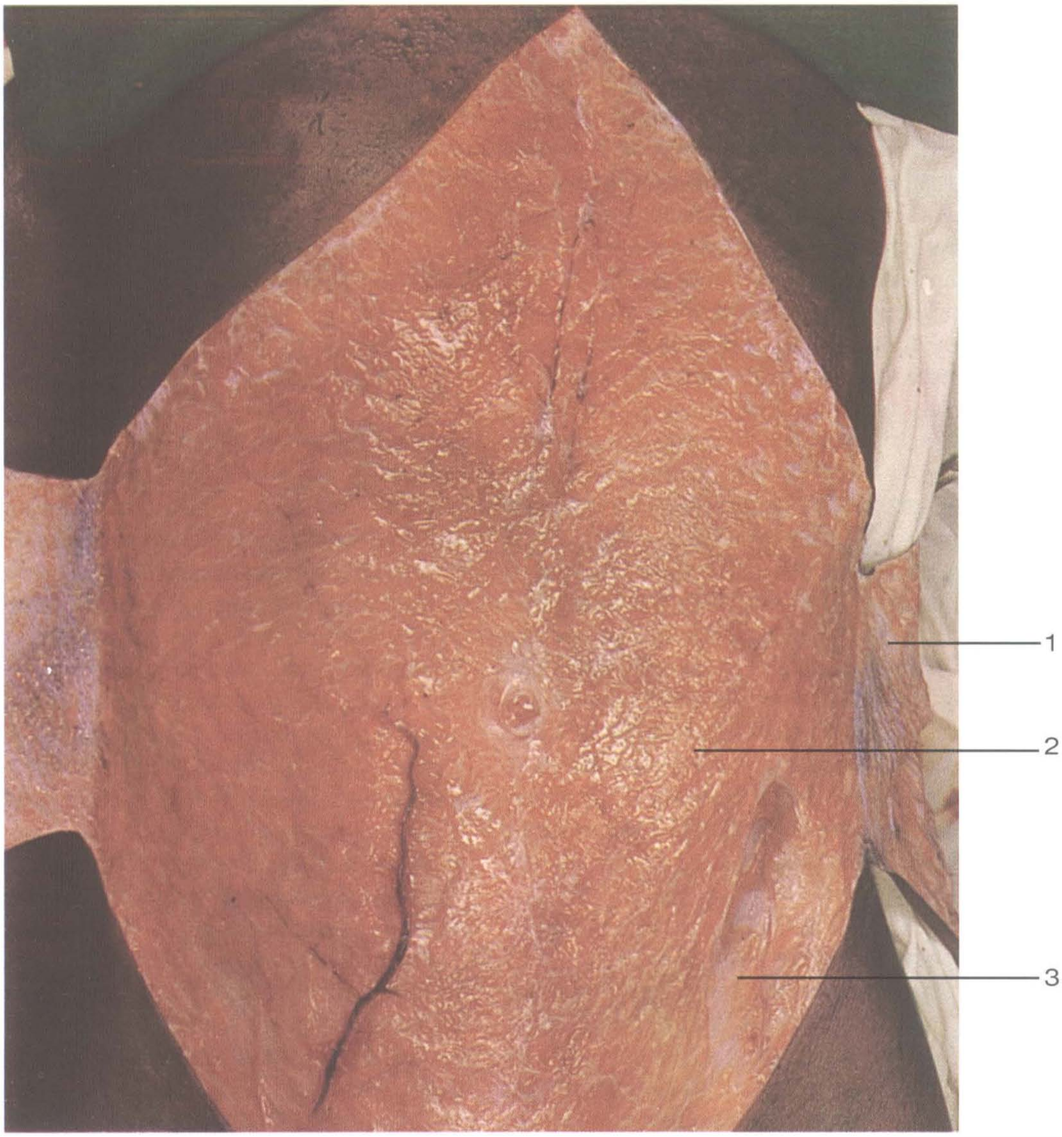
[110] The needle-twirling manoeuvre vigorously stimulates muscle proprioceptors and gives rise to a sensation known in TCM as the Deqi. This is outside any normal experience of pain and must be experienced, in person, in order to fully comprehend the unmistakable quality of myofascial pain. (Mann F, 1995)

[111] The ground substance is the non-fibrillar component of the matrix within which cells and fibres are included. It consists of a viscous gel containing an elevated proportion of water, mostly connected to carbohydrate and proteoglycan molecules. The structural proteoglycans are important for adhesion between the cells and other matrix components as well as for general interactions. These proteoglycans include laminin and fibronectin that seem to act as adhesives between the different matrix components. The amorphous ground substance is mainly synthesised by the fibroblasts of the rough endoplasmic reticulum. (Gray H, 1993)

[112] Hence one induces a modification of the patient's myofascial tensional state; or rather an immediate regression of at least 50% of the symptoms, an increase in ROM and a subjective sensation of lightness of the treated part. (Ferrari S, 1998)



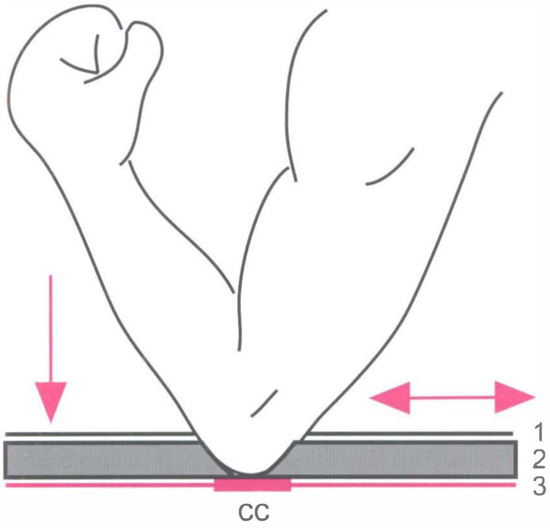


Figure 58. A - Dissection of the abdominal wall: subcutaneous plane (from Fumagalli - Colour photographic atlas of macroscopic human anatomy; - Published by Dr. Francesco Vallardi/ Piccin Nuova Libraria) - B, example of fascial manipulation.

1, The therapist's skin must adhere to that of the patient during manipulation in order to avoid sliding back and forth which can cause grazing; 2, a slow, deep pressure shifts the loose subcutaneous connective tissue allowing access to the fascia. The loose connective tissue separates the cutaneous exteroception (dermatomere) from the fascial proprioception (fasciatomere); 3, part of the deep abdominal fascia freed from the loose connective tissue. Manipulation must reach this fascia and in particular the cc of the mf unit; furthermore manipulation is only carried out on the cc which is densified and which produces referred pain.

of friction means that no rise in temperature will occur and, therefore, manipulation can last for a long time without any decrease in the pain.

The Figure 57, demonstrates the temporal relationship that exists between localised pain as reported by the patient and the arousal of referred pain.

The red line illustrates how the patient reports an increasing pain in the first minute of treatment and how it remains strong for several minutes. Pain diminishes suddenly when the increase in temperature caused by the manipulation reaches the level required for the ground substance to transform from gel-to-sol.

The green line illustrates how referred pain manifests itself shortly after the beginning of the treatment and attenuates after the decrease in local pain.

With reference to the previously mentioned example of periarthritis, the patient will be placed in side-lying, on the non-painful side, for treatment. The fascial therapist positions one hand on the plinth in order to regulate the required weight and pressure to be applied during treatment. The therapist's other elbow is positioned over the cc of la-hu and the point is manipulated until the consistency of the fascia modifies itself. A certain ambidextrous ability is preferable to avoid trauma from overuse for the therapist.

Possible reactions following treatment

Once the manipulation has been completed the treated point can manifest the following reactions:

- Immediately after the treatment the patient feels improvement in his/her symptoms and a certain amount of local heat around the treated point. In this area there might be a small indentation due to shifting of the loose connective tissue.
- After ten minutes (Figure 59) the patient can notice a worsening of symptoms and an increase in local soreness. This is due to the oedema that forms as a consequence of the exudation phase along with an increase in haematic influx. Manipulation of the fascia disturbs the cohesion of the ground substance paving the way to a new orientation of the fibroblasts.
- In the hours that follow the inflammatory phase of the fascia proceeds[113] with the arrival of neutrophils followed by macrophages, which together eliminate the newly formed necrotic matter. Myofibroblasts become active, producing new type-III collagen fibres.
- Over the next three days there may be a temporary worsening of symptoms with, in individuals who are predisposed, the eventual appearance of a small haematoma in the area of the treated point.
- Five days after treatment the patient notes a reduction in local soreness and his/her symptoms improve.
- In the next twenty days the initial type-III collagen slowly orients itself in the direction of the lines of traction and is subsequently replaced by more stable, type-I collagen.

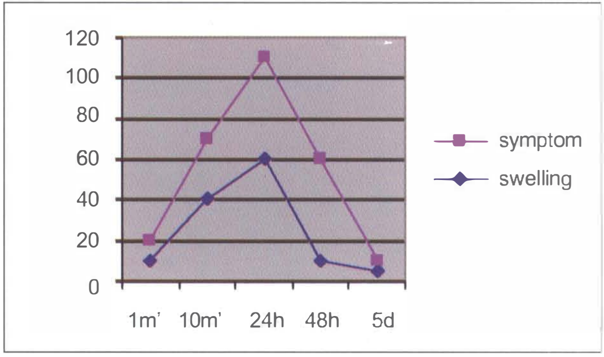


Figure 59. Reactions after treatment

The Figure 59, illustrates the relationship between swelling of the treated cc's and the patient's symptoms. Immediately after treatment there is no swelling and the patient feels better.

Ten minutes later it is possible that the symptoms worsen as the inflammatory reaction sets in. The inflammatory reaction diminishes after 24 hours whilst the tensional balance of the fascia can manifest itself even up to five days after treatment.

Outcome and prognosis

If, after treatment, there is a radical improvement in symptoms a complete resolution of the problem is possible and therefore further appointments need

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[113] The augmented soft tissue mobilisation is a mobilisation of soft tissue fibrosis. This controlled micro-injury causes micro vascular trauma that induces a localised inflammatory response. This process stimulates connective tissue remodelling through re-absorption of excessive fibrosis and regeneration.

The direction of the formation of fibres seems to depend on the tensions which act on tissues...
Movements of fibroblasts along lines determined by piezoelectric currents that originate...
It is to be noted that in most cases collagen is laid down according to a precise geometric pattern, with layers in succession that alternate regularly in diverse directions. (Stover S, 1998)

not be arranged. In this case, on the assessment chart near the treated cc, three plus signs (+++) can be recorded.

If the treatment has improved symptoms by more than 50% then two plus signs (++) can be recorded. In this case it is more than likely that a second treatment will be required to resolve the minor remaining symptoms.

If treatment has improved the pain or the joint limitation by less than 50% then an evaluation of one plus (+) is recorded and another appointment should be made in order to define the problem better, with a review of the initial hypothesis.

If treatment has not given any immediate results, or one week later the patient returns with exactly the same symptoms, then a zero (0) is recorded near the treated cc and a detailed history, hypothesis and verification need to be repeated from the beginning.

If after a second treatment the pain still remains constant then it is advisable to refer the patient back to his/her doctor for further tests (e. g. for neoplasm, internal disturbances, neuritis...).

Quite frequently the initial treatment will resolve one pain and cause another to emerge. This occurs because a compensation that the body had created in order to cope with an unstable posture has been removed, causing the loss of an already precarious equilibrium. In this case, as the body reveals all its compensations they are gradually and progressively remediated.

At other times new symptoms will appear following manipulation as the fascia adjusts to changes in postural tensions. In this case it is advisable to organise two or three weekly treatments, followed by a pause of one month. In fact collagen fibres need about twenty days to align themselves according to the new posture and the body also needs time to be able to adjust.

Clinical case studies

In the following case studies of segmentary disturbances the first demonstrates how one can trace from the site of pain, or centre of perception, back to the centre of coordination of the same mf unit; the second case demonstrates how a compensation can develop between the two agonist/antagonist mf units that move the same segment in one plane.

From cp to cc of a mf unit.

An 18-year-old athlete with a medical diagnosis of sprained right ankle:

Questions asked:

1. Where is your pain?
   – In the right ankle. (rt ta)
2. Exactly which part of the ankle?
   – In the outer part. (la)
3. How long has it been painful?
   – For one month now. (1m)
4. Have you ever sprained your ankle before?
   – No, this is the first time.
5. What does this pain prevent you from doing?
   – To run, most of all.
6. Does your joint feel free to move?
   – No, I have to hold it turned inward. (me -5°)

On the assessment chart these answers were summarised as follows:

SiPA	TA LA rt 1m * ME -5°

This data indicated a hypothesis of either the mf unit of la-ta (pain in the lateral part of the talus) or else me-ta (limitation).

These hypotheses were then verified with palpation and movement assessments.

During the movement assessment, the range of mediomotion of the talus was found to be notably limited due to pain in the mf unit of lateromotion.

The grid is completed in the following manner:

Frontal plane	*Sagittal pl.*	*Horiz. plane*
LA-TA**	RE-TA	ER-TA
ME-TA	AN-TA	IR-TA

Palpation assessment confirmed that pain in the lateral part of the talus was a consequence of densification of the same mf unit's centre of coordination (Figure 60).

The cc of la-ta was treated in the point where the traumatic sprain had injured the fascia one month previously. The repair process had begun with exuberance in as much as an immediate return to training had caused a recurrent inflammation in the strained part. After several minutes of work on this point a sudden relaxation of the tissue was noted. The post-treatment movement assessment, which basically repeated the initial movement assessment, affirmed that the complete and painless ROM of the articulation had been recuperated (la-ta+++).

Figure 60. Palpation-manipulation with knuckles. The use of knuckles avoids straining the tendons of the fascial therapist's fingers. Prolonged manipulation of particularly densified points is possible with this technique. It should be noted that treatment of each cc requires precise positioning for both the patient and the therapist. In this photograph the cc of LA-TA is being treated.

Figure 61. Manipulation with the pisiform. The palpation assessment cannot be carried out with the pisiform because it is difficult to perceive tissue variations with this part of the body. This bony prominence is however useful, above all, for exerting an ischaemic and analgesic pressure on the more sensitive points. In this photograph the cc of RE-TA is being treated.

From the centre of perception to the cc of the antagonist mf unit.

A 40-year-old housewife with a medical diagnosis of right epicondylitis:

The session began with the subjective assessment:

1. Where do you feel the pain?
   – In the right elbow. (cu rt)
2. In which part of the elbow?
   – In the outer part. (la)
3. How long has this pain been bothering you?
   – For about 3 months. (3m)
4. Have you ever had pain in your elbow before?
   – No, it is the first time.
5. What does the pain stop you from doing?
   – I'm unable to work. (**).
6. Does the joint feel limited?
   – I can't straighten it completely. (re -10°)

This data is summarised in the following way:

SiPA	LA CU rt 3m ** RE –10°

This data hypothesised an involvement of the mf units of la-cu and re-cu.

Movement and palpation assessments were required to test the validity of these hypotheses.

During the movement assessment resisted lateromotion was strong and the elbow was able to maintain its position, whilst on resisted mediomotion the elbow yielded its hold due to pain in the lateral part of the elbow.

The grid was compiled in the following manner:

Frontal plane	*Sagittal pl.*	*Horiz. plane*
LA-CU *	RE-CU *	ER-CU
ME-CU **	AN-CU	IR-CU

Two asterisks were used for mediomotion because during the movement assessment of this mf unit the pain increased and a deficit of force was revealed. For retromotion cubitus only one asterisk was used because the movement was only slightly limited, without pain or weakness.

It was deduced that the lateral pain was a consequence of an imbalance between the agonist and antagonist mf units with regards to the elbow's holding ability on the frontal plane. In this case incoordination of the mf unit of me-cu had determined a strain on the free nerve endings in the lateral part of the elbow.

The palpation assessment, comparing the cc(s) of me-cu and la-cu, confirmed that a densification was located in the medial mf unit.

Treatment of me-cu resulted first in a referred pain in the lateral part of the elbow followed by resolution of this pain along with recuperation of full range extension. On the assessment chart this result was recorded with three plus signs alongside the cc of me-cu (me-cu+++).

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PART II
THE MYOFASCIAL SEQUENCE

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Chapter 8
THE ANATOMY OF THE MYOFASCIAL SEQUENCES

The study of the myofascial sequences takes into consideration two different forms of fascial organisation:

- the first is that which unites unidirectional mf units of the trunk, or a limb, within a single fascial compartment (for example, the anterior fascial compartment of the upper arm and the forearm surrounds the mf units of ante-humerus, cubitus, carpus and pollicis) (Figure 62);
- the second is that which connects sequences engaged in the maintenance of the body's alignment on one spatial plane (for example: in order to hold a weight away from the body all of the sequences on the frontal plane are activated i.e. the latero sequence of the upper limb and on the opposite side, the latero sequences of the trunk along with the la and me sequences of the lower limb) (Figure 63).

These two fascial configurations are the pathways along which compensations, caused by densi-

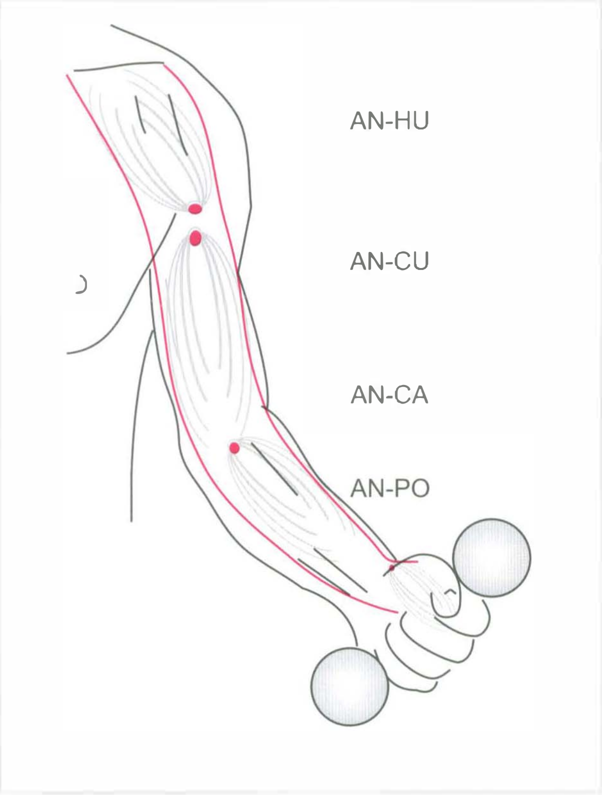

Figure 62. Sequence of antemotion of the upper limb.

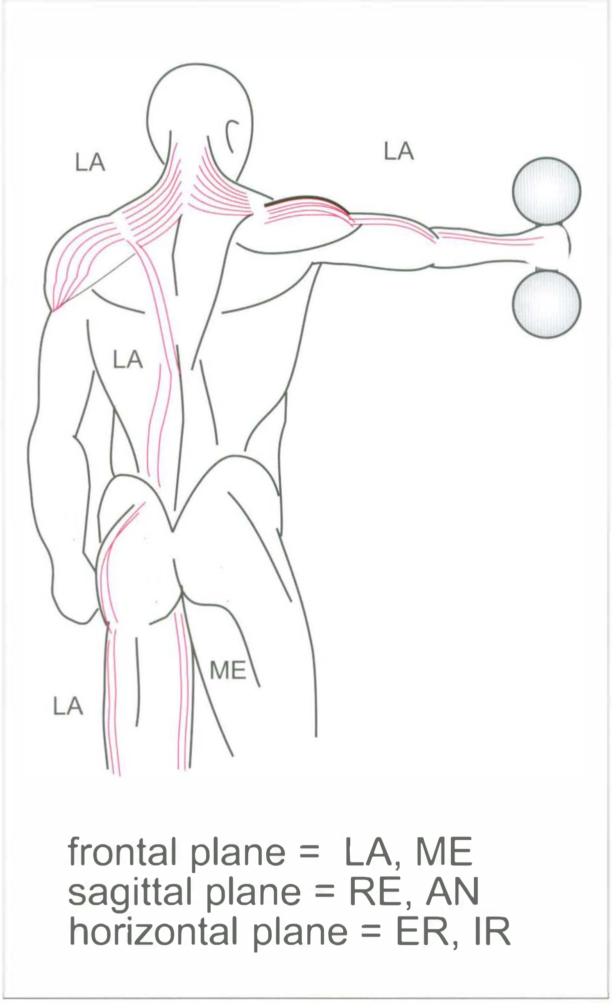

Figure 63. Continuity between sequences on the same plane.

fication of a point of the fascia, can spread through the body.

Since ancient times musculoskeletal pain has been called rheumatism (from the Greek *rheuma* = to flow) in as much as it seemingly flows from one part of the body to another. This *flow* of pain is not casual because it actually follows the structural organisation of the fascia.

In the first part of this book two functions of the fascia have already been analysed:

- its function of uniting the motor units that move a segment in one direction;
- its function of separating the fibres of a single muscle into biarticular and monoarticular components.

In this second part two more functions of the fascia will be analysed:

- its function of uniting all of the myofascial units that move a limb or the trunk in one direction[114];
- its function of perceiving body movements in the three planes.

For the fascia to be able to effectuate its role of perception and coordination it must be maintained under a certain resting tension. This resting tension, or basal tension, is essential for the perception of stretch that results from postural changes. It also enables the fascia to adapt tension within a mf unit to the needs of the entire body.

If a cc densifies then this creates an imbalance within its own mf unit. This imbalance can then be propagated to the antagonist mf unit and subsequently along its own mf sequence and, ultimately, along other sequences within the same plane. Hence abnormal tension caused by densification of a single point of the fascia does not spread within the body haphazardly.

These compensations not only develop along unidirectional sequences. They often modify the tension between antagonist mf units that work on the same spatial plane as well. If, for example, a boat's mast is in perfect equilibrium then the rigging on both sides is tensioned to the same degree. When part of the rigging becomes wet then it shortens, pulling the mast to that side; only an increase in tension of the rigging on the opposite side prevents a shift from the vertical position. Likewise, in the body, if a certain sporting activity reinforces only the agonist mf unit then the antagonist mf unit is forced to increase its fibres to maintain alignment of the segment.

If the human body consisted of a single articulation, the counterbalance of the antagonist would be sufficient to maintain postural alignment. However, in the human body there are many "masts" placed one on top of the other, as well as being connected to each other. In effect each joint regulates its alignment in relation to its proximal and its distal segment. The myofascial sequences link together all of the mf units that maintain the verticality of the segments on one plane.

The compensations that form as a consequence of fascial densification are distributed along these sequences according to two fundamental strategies:

- it is possible to have an ascending or descending compensation. A right-sided back pain could be a consequence of a densification of the cc of lateromotion collum (descending compensation) or it could be a consequence of densification of the cc of lateromotion coxa (ascending compensation).
- it is possible to have an ipsilateral or contralateral compensation. An ipsilateral compensation develops along the same sequence (la-cx, la-lu, la-hu); a contralateral compensation in the limbs will be located in the antagonist sequence (la-ta, me-ge) whereas in the trunk it will be located in the opposite half of the body e.g.densification of the cc of la-lu on the right could give rise to a densification of la-pv or la-th on the left. This type of compensation maintains the verticality of the body but limits the joint range of movement. In such a case the person does not necessarily suffer from intense pain but they do, nevertheless, feel tense and impeded in their movements.

The structure of the myofascial sequences

The internal structure of the limb sequences is formed by a chain of unidirectional muscles ensheathed in a single fascial compartment e.g. the fascial compartment of the triceps brachii (re) or the anterior compartment of the leg (an) (Figure 64 A, B). In the trunk, the sequence of retromotion (re) is formed by two parallel fascial compartments (the right and left erector spinae) whereas the sequence

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[114] The function of a muscle is impossible to comprehend if considered in isolation from the other muscles that act in synergy with it. The aponeuroses and the muscle sheaths connect all contractile elements in a unique system. The single components of this system have a certain autonomy governed, via reflexes, by the nervous system. (Benninghoff G, 1972)

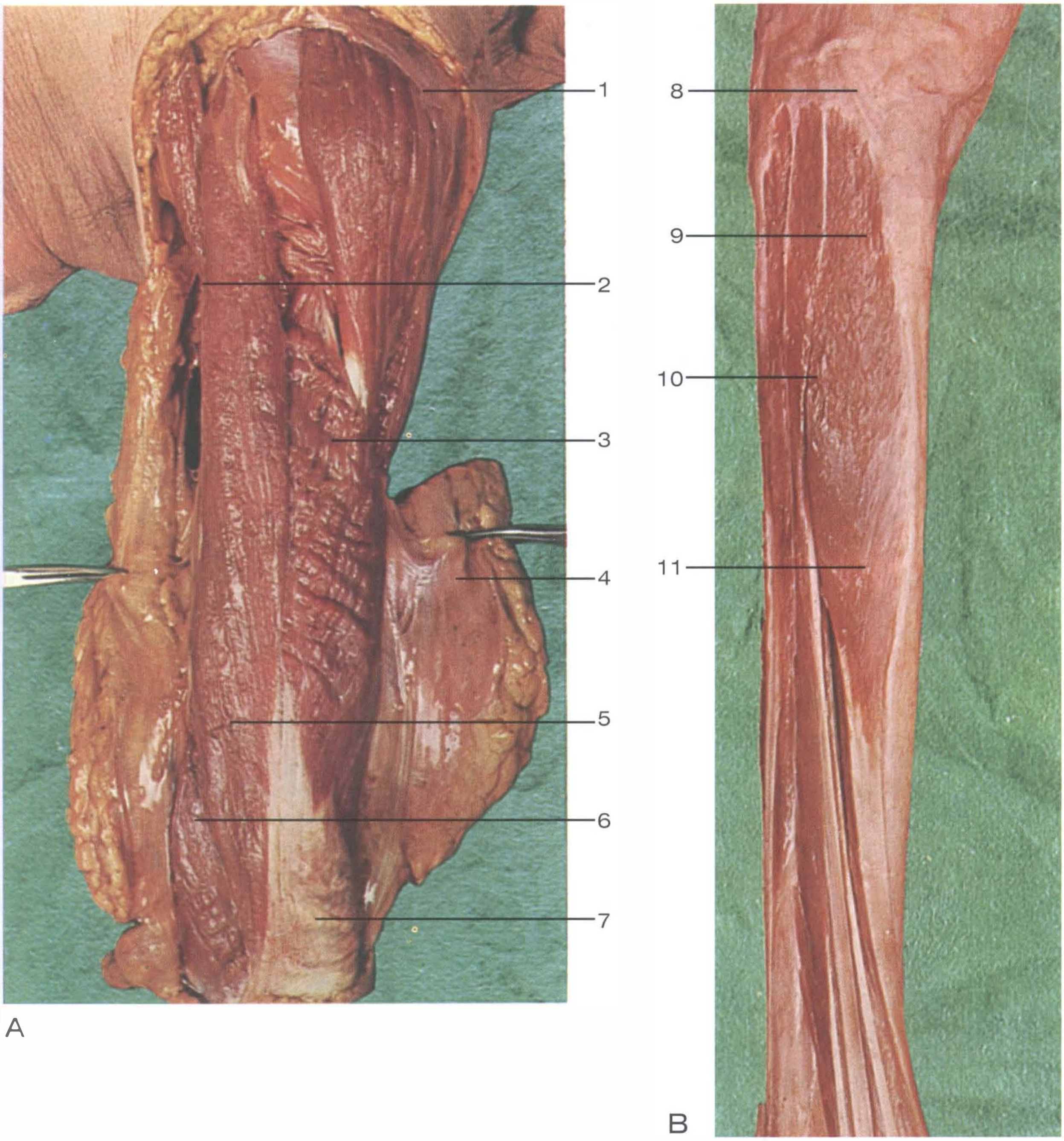

Figure 64. A - Dissection of the posterior compartment of the arm; B - Anterior compartment of the leg (From Fumagalli - Colour photographic atlas of macroscopic human anatomy. - Published by Dr. Francesco Vallardi/ Piccin, Nuova Libraria).

A-1, Deep fascia of the deltoid which has been sectioned; 2, long head of triceps, which participates in the formation of the mf unit of retro-humerus; 3, lateral head of triceps with overlying epimysial fascia slackened due to the fact that the underlying muscle lacks resting tone; 4, Deep brachial fascia united to the superficial fascia; both of which have been sectioned and turned back to show the underlying muscle tissue. The deep fascia forms the posterior brachial compartment that contains the mf unit of retro-cubitus; proximally it is continuous with the mf unit of retro-humerus and distally with retro-carpus; 5, long head of triceps, which participates in the formation of retro-cubitus along with its medial and lateral heads; 6, medial head of triceps; 7, distal tendon of triceps that extends, by means of a lamina, into the posterior antebrachial compartment (re sequence). B- 8, Deep fascia of the knee; 9, muscular fibres of tibialis anterior; the anatomist has removed the deep fascia, which at this point is united to the epimysial fascia, in order to reveal these underlying muscular fibres (fibres which tension the antemotion sequence); 10, intermuscular septum between tibialis anterior and extensor digitorum longus; 11, epimysial fascia of the tibialis anterior, which in this point is free to glide under the deep fascia (cc of an-ta) of antemotion (an) is formed by the right and left rectus abdominis separated by the linea alba.

In the description of each mf unit, the presence of monoarticular and biarticular fibres was highlighted. The monoarticular fibres are involved in the activity of a single mf unit whereas the biarticular fibres participate in the organisation of the mf sequence. An analysis of the mf unit of antemotion of the upper limb reveals that the mf unit of antemotion humerus (flexion) is linked to antemotion cubitus via the bicipital aponeurosis and in turn, an-cu is linked to the mf unit of antemotion carpus by means of the flexor carpi radialis.

Muscular fibres only provide contractile force; this force is stimulated by a nervous impulse and is regulated by the stretch of fascial elements that are placed both in parallel and in series to these muscle fibres. Having already examined this regulatory mechanism within the mf unit, its role in the organisation of force along a sequence will now be considered.

Once again topographical anatomy[115] will be considered as a means of interpreting the physiology.

In all segments of the body the fascia is tensioned by tendinous expansions that originate from underlying muscles. As already mentioned, in the elbow (Figure 65, 89) the bicipital aponeurosis of the biceps stretches the antebrachial fascia in a proximal direction. The same fascia is drawn distally by the flexor carpi radialis. This tensioning is not normally visible because the subcutaneous loose connective tissue (superficial fascia) glides freely over the deep fascia and the physiology remains hidden to the naked eye. Obviously, during flexion of the elbow, it is the contraction of the biceps that tensions the antebrachial fascia, which consequently transmits tension to the flexor carpi radialis. The muscle spindles of the flexor carpi radialis are activated by this stretch and they synchronise the mf unit of antemotion cubitus with antemotion carpus. In the posterior part of the arm the same organisation is found: triceps sends a tendinous expansion exactly to the point where some fibres of the extensor carpi ulnaris originate[116] thus placing the posterior antebrachial fascia under tension (Figure 65).

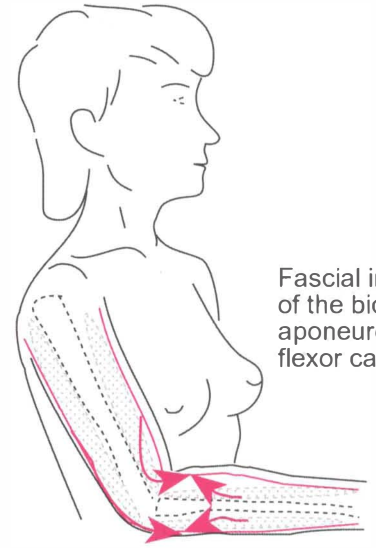

Figure 65. Myofascial insertions distributed along the sequences.

The fascia ensheaths this unidirectional muscle chain in a single compartment. Within this fascial compartment a part of the fascia is free to slide over the muscle fibres and to transmit tension along the limb whilst another part is joined to, and tensioned by, the muscle fibres. Due to these myofascial links, all of which will be highlighted in the description of each single mf sequence, the unidirectional mf units can synchronise their activity according to the effort required.

Four factors determine the unity between the unidirectional mf units:

1. the biarticular muscle fibres; for example, the long head of biceps participates in the antemotion of the humerus and the cubitus;

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[115] The antebrachial fascia of the forearm continues above with the brachial fascia of the arm. The antebrachial fascia consists of transverse, vertical or oblique fibres that originate from the epicondyles and the bicipital aponeurosis. Its superficial surface is in contact with the superficial fascia which slides easily across it; its deep surface covers the muscles of the area which send various tendinous expansions up to the fascia". (Testut L., 1987)

[116] A part of the triceps tendon extends into the forearm fascia and it can almost completely cover the anconeus muscle. (Platzer W, 1979)
The extensor carpi ulnaris originates from the epicondyle, the radial collateral ligament of the elbow and the antebrachial fascia that covers it... (Chiarugi G, 1975)

2. the fascia that extends over these muscular fibres; for example, the anterior brachial compartment that ensheaths biceps and brachialis is continuous with the mf unit of antemotion humerus and with the mf unit of antemotion carpus distally;
3. the insertion of some muscle fibres of each mf unit onto the overlying fascia; for example, pectoralis major inserts onto the brachial fascia and biceps inserts onto the antebrachial fascia, via the bicipital aponeurosis;
4. the endofascial, collagen fibres arranged in a longitudinal direction; for example, the longitudinal fibres of the brachial and anterior antebrachial fascia form links between the unidirectional mf units. This is similar to the endomysium, perimysium and epimysium linking the unidirectional motor units of a single mf unit.

In this amazing organisation of our body, all myofascial sequences respect these laws. In this way it is clear how the brain can concentrate on moving distal segments whilst the rest of the limb organises itself in response to the effort required.

Expanding on the Hill model[117], it can be said that the connective tissue structure, which is placed in parallel to the muscular fibres, is made up of:

- perimysium and epimysium[118]; these are affected by traction of the unidirectional motor units in such a way as to cause convergence of these vectors at a single point, or centre of coordination (mf unit);
- the fascia that slides freely over the unidirectional mf unit in order to perceive traction of the proximal and distal mf units (mf sequence);
- oblique fibres of the retinaculum that slide freely within the fascia[119] and that synchronise the cc(s) of fusion in the realisation of complex movements (mf spiral).

The external structure of the sequences of the trunk

While the sequence of retromotion of the arm (or leg) is composed of a single fascial compartment, the retro sequence of the trunk is composed of the two fascial compartments of the erector spinae. These two chains of extensor muscles that run on either side of the spinous processes form a single mf sequence due to the thoracolumbar fascia. This fascia, common to both sides of the body, is anchored to the spinous processes of the vertebrae. For this reason densification of the two cc(s) of re-lu or re-th is not always symmetrical, or rather, it can be located in different metameres between the right and the left sides.

The same myofascial organisation is found in the anterior antagonist sequence (an). During antemotion of the trunk the fascial compartment of rectus abdominis synchronises the bilateral sequences of an-lu and an-th.

Lateromotion of the trunk is effectuated by the single mf units of la-th, la-lu and la-pv and also involves the synergy of the ipsilateral, anterior lateromotion musculature[120]. Thus the sequence of lateromotion has a posterior line of force consisting of segmentary cc(s) and an anterior line of force formed by the cc(s) of fusion of an-la-th, an-la-lu and an-la-pv.

Two vectors are also necessary for stability and harmonious movement on the horizontal plane. Two sequences on the same plane that effectuate movement in opposite directions, intervene. Active trunk movement on the horizontal plane is therefore effectuated by the simultaneous activation of the sequence of extrarotation, together with the contralateral sequence of intrarotation (coupled force).

Despite these discernible differences in the sequences of the trunk, the principles pertaining to the mono and biarticular fibres, the fibres inserted

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[117] From Hill's mechanical model it can be seen that when contractile tissue is inactive, the extendibility of muscle is limited by virtue of the resistance of the parallel elements, namely the external and internal collagen that invests muscle. Maximum muscle lengthening exploits the gliding that occurs between collagen filaments and is curbed by the scarce extendibility of these elastic elements that are placed in parallel. (Esnault M, 1988)

[118] The deep fascia corresponds to the epimysium of single muscles and is continuous with the perimysium and endomysium of the same muscles. The fascia allows for reciprocal gliding to occur between adjacent structures; it is composed of different layers. (Lockart RD, 1978)

[119] The muscular or deep fascia is often indistinguishable from aponeuroses given that, like aponeuroses, in fascia we find layers of fibres that are parallel to each other but that are arranged at right angles with respect to the successive layer. (Gray H, 1993)

[120] A muscle or a muscle group is not isolated in its mechanical activity but is part of an extensive complex that the nervous system is able to sensitise functionally in order to effectuate a great variety of movements...One needs to consider a long muscular band with latero-cervical and abdominal origins that terminates in the thigh: all of this non-linear fascia is involved in lateral flexion of the trunk... (Benninghoff G, 1972)

onto the fascia and the fascia that slides freely linking the various mf units are still respected.

The sequences and the spatial planes

Each mf sequence is not an isolated entity because it forms a functional unit with the other sequences that operate on the same spatial plane.

- Thus the sequences of latero and medio of the limbs and trunk form a functional unit that maintains the verticality of the body segments on the frontal plane.
- The sequences of retro and ante of the limbs and trunk form a functional unit that maintains the verticality of the body segments on the sagittal plane.
- The sequences of extra and intra of the limbs and trunk maintain coordination between the body segments on the horizontal plane.

These functional units intervene in the management of normal posture and they also guide the therapist in tracing the pathways of pathological compensations.

The sequences and management of posture

Activities of daily living are regulated by postural compensations on one plane: lifting a full bucket with the right hand obliges one to raise the left arm laterally in order to compensate for the imbalance created on the frontal plane (Figure 66). If it were not for the continuity between the lateromotion sequences of the upper limb with that of the trunk and of the trunk with the lower limb, this postural balance would be impossible. When the weight of the full bucket is shifted, postural regulation occurs automatically due to a variation in the tension of the fasciae.

Taking into consideration the example of maintenance of equilibrium on the sagittal plane (Figure 66) it is evident that an increase in volume of the abdomen[121] requires a counterbalance behind the shoulders to compensate for the anterior loading. Often postural adjustments in an obese person, or in a pregnant woman, do not result in pain because there is a gradual, symmetrical compensation of the whole sequence.

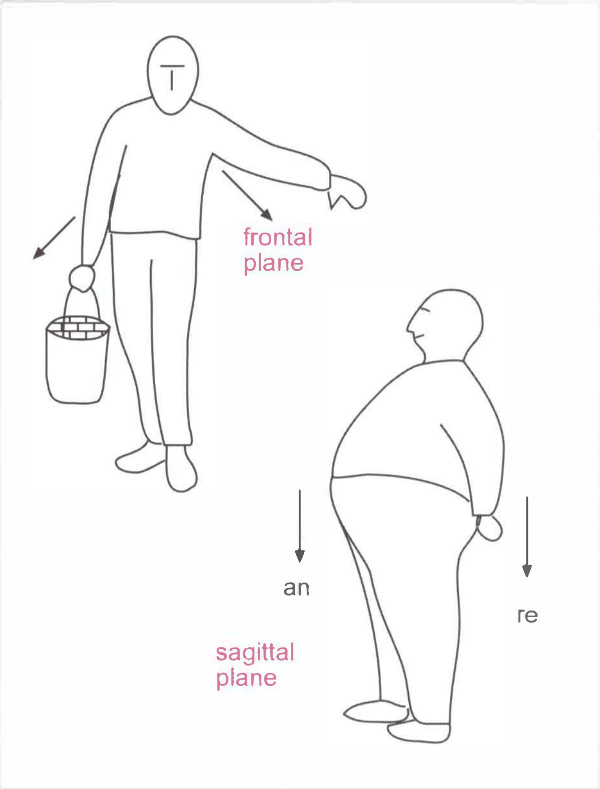

Figure 66. Compensations between sequences on one plane.

The fascia is responsible for the maintenance of equilibrium within physiological limits or, at least, in the most economical position possible. Pain only results when factors occur that modify the execution of this role of the fascia. If, for example, a fascial therapist always uses the same elbow to manipulate the fascia then only one side of the body is reinforced. This can cause a postural imbalance and a derangement of the collagen fibres with consequent pain. If instead the due elbows are used in alternation, then the muscles and fascial fibres will be strengthened equally without pain.

The sequences and compensations on the spatial planes

If the fascia presents densifications then the necessary postural adjustments, such as those required during a pregnancy, cannot take place. Fascia that is

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[121] An alternative function recently proposed for the interspinous ligaments is that of anchoring the thoracolumbar fascia to the spine. Collagen fibres of the interspinous ligaments merge with those of the thoracolumbar fascia. Experimental and theoretical studies have led to the suggestion that tension in the fascia, produced by contraction of the abdominal muscles, may produce extension of the lumbar spine thus providing support and contributing to stability during lifting. (Thesh K, 1985)

unable to lengthen places abnormal tension on nociceptors, resulting in pain. In order to neutralise pain the body adopts all possible strategies: in some cases it limits joint range of movement, in many cases it tries to substitute the fascial densification by exploiting the elasticity of the unidirectional sequences. This particular attempt to equilibrate tension releases the strained free nerve endings and the pain, at least temporarily, ceases. Compensation, however, does not resolve the initial densification but slowly proceeds to create other densifications along the sequences of the same plane. The pain is apparently resolved but each densification becomes a potential source of imbalance and an unusual movement can be sufficient for an acute, painful episode.

Chronic pain is persistent because the fascia can no longer compensate for the numerous densifications that have formed over time. It is relatively easy for a densification in a child's body to develop a compensation, due to the elasticity of a growing musculoskeletal system, but this can determine future deformities if not corrected. A densification in an adult can be neutralised by a contralateral densification and, in turn, this point can be neutralised by a proximal densification. However, when the fascia is unable to adapt itself anymore or its capacity to maintain postural alignment is jeopardised, then abnormal tension on the nociceptors becomes continuous. At this stage, in order to neutralise pain, there is no other alternative for the body than to start deforming its various articulations. Fascial Manipulation can intervene to prevent the slow adaptation of the body to these abnormal fascial tensions.

Sometimes the presence of numerous densifications does not manifest itself simultaneously but in alternation. That is, the contraction of one mf unit might momentarily release the tension in another mf unit. In such a case the patient at first complains of back pain, which then seems to ease, followed by onset of neck pain, then the pain shifts to the shoulders or to the lower limbs and then the back pain returns. A careful study of the planes on which the compensations form can assist in the research of the most densified mf unit.

At other times pain in the locomotor system can be related to an internal or visceral problem. For example, this type of pain can be diagnosed as colic and it is normally attributed to the movement of small gallstones. However, the cause is not in the gallstone itself but in the rigidity of the internal fasciae unable to adapt to the sudden stretch caused by the passage of these small crystals. When the fasciae of the ducts are healthy and elastic a person can live with large gallstones without pain. Referred pain from these internal organs follows the distribution and continuity of the internal fasciae with the external fasciae.

During investigation of the cause of a compensation it is quite common to discover that pain is present in two spatial planes (e.g. latero as well as extrarotation). The component that is the principal cause of the imbalance needs to be identified in order to distinguish the origin of the compensation. Therefore, even if lateromotion is associated with extrarotation, in any one session the cc(s) on only one plane are to be treated. If the outcome is sufficiently positive (e.g. ++ or +++) then a clear indication as to how to proceed in the therapeutic programme has been established. If in one session two planes are treated and the outcome is uncertain then it would be difficult to decide on which plane to continue treatment. The therapeutic procedure is always aimed at assisting the fascia in recuperating its coordinating function by eliminating any densifications that impede this activity.

The sequences terminate in the extremities

It is relatively rare that a patient presents dysfunctions that are localised only on one plane. Selection of the sequences to be treated can be aided by asking the patient about any pins and needles and/or deformities, present in their fingers or toes or head. Distal paraesthesiae occurs when fascial compensations along a sequence, in response to one or more densifications, culminate in the terminal part of the sequence. In these zones the neuroreceptors are stretched abnormally therefore their afferent information is transformed into paraesthesiae. At other times tension along a sequence is neutralised with the deformation of its distal parts (hallux valgus, hammer toe, trigger finger etc.). In practice the precise relationship that exists between a sequence and a finger, or toe, is less definitive than that which is represented in these illustrations. For example, the sequence of lateromotion of the upper limb terminates in the index finger but the fascia of the first interosseus also continues above the other interossei muscles, hence, at times, paraesthesia can be distributed over the whole hand.

The extremity of the upper limb

The sequence of antemotion terminates in the

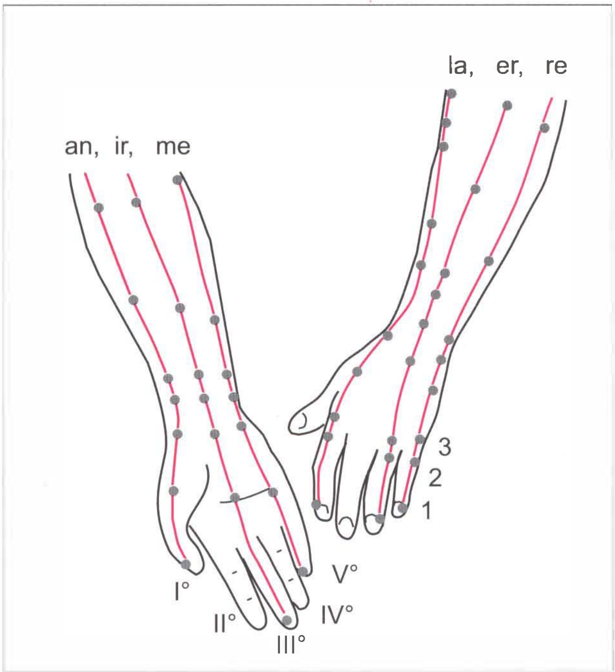

Figure 67. Confluence of the sequences in the hands.

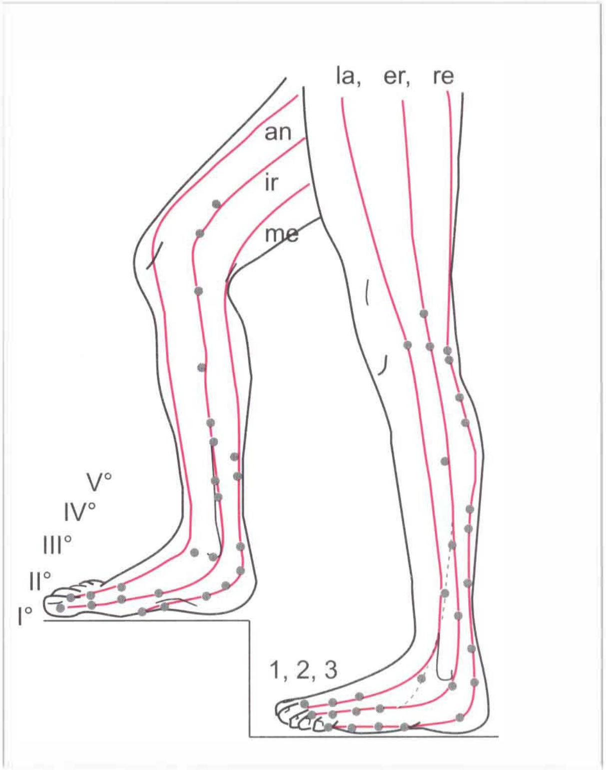

Figure 68. Confluence of the sequences in the feet.

pollex (thumb); lateromotion in the index; the sequence of intra in the middle finger, the sequence of extra in the ring finger and the sequences of mediomotion and retromotion end in the little finger.

To be able to handle objects and to perceive their three dimensional structure, fingers possess their own locomotor independence. The fact that a specific mf sequence terminates in each finger seems to serve this purpose (Figure 67).

To specify which finger is disturbed Roman numbers can be used (I° = pollex, II° = index... etc.). To distinguish which interphalangeal joint is involved of any particular finger Arabic numbers are used (1 = interphalangeal joint between distal and medium phalange; 2 = interphalangeal joint between medium and proximal phalange, 3 = joint between proximal phalange and metacarpus; in the case of the thumb and the hallux the number 3 indicates the carpus metacarpal joint and the tarsus-metatarsal joint).

The extremity of the lower limb

The sequences of antemotion and intrarotation terminate in the hallux; lateromotion and mediomotion terminate in the three middle toes and the two sequences of retromotion and extrarotation end in the little toe.

The toes are somewhat like antennas, perceiving the ground below and organising the appropriate adaptations of the sequences above (Figure 68). Many righting reflexes are managed by these reciprocal tensions, as variations in the position of the foot stretch and activate different sequences and mf units.

The toes (the hallux, three middle toes and the little toe) do not need their own locomotor independence as they tend to act together as a group.

The extremity of the head (caput)

The sequences of the limbs are joined with those of the trunk and they terminate in the head (Figure 69). As the head contains the organs that perceive direction (eyes and ottoliths) all of the sequences are directed to it in a precise manner.

A pathological sign arising from the fascia of the head usually indicates a particular plane rather than a sequence. If, for example, a patient complains of vertigo or tinnitus during retromotion of the head then it is logical to hypothesise a densification on the sagittal plane. If instead the vertigo accentuates in side lying then this is an indication for the frontal plane. Other patients might complain of vertigo when they turn their head (e.g. when reversing in the car) and this would indicate the horizontal plane.

The indications for a specific sequence can also be drawn from pain or dysfunction of a single intrinsic eye muscle. For example, if a patient complains of pain in one or both eyes on gazing upward then this is an indication for the sequence of retromotion.

Dysfunctions of the temporomandibular joint provide less specific indications. If pain is predominately accentuated with closure of the jaw then it is likely that the sequence of lateromotion is involved; this sequence has a sub-unit in the temporalis muscle and another in the masseter muscle.

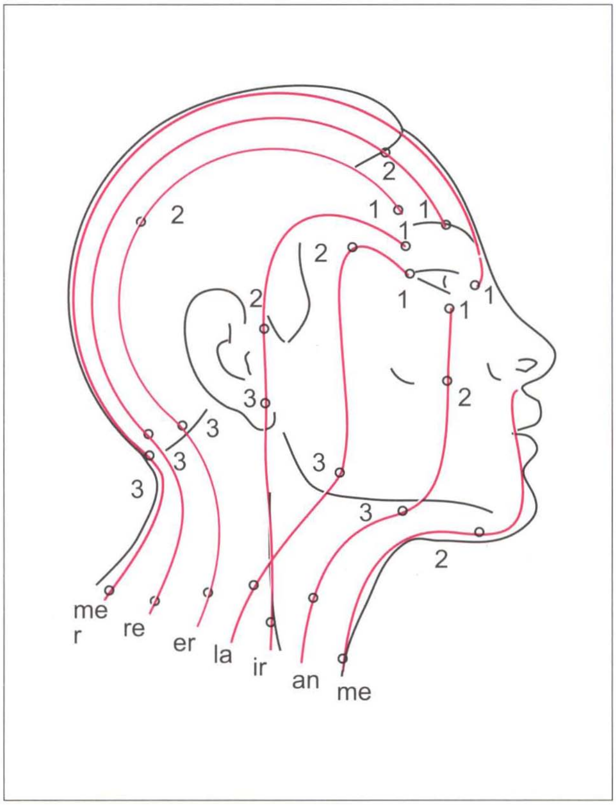

Figure 69. Confluence of the sequences in the head.

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Chapter 9
THE EVOLUTION OF THE MYOFASCIAL SEQUENCES

Myofascial sequences can be considered as a type of anatomical equivalent for numerous functions of the Central Nervous System such as referred pain, coordination, spatial perception and facilitation. In order to demonstrate the basis of this hypothesis, various factors will be examined in detail in this chapter.

- First of all, the fasciae of the sequences of the trunk are continuous with those of the limbs. This continuity is specific and not undifferentiated. More precisely, the sequence of retromotion of the trunk (epaxial muscles), for example, is continuous with the corresponding sequence of the limbs (extensor muscles). Likewise the sequence of antemotion of the trunk (hypaxial muscles) is continuous with that of antemotion of the limbs (flexion muscles), and so forth. This continuity will be illustrated in the section dealing with the evolution of the deep muscles of the limbs.
- In many complex motor activities limb motion is guided by a reciprocal exchange of information. The upper limb on one side advances simultaneously with the contralateral lower limb during the normal gait cycle. This peripheral motor coordination has its anatomical-evolutional basis in the myofascial connections formed by the large, superficial muscles.
- Our awareness of the three dimensions of our body and its actions is a direct consequence of the evolution of the mf sequences. The sequences have formed gradually, along with living beings' progressive mastering of new planes of movement (aquatic environment > laterality = frontal plane; terrestrial environment > retromotion = sagittal plane; complex motor activities = horizontal plane).

Evolution of the deep muscles of the limbs

Throughout evolution Nature has tried all possible expedients to produce faster, more energy-saving motion. One such strategy proved to be the strengthening of lateral flexion in fish through the development of flattened projections (fins) on the sides of the trunk, thereby increasing aquatic propulsion (Figure 70). Fins are involved in movement on the frontal plane hence they originate from the lateral flexor muscles of the trunk[122].

In the human embryo a similar process of limb growth is reproduced; towards the end of the fourth week limb buds develop from a ridge along the sides of the body. This ridge is formed through the proliferation of the somatopleuric lateral plate mesoderm, the same mesoderm as the paraxial somites. Each somite consists of a sclerotome, a dermatome and a myotome. These somitic metameres mix part of their cells with the somatopleuric mesenchyme and with the neural crest[123]. As a result, growing limb buds consist of an external ectodermal layer and an internal mesenchymal nucleus of mixed origin.

At the base of the pairs of fins, which protrude from the sides of the body in fish, a subsequent development occurs: the formation of muscular buds for movements of elevation and depression[124].

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[122] Towards the end of the fourth week the limbs start to form small outgrowths, the limb bud, from a thin lateral crest that extends along both sides of the trunk. This crest coincides with the fin fold. (Gray H, 1993)

[123] The somatopleuric mesenchyme receives contributions from the nearby neural crest and it also mixes with the adjacent dermatomes, myotomes and sclerotomes. (Gray H, 1993)

[124] Fin extensors (elevators) originate from the dorsal blastemae; fin flexors (depressors) originate from the ventral blastemae. The derived musculature establishes connections with the girdles (pelvic, pectoral) and with the fascia that covers the base of the fin. The pectoral fin articulates in the glenoid fossa of the scapula, the pelvic fin articulates with the lateral portion of the ilium. The ilium is joined dorsally to the robust transverse processes of the sacral vertebrae: in amphibians there is one sacral vertebra, two in reptiles and numerous in mammals Appendicular musculature appears to derive from the metameric musculature of the trunk and from myotomes, therefore it is part of the somatic system. The distinction between extrinsic and intrinsic muscle (with origin from the limb) is incorrect. (Romer P, 1996)

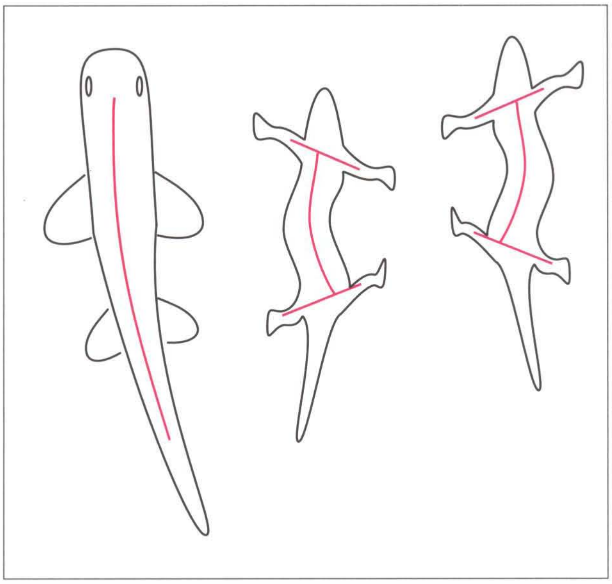

Figure 70. Like the limbs of the salamander, shark fins potentiate lateral flexion of the trunk.

These muscles are the equivalent of the deep muscle layer in humans: pectoralis minor, which connects antemotion of the scapula to the hypaxial sequence of antemotion of the trunk; the rhomboids, which connect retromotion of the scapula to the epaxial sequence of retromotion of the trunk (Figure 71).

In humans the pelvis is less mobile than the two scapulae, hence the muscular structure of the two girdles is not exactly the same. The gluteus medius is the deep monoarticular muscle that originates from the iliac crest in continuity with the chain of epaxial muscles. It acts on the femur during retromotion and is continuous with the sequence of retromotion of the trunk. Similarly, with regards to the scapula, the supraspinatus, which is continuous with rhomboids, connects the epaxial muscles to the mf unit of retromotion of the humerus.

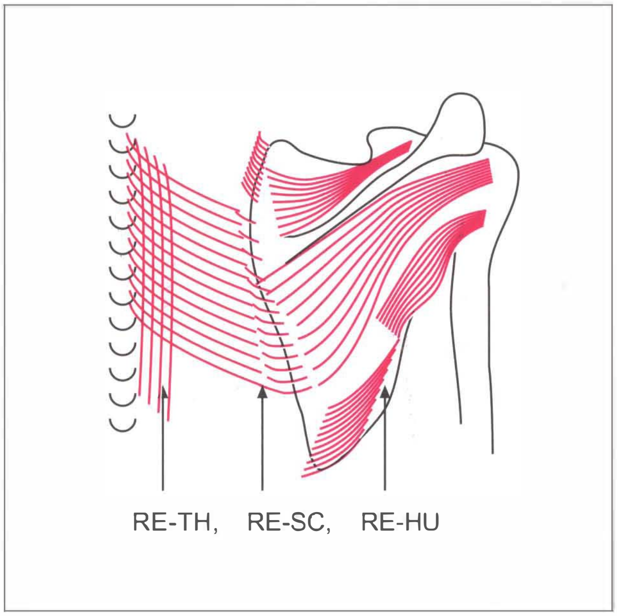

Figure 71. The rhomboids link the sequence of retromotion of the trunk with retromotion of the upper limb.

In the following chapters the description of the continuity between sequences will emphasise how each mf unit of the limbs blends with the equivalent mf units of the trunk. This pattern is not only present in the deep muscle layer but also found in the unidirectional fibres of the superficial muscles.

Evolution of the superficial muscles of the limbs

The limbs of amphibians move in synchrony with the trunk and, just like fins in fishes, they strengthen lateromotion propulsion. Amphibian limbs are on the same plane as the trunk, that is, horizontal to the ground[125]. Their myofascial connections are mostly with the epaxial and hypaxial musculature of the trunk. As a consequence, the right limb, for example, can only comply with the trunk and is unable to regulate its action with that of the left limb. This type of movement is still very energy consuming because it always requires simultaneous trunk movements. On the other hand, without the trunk as a point of reference the limbs would not be able to act synchronously at all.

In order to improve motion, the development of the continuity of the fascia of one limb with the fascia of the other limb was achieved. This evolutional process passed through various stages that will now be examined[126].

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[125] The limb of a primitive terrestrial tetrapod is comprised of three segments: the proximal segment (stylosteophyte) that projects laterally from the body and consists of a single bony element, the humerus or the femur, which originally could move forward or backward practically on a horizontal plane. The lateral flexion of the vertebral column to the right and left made gait possible. (Romer P, 1996)

[126] The extrinsic appendicular muscles originate on the axial skeleton or the on the connective tissue fasciae of the trunk. The latissimus dorsi is the most commonly present extrinsic muscle in the dorsal position. In the urodela this is a delicate triangular muscle that originates from the superficial fascia covering the epaxial myomeres in the shoulder region. In reptiles it is more substantial, inserting itself dorsally onto the robust fascia that connects the neural spines of the vertebrae; it progressively extends its axial origins in a posterior direction. (Kent Cg, 1997)

In the urodela (amphibian) the fascia of the trapezius and the latissimus dorsi is embedded laterally to the erector spinae. Hence, similar to the salamander, the urodela moves its limbs in synchrony with the trunk because the fasciae of the two limbs are still separate. In the sphenodon (reptile), however, the two anterior limbs move in synchrony with one another. The fasciae of the two trapezii, in this case, cross the erector spinae chain and unite at the level of the supraspinous ligaments (Figure 72).

The fascial connection between the two lower limbs can be identified in the gluteal fascia. Due to the fact that it crosses over the sacrum this fascia effectively synchronises the right lower limb with the left. In all animals that move forward, using a synchronised action of the two posterior legs (e.g. rabbits, kangaroos etc.) this type of myofascial organisation prevails. The movement is repetitious and different speeds are reached by simply reproducing the same action at a greater frequency.

As limbs have gradually substituted the trunk in its locomotive role a progressive atrophy of the axial muscles has taken place, with a subsequent increase in the mass of the appendicular (limb) muscles.

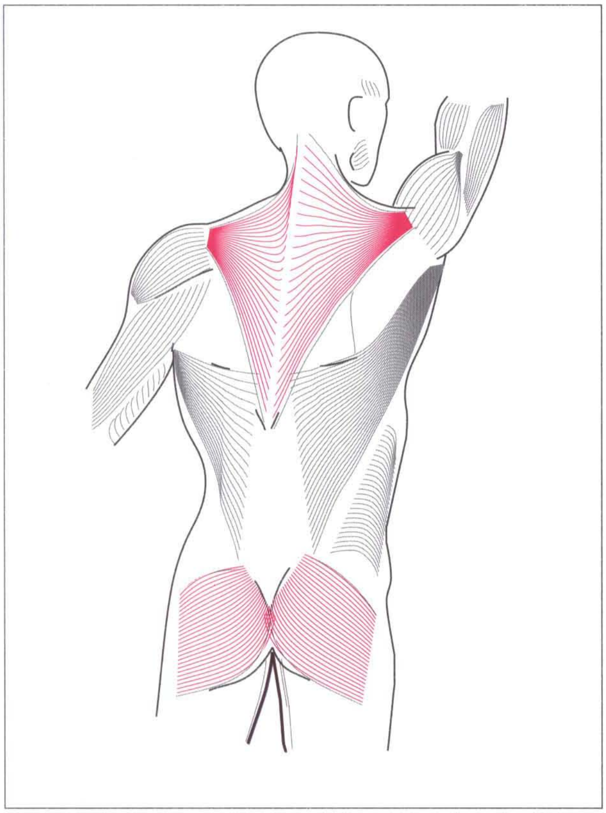

Figure 72. The union of the two trapezii mm. facilitates synergy between the two upper limbs.

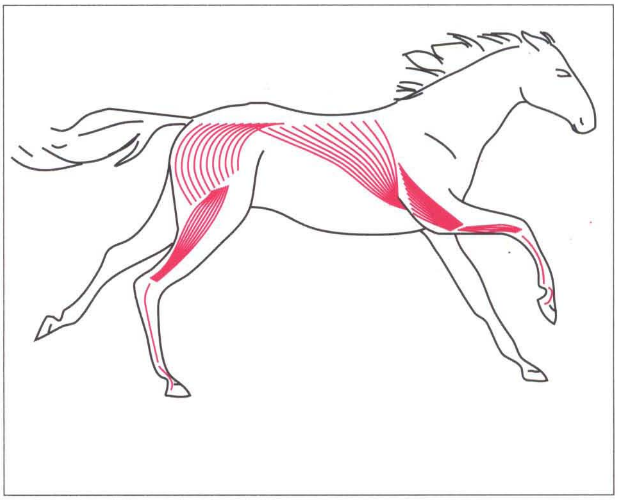

Figure 73. Caudal migration of the latissimus dorsi links the retromotion sequence of the upper limb with that of the lower limb.

Nature's continuous evolution towards greater velocity has resulted in migration of the limbs under, and parallel, to the trunk. In order to elevate the trunk from ground level various modifications[127] in the previous anatomical relationships became necessary. Rotation of the limbs and the synchronisation of the anterior limb with the contralateral posterior limb are two examples of these modifications. The latter was realised by the migration of the latissimus dorsi muscle from the upper limb caudally, towards the lower limb (Figure 73). This connection resulted in the ambling pace of the giraffe (i.e. both legs on the same side move forward simultaneously) and it has been also retained as an alternative strategy in other animals.

The horse, for example, uses the pace, trot, or gallop according to the velocity of its gait. The passage from one motor strategy to another is not a matter of choice for the horse. It is due to the progressive distance between the limbs, which causes tensional changes in the fascial structure, resulting in the appropriate motor programme.

In the chapters that deal with the spiral organisation of the fascia (Part III) it will be highlighted

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[127] In the superior tetrapods the stylosteophyte rotates in such a way as to align itself parallel to the body allowing for a gait with pendular movements of the limbs, thus avoiding bending the trunk. The anterior stylosteophyte rotates caudally and the posterior one, anteriorly, and in this way the elbow comes to be opposite the knee.(Stefanelli A, 1968)

how some fibres of the latissimus dorsi pass from one side of the body to the other. This connection provides for an intersecting synchrony of the limbs, allowing for greater stability in the trunk especially when walking or straightening up.

Evolution of spatial orientation and perception

The evolution of peripheral receptors clearly demonstrates how the brain depends upon the fascia in order to be able to formulate the concept of space and time.

To enable it to organise movement in general the brain requires feedback concerning whatever is taking place in the periphery. This feedback transmits information to the CNS regarding the exact position of any given body segment. The fascia and, in particular, its directional sequences, have a predefined length and therefore can act as a type of measuring device in the periphery. Furthermore, because of its elasticity it is also capable of applying stretch to neuroreceptors.

How this physiology of the mf sequences has developed throughout the evolutionary process will now be taken into consideration. Fish only move by means of lateral flexion hence their locomotor apparatus consists of two lateromotion sequences. Feedback for this movement is transmitted via the lateral line system (Figure 74). This structure is composed of a series of sense organs (neuromasts) connected to each other by means of anastomotic branches[128]. These receptors are implanted in the skin because, in fish, the fascia adheres to the skin.

As evolution introduced the formation of the mandible in fish (after cyclostomes) the lateral line formed an alignment of sopraorbital, infraorbital and mandibular neuromasts.

Amphibians and reptiles subsequently developed the myofascial sequences of antemotion and retromotion. During this period the lateral line formed another two alignments: one dorsal and one ventral.

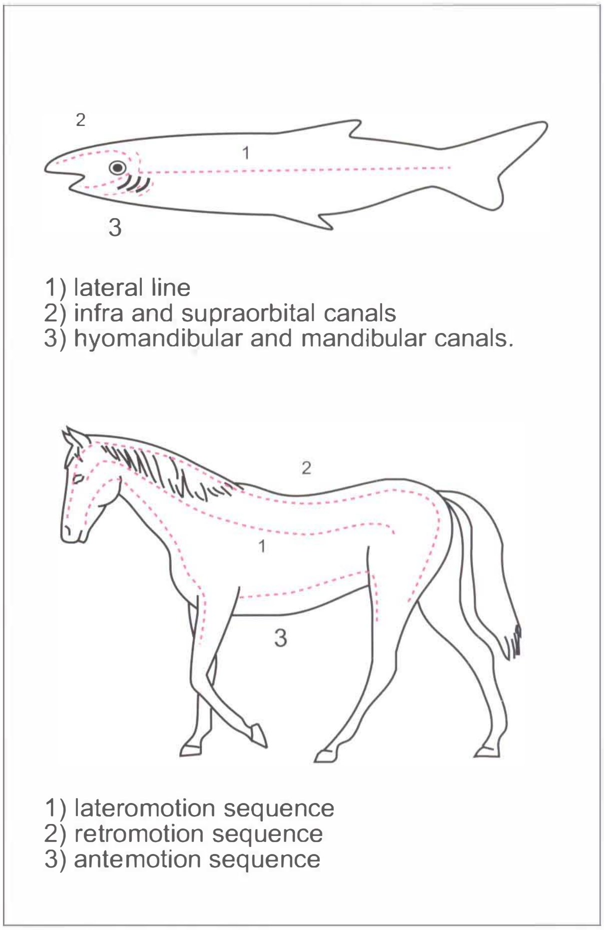

Figure 74. From the lateral line to the perceptive functions of the mf sequences.

At this point neuromasts were no longer located in the skin but progressively submerged into the fascia. In effect, the skin would not have been capable of detecting a variety of stretches to such a fine degree as a fascial sequence united to a specific muscle chain. In this way the skin specialised in exteroception and the fascia, which had become independent from the skin due to the interposition of the subcutaneous connective tissue, became specialised in proprioception[129].

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[128] Neuromasts consist of groups of epithelial receptors (mechanoreceptors). The system of canals of the lateral line and of the cephalic canals is the most diffuse system amongst the complex of neuromasts in fishes. The system of canals diminished successively due to extension and development. In shark forms the canals are in the skin of the head and the trunk. Tadpoles of the anura group usually lose the lateral line system during metamorphosis. (Kent CG, 1997)

[129] The spatial orientation of the trunk midline divides our normal perception of space into an egocentric 'left' and an egocentric 'right' sector and seems to be the decisive factor in determining the neglected 'contralateral' part of space in patients with brain-damage. They indicate that the trunk midline constitutes the physical anchor for calculation of the internal egocentric coordinate frame for representing body position with respect to external objects. (Karnath HO, 1991)

There is a certain continuity from reptiles to human beings with regards to the myofascial sequences. In fact, observation of a crocodile's foot, a bird's wing or the limb of a mammal reveals that the sequence of retromotion terminates in the fifth or little finger, the sequence of antemotion extends towards the thumb, the sequence of lateromotion has a lateral pathway whilst that of mediomotion has a medial pathway. In the human trunk one can observe the preservation of the sequence of lateromotion along the sides, the sequence of retromotion dorsally and the sequence of antemotion ventrally. Hence each sequence occupies a precise position in the three spatial planes.

The development of the sequences has taken place simultaneously with that of the three semicircular canals[130] in the ear. These canals matured gradually as the body simultaneously developed new motor sequences and achieved domination of subsequent spatial planes.

Each one of the six trunk sequences is also linked to a specific eye muscle. The fascia that extends from the orbital cavity over the sheath of the oculomotor muscles[131], ensures this connection.

Hence, each ocular muscle, along with the semicircular canals (which coordinate equilibrium), has a direct link or connection with the myofascial sequences of the trunk.

The trunk, in turn, maintains its verticality thanks to the contribution of the limbs. All limb sequences intersect with those of the trunk as a means of unifying motion and the perception of motion.

The tonic reflexes of the neck, which are often quoted as being a key element with regards to equilibrium, are not only a prerogative of the cervical segment but of the whole body. The neck is actually the site where all of the myofascial sequences[132] converge (Figure 75).

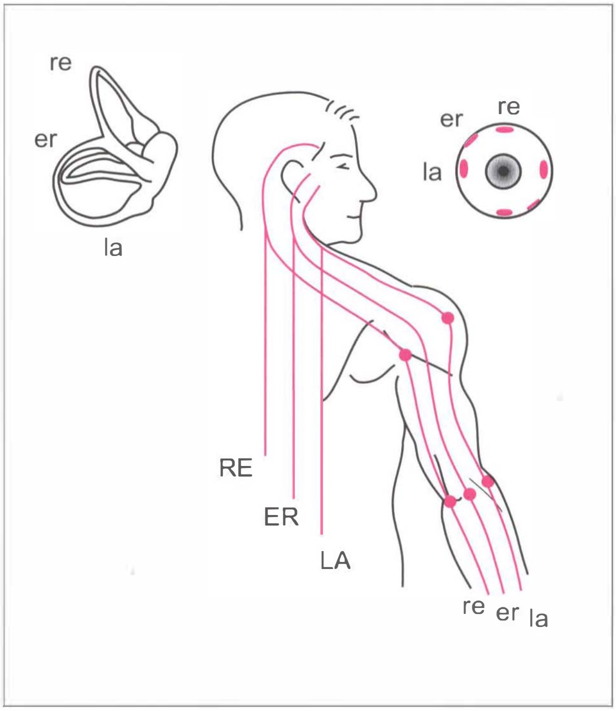

Figure 75. Correlation between the semicircular canals, the eyes and the tonic reflexes or sequences.

Evolution of spatial perception corresponds to the development of coordination in infants.

- in the first months infants move their heads, explore objects with their mouth and grasp objects thanks to mostly reflex action. Infants gradually bring each segment of their body under voluntary control.
- in the following months infants begin to sit, crawl, walk and to turn around 180°; they begin to unite their various segments in order to effectuate global movements.

Maturation of the psychomotor processes also

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[130] Cyclostomes develop only one semicircular canal whereas petromyzons develop two; in all vertebrates, starting from selachii, the three semicircular canals are arranged according to the three planes of space: an anterior canal (vertical), a posterior canal (at right angles to the previous) and a horizontal canal. (Stefanelli A, 1968)

[131] "Each ocular or extrinsic muscle is covered by a sheath that originates at the bottom of the orbital cavity and which gradually thickens as it extends forwards until it adheres to the anterior tendon of the muscle itself. The sheaths of the recti muscles are continuous with one another in such a way as to form a myofascial cone that divides the adipose body of the orbit in a central part and a peripheral part. The sheath sends an expansion, called the check ligament, to the base of the orbit. Two medial and lateral check ligaments which are connected to one another can be noted..." (Fumagalli Z, 1974)

[132] Subsequent to the destruction of the labyrinths in decerebrate dogs and cats the following reactions were observed: rotation of the head determined extension of the ipsilateral limbs (mandibular side) and flexion in the contralateral limbs. Lateral deviation of the head produced pure extension of the extremities to the side of the mandible and flexion on the contralateral side. Dorsal flexion of the head produced extension of the upper limbs and relaxation of the lower limbs. (Chusid JG, 1993)

passes from a segmentary phase to a global one:

- through use of the mouth and hands an infant is able to assign a dimension to each single object and to become aware of its consistency and size.
- space and time concepts only begin to have significance once a certain control of the body has been achieved: forward-behind, before-after, left-right.

The structure of the fascia is implicated in this learning process. An infant requires integration and verification of his/her experiences, which directly involves the mf sequences. They help to mature perception of space because they allow for such experiences as body laterality and the perception of directions (e.g. forward/ behind).

Perceptive memory is able to recognise geometrical forms only when it has matured all of the spatial directions.

Procedural memory can facilitate a complex motor action (e.g. driving, jumping, playing an instrument) thereby reinforcing the collagen fibres of the fascial spirals.

Chapter 10
THE PHYSIOLOGY OF THE MF SEQUENCES

The principle aspects of the physiology of the mf sequences will be discussed in this chapter. It will be demonstrated how:

- each mf sequence is tensioned by muscular fibres in such a way as to be capable of detecting any minimal amount of stretch generated by movement;
- each mf sequence is located in a specific area of the body connected to a specific direction of motion;
- each mf sequence guarantees the body's postural stability on a precise plane;
- each mf sequence, although incapable of eliminating a fascial densification, is able to compensate for its presence through adaptation of the body's posture.

Tensioning of the mf sequences

The mf sequence is like a mirror that reflects the directions of peripheral movement to the brain. It would be impossible for the brain to carry out its assigned task of movement control without the fascia because the fascia unites the numerous mf units that move the single body segments[133] on the three planes.

Activation of neuroreceptors inserted along the fascia of the sequences can only occur if the fascia has a basal tension. In order to effectuate this tension, many muscles extend tensional fibres onto the overlying fascia. All of these muscular insertions onto the fascia are listed in the following chapters.

In anatomical texts these insertions are usually mentioned, but little importance is given to them. The following observations encourage further in-depth studies of these insertions:

- In each mf unit there are muscular fibres that insert onto the overlying fascia.
- The fascia is elastic hence these myofascial insertions are not useful for increasing muscle strength.
- A similar expenditure of force by the body must have a reason as Nature does nothing by chance.
- These muscular insertions onto the fascia are distributed in such a way as to stretch the fascia in specific directions.

The myofascial sequence is an anatomical structure that was designed to be stretched. Neuroreceptors, which are activated when stretched, are located within the fascia. As reported in physiology texts regarding the perception of movement, all muscular and joint receptors are sensitive to stretch (Table 13).

These receptors are located within periarticular (ligaments, joint capsule) and perimuscular soft tissues (endomysium, epimysium, epitendineum), which are all fascial expansions. The fascia is arranged in sequences and each sequence is struc-

Table 13. Kinaesthetic receptors imbedded in the fascia.

Muscular receptors	*Sensitive to*
Muscle spindles	Stretch
Golgi Tendon Organs	Lengthening
Pacini Corpuscles	Tensioning
Free nerve endings	Tension
Joint receptors	***Sensitive to***
Ruffini Corpuscles	Minimum stretch
Golgi Corpuscles	Maximum stretch
Pacini Corpuscles	Beginning/end of movement.
Free nerve endings	Mechanical stimuli

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[133] It remains to be understood the degree to which monosegmentary or monoarticular movements can be coordinated and organised within global, bisegmentary and multiarticular strategies. (Mesure S, 1996)

tured to perceive motion that occurs in a specific direction.

It could be said that, to be able to convey directional afferents, every *colony* of receptors needs to be connected to a mf sequence. As already mentioned, a basal tension of the mf sequence is essential to allow for activation of these receptors. Basal tension or tone refers to the length of fascia in an animal when it is in its most habitual posture. In this position, muscle tone maintains the fascia at the minimal required tension that allows for the perception of any variations. Each mf unit contributes to this purpose by extending some muscle fibres to the overlying fascia. These insertions have two main functions: a) to tension the fascia b) to synchronise the activity of the single mf units with that of the other mf units in that sequence. This latter function is effectuated via stretch of the muscle spindles.

Kinaesthetic receptors can be tensioned more effectively by the fascia for two reasons: a) the fascia is an elastic tissue capable of exerting stretch; b) the fascia is located at a certain distance from the joint hence it is comparatively more responsive to even the slightest movement. In fact, based on the principle of concentric circles, the section of the circumference situated between two radii is directly proportional to the length of the radii. If the angle is constant and the radius is increased then the section of the circumference is greater. Thus a minimal movement at the level of a vertebra, for example, becomes a significantly greater stretch by the time it is transmitted to the peripheral fascia (Figure 76).

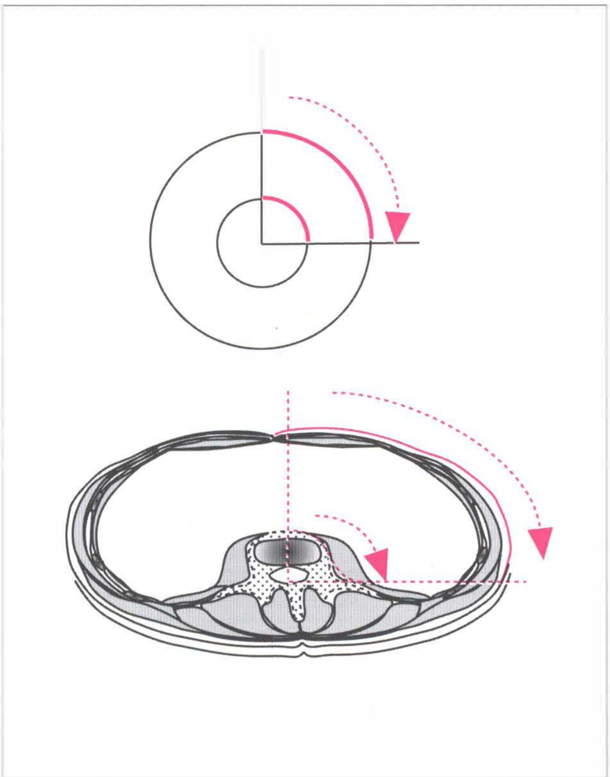

Figure 76. The greater the radius the greater the circumference.

It appears that fascial receptors perceive movements much more clearly than vertebral receptors. It is certainly true that when one moves one's head, or trunk, the movement/stretch is perceived at a cutaneous level rather than at the vertebral level. This same principle can be applied in the analysis of a pathological state of a mf sequence. For example, when a person suffering from sciatic pain bends forward and feels pain down the leg it could be interpreted as a stretch of the nociceptors[134] of the peripheral fascia, rather than of the deep sciatic nerve itself.

The fasciae have a peripheral disposition, which allows for accurate perception and organisation of movement.

Normal gait involves a continuous loss of equilibrium on all planes: anterior/posterior, lateral and transversal[135]. In order to maintain the body's centre of gravity within its base, the fascia is required to synchronise the muscular forces acting on all three planes. The peripheral muscular forces carry out their task with less energy expenditure due to the fact that the magnitude of the moment of force increases with the distance between its line of action and a given point (Figure 77). For example, antemotion (an) lumbi requires much less energy if it is effectuated by rectus abdominis rather than by the iliopsoas muscle. The first has a much greater leverage with respect to the second, which is located closer to the fulcrum (in this case, the vertebrae).

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[134] We have compared 159 patients in whom indications for prolapsed disc surgery had been found. These patients were divided into two groups: those with an intact anulus fibrosus and those with a ruptured anulus fibrosus. Patients with an intact anulus suffered pain more frequently than those with a ruptured anulus. (Basmajian JV, 1997)

[135] Throughout evolution animals have assumed positions of increasing instability. The maximum instability predisposes animals to a greater degree of readiness with regards to movement but requires a more complex neuromuscular control for the maintenance of equilibrium. In the upright position, a person's kinaesthetic receptors detect minute changes in the centre of gravity and stimulate muscular activity that ensures a return to the centre of the baseline. (Cromer AH, 1980)

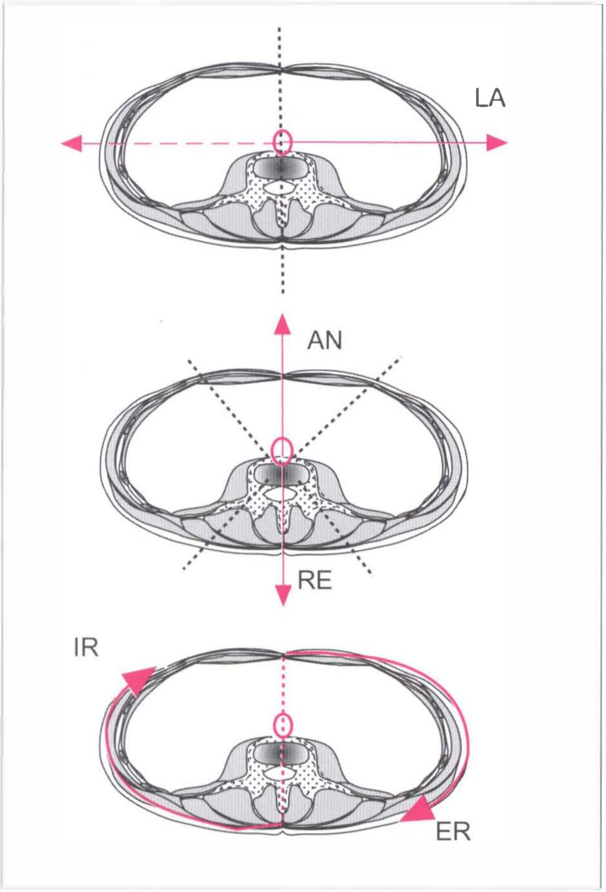

Figure 77. The centre of gravity and moment of the directional forces.

If the moments of force of the agonist and antagonist are exactly equal then the maintenance of the upright position requires virtually no muscular activity.

The energy expenditure is even less when all of the forces acting on the three planes annul each other in a single point, or centre of gravity. The sequence of mediomotion (black dotted vertical line in Figure 77, LA) intersects the linea alba anteriorly and the supraspinous ligaments posteriorly. The body's centre of gravity on the three planes is located halfway along the line that unites these two structures.

- The two moments of force of right lateromotion (la) and left lateromotion (frontal plane) are annulled at this point.
- The moment of force of antemotion (an) is equal to the moment of force of retromotion at this point.
- The centre of gravity remains still during rotation because the resultant of the vectors of extra (er) and intrarotation (ir) is zero[136].

Fascial compartments and directions of movement

The fascia that surrounds the two muscular chains of the erector spinae is stretched during the act of straightening up (re) (Figure 78). Uniform perception of the movement is provided for by the fascia, whereas the receptors of each single vertebra produce multiple afferent information. The extensor muscle fibres transmit tension to the two fascial compartments, which, in turn, translate this information into a specific motor direction.

Fascial compartments of the trunk

When a heavy weight is lifted the fascial compartment of the erector spinae synchronises the mf units of retro-collum, retro-thorax, retro-lumbi.

These mf units work independently when, for example, a person only moves their neck or else their lower back. It is impossible however for a person to move a single lumbar vertebra or a single cervical articulation independently. The seven cervical vertebrae have been grouped together in the same mf unit for this reason, likewise in the thorax and the lumbar region (Figure 79).

Lateromotion (la) consists of eccentric activity of the iliocostalis, paravertebral and oblique muscles. In this case, tensioning of the lateral fascia on one side of the body is responsible for the perception of movement.

Extrarotation (er) is experienced as a posterior stretch of the retro-lateral fascia, whereas intrarotation is experienced more like a stretch in a forward direction.

Fascial compartments of the upper limb

The ability to perceive position and changes of position of the upper limb in the three dimensions of space depends upon the basal tone of the fascial

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[136] In order for the resultant of two forces acting on a body during rotation to be zero, it is essential that the centre of gravity remain still. The moment of a force in relation to an axis is the product of the intensity of the force by the distance of the axis from its line of action. The magnitude of the moment increases with the distance between the line of action and a given point. (Cromer AH, 1980)

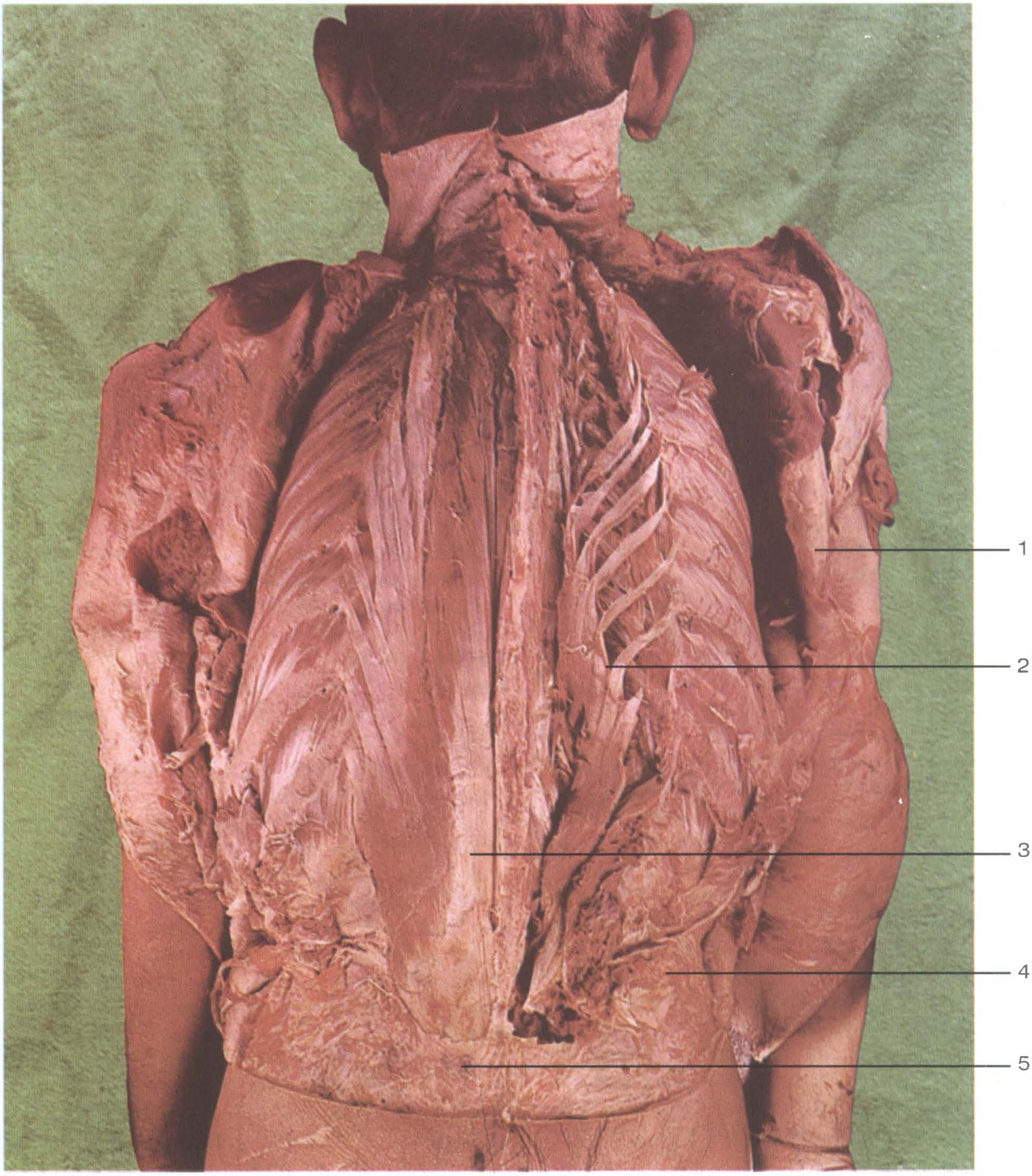

Figure 78. Muscles of the back - deep layer (From Fumagalli - Colour photographic atlas of macroscopic human anatomy; - Published by Dr. Francesco Vallardi/Piccin Nuova Libraria).
1, Layer of superficial muscles (latissimus dorsi) and medium layer (serratus posterior inferior) cut and folded back to highlight the compartment of the erector spinae; 2, aponeurosis of the iliocostalis muscle that uses the ribs as a fulcrum to actuate unilateral lateromotion (la-th, la-lu = sequence of lateromotion); 3, epimysial fascia of the erector spinae, it unites the mf units of re-th, re-lu = sequence of retromotion; due to the fact that longitudinal fibres insert onto this fascia it has assumed the appearance of an aponeurosis, or flat tendon, with parallel and inextensible collagen fibres; 4, point of union of the superficial and deep layers of the thoracolumbar fascia and the abdominal fasciae; the horizontal muscular fibres, that traction the trunk in a posterior direction, cause extrarotation (er sequence) ; 5, superficial layer of the thoracolumbar fascia which is tensioned above by the latissimus dorsi and below, or distally, by the contralateral gluteus maximus.

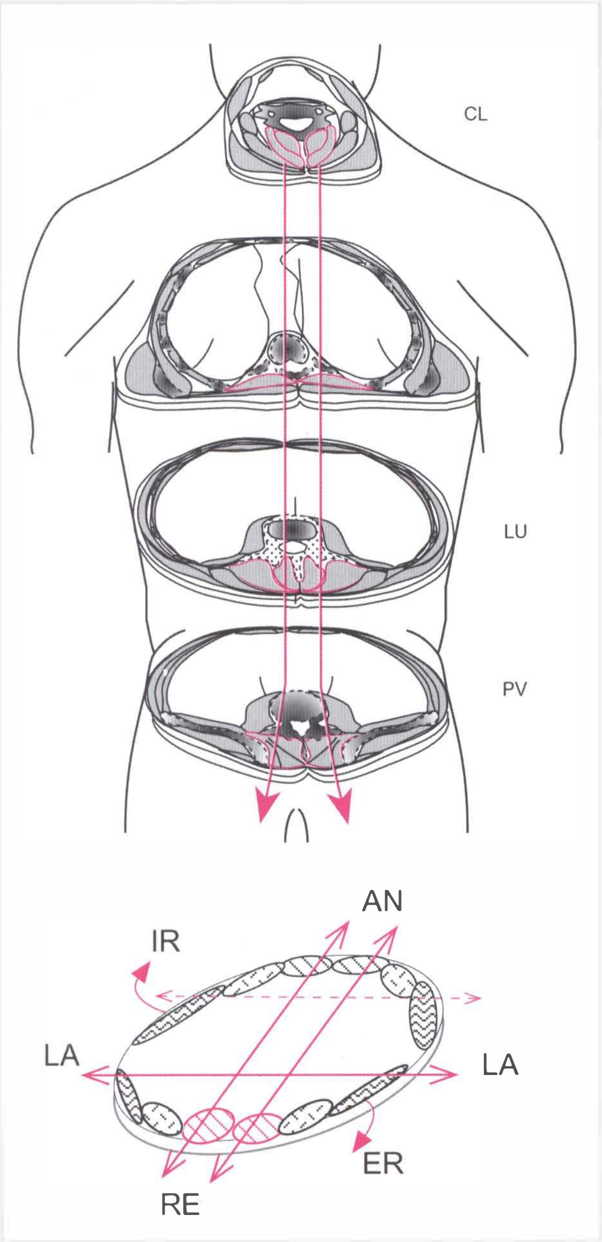

Figure 79. Sections and sequences of the trunk.

sequences: ante/retro (sagittal plane), intra/extra (horizontal plane), latero/medio (frontal plane). In Figure 80, the compartment or sequence that surrounds the mf unit of lateromotion (la) of the various segments of the upper limb is indicated in red. The most common movement in the limbs is that of ante/retro (flexion/extension), hence, the more developed compartments are those of antemotion and retromotion.

These compartments appear to be interrupted at the elbow or knee but this partial interruption simply ensures the independence of the mf units e.g. independence of the mf unit ante-cubitus from that of ante-carpus. Longitudinal, endofascial collagen fibres span these two articulations thereby maintaining continuity.

Movements executed on the horizontal plane do not occur within proper fascial compartments. These sequences exploit the muscular fibres attached to the septa at an oblique angle. The posterior direction is a characteristic of extrarotation,

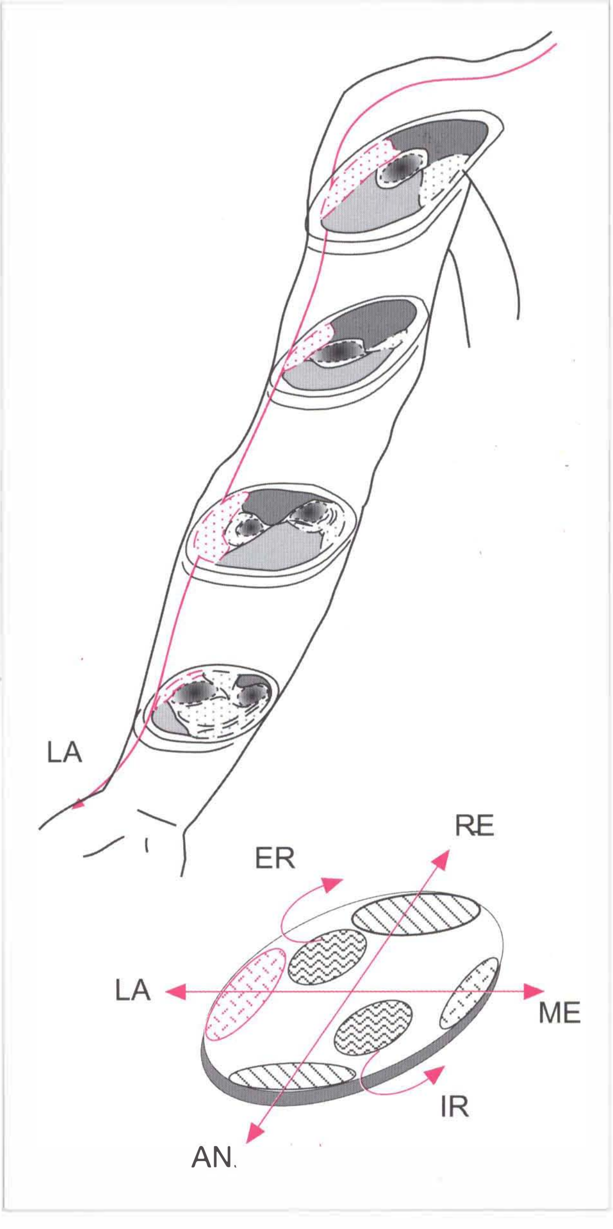

Figure 80. Sections and sequences of the upper limb.

whereas the anterior direction pertains to the mf sequence of intrarotation.

In the diagrams concerning the limbs, sections at different levels have been chosen to highlight the muscular compartments. In the lower part of these diagrams the muscular compartments have been schematised. Circles highlight the way in which the sequences act on the fascia that surrounds these segments. When active, the sequence of ante stretches all of the anterior fascia; the retro sequences stretch the posterior fascia and so forth. The precise motor trajectory of these stretches, which is transmitted to the brain during movement, is indicated by the red arrows.

Fascial compartments of the lower limb

The fascial compartment that surrounds the quadriceps (an-cx, an-ge) (Figure 81 – circled in red) is continuous with the anterior compartment of the leg and the foot (an-ta, an-pe). Together they form the antemotion sequence of the lower limb.

The posterior fascial compartment that surrounds the hamstrings (re-cx, re-ge) continues through the popliteal fossa to unite with the posterior compartment of the leg and the foot. These unidirectional mf units, together with their fascial compartments, form the sequence of retromotion.

The fascia of the gluteus medius continues over the extrarotatory muscles of the hip (er-cx) and then moves down over the short head of biceps femoris (er-ge). The tendon of biceps femoris extends over the fascial sheath of the peronei muscles.

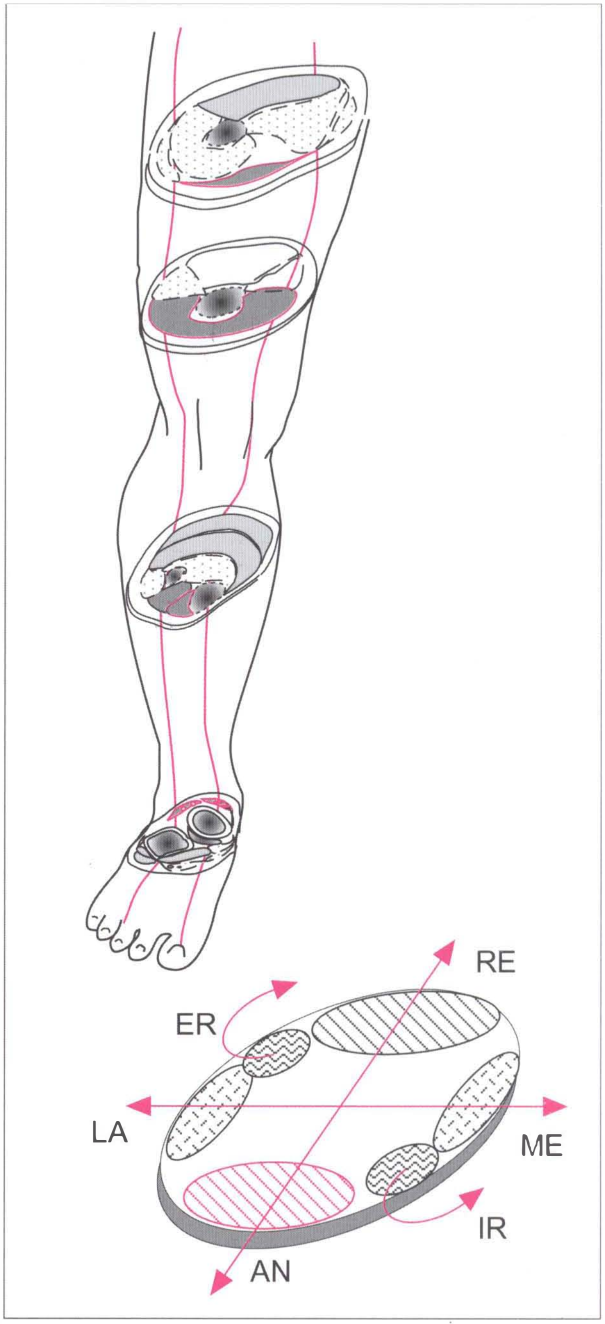

Figure 81. Sections and sequences of the lower limb.

Mf sequences and static posture

During the performance of a voluntary movement two motor programmes enter into play: one that initiates the specific movement and another that generates the postural response[137].

This double motor efferent is completed by a corresponding double afferent, due to the fact that two types of proprioception can be identified: a static proprioception and a dynamic proprioception.

A certain parallelism between the organisation of the fascia and these double nerve pathways can also be found:

- the longitudinal fibres of the mf sequences are involved in the organisation of posture;

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[137] The premotor cortex controls the proximal and axial muscles during the body's orientation phase, after which a second stimulus parts, stimulating the directional movement of the limb....
During the performance of a voluntary movement two motor programmes enter into play: one that initiates the movement, another that generates the postural response coordinating the movement. (Kandel ER, 1994)

- the spiral endofascial fibres organise motion, or complex motor activity.

In the section below postural organisation will be examined[138].

Under normal conditions the upright position requires no conscious postural control. Basmajian has demonstrated how the supporting action of ligaments and fasciae is important, whereas muscles are hardly used at all in this position[139]. The tensioning of the fascial sequences is directly dependent on movement occurring within a particular plane. In the upright position, normal oscillations around the vertical line of gravity or plumbline fall within a surface of approximately two centimetres.

During these small oscillations, any movement that occurs on the sagittal plane is in fact independent from that which occurs on the frontal plane (Figure 82)[140].

Movements on the frontal plane spontaneously activate the mf units of latero and medio as follows:

- In the foot, plantar (me) and dorsal (la) interossei muscles widen or narrow the standing base, according to the degree of lateral deviation;
- In the ankle, the talus is rotated medially (me) or laterally (la), according to the way in which the leg muscles are stretched when loss of lateral balance occurs;
- Even though the knee has no movement on the frontal plane it has a large number of ligaments-fasciae that prevent excessive lateral, or medial, shifting.
- In the thigh, the lateral and medial muscular fibres support the contralateral pelvis when a person is standing on one leg;
- In the trunk, the latero sequence of the lower limb is continuous along the sides of the trunk, whereas the sequence of medio is limited posteriorly to the supraspinous vertebral ligaments and, in the abdomen, to the linea alba.

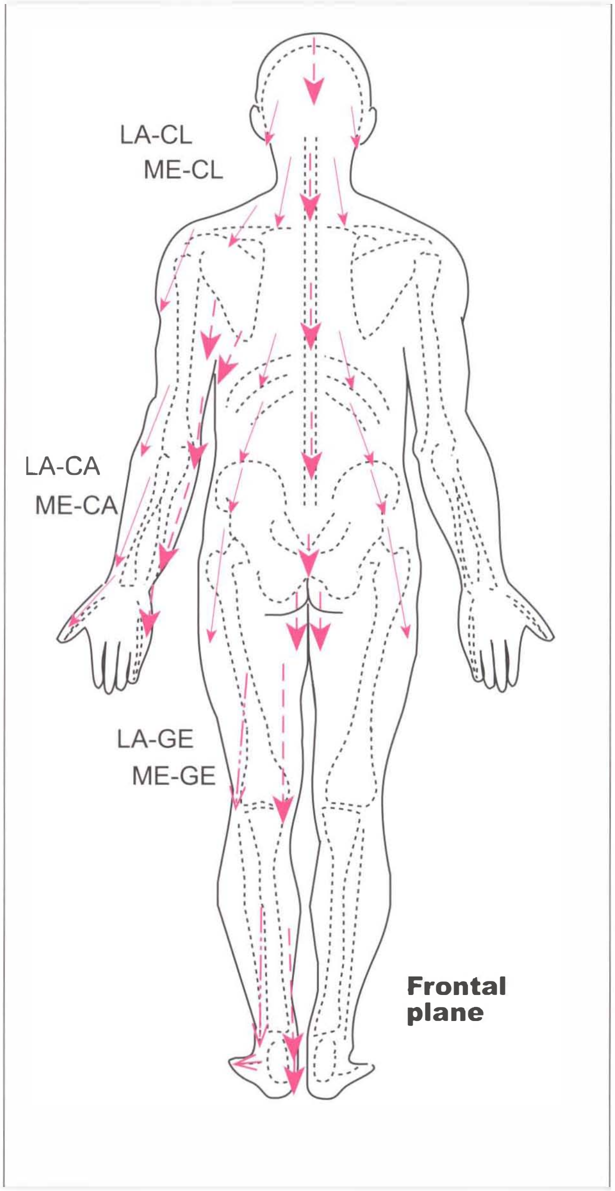

Figure 82. Postural stability effectuated by the mf units of latero and medio

In this way the fascia, by means of its basal tension, assists in maintaining the body in the upright position. If a postural misalignment increases oscillations to a point where they extend beyond the perimeter of the standing base, tensioning of the fascia causes stimulation of the muscle spindles of the mf unit, resulting in an appropriate muscle con-

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[138] Posture is intended to mean the comprehensive position of the body and limbs in relation to one another and their orientation in space. Postural adjustments are effectuated by means of two types of mechanisms: anticipatory or preview mechanisms (feed-forward) and compensatory mechanisms for the loss of equilibrium (feed-back). (Kandel ER, 1994)

[139] Most muscle physiologists now agree that electromyography shows conclusively the complete relaxation of normal human striated muscle at rest. (Basmajian JV, 1993)

[140] With the introduction of the stabilimeter, Kapteyn pointed out that oscillations that occur on the sagittal plane are independent from those occurring on the frontal plane. Theoretically, fine control of the standing posture does not utilise information from the semicircular canals. (Gagey PM, 1995)

traction[141]. Whenever oscillations beyond the plumbline are sufficient to require complex motor reactions, either the mf units arranged in spiral or a schematic motor response are activated.

In summary, it is possible to compare the fascia to the director of an orchestra who directs the motor units of a single mf unit, the mf units of sequences and the sequences on one plane. Voluntary activity intervenes to modify this basic tensile organisation. In animals, evolution has developed a specific fascial framework for each species. For example, the ligamentum nuchae of a cow is sufficiently strong enough to support its head without the need of continuous muscular tension. Whenever the animal wants to graze, a minimal expenditure of energy is sufficient to overcome the elasticity of the ligamentum nuchae to allow for its mouth to be brought close to the ground.

In humans, this process has resulted in the development of the upright position.

The following examples demonstrate how the mf units of the ante and retro sequences control alignment on the sagittal plane (Figure 83).

- The foot perceives uneven terrain and organises, together with its fascial/ligament complex, the alignment of the body segments.
- The talus has a rounded shape, which allows for the balancing of overlying body segments in an anterior/posterior direction.
- The soleus and tibialis anterior act like two guy-ropes on the sagittal plane, stabilising the tibia in relationship to the foot.
- The hamstrings and the quadriceps also act like guy-ropes, regulating the knee joint on the sagittal plane in relation to the variations of the talus.
- The mf unit of re-ge continues proximally with the retromotion mf units of the trunk[142]. The mf unit of an-ge is continuous with the antemotion mf units of the trunk.

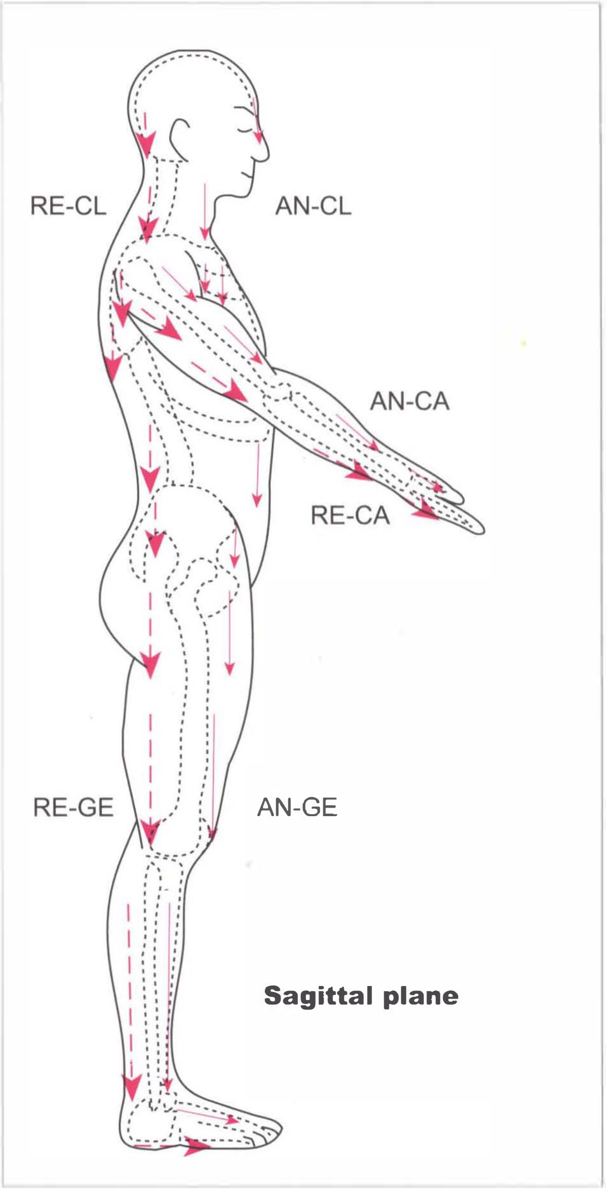

Figure 83. Postural stability effectuated by the mf units of ante and retro.

Even though the mf units on the horizontal plane (Figure 84) contribute to a certain extent, the maintenance of the upright position is controlled principally by the mf units on the sagittal and frontal planes.

Mf sequences and postural compensations

If the basal tension of the fascia is altered by the formation of a densification then neuroreceptors

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[141] Fine movements are not controlled in the same way as ample movements. Mathews and Stein have demonstrated that in the case of an important muscular stretch, the response of muscle spindles fluctuates around a frequency of three to ten points a second per millimetre of stretch. (Gagey PM, 1995)

[142] Control of posture entails reflex mechanisms involving coordinated activity of three balance senses: visual, vestibular, and somatosensory systems.
The vestibular system plays only a minor role in the maintenance of balance when visual and somatosensory systems are functioning. The primary role of the vestibular system is to signal sensations of acceleration of the head in relation to the body and the surrounds. (Bernier JN, 1998)

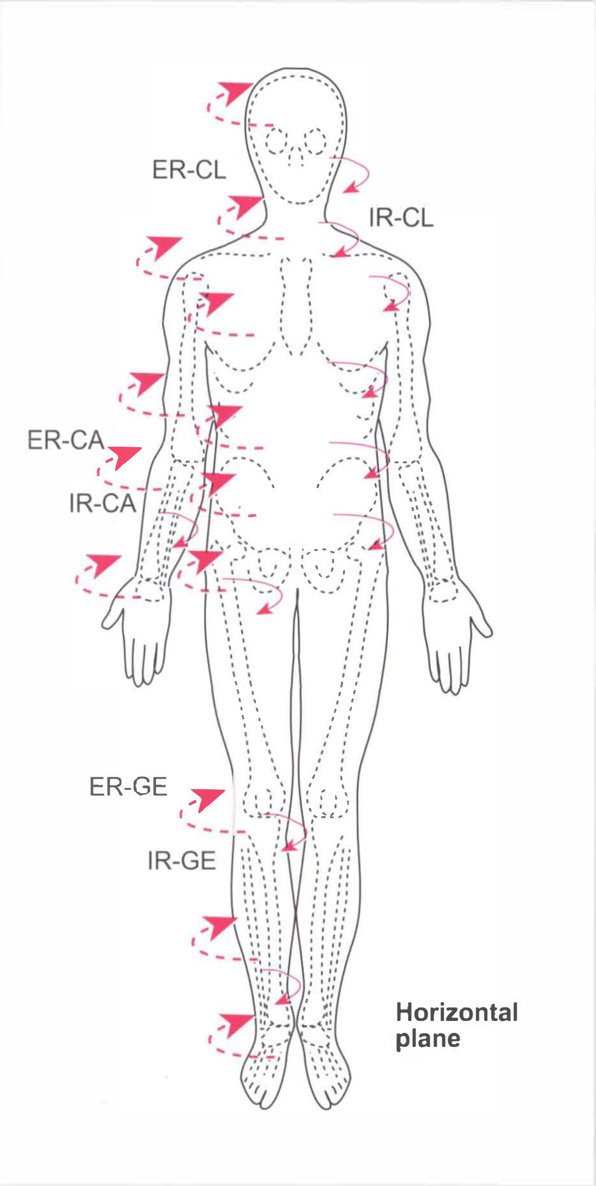

Figure 84. Postural stability effectuated by the mf units intra and extra.

respond to this abnormal stretch, signalling a potential danger by means of a pain signal. The body neutralises this pain signal by adopting a postural compensation.

It is imperative that compensations along a sequence always maintain an optimal, basal tension of the fascia. It is only in this way that the fascia is capable of perceiving any minimal movement away from its resting position.

A tensile alteration in any given mf unit provokes a counter tension in another mf unit along the same sequence as a means of preserving this basal tension. For example, if the mf unit of lateromotion coxa (la-cx = tensor fascia lata) increases its traction, then a counter traction in the distal mf unit of the same sequence (la-ta) is induced. Such tensile adjustments (Figure 85) are a remedy that often creates acute pain because the free nerve endings in this segment of fascia are subjected to an excessive and abnormal traction. The body then creates a contralateral compensation as a means of re-establishing equilibrium.

Contralateral compensation means contraction of one or more mf units situated on the opposite part of the limb. Compensatory tension of this kind can be symmetrical but, with reference to the mf unit where the compensation originated, it is often localised in a proximal or distal segment. Taking into consideration the previous example, the body

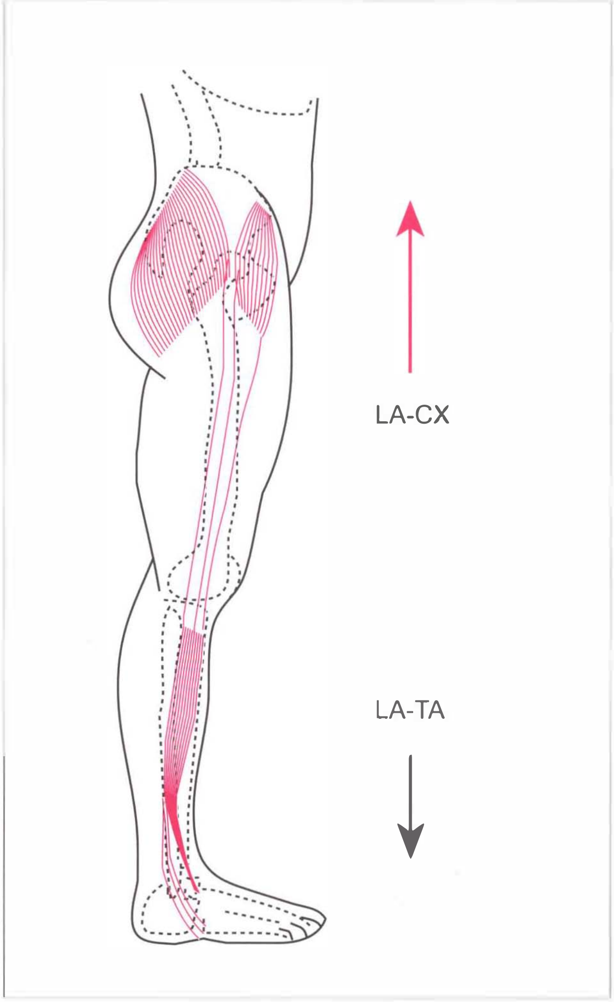

Figure 85. Thigh pain due to excessive tension of the latero sequence.

will attempt to oppose the spasm of the mf units of lateromotion coxa and talus with a counter tension in the mf unit of mediomotion of the knee (me-ge).

In summary: a densification can find compensations either in the symmetrically antagonist mf unit or along the ipsilateral sequence, or in the contralateral sequence. All of this serves to maintain a certain tensile balance in the fascia, allowing it to perceive movements on the three planes.

A postural compensation can neutralise a congenital malformation or it can neutralise an acquired misalignment.

It is this latter form of compensation that can be effectively treated with the technique of Fascial Manipulation.

In reference to the technique of Manipulation of the Fascia, the following questions should be taken into consideration when examining the posture of a patient:

- In which plane have the various compensations developed?
- What could have been the initial trauma that determined these compensations?
- Are they ascending or descending compensations?
- Are there any hidden compensatory strategies (silent cc(s))?

Ascending compensations on the three planes, which originate in the foot, will now be examined.

On the frontal plane lowered arches (flat feet) often produce a medial deviation of the knee or genu valgus. Hip abduction (frontal plane) ensues, with a lowered iliac crest due to a restriction of the tensor fascia lata. This variation in the level of the pelvis inclines the vertebral column initially to the same side and, in time, produces a compensation to the opposite side. According to the level at which these compensations occur, shoulder adduction (lowered shoulder) or shoulder abduction (raised shoulder) can subsequently develop. Various combinations are possible e.g. elevated right hip with lowered right shoulder or raised right shoulder and so forth. The neck fixates in an intermediate position in order to maintain the eyes as near to the horizontal plane as possible. This muscular spasm tensions the fascia of the head in an abnormal manner resulting in myofascial tension headaches.

The complex of pharynx-larynx-mandible that governs mastication, deglutition, respiration and phonation has an influence on postural tone generally. One brief example of a descending compensation on the frontal plane is when a malocclusion causes inclination of the head to that side and the ipsilateral shoulder is raised as a consequence.

On the sagittal plane, a restriction of one of the tendons of the toe extensors (e.g. hammer toe) can provoke a contraction of the triceps surae.

Compensatory tension between a distal agonist mf unit and a proximal antagonist can be propagated along the fascial sequences extending as far as the head. Alternation between agonist and antagonist mf units maintains a certain balance, functioning as a sort of shock-absorber. In these cases fascial densification recreates a homeostasis and Fascial Manipulation is not required. Treatment is required in those cases when the knee hyperextends to compensate for the increase in the angle of the ankle joint caused by a restriction of the triceps surae. The hyperextended knee (genu recurvatum) causes antemotion of the pelvis with consequent shortening of the iliopsoas muscle. An exaggerated

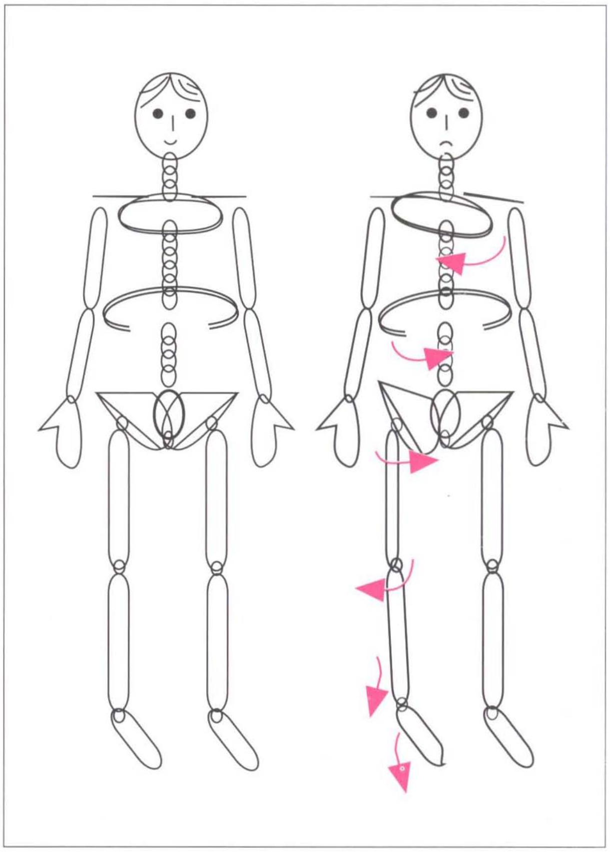

Figure 86. Aligned posture and misaligned posture

lumbar lordosis results, leading to a dorsal kyphosis and finally, in an attempt to neutralise the other curves, an exaggerated cervical lordosis forms.

At other times it is possible to find a lumbar kyphosis together with a flattened dorsal curve and a kyphotic cervical segment.

Only the accurate examination of each individual case enables the therapist to identify the densified mf units that are involved in the specific compensations in question. Often rigidity occurs only in one part of a mf unit. In effect each mf unit of antemotion and retromotion of the trunk can act with the right and/or left-side of the body. It is possible to find that the left-sided component of the mf unit of antemotion is hypertonic and it is compensated by the right-sided component of retromotion.

On the horizontal plane misalignment can begin with a unilateral hallux valgus (Figure 86). (obviously this alteration can be bilateral but in order to simplify the analysis only one limb will be considered). Intrarotation of the forefoot (ir-pe)(hallux valgus) is compensated by eversion of the talus due to contraction of the peroneal muscles (talus valgus). The knee and the hip intrarotate, bringing the pelvis forward on the same side. The compensation of the trunk is contralateral, with consequent anterior rotation of the contralateral scapula (ir-sc). This determines an increase in the rotation of the pelvic girdle in the opposite direction to the shoulder girdle. In the neck and the lumbar regions, the coupled forces of intra and extrarotation become hypertonic in an attempt to compensate for the various imbalances and to restore the centre of gravity to its neutral position.

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Chapter 11
MYOFASCIAL SEQUENCES OF THE UPPER LIMB

The best way to comprehend the myofascial sequences is by studying muscles together with their fascia, rather than from the perspective of their origins and insertions.

If we take the fascia above the deltoid tendon (Figure 87), as an example, we find that the deltoid fascia is united to the muscular fibres of the deltoid by numerous septa[143]. Depending on which portion of the muscle contracts, the septa and the overlying fascia will be tensioned differently.

The deltoid tendon exerts a longitudinal traction on the lateral intermuscular septum. The brachioradialis and the extensor radialis carpus muscles are inserted onto this septum. These myofascial insertions form the sequence of lateromotion.

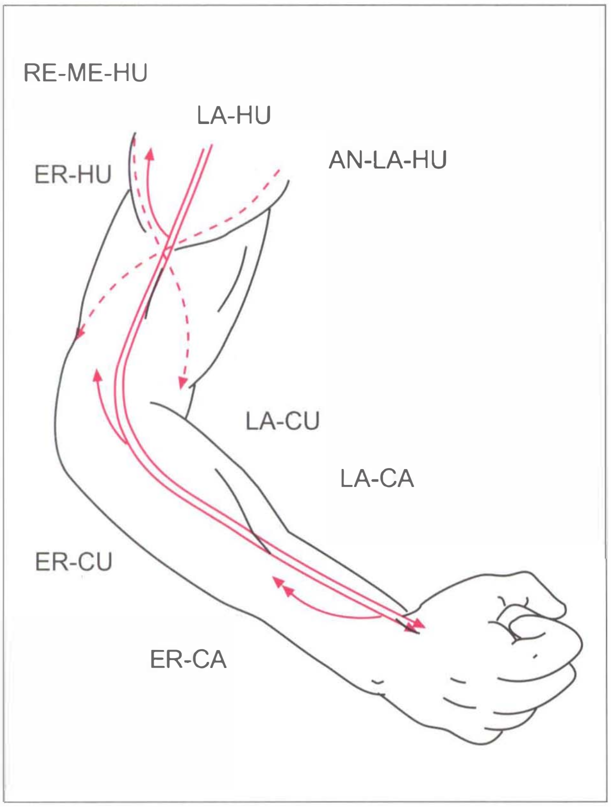

Figure 87. Antagonist forces and longitudinal traction of the latero sequence of the upper limb converge over the deltoid tendon.

The extrarotatory muscle fibres of the humerus (ex-hu), cubitus and carpus exert a transverse traction on the lateral intermuscular septa. The sequence of extrarotation is formed by the sum of these retro-lateral forces.

Last of all, there is the tensile force of the fascial spirals that acts on the more superficial fascial fibres. The anterior fibres of the deltoid that move the humerus forward and laterally (an-la-hu) exert tension on the posterior brachial fascia. The posterior fibres of the deltoid that move the humerus backward and medially (re-me-hu) traction the anterior brachial fascia.

There are many therapeutic applications to be derived from this particular way of interpreting muscles together with their fascial connections. If, for example, a patient complains of a pain along the lateral border of the arm then, before even considering a possible nerve compression, an analysis of the lateromotion sequence often reveals a densified cc in a mf unit along this sequence.

This type of manual investigation, as well as being a potential pain reliever, may well avoid the need for other types of examination. In other words, if after treatment a patient no longer feels pain in the lateral part of the arm then one could deduce that the problem involved the fascia. In this way the diagnosis is confirmed by the outcome of the therapy, saving both time and money for the patient and for the National Health system. If the problem per-

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[143] The anterior and posterior fibres of deltoid converge directly onto the tendon, whilst the middle part of the muscle is multipennate: four tendinous intermuscular septa extend from the acromion downwards and they intersect with three tendinous septa that extend upwards from the deltoid tuberosity. Short muscular fibres extend from one to another of these septa guaranteeing powerful traction. The tendon sends an expansion to the brachial fascia. (Gray H, 1993)

sists then other types of clinical tests can then be taken into consideration.

In this chapter, the fascial insertions of the biarticular muscles within each mf sequence of the upper limb will be emphasised. If all these insertions exist in anatomy there must surely be a valid reason.

The antemotion sequence of the upper limb

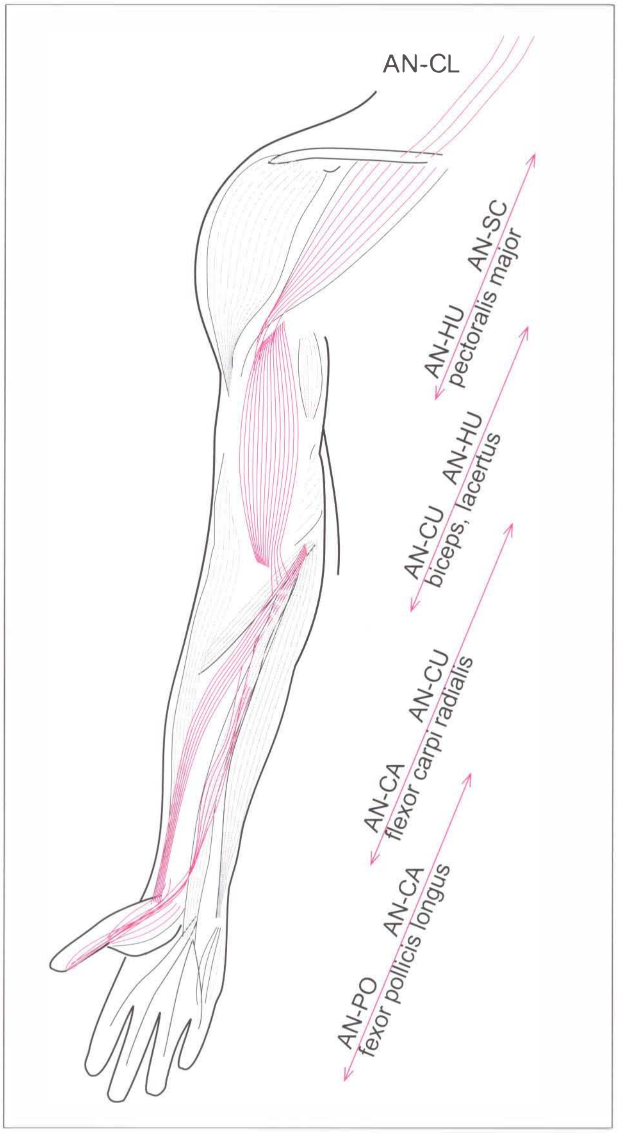

Figure 88. The antemotion sequence of the upper limb.

Antemotion of the pollicis (an-po)(thumb) is effectuated by flexor pollicis longus and brevis, opponens pollicis and abductor pollicis brevis (Figure 88). Many fibres of these muscles originate from the flexor retinaculum[144], which is a reinforcement of the anterior antebrachial fascia. Hence, any increase in force from the part of the thumb will cause greater traction on this fascia. A number of fibres of the flexor carpi radialis (an-ca) and some fibres of the biceps brachii[145] also originate from the anterior antebrachial fascia. The biceps brachii is inserted onto this fascia by way of the bicipital aponeurosis (Figure 89). The passive tensioning of this aponeurosis activates the muscle spindles of the mf unit of ante-cubitus. The brachialis muscle originates from the intermuscular septa and, therefore, when it contracts it stretches the anterior brachial fascia in a distal direction. Fibres of the deltoid muscle and pectoralis major are inserted onto the brachial fascia[146].

The fascia that covers the clavicular part of pectoralis major is continuous with the cervical fascia, which, in turn, surrounds the clavicular part of the sternocleidomastoid muscle[147]. These two structures are at times continuous, either through the fascia or via the platysma muscle, which links the shoulder and the neck regions.

In this way the sequence of antemotion of the upper limb intersects with antemotion collum (neck)(an-cl).

When the arm is hanging freely (open kinetic chain), pectoralis major and deltoid participate in antemotion humerus (an-hu) with their clavicular fibres. When the arm is fixated (closed kinetic chain) they participate in antemotion scapula (an-sc).

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[144] The flexor retinaculum of the hand is tensioned between the bony prominences that outline the arch of the carpus. Some of the hypothenar and thenar muslces attach to its anterior surface. Proximally it is continuous with the palmar aponeurosis, which, in turn, is continuous whit the anterior antebrachial fascia. (Baldoni CG, 1993)

[145] The flexor carpi radialis originates from the anterior surface of the medial epicondyle and from the antebrachial fascia. The biceps brachii muscle extends a large aponeurotic band, the bicipital aponeurosis, into this fascia. (Chiarugi G, 1975)

[146] The brachial fascia surrounds the entire arm like an elastic stocking. Close to the muscle bellies it consists of essentially circular fibres, associated with robust longitudinal fibres in the passage towards the elbow and the shoulder. These longitudinal fibres are formed proximally due to the pulling traction of the strong tendinous insertions of pectoralis major. (Lang J, 1991)

[147] The superficial cervical fascia is attached below to the anterior margin of the clavicle. The platysma muscle is fused to the external surface of the superficial cervical fascia. (Chiarugi G, 1975)

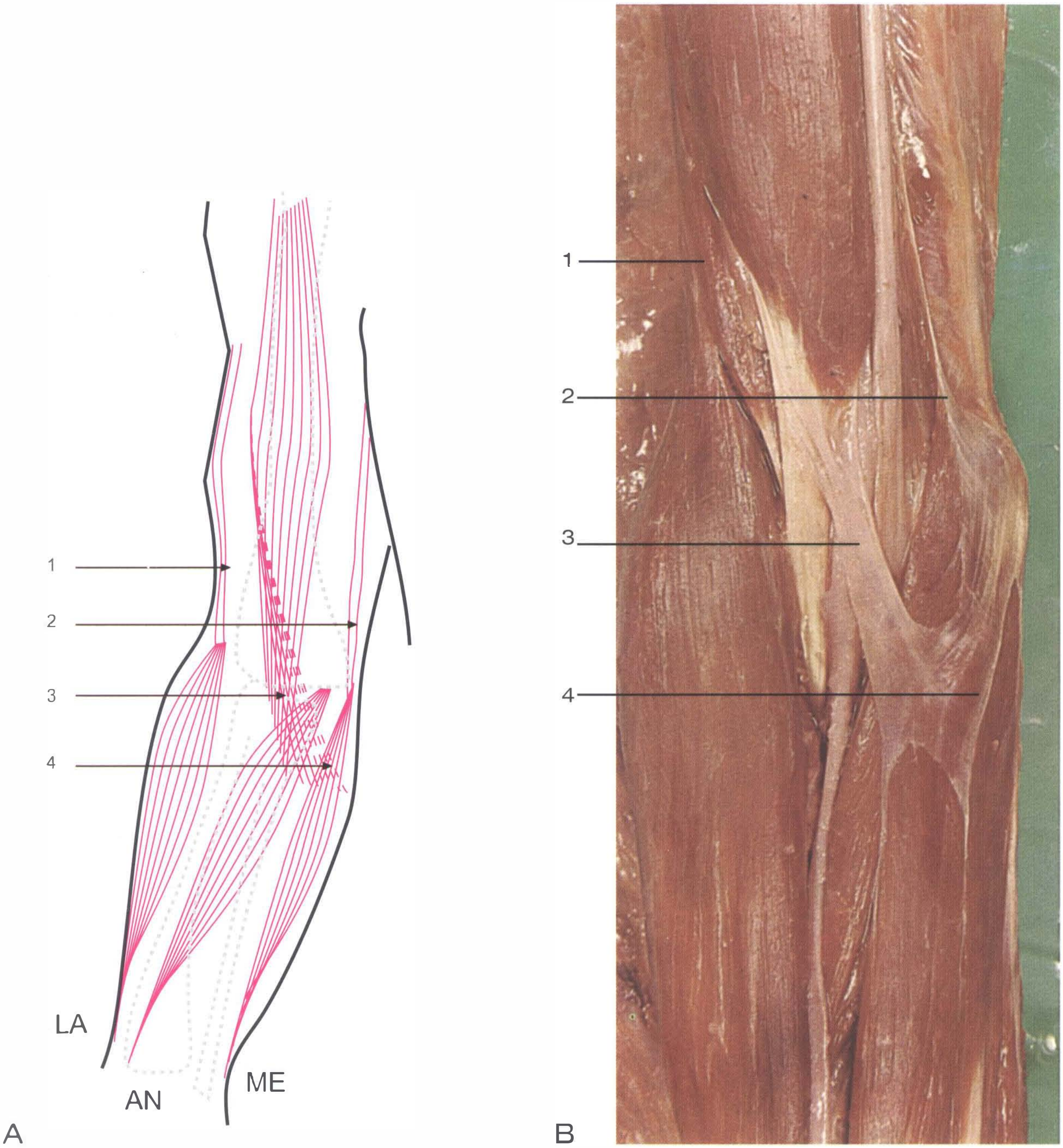

Figure 89. A - **Schematic diagram to illustrate the tensioning of the fascial compartments that form the sequences of ante, medio and latero. B - Dissection of the cubital fossa (from Fumagalli - Colour photographic atlas of macroscopic human anatomy. - Published by Dr. Francesco Vallardi/Piccin, Nuova Libraria)**

1, Lateral intermuscular septum tensioned proximally by deltoid and distally by extensor carpi radialis (lateromotion sequence - la); 2, medial intermuscular septum tensioned proximally by coracobrachialis and distally by flexor carpi ulnaris (mediomotion sequence - me); 3, bicipital aponeurosis inserted onto the fascial compartment of flexor carpi radialis; the anterior antebrachial fascia is tensioned proximally by biceps brachii and distally by the flexor carpi radialis; flexor carpi radialis originates from the intermuscular septa, which form the previously mentioned flexor compartment (antemotion sequence - an); 4, oblique fibres of the bicipital aponeurosis extending towards the posterior antebrachial fascia (spiral).

The retromotion sequence of the upper limb

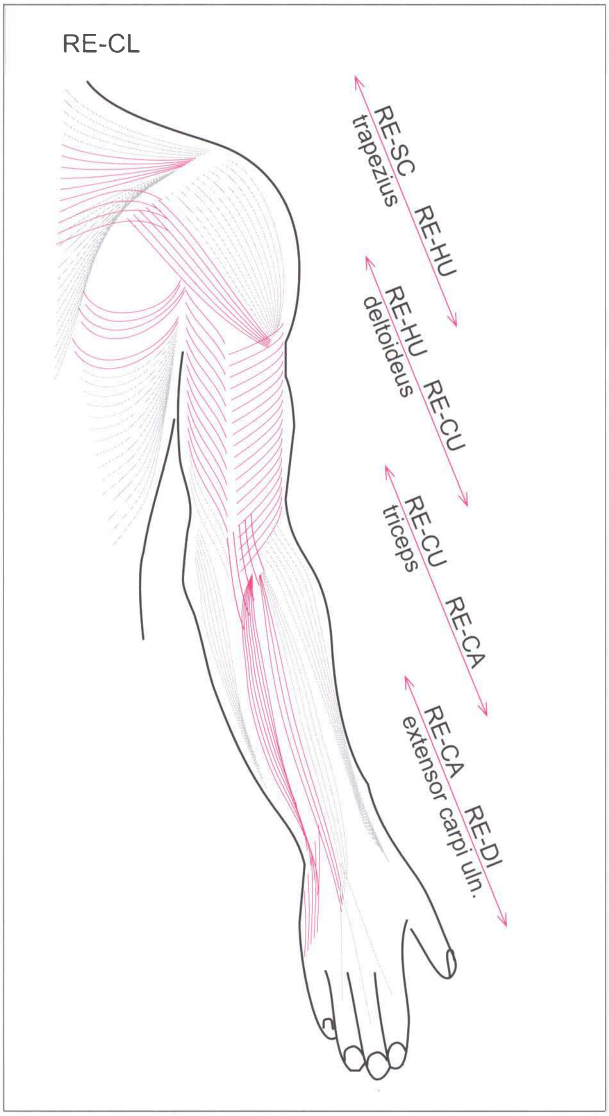

Figure 90. The retromotion sequence of the upper limb.

Abductor digiti minimi (re-di) moves the little finger away from the rest of the hand in an ulnar direction. During contraction of this muscle the fascia is tensioned distally because some of its fibres originate directly from the fascia[148]. In all vertebrates the retromotion sequence is always located on the ulnar side of the upper limb (Figure 90).

The contraction of the mf unit of retromotion digiti (re-di) expands to the antebrachial fascia via the longitudinal fibres found within the carpal fascia. These collagen fibres[149] act like transmission belts that synchronise extension of the fingers with that of the carpus (re-ca).

The posterior antebrachial fascia gives rise to some of the fibres of the extensor carpi ulnaris muscle; the triceps brachialis[150] sends a tendinous expansion to this same fascia. Due to these fibres, triceps is to be considered a fascial tensor (re-cu).

The posterior antebrachial fascia transmits the tension of the extensor carpi ulnaris proximally and the tension of the triceps distally. This means that if a movement originates in the hand, the proximal mf units are recruited. If the force originates at the shoulder, activation of the muscle spindles, and consequently of the mf units, proceeds in a distal direction.

In the cephalic direction the brachial fascia is tensioned by the posterior part of deltoid, which together with teres major and infraspinatus muscles participates in retromotion humerus (re-hu). The deltoid muscle not only tensions the fascia via the numerous septa that intersect it, but it also sends some muscular fibres to the infraspinatus fascia[151].

The trapezius and the rhomboids effectuate retromotion of the scapula (re-sc). Both of these muscle are connected to the fascia of the erector spinae and, therefore, to the retromotion sequence of collum (neck) and thorax.

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[148] The abductor digiti minimi originates from the flexor retinaculum, the pisiform and the pisohamate ligament; it inserts onto the ulnar margin of the fifth finger and, in part, extends into the aponeurosis of the extensor digiti minimi. (Platzer W, 1997)

[149] The volar carpal ligament (flexor retinaculum) consists of oblique and longitudinal fibres that are continuous with the proximal, tendinous insertions of the hypothenar and thenar muscles. The deep fibres of the containing fascia run transversely and are the only ones that insert onto the bones of the forearm. (Lang J, 1991)

[150] The extensor carpi ulnaris originates from the medial epicondyle, the antebrachial fascia that covers it and from the septa that separates it from the anconeus muscle. (Chiarugi G, 1975)
A part of the tendon of the triceps extends into the antebrachial fascia and can almost completely cover the anconeus muscle. (Platzer W, 1979)
The antebrachial fascia is reinforced anteriorly by the bicipital aponeurosis and dorsally by the tricipital aponeurosis. (Fumagalli Z, 1974)

[151] The muscles of the superficial plane of the scapular are surrounded by their own aponeurosis. In part, like the posterior part of the trapezius and the scapular part of deltoid, they expand into the aponeurosis that covers the infraspinatus muscle. (Lang J, 1991)

The mediomotion sequence of the upper limb

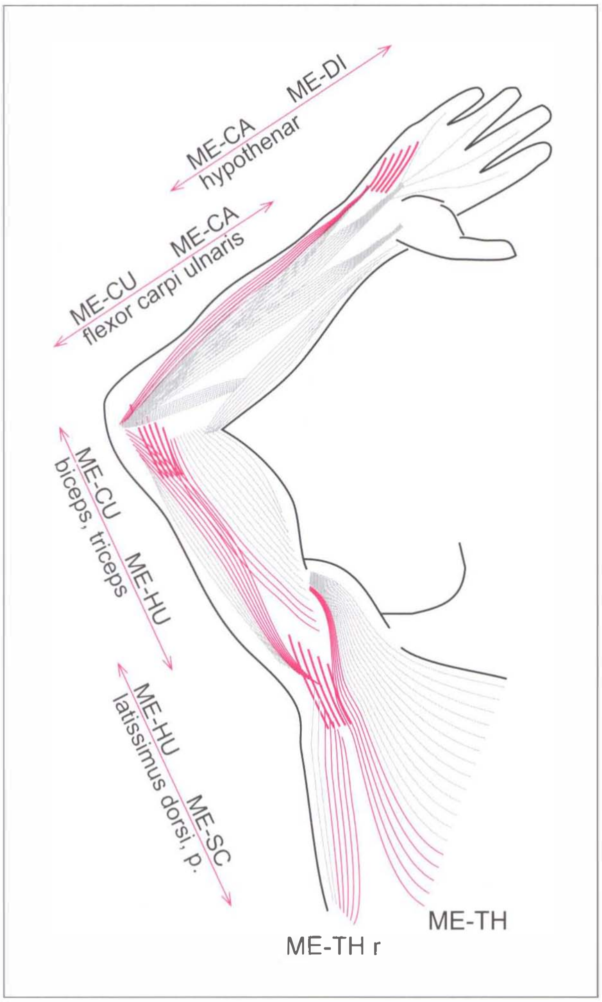

Figure 91. The mediomotion sequence of the upper limb.

The opponens digiti minimi (me-di) and flexor digiti minimi brevis muscles originate from the inferior part of the flexor retinaculum (Figure 91). These muscles share a common origin from the hamate bone with the fascial sheath of the flexor carpi ulnaris. Together they compete with the palmar interossei in effectuating adduction of the fingers. During adduction of the fingers, which is a component of the movement scheme of hand closure, these muscles traction the antebrachial fascia[152].

Flexor carpi ulnaris (me-ca) has two distinct origins: an ulnar head, specific for mediomotion (adduction) of the carpus and a humeral head, which assists the ulnar collateral ligament of the elbow in stabilising the elbow on the frontal plane (me-cu). Some muscular fibres of the flexor carpi ulnaris muscle, which are part of the mf unit of medio carpus (me-ca), are inserted onto the medial part of the antebrachial fascia. Other muscular fibres of the flexor carpi ulnaris, which are part of the mf unit of medio-cubitus (me-cu), are inserted onto the brachial fascia and the medial intermuscular septum[153]. Contractions of the flexor carpi ulnaris muscle traction the medial intermuscular septum of the arm in a distal direction. A proximal counter tension is created by a few fibres of the coracobrachialis[154] that originate from this medial septum. The medial intermuscular septum fuses into the axillary fascia where the two primary adductors of the upper limb, pectoralis major and latissimus dorsi (me-hu), extend tendinous expansions[155].

The fascia of the latissimus dorsi fuses with that of the trunk at the level of the supraspinous ligaments, which is precisely the posterior reference point for mediomotion of the trunk (me-th r). The fascia of pectoralis major fuses with the divider of the two halves of the body, the sternal fascia, in the thorax (me-th).

The fascia that covers the coracobrachialis muscle contributes proximally to the formation of the fibrous arch of the arm in the axilla. This fibrous arch unites with the axillary arch, which, in turn, is continuous with the fascia of the serratus anterior muscle (me-sc).

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[152] The deep palmar fascia, also known as anterior interosseus fascia, extends in front of the interossei spaces. It is interrupted at the level of the third metacarpal bone to allow for the insertion of the adductor pollicis muscle. Proximally the deep palmar fascia is continuous with the fibrous elements of the radiocarpal joint. (Testut L, 1987).

[153] The humeral head of flexor carpi ulnaris originates from the medial epicondyle, the fascia and fibrous septa. The ulnar head originates from the medial margin of the olecranon and, by an aponeurosis that fuses with the antebrachial fascia, from the superior two thirds of the ulnar. (Chiarugi G, 1975)

[154] The coracobrachialis originates from the coracoid process together with the short head of biceps. It inserts halfway on the diaphysis of the humerus. Accessory parts of this muscle can insert onto the medial epicondyle or the medial intermuscular septum. (Gray H, 1993)

[155] The medial septum extends proximally to the area of insertion of the coracobrachialis and reaches the tenson of insertion of the latissimus dorsi from which it receives reinforcing fibres. (Lang J, 1991)
Pectoralis Major extends a tendinous expansion that unites with the shoulder joint capsule and another that covers the intertubercular groove and a third that extends towards the brachial fascia. (Gray H, 1993)

The lateromotion sequence of the upper limb

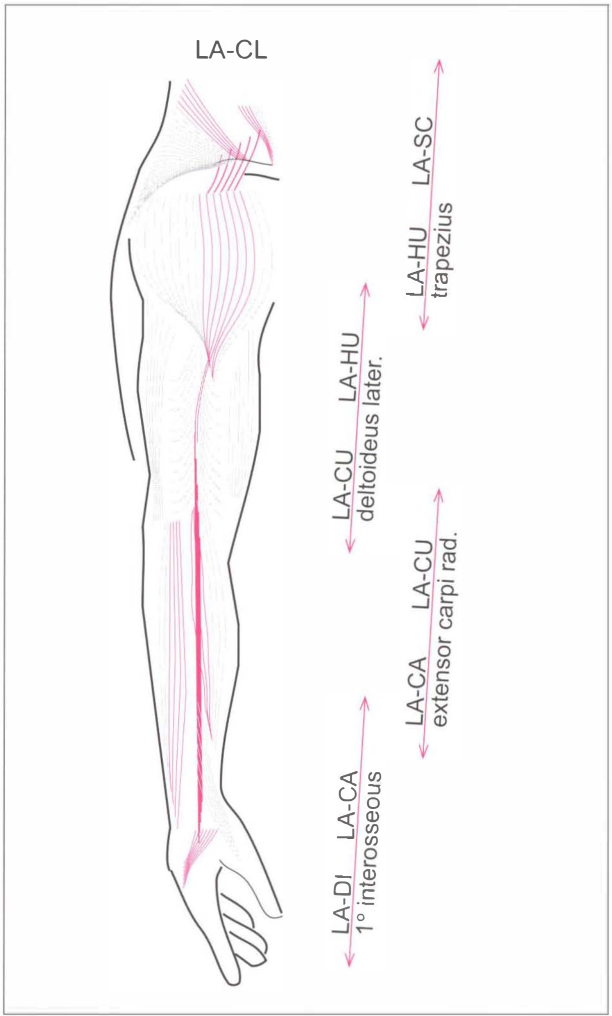

Figure 92. The lateromotion sequence of the upper limb.

Lateromotion of the fingers (la-di) is governed by the dorsal interossei muscles (Figure 92). The first interosseus is located in the space between the first and second metacarpal. The fascia of this space extends over the other dorsal interossei[156].

In the hand it is possible to recognise six types of fasciae: the fascia of the thenar eminence or thumb flexors (an-po); the fascia of the hypothenar eminence or abductor digiti minimi (re-di); the deep palmar fascia or fascia of the palmar interossei (me-di); the deep dorsal fascia or fascia of the dorsal interossei (la-di); the superficial palmar fascia or the aponeurosis of palmaris longus (ir-di); the superficial dorsal fascia or fascia of the extensor tendons (er-di).

The first dorsal interossei muscles have some fibres that originate from the tendons of the extensor radialis brevis and longus[157]. The contraction of the interossei is spread, therefore, in a proximal direction by means of a direct stretch on the tendons or via a stretch of their fasciae and sheaths.

The extensor radialis longus (la-ca) has a few fibres that originate from the lateral intermuscular septum, whilst the extensor radialis brevis has some fibres that originate from the antebrachial fascia[158]. When they contract, they traction the lateral septum in a distal direction (la-cu).

A number of deltoid muscle fibres are inserted onto the proximal part of this septum[159] and they tension it in a cephalic direction. In some cases the deltoid has muscular fibres that descend the arm blending with the fibres of the brachioradialis muscle. These fibres are not constant however, probably due to the fact that lateromotion of the elbow is more of an activity of fixation, rather than a large range movement.

When the deltoid contracts it not only stretches the lateral septum, but also the supraspinatus fascia[160] and the fascia of the trapezius, a continuation of the deltoid fascia.

The trapezius participates in lateromotion of the scapula (la-sc) and collaborates together with the sternocleidomastoid in lateromotion collum (la-cl).

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[156] The deep dorsal fascia, also known as dorsal interosseus fascia extends over the interossei spaces. The lateral palmar septum of the thumb and index extends a fascial expansion towards the third metacarpal. The adductor pollicis originates from the anterior margin of the third metacarpal. (Testut L, 1987).

[157] At times the 2° dorsal interosseus has a head that originates from the index; the 1° dorsal interosseus can receive an additional fascicle from the extensor carpi radialis and similarly the 2° can be joined by a fascicle from the extensor carpi radialis brevis. (Chiarugi G, 1975)

[158] The extensor radialis longus originates from the lateral margin of the humerus and from the lateral intermuscular septum. The extensor radialis brevis originates from the lateral epicondyle and from the antebrachial fascia. (Chiarugi G, 1975)

[159] When the lateral intermuscular septum of the arm reaches the deltoid tubercle it blends with the fibres of the deltoid muscle. (Lang G, 1975)

[160] The middle part of deltoid is multipennate: four intermuscular tendinous septa extend from the acromion downwards and intersect with three tendinous septa that extend upwards from the deltoid tuberosity. (Gray H, 1993)

The intrarotation sequence of the upper limb

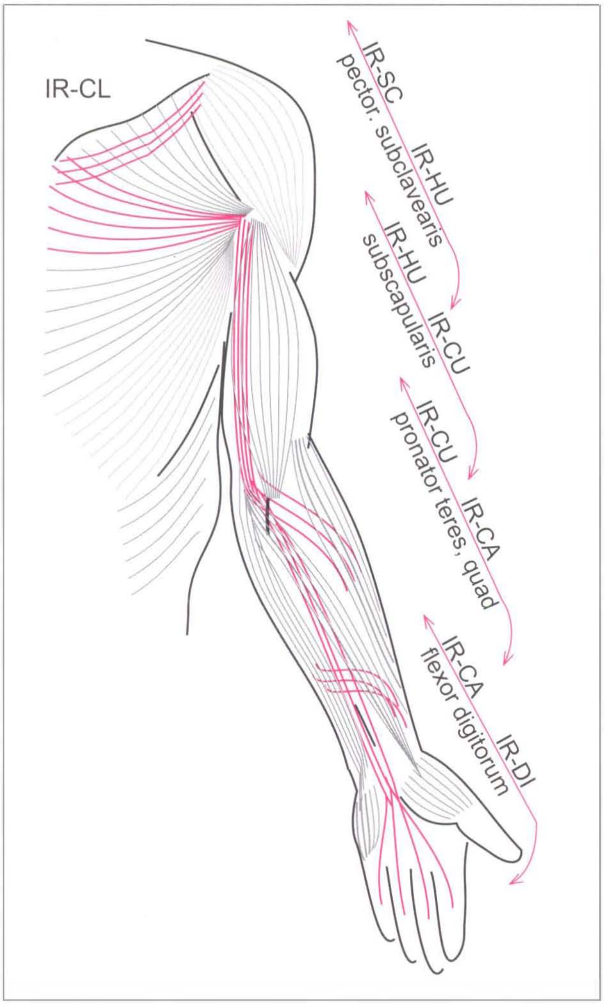

Figure 93. The intrarotation sequence of the upper limb.

Intrarotation of the digiti (fingers) (ir-di) is another component of the movement scheme of hand closure (Figure 93). The lumbricals originate from the tendons of the flexor digitorum profundus. When the lumbricals contract they tension the fascia in a distal direction. The palmaris longus tensions the palmar fascia in a proximal direction[161] during hand closure. The flexor digitorum profundus[162] originates from the interosseus membrane and from an aponeurosis in common with the flexor carpi ulnaris. The origin from the interosseus membrane synchronises the action of hand closure with the other movements of intrarotation. The extensor pollicis longus and brevis (extrarotation) originate from the same membrane on the opposite side. The fact that the flexor digitorum profundus originates from an aponeurosis, in common with other muscles, indicates that the closure of the hand is a motor scheme movement, more than a purely directional movement. The carpus moves in synchrony with the elbow during intrarotation but each one is governed by its own mf unit with its own muscle: pronator quadratus for ir-ca and pronator teres for ir-cu. The fascial continuity between these two forces is provided by the deep antebrachial fascia and by the interosseus membrane. The pronator teres and the flexor digitorum muscles converge superficially at their common origin from the medial epicondyle and the medial intermuscular septum[163]. During intrarotation of the forearm this septum is tensioned in an anterior direction. This traction is neutralised by the counter traction of a number of fibres of the subscapularis muscle (ir-hu)[164], which originate from the fascia that covers the muscle. Once this fascia reaches the short head of biceps it extends forwards into the clavipectoral fascia.

The clavipectoral fascia transmits tension from the axilla towards the pectoralis minor and the subclavius muscle, in order to simultaneously stabilise the scapula (ir-sc).

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[161] The palmar aponeurosis or palmar fascia presents two types of fibres: longitudinal and transverse. The longitudinal fibres are an extension of the palmaris longus muscle. They unite to form four band-like formations in correspondence to the flexor tendons. (Testut L, 1987)

[162] The flexors digitorum profundus also originates from an aponeurosis in common with the flexor and extensor carpi ulnaris muscles; it originates from the anterior surface of the interosseus membrane as well. (Gray H, 1993)

[163] The pronator teres originates from the medial epicondyle and the medial intermuscular septum of the arm. The palmaris longus m. originates from the medial epicondyle (by means of a tendon in common with other muscles) the antebrachial fascia and the fibrous septa that separate it from neighbouring muscles. The flex.dig.profundus originates from the ulna, the antebrachial fascia and the interosseus membrane..... The pronator quadratus adheres to the forearm bones and the interosseus membrane. (Chiarugi G, 1975)

[164] A number of fibres of the subscapularis muscle originate from the deep surface of the subscapularis fascia. The distal tendon of this muscle extends into the bicipital groove. (Chiarugi G, 1975)
The clavipectoral fascia is a robust lamina situated behind the pectoralis major. It surrounds the subclavius and the pectoralis minor, then unites with the axillary fascia and, laterally, with the fascia of the short head of biceps. (Gray H, 1993)

The extrarotation sequence of the upper limb

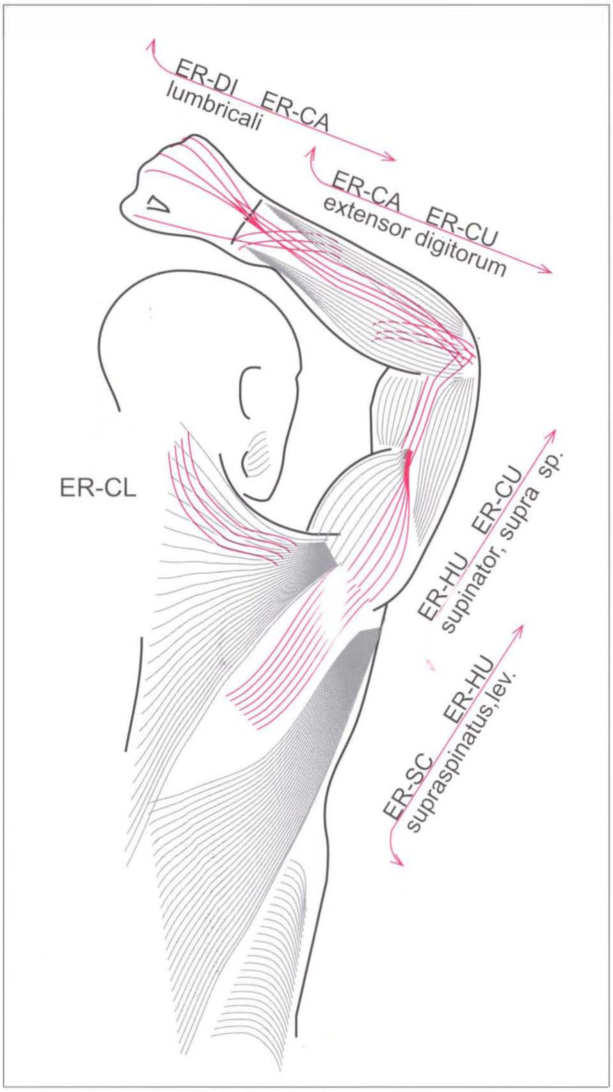

Figure 94. The extrarotation sequence of the upper limb.

Extrarotation of the digiti (fingers) (er-di) is a component of the movement of opening the hand (Figure 94). Via their tendinous expansions, the tendons of extensor digitorum are tensors of the dorsal fascia of the hand[165]. Extension of the thumb is effectuated by extensor pollicis longus and abductor pollicis longus, which also participate in extrarotation carpus (er-ca). Extensor pollicis longus and abductor pollicis longus originate from the interosseus membrane below the insertion of the supinator muscle[166]. One could question why these muscles originate from an interosseus membrane, which does not provide a stable anchorage compared to origins from bone. These muscular insertions tension the interosseus membrane in order to synchronise their actions with the activity of the supinator muscle (er-cu). Furthermore, these insertions participate in the inhibition of the pronator muscles inserted on to the opposite surface of the same membrane. The posterior antebrachial fascia, the superficial part of the extensor digitorum, the deeper parts of extensor pollicis longus and supinator[167] all converge towards their common origin from the lateral epicondyle and the lateral intermuscular septum. This septum is tensioned during extrarotation (supination) of the forearm; the posterior fibres of deltoid[168] together with the deep fibres of the rotator cuff (er-hu) fixate the septum in a posterior direction. The lateral intermuscular septum perceives and coordinates abduction when it is stretched in a longitudinal direction. The same septum perceives and coordinates extrarotation when it is stretched in a posterior, transversal direction. Posterior deltoid inserts onto the border of the supraspinatus fascia. The levator scapulae muscle tensions this fascia proximally. Together with the trapezius, the levator scapulae effectuates extrarotation of the scapula (er-sc) if the collum (neck) is fixated, or extrarotation of the collum if the scapula acts as a fixed point of leverage (er-cl).

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[165] The superficial dorsal fascia of the hand is continuous laterally with the fascia of the hypothenar and thenar eminences and distally it blends with the expansions of the extensor tendons. (Testut L, 1987)

[166] The abductor pollicis longus muscle originates from the posterior surface of the ulna, radius and interosseus membrane, below the origin of the supinator muscle. (Chiarugi G, 1975).

[167] The supinator m. originates from the lateral epicondyle, the collateral ligament of the elbow, the annular ligament of the proximal radio-ulnar joint and from the aponeurosis that covers the muscle. Some of its parts have been given specific names: lateral and medial tensor of the annular ligament... (Gray H, 1993)

[168] The distal deltoid tendon sends expansions to the brachial fascia that descend to the epicondyle.
The supraspinatus m. arises from the supraspinatus fossa and the overlying fascia. It inserts into the highest facet of the greater tubercle of the humerus and reinforces the articular capsule. (Gray H, 1993)

Chapter 12
MYOFASCIAL SEQUENCES OF THE TRUNK

The trunk is made up of the thorax, the lumbar region and the pelvis. In Fascial Manipulation the segments of the collum (neck) and caput (head) are included with the trunk in order to respect the continuity of the muscular chains, or sequences.

The sequences of the trunk link the unidirectional sequences of the upper and lower limbs together. When an object is raised with one hand only, for example, the antemotion sequence of the upper limb is activated; the heavier the object, or the stronger the force required, the more the involvement of other sequences.

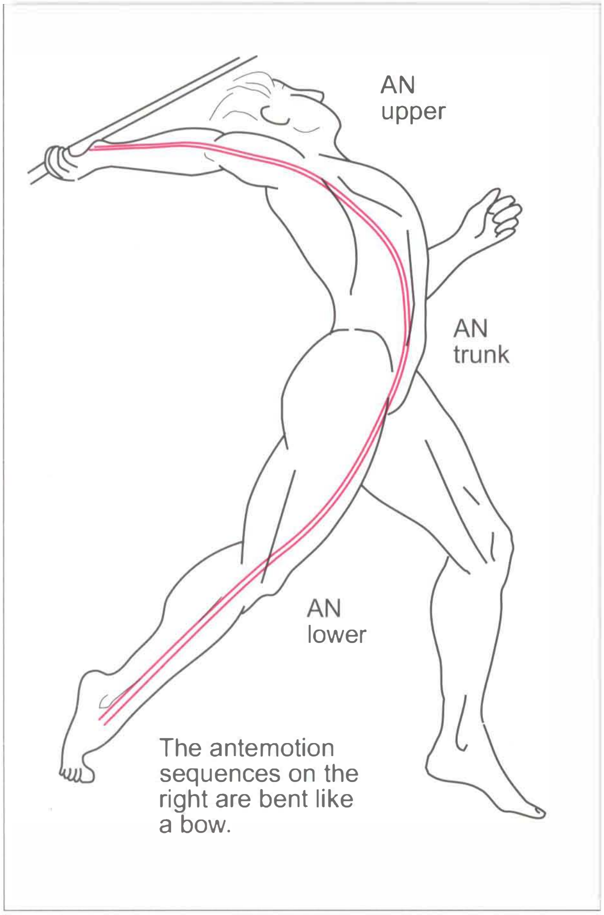

Figure 95. The act of javelin throwing is the result of the sum of the antemotion sequences.

In the case of throwing a javelin (Figure 95) all mf units of antemotion are recruited. In the preparatory phase, the sequences of antemotion of the trunk, upper and lower limbs are all subjected to a build up in tension. Together they form a single curved bow, tensioned to a maximum and prepared to express all of its accumulated energy in a single throw. Whilst the athlete concentrates on throwing, the fascia organises the single mf units and the myofascial connections, reinforced through training, respond[169]. This kinetic memory of the fascial sequences involves all three planes. Having formed mostly during evolution it is reinforced by repeated gestures. The fascia that accompanies the three antemotion sequences is the common final elaborator (servomotor) that synchronises all of the unidirectional mf units[170] via stretch of the muscle spindles.

Javelin throwing is enacted primarily on the sagittal plane hence the sequences that act on this plane come into play. The high jump (Figure 96), on the other hand, at one stage of its execution involves maximum push of the trunk into lateral flexion, aided by the lateromotion sequences of the upper and lower limb. One side of the body shortens while the contralateral side stretches all of its lateromotion mf units. The sequences, which are assigned to uniting all of the unidirectional mf units with one another, intervene most of all in forceful motor gestures or else in the static posture.

The sequences that act on the horizontal plane

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[169] Muscular tensions are an expression of the central organisation of motor acts and the significance each single muscular tension can only be interpreted in terms of the global dynamic context. A muscular tension can be the starting force for the trajectory of a movement. (Grimaldi L, 1984)

[170] Autogenic circuits are in effect local feedback loops whose function is to regulate the mechanical variables monitored by the various muscular receptors. These variables are the muscular length evaluated by the muscle spindles and the muscular force evaluated by the Golgi tendon organs. The servomotor mechanism is implicated in all motor acts. (Houk JC, 1981)

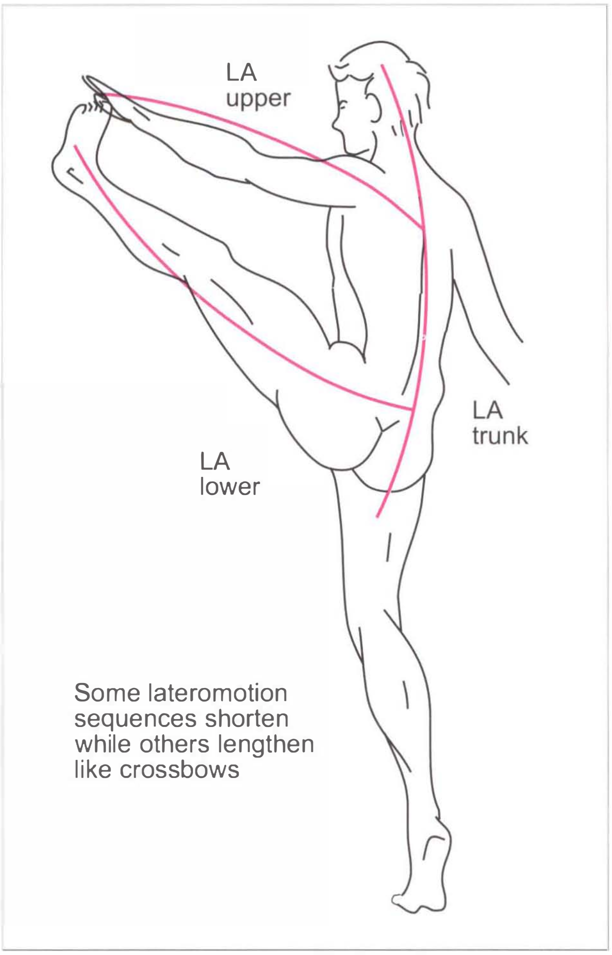

Figure 96. High jumping is the result of the sum of the lateromotion sequences.

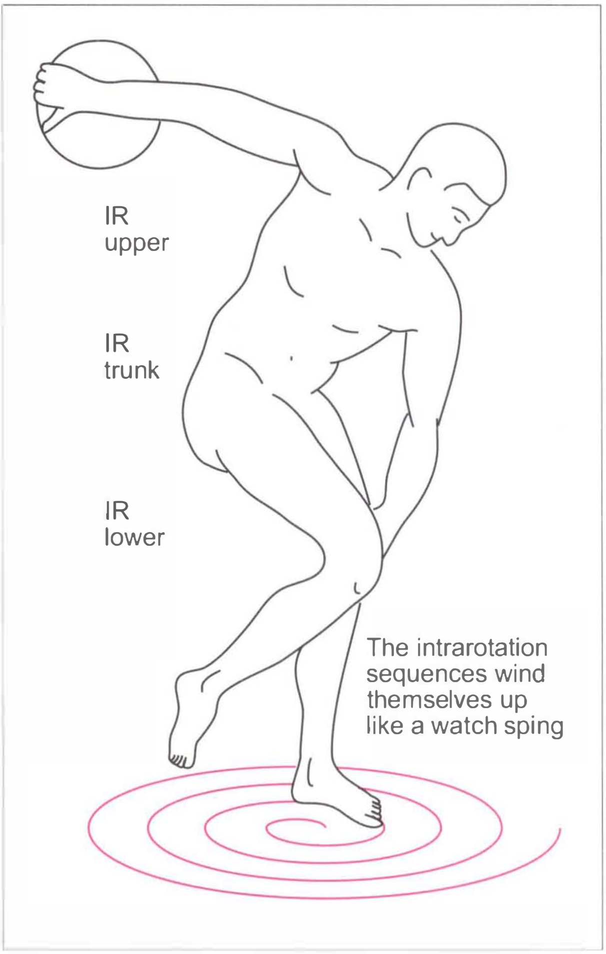

Figure 97. Disc throwing is the result of the sum of the extrarotation sequences

are recruited for discus throwing (Figure 97). In order to place the sequence of extrarotation under tension, the athlete rotates around him/herself, similar to the winding up of a watch spring. Intrarotation of the upper limb, the trunk and the lower limb places the external fasciae under tension in preparation for the throw.

The myofascial sequences are responsible for the motor organisation of the various parts of the body involved in this type of unidirectional effort. The sequences are located in specific parts of the body so that they can be stretched during motor activity[171]. The fascia of the sequences is stretched in the preparatory phase of the sporting gesture, activating the mf units along those sequences.

The fascia has a fixed length but it consists of elastic and undulated collagen fibres that allow it to lengthen when subjected to traction, returning to its resting position when the stretch ceases. It is really the only tissue in the body to have these spring-like properties. This capacity of the fascia to accumulate energy and then unleash it is only possible if the collagen and elastic fibres are free to glide within the ground substance.

The fluidity of the ground substance depends upon glycoaminoglycans, which are hydrophilic sugars and fibronectin, a protein that unites the fascial fibres (The Lancet, vol. 357).

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[171] We reached a conclusion that, rather than single muscles, a muscular collective (coordinating structure) best represents the unit that constitutes action. It remains to be seen if individual changes in the ratio between force and length are capable of transforming a muscular collective into a mass-spring system. The sum is valid if the forces are converted into torque (also known as mechanical moment) i.e. the product of the force by the lever arm of each muscle. (Grimaldi L, 1984)

The antemotion sequence of the trunk

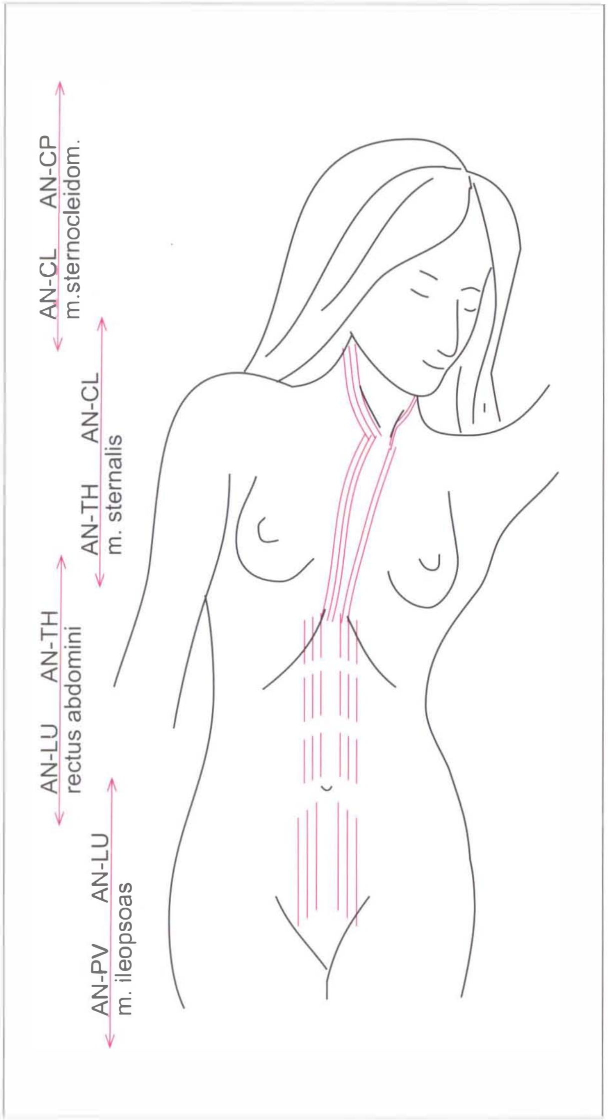

Figure 98. The antemotion sequence of the trunk.

Antemotion caput (an-cp) is formed by three sub-units: the first by the inferior rectus muscle of the eye, the second by the orbicularis oris muscle and the third by the anterior muscle belly of the digastric muscle.

The small facial muscles connected to the *ante* trajectory (antagonists to the *retro* sequence) unite some of their muscle fibres to those of the platysma. This muscle unites the face with the pectoral fascia (Figure 99). The superficial lamina of the deep cervical fascia covers the digastric muscle[172], which is the most important muscle for the act of opening the mouth. A doubled layer of this fascia surrounds the sternocleidomastoid muscle, which is the most important muscle for antemotion collum (neck) (an-cl). The transverse septum of the neck connects the deep muscles of the neck (longus colli, longus capitis) to the superficial lamina of the deep cervical fascia.

The sternal insertion of the sternocleidomastoid is, at times, connected to the sternal insertion of the rectus abdominis via a few residual longitudinal fibres (Figure 98). Some authors call these fibres the sternalis muscle[173]. This muscle is unable to carry out its function of antemotion of the trunk (an-th) because of the rigidity of the sternum.

Antemotion lumbi (an-lu) is effectuated by the left and right portions of the rectus abdominis. Three or more tendinous intersections traverse this muscle above the umbilicus. These tendinous intersections connect with the overlying fascia/aponeurosis to become fascial tensors[174].

Antemotion pelvi (an-pv) is effectuated partially by the pubic insertion of the rectus abdominis and partially by the iliopsoas muscle. The fascia iliaca is continuous with the transversalis fascia, which covers the internal surface of the inferior rectus abdominis[175], and with the fascia of the vastus medialis of the quadriceps femoris (an-cx).

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[172] The middle tendon of the digastric muscle is fixated by a fibrous ring that is an extension of the cervical fascia. The anterior belly of this muscle, together with the masseter muscle, the pterygoids and the tensor tympani are derived from the first branchial arch. (Chiarugi G, 1975)

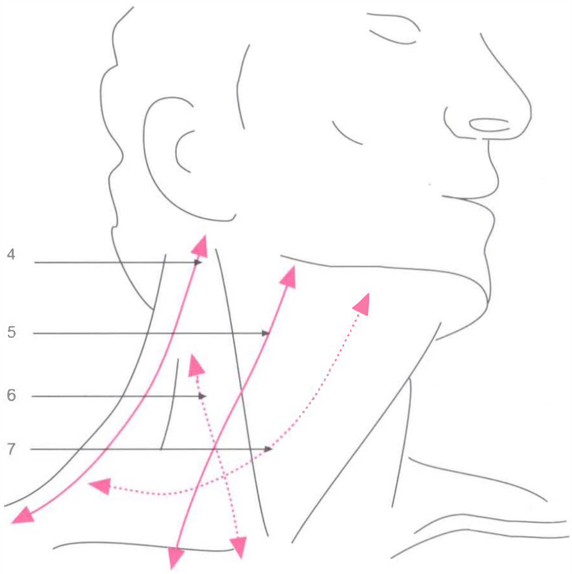
[173] The sternalis muscle is to be found near the sternal origins of the pectoralis major. In the more typical cases it connects above with the sternal tendons of the sternocleidomastoid and below to the cartilage of the 5° to 7° rib. (Chiarugi G, 1975)

[174] The upper half of the rectus abd. muscle is interrupted by transverse tendinous intersections. The tendinous intersections are intimately united with the fibrous sheaths that surround the muscle. The proximal insertion of the rectus can extend up to the 3° rib, which is similar to normal physiology in monkeys, where this muscle inserts onto the 1° rib. (Chiarugi G, 1975)

[175] The fascia iliaca covers the iliacus muscle and is separated from the peritoneum by the loose extra peritoneal connective tissue. Laterally the fascia is continuous with the posterior margin of the inguinal ligament and with the transversalis fascia. The iliacus originates from the iliac fossa and the sacroiliac and iliolumbar ligaments. Psoas Major and iliacus are potent vertebral flexors e.g. the passage from supine to the seated position. (Gray H, 1993)

Figure 99. A - The platysma muscle and superficial lamina of the deep cervical fascia (from Fumagalli - Colour photographic atlas of macroscopic human anatomy. - Published by Dr. Francesco Vallardi/Piccin, Nuova Libraria), B - Muscular tensor fibres of the middle and deep laminae of the cervical fascia.

A -1, All fascia must be maintained at a basal tension by muscular expansions in order to be able to perceive movement. The platysma muscle glides over the cervical fascia acting as a bridge between the lateral pectoral fascia, from where it originates, to the masseteric fascia and the facial muscles, where it inserts; 2, The superficial lamina of the deep cervical fascia is tensioned anteriorly by the sternal head of the sternocleidomastoid and laterally by the clavicular head (3) of the same muscle together with trapezius; they are surrounded by a second layer of this lamina; B - 4, the deep lamina of the deep cervical fascia (nuchal fascia) is tensioned posteriorly by longissimus cervicis and anteriorly by the longus colli muscle (prevertebral fascia) (5); 6, the middle lamina of the cervical fascia is tensioned by the splenius and by the omohyoid muscle (7), also known as the tensor of the cervical fascia.



The retromotion sequence of the trunk

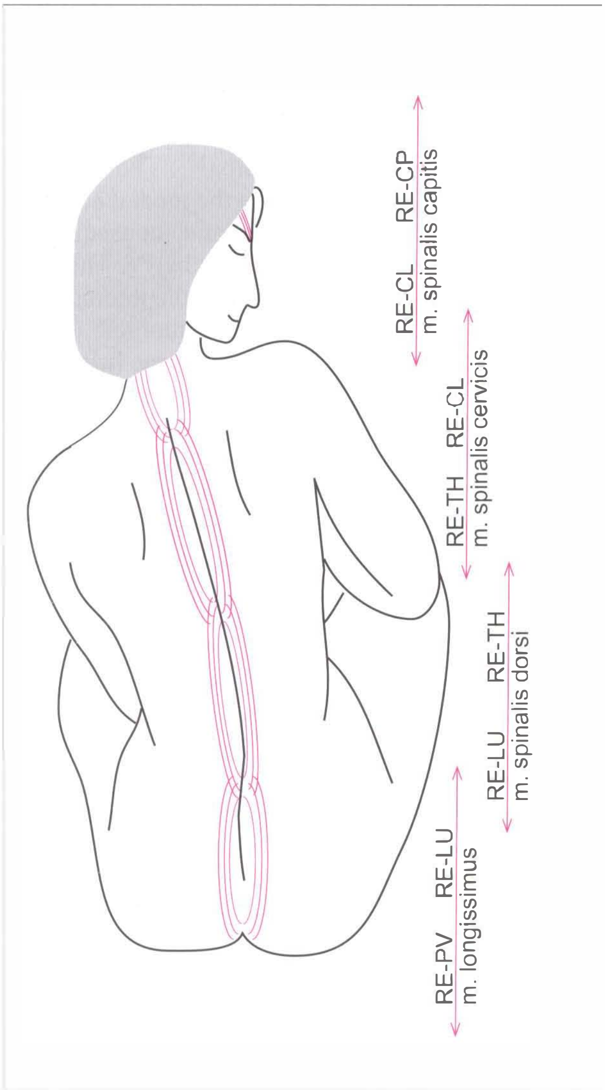


Figure 100. The retromotion sequence of the trunk.

The sequence of retromotion of the caput (head) (re-cp) begins at the medial border of the eyebrows (Figure 100). The vectors of the orbicularis oculi, corrugator supercilii and rectus superior of the eye converge at this point.

The inferior fibres of the orbicularis oculi muscle descend to join with the levator labii and the procerus muscles. The superior fibres of the orbicularis join with the occipito-frontalis muscle. The occipito-frontalis muscles are the two tensors of the galea aponeurotica, or superficial cranial fascia, which is adherent to the scalp. Like the platysma these two muscles are located in the subcutaneous tissue. The deep cranial fascia or epicranial fascia is found below the galea between two layers of loose connective tissue[176]. These two layers of loose connective tissue allow for the epicranial fascia to transmit tension from the occipital area to the face or vice versa, without interfering in the sliding of the scalp. The deep cranial fascia is continuous with the nuchal fascia[177] at the base of the occiput.

During retromotion caput (re-cp) the semispinalis capitis, spinalis capitis and longissimus capitis apply traction to the epicranial fascia distally.

During retromotion collum (re-cl) the semispinalis cervicis, spinalis cervicis and longissimus cervicis (this latter originates from the thoracic fascia[178]) traction the thoracic fascia proximally and the nuchal fascia distally.

During retromotion thorax (re-th), lumbi (re-lu) and pelvis (re-pv) the thoracolumbar fascia is subjected to similar tensions. This fascia, like the nuchal fascia with which it is continuous, acts as a bridge that synchronises the various body segments during retromotion of the trunk (straightening up).

At the level of the sacrum the erector spinae and the gluteus maximus are inserted onto the thoracolumbar fascia[179]. This latter muscle participates in retromotion pelvis when the thigh is fixated or in a closed kinetic chain. The muscular chain of the erector spinae, surrounded by the superficial and deep layers of the thoracolumbar fascia, forms the sequence of retromotion of the trunk. The gluteus maximus muscle connects this sequence to the sequence of retromotion of the lower limb.

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[176] The connective tissue beneath the galea aponeurotica is subdivided into three layers; the intermediate layer is dense and resembles the galea aponeurotica because of its insertions. (Gray H, 1993)

[177] The nuchal fascia is located superficially between the trapezius and rhomboid muscles and deeply between the splenius and semispinalis muscles. Laterally it continues with the superficial cervical fascia and medially it fuses with the ligamentum nuchae. (Baldoni CG, 1993)

[178] The longissimus muscle represents the middle portion of the sacrospinalis muscle. In particular it originates from the spinous processes and from the anterior surface of the thoracolumbar fascia. (Chiarugi G, 1975)

[179] The gluteus maximus originates from the posterior gluteal line of the ilium, the aponeurosis of the erector spinae, the sacrotuberous ligament, the fascia that covers the gluteus medius... (Gray H, 1993)

The mediomotion sequence of the trunk

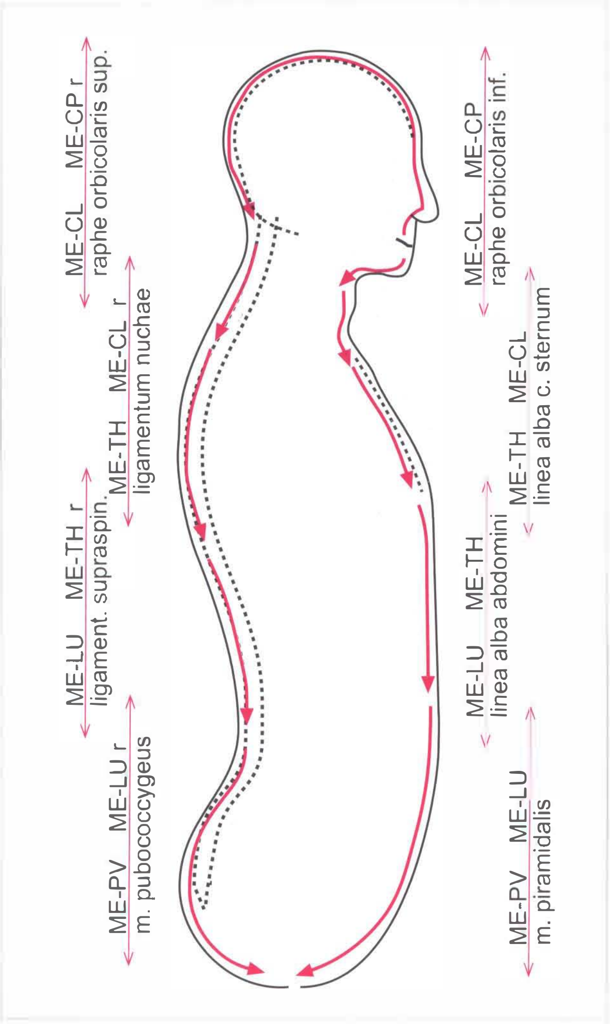

Figure 101. The mediomotion sequence of the trunk.

Mediomotion of the caput (me-cp) corresponds to the median line that extends from the occipital protuberance posteriorly to the upper lip anteriorly, dividing the head into perfectly symmetrical halves. The medial collagen fibres of the epicranial fascia are duplicated inside the cranium by the falx cerebelli and falx cerebri of the brain. The mouth is the median aperture that interrupts the continuity of the sequences. In fish, birds and almost all mammals the mouth is the most forwardly positioned part of the body. The majority of animals use the mouth to grab, inspect and to experience objects. Its muscles are directly inserted into the fascia therefore any movement of the mouth is propagated to the adjacent fasciae. The muscular fibres of the orbicularis oris are mostly concentrated in the central raphe of the upper and lower lips[180]. These fibres tension the sequence of mediomotion proximally. Distally, tension is maintained by the pyramidalis muscle (pubis) and the coccygeus muscle (below the coccyx).

The raphe of the lower lip (Figure 101) is continuous with the cervical linea alba[181]. The raphe of the upper lip is continuous with the medial collagen fibres of the epicranial fascia and, consequently, with the ligamentum nuchae (me-cl r)[182]. The ligamentum nuchae is continuous with the interspinous and supraspinous ligaments of the thoracic (me th r), lumbar (me-lu r) and pelvic vertebrae (me-pv r).

The cervical linea alba is continuous with the presternal fascia (me-th), the linea alba above the umbilicus (me-lu) and the linea alba below the umbilicus (me-pv). In the pelvic region these central collagen fibres have muscular tensors. Anteriorly, the tensor is the pyramidalis muscle which inserts into the linea alba[183] and posteriorly the pubococcygeus muscle, which originates from the coccyx.

The fasciae of the adductor muscles of the thigh originate from the fasciae of the pelvic diaphragm (me-cx). The adductors of the humerus (me-hu) (latissimus dorsi and pectoralis major) originate from the sternal fasciae anteriorly and, posteriorly, from the supraspinous ligaments.

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[180] Five muscles converge near the angle of the mouth: levator angoli oris (originates from below the infraorbital foramen); zygomaticus major (originates from the bone of the same name); risorius (originates from the fascia and is joined by fibres of the platysma); the depressor angoli inferioris.
Towards the inferior junction of the orbicularis muscle the mentalis muscle (connects the skin of the chin) and the depressor labii inferioris (it originates from the left and right oblique lines of the mandible) converge. (Basmajian JV, 1993)

[181] The superficial cervical fascia forms a raphe called the cervical linea alba along the anterior median line, which unites the right half of this fascia with the left half. (Chiarugi G, 1975)

[182] The posterior margin of the ligamentum nuchae intermingles with the tendinous fibres of the trapezius muscle. The right and left margins of the ligamentum nuchae are adjacent to the muscles of the head and neck to which they provide numerous insertions. (Testut L, 1987)

[183] The pyramidalis muscle originates from the body of the pubis and its fibres terminate, with a series of tendinous slips, into the linea alba. (Chairugi G, 1975)

The lateromotion sequence of the trunk

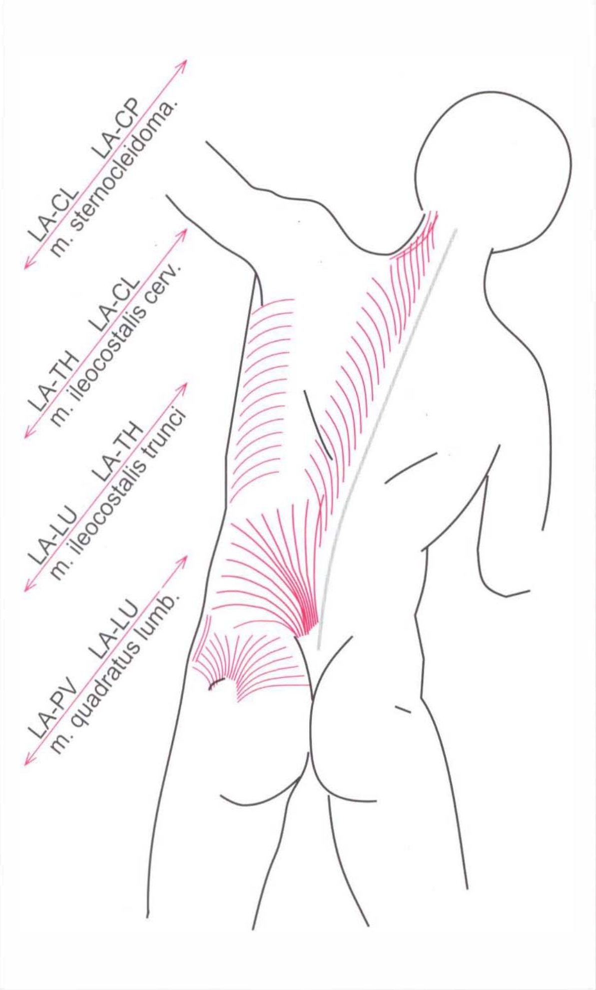

Figure 102. The lateromotion sequence of the trunk.

Lateromotion of the caput (head) (la-cp) is connected to the muscles of mastication and in particular to the fascia of the masseter muscle. This fascia unites with the superficial lamina of the deep cervical fascia via the tractus angularis ligament of the mandible[184]. The sternocleidomastoid muscle is surrounded by the superficial lamina of the deep cervical fascia and connects with other lateromotion muscles of the neck (scalenii, iliocostalis cervicis) via a prolongation of this fascia towards the vertebrae[185]. The iliocostalis muscles form the principal vectors of lateromotion collum (la-cl), thorax (la-th) and lumbi (la-lu). Their rib insertions (Figure 102) place them in direct contact with the fasciae of the intercostal muscles (remnants of the metameric lateroflexor musculature in fish). The intercostal muscles are substituted by the internal oblique and transversus abdominis muscles at the lumbar level. Posteriorly the fascia of these muscles surrounds the paravertebral muscles[186]. The anterolateral component thus converges in the lateral border of the compartment of the thoracolumbar fascia. The insertions of the anterior (intercostals, obliques) and posterior (iliocostalis, quadratus lumborum[187]) muscles are distributed along this border.

At the level of the pelvis (la-pv) some fibres of the gluteal muscles originate from the thoracolumbar fascia. With their sustaining force these fibres prevent a fall when the trunk bends laterally. This fascial continuity allows for the contractions of the gluteal muscles to adapt to any increase in the degree of lateromotion[188] of the trunk. An increase in lateromotion determines a greater stretch on the fascia, hence more muscle spindles are activated, resulting in a greater recruitment of muscular forces.

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[184] The superficial cervical fascia is fixed above to the inferior margin of the mandible and is continuous with the parotideomasseteric fascia. (Chiarugi G, 1975)

[185] From the deep surface of the superficial cervical fascia a prolongation extends towards the scalenii muscles surrounding them with fascial sheaths that accompany them towards their insertions onto the tubercles of the cervical vertebrae. (Chiarugi G, 1975)

[186] The lower internal intercostal muscles are in direct contact with the internal abdominal oblique muscles. These oblique muscles originate from the posterior surface of the united layers of the thoracolumbar fascia. Via this fascia they are connected to the ultimate lumbar vertebrae and the iliac crest. (Chiarugi G, 1975)

[187] Quadratus lumborum is derived from myotomes that previously constituted the lumbar intertraversarii muscles. It is contained within a fibrous sheath, the posterior layer of which is formed by the insertion aponeurosis of the transversus abdominis muscle and the anterior layer of the thoracolumbar fascia. (Chiarugi G, 1975)

[188] Movements of the pelvis. Movement of the hip in human beings is almost always associated to movement of the vertebral column.
The gluteus maximus originates from the external surface of the ilium and cranially from fascial/aponeurotic segments. The muscle is multilayered and the fibres that originate from the coccyx can acquire such autonomy as to appear almost like a separate muscle. (Lang J, 1991)

The intrarotation sequence of the trunk

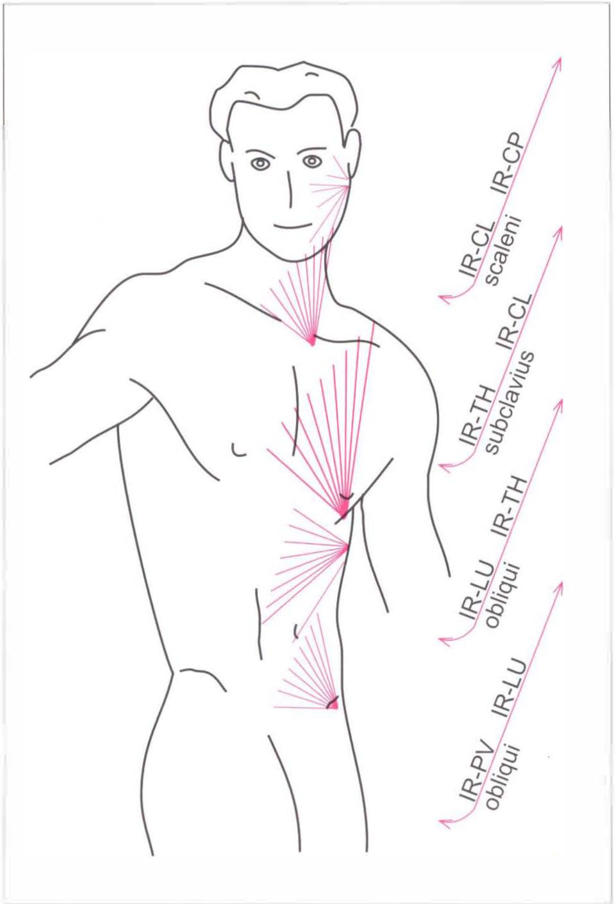

Figure 103. The intrarotation sequence of the trunk.

The movement of intrarotation caput (head)(ir-cp) corresponds to the intention to return oneself to a forward-facing position. It has already been discussed how movements carried out in the trunk on the horizontal plane are always a result of coupled forces. The synergy that occurs between all of the mf units of intrarotation when they are involved in a unidirectional effort will now be considered.

Based on its involvement in the rotatory movements of the mandible, the interpterygoid fascia[189] appears to be the perceptive and locomotor element for intrarotation caput (Figure 103). The sphenomandibular ligament places the pterygoid fascia in continuity with the intermediate lamina of the deep cervical fascia, which overlies the scalenii muscles[190]. The scalenii muscles, together with part of the sternocleidomastoid, participate in intrarotation collum (ir-cl). The intermediate lamina of the deep cervical fascia accompanies the scalenii, which insert onto the first rib, and then continues on into the fascia of the intercostal muscles[191]. Rather than effectuate intrarotation of the thorax (ir-th), which is not possible due to the rigidity of the sternum, the unilateral contraction of the intercostal muscles fixates the thorax, allowing for movements of intra collum (ir-cl) and lumbi (ir-lu). Once again it can be seen how the thoracic zone links together other areas[192]. The obliques and the transversus muscles in the abdominal zone effectuate a forwards pulling action. The obliques insert onto the inguinal ligament in the pelvis. Due to this insertion the fascia of the obliques, which is involved in the coordination and perception of intrarotation of the trunk, is able to exert tension proximally[193]. It should be emphasised that part of the fascia is free to slide and part is united to the external oblique aponeurosis in order to be tensioned by this muscle.

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[189] The posterior margin of the interpterygoid aponeurosis is fixated to the base of the cranium by the sphenomandibular ligament. The more dorsally located fibres are called the tympanomandibular ligament.
The contraction of only one lateral pterygoid pulls the condyle on that side forward and the mandible effectuates a rotatory movement. (Chiarugi G, 1975)

[190] The anterior scalenus muscle originates from the anterior tubercles of the transverse processes from C3 to C6. Its principal action is the ipsilateral flexion and the contralateral rotation of the neck. (Clarkson HM, 1996)

[191] The lack of external intercostal muscles medially is substituted by a fascia known as external intercostal; the absence of internal intercostal muscles from the costal angle is substituted by a fascia called internal intercostal. These fasciae serve no purpose apart from a protective function. The external intercostals are inspiratory muscles and when they contract unilaterally they also have a modest action of ipsilateral rotation. (Pirola V, 1998)

[192] The endothoracic subpleuric fascia can be divided into three parts: 1° a thin layer of loose connective tissue; 2° the endothoracic fascia of elastic fibrous tissue; 3° a thin layer of loose connective tissue. It is continuous with the periosteum, the prevertebral fascia and with the sternum. (Testut L, 1987)

[193] Beneath the superficial fascia of the abdomen a fibrous lamina extends across the external abdominal oblique muscle. This is called the fascia of the external oblique muscle, which is not to be confused with the insertion aponeurosis. This terminal aponeurosis, true tendon of the muscle, inserts into the linea alba, the pubis bone and the inguinal ligament. (Testut L, 1987)

The extrarotation sequence of the trunk

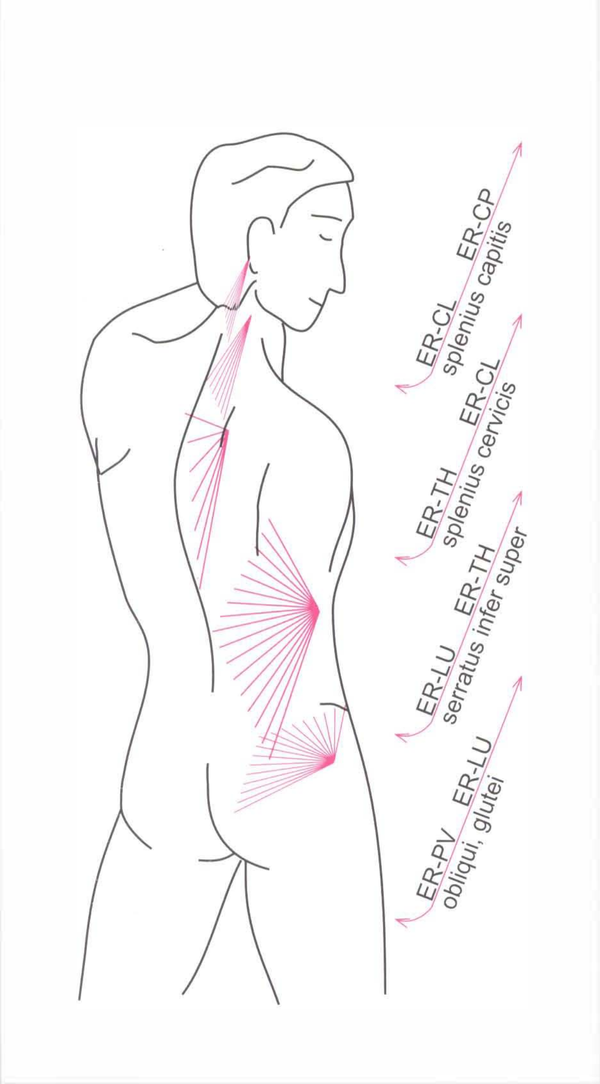

Figure 104. The extrarotation sequence of the trunk.

Extrarotation caput (er-cp) corresponds to tensioning (Figure 104) of the temporaparietal and epicranial fascia in a proximal direction by the auricularis muscle[194] and in a distal direction by the splenius capitis muscle[195]. This fascial tensioning extends along the entire retro-lateral part of the trunk, down to the gluteus medius. The fasciae of the splenii (er-cl) and the serrati posterior[196] (er-th) are principally subjected to extrarotation tension. The fascia of the serratus posterior inferior is continuous with the fascia of the internal oblique muscle[197] at the level of the lower ribs. The internal oblique is the principal agonist of extrarotation lumbi (er-lu).

The fascia of the internal oblique is in part fixed to the iliac crest and in part continues in the fascia of the gluteus medius. The external fibres of this muscle insert on to its own fascia[198] and, in this way, it becomes a distal tensor of the sequence of extrarotation. The muscular fibres of the gluteus medius, which participate in extrarotation pelvis (er-pv), continue below with the fibres of the piriformis muscle (er-cx). The division of the sequences of the trunk from those of the limbs is for teaching purposes, as well as to illustrate the partial autonomy of each sequence.

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[194] The mastoid aponeurosis is represented above by the epicranial aponeurosis. The inner surface is united to the periosteum by means of loose connective tissue; two transverse bundles of fibres of the posterior auricularis muscle insert onto the outer surface. Inferiorly the aponeurosis fuses with the tendons of the muscles that insert onto the mastoid. (Testut L, 1987)

[195] The splenius muscle originates from the ligamentum nuchae and from the spinous processes. The part known as splenius cervicis inserts, deep to levator scapulae, into the transverse processes of the first four cervical vertebrae; the portion known as splenius capitis inserts, deep to the sternocleidomastoid muscle, onto the mastoid process. (Testut L, 1987)

[196] The second layer of muscles of the neck consists of four muscles: the splenii, levator scapulae, rhomboids and the serratus posterior superior. When the splenius contracts alone it extends the head and brings the face to the same side. (Testut L, 1987)
At the level of the thorax four muscular layers can be noted: the third layer is comprised of the serratus posterior superior, behind the rhomboids, and the serratus posterior inferior. These two muscles are united to one another by a very resistant fibrous membrane called the intermediate aponeurosis. (Testut L, 1987)

[197] The internal oblique muscle appears briefly in the lumbar triangle of Petit. It is part of the fascial triangle that lies above the lumbar triangle. The caudal fibres of the serratus posterior inferior cover the posterior part of this fascial space. Unlike the external oblique, the contraction of the oblique internal on one side rotates the thorax to the same side. (Chiarugi G, 1975)

[198] The gluteus medius muscle originates from the lateral surface of the ala of the ilium, the outer lip of the iliac crest, the fascia that covers it anteriorly and superiorly and from the aponeurosis that inserts between it and the tensor fascia lata. Its posterior margin borders with the pyramidalis muscle. When the thigh is fixed the gluteus medius extends the pelvis and rotates it to the same side. (Chiarugi G, 1975)

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Chapter 13
MYOFASCIAL SEQUENCES OF THE LOWER LIMB

Two types of muscular forces can be distinguished in physiology:

1) the explosive force, or contraction of a muscle without being stretched e.g. a horse rearing up on its hind legs (Figure 105);
2) the pliometric force (from Gr. *pleion* = more) or muscular contraction after stretch.

The pliometric force is the consequence of a chemical process together with a certain viscoelasticity. It makes use of the stretch reflex, involving the lengthening of a muscle with respect to its resting position. Hence it produces a better response because it associates stretch of the muscle spindles, lengthening of the elastic structures placed in parallel to the muscle and internal chemical processes.

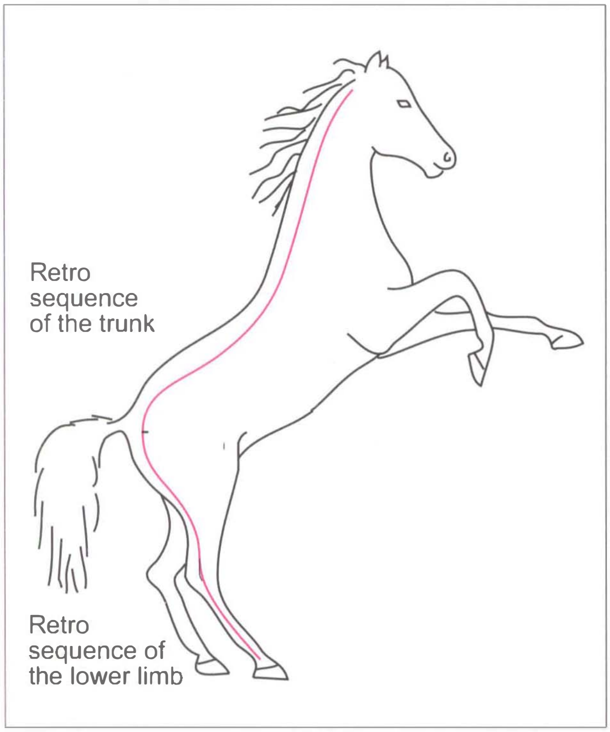

Figure 105. The explosive force of the retromotion sequences of the trunk and the lower limbs.

The unidirectional myofascial units, linked together in series, can be added to this list. A soccer player, for example, (Figure 106) prepares to kick the ball by placing the antemotion sequence, which links the mf units of antemotion coxa, genu, talus and pes in series, under tension.

In this preparatory phase it is actually the antagonist sequence (retromotion) that places the anterior connective tissue structures under tension. When the motor command to kick the ball is generated by the nervous system the various mf units of antemotion then become one lever, governed by the fascial

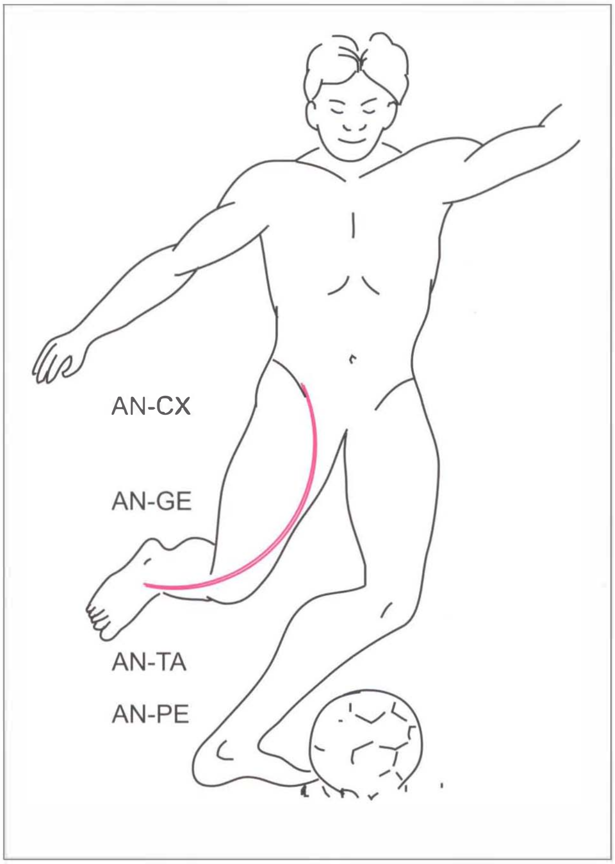

Figure 106. Pliometric force of the antemotion sequence of the lower limb.

sequence. A single malfunction in this chain of motor events can determine a reduction in force and discrepancies in the proprioceptive information. If these initial signals are ignored then incoordination can cause articular derangement. At the end of a soccer game, for example, one or more joints can be sore and swollen. Furthermore, if analgesics are used instead of specific treatment to harmonise the sequences then ongoing incoordination can result in permanent damage to the joint structures, ligaments or muscles.

The antemotion sequence of the lower limb

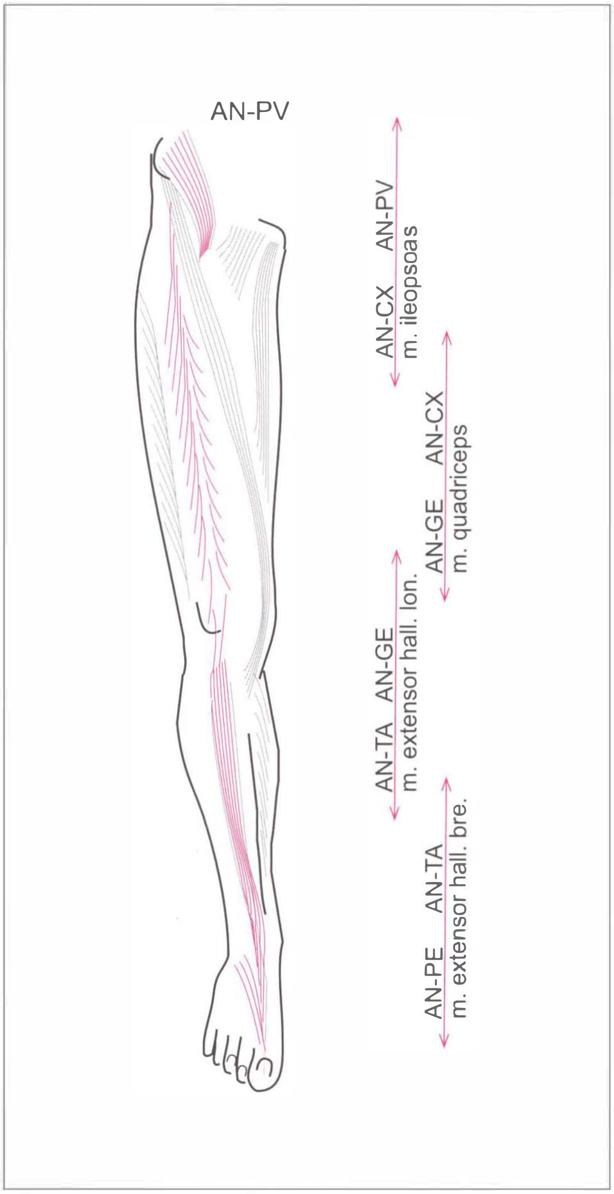

Figure 107. The antemotion sequence of the lower limb.

Antemotion pes (foot)(an-pe) is effectuated mostly by the powerful muscles of the anterior compartment of the leg (Figure 107). As in the hand, the small distal muscles of the foot are used for fine movements. The prime movers of the extremities are the muscles located in the leg and the forearm. For this sequence of antemotion the key muscle of the foot is the extensor hallucis brevis, the most medial part of extensor digitorum brevis. With its origin from the extensor retinaculum[199] this muscle tensions the anterior fascia of the leg distally. The extensor hallucis brevis has its own anatomical independence from the rest of extensor digitorum, as well as a different motor function[200].

Antemotion talus (an-ta) is effectuated by tibialis anterior, extensor digitorum longus and extensor hallucis longus muscles. These muscles originate from the condyles of the tibia and the fibula, the intermuscular septa and the overlying fascia[201].

The tendinous expansion of the quadriceps[202] (an-ge) tensions the anterior fascia of the leg proximally, whereas the previously discussed muscles traction it distally.

The fascia lata, which distends over the quadriceps and is in part free to glide across it, is tensioned[203] in a proximal direction by a small number of muscular fibres of the iliopsoas muscle. It is tensioned distally by its insertions into the intermuscular septa of the vastus medialis and lateralis.

The iliopsoas fascia continues down over the vastus medialis of quadriceps and is tensioned distally by the same vastus medialis, together with sartorius. It is connected proximally with the muscles involved in antemotion pelvis (an-pv) and is tensioned in this direction by the iliacus and psoas minor muscles.

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[199] The extensor digitorum brevis originates from the front of the upper surface of the calcaneus, from the talo-calcaneal ligament and from the lateral part of the inferior extensor retinaculum. (Gray H, 1993)

[200] The muscular head for the hallux is considered by some as a muscle in its own right, called the extensor hallucis brevis muscle (Chiarugi G, 1975)

[201] The extensor digitorum longus originates from the condyle of the tibia... from the proximal part of the interosseus membrane, from the deep surface of the fascia of the leg, and from the intermuscular septum. (Gray H, 1993)

[202] The common tendon of the quadriceps is attached to the base of the patella; its more superficial fibres are continuous with the fibres that form the ligamentum patellae. (Chiarugi G, 1975)

[203] The psoas minor inserts into the arcuate line, reaching the iliopectineal eminence and the fascia iliaca. It collaborates in flexing the vertebral column and tensions the fascia iliaca. (Chiarugi G, 1975)

The retromotion sequence of the lower limb

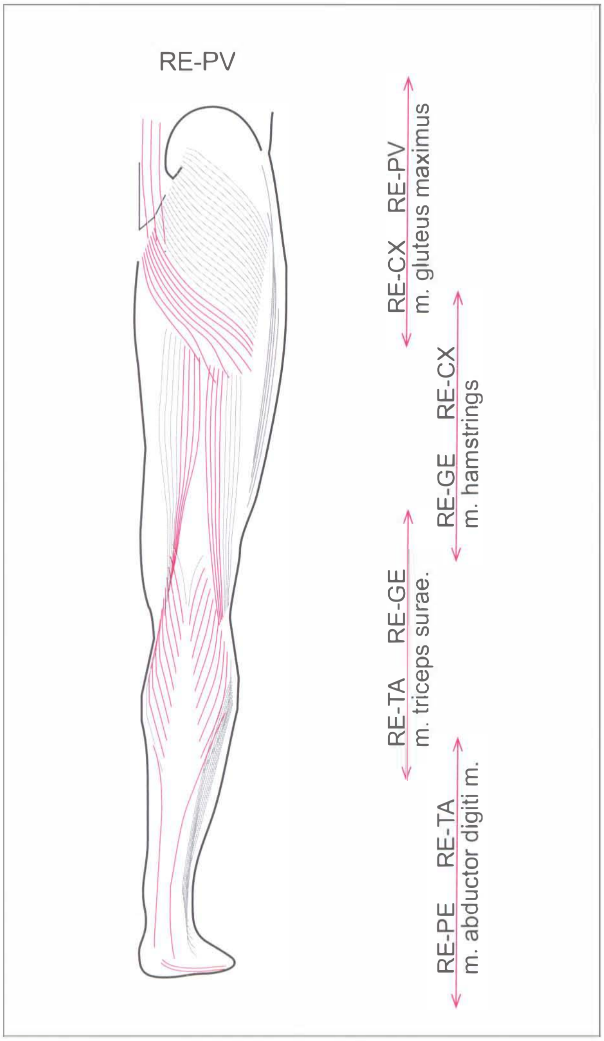

Figure 108. The retromotion sequence of the lower limb.

Retromotion pes (foot) (re-pe) begins in the lateral compartment of the foot, which contains the abductor digiti minimi and flexor digitorum brevis (Figure 108). These muscles are the distal tensors of the retromotion sequence as some of their fibres originate from this fascial compartment[204]. Retromotion of the foot is activated in the moment prior to the push-off or toe-off phase of the gait cycle. In this phase the foot is slightly supinated therefore the lateral compartment, comprising the abductor digiti minimi, is in contact with the ground. Abductor digiti minimi originates from the plantar aponeurosis, which is the continuation of the Achilles tendon of triceps surae (re-ta). The contraction of the triceps surae stretches the popliteal fascia and, in turn, the fibres of the gastrocnemius inserted into it[205]. The fascia popliteal and the fascia of the leg are tensioned proximally by a few fibres of the biceps femoralis, as well as some fibres of the semitendinosus and semimembranosus[206] (Figure 110).

The three previously mentioned muscles participate both in retromotion genu (knee)(re-ge) and retromotion coxa (hip)(re-cx). These muscles therefore not only tension the popliteal fascia[207] but also the sacrotuberous ligament[208]. This myofascial concatenation is tensioned during the push-off phase of each step.

The sacrotuberous ligament is continuous proximally with the thoracolumbar fascia. The erector spinae muscles originate from the thoracolumbar fascia[209] and during retromotion lumbi (re-lu) they become tensors of the retromotion sequence of the lower limb.

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[204] The abductor digiti minimi originates from both processes of the calcaneus, the plantar aponeurosis and the intermuscular septum that lays between it and flexor digitorum brevis. (Gray H, 1993)

[205] It is quite difficult to separate the fascia popliteal from the underlying tendons. An intimate adherence at this point is derived from the fact that numerous fibrous bundles pass from the tendon into the fascia, reinforcing it. In some cases these tendinous bundles that are fused with the fascia or, more precisely, are inserted directly onto the fascia, can lead to the formation of tiny muscles, the so-called tensor muscles of the fascia. (Testut L, 1987)

[206] The deep transverse fascia of the leg extends from the medial border of the tibia to the posterior border of the fibula. Above it is continuous with the fascia that covers the popliteal fossa and it is united to the tendon of the semimembranosus. Below it is continuous with the flexor retinaculum (laciniate ligament) and the peroneal retinaculum. (Gray H, 1993)

[207] The distal tendon of the semimembranosus is divided into three parts. The first part extends forwards to the medial condyle of the tibia, a second part is continuous with the fascia of the popliteus muscle; a third part extends into the posterior wall of the joint capsule (oblique popliteal ligament). (Platzer W, 1979)

[208] The inferior fibres of the gluteus maximus muscle originate from the posterior surface of the sacrotuberous ligament; some fibres of the ligament are continuous with the tendon of the long head of biceps femoris. (Gray H, 1993)

[209] The longissimus thoracis and iliocostalis muscles originate from the posterior surface of the sacrum, from the posterior layer of the thoracolumbar fascia.... and they extend upwards. (Baldoni CG, 1993)

The mediomotion sequence of the lower limb

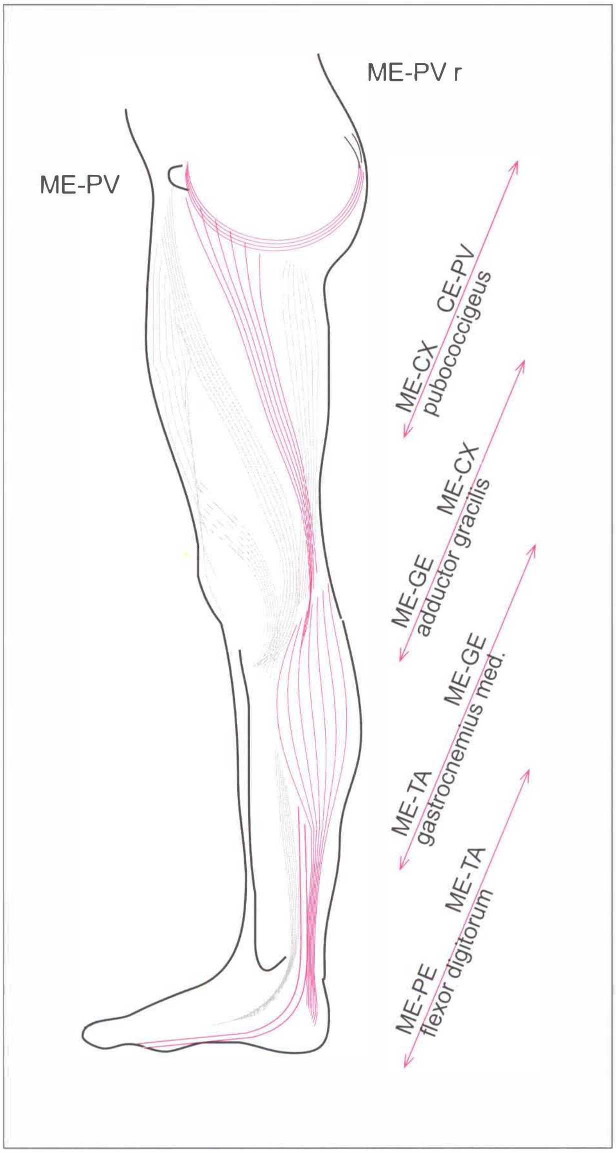

Figure 109. The mediomotion sequence of the lower limb.

Mediomotion pes (me-pe) is equivalent to adduction of the fingers in the hand. The muscles that move the toes medially are the plantar interossei, opponens digiti minimi (part of flexor digiti minimi) and adductor hallucis (Figure 109). These three muscles are arranged in three different layers of the plantar fascia and they all adduct the sole of the foot. They originate directly from the plantar fascia with a number of fibres or from its ligamentous expansions[210] and for this reason they are to be considered distal tensors of the mediomotion sequence. The deep plantar fascia, which is in contact with the plantar interossei muscles, forms the transverse ligament of the metatarsal heads anteriorly and, posteriorly, it continues with the fasciae adjacent to the tendons of flexor digitorum longus. Flexor digitorum longus originates from the tibia and the deep fascia of the leg[211]. This fascia continues above with the deep lamina of the popliteal fascia (Figure 110) onto which the gracilis muscle sends some tendinous expansions[212]. The muscles that insert into the medial condyle collaborate in stabilising the knee medially. As in the elbow, in the knee there is no true movement of mediomotion but myofascial continuity ensures and coordinates medial stability. The gracilis muscle is surrounded by a fascial sheath that accompanies it from the pubis to the tibia. This muscle is biarticular and participates in medial stability at the knee and mediomotion of the thigh. The fascial sheath of the adductor muscles of the thigh is tensioned proximally by muscular fibres from the rectus abdominis[213].

The fascial insertions of muscular fibres have been generally ignored in the past, due to the fact that only insertions onto bone were examined as a means of determining muscular activity. Because they only tension elastic structures, the bundles of fibres of the fascial tensors are naturally much smaller than those of muscles inserted onto bone, which must lift many kilograms, or even tonnes.

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[210] The opponens digiti minimi originates from the plantar ligament and inserts into the 5° metatarsal. The adductor hallucis originates from the long plantar ligament and it extends forwards and medially. (Baldoni CG, 1993)

[211] Flexor digitorum longus originates from the posterior surface of the tibia and from the fascia that covers the tibialis posterior muscle. (Gray H, 1993)

[212] The gracilis muscle originates via a thin aponeurosis from the medial and inferior border of the pubis and from the superior ramus of the ischium; it inserts beneath the medial condyle of the tibia. A small number of fibres continue distally with the fascia of the leg. (Gray H, 1993)

[213] The rectus abdominis terminates at the pubic crest; a medial strip of the tendon from both sides crosses in front of the symphysis pubis and fuses with the fascial sheath of the adductor muscles. (Chiarugi G, 1975)

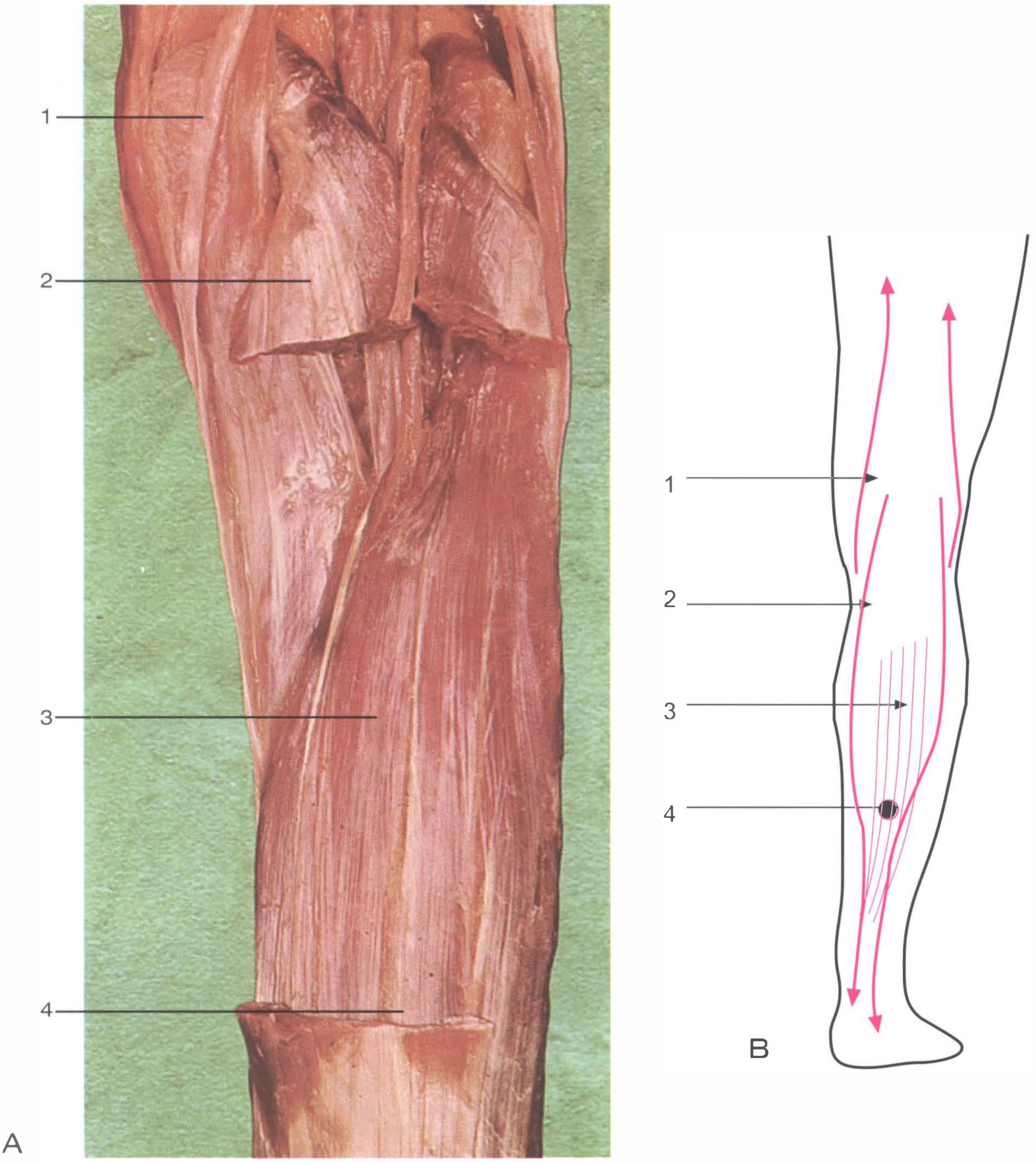

Figure 110. A - Epimysial fascia of the soleus. (from Fumagalli - Colour photographic atlas of macroscopic human anatomy; - Published by Dr. Francesco Vallardi/Piccin, Nuova Libraria). B - Diagram of the tensile concatenation of the retromotion sequence.

1, The semitendinosus tendon which, together with gracilis, tractions the popliteus fascia proximally (deep lamina); the latter is continuous with the fascia of the leg (deep lamina) that terminates in the medial part of the talus (me-ta); 2, Sectioned medial head of gastrocnemius highlights the underlying soleus covered by its epimysial fascia, or retaining fascia. The gastrocnemii are inserted onto the popliteal fascia (superficial lamina) and they tension it distally. 3, the epimysial fascia of the soleus with its collagen fibres aligned according to traction of the underlying muscular fibres; they are all longitudinal, unlike the multi-directional fibres of the deep fascia (superficial lamina). The fascia is less transparent here due to hypertrophy of the collagen fibres; 4, the myofascial vectors of retromotion talus (re-ta), formed by biarticular fibres (gastrocnemii) and monoarticular fibres (soleus), converge at this point; this cc appears to be over the musculotendinous part of the gastrocnemius but, like all segmentary cc(s), its location is in relation to the monoarticular fibres, namely the muscle belly of soleus.

The lateromotion sequence of the lower limb

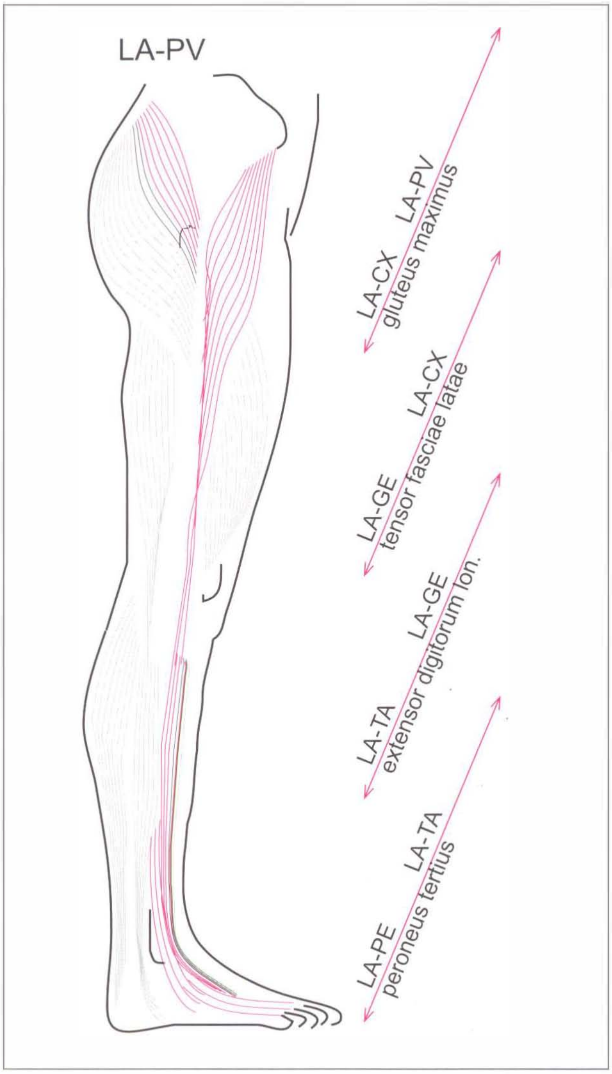

Figure 111. The lateromotion sequence of the lower limb.

Lateromotion of the pes (foot) (la-pe), being the equivalent of abduction of the fingers in the hand, involves the dorsal interossei muscles of the foot (Figure 111). These muscles are connected to the deep dorsal fascia of the foot. Contraction of the dorsal interossei tensions this fascia[214] distally, whereas proximally it is tensioned by the peroneus tertius and extensor digitorum muscles. Both of these muscles originate with a number of fibres from the anterior intermuscular septum and the fascia of the leg[215] and their synergic activity also effectuates lateromotion talus (la-ta). Hence, during lateromotion talus the proximal lateral fascia of the leg is tensioned. A tendinous expansion of the iliotibial tract of the tensor fascia lata muscle inserts onto this fascia[216]. The tensor fascia lata is equivalent to the gracilis muscle from the sequence of mediomotion, in as much as it is biarticular and effectuates lateromotion coxa (la-cx) as well as stabilising the knee laterally (la-ge)[217].

The tensor fascia lata muscle tensions the lateral fascia of the leg via the iliotibial tract. It also tensions the fascia lata itself by means of a number of its fibres that originate from the iliac crest and insert directly into the overlying fascia lata. The gluteus maximus inserts onto the iliotibial tract and thereby participates in both lateromotion coxa (la-cx) and lateromotion pelvis (la-pv). In this way pelvic lateral stability is synchronised with the lateral stability of the lower limb[218]. However, because this sequence, especially in its distal part, contains very few muscular fibres frequent sprains of the lateral ligaments of the ankle occur when the foot is placed incorrectly.

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[214] The deep dorsal fascia of the foot is in close relationship to the dorsal interossei muscles and the dorsal surface of the metatarsal bones, such that it is called the dorsal interossei fascia. (Testut L, 1987)

[215] The peroneus anterior or tertius originates from the fibula and the anterior intermuscular septum. It inserts into the base of the fifth metatarsal; usually a thin expansion extends distally along the shaft of this bone. The extensor digitorum longus originates... from the fascia of the leg and from the anterior septum. Its distal digital expansion receives some fibres from the interossei muscles. (Gray H, 1993)

[216] Incidentally, it needs to be stressed that over the lateral part of the patellar region, the fascia of the knee is reinforced by tendinous fibres of the tensor fascia lata muscle constituted by the iliotibial tract, or Maissiat's band. These fibres are classified according to their insertion : posterior, that run longitudinally to insert partially onto the head of the fibula, deep anterior fibres that insert into the ligamentum patellae; superficial anterior fibres forming a fan-shaped expansion that extends to the medial side of the knee. (Testut L, 1987)

[217] The tensor fascia lata originates from the iliac crest and the deep surface of the fascia lata. It extends distally between the two laminae of the iliotibial tract of the fascia lata to which it is also fused. By way of the iliotibial tract it fixates the femoral condyles of the tibia. (Gray H, 1993)

[218] The superficial part of gluteus maximus originates from the iliac crest and from the thoracolumbar fascia; its proximal part extends into the iliotibial tract. (Platzer W, 1979)

The intrarotation sequence of the lower limb

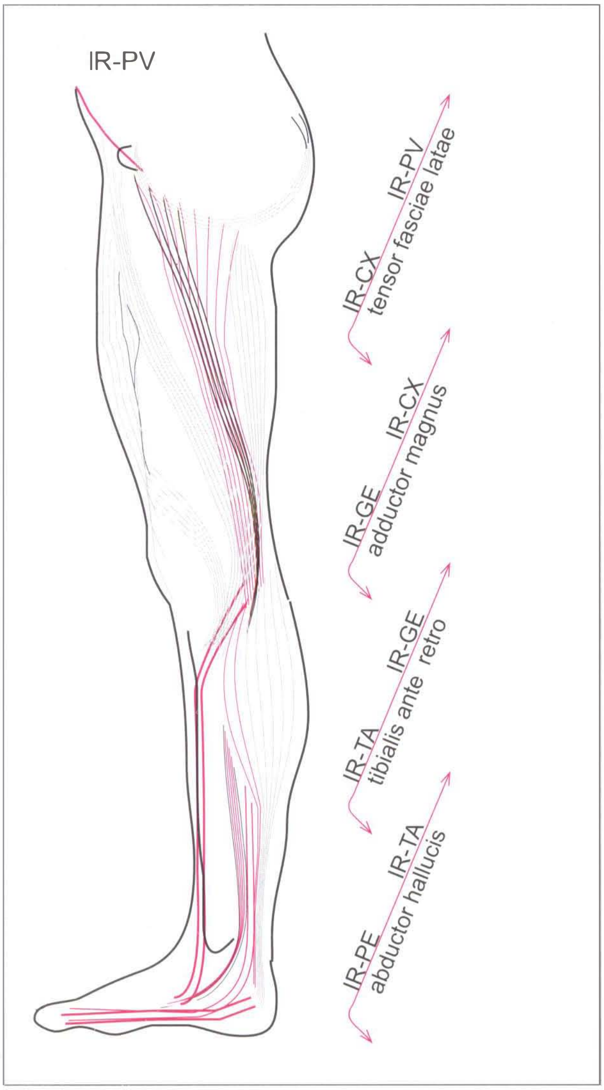

Figure 112. The intrarotation sequence of the lower limb.

Intrarotation of the pes (foot) or internal deviation of the forefoot is effectuated chiefly by the abductor hallucis (Figure 112). If this were the only motor function of abductor hallucis then its origin from the medial process of the tuber calcanei would have been sufficient. However, this muscle tensions the fascia of the leg therefore it also originates from the deep surface of the fascia as well as from the flexor retinaculum[219]. This retinaculum is formed by two layers: the superficial that extends into the medial compartment of the abductor hallucis (ir-pe) and the deep layer that is continuous with the middle compartment of the foot (me-pe).

Intrarotation talus (ir-ta) is effectuated by the two tibialis muscles and flexor hallucis longus. These muscles are inserted onto the overlying fasciae[220] therefore, when they contract, they tension the fascia of the leg distally. This fascia is tensioned proximally by the muscles that insert below the medial condyle of the tibia and effectuate intrarotation genu (ir-ge).

A few fibres of the sartorius muscle[221], along with a few fibres of tensor fascia lata, extend over the fascia of the tibialis anterior. The tensor fascia lata participates in intrarotation coxa together with adductor magnus[222]; the cc of ir-cx is located above the pubic portion of the adductor magnus. The inguinal ligament acts as a mediator between the medial and lateral intrarotatory forces of the thigh.

The mf unit of intrarotation pelvis is located beneath the anterior superior iliac spine. The tensor fascia lata originates from this bony protuberance and when the thigh is in an open kinetic chain, it effectuates intrarotation coxa. It effectuates intrarotation pelvis (ir-pv) when the leg is firmly placed on the ground i.e. closed kinetic chain. The brain does not distinguish between these two mf units therefore the activation of one or the other depends upon the stretch to which the leg and pelvis is subjected.

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[219] The medial annular ligament (or laciniate ligament or flexor retinaculum) surrounds the abductor hallucis in a sort of fold. This ligament is continuous proximally with the deep compartment of the posterior region of the leg; distally it is continuous with the medial and middle compartments of the sole of the foot. (Testut L, 1987)

[220] The tibialis anterior originates from the condyle...from the interosseus membrane, the fascia of the leg and from the septum that separates it from extensor longus.

Flexor hallucis longus originates from the posterior surface of the fibula...from the overlying fascia and from the intermuscular septum. (Chiarugi G, 1975)

[221] The anterior fascia of the knee is reinforced medially by fibres of the sartorius muscle. The terminal tendon of this muscle is extensive and it fuses with the fascia, forming the superficial layer of the bursa between the insertions of semitendinosus and gracilis. (Testut L, 1987)

[222] The adductor magnus originates from the anterior surface of the pubis and the inferior ramus of the ischium, from the ischial tuberosity. The part that inserts towards the medial condyle acts as an internal rotator. (Platzer W, 1979)

The extrarotation sequence of the lower limb

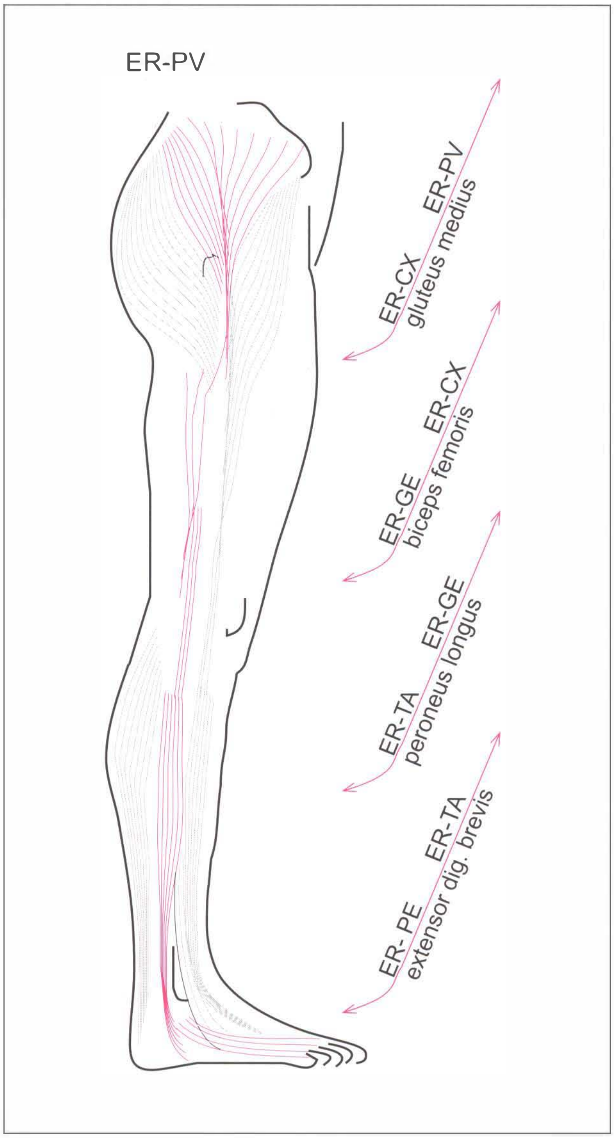

Figure 113. The extrarotation sequence of the lower limb.

Extrarotation of the pes (foot) (er-pe) or lateral deviation of the forefoot is effectuated by extensor digitorum brevis[223]. Like the abductor hallucis this muscle originates from the anterior part of the calcaneus (floor of sinus tarsi), from the lateral part of the inferior extensor retinaculum and from the interosseus talocalcaneal ligament[224] (Figure 113). This ligament is a part of the group of ligaments that unite the talus to the other tarsal bones[225].

The tendons of the peroneus longus and brevis are the proximal tensors of these fibrous structures because they are connected to them via the mesotendineum.

In the leg, the peroneus longus and brevis muscles are surrounded by the fascial compartment of the same name. These muscles extrarotate the talus (er-ta) and some of their fibres originate from the overlying fascia, hence they are the distal tensors of the peroneal fascia[226].

Proximally, the fascial compartment of the peronei is tensioned by a number of fibres of biceps femoris that are inserted onto this fascia[227]. The biceps femoris is the primary external rotator of the knee (er-ge). The short head of biceps femoris is inserted into the lateral intermuscular septum, which forms the anterior part of the fascial sheath of the biceps femoris. This sheath fuses with the deep gluteal fascia in the proximal part of the coxa. The deep gluteal fascia overlies the mf unit of extrarotation coxa (er-cx) formed by the quadratus femoris, obturators, piriformis and gluteus muscles. The gluteus medius and minimus also participate in extrarotation pelvis (er-pv) and due to a number of fibres inserted onto the overlying fascia they are to be considered the proximal tensors of the extrarotation sequence[228].

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[223] The extensor brevis (pedidio m.) extends the first phalange of the four medial toes vigorously and it pulls them laterally. (Chiarugi G, 1975)

[224] The interosseus talocalcaneal ligament is situated in the sinus tarsi and its medial fibres are tensioned during eversion. (Gray H, 1993)

[225] The ligaments that unite the talus to the other tarsal bones are: the dorsal talonavicular ligament, the interosseus talocalcaneal ligament, the lateral and medial talocalcaneal ligaments, the posterior tibiofibular ligament. (Platzer W 1979)

[226] The peroneus longus originates from the head of the fibula, the deep fascia of the leg and both the anterior and posterior intermuscular septa. The peroneus brevis originates from the lateral surface of the fibula and from the anterior and posterior intermuscular septa. (Gray H, 1993)

[227] Many muscles of the thigh, especially the semitendinosus, gracilis and biceps femoris extend numerous reinforcing fibres onto the fascia and in this way become tensor muscles of the fascia. (Testut L, 1987)

[228] The anterior two-thirds of the gluteus medius is covered by deep fascia from which numerous muscular fibres originate. Gluteus minimus can be divided into an anterior part and a posterior part. It can unite, by means of separate fascicles, to the piriformis and superior gemellus muscles. (Gray H, 1993)

Chapter 14

MANIPULATION OF THE MF SEQUENCES

In this chapter the procedure to follow for the assessment and treatment of musculoskeletal dysfunctions involving more than one segment will be discussed. A predominant pain in one segment together with concomitant minor pains in other segments is a much more common occurrence than pain in one segment alone. In the case of widespread pain not all densified centres of coordination are to be treated but an accurate analysis of the distribution of pain is always necessary prior to commencing treatment. Analysis might reveal that:

- Various painful areas are distributed along a sequence: for example, if pain is localised in the lateral part of the shoulder, elbow and wrist then one could hypothesise a dysfunction of the lateromotion sequence of the upper limb.
- Various painful areas are distributed on one plane: for example, pain in the right side plus lateral right thigh and medial lower leg, then one could hypothesise a dysfunction on the frontal plane.

Accurate compilation of the assessment chart is required in order to decide which of the above forms of compensation the body has chosen to counterbalance a fascial densification.

Compilation of a global assessment chart

The procedure for the compilation of this assessment chart is similar to that applied in cases of segmentary dysfunctions but the examination now takes into consideration the following three elements:

1. Existing connections between the concomitant painful areas: are they distributed along a sequence or on one plane?
2. The cause and effect relationship between concomitant painful areas: which was the first pain to cause these compensations?
3. Existence of silent compensations that contribute to the predominant pain: which is the hidden point that interferes in re-establishing postural balance?

Data

The predominant pain is often the last link in a chain of compensations. For example, if a patient complains of tendinitis in one elbow, investigations should not to be limited to that one segment otherwise it is likely that treatment will only be partially beneficial. Analysis has to be extended to concomitant pains and previous disturbances, in order to disclose the pathway of compensations that have led to the present pain.

Compensations and counterbalancing

A fascial compensation is the body's attempt to alleviate or eliminate pain. The initial pain is produced by densification of a cc and the body tries to neutralise this pain by establishing a tensile balance along the sequence. This involuntary physical process alleviates the pain but actually causes an imbalance in the tensile harmony of the fascia. Initially this imbalance is only along one sequence but, progressively, all of the sequences that control posture on one plane are involved. Furthermore, the

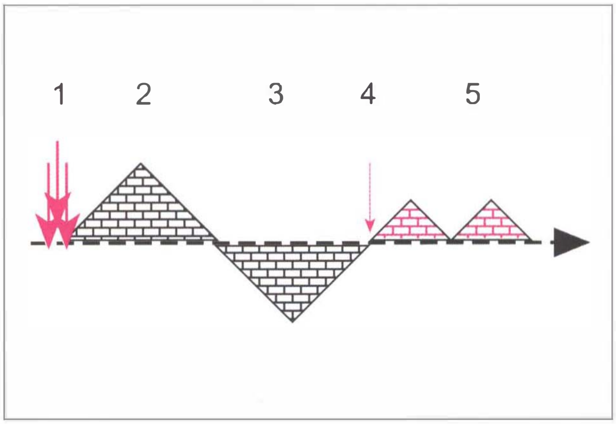

Figure 114. Compensations following densification of the fascia.

process of compensation is encouraged if analgesics are taken or if one simply waits for a spontaneous resolution of the pain instead of treating it as it manifests.

The process of fascial compensations and counterbalancing is similar to that of all other organs (Figure 114):

1. Repeated, or intense mechanical, chemical and thermal stresses (the first three arrows) can alter the normal elasticity of the fascia.
2. The densification of a cc provokes an initial local imbalance that manifests itself in the cp of the mf unit involved.
3. In an attempt to neutralise this pain the body counterbalances by creating a counter tension in the antagonist unit, or in a mf unit further along the same sequence.
4. This rather precarious counterbalance can easily decompensate in the presence of a minor trauma, or a hormonal or thermal stress (small arrow).
5. Patients tend to attribute the cause of the latest pain to the more recent trauma. It is the therapist's role to backtrack through the various traumas in order to restore fascial equilibrium.

Figure 115, demonstrates two feasible developments that the same trauma might exhibit over the period of one year.

The yellow line indicates the normal healing process: trauma to the soft tissues causes an inflammatory reaction that resolves itself completely over a period of about eight days.

The red line indicates the evolution of an abnormal reaction: local inflammation provokes an overreaction of the autonomic nervous system resulting in excessive densification of the fascia. After eight days the pain diminishes but a certain amount of motor deficit and perceptive impediment persists. After several months a minimal irritation of this fascia sets off a new inflammation, which will be resolved by more fibrosis. The pain is now chronic with exacerbations becoming increasingly frequent.

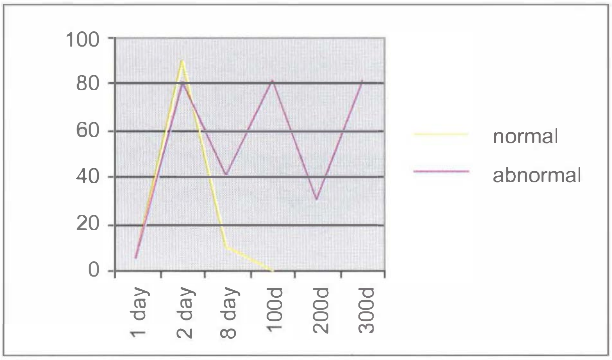

Figure 115. Evolution of the healing process.

It is a fairly common practice to avoid treatment in the acute or inflammatory phase. It would be advantageous, however, to be able to intervene in this phase in order to provide early relief to acute periarthritis, acute lumbalgia and sprained ligaments. With Fascial Manipulation early intervention is possible due to the fact that treatment is never applied directly to the inflamed point but only to points that lie proximally or distally. Obviously only the selection of the most appropriate point along the most appropriate sequence will alleviate suffering. A 10 % reduction in pain signifies that only the general fascial tension has been relaxed[229]. Confirmation of the successful localisation of the specific problem occurs when a reduction of more than 50% of the pain present prior to treatment is obtained.

Concomitant and previous pain

Once a patient decides to seek treatment for a predominant pain he/she often forgets about, or does not report, concomitant pain. For a fascial therapist these minor painful areas are useful in indicating the disturbed sequence or plane. The following questions are designed to draw the patient's attention to disturbances that might otherwise be considered unimportant.

- "Do you have any other pain in the same limb/body part?"
  These questions should be presented impartially without leading the patient into confirming one's hypotheses. For example, if the person has been diagnosed with epicondylitis and the sequence of lateromotion is hypothesised then leading questions such as " Do you also have a pain in the outer part of your shoulder?" are to be avoided. A question such as "Can you indicate precisely, perhaps with your finger, where the pain is?" is preferable in this case. If all of the concomitant pain is localised along the lateral part of the limb/segment then a disturbance along the sequence of lateromotion can be hypothesised; if

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[229] In some cases it can be sufficient to penetrate any point of the part to be cured with a needle, for example an arm or a leg, in order to alleviate the symptoms. (Mann F, 1995)

all of the pain is along the anterior part, then an involvement of the sequence of antemotion can be hypothesised and so forth.

- "Do you have any pain in another part of your body?"
  This question is to verify if any compensations have formed outside of the sequence, affecting the overall tensile harmony of the fascia that controls posture on one plane. The patient must indicate exactly where the pain is localised. For example, in the case of a painful knee, indicate precisely which part of the knee. With reference to the previous example of epicondylitis, if this secondary knee pain were on the medial or lateral sides of the joint (sequences of mediomotion and lateromotion) then this could confirm an imbalance on the frontal plane.
- " In the days prior to this particular pain did you have any other pain (s)?"
  Patients often think that a past pain is an eliminated pain, but a previous pain (PaPrev), which is now dormant, is frequently the cause of a present acute pain. The fascia often repairs a trauma with an excess of fibres and densification. Once this restrictive repair has been established the fascia can neutralise this localised lack of elasticity by extending tension along the same sequence. Neither the body nor pharmacotherapy produce substances that destroy the fibres in excess because they are normal collagen fibres and are not recognised as being inappropriate.
- " In the previous months or years have you had any fractures, dislocations or operations (of the locomotor apparatus)?"
  Often patients forget about pain they experienced only a few days before, therefore they certainly need help in recalling pain experienced in the more distant past. This memory void can even relate to important traumas such as fractures and operations. The therapist can omit recording past traumas that have been perfectly resolved within normally sanctioned time spans. However, if complications occurred, lengthy recovery time was required or permanent articular or postural disability ensued, then further questioning is necessary to understand the eventual compensatory pathways.
- " Do you have, or have you had in the past, any pins and needles, cramps, numbness or deformities in your hands and feet?"
  We have seen that each sequence terminates in a specific finger or toe. Therefore, it is natural that an attempt to compensate a densification can get to the stage of involving the terminal part of a sequence. A restriction of the distal fascia initially disturbs the neuroreceptors, which, subjected to abnormal traction, will then transmit distorted afferents. At times the fascial tension is such that a minor drop in temperature, as occurs when one is resting, can set off a cramp-like pain.

Hypothesis

Initially it can be useful to record the hypothesis on the assessment chart because it helps the therapist to develop objectives and a therapeutic plan. After some practice it becomes unnecessary because the hypothesis can vary continuously during the movement assessment.

In the specific case of manipulation of the sequences, in the presence of concomitant pain in a number of segments, the fascial therapist is faced with several questions:

1. Are these pains distributed along one particular sequence? Which one?
2. Are these pains distributed over one particular plane? Which one?

In the case that the first hypothesis is confirmed then the factors to consider are:

- which proximal and distal segments of this sequence are to be tested?
- has the antagonist sequence developed silent or dormant tensions?

In the case that the second hypothesis is confirmed then the following factors are to be considered:

- which segments on this plane have initiated the imbalance?
- which cc on this plane can be manipulated without causing excess imbalance to the bodily structure?

At the beginning, the idea of all these variables can discourage a therapist starting out with Fascial Manipulation but, with practice, these steps become almost automatic. The formulation of a hypothesis is certainly the most difficult part of the technique. Throughout the assessment the therapist must choose between the visible variables; throughout the treatment tactile information is elaborated; in the phase of the hypothesis the therapist has to extract an indication from infinite variables. This is due to the fact that pain in itself does not exist but only the individual, with an individual variety of pain. If we consider that the more than one hundred cc(s) in one half of the body can associate themselves differently from one case to another, then we can comprehend the number of variables that can occur.

Verification

The segmentary movement assessment verifies the mobility of only one joint on all three planes of movement. The most painful movement or direction indicates which cc requires treatment.

In the global verification two or more articulations are examined (Table 14) and their mobility is compared on all three planes of movement. The most painful movement in the majority of segments indicates the sequence or the plane of movement to be treated.

Table 14. Grid for the global movement assessment

frontal plane.	*sagittal plane*	*horiz. plane*
LA-CL	RE-CL *	ER-CL
LA-TH	RE-TH **	IR-TH *
LA-LU	AN-LU **	ER-LU

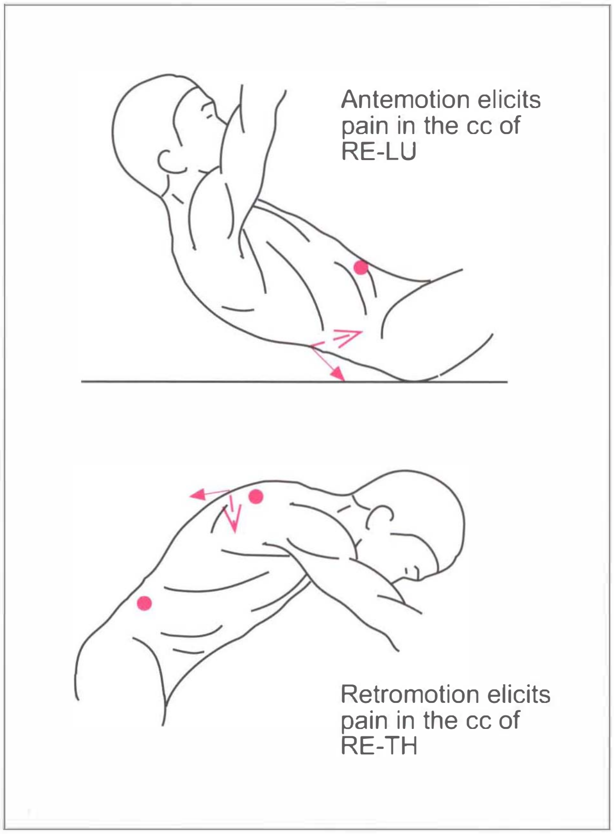

Figure 116. Movement assessment and treatment of the sequences on the sagittal plane.

For the global movement assessment the following segments are normally examined:
- the upper limb: the humerus and the carpus;
- the lower limb: the coxa and the talus.
- the trunk: the collum and the lumbi.

The two most mobile segments are chosen because pain along a sequence or on a plane of movement involves all segments to some extent. Furthermore the scapula, cubitus, digiti, pes, thorax, pelvis and genu segments give fewer indications because their principal movements occur on one plane. In the case of doubt a third segment may be examined. The more mobile articulations are used for the following reasons:

- The impeded direction can best be determined by examining joints that are free to move on all three planes. A patient might arrive with pain in the pelvis, or the genu, but the lumbi and the coxa are assessed and in case of doubt, the genu (knee) will be examined.
- By testing non-painful joints then silent cc(s) are more easily revealed. For example, pain in the pelvis or the knee can be the latest counter compensation, the cause being the now silent lumbar segment.

If, during the movement assessment of the lumbi on the three planes, for example, pain in lateromotion is revealed, it may well be a movement that the patient unconsciously avoids in daily life (silent cc). Silent cc(s) have not necessarily been treated hence they develop stable compensations over time. Silent cc(s) should be located and treated especially when a pain relapses frequently.

The movement assessment for sequences and planes uses essentially the same procedure as the segmentary assessment, except that more segments are compared to one another (Table 14).

In the grid only the most painful movements are recorded and not all of the movements that are examined i.e. an-cl, re-cl are not recorded even though they are both examined, only re-cl because it is the most painful.

Treatment of the sagittal plane is indicated here because, in the middle column, retromotion thorax and antemotion lumbi have been marked with two asterisks (**).

The movement assessment (Figure 116) indicates the plane of movement and the palpation assessment will indicate the cc(s) to be treated on that plane.

The palpation assessment in global treatment is identical to that of the segmentary treatment except for the fact that instead of comparing the cc(s) of a single segment, all of the cc(s) of the implicated segments are assessed. Whilst on the assessment chart the grid itself may become superfluous, in clinical practice the assessments should never be overlooked.

Treatment

Treatment of the sequences is characterised by the fact that the cc(s) selected for treatment must enter into a plan for restoring global postural equilibrium.

For example, in the case of a patient with pain in the neck, thorax, lumbar and thigh regions (collum, thorax, lumbi, coxa) involving primarily the sagittal plane, obviously not all of the implicated cc(s) can be treated. A selection needs to be made:

- Choose a proximal cc and a distal cc. A distal cc and a proximal cc of the two sequences of retromotion (re-lu and re-ta) can be treated simultaneously in order to release fascial tension (Figure 117).
- Choose one or more cc(s) of the antagonist sequences i.e. antemotion trunk or lower limb. This choice is made during the movement assessment. For example, if antemotion lumbi accentuates the pain in the lumbar region then treatment is directed to antemotion lumbi (an-lu).

When these silent cc(s) are discovered, the patient often recalls a trauma or disturbance that they had previously forgotten e.g. "Oh, in the past I have had pain in the abdomen but I always thought that it was colitis".

After having manipulated two points then it is useful to re-assess the outcome of one's therapeutic plan. If symptoms have improved then it can be taken as an indication to continue with that sequence or plane, otherwise it is best to re-elaborate one's choices.

The following example illustrates the most frequent cc(s) that are treated in one common global dysfunction: back pain with right leg symptoms. It can be noted that the same dysfunction can be caused by compensations on any spatial plane.

Frontal plane (Figure 118):
- Back pain with right leg symptoms: la-lu lt, *me-cx bi*, la-ge, la-ta rt.

Sagittal plane:
- Back pain with right leg symptoms: re-lu bi, *an-ge rt, re-cx , re-ta rt*

Horizontal plane:
- Back pain with right leg symptoms: er-th rt, *ir-lu lt*, er-pv rt, ir-ge, ir-ta rt

Figure 117. Palpation-manipulation effectuated with the ulnar border near the elbow. The muscular masses of the thigh and the trunk are palpated and treated with the elbow. After some practice, alterations in fascial fluidity can be preceived even with the elbow. Penetration between the tissues is varied according to the angle of flexion of the elbow. In this photograph the cc of RE-LU is being treated.

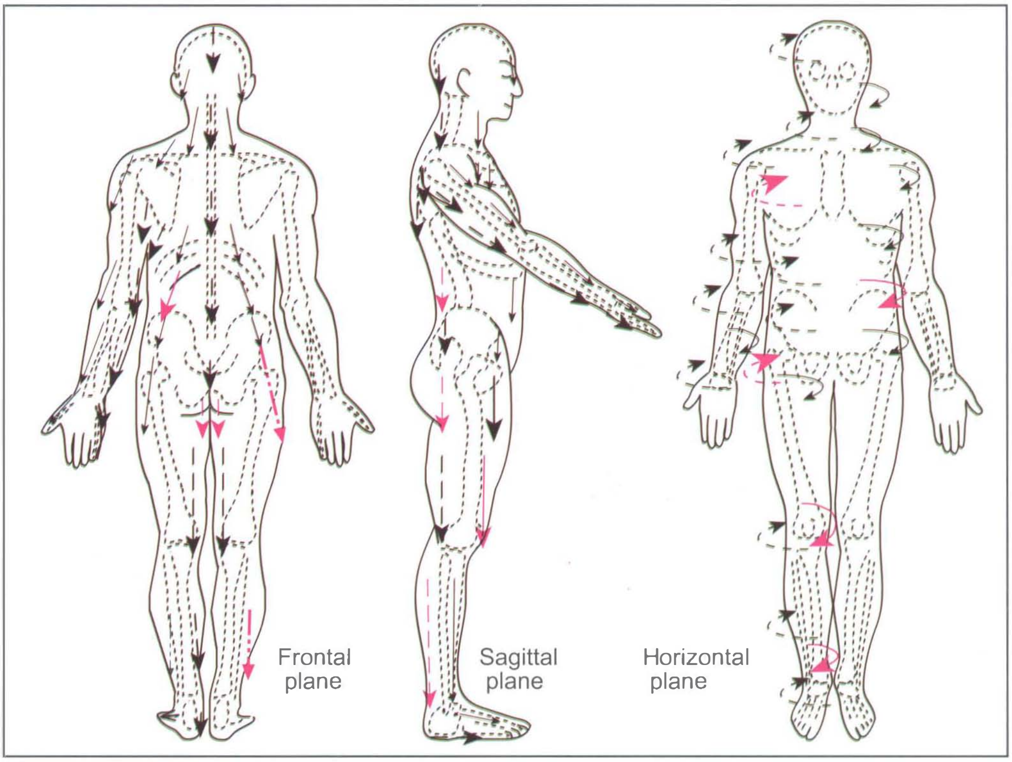

Figure 118. The most frequent cc's that are treated in one common global dysfunction: back pain with right leg symptoms (sciatica?).

The silent cc(s) are recorded in italics. These are points that the patient has not previously noticed were painful but they are often very useful in resolving fascial imbalances. These points are deduced from the patient's symptoms and can be traced using one's knowledge of the continuity of the sequences on the three planes.

All of the above points are treated with a deep prolonged pressure because they have accumulated an excess of collagen. This type of manipulation aims to dissolve the densification that impedes gliding movements between fasciae and the bundles of endofascial fibres. During treatment the patient often reports a pain that radiates along the sequence. When a point has been dissolved then the patient notes that the local tension, as well as the general tension along the sequence, has been alleviated.

How and where Fascial Manipulation works

Fascial Manipulation affects principally the ground substance of the fascia. The ground substance unites cells and influences their development, polarity and behaviour. It contains[230] various protein fibres interwoven in a hydrophilic gel composed of GAGs (glycosaminoglycans[231]). The constituent protein of these fibres can be divided into structural protein (collagen and elastin) and adhesive protein (fibronectin and lamina) (Table 15).

The GAGs are divided fundamentally into two groups: hyaluronic acid (not sulphate) and sulphate GAGs. The first is more abundant in the loose connective tissues and facilitates cell migration during morphogenesis and tissue repair processes. For example, it can increase or inhibit the activity of the fibroblast growth factor. The sulphate GAGs are

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[230] The macromolecular components of the extracellular matrix are produced by fibroblasts in connective tissues, chondroblasts in cartilage and osteoblasts in bone tissue. (Monesi V. 1997)

[231] Hyaluronic acid: a mucopolysaccharide that acts as a lubricant and shock absorber throughout the body. Hyaluronidase: a soluble enzyme suggested in the treatment of certain forms of arthritis to promote resolution of redundant tissue; it is used to accelerate the re-absorption of traumatic or postoperative oedema and haematoma. (Stedman's, 1995)

Table 15. Ground substance composition

Protein Fibres	Structural	Collagen Elastin
	Adhesive	Fibronectin Lamina
GAGs	Non sulphates	Hyaluronic Acid Chondroitin ac
	Sulphates	Chondroit. sul Dermatan-sul Keratan-sul

more common in dense packed connective tissues[232].

GAGs are very gelatinous and are responsible for the viscosity of the extracellular matrix[233]. Apart from hyalonuric acid, GAGs are attached to non-collagenous proteins forming macromolecules called proteoglycans[234]. GAGs can unite many ions and the nature and concentration of the electrolytes influences the macromolecular structure. This can vary from loose to twisted, with consequent changes in the viscosity of the solution. Furthermore, proteoglycans can interact via electrostatic attachments with collagen influencing the morphology and the function of the connective tissue fibres. Links between fibronectin and collagen can also be modulated by various GAGs[235].

In conclusion, densification of the ground substance hinders collagen fibre orientation in response to applied traction, as well as impeding aligned collagen fibres from gliding between one another. Diminished elasticity of the fascia determines incoordination between the muscular fibres of single mf units and between the mf units of a myofascial sequence.

This is where Fascial Manipulation intervenes, creating local heat through friction as well as a local inflammation. The heat immediately modifies the consistency of the ground substance. The inflammation intervenes in the following hours, as the extracellular proteolytic enzymes secreted locally from cells collaborate in the degeneration of matrix proteins (collagen and fibronectin)[236].

Turnover of collagen and other macromolecules of the extracellular matrix is normally very slow[237]. Hence, unless an external intervention such as Fascial Manipulation is applied, a patient could take years to recover from pain generated by a fascial densification and in the meantime, compensations and counter compensations multiply.

Case studies

In the following pages two examples of treatment will be presented: one involving dysfunctions along a myofascial sequence as well as involvement of the antagonist sequence; the other involving concomitant dysfunctions distributed in a number of segments on one plane.

Along the myofascial sequence

G.A., a twenty-five year old male suffering from sciatic-type pain over the last year, resistant to treatment of any kind.

The recorded data attested to the fact that he had never suffered from backache in the past and a CAT scan had excluded a prolapsed disc. The pain was localised along the right posterior thigh and calf (re-cx,-ta rt l y **). The pain began after a cross-country

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[232] GAGs of the connective tissues belong to two categories. The sulphate group comprised of chondroitin sulphate (cartilage) dermatan sulphate (dermas, tendons) keratan sulphate (cornea, dense packed tissue) heparan sulphate (basal membranes) ... (Monesi V.1997)

[233] A portion of scarred fascia dermatan sulphates chains demonstrated higher molecular weight compared with those from normal tissue. (Kosma EM, 2001)

[234] The non-structural collagens associated with fibrils mediate interactions between collagen fibrils and other macromolecules of the matrix. In this way they determine the organisation of the fibrils in the matrix. (Alberts B., 1996)

[235] Fibronectin is a protein that guides migration of embryonic cells in all vertebrates. It assists cells in uniting with the matrix. For this purpose, regulation must be precise, such that the migrating cells can adhere to the matrix without becoming completely immobilised by it. (Alberts B, 1996)

[236] An important proteinase involved in the degeneration of the matrix is the urokinase type plasminogen activator that accumulates in sites of inflammation and remodelling. (Alberts B, 1996)

[237] Regulation of macromolecular turnover in the extracellular matrix is crucial for many important biological processes. Even in the apparently static extracellular matrix of adult animals one can assist to a slow but continuous turnover due to phenomena such as degeneration and renewed synthesis. For example the collagen molecules from bone are degenerated and substituted about every ten years...Some metalloproteinases, such as collagenease, are highly specialised because they separate particular proteins in a small number of limited sites. (Alberts B, 1996)

run and since then it had never completely disappeared but it varied in intensity. The pain was accentuated by running and bending forward (PaMo: re).

Up until this point the assessment is similar to a segmentary assessment. The only difference is that two segments (cx, ta) are indicated as sites of pain and the pain is distributed in the posterior part (re) of both segments. This could already indicate the sequence of retromotion but this would mean that only the present situation was taken into account without considering the cause. Certainly by treating re-cx and re-ta it is likely that the patient would have some relief but at the first attempt at running it may well recur.

In reply to the generic questions "Do you have any pain(s) in another part of the body?" and "Have you ever had pain in the past in any part of your body?" the young man strongly denied both, as if to emphasise his state of good health. Responding to the more specific question " Did you ever have "growing pains" in your right knee when you were younger?" the young man recalled having had pain in his knee when he was ten years old (PaPrev: rt an ge 15y). In answer to the question "Do you have, or have you had in the past, any pins and needles, cramps, numbness or deformities (including corns) in your feet?" the patient recalled having had cramps in the lower leg three times over the last year (Paraesthesia = Par.: rt re ta cramp 3xy)

From this data it was possible to hypothesise that the spasm in the retromotion sequence had been determined by a compensation created by the antagonist antemotion sequence. The compensation between the antemotion and the retromotion sequence of the leg had not caused any problems for fifteen years. It had required an intense physical stress such as a cross-country run to decompensate the tensile equilibrium.

Having analysed this compensatory mechanism, it was easier to note any unconscious adjustments during the movement assessment and to find the most appropriate point straight away during the palpation assessment.

The movement assessment revealed pain along the posterior thigh during antemotion coxa/genu and the palpation assessment revealed densification of rt an-ge, re-cx and re-ta.

The first point to be treated was an-ge; the post-treatment movement assessment demonstrated that the pain in the posterior thigh had disappeared. The other two cc(s) were treated in order to complete the tensile balance.

As the patient was pain free after the first treatment the following advice was given: "When the treated points are no longer tender you can recommence running. The first run should be brief and you should stop if any pain reappears. Try again after two days and if the pain is felt again then contact me for a second appointment". The athlete called after ten days to say that he had some pain during the first run but during the following run no disturbance had been felt.

All on one plane

After a fall eight days previously Mrs. G. presented herself for treatment supporting her left arm with her right, apparently the only way to get some relief from an intense pain in her left shoulder. Radiographic checks had not indicated any bone lesions and she had been instructed to apply ice packs locally.

The subjective examination revealed that the pain was chiefly in the lateral part of the left shoulder, where movement was limited to lateromotion 30° and antemotion 50° (Table 16). For the patient this pain in the shoulder was the only important factor but, with insistence, she admitted to having some pain in the head and neck and that, over the last two years, she had suffered from pain in the lateral part of the right coxa. The pain in the thigh/hip was not continuous but it relapsed (rel) with a certain regularity once a month (1xm). In the past the patient had suffered from brief episodes of back pain but this problem had been completely resolved. Questioned about paraesthesia the patient immediately reported that, since her fall, a persistent pins and needles sensation on the radial side of her right hand had appeared (thumb and index).

From this data it was possible to hypothesise a global imbalance accentuated by the recent trauma. The shoulder sprain had been unable to find other compensations, so it had continued to cause acute

Table 16. Assessment with data that indicate a disorder on the frontal plane

SiPa	HU la lt 8d*** trauma
PaMo	LA-HU 30°, AN 50°
PaConc.	CL CP bi yy * CX la rt 2 y** rel 1xm,
PaPrev.	LU bi
Paraesthesia	Pins needles. DI I°, II° lt
Treatment	
1°	LA-CL bi ++hu, LA-CA lt//+hu
2°	LA-HU, SC, DI lt ++ //++hu
3°	LA-LU lt +, LA-CX rt +

pain. The counter compensations, both recent and past seem to have distributed themselves on the sagittal plane (retro lumbi, pins and needles I° digit), as well as the frontal plane (latero humerus, coxa, pins and needles II° digit). The blockage of the shoulder was in almost all directions hence it was not indicative at this point.

It was decided to use the movement assessment of the collum (neck) and coxa (hip) to analyse which of the two planes was more afflicted. This assessment clearly indicated that the counter compensation had developed on the frontal plane.

The decision was made not to treat the cc of lateromotion humerus first, as it would have been too painful, but to treat lateromotion collum (la-cl). Following dissolution of this cc an immediate benefit in the neck was noted and, above all, a marked decrease in shoulder pain as well. A release of the spasm in the fasciae on the frontal plane had allowed the inflamed part to find some compensation. In the first session a distal point along the same sequence was also treated: la-ca. The result obtained immediately after the first session (++hu) was not completely maintained over the following days (//+hu). In the second session, therefore, it was decided to treat the mf unit of lateromotion humerus, scapula and digiti. The immediate result was very good and after one week it had been maintained (//++hu).

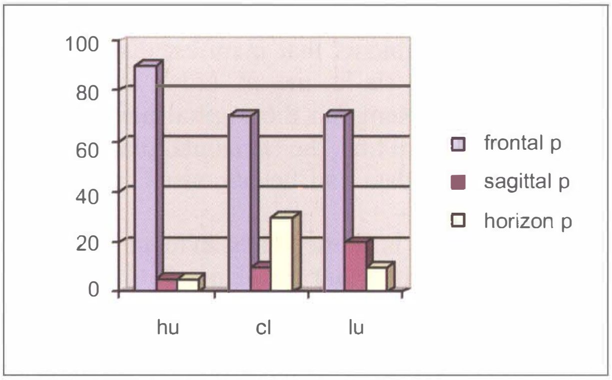

Figure 119. Percentage of pain in three segments during movement on the three planes.

In the third session an attempt to restore a general tensile equilibrium meant that the cc(s) of la-cx rt and la-lu lt were treated.

In order to facilitate *beginners* in the treatment of global fascial dysfunctions the assessment chart (Figure 189) can be modified by substituting the section " anamnesis loc. app." with a section for the

Figure 120. Palpation-manipulation using the olecranon of the elbow. Manipulation with the elbow is the most common technique used in treatment. Therapists should use the weight of their own body in order to reduce fatigue and to allow for the possibility to work on one point for a prolonged period. At times, patients prefer manipulation effectuated with the elbow because it acts over a greater surface. In this photograph the cc of LA-PV is being treated.

localisation of the pain. This box records: on the first line the segments that manifest disorders on the frontal plane (la-lu, me-cx, la-hu, cu); on the second line problems on the sagittal plane (an-cl, re-th); on the third line, the horizontal plane (er-ta).

Alternatively data can be organised in a graph (Figure 119).

In this way it is immediately evident on which plane the most important imbalance is to be found. If pain is localised in the medial or lateral zones then, in the first treatment session, the frontal plane is treated (Figure 120). In the following sessions, if necessary, other planes are treated. As the fascial therapist gains familiarity with this procedure then compilation of the section for the localisation of pain will no longer be necessary and this data can be recorded on the lines reserved for SiPa and PaMo.

Hopefully, in the future, it will be possible to develop an instrument that, like this manual technique, is able to restore fluidity to the ground substance in a less painful way. The author encourages all therapists to experiment new methods for inactivating cc(s), based on their own specific experience and expertise, utilising the various modalities at their disposal.

PART III
THE MYOFASCIAL SPIRAL

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Chapter 15
THE ANATOMY OF THE MYOFASCIAL SPIRAL

In the first part of this book the mf unit has been discussed. It is regarded as being the result of the tension that unidirectional motor units exert on the fascia. The mf units are involved, above all, in the motor organisation of single segments.

In the second part the mf sequence was taken into consideration. It is regarded as being the result of the tension that unidirectional mf units exert on the fascia. The mf sequence influences, principally, postural control.

In this third part the mf spirals will be analysed. They are considered to be the sum of the helicoidal tensions that the cc(s) of fusion exert on the fascia. These components intervene in the regulation of complex motor activities or gestures. The mf unit utilises the deep collagen fibres, the sequence utilises the longitudinal fibres of the fascia and the mf spirals utilise the oblique fibres (retinacula)[238].

All of these fibres must be able to glide independently from one another within the ground substance. This independence has become so reinforced in the transversal fibres that in some parts they have formed retinacula that are separable from the fascia[239]. A retinaculum is formed by a network of fibres that cross over each other and at the same time slide independently from one another[240].

This complexity of fibres would not be necessary if the only role of the retinacula were to bind the tendons close to the bones. There are elements that, in addition, induce one to hypothesise other functions for the retinacula:

- The superior retinaculum of the extensor muscles of the foot is situated in the inferior third of the leg where the tendons do not bend like they do under the inferior retinaculum.
- If the only role of the inferior retinaculum of the foot were that of restraint then all of its fibres would be inserted onto bone. Instead many fibres are continuous with the posterior fascia[241].
- Around the knee the patellar retinaculum and the popliteal retinaculum do not maintain any tendons close to the bone.
- At the wrist the transverse carpal ligament restrains the flexor tendons whilst the flexor retinaculum is effectively independent.

Close study of the connections that exist between retinacula and tendons[242, 243] has lead to the hypothesis of their participation in the organisation of the peripheral motor system (Figure 121). Retinacula are present in all articulations, they are connected to tendons and are more or less evident, depending on the load to which they are subjected.

The collagen fibres of the retinacula do not stop

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[238] With regards to the structure of the antebrachial fascia it is constituted mostly by transversal fibres that cross each other at various angles, from vertical and oblique fibres. (Testut L, 1987)

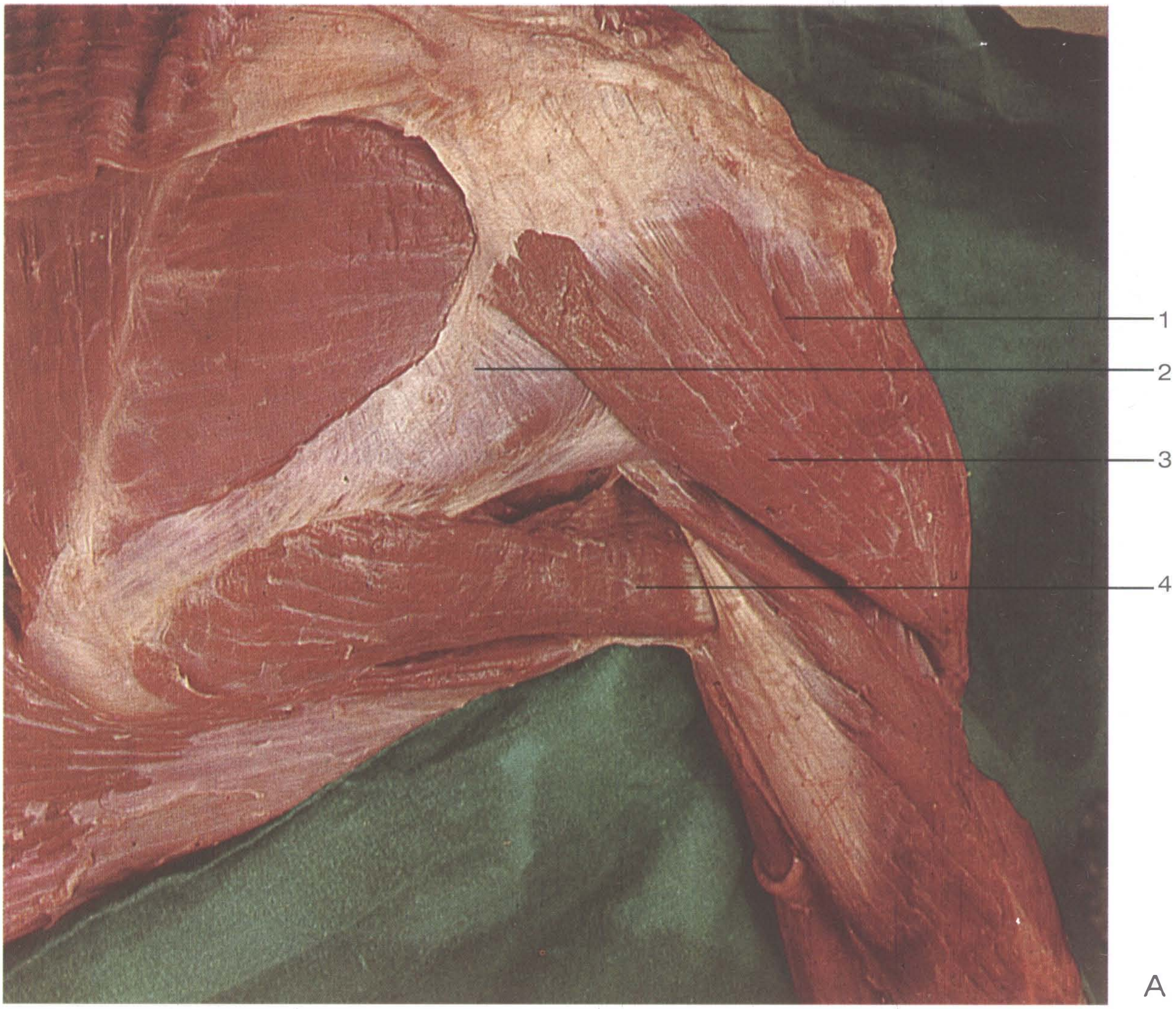
[239] The superior and retinaculum of the extensor muscles and the inferior retinaculum of the dorsal region of the tarsus can be isolated by dissection from the fascia. (Platzer W, 1979)

[240] Three distinct layers are identified in the retinacula of both the ankle and wrist: the inner gliding layer, with hyaluronic acid-secreting cells; the thick middle layer contains collagen bundles, fibroblasts, and interspersed elastin fibers; and the outer layer consists of loose connective tissue containing vascular channels. This basic 3-layered histological composition of the extensor retinaculum is repeated in anatomic pulleys throughout the body. (Klein DM, 1999)

[241] At other times almost all of the tibial insertions of the retinaculum are absent and the ligament continues on with the posterior fascia of the leg. (Testut L, 1987)

[242] Dissections of the fiber orientation and interconnections of the lateral knee retinacula in 23 cadaver knees and one fresh knee demonstrate a superficial, oblique retinacula ligament running from the fascia lata to the patella. Deep to this structure are a separate distinct transverse band to the patella, a condilopatellar and a patellatibial band. (Fulkerson JP, 1980)

[243] The lateral ulnar collateral ligament adheres closely to the supinator, the extensor muscles, the intermuscular fascia and the anconeus muscle and it lies posterior to the radial collateral ligament. (Imatani J, 1999)



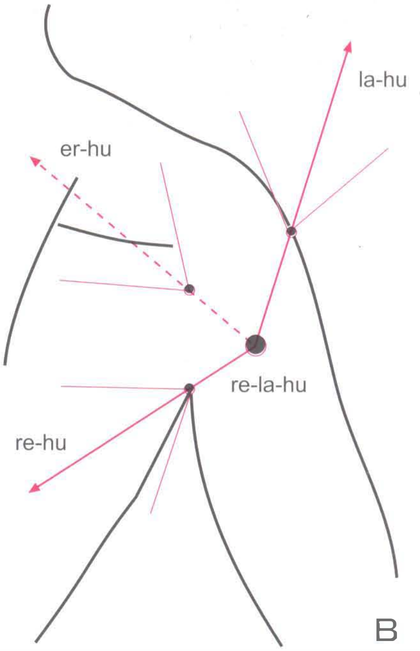


Figure 121. A - Dorsal side of dissected shoulder muscles (from Fumagalli - Colour photographic atlas of macroscopic human anatomy. - Published by Dr. Francesco Vallardi/Piccin, Nuova Libraria), B - Diagram that demonstrates the intermediate position of the cc(s) of fusion as compared with the segmentary cc(s). 1, Deltoid fascia: the cc of la-hu, collocated on its lateral border, is formed by the vectors of long head of biceps and the medial fibres of deltoid m.; 2, Infraspinatus fascia: becomes aponeurosis in the zone where infraspinatus m. inserts and, together with deltoid, forms the cc of er-hu; 3, Cc of fusion that actuates the motor scheme of re-la-hu. The resultant is situated higher or lower depending on whether retromotion or lateromotion prevails. If the mf unit of retro and latero work with the same force then the resultant of the mf unit of er-hu coincides with the resultant of the cc of fusion re-la-hu; 4, Cc of re-hu, point of convergence formed by the vectors of latissimus dorsi, teres major and long head of triceps.

at joints but continue, in a helicoidal pattern, along the various fasciae[244].

Segmentary motor schemes

Before analysing the fascial spirals, the foundations on which they are based need to be studied, namely: the motor schemes, the mf units of fusion, the cc(s) of fusion and the motor diagonals.

To move a limb on one plane the mf sequences utilise the segmentary mf units; in order to control a complex motor activity the spirals utilise the intermediate muscle fibres, fusing them together in a new mf unit. These mf units of fusion have their own cc(s), which coordinate the muscular fibres involved in intermediate movements between two directions. The name of each cc of fusion is equivalent to the resultant of the two planes of movement (Figure 121).

The abbreviated name of a trajectory on one plane together with the abbreviated name of a trajectory on another plane, united by a hyphen with the name of the moving segment, gives us the name of the cc of fusion e.g. re-la-hu. For example, the motor scheme involving the right hand moving to the left shoulder involves ante-medio-motion of the humerus. The abbreviation for the cc of fusion that coordinates this motor programme is an-me-hu (Figure 122).

Trajectories on the horizontal plane are always present in spiral-form movements hence they are not noted in the names of cc(s) of fusion but are always inferred.

As can be seen in the transverse section (Figure 122), the intermediate movement in the trunk activates three cc(s) of one quarter of the body. The motor organisation of the fascial spirals in the trunk respects the law of agonism-antagonism, that is, the cc of fusion an-la-cl on the left works in antagonism with the cc of fusion re-la-cl on the right.

Therefore the names of the cc(s) of fusion indicate the motor scheme that is actuated by the articulation in that moment.

The cc(s) of fusion are named as such because they combine several functions:

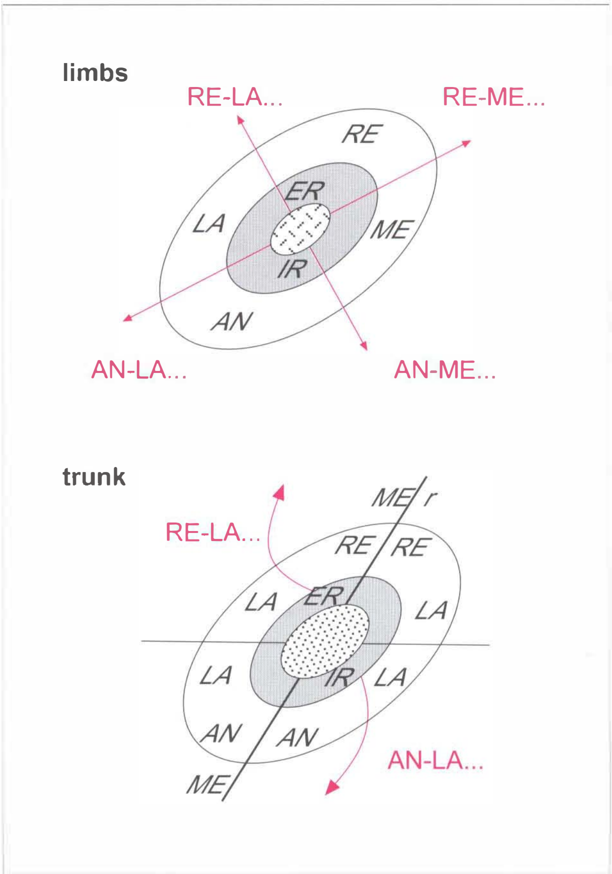


Figure 122. The names of the cc(s) of fusion are derived from the analysis of the transverse sections of the limbs and the trunk.

- They are the converging points for the vectors of different mf units and the resultant is part of a segmentary motor scheme (Figure 123).
- They are the converging points for vectors of the mf units of fusion, or intermediate muscular fibres of two different directions.
- They are the converging points of vectors coming from proximal segments and of vectors that go towards the antagonist mf unit of the distal segment.

The point(s) to be treated in global therapy can be chosen following analysis of the most painful movement, just like in the segmentary assessment. However, in the segmentary analysis joint movements on the three planes are interpreted from an orthogonal viewpoint whereas in global assessments the intermediate grades of movement are considered. In fact, the humerus can be moved forward (an-hu), laterally (la-hu) and backward (re-hu) but also in the intermediate positions of ante-latero (an-la-hu), retro-latero (re-la-hu) etc. Furthermore,

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[244] The flexor retinaculum continues above in the deep fascia of the leg, particularly in the transverse intermuscular septum, and below with the planter aponeurosis. Beneath the inferior peroneal retinaculum, that continues above with the undivided band of the inf extensor retinaculum... (Lockhart RD, 1978)

during these movements the humerus can be either intrarotated or extrarotated. Even without volition each variation from one position to another always involves a simultaneous, automatic rotational component[245].

It would be very energy consuming for the human brain to have to keep track of all these variables in one joint, even more so if it had to coordinate all these variables with those of all the other articulations. It is more probable that this regulation is provided for by the tensile interchange of the fascial structures (sequences, retinacula, spirals) and of the neuromuscular structures (muscle spindles, Golgi tendon organs). These fascial pulleys function like the transmission belts of the joystick of an aeroplane that synchronise the various wing tips or balancing flaps.

Taking the glenohumeral joint as an example, analysis of the passage from the position of 90° antemotion (flexion) to 90° lateromotion (abduction) demonstrates that the intermediate grades between the two positions are actuated by motor units in succession, just like in a rheostat.

In Figure 124, the fascicles of the muscular fibres of pectoralis major and deltoid are clearly separated from each other by the perimysium. In this way they can be activated in succession according to the degree of joint movement.

If the motor units situated anteriorly to the humerus are activated then a movement of pure flexion results. If activation of the motor units situated in a progressively lateral position occurs then the intermediate movement of flexion-abduction results, until the humerus reaches the lateral position (pure abduction) where the simultaneous activation of the laterally placed motor units takes place (Figure 123).

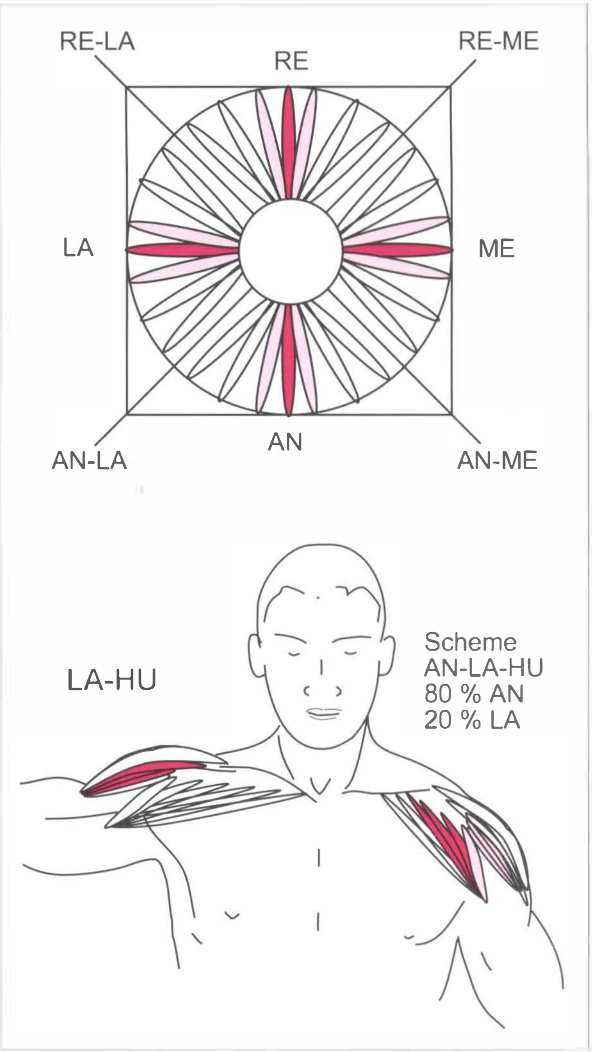

Figure 123. Recruitment of the intermediate fibres of the two mf units, similar to a rheostat.

Hence the number of activated motor units within the mf unit of antemotion decreases gradually as the motor units of the mf unit of lateromotion are progressively activated[246].

Halfway between the passage from one plane to another a *no man's land* is created. At this point the mf unit of antemotion has completed its activity and that of lateromotion is yet to begin. It is in this area that the mf unit of fusion is located, apparently created by the body in order to balance this reduction in force. The cc of fusion is located over the muscular fibres of the mf unit of fusion and between the tendons of the two segmentary mf units. Just like the director of an orchestra it directs the *crescendo* of one mf unit and the *diminuendo* of the other. This coordination is effectuated by tendons tensioning the retinacula together with the consequent activation of the Golgi tendon organs.

This peripheral organisation is similar to that which takes place at the cerebral level, in as much as movements are not programmed on the basis of muscles but on the basis of directional vectors.

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[245] That which Mac Conaill has defined as combined rotation appears in movement in succession effectuated around two axes of an articulation. (Kapandji IA, 1983)

[246] The force of contraction of a muscle is based primarily on the number of motor units stimulated since each motor unit functions according to the law of all-or-nothing. H. Jackson affirms that nervous centres know nothing of muscles, they only know about movements. (Licht S, 1971)

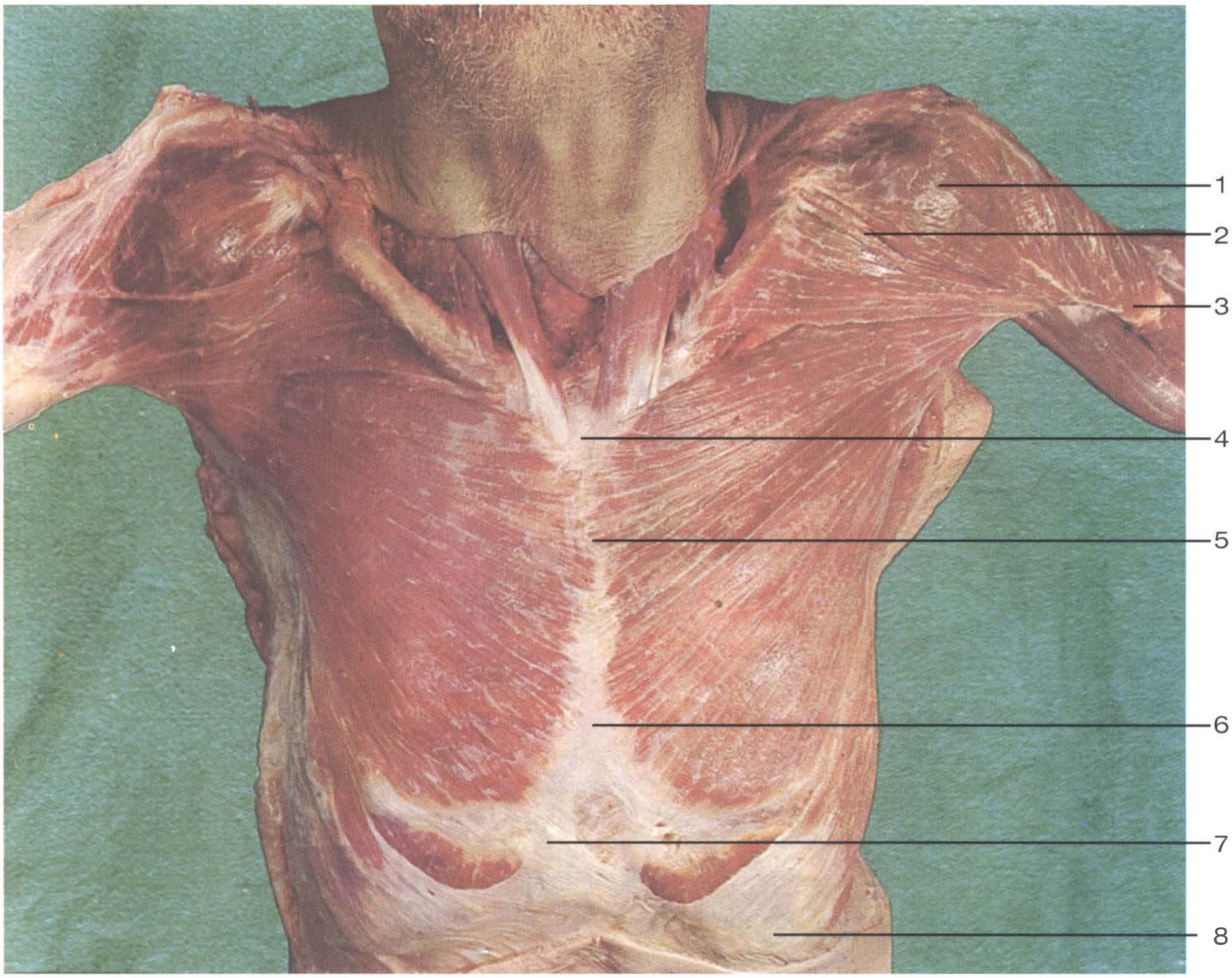

Figure 124. Anterior wall of thorax, superficial muscles (from Fumagalli - Colour photographic atlas of macroscopic human anatomy; - Published by Dr. Francesco Vallardi/Piccin, Nuova Libraria).
1, The clavicular head of pectoralis major and deltoid are part of the mf unit of ante-humerus; as one can note from the photograph it is rather arbitrary to name this unidirectional group of fibres by two different names; 2, the fascia and a number of muscular fibres of ante-humerus-scapula continue in the superficial cervical fascia which is connected to the ante-collum unit; 3, the deltoid fascia, with spiral fibres that pass from retro-medio-humerus to ante-latero cubitus; 4, some fibres pass from the sternal insertion of sternocleidomastoid into the pectoral fascia but, because this latter has been removed, they are not visible; 5, some muscular fibres of the right pectoralis major intermesh with the left side; this allows for a perfect bilateral synchrony of adduction of the upper limbs. If muscles were only destined to be a brute force then they would only insert onto bones without all these apparently superfluous fibres; 6, the linea alba and the suprasternal fascia form a continuity and acting like a plumb-line they regulate equilibrium between the two sides of the body (mediomotion); 7, a number of fibres of the right pectoralis major insert onto the aponeurotic sheath of the rectus abdominis; they exert tension which is propagated to the contralateral side of the body (spiral); 8, the aponeurosis of the external oblique has parallel collagen fibres that transmit the force of the muscle. A part of these collagen fibres connect with the abdominal fascia in order to tension it and to receive information (feed-back) about the general state of the body.

Georgopoulos[247] has hypothesised that movement in a particular direction is determined by the activity of a whole neuronal population. He suggested that the contribution of each neurone could be represented by a vector whose length depends on the degree of activity demonstrated during movement in that particular direction. The sum of single cell contribution could therefore generate a final vector for the whole neuronal population[248]. Other experiments have shown that neurones that discharge towards a muscle during one movement remain silent when the same muscle effectuates a different movement[249]. Thus, when a muscle actuates a movement towards an orthogonal direction it activates certain fibres and when it actuates a motor scheme, or programme, it recruits other fibres. The previous experiments indicate that "ensembles of neurones" are activated for directions on the orthogonal planes (flexion-extension, adduction-abduction) and other ensembles are activated for the intermediate degrees of movement. If there are specific neurones for intermediate motor schemes at the cerebral level, then there must also be muscular fibres in the periphery that respond to stimuli for these intermediate directions.

The diagonals

A motor scheme is equivalent to the movement of a single segment in the intermediate degrees between two orthogonal directions, or planes.

The diagonal corresponds to the movement of a limb, or of the trunk, in the direction that lies between two planes and two adjacent sequences (Figure 125). The diagonal synchronises all of the cc(s) of fusion of the various segments activated by a nervous impulse: for example, the an-la diagonal of the upper limb coordinates the cc(s) of fusion of an-la-sc, an-la-hu, an-la-cu, an-la-ca and moves the upper limb in the direction that lies between the sequences of latero and ante (for diagonals see Figures 177, 178, 179,180). If, during this movement, the person desires to move the limb more to one side then the sequence of lateromotion will be activated further. As the limb passes from the anterior position to the lateral position the activity of one sequence increases while the activity of the other decreases. This is a smooth sequence, not at all jerky as it would be if controlled exclusively by nervous stimuli, which respond to the all-or-nothing law. The presence of the cc(s) of fusion modulates the *diminuendo* of one sequence in relation to the *crescendo* of the other. The cc(s) of fusion of the diagonal of an-la-sc, hu, cu, ca regulate excitomotory impulses as well as proprioception[250] during this movement.

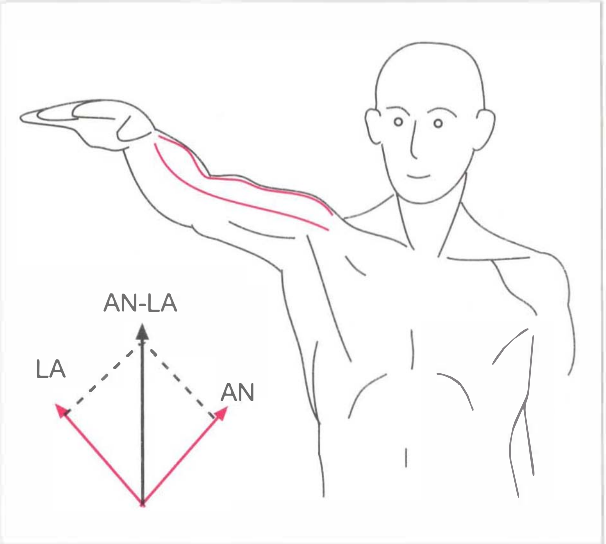

Figure 125. Diagonal or resultant of two adjacent sequences.

In the maintenance of the upright posture, where volition is not greatly involved, this type of control is even more important. Some experiments have demonstrated that vibration applied to certain muscle points induces an ipsilateral sway of the body. Stimulation of the anterior muscles of the ankle caus-

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[247] Neuronal activity varies with variations in the direction of movement: they discharge energetically with movements that are performed in a specific direction and cease to discharge with movements performed in the opposite direction. Furthermore, the elective direction of neurones placed within the same cortical ensemble is very similar. (Georgopoulos AP and others,1982)

[248] Cortical neurones demonstrate sensitivity to direction of movement. The diagrams illustrate cortical neurone activity throughout the execution of movements in eight different directions. (Kandel ER, 1994)

[249] Roger Lemmon has observed that neurones, which discharge when a monkey squeezes a small transductor between thumb and index finger developing a particular level of force, remain silent when the animal develops the same force when grabbing a stick with its fingers. (Kandel ER, 1994)

[250] Roll and Roll have suggested that muscle-spindle inputs might form a continuous "proprioceptive chain" from the feet to the eyes, since applying tendon vibration at any level in the chain apparently alters the internal representation of the body posture. Little is known, however, about how this multiple proprioceptive information is integrated. (Kavounoudias A, 1999)

es the body to sway forwards; stimulation of the lateral muscles causes the body to sway to the same side.

This is not a voluntary process but one that is under peripheral control. By applying vibration simultaneously to the previously mentioned anterior and lateral muscles, the body sways in the direction of the resultant of these two vectors[251]. In Fascial Manipulation this resultant is called the diagonal as it is situated between the two orthogonal planes (Figure 177-180).

In the human body there are many movements that are executed along a diagonal: for example:

- radial deviation of the upper limb is the resultant of ante and lateromotion;
- ulnar deviation is the resultant of retro and mediomotion;
- push-off of the lower leg in the gait cycle is the resultant of retro and mediomotion

In any one movement it is difficult to define when the organisation of the sequence, the diagonal or the spiral enters into play. Ulterior studies are required to demonstrate exactly how the tensioning of the fascia selectively activates the segmentary cc(s) or the cc(s) of fusion. The distribution of referred pain, together with the anatomical connections of the fascia, suggest that static and longitudinal traction activates the segmentary cc(s) of the sequence and that dynamic and oblique traction activates the cc(s) of fusion of the spirals.

The spirals

The diagonal synchronises the unidirectional cc(s) of fusion of the various segments of a limb (or of the trunk) in the intermediate movements between two planes.

The spiral synchronises the cc(s) of fusion that act in the opposite direction in the distal segment with respect to the more proximal segment: for example, the spiral of re-la-pe activates ante-mediomotion talus and retro-lateromotion genu simultaneously (see the swing phase of gait).

To understand the spiral organisation of the fascia a brief revision of connective tissue structures is required.

A ligament does not perform the same function as a retinaculum therefore it does not have the same structure.

A ligament, as the name suggests (from Latin *ligamentum* = bond), bonds two bones together and has a resistant structure, with fibres that are arranged along a rather uniform line of traction[252].

A retinaculum, as the name suggests (from Latin *rete* = net) is a network or grid of collagen fibres arranged according to multiple lines of traction, with functions that are distinctly different from those of a ligament[253]. In anatomical texts, without taking into consideration the diverse physiology of the two structures, retinacula are often erroneously called ligaments[254].

The retinacula, even more so than ligaments, are in continuity with the fascia. The retinacula form rings around the articulations of the body and, via endofascial collagen fibres arranged in a spiral, they connect proximal articulations with distal articulations.

A similar spiral structure is to be found in the fascia of the fingers and toes[255]. The fascia of each finger or toe is formed by cruciate fibres that alternate with transverse fibres[256].

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[251] When one antero-posterior muscle group was stimulated together with another muscle group, an obliquely oriented body sway was always induced. It corresponded roughly to the sum of the two orthogonal body sways previously observed in response to stimulating these same muscles separately. (Kavounoudias A, 1999)

[252] Ligament = fibrous band, variable in its form and thickness, resistant and not very extensible. It unites two bones together; it is present around articulations. (Stedman's, 1995)

[253] Patellar retinaculum: extensions of the aponeuroses of the vasti medialis and lateralis muscles which pass on each side of the patella, attaching to the margins of the patella and patellar ligament anteriorly, the collateral ligaments posteriorly and the tibial condyles distally. (Stedman's, 1995)

[254] Superior extensor retinaculum: the ligament that binds down the extensor tendons proximal to the ankle joint; it is continuous with the deep fascia of the leg. Syn. Ligamentum transversum cruris, superior ret. of extensor muscles, transverse crural ligament, transverse ligament of leg.
Antebrachial flexor retinaculum: thickening of distal antebrachial fascia just proximal to radiocarpal joint. Continuous with extensor retinaculum at margins of forearm. This structure is distinct from the transverse carpal ligament, commonly called "the flexor retinaculum" which forms the roof of the carpal tunnel. Syn. Flexor retinaculum of forearm, palmar carpal ligament. (Stedman's, 1995)

[255] Of the five annular pulleys two are situated near the shaft of the phalanges while the other three are close to the three articulations; the cruciate pulleys are all situated close to the shaft of the bones but are collocated fairly close to the adjacent articulations. (Gray H, 1993)

[256] Fibrous sheath of the flexor tendons. Beneath the skin and subcutaneous tissues we find a very resistant fibrous lamina that covers the flexor tendons. The sheath begins at the level of the metacarpophalangeal joints in continuation with the transverse fibres of the superficial palmar fascia. Taking into consideration the structure, the fibrous sheath consists of transverse fibres over the shaft of the phalanges and over the articulations the sheath consists of oblique and cruciate (X) fibres. (Testut L, 1987)

The same alternation of fibres is repeated all over the body. In the foot, from the toes extending up to the talus, a retinaculum covers the articulations (annular extensor retinaculum) and cruciate fibres extend over the bone shafts (cruciate fibres in form of 8, of the posterior fascia of the leg). Around the knee the patellar retinaculum is continuous with the fibres of the vasti lateralis and medialis. Similarly, annular fibres surround the articulations of the trunk and cruciate fibres connect these *belts* (lumbodorsal fascial belt, cervicodorsal fascial belt)[257].

In the hand the long and short vincula of the tendons insert onto the retinacula of the fingers[258]. At the carpus, the extensor retinaculum forms septa that pass between the synovial sheaths to reach the mesotendineum.

All of these connections are significant when considered in reference to peripheral motor coordination. This coordination utilises a combination of nervous structures that are sensitive to stretch (Golgi tendon organs) and fascial structures that are tensioned by movement (retinacula).

Retinacula cover the insertions of tendons that move the same segments after which the retinacula are named. At the same time the retinacula are close to the origins of the muscles that move the proximate segment. The muscular sheaths of spiral-form muscles, such as sartorius, connect the anterior part of the proximal retinaculum with the posterior part of the distal retinaculum.

The retinacula partially interrupt the continuity of the fascial spirals. If the spirals where continu-ıs then we would only be able to execute stereo-:d gestures similar to those of reflexes. These ɜrruptions, however, allow for a wide variety of possible motor combinations. Reflexes and many automatic movements utilise the collagen fibres arranged in spirals that have developed in human beings throughout evolution.

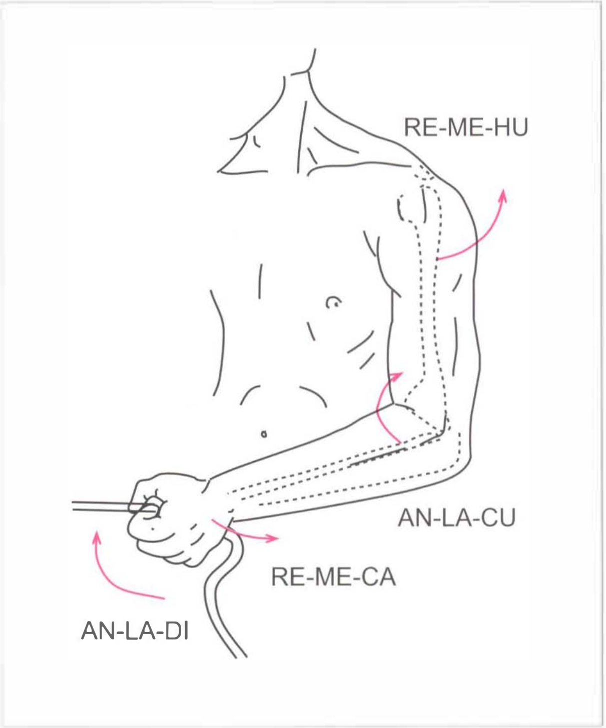

Figure 126. Dynamic movement or gesture organised by a spiral.

These fascial spirals control opposite directions during movements that involve a number of articulations. For example, when pulling a rope, the fingers flex and abduct (an-la-di), the wrist extends and adducts (re-me-ca) the elbow flexes and abducts (an-la-cu) and the shoulder extends and adducts (re-me-hu) (Figure 126).

For the most part complex motor activities are organised as described above. Peripheral motor control by the fascial spirals can explain why the excitability of a distally placed muscle varies with variations in the angle of a proximal articulation. For example, the vasti of the quadriceps demonstrate a diverse excitability if the hip is flexed to 90° or to 150° [259]. No known neurological mechanism or muscular continuity can explain this type of control.

On the other hand, the continuity of the spirals

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[257] The body retinacula represent a functional connecting structure through the body where there are no traditional anatomical connections from front to back. We describe the straps as being just under the skin because that is where we see them. (Schultz RL, 1996)

[258] It has been shown that the cruciate parts do not join to the adjacent pulleys in an ordered way, i.e. each one following its own individual margins in a regular manner without folds, but rather they continue in the superficial layer of the thickened areas before uniting to the superficial surface of these structures.

Near their insertions, the tendons are connected to the dorsal portion of their synovial sheaths and to the nearby bony or ligamentous surfaces by fibrous bands of the synovial membrane, called vincula. (Gray H, 1993)

[259] The results indicate that excitation of the one-joint knee extensor muscles (vastus lateralis and medialis) depends systematically on hip joint angles. In particular, excitation levels are higher at hip joint angles of 90 degrees (sitting) and 180 degrees (lying) compared to intermediate hip joint angles (112, 135, 157 degrees). (Hasles EM, 1994)

could provide the explanation of this mechanism. In complex motor activities the brain cannot programme the movement of the hand in one direction, the elbow in another and so forth. It thinks about the direction of the motor gesture of the hand and the other articulations must adapt themselves as a consequence. The orthogonal mf units are synchronised by the endofascial collagen fibres of the longitudinal sequences. The mf units of the motor scheme are synchronised by the endofascial collagen fibres of the spirals. With re-evaluation of myofascial connections the anatomy of the locomotor apparatus can be viewed in a new light.

By observing the photograph of the retro-lateral part of the deltoid muscle (Figure 121) a large bundle of oblique fibres can be seen. These fibres pass forward to participate in the formation of the mf unit of fusion of re-me-hu. Some of these fibres insert distally in the anterior brachial fascia, which in turn covers the muscles that effectuate ante-latero-cubitus (an-la-cu). The fascia itself, subjected to this traction, develops fibres that are able to transmit force[260]. It will be demonstrated the presence of these oblique muscle fibres in each spiral of the limbs and the trunk and how, within the fascia, there are spiral collagen fibre arrangements. These oblique collagen fibres, which extend independently from the longitudinal fibres within the same fascia, are described in numerous anatomical texts[261].

There are experiments that from a physiological view-point confirm a similar spiral organisation. In posturology it has been observed that vibration applied to the muscle belly of the triceps surae induces a posterior sway of body, whereas vibration applied to the heels induces a tilt in the opposite direction[262].

This diversity in motor responses to the same stimulus can be explained in the first case as a segmentary mf unit response (stimulus of the muscle belly of triceps surae) and in the second case, as a global response of the myofascial spiral (stimulus of the retinacula of the heel).

With reference to clinical experience it can often be noted that referred pain does not always follow the longitudinal arrangement of the sequences but is often distributed according to a spiral arrangement. For example, the stimulation of the lower abdomen can project pain either in a longitudinal sense along the rectus abdominalis or in an oblique direction, manifesting itself in the lumbar area. Similar examples of projection can be found when the paravertebral muscles are stimulated: if the sequence is involved then pain will be distributed in a longitudinal direction; if the spiral is involved then pain will be distributed in an oblique direction, manifesting itself, for example, in the inguinal area. Hence, from the therapeutic point of view, an abdominal pain can be cured by treating the back and vice versa[263].

Differences between segmentary cc(s) and cc(s) of fusion

- Segmentary cc(s) are located over the muscle belly and they coordinate mf units via the epimysium, the perimysium and the endomysium.
- The cc(s) of fusion are located over tendons and they coordinate motor schemes via the retinacula and the fascial spirals.
- Segmentary cc(s) are located in parts of the body that are in line with the three spatial planes.
- The cc(s) of fusion are located near articulations and in intermediate zones between two planes (diagonals).
- Segmentary cc(s) are recruited when effort, or force, is required and when muscular insertions on the fascia are tensioned (sequence).
- The cc(s) of fusion are recruited by tensioning of the retinacula either directly (via tendons) or indirectly (via movements of bones onto which they are inserted).

In order to coordinate motor schemes both segmentary and fusion cc(s) tension the muscle spindles and Golgi tendon organs that belong to the muscle fibres of their mf units.

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[260] The connective tissue component within these stress lines is stimulated to increase fiber production, and these fibers are arranged along stress lines. (Schultz RL, 1996)

[261] The muscular fasciae, known as deep fasciae, consist of mostly collagen fibres; at this point they are arranged more compactly and they have a very orderly orientation, such that the deep fascia is often indistinguishable from the aponeurotic tissue; given that, as in the latter, the parallel fibres in one layer are at an angle with respect to the consecutive layer. (Gray H, 1993)

[262] Stimulating the two heels induced a forward body tilt whereas stimulating the triceps surae proprioceptors induced a postural response in the opposite direction.
These results show that the vibration-induced sensory messages from cutaneous or muscle proprioceptive receptors are able to provoke a compensatory whole-body motor response to regulate upright body posture. (Kavounoudias A, 1998)

[263] The transversus abdominis and internal oblique are considered important in the provision of dynamic and static stability in the lumbar spine. Furthermore, these muscles have been shown to be preferentially affected in patients with chronic low back pain. (Hodges P, 1996)

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Chapter 16
THE EVOLUTION OF THE MYOFASCIAL SPIRALS

The fascia has contributed to the body's mastery of the frontal and sagittal planes respectively with the formation of the longitudinal and transverse septa.

The role of the intermediate fascia in mastering the horizontal plane will now be examined.

Movement on the horizontal plane allows for:

- Motor schemes, or movement of a single segment in the intermediate degrees between two planes.
- Motor diagonals, or movement of an entire limb in the intermediate degrees between two planes.
- Spiral motor gestures, or complex motor activities that involve movement of segments of the same limb in opposite directions.

The formation of motor schemes

If the fascial compartments of the erector spinae and the lateral flexors were the body's only fascial compartments then motion would be restricted to retromotion and lateromotion (Figure 127, A). Any motion within the 90° between these two planes would be impossible. It is only in virtue of a rotatory component that a harmonious transition from the lateral position to the retromotion position is possible.

Hence, the motor scheme is the transition of a segment from one plane to another. During this transition three mf units are activated: the initiator mf unit (retro or ante), the target mf unit (latero or medio) and the rotatory mf unit (intra or extra). The mf units on the horizontal plane allow for these transitions because they are connected to the intermediate fascia, which is like a layer of ball bearings between the two muscular planes (Figure 127, B).

Throughout evolution it can be noted how the formation of these muscular layers has allowed the body to master the intermediate degrees between the sagittal and frontal planes.

In the cephalachordata, musculature is typically

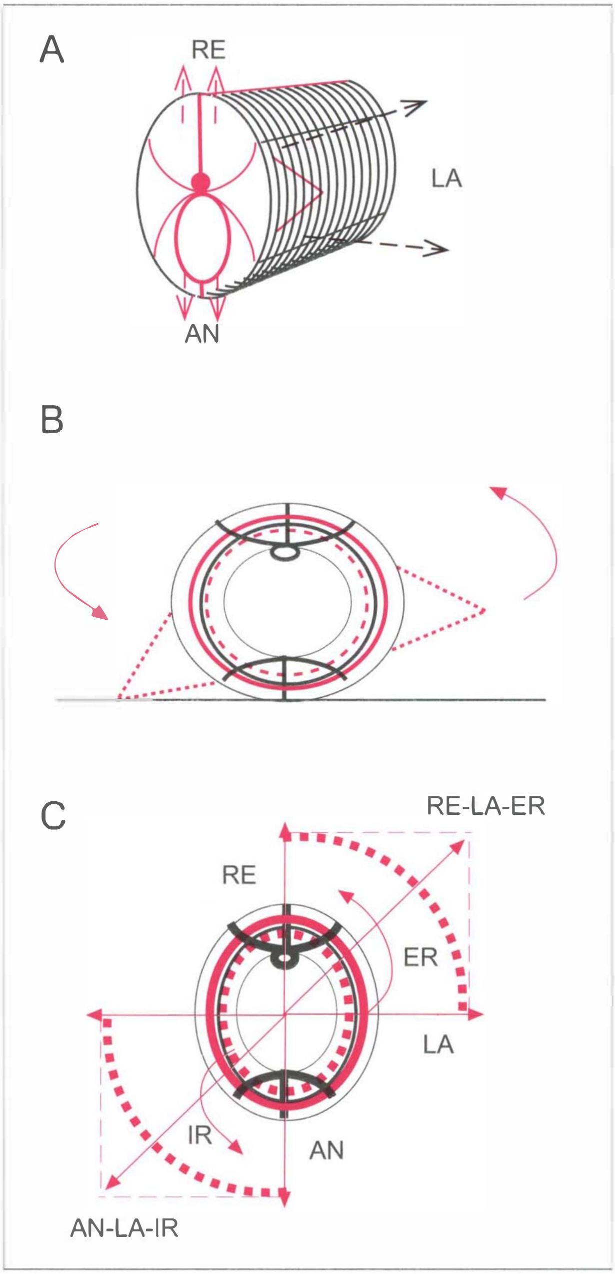

Figure 127. The rotational component is essential for motor schemes.

metameric with a longitudinal orientation of muscular fibres from one myoseptum to the next.

In cyclostomes the myomeres are curved and inclined caudally.

In bony fishes, the myomeres curve even more and they insert into each other like funnels. In this way, when a myomere contracts it not only affects the two vertebrae between which it is situated but also influences vertebrae at a distance. In fish, the retrorse (backward) inclination of the myomeres forms a precursor of the differentiation between a deep and a superficial musculature of the trunk. The myomeres are slowly replaced by broad muscular laminae. This laminar formation of muscles is manifested on the sides of the body, both ventrally (hypaxial) and dorsally (epaxial).

Fins, situated on the sides of the body (Figure 127, A) reinforce the lateral propulsion of the trunk in aquatic environments. The lateral flexor motion of fish remains the base movement even for amphibians where we find that the fins have evolved into limbs, which move in synchrony with the trunk. Because the amphibian's trunk rests on the ground the limbs take leverage on the terrain in order to advance the amphibian's body (Figure 127, B). Initially the limbs are situated to the side of the trunk therefore the trunk must rotate downwards to allow for leverage. If the two limbs moved simultaneously then the trunk would not be required to rotate. Instead, the limb on the concave side of the trunk is lowered while the limb on the convex side is raised in order to facilitate its forward movement. This procedure can also be observed in seals when they transit on solid ground.

In amphibians (salamander), the continuous movement of raising one limb and lowering the contralateral limb has increased the laminar formation of the muscles to a point where independent layers of trunk muscles have formed (rotation) (Figure 127, C).

The division of the lateral musculature becomes even more evident in tetrapods because it breaks up into the internal and external oblique muscles[264].

The structure of this musculature in the thoracic region of amniotes is complicated by the presence of the ribs[265]. The external oblique muscle delaminates into two layers, the superficial layer becoming the levator costarum while the external intercostals develop from the deep layer. The internal intercostals develop from the internal oblique muscles. In amniotes, the intercostals and the oblique muscles are important for respiration but less so in mammals. The subcostals form from the trasversus. In the scapula region of superior tetrapods the serrati muscles, the levator scapulae and the rhomboids, which are all differentiations of the external oblique muscle[266], can be found. The prevertebral muscles (hypaxial) form a chain of flexors close to the vertebral column (longus colli, quadratus lumborum, psoas) as well as a superficial muscular chain (sternalis, rectus abdominis).

A long, superficial and a deep intervertebral musculature forms on the epaxial side. This new structure of the vertebral musculature allows for dorsal arching, especially in mammals.

This new bi-laminar myofascial structure allows the body to pass from the dorsal arching position (re) to lateral flexion (la) (Figure 127, B), thus gaining control of the intermediate 90° between the two planes. There is no longer activation of the single mf units of retromotion or lateromotion but a slow increase in the activity of one mf unit with a simultaneous decrease of the other mf unit (*crescendo* and *diminuendo*). This *symphony* of motion is no longer directed by the centres of coordination of retro or latero, but by the cc of fusion (re-la). This cc forms simultaneously with the cc(s) for the movements of intra and extra. The segmentary cc(s) that act on the horizontal plane and the cc(s) of fusion are often located near to one another, but they maintain a partial independence in the organisation of movement.

Muscles that act on the horizontal plane also form in the limbs. They occupy an intermediate layer and often unite their activity to motor scheme movements, even though they can contract inde-

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[264] In amniotes the external oblique delaminates into two layers: the superficial layer becomes the levator costarum and the deep layer the external intercostals. The internal intercostals develop from the internal obliques and the subcostals from the trasversus. The serrati and levator muscles of the scapula, and in mammals the rhomboids, are differentiations of the external oblique. (Stefanelli A, 1968)

[265] The amphibian Urodela have maintained the primitive metamerism of the epaxial and hypaxial muscles. The disappearance of the epaxial septa in amniotes has resulted in the development of long fascicles, arranged over the transverse processes of the vertebrae, with metameres remaining only in the deep layers. (Kent CG, 1997)

[266] The serrati muscles, the levator scapula and rhomboids are derived from the external oblique and form the suspensory band of the scapula. Ventrally the pectoralis maintains the base of the limb in place. (Kent CG, 1997)

pendently. The cc(s) of fusion are located in the intermediate part of the fascia that unites the two sequences. Thus the cc(s) of ante-medio are situated medially to the sequence of antemotion (Figure 179) and the cc(s) of ante-latero are situated laterally to the sequence of antemotion (Figure 180).

The existence of these cc(s) allows for an immediate control of the motor resultant, without having to sum the vectors of two separate sequences[267].

The evolution of the mf diagonals

There is not a great deal of information regarding the evolution of motor diagonals in comparative anatomy texts[268].

Through the study of the evolution of human musculature Bart arrived at the conclusion that muscles in the trunk are arranged in diagonal layers and that, if one traces their continuity around the whole body, they form two intersecting spiral layers. This spiral arrangement can also be found in the limbs. Kabat has acknowledged the spiral conformation of the human body's muscles but, above all, acknowledges the diagonal and spiral characteristics of human movement.

Fascial Manipulation theory in general intends to demonstrate that the fasciae is the structure that provides for that which others often attribute to muscular and nervous tissue structures.

To this purpose, the latest achievement of the human locomotor apparatus, bipedalism, will now be discussed. From the viewpoint of the fascia the first phase of the upright position was possibly organised by the mf diagonals and successively by the evolution of the mf spirals.

How all this actually came about is still conjecture even though there are various current theories that explain the transition from the quadruped position to the upright position[269]. We know that the common ancestor (Proconsul) of the great apes (Pongidae) and human beings existed in the geological epoch of the Lower Miocene (20 million years ago). It is common knowledge that at the beginning of the Middle Miocene epoch (about 15 my ago), with the expansion of savannah woodland environments, the two species began to differentiate into Dryopithecus (monkeys) and Ramapithecus (humans). The monkey species adopted various survival and defensive strategies such as moving through trees (gibbons) and dentition development (baboons). To defend themselves hominids lacked such morphological features as could have served as a "natural" defence against predators however, they had started to adopt external weapons and tools made from wood or long bones. Whilst only stone fossils are known today we cannot base our conjectures on the surviving material because all inferences from ethnographic parallels and other generalisations suggest that bone and wood tools were in everyday life long before stone tools were made.

In this same period important changes in the locomotor apparatus provided for the transition from quadrupedalism to bipedalism. Obviously, concomitant factors have contributed to this transition and current theories consider aspects such as increasing distance between trees and the greater need to relate to others for survival in an environment where food was less abundant as compared to the tropical forest.

This brings us to the suggestion that it could be plausible to hypothesise that hominids became bipeds also through the use of sticks, or long bones, used firstly as source of defence and subsequently for support. This hypothesis has no greater pretence than to stimulate discussion around the topic of the transition from quadrupedalism to bipedalism.

Chimpanzees are capable of grasping a stick and throwing it at an aggressor but this strategy offers only momentary defence. A stick actually offers more defence by holding it and agitating it in a

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[267] Force is defined as that which influences a body in such a way as to modify its state. If two (or more) forces act simultaneously on the same body their effect is that of a single force equal to the vectorial sum of the single forces. The resultant is a vector which is the sum of a number of vectors, in the simplest case obtained by applying the law of the parallelogram. (Cromer AH, 1980)

[268] In mammals all limb musculature seems to have an origin that is independent from the myotomes. Limb musculature, both intrinsic and extrinsic, can be divided into two antagonist groups, comparable to the dorsal and ventral muscles in fish. Muscular function is assisted by a connective tissue fascia. There is a rotation in the inferior limb that... (Stefanelli A, 1968)

[269] Two hypotheses have been postulated as to how the change occurred: 1. a gradual evolution from the horizontal to a progressively vertical body posture; and 2. an "either-or" position, in which our early ancestors assumed either a horizontal or a vertical posture. It is calculated that, in a static equilibrium, a semi-erect posture would be disadvantageous from the point of view of muscle forces as well as from energetic constraints. These stresses make it probable that an upright posture and carrying of objects in the hands were jointly favoured by natural selection and that an intermediate stage would be short and inconclusive. (Helmuth H, 1985)

menacing way. We can easily think of instances when a cow, a dog or any other animal has remained indifferent to our commands until they have seen us armed with a big stick in our hand! The positive feedback gained by such an action might also have helped hominids understand that their survival was dependent on a defensive weapon.

Certainly, once the hominid was in the savannah it was necessary to always keep a stick with him/her because it would have been more difficult to find one in case of danger. In this way a club, made of wood or long bone, could have become an inseparable weapon of the Ramapithecus. This ancestor had a quadrupedal march, which was posteriorly plantigrade, sustained that is on the entire arthropod with anterior knuckle walking (Figure 128). Locomotion by brachiation lifted the anterior portion of the body and moved the centre of gravity towards the pelvis. Less weight on the anterior limb would have allowed the Ramapithecus to grasp a club and to hold it in one hand during locomotion. Locomotion in the quadruped position whilst holding a stick in one hand would have been difficult and uncomfortable, painful on the knuckles and disturbing for the posterior limbs. The problem was resolvable by holding the stick in a vertical position (Figure 128) similar to a walking stick. This could explain some suggestions that bipedalism was preceeded by a period of tripedalism[270], which would have shifted the centre of gravity towards the lower limbs and simultaneously encouraged the preferential use of one hand as opposed to the other[271]. The myofascial organisation would then have slowly modified, as the thorax and lumbar regions on the side of the limb holding the stick were shifted higher than the contralateral part. This would have meant that the trunk no longer moved exclusively in retromotion or lateromotion. Consequently, rotation[272] of the trunk would have been induced and a motor scheme (re-la-th rt and re-la-lu lt) developed.

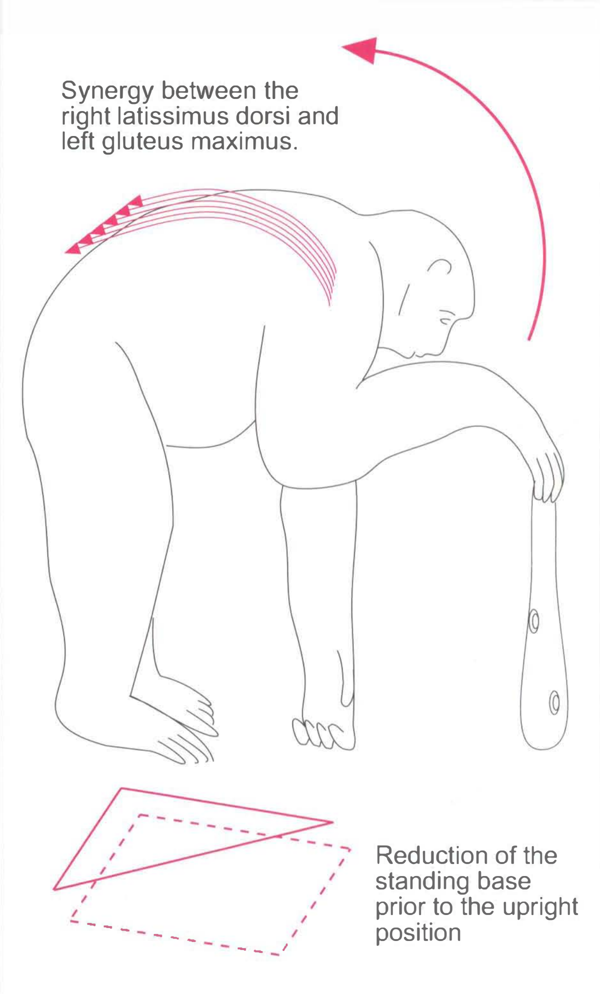

Figure 128. Evolution towards bipedalism.

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[270] Fascialization of the contrahentes and dorsiepitrochlearis muscles in the human as well as depilation of the middle phalanges; the webbing (syndactyly) of the palm; the direction of the fibers of the interosseous membrane of the forearm; the shape of the puerile annular ligament, and the direction of the human glenoid fossa strongly suggest that the ancestor of man used a knuckle-walking form of locomotion prior to becoming bipedal. A model is presented that suggests that bipedalism was attained through an intermediate stage of tripedalism. The model is based on the fact that man's anatomy is much more asymmetric than that of the great apes. (Kelly RE, 2001)

[271] The study noted right-hand biases for bipedal reaching in humans, great apes, and tufted capuchins and shifts toward greater use of the right hand for bipedal vs. quadrupedal reaching in great apes, tufted capuchins, and rhesus macaques. These results suggest that posture alters both the direction and strength of primate hand preference and that bipedalism may have facilitated species-typical right-handedness in humans. (Westergaard GC, 1998)

[272] The dolphin is subject only to minor shear on torsion of the lumbar spine, presenting mainly axial loading during propulsion through sagittal strokes of the tail fluke. The seal, in contrast, displays a lateral stroke of the rear appendages in propulsion. In the lama, the torsion towards the sacrum was not anticipated in view of the expected lack of torsion in pacing. When present in pan troglodytes, bipedalism is performed with kyphotic trunk posture, pronounced flexion of the hips and a lack of countering rotation of the pelvis and shoulder girdle. In human bipedalism, the lordotic lumbar spine is the focus of axial load and torsion through the countering rotation of shoulder girdle and pelvis, with an increase during faster walking and running. (Bronek M. 2001)

Continuing on with this same hypothesis, the use of sticks or clubs of increasing length would have made defence more efficient in as much as a predator could have been kept at a greater distance. In turn, hominids would have walked in positions that were increasingly vertical. At the same time, with less request placed on the gluteal muscles to hold the trunk upright but more to stabilise it, enlargement of the pelvis and a progressively lateral position of the gluteal muscles occurred in anthropoids. In the foot the formation of the peroneus tertius muscle improved pronation and weight bearing[273]. At the end of the Upper Miocene (5 my ago) the Australopithecus was already a biped being, with its centre of gravity falling neatly between the two feet.

The use of sticks and other implements not only contributed to mastering the upright position (*homo erectus*) but also to the development of intellectual capacity (*homo sapiens*). The Homo sapiens learnt to move rocks using implements and to build up piles of rocks to form shelter. This certainly provided for better protection allowing for survival during the glacial period (300.000 years ago). According to the need, implements in general stimulated inventiveness. Thus a long bone or club became the hammer to break open nuts, a lever to move rocks, a rod that made fruit fall from the tree or the weapon that killed small prey.

All of these actions were not merely a consequence of genetically inherited reflexes but required suitable evaluation of the changing circumstances. These implements provided Homo sapiens with a means of interpreting the surrounding environment and therefore, enhanced the development of cerebral synapses more than peripheral reflexes. From a philosophical viewpoint it is interesting to consider that, in the process of child development, infants master the upright position with the aid of different types of support and during the process of ageing or involution, *homo sapiens* often lean on a walking stick, or similar device, for support (Figure 129).

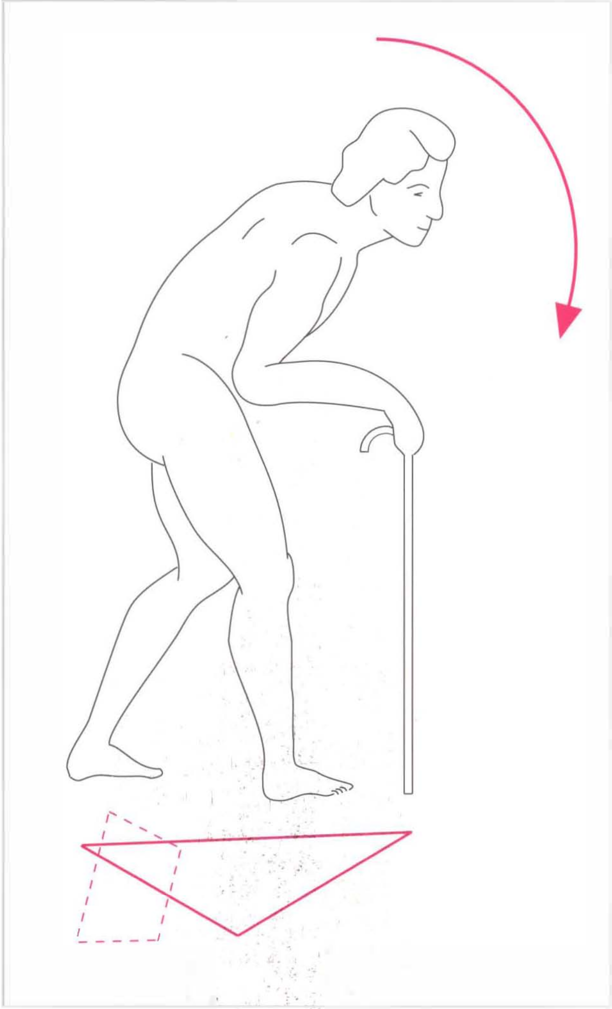

Figure 129. Involution of the upright position.

The evolution of the myofascial spirals

The spirally arranged endofascial, collagen fibres of the trunk formed simultaneously with the mastering of biped locomotion, whereas the spirals of the limbs had developed previously. Upright locomotion was initially associated to a lateral flexor movement of the trunk as can still be seen in some bipedal monkeys[274]. In the primitive biped, the amble type of locomotion, which in quadrupeds

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[273] In the anthropoids the involution of peroneus dig, is associated with the evolution and acquisition of the M. peronaeus III. To obtain strong effects for pronation and dorsiflexion necessary for the upright gait the M. peroneus III inserts at the stable metatarsus instead of the mobile fifth toe by which an earlier phylogenetic stage is achieved. (Reimann R, 1981)

[274] The human crawling may be a behavioural recapitulation of a quadrupedal evolutionary stage. However, with reference to kinematics, man is not only characterised by his unique, habitually bipedal, upright gait but also by a second, equally unique locomotion, namely crawling, which he assumes for a short phase during his first year of life. --The walking movements of the limbs in toddling infants were mainly characterised by rather stiff, abducted arms, which were moved mostly by spinal torsion (similar to those of bipedally walking Gorilla) and not as a suspensory pendulum. However, they rather work as levers for the elastic torsion pendulum of the spine. (Niemitz C, 2002)

Figure 130. Oblique, transversus and rectus abdominis muscles (from Fumagalli - Colour photographic atlas of macroscopic human anatomy.- published by Dr. Francesco Vallardi/Piccin Nuova Libraria). 1, the muscle fibres of the rectus abdominis are arranged longitudinally in conformity with the distribution of the antemotion sequence of the trunk (AN). The collagen fibres of the epimysial fascia of the rectus also present this same arrangement; this fascia is united to the tendinous intersections and, medially, it merges with the linea alba; 2, the superficial layer of the rectus sheath is formed from collagen fibres of the abdominal fascia which are arranged in a spiral pattern (AN-LA lumbi and pelvis); 3, above the arcuate line, the fascia of the transversus abdominis muscle passes behind the rectus sheath and it connects with the fascia of the contralateral transversus m. The collagen and muscular fibres are arranged horizontally which corresponds to the movement of intrarotation (IR) lumbi; 4, the arrangement of the fibres of the internal oblique mirrors those of the iliocostalis mm.; these fibres are thus involved in lateromotion or lateral flexion of the trunk (LA). The fasciae of the external obliques, internal obliques and the transversus merge laterally to the rectus sheath as well as along the linea alba (diagonal AN-ME-TH...)

synchronises the retromotion of the upper limb with the ipsilateral lower limb[275], synchronises the lateromotion of the two ipsilateral limbs with the trunk. Cruciate or reciprocal limb locomotion became possible when some collagen fibres of the latissimus dorsi on one side[276] crossed over the supraspinous ligament[277] to connect to the fascia of the contralateral gluteus maximus (Figure 131).

Repetition of this cruciate synergy over time encouraged the formation of specific collagen fibres within the thoracolumbar fascia that connect the latissimus dorsi to the contralateral gluteus maximus (Figure 128). This myofascial spiral actively synchronises retromotion of the upper limb with the contralateral lower limb during bipedal walking.

The same connection exists between the muscles of antemotion in the anterior part of the body (Figures 130, 155). The lower fibres of the pectoralis major insert onto the fascial sheath of the rectus abdominis, which is formed by the aponeuroses of the oblique muscles. The S-shaped collagen fibres of the abdominal fascia are continuous with the contralateral leg fascia[278]. These anterior, collagen connections synchronise antemotion of the upper limb on one side with the contralateral lower limb during walking (Figure 132).

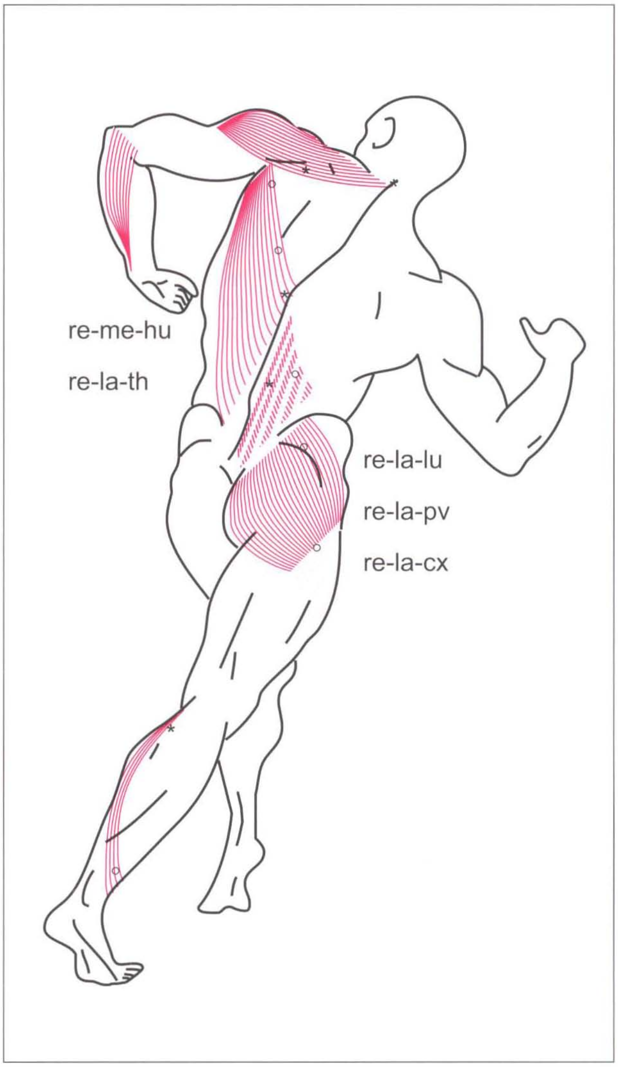

Figure 131. Spiral that unites the motor trajectory of retro-latero-coxa with that of retro-latero-humerus.

The two macroscopic retinacula of the trunk are continuous with the spirals of the limbs formed by the various periarticular retinacula. These spirals synchronise the ante-latero movement of one segment with the retro-medio movement of the successive segment.

With particular attention to the function of the fascia the development of the locomotor apparatus (Figure 133) can be summarised as follows:

1. Considering only vertebrates and starting from the chordates, one finds that cephalochordates are formed by a series of identical metameres

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[275] In the urodela the latissimus dorsi is a delicate triangular muscle that originates from the superficial fascia covering the epaxial myomeres in the region of the shoulder. In reptiles it becomes more consistent, anchoring dorsally to the robust fascia that unites the neural spines of the vertebrae; it extends increasingly in a posterior direction from its axial origins. In mammals the tendency continues to be towards a more ample dorsal anchorage that unites the lumbar vertebrae and which extends down to the base of the tail. (Kent CG, 1997)

[276] The posterior layer of the thoracolumbar fascia was found to consist of two laminae: a superficial lamina formed by the aponeurosis of latissimus dorsi, and a deep lamina formed by bands of fibres passing caudally and laterally from the midline. Both laminae constitute a retinaculum that binds down the back muscles. (Bogduk N, 1984)

[277] In no specimen of dog, cat or baboon was there macroscopic or microscopic evidence of a supraspinous ligament in the human sense of the term. Unlike man, the lumbar spines of these animals do not possess a supraspinous ligament and there is no decussation of the erector spinae tendons in the lower lumbar region. (Heylings D, 1980)

[278] Rizk (1980) carried out extensive research on the musculature of the anterior abdominal wall in 41 humans and 75 examples of other mammals. It resulted that in humans the principal part of the external obliques was bilaminar and its fibres did not terminate in the linea alba but crossed over the midline to join with the contralateral half. After this decussation the superficial fascicles extend inferiorly and laterally crossing the deep fibres (S shaped system). Some fibres insert onto the pectineus crest of the pubic bone (lacunar ligament) and others... (reflected part). (Gray H, 1993)

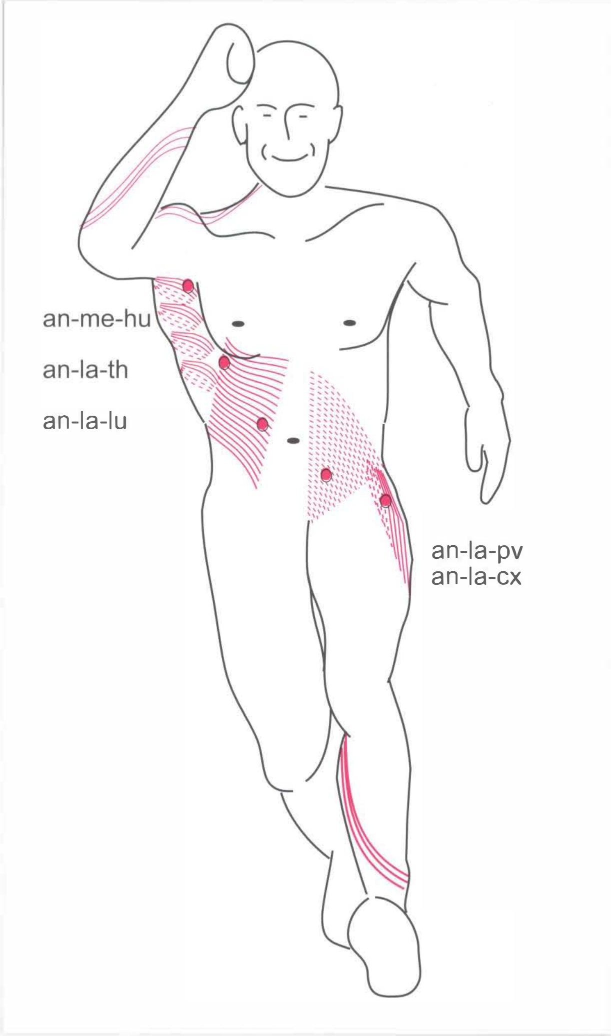

Figure 132. Spiral that unites the motor trajectory of ante-latero-coxa with that of ante-latero-humerus.

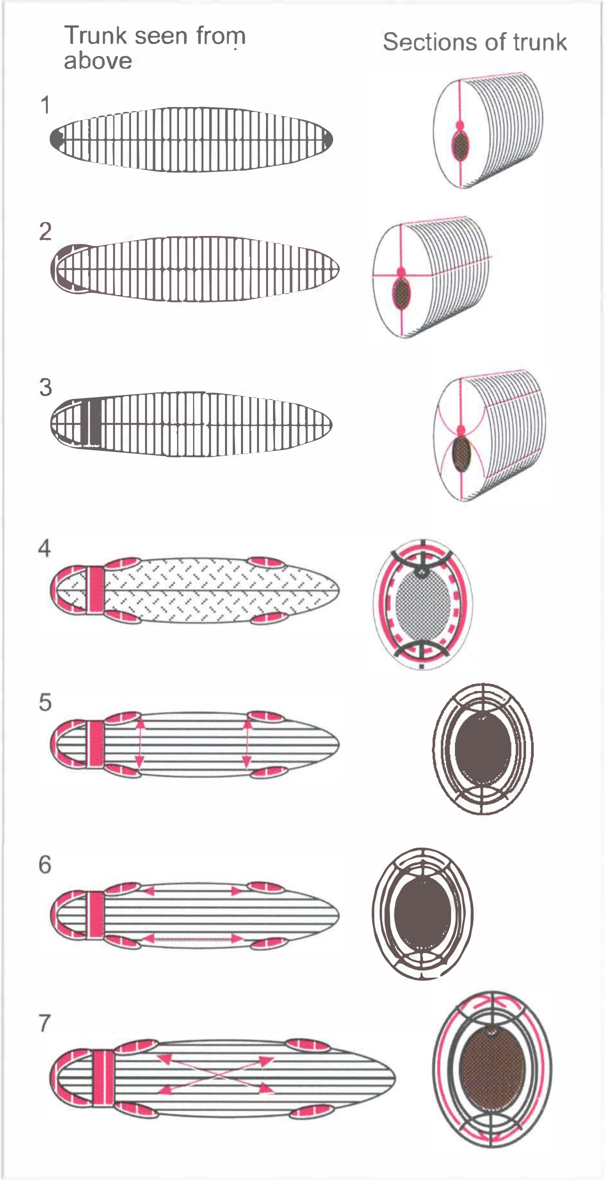

Figure 133. Evolution from metamerism to the spirals.

divided by a longitudinal septum. The muscular fibres on one side form a single mf unit of lateromotion and the other side forms the antagonist mf unit (the frontal plane).

2. Selachii (sharks) possess the previously mentioned longitudinal septum as well as a transverse septum that divides in half the lateral flexor muscles. Lateral flexion is subsequently more precise because it is the resultant of two vectors. The mouth, no longer a simple inhalation tube, possesses a mandible, controlled by two mf units that act on a different plane from the trunk (sagittal plane).
3. At this stage in evolution, an increased independence of movement of the head and the mandible would have allowed for a more efficient organisation of movement. Hence, the formation of the neck, with musculature derived partially from the branchial muscles and partially from the trunk muscles, came about. The hypaxial and epaxial muscles became independent from the lateral flexor muscles (Figure 133, 3).
4. In amphibians, the fins were substituted by the limbs as their movement was tied to that of the trunk. Limb elevation generated motor schemes thereby inducing rotation of the trunk. The bilamination of the trunk muscles became accentuated (horizontal plane).
5. In reptiles, the two anterior limbs move inde-

pendently from the trunk due to the union of the two trapezius muscles posteriorly and the union of the two pectoralis major muscles at the sternum. Metamerism and myosepta are substituted by the continuity of the fascia (sequence).

6. As the limbs achieved more power the muscles of the trunk atrophied. The trunk lost its function of synchronising the upper limb with the ipsilateral lower limb. This synergy is provided by the latissimus dorsi, which unites the shoulder and pelvic girdles for the intermediate movements (diagonals).
7. In many mammals locomotion became more refined with reciprocal movements of the limbs: the fascia of the latissimus dorsi crossing the midline to unite with the fascia of the contralateral gluteus maximus[279]. An increasing variety of complex motor activities, or gestures, of the limbs developed as this crosswise pattern extended on into the retinacula (spirals).

In the following chapters the endofascial, collagen fibres will be highlighted in order to demonstrate the continuity between the fascial spirals of the trunk and those of the limbs.

It should be noted that the continuity of the fascial spirals is less defined as compared to the continuity of the fascial sequences. At the pelvic girdle the spirals of the lower limb intersect with those of the trunk in a variety of manners. For example, the spiral of re-la-cx can continue with the re-la-pv spiral of the trunk or with that of re-me-pv.

The spirals of the upper limb place the cc(s) of the humerus in continuity with those of the scapula[280], for example, the spiral of re-la-hu is almost always continuous with re-la-sc. Between the scapula and the neck (collum) continuity is variable. Re-la-sc, for example, can continue on with the ipsilateral re-la-cl spiral or with the contralateral re-me-cl spiral.

Apart from this variability at the pelvic and shoulder girdles, the rest of the body organises itself with reference to the two large fascial spirals of the trunk and the spirals of the limbs.

According to the angle of the articulation and therefore the fascial stretch, a sequence, a diagonal or a spiral is activated with each step or movement. Segmentary cc(s) are recruited by the unidirectional sequences. The cc(s) of fusion respond to stretch coming from both the diagonally and spirally arranged collagen fibres. In other words the mind initiates a motor scheme and the fascia assists in the process of its realisation.

The path of the spirals could appear to invalidate the presence of the diagonals whereas they actually complete the following myofascial structure:

- on a deep layer the fasciae and the monoarticular muscles (interspinales, intertraversarii) are involved in the segmentary cc(s) of the mf units and of the unidirectional sequences;
- on an intermediate layer, the longitudinal biarticular muscles (longissimus, iliocostalis, rectus abdominalis) participate in the formation of the mf sequences;
- on a superficial layer, the fasciae and the polyarticular oblique muscles (latissimus dorsi, gluteus maximus, external obliques) form the myofascial spirals. These spirals connect the cc(s) of fusion together in the realisation of complex motor activities (e.g. walking)

In mammals, variations in gait velocity determine a substantial modification in locomotor and articular relationships. The quadrupedal gait entails three simultaneous contact points with the ground; the trot involves two and the gallop only one. It is the tensioning of the myofascial framework, rather than volition, that determines the recruitment of one or the other of these motor programmes.

Even in humans when gait is faster than 3 metres a second it is almost impossible to maintain a normal walking pattern and, even without intending to, one begins to run.

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[279] The thoracolumbar aponeurosis, which is known for its resilience, extends over the whole lumbar region and terminates in part on the iliac crest and in part on the spinous processes and the interspinous ligaments. It is to be noted that a certain number of fibres, having reached the midline, cross over it to reinforce the thoracolumbar aponeurosis on the opposite side. (Testut L, 1987)

[280] The degree of humeral external/internal rotation, scapulothoracic anterior/posterior tilting and scapular protraction/retraction varied from subject to subject. However, this did not have a significant influence on the scapulohumeral rhythm, as defined in this study, indicating that the scapulohumeral rhythm is a robust kinematic couple. (McQuade KG, 1998)

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Chapter 17

THE PHYSIOLOGY OF THE MYOFASCIAL SPIRALS

Segmentary fascial tension regulates the fibres of the mf unit and, through reciprocal inhibition, inhibits the antagonist mf unit.

Activation of the unidirectional mf units (via radiation or overflow) is synchronised through tensioning of the mf sequences. The reciprocal tension that exists between sequences regulates body posture (Table 36).

Tensioning of the spirals and the diagonals intervenes in some reflex activity and in all complex motor activities (successive induction).

The fascia (mf unit, mf sequence, mf diagonal, mf spirals) provides an important peripheral support for motor functions that, until now, have been entirely attributed to the nervous system. It goes without saying that they are reciprocally dependent on one another.

Myofascial diagonals and motor schemes

The motor schemes organised by diagonals and those organised by mf spirals can be distinguished as follows: the first involves simultaneous activation of all segments of a limb (or of the trunk), on a given diagonal between two planes; the second involves the movement of two adjacent segments in opposite directions.

In anatomy it can be noted that some muscles are arranged in a longitudinal direction and others are arranged in a spiral configuration[281].

The longitudinal fibres are activated with movements in precise planes (sequences) and in movements along the intermediate vectors between two planes (diagonals). Clearly, the pure form of both of these types of movements is not so common in normal human motion. Nevertheless, comprehension of the simpler components of movement assists in the understanding of more complex motor activities.

The first of the four[282] diagonals is flexion-abduction-rotation of the upper and lower limbs, with extension of the elbow or knee. This pattern, as proposed by Knott and Voss, can be executed in either intrarotation or extrarotation (Figure 134).

The diagonal of ante-latero involves the simultaneous activation of the mf units of the antemotion and lateromotion sequences, as well as those of the sequences of rotation. The resulting movement is an intermediate, or diagonal, movement. Single sequences alone are unable to coordinate these intermediate movements and there would be too many variables for the motor cortex to control. The need for an appropriate, peripheral, tensile structure is satisfied by the cc(s) of fusion. Throughout the whole body, situated halfway between the principal sequences, the cc(s) of fusion intervene in the management of intermediate movements.

The antagonist to the previously mentioned diagonal is the retro-medio (extension-adduction) diagonal, which is activated during the return movement. When the arm is elevated and abducted the cc(s) of fusion of re-me-hu, re-me-cu, re-me-ca are activated in order to overcome a counter resistance, thereby returning the arm to its starting position.

The other diagonal/trajectory is that of ante-medio and retro-latero. For example, in the lower

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[281] Muscles can be classified according to the orientation of their fibres, which can be parallel, oblique or in a spiral with regards to the direction of traction. Parallel: quadrate, ribbon-like, fusiform, tendinous intersections. Oblique: triangular, pennate (bi-pennate, mono-pennate, multipennate). Some muscles are spiral form or "twisted"; between its two insertions the trapezius follows a 90° spiral. The sternocostal fibres of pectoralis major and latissimus dorsi execute a 180° spiral. When these muscles contract they partially unwind. Other spiral form muscles are composed of two or more intersecting layers: the sternocleidomastoid, adductor magnus... (Gray H, 1993)

[282] Each pattern has a principal flexor or extensor component associated with abduction or adduction and the two rotatory components. There are two diagonals of movement and each diagonal is comprised of two patterns that are reciprocally antagonistic: for example, the facilitation of dorsiflexion of the ankle by means of triple flexion of the lower limb against resistance. (Licht S, 1971)

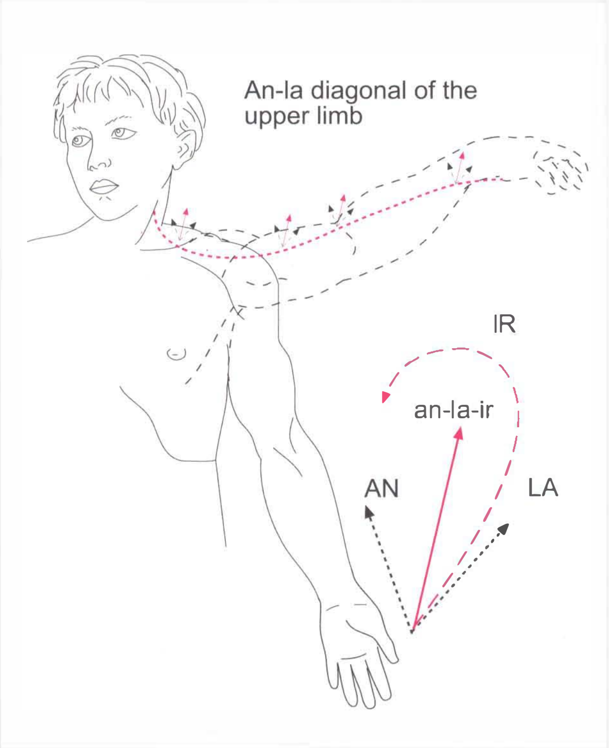

Figure 134. Diagonal movement of the upper limb.

limb these diagonals involve activation of the cc(s) of fusion of an-me coxa, genu, talus and pes in the first instance and, subsequently, the cc(s) of fusion of re-la for the same segments.

In the trunk the movement of ante-latero on one side of the body is paired with the diagonal of retro-medio of the opposite side of the body for the return movement (Figure 177-180). Alternatively, the diagonal of retro-latero on one side of the trunk is activated and subsequently, during the effort to return the trunk to its central position, the diagonal of ante-medio is activated. The same diagonals that are in its anterior half are reproduced in the posterior half of the body, thereby maintaining the body's perfect symmetry.

Through the repetition of intermediate movements the fascia has been subjected to a variety of stretches and consequently, due to its plasticity, it has formed other collagen fibres[283]. Longitudinal fibres, which lie parallel to those of the sequences, have formed with the role of coordinating cc(s) of fusion during diagonal movements. Collagen fibres arranged in a spiral formation (myofascial spirals) coordinate cc(s) of fusion during the movement of adjacent segments in opposite directions.

Myofascial spirals and reflex activity

Reflexes constitute the first level of motor organisation[284]. Reflex activities are integrated into the motor commands that originate from the cerebral cortex. The structure of the fascia can help to explain, from a mechanical aspect, how these reflexes are actuated.

In the musculoskeletal system we can find both segmentary and global reflexes.

- Segmentary reflexes activate only one mf unit. This activation can come about either by percussion over a tendon (centre of perception of the mf unit) or by stroking over the muscle belly (centre of coordination of the mf unit).
  ◊ Deep tendon reflexes (cp):
  - biceps (an-cu)
  - triceps (re-cu)
  - patellar (an-ge)
  - Achilles (re-ta)

  ◊ Superficial or cutaneous reflexes (cc):
  - interscapular (re-th)
  - plantar (me-pe)
  - sup. abdominal (an-lu)
- The global reflexes activate a sequence or a spiral. In order to illustrate the involvement of the fascial sequences a few pathological reflexes, which emerge with lesions of the upper motorneurone, will now be examined. In these examples the peripheral organisation is evident due to the absence of higher cortical control.
  ◊ Sequence and diagonal reflexes:
  - Raimiste's sign in the leg (bilateral continuity of sequences)[285]
  - Tibialis anterior sign (radiation of an-cx to the mf unit of an-ta)[286]

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[283] Soft tissue is adaptable, lengthening when stretched a lot shortening when contracted a lot. Your soft tissue takes on new shapes based on usage as it adapts to these novel positions and movement patterns. So, even after the pain has gone, you may still hang on to an old comfort zone pattern based on some reshaping that has taken place. Rebalancing may require going through an uncomfortable period as your muscles, tendons... become reshaped to their proper sizes and position. (Brourman S, 1998)

[284] The voluntary extension of the lower limb for walking can be facilitated by the positive supporting reflex, which is an extensor reflex induced by the stimulation of the sole of the foot: this stimulation provides the impetus for each step. (Licht S, 1971)

[285] With the person supine and the lower legs abducted the paretic limb effectuates a similar movement to that of the sane limb (abduction or adduction). (Chusid GJ, 1993)

[286] Strumpell. With flexion of the thigh on the pelvis the foot dorsiflexes, especially if a strong resistance is applied by the examiner. (Chusid GJ, 1993)

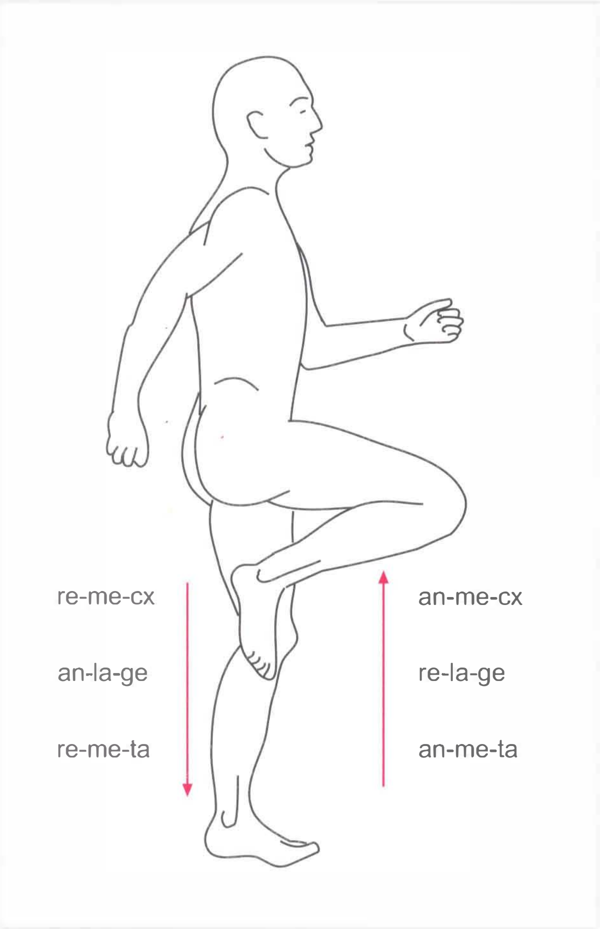

Figure 135. Right leg: triple flexion reflex. Left leg: triple extension or crossed extensor reflex.

- Sterling's sign (as above, but between two unidirectional sequences in 2 limbs)[287]

◊ Spiral reflexes:
- Flexor reflex, which is equivalent to the forward movement of the leg during locomotion.
- Extensor reflex, similar to the stance phase of the gait cycle.

The role played by the spiral fascial structures in the flexor reflex[288] will now be analysed. Note that the new directional terms for flexion, as used in Fascial Manipulation, will be applied. In other words a painful stimulus determines antemotion coxa, retromotion genu and antemotion talus rather than *triple flexion* (Figure 135). These movements can be regulated by a single spiral or by two spirals. To simplify this analysis only one spiral will be considered. In this dynamic movement antemotion coxa is actuated by the cc of fusion of ante-medio-coxa (an-me-cx) and retromotion genu is actuated by the cc of fusion of retro-latero-genu (re-la-ge). Antemotion talus is actuated by the ante-medio-talus (an-me-ta) cc of fusion.

Thus these dynamic movements only involve the cc(s) of fusion. Furthermore, segmentary mf units are associated with these movements only when a sudden effort in a particular direction is required[289] (e.g. the segmentary mf unit of an-ta could be activated to enhance the movement).

During *triple flexion* of one lower limb, the contralateral limb is subjected to the crossed extensor reflex to enable it to support the additional weight thrust upon it. This reflex consists of retromotion talus, antemotion genu (quadriceps contracts to maintain knee extension) and retromotion coxa (pelvis is stabilised to avoid a forward fall). This reflex involves the spiral of retro-medio-talus (re-me-ta), ante-latero-genu (an-la-ge) and retro-medio-coxa (re-me-cx).

Gait analysis from a fascial viewpoint

With some given modifications, this motor organisation of the flexor and extensor reflexes can be found in the gait cycle[290]. Each step can be divided into a stance phase and a swing phase.

The stance phase[291] (Figure 136) requires retro-

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[287] Adduction of a paretic limb following active resisted adduction of the normal limb. (Chusid GJ, 1993)

[288] The flexor reflex consists in the simultaneous flexion of the three major articulations of the limb (for the lower limb, triple flexion of the hip, knee and ankle) and it can be evoked in intact and decerebrate animals by painful stimuli applied the limb itself. Together with triple flexion of the stimulated limb, extension of the contralateral limb (crossed extensor reflex) is also observed. (Baldissera F, 1996)

[289] The cerebral cortex is unaware of the consequences of its commands because these commands intervene in a context against a background of incoming conditions and their final result will necessarily be modified by those conditions. (Turvey MT, 1982)

[290] Comparison between the muscular activity of limbs during locomotion in a spinal animal and in an intact animal does not demonstrate substantial differences. This indicates that the spinal cord alone is capable of generating coordinated and efficient sequences of locomotor activation in the limbs. (Baldissera F, 1996)

[291] At the end of the swing phase the foot touches the ground with the heel first and then, due to a brief ankle extension, with all of the sole. Once contact is established the hip begins to extend (contraction of the glutei) and the knee is maintained in extension by the contraction of the quadriceps. (Baldissera F, 1996)

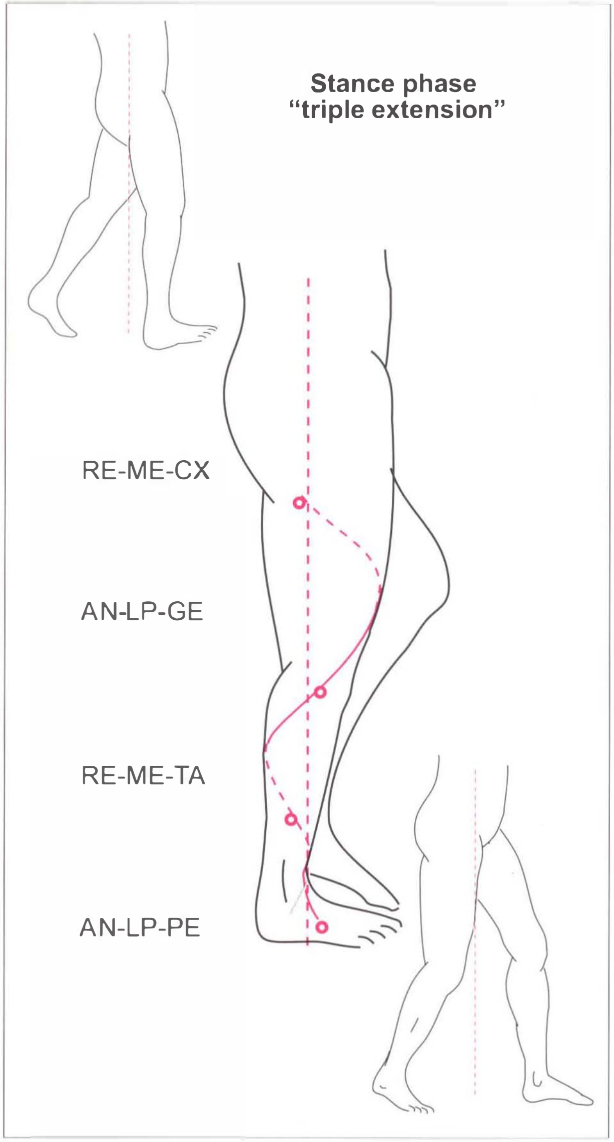

Figure 136. Spiral an-la-pe during management of stance phase.

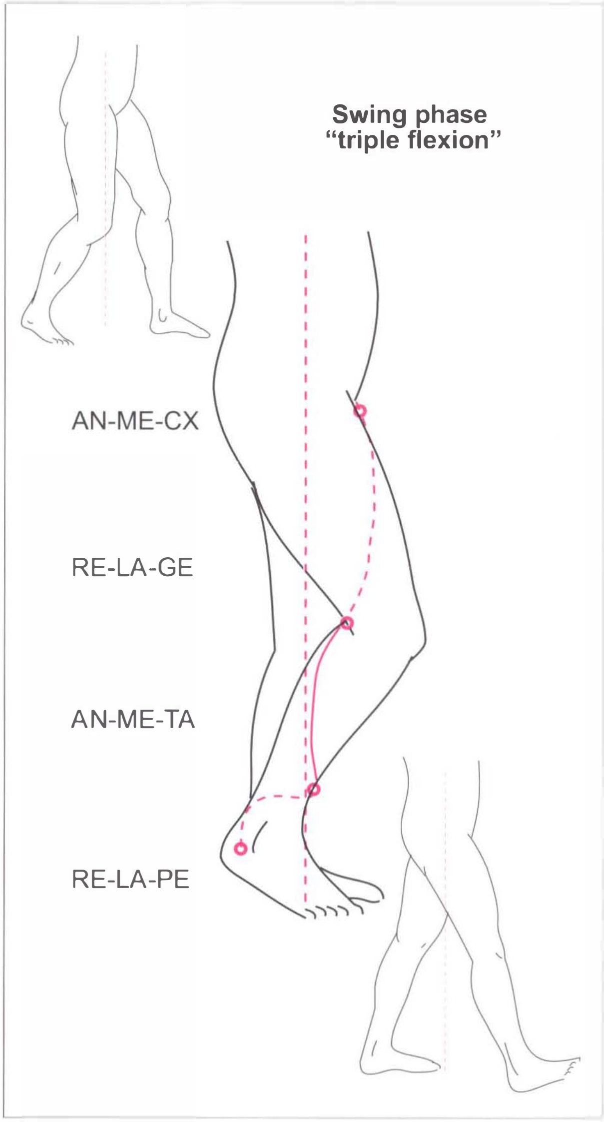

Figure 137. Spiral re-la-pe during management of swing phase

motion of the hip (re-me-cx), quadriceps activity to stabilise the knee (an-la-ge) and stability at the ankle (re-me-ta).

The swing phase (Figure 137) begins with contraction of the mf unit of retro-latero-genu (re-la-ge) whilst antemotion coxa (an-me-cx) and talus (an-me-ta) are activated simultaneously. The foot begins the swing phase in a retro-latero position and then passes into an antero-latero position.

Throughout each step the spirally arranged collagen fibres of the lower limb go through a process of reciprocally "winding up" and "unwinding" themselves. Movement of the various segments in opposite directions is synchronised by tensioning of the retinacula, which in turn are connected to the fascial spirals[292].

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[292] Muscular joint moments and initial joint angular velocities were altered to determine the effects of each upon peak knee flexion in swing phase. As expected, the simulation demonstrated that either increasing knee extension moment or decreasing toe-off knee flexion velocity decreased peak knee flexion. Decreasing hip flexion moment or increasing toe-off hip flexion velocity also caused substantial decreases in peak knee flexion. The rectus femoris muscle played an important role in regulating knee flexion; removal of the rectus femoris actuator from the model resulted in hyperflexion of the knee, whereas an increase in the excitation input to the rectus femoris actuator reduced knee flexion. (Piazza SJ, 1996)

According to neurophysiologists, the spinal organisation of locomotion frees the higher nervous centres from the organisation of movement details. The cortical centres are however responsible for initiating, directing and halting its course.

The capacity of the spinal centres to transform a descending command into the rhythmic and coordinated activity of locomotion is dependent upon the integrity of the stretch reflex arc. It has been demonstrated in numerous animals that this rhythmic activity persists even when the posterior spinal roots have been severed[293].

The organisation of the endofascial spirals provides an explanation for this reflex activity. In laboratory experiments it has been noted that, following sectioning of the posterior roots in cats, the limbs continue to move in a coordinated manner. The question is raised as to how the efferent nerve impulse, in the absence of the afferent impulse, activates the two limbs in alternation. One could hypothesise that, due to the influence of the spirals of the Golgi tendon organs, it is the myofascial tension that allows for one impulse to be activated and the other to be inhibited.

The stretch reflex arc, which corresponds to the contraction of a single muscle in reply to an afferent impulse, cannot synchronise all of the body during locomotion. Antemotion of the lower leg is normally associated with forward movement of the ipsilateral pelvis and retromotion of the contralateral thorax and upper arm[294]. Only the continuity of the mf spirals can explain the sychronisation of movement between all of the body segments.

Myofascial spirals and motor activity

A spiral is a continuous elongated helicoidal line that curves around a central axis.

A spiral structure can flex without folding, lengthen without breaking and is capable of rotation without deformation. A rectilinear structure, such as the longitudinal sequences, is less adaptable to lengthening and twisting but offers more stability and strength.

Segmentary cc(s) coordinate the motor units of a mf unit mostly via feedback from the muscle spindles[295].

The cc(s) of fusion coordinate three mf units, mostly via feedback from the Golgi tendon organs[296].

The segmentary cc is located over the muscle belly and the cc of fusion over retinacula and tendons.

Segmentary cc(s) synchronise the actions of a single segment with the activity of other segments within a unidirectional mf sequence.

The cc of fusion regulates the action of a segment according to the demands of the mf spiral.

It can be said that the more unrestricted the movement the more the spiral organisation intervenes; the more strength is required, then the more the mf sequences are recruited.

By examining the structure of the quadriceps femoris muscle comprehension of these concepts can be enhanced. This muscle has a longitudinal tendon (patellar) that transmits the force of antemotion to the tibia and to the fascia of the anterior compartment of the leg (sequence). Some fibres of the vastus medialis continue on with the patellar retinaculum and also extend towards the lateral part of the tibia. Some fibres of the vastus lateralis participate in the formation of the previously mentioned retinaculum and also extend towards the medial part of the tibia. The activation of one or the other of these three portions of tendon depends on the joint angle. Tensional force in the patellar retinaculum is transmitted to the spirally arranged col-

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[293] Locomotor centre activity in spinal and mesencephalic preparations persists even after sectioning the posterior spinal roots: this excludes the possibility that step rhythm is generated by afferents arising from the movement itself. (Baldissera F, 1996)

[294] The third modification that accompanies the appropriation of adult locomotor movements is the emergence of trunk rotation, which assists the forward movement of the limb. The pelvic girdle is rotated about 5° around the vertical axis in order to bring the side of the transferring limb forward. (Baldissera F, 1996)

[295] Electromyographic analysis demonstrates that the movements are carried out without the use of secondary synergic muscles; nevertheless, the majority of complex movements result from a gradual interaction between external forces, including gravity and passive mechanical properties of various tissues, and an integrated play of variations in tension and length in the prime movers, antagonists, synergists and fixators. There is a constant feedback regarding these models and joint positions, via receptors that are located in different tissues (connective, periarticular, muscular) and, in this way, they are bound to integration and control at all levels of the CNS. (Gray H, 1993)

[296] Altered proprioception highlights many asymmetries. The Golgi tendon organ is centrally involved in the process. Golgi tendon organs pervade all soft tissues including joints, fascial sheaths and aponeuroses. Since Golgi tendon organs are either "on or off" and do not exhibit neural plasticity, they readily respond to outside forces, such as manual manoeuvres. (Basmajian JV, 1993)

lagen fibres of the posterior crural fascia and from here to the retinaculum of the ankle (cruciate retinaculum). In this way ante-mediomotion of the knee during take-off (gait cycle) facilitates retro-lateromotion of the talus. If the only function of the quadriceps were to extend the knee than it would not be formed by a number of muscle bellies but by a single muscular mass. Furthermore, the quadriceps is innervated by different nerve roots with many motor units, indicating a complexity of functions rather than a single function (knee extension) requiring a single motor unit. Given their spiral arrangement the overlying fascial fibres are tensed or relaxed according to the motor activity[297]. When the knee is flexed the anterolateral collagen fibres are under tension and the posterior fibres of the leg are relaxed. Gradually, as the knee extends, the anterolateral fibres loosen and the posterior fibres tighten. The cc(s) of fusion of the various mf units involved in a specific motor activity are recruited, in alternation, by this mechanism.

During every motor activity variations in the setting can demand for sudden changes in roles, not only for segmentary muscular fibres or for one limb but possibly for the whole body. For example, if a person trips while running the spiral scheme is immediately substituted by the directional sequences, in an attempt to block a fall. It is obvious therefore that the dynamic forces (spirals) need to be integrated with the directional forces (sequences). Both the longitudinal and the oblique collagen fibres are comprised within the same fascia. When a tensile variation of these fibres occurs the fascial organisations can be activated separately or simultaneously. Changes in afferent information involve diverse spinal motor schemes hence efferent responses that are appropriate to the situation are produced[298].

The same asynchronous motor activity or coordination can be found in the upper limb. In order to grasp an object the thumb is flexed and adducted and the other fingers are stimulated to flex and abduct to close the grip. The fingers require the extension of the carpus to reinforce their grip[299]. To actuate these variations the brain would have to organise a vector in one direction for the thumb and a vector in the opposite direction for the fingers. It is more probable that peripheral elements perceive and synchronise these gestures. In the anterior part of the carpus (wrist), for example, the flexor retinaculum, which is formed by longitudinal and transverse fibres[300], separates into two laminae. The transverse and oblique fibres continue on with the fascial spirals whereas the longitudinal fibres participate in the sequences. As already mentioned, the sequences coordinate the forces of the unidirectional mf units whereas the spirals coordinate dynamic movements.

The fact that the faster a muscle shortens the lesser the force it is able to exert, somewhat confirms this division of tasks between the fascial sequences and spirals. A person lifting a bag of cement tends to take more time and generally moves in simple, unidirectional directions. When a person punches then they utilise a fast, complex motor scheme. Prior to this action there is a counter movement that accumulates energy[301]: the upper arm positions the humerus (potential energy) in retromotion-mediomotion (re-me), the cubitus (elbow) in antemotion-latero (an-la) and the carpus in retro-medio (re-me) (Figure 138). When the kinetic energy is liberated (movement) the humerus passes into antemotion-lateromotion (an-la), the cubitus into retro-medio and the carpus in antemo-

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[297] An appendage such as an arm or a leg is a biokinematic chain – that is it consists of numerous connected links – so that a change in any one link will influence all the other links. An isolated active movement of the shoulder joint necessarily changes the rest of the arm in some way because all of the articulations are connected. (Turvey MT, 1982)

[298] The segmental apparatus of the spinal cord is an active apparatus that does not passively reproduce descending commands. There are horizontal and vertical connections via interneurones that provide the spinal cord with an autonomous organisation. Signals arriving via afferents adapt transmitted impulses according to the effective circumstances occurring in the periphery. Signals transmitted to the motor cortex concerning muscular tension, muscle length… If the probability of all of the possible combinations of perceptive states were to be calculated moment by moment, by means of afferent mediation, it would place an ever-changing burden on the person carrying out the task. (Grimaldi L, 1984)

[299] If one observes flexion and extension of the wrist together with simultaneous closure and aperture (flexion and extension) of the fingers of the hand it can be noted that, on full flexion of the wrist with the fingers relaxed the fingers tend to extend and widen apart. The opposite occurs with full extension of the wrist: the fingers tend to flex. (Pirola V, 1998)

[300] With regards to structure, the transverse carpal ligament of the wrist is composed of two layers of fibres: a deep layer, formed by transverse fibres; a superficial layer, formed by vertical and oblique fibres that are closely related to the tendon of palmaris longus muscle and the tendons of origin of the hypothenar and thenar eminence muscles. (Testut L, 1987)

[301] The accumulation of elastic energy is greatest when both kinematic and potential energy are at a minimum. Calculations based on tendon elasticity indicate that, in this way, the effort that muscles must exert is reduced by 40%. (Baldissera F, 1996)

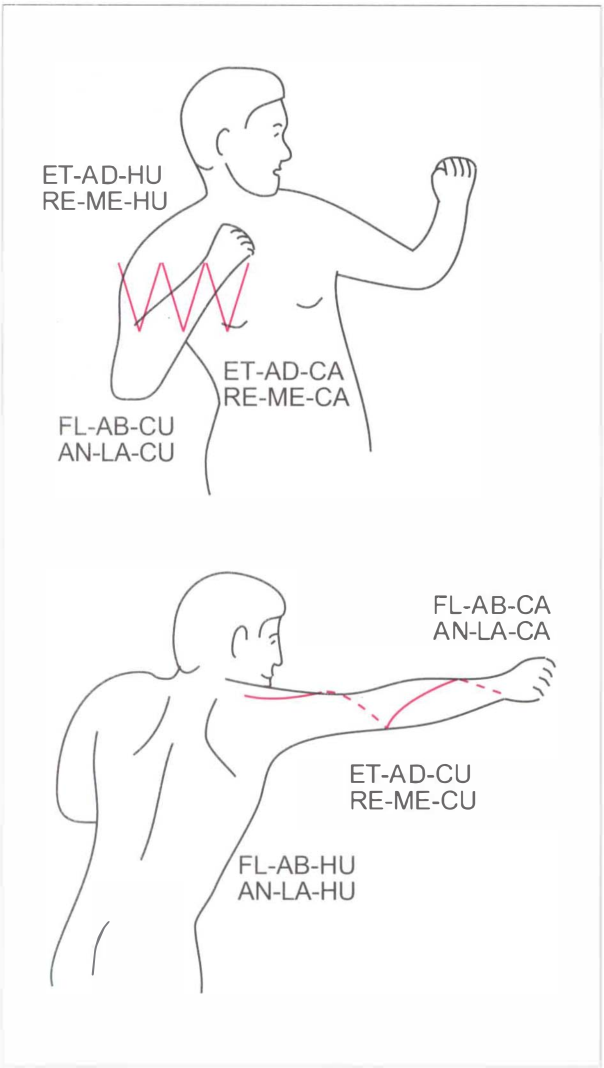

Figure 138. The spirals direct the build up of energy in dynamic gestures.

tion-lateromotion. This alternation of movement between the various segments of the upper limb is united by a spiral of endofascial, collagen fibres. This spiral "winds up" during the preparatory stage (energy of position or potential energy) and it "unwinds" in the dynamic phase. In the preparatory stage the tendons are stretched, allowing for activation of specific nervous receptors for each direction and the synchronisation of the mf units involved in the movement.

Myofascial spirals and tendinomuscular meridians

In clinical practice patients often describe a sciatic-type pain as follows: "The pain starts in my buttock than passes anteriorly over my thigh, the inner side of my knee and ends behind my heel". Yet at other times patients describe the following pain distribution "The pain starts in my buttock and goes straight down the back of my leg". This type of pain distribution in the first case corresponds to the path of a spiral and, in the second case, to the retromotion sequence. Compression of a cc causes pain that radiates either longitudinally or in a spiral pattern. On the basis of this type of pain distribution ancient acupuncturists described two different meridian pathways: the principal meridians, which extend longitudinally, and the tendinomuscular meridians, which follow a spiral pattern.

There are twelve principal meridians, coupled with another twelve distinct (or divergent) meridians whilst, more superficially[302], there are another twelve tendinomuscular meridians (TMM).

The principal meridians correspond to the unidirectional mf sequences (Table 17) and the acupuncture points situated over muscle bellies correspond to the cc(s) of the segmentary mf units[303].

Fascial Manipulation was initially a segmentary treatment that aimed at disentangling free nerve endings from newly formed connective tissue. At first, only the principal meridians were taken into consideration therefore treatment was limited to segmentary points situated over muscle bellies.

Clinical practice, however, highlighted the fact that the body is a single organism and not a series of disconnected segments. At that stage the relationship between the single cc(s) was studied and it was noted that the cc(s) in sequence on one plane were often densified at the same time. The ancient Chinese followed different methods in order to formulate the principal meridians, joining them

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[302] The Chinese divide the planes of the body into five layers where energy circulates: the tendinomuscular meridians are secondary channels that run superficially through the body in the grooves that form between tendons and muscles. Superficially, like ribbons, they follow the pathways of the principal meridians. (Lebarbier A, 1980)

[303] Acupuncture points are characterised by a macroscopic visible nerve-vessel bundle wrapped in loose connective tissue. Before reaching the skin each nerve-vessel bundle has to pass through a narrow channel. In most cases this narrowness is formed by a perforation of the superficial collagen body fascia. The mesenchymal envelope of the nerve-vessel bundle can easily be inflamed. An inflammatory reaction within an acupuncture point channel could cause a compression of the corresponding nerve-vessel bundle with strong pain radiating into the skin (trigger points). (Bauer J, 1998)

Table 17. Names of the meridians and the corresponding mf sequences

Meridians	OMS	Sequence
Lung	LU	Ante upper
Large intestine	LI	Latero upper
Stomach	ST	Latero lower Latero trunk
Spleen	SP	Fusion and Antero trunk
Heart	HT	Medio upper
Small intestine	SI	Retro upper
Bladder	BL	Retro infer Retro trunk
Kidney	KI	Medio lower and Fusion trunk
Peri-cardium	PC	Intra upper
Triple heater	TE	Extra upper
Gallbladder	GB	Extra lower Extra trunk
Liver	LR	Intra lower Intra trunk
Conception	*CV*	*Medio trunk*
Governor v	*GV*	*Medio trunk p*

Table 18. Meridians in series that correspond to sequences of one plane

Energy channels between principal meridians	*Continuity between unidirectional sequences*
TaéYang channel between Bladder and Small Intestine	Sagittal plane Retro sequences upper + lower limb + trunk
Chao Yang channel between Gall Bladder and Triple heater	Horizontal plane Extra Sequences upper + lower limb + trunk
Yang Ming channel between Stomach and Large intestine	Frontal plane Latero Sequences upper + lower limb + trunk.
Taé Yin channel between Spleen and Lung	Sagittal plane Ante Sequences Upper + lower + trunk
Tsiué Yin channel Liver and Pericardium	Horizontal plane Intra sequences Upper + lower + trunk
Chao Yin channel between Kidney and Heart	Frontal plane Medio sequences Upper + lower limbs + trunk

together in series[304] (Table 18).

For example the Taè-yang channel connects the Bladder and Small Intestine meridians in series and corresponds to the posterior part of the sagittal plane (retro sequences of the trunk, upper and lower limbs); the Taè-yin channel connects the Spleen and Lung meridians in series and corresponds to the anterior part of the sagittal plane (ante sequences of the trunk, upper and lower limbs).

Other factors were noted during clinical practice, one being that pain was not always elicited with movements on precise planes but was often accentuated during intermediate trajectories (diagonals). At first it was hypothesised a possible simultaneous involvement of two adjacent sequences but this meant associating two sequences that worked on two different planes. It was noted in fact that points that were quite different from the segmentary cc(s) were involved in the coordination of intermediate transitions. These points became known as the cc(s) of fusion. The Chinese called them luò points[305] and crossing points and they found that these points linked a Yin meridian to a Yang meridian[306]. In the physiology of Fascial Manipulation the synergy between two sequences forms, with their cc(s) of fusion, the intermediate diagonals. These diagonals are readily discernible in many physiological movements such as the ulnar or radial deviation of the forearm (Table 19).

Further progress was made in the understanding of the fascial system with the observation of the fact that points of fusion do not act individually but always in association with one another. Two aspects in particular led to this conclusion:

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[304] The twelve principal meridians are associated to form lines that unite the earth and the sky, in other words the energies of the earth with those of the sky. (Lebarbier A, 1980)

[305] The longitudinal luo points have a supplementary and equilibrating function. The transverse luo points exert an anastomotic action between the coupled principal meridians. The luo channels present a specific point on these meridians called the luò point from which they spread out. (Di Concetto G, 1992)

[306] From the luo point of the Yang meridian a secondary channel passes to the Yu point of the principal Yin meridian. (Lebarbier A, 1980)

The first couple of distinct meridians originate from the principal meridians of Bladder and Kidney in the popliteal fossa. The second couple originate from the Gall Bladder and Liver meridians near the hip and pubic area. The third couple originate from the Stomach and Spleen meridians near the inguinal area. The fourth couple originate from the Small Intestine and Heart meridians near the shoulder. The fifth couple originate from the Triple Heater and the Heart Constrictor meridians in the area of the neck. The sixth couple originate from the Large intestine and the Lung meridians. (Di Concetto G, 1992)

Table 19. Meridians in parallel associated to corresponding mf diagonals

Energy exchange between Yin Yang meridians	*Diagonals resulting from synergy of two sequences*
Bladder-Kidney	Retro-medio lower = Retromotion of leg
Gallbladder-Liver	Trunk coupled force = Extra-Intrarotation
Stomach-Spleen	Ante-latero lower = Antemotion of leg
Small Intestine-Heart	Retro-medio upper = Ulnar deviation
Triple Heater - Pericardium	Synergy of forces = Motor scheme rotat.
Large Intestine-Lung	Ante-latero upper = Radial deviation

1) in clinical practice it was noted that these points radiated symptoms along a spiral pathway;
2) from anatomical studies it was noted that these cc are positioned above retinacula, all of which have a spiral configuration.

Likewise, in acupuncture, the tendinomuscular meridians (TMM) have crossing points near articulations as well as non-linear pathways. The cc(s) of fusion are rarely treated along a diagonal (e.g. an-la-ca, an-la-cu, an-la-hu) whereas they are often involved together in a spiral (e.g. an-la-ca, re-me-cu, an-la-hu). In fact, movements are more commonly organised in a spiral mode.

Some parallels between the tendinomuscular meridians and the myofascial spirals will now be discussed.

- The TMM or ligamentous meridians[307] are more superficial than principal meridians and they have crossing points that correspond to some cc(s) of fusion (Table 20). The crossing point of the three Yin meridians corresponds to the motor scheme of ante-medio-intrarotation. The crossing point of the three Yang meridians corresponds to the motor scheme of retro-latero-extrarotation.
- In the TMMs the circulation of energy is from below to above. The spirals begin in the extremities of the limbs and they extend proximally; it is the hand or the foot that requires that the rest of the limb adapts to its needs. The mf sequences maintain the centre of gravity of the body over its base hence they originate in the trunk and extend out to the extremities.
- The TMMs anastomose with the principal meridians at points of insertion[308]; these points are found around the large articulations such as the ankle, knee and hip in the lower limb and the wrist, elbow and humerus in the upper limb. The cc(s) of fusion of the spirals are also located in the retinacula of these same articulations. These cc(s) of fusion, which are linked with the Golgi tendon

Table 20. Crossing points of the tendino-muscular meridians and cc(s) of fusion of the spirals

TM Meridians	*Points*	*CC of fusion*
3 Yang meridians of the foot unite over the maxilla	18 SI	AN-LA-CP Convergence of an, me sequences
3 Yin meridians of the foot unite above the pubis	3 VC	AN-ME-PV Convergence of An, me inf seq.
3 Yang meridians of the hand unite in temporal fossa	13 GB	RE-LA-CP Convergence of re, la sequences
3 Yin meridians of the hand unite near the axilla	22 GB	AN-ME-HU Convergence of an, me sequences

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[307] The TM meridians are the most superficial energy channels amongst the secondary meridians. They distribute Qi from the 12 principal meridians to muscles and tendons and maintain normal movements. Their course begins in the extremities (hands and feet) and involves the larger joints as they extend centrally. (Di Concetto G, 1992)
The TM meridians are divided into four groups; each group represents a system composed of three meridians: the three yang meridians of the hand anastomose at the hairline (VB 13). The three yin meridians of the hand anastomose in the region beneath the axilla (GB 22). The three yang meridians of the foot anastomose near the mandible (IG 18). The three yin meridians of the foot anastomose in the region above the pubic bone (CV 3). (Di Concetto G, 1992)

[308] The pathways of the Tendinomuscular channels begin in the extremities (fingers or toes) and as they ascend involve the larger articulations of the limbs: in this way, from an energetic aspect, the articular connection required for movement is guaranteed. Anastomoses with deep tissues come about via points of insertions with the principal meridians. The Tendinomuscular meridians have their own ample and diffuse pathways that could be described as being like a sash. (Di Concetto G, 1992)

organs, interact with the segmentary cc(s) which are more closely linked with muscle spindles.

- The TMMs have a sash-like pathway and they unite functionally in groups of three in predetermined points. The spirally arranged collagen fibres and the retinacula, quite differently from the longitudinal formation of the mf sequences, have a ribbon-like form. These spirals unite and exchange roles in proximity of the large articulations.
- The TMMs have numerous branches or ramifications that detach from the main pathway. By connecting the ramifications of the meridians on one side with those of the opposite side it can be seen that they form a type of continuity, which is similar to the mf spirals. The divergent meridians and the tendinomuscular meridians of the upper limb are directly connected with those of the lower limb.

In order to explain certain parallels that exist between the spirals and the tendinomuscular meridians, the TMM of the Stomach will now be examined (Figure 139). This meridian starts in the II°, III°, IV° toe as opposed to the principal meridian which originates in the II° toe. This demonstrates how the tendinomuscular meridians have a band-like pathway and not a linear one, such as the principal meridians. Furthermore, the pathway of the TMM involves a number of points[309] that lie outside of the principal meridians. In fact, near the ankle, the TMM of the Stomach divides into two branches[310], which correspond to the subdivision of the extensor retinacula. The successive pathways can be superimposed over the sequences of antemotion and lateromotion. The branch that extends up the anterior part of the leg and thigh corresponds to the sequence of antemotion; the branch that extends along the lateral part of the leg and thigh is analogous to the sequence of lateromotion. Once it reaches the trunk the internal branch continues over the anterior part of the abdomen and the thorax, similar to the sequence of antemotion; the external branch extends over gluteus maximus and over the floating ribs, corresponding to the sequence of lateromotion. A spiral formation emerges by tracing the continuation of these two branches from one side of the body to the contralateral side. Once the internal branch[311] reaches the inguinal area it con-

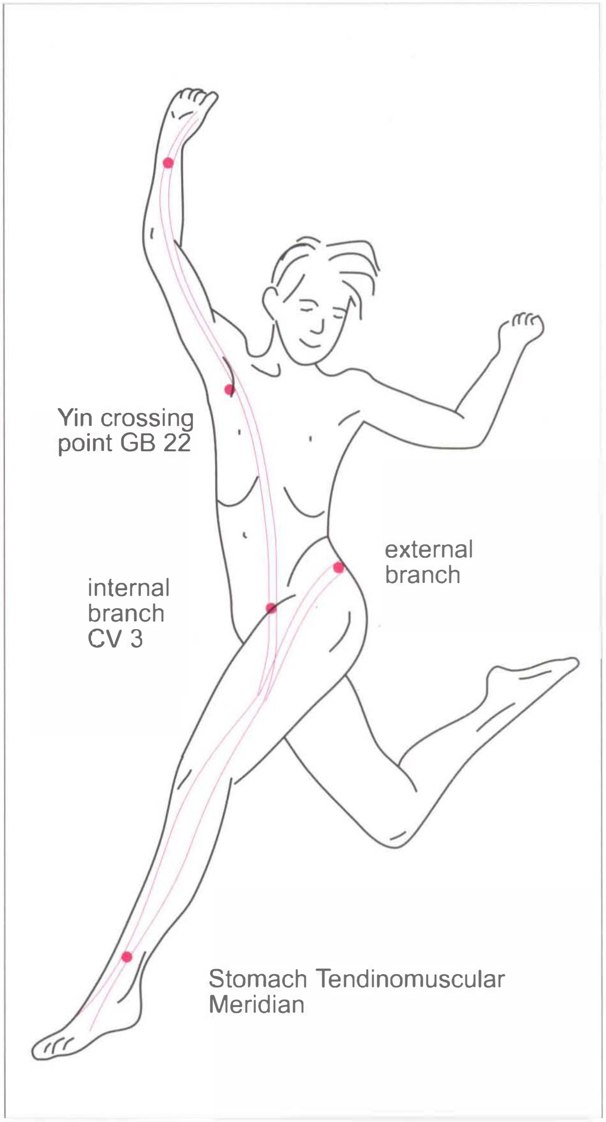

Figure 139. The Tendinomuscular Meridians and the myofascial spirals.

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[309] The TMMs reunite functionally in groups of three around specific meeting areas; these areas do not coincide with a single point but with at least two acupuncture points due to the ribbon-like pathway of the TMM. (Di Concetto G, 1992)

[310] The external branch follows the external part of the knee and the hip to reach the floating ribs and terminates at the vertebral column. The internal branch passes from the ankle to beneath the patella over the anterior muscles of the thigh and converges in the genital area (VC 2)...(Di Concetto G, 1992)

[311] Many channels cross at one point, the so-called crossing points, which acquire those therapeutic qualities that are common to the different channels. For example the three Yin channels of the foot cross in the lower abdomen at Ren 3; consequently points along the three Yin channels can be used in the cure of pelvic disturbances. (Lebarbier A, 1980)

verges with the linea alba where the contralateral internal branch also converges. By continuing the internal branch of the left leg, for example, with the internal branch on the right side of the trunk, the pathway of the anterior spiral is formed (Figure 139). In the thorax the TM meridian of the Stomach (ST 12) connects with that of the Gallbladder; on this meridian the three Yin meridians of the upper limb converge (at GB 22). In the axilla there is also a branch of the TM meridian of the Bladder. The possibility to superimpose the TM meridians over the myofascial spirals demonstrates that myofascial spirals are connected to multiple directions or motor schemes. The ancient Chinese did not elaborate the TM meridians just to complicate life[312] but because it was noted that referred pain often followed different pathways to those mapped out for the principal meridians.

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[312] A possible ancient Chinese scholars' saying: "If we can manage to make acupuncture so complicated that it is practically incomprehensible then we will hold the power!" (Mann F, 1995)

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Chapter 18
MF SPIRALS OF THE UPPER LIMB

The upper limb is capable of a greater variety of complex motor activities than the lower limb. During a person's life walking is the most dominant activity of the lower limbs. This activity reinforces endofascial, collagen fibre connections to such an extent (with criss-cross fibres, superior, inferior and patellar retinacula etc.) that they are easily visible and widely documented by anatomists. Even though spirally arranged collagen fibres are also found in the fascia of the upper limbs, these limbs carry out such a great variety of movements that any one particular arrangement has not been reinforced. Anatomists have limited their description of the structure of these fasciae to a composition of collagen fibres of multiple directions that cross over each other. However, if these criss-cross fibres are studied as being the result of traction caused by motor activity then the existence of well programmed spirals becomes evident. For example, when we grasp an object the fingers flex in a radial direction (ante-latero-digiti) and the thumb flexes in an ulnar direction (ante-medio pollex). Repetition of this gesture has reinforced the flexor retinaculum. Without voluntary intervention the wrist extends whenever the fingers flex[313]. These two segments are synchronised in opposite directions, not by volition but by the continuity of the endofascial, collagen fibres that pass from the flexor retinaculum to extend over the extensor tendons[314].

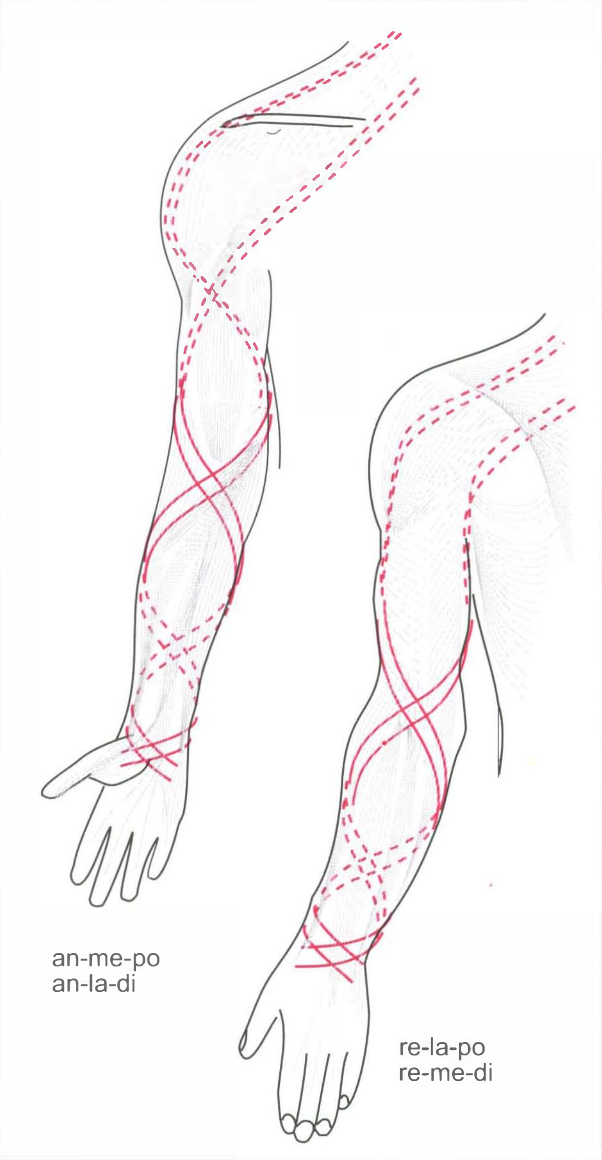

Figure 140. The synergy between spirals.

Figure 140, illustrates the synergy between the two spirals of the upper limb that start anteriorly and the two spirals that start posteriorly. These spi-

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[313] Optimum wrist function during grip requires about 40° of dorsiflexion and a simultaneous ulnar abduction of about 10°. This is brought about by the action of the tendons of the multiarticular muscles, which is subdivided into concurrent and counter current movement, or agonist and antagonist synergy. (Pirola V, 1998)

[314] Disregarding the rule that the deep fascia adheres to all subcutaneous bony parts, the more proximal fibres of the extensor retinaculum curve around the head of the ulna and continue on with the deep fascia of the ventral surface of the forearm. (Basmajian JV, 1984)

rals can work together, as do their counterparts in the lower limb.

The retro-latero-pollex spiral

The retro-latero-pollex spiral begins at the centre of the anatomical snuffbox and ascends, with the collagen fibres of the extensor retinaculum[315], up to the medial part of the ulna (Figure 142). It continues with the proximal fibres of the flexor retinaculum, also known as the annular ligament (so called because its fibres do not stop at the ulna but form a ring around the whole wrist). By following the collagen fibres that separate from this ligament and continue on in the antebrachial fascia, it can be seen that this spiral extends to the lateral part of the forearm. Here it joins with collagen fibres that are aligned according to the traction of the medial head of triceps. As already mentioned, a part of the triceps tendon continues on into the posterior fascia of the forearm. The longitudinal fibres of this myofascial insertion were taken into consideration with the study of the mf sequences whereas the oblique fibres of this insertion are involved in this mf spiral. By following the fibres aligned along the lines of force of the medial head of triceps, this spiral arrives at the medial intermuscular septum (Figure 144). This septum is a continuation of the axillary fascia[316], which is tensioned by the tendinous expansions of the pectoralis major[317] and minor[318]. The myofascial spiral, which is influenced by the traction of these pectoralis muscles, passes over them.

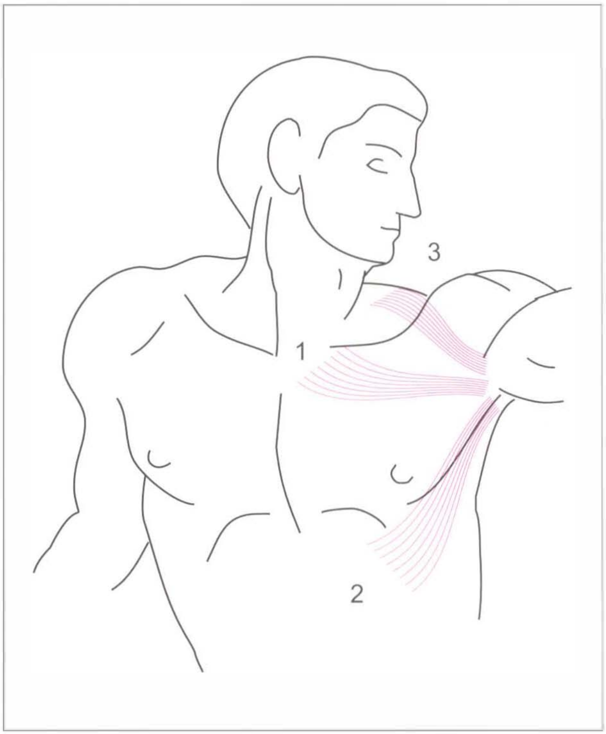

Figure 141. Possible extensions of the re-la-po spiral.

The pathway of this spiral can then proceed as follows (Figure 141):

1. it continues over the pectoralis fascia where the synergic cc of ante-medio-scapula is located; from here it continues with those fibres that extend towards the sternal insertion of the contralateral sternocleidomastoid;
2. it joins with the collagen fibres that descend from the pectoralis major to pass over the abdominal muscles and fasciae (forms the connection with the lower limb necessary for the cruciate synchrony of gait: antemotion coxa on one side together with contralateral antemotion humerus);
3. it continues on with the collagen fibres of the anterior trapezius, united to the clavicular part of deltoid, in order to connect with the antagonist cc of fusion (re-la-sc).

Uniformity of location between the cc(s) of fusion and points indicated from other methods is often not precise. However, these differences do highlight the fact that the same dysfunction can be attributed to different causes: energetic (acupuncture), muscular (Travell), vertebral (Maigne) or tendinous (Cyriax).

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[315] With regards to structure, the dorsal carpal ligament is composed of transverse fibres, vertical fibres and cruciate oblique fibres. (Testut L, 1987)

[316] The axillary fascia is the continuation of the pectoralis fascia that separates from the pectoralis major muscle along its inferior margin (anterior axillary fold). It passes across and below the axilla to join with the inferior margin of the latissimus dorsi muscle (posterior axillary fold); from here on it continues with the fascia of the lat. dorsi. A fibrous-tendinous band, concave towards the arm (the fibrous arch of the axilla), forms the axillary fascia together with an entirely fibrous margin externally, which is formed by the fascia of the arm and is concave towards the axilla (the fibrous arch of the arm). (Chiarugi G, 1975)

[317] The axillary arch of the latissimus dorsi may insert onto the humerus, together with the abdominal portion of the pectoralis major m., at the level of the fascia of the coracobrachialis and biceps muscles (axillary arch of pectoralis). (Lang J, 1991)

[318] The medial margin of the suspensory ligament of the axilla or Gerdy's ligament, merges with the fascia of pectoralis minor and the lateral margin of the same ligament merges with the fascia of the coracobrachialis m. (Testut L, 1987)

Mf unit of the re-la-po spiral

Retro-latero-pollex (re-la-po) cc of fusion

– This cc is located in the anatomical snuffbox, distally to the styloid process of the radius. From here it controls the tendons of the extensor pollicis longus and brevis (re) and of the abductor pollicis longus (la) (Figure 142) (Table 32).

– This cc corresponds to the acupuncture point LI 5 and to the treatment point that Cyriax indicates for early arthritis, or arthritis due to trauma to the thumb[319].

Ante-medio carpus (an-me-ca) cc of fusion

– This cc is proximal to the flexor retinaculum, between the tendons of palmaris longus (me) and flexor digitorum (an).

– This cc corresponds to the acupuncture point PC 5 (Luo point for the group of Yin meridians of the upper limb). It also corresponds to the treatment point that Cyriax indicates for tenosynovitis of flexor digitorum caused by overuse.

Retro-latero-cubitus (re-la-cu) cc of fusion

– This cc is located along the lateral intermuscular septum of the forearm, over the space between the lateral epicondyle and the olecranon. From here it organises the retromotion-cubitus component, effectuated by the triceps tendon and the lateromotion component, effectuated by brachioradialis (la).

– This cc corresponds to the acupuncture point TE 9, to the trigger point (TP) of the anconeus, as well as being one of the four sights that Cyriax indicates for the treatment of epicondylitis.

Ante-medio-humerus (an-me-hu) cc of fusion

– This cc is located over the thoracic border of the axillary retinaculum and from here it organises the synergy between pectoralis major, coracobrachialis (an) and latissimus dorsi (me)[320].

– This cc corresponds to the acupuncture point GB 22, as well as to the lesion of the glenoid capsule as indicated by Maigne[321].

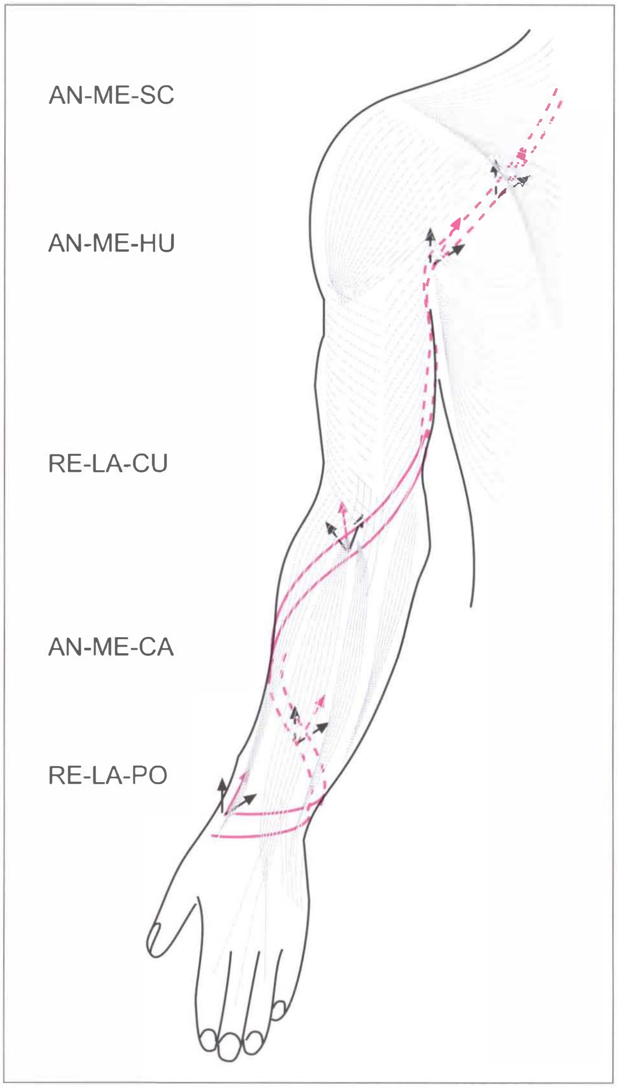

Figure 142. Cc(s) of fusion of the re-la-po spiral.

Ante-medio-scapula (an-me-sc) cc of fusion

– This cc is at the centre of the sternal portion of the pectoralis major (II intercostal space) From here it synchronises the coracoclavicular-axillary fascia (an, ir) and the pectoralis major fascia (me).

– This cc corresponds to the acupuncture point ST 15, as well as the three TPs of the sternal portion of pectoralis major.

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[319] The pathognomonic, or characteristic, sign of arthritis of the first carpometacarpal joint is pain on posteriorly directed passive movement applied during extension because it is the capsule of the joint that is principally involved. (Cyriax J, 1997)

[320] The medial septum extends proximally up to the zone of insertion of the coracobrachialis, sometimes bridging the intervening solcus to reach the tendon of insertion of latissimus dorsi from which it receives reinforcing fibres. (Lang J, 1991)

[321] The object of palpation will be the cutaneous planes by means of "Pincé roulé". The existence of a piercing pain in the anterior part of the axillary cavity would indicate a lesion of the glenoid capsule. (Maigne R, 1979)

The retro-medio-digiti spiral

The retro-medio-digiti spiral begins at the ulnar extremity of the dorsal carpal ligament (Figure 144). It continues on with the fibres of the superficial surface of the extensor retinaculum until it reaches the lateral border of the radius (Figure 145). From here the spiral winds towards the medial part of the forearm following the proximal oblique fibres of the flexor retinaculum. This retinaculum is continuous with the antebrachial fascia[322]. Within this fascia, in continuity with various motor tractions, there are fibres that cross each other at different angles. Such traction can be passive, that is it originates from the movement of bones onto which the retinacula are inserted or else active, produced by the muscular insertions onto the fascia. Near the medial part of the elbow the spiral proceeds with collagen fibres[323] that are formed from traction of the lateral head of triceps[324] (Figure 143). This muscular part originates from the lateral septum, which, in turn, is the continuation of the deltoid fascia[325]. The fascia over the deltoid tendon has the formation of a retinaculum because anterior flexor, posterior extensor and longitudinal abductor traction of the deltoid are all transmitted to this area. The spiral, influenced by the flexor tension, extends above the antero-lateral part of the deltoid muscle. The anterior fibres of deltoid originate from the clavicle and the spiral follows these fibres to pass into the supraclavicular fossa, anteriorly to the clavicular insertion of the trapezius muscle[326].

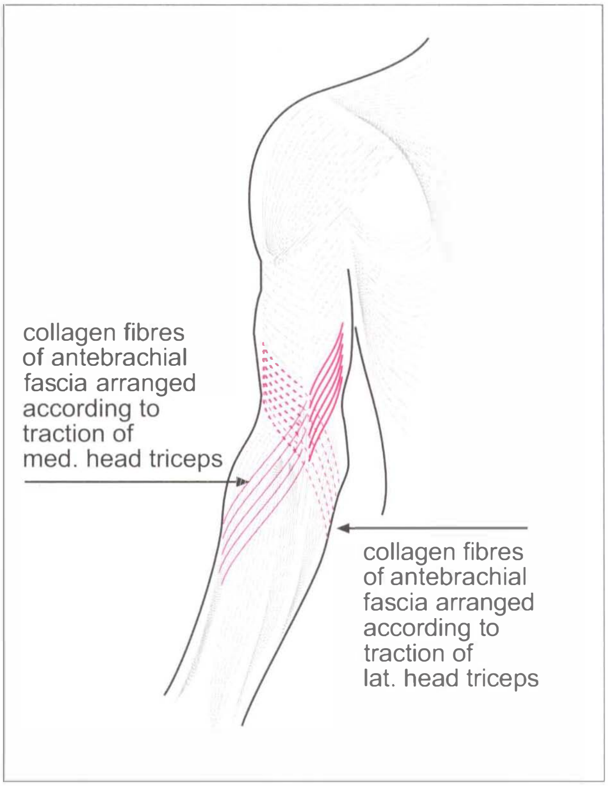

Figure 143. Oblique fibres of the olecranon fascia.

This spiral continues on:

1. in the anterior part of the trapezius with the synergic cc of fusion of the scapula, from where it then ascends to the cc of fusion of the ipsilateral part of the neck;
2. in the posterior part of the trapezius where it can unite with the antagonist cc of fusion.

Each retinaculum at each articulation allows for variations in the pathways of these fascial spirals. The fascia, on the basis of the movements requested by the brain, coordinates the peripheral motor organisation. The spirals described here correspond to the most frequently repeated motor gestures. However, according to the variables of the requested movement, the traction to which the fascia is subjected changes hence variations in the inhibition and facilitation of muscular fibres occur.

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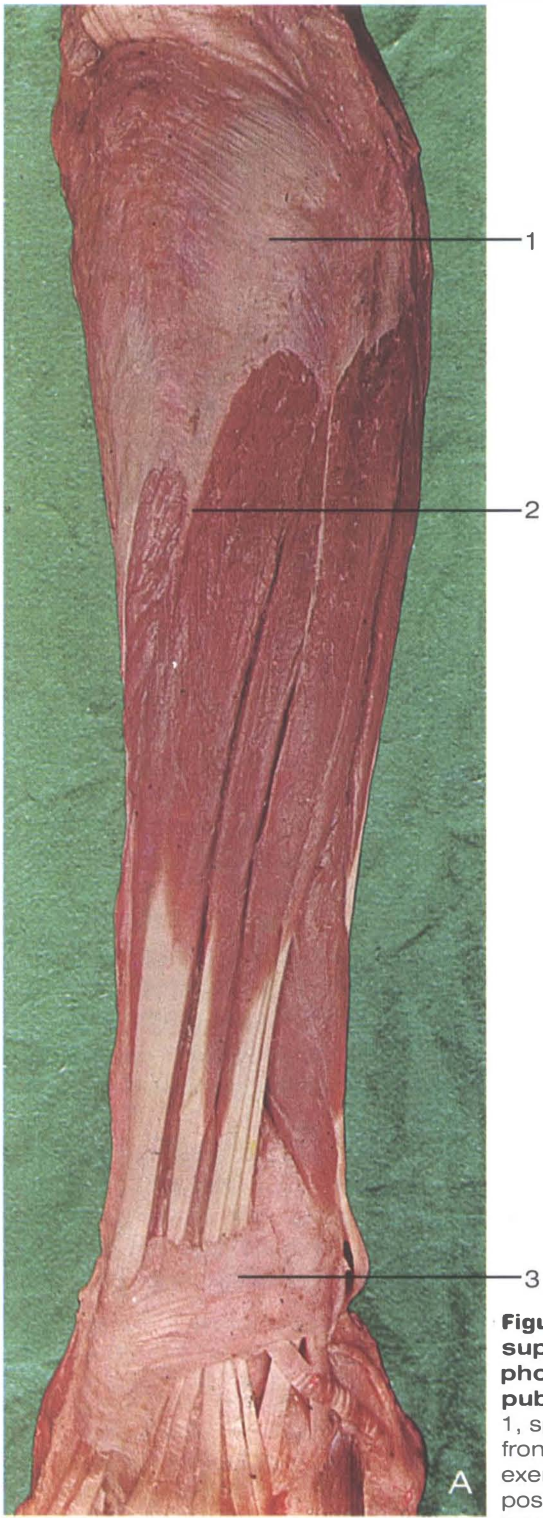
[322] The antebrachial fascia is reinforced in the distal part of the forearm by transverse fibres that form the extensor retinaculum on the dorsal side and the flexor retinaculum on the palmar side. (Platzer W, 1979)

[323] The structure of the fascia of the forearm consists of three types of fibres; they can run longitudinally, in a circular manner or obliquely, with a great variety of criss-cross fibres. (Chiarugi G, 1975)

[324] The structure of the triceps consists of two aponeurotic laminae. After having received the muscular bands the two laminae reunite... a bundle of fibres continues below , over and above the anconeus and merges with the antebrachial fascia. (Gray H, 1993)

[325] The lateral intermuscular septum unites with the deltoid tendon. (Gray H, 1993)

[326] The inferior insertions of the trapezius correspond to the superior insertions of the deltoid, hence the supposition that the two muscles are part of the same system. This supposition is confirmed by the fact that in those animals in which the clavicle is lacking, the anterior part of the trapezius forms a single muscle together with the corresponding part of the deltoid. (Chiarugi G, 1975)



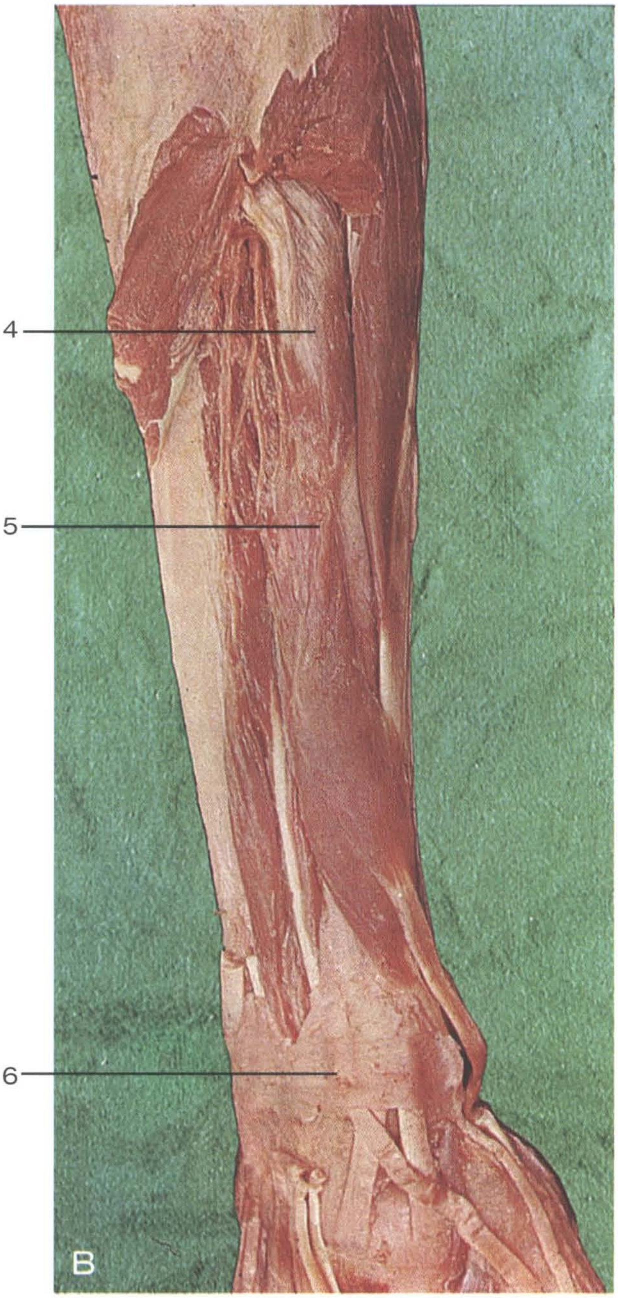


Figure 144. The posterior compartment of the forearm; A - superficial layer, B - deep layer (from Fumagalli - Colour photographic atlas of macroscopic human anatomy; - published by Dr. Francesco Vallardi/Piccin Nuova Libraria). 1, spirally arranged fibres of the antebrachial fascia, which extend from retro-latero-cubitus to ante-medio in accordance to traction exerted by the medial head of triceps; 2, longitudinal fibres of the posterior brachial fascia that align themselves according to the traction that the triceps tendon insertion exerts on the compartment of the extensor carpi ulnaris (retromotion sequence); 3, spirally arranged fibres of the extensor retinaculum; here the deep fascia reconnects with the tendons after having become independent from the epimysial fascia; 4, fascia of the supinator muscle, which is continuous with that of the abductor pollicis longus. The extrarotation sequence follows a deep pathway; 5, the proximal fibres of the abductor pollicis longus; their alignment differs from that of the distal fibres; the proximal fibres can only act as extrarotators of the carpus; 6, extensor retinaculum with pathway that ascends from the thumb; the anatomist has evidenced in Photo A. some collagen fibres (re-me-di spiral) and in Photo B. other collagen fibres (re-la-po spiral).

Mf unit of the re-me-di spiral

Retro-medio-digiti (re-me-di) cc of fusion

– This point is located over the carpal bones between the tendons of extensor digitorum and extensor digiti minimi. From here it controls the extensor trajectory of these tendons as well as the ulnar deviation component, actuated by flexor carpi ulnaris and extensor carpi ulnaris (Figure 145) (Table 33).

– This cc corresponds to the acupuncture point SI 5 and to the treatment point at the base of the fifth metacarpal indicated by Cyriax for the extensor carpi ulnaris.

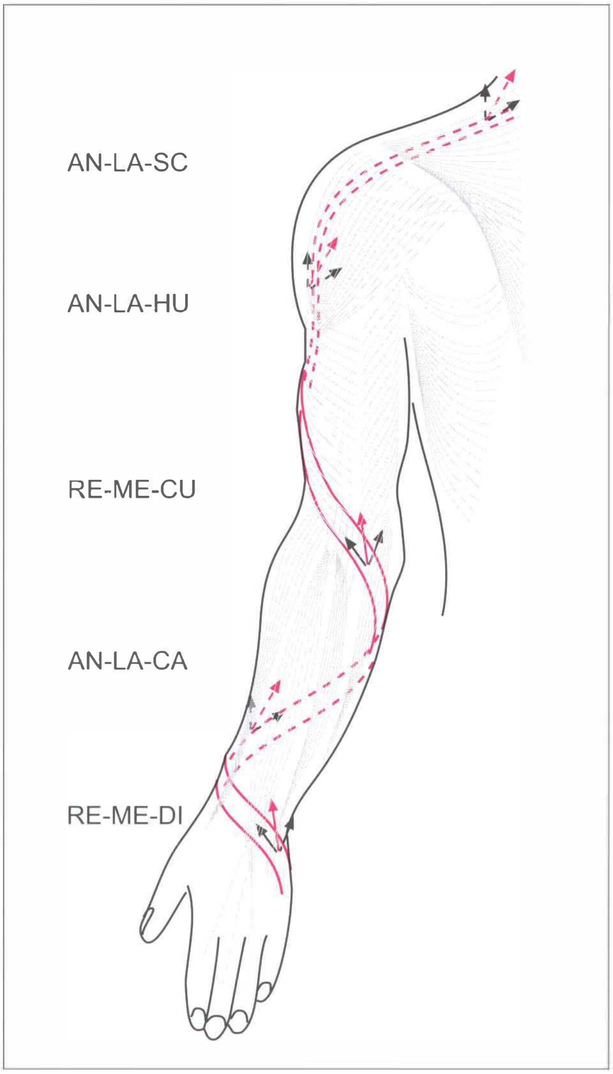


Figure 145. Cc(s) of fusion of the re-me-di spiral.

Ante-latero-carpus (an-la-ca) cc of fusion

– This point is located where the flexor retinaculum terminates, over the flexor pollicis longus muscle.

– This cc corresponds to the acupuncture point LU 7 (Luo point, from which both a longitudinal and transverse channel for the Large Intestine originate). It also corresponds to the zone of treatment indicated by Cyriax for tenosynovitis.

Retro-medio-cubitus (re-me-cu) cc of fusion

– This point is located medially to the triceps tendon between the medial epicondyle and the olecranon. From here it controls the adductor component of the muscles inserted onto the medial intermuscular septum and the extensor component of triceps.

– This cc corresponds to the acupuncture point SI 8 and to the medial epicondylitis of Maigne[327].

Ante-latero-humerus (an-la-hu) cc of fusion

This point is located proximally and anteriorly to the deltoid insertion. From here it influences the abductor component of deltoid and the flexor component of pectoralis major.

– This cc corresponds to the acupuncture point LI 14 and the zone of treatment indicated by Cyriax for lesions of the biceps tendon[328].

Ante-latero-scapula (an-la-sc) cc of fusion

– This point is located in the supraclavicular fossa near the clavicular insertion of the trapezius muscle. It controls the lateromotion or abductor force of the scapula (trapezius) as well as the antemotion force (omohyoid).

– This cc corresponds to the acupuncture point ST 12 (point of anastomosis of the tendinomuscular meridians of the lower limb, crossing point of the Luo meridians of the upper limb and the point of passage for the Yang meridians).

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[327] Often in epicondylitis there is a loss of passive mobility at the elbow, which can be treated with lateral mobilisations and/or intra-articular injections of cortisone. The cervical origin can possibly be found in a "cervical disorder of C7-D1". (Maigne R, 1979

[328] Almost always the tendon is damaged in its upper part but the therapist must palpate along its whole length in order to find the exact point. Then massage has such a rapid effect, even in cases that have persisted for years, that infiltration is practically useless. (Cyriax J, 1997)

The ante-medio-pollex spiral

The ante-medio-pollex spiral begins over the transverse carpal ligament between the tendons of flexor carpi radialis and the styloid process of the radius. The muscles that effectuate the movements of flexion and adduction of the thumb insert onto this ligament[329]. Hence this ligament, come retinaculum, guides (Figure 146) the movement scheme for opposition of the thumb (ante-medio-po).

Traction, exerted by the previously mentioned muscles, forms the collagen fibres that extend from the thenar eminence to the ulna. The spiral follows these fibres passing to the medial part of the ulna where it connects with the flexor retinaculum. This retinaculum is in fact the continuation of the dorsal carpal retinaculum; in a proximal direction this retinaculum continues on with the antebrachial fascia; the spiral follows the endofascial, collagen fibres[330] which extend towards the lateral border of the forearm. From here it follows the fibres created by the traction of the pronator teres muscle (Figure 148).

From the medial epicondyle the spiral ascends, following the oblique fibres of the posterior brachial fascia and, in particular, the collagen fibres that have formed as a consequence of deltoid muscle traction on the brachial fascia.

The pathway of this spiral continues on from the retro-lateral part of the deltoid:

1. with the fibres of the trapezius and the supraspinatus where the synergy of the scapula with the humerus, in the movement of extension and abduction, is to be found (re-la-sc);
2. with the fibres of the anterior deltoid-pectoralis fascia, where the fibres that move the scapula in an antagonist direction to the humerus are located.

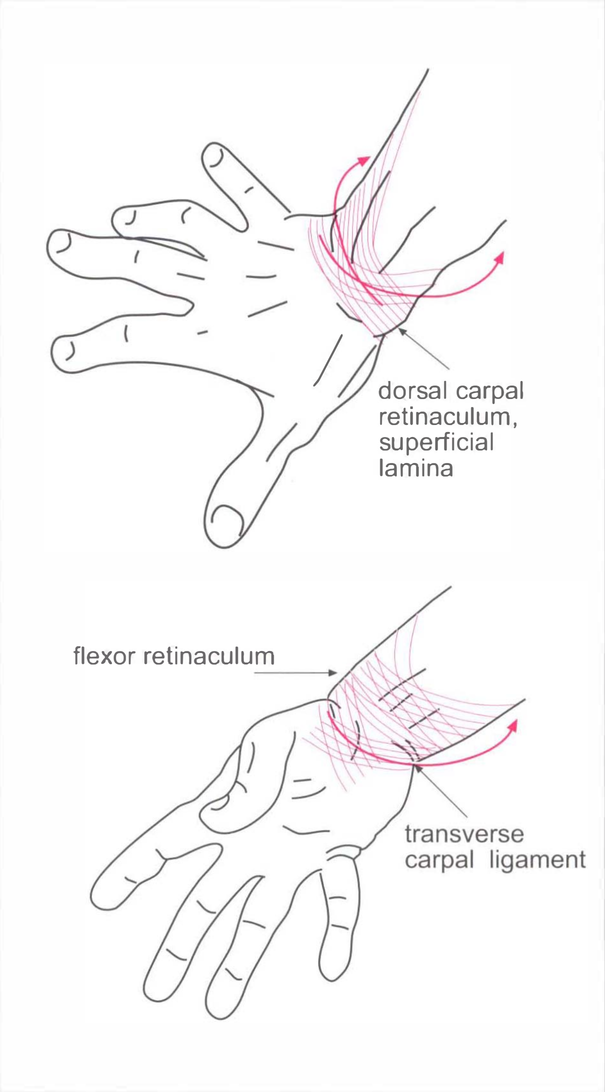

Figure 146. Traction on the retinacula of the carpus.

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[329] The transverse carpal ligament measures 2.5-3 cm. in width; its proximodistal length is about the same. Laterally it divides into two laminae, which contain the tendon of flexor carpi radialis. On its volar surface the tendons of palmaris longus and flexor carpi ulnaris are partially inserted; distally some thenar and hypothenar muscles are also inserted. (Gray H, 1993)

[330] The two systems of fibres pertaining to the antebrachial fascia are practically all directed longitudinally; to these are added – along all the length of the forearm – circular fibrous bands, which can be considered as muscular bands, produced by the expansion and retraction mechanism of the single muscle bellies. These fibres insert onto both sides of the dorsal margin of the ulna and reach their maximum density in the zone of passage near the wrist, where they literally become ligaments: the anterior and posterior ligaments of the radiocarpal articulation. Scars that form following injury or inflammatory processes, cause adhesions between the fascia and the skin resulting in a limited mobility of the singular muscle groups and hence limitation of forearm, wrist and hand function. Even small scars on the forearm can bring about rather obvious limitations of the hand. (Lang J, 1991)

Mf unit of the an-me-po spiral

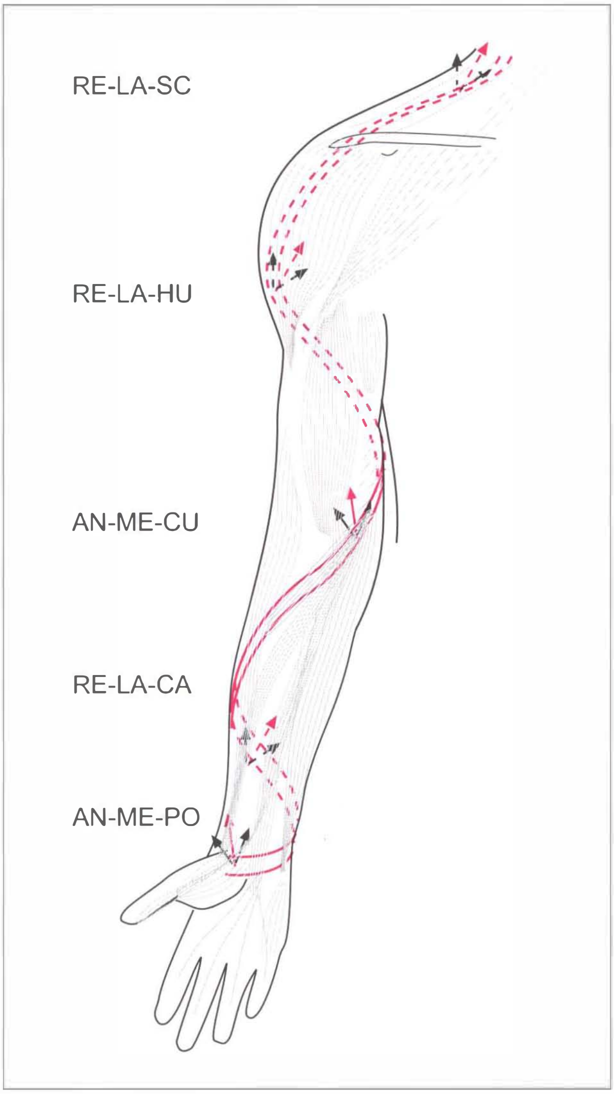

Figure 147. Cc(s) of fusion of the an-me-po spiral.

Ante-medio-pollex (an-me-po) cc of fusion

– This point is located over the volar surface of the wrist near its lateral crease. The traction of flexor pollicis brevis (ante) and opponens pollicis (medio) converges at this point (Figure 147) (Table 35).

– This cc corresponds to the acupuncture point LU 9 (point which receives the transverse Luo vessel of LI 6 and is also part of the eight crossing points of the energetic vessels). It also corresponds to the zone indicated by Cyriax for the treatment of tenosynovitis of the flexor pollicis longus.

Retro-lateral-carpus (re-la-ca) cc of fusion

– This point is located in the solcus between the extensor carpi radialis (retro) and the abductor pollicis longus (latero).

– This cc corresponds to the acupuncture point TE 5 (key point of the Yang connecting vessel).

Ante-medio-cubitus (an-me-cu) cc of fusion

– This point is located on the medial part of the arm where pronator teres (ir), flexor carpi ulnaris (me) and flexor digitorum (ante) converge.

– This cc corresponds to the acupuncture point HT 3 and to the zone indicated by Cyriax for medial epicondylitis or golfer's elbow[331].

Retro-latero-humerus (re-la-hu) cc of fusion

– This point is posterior and proximal to the deltoid insertion where the forces of extension (retro) and lateromotion humerus converge.

– This cc corresponds to the acupuncture point TE 13 (crossing point with the curious meridian, Yangwei) and to the TPs of the posterior border of deltoid[332].

Retro-latero-scapula (re-la-sc) cc of fusion

– This point is located in the medial part of the supraspinatus fossa where trapezius and levator scapula act on the scapula together, elevating it and moving it backwards.

– This cc corresponds to the acupuncture point GB 21 (crossing point of the LI, TE, and ST meridians) and to C4-C5 intervertebral dysfunctions, as described by Maigne[333].

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[331] The musculotendinous sight is situated about 1 cm. distally to the medial epicondyle. A vigorous friction is required, which causes considerable pain but healing takes place with a minimum of four, to a maximum of eight, sessions. This massage is tiring and painful but there is no other alternative. (Cyriax J, 1997)

[332] Both the anterior and the posterior parts of deltoid consist of long bundles of fibres that extend from one insertion to the other. The middle part has a bipennate form. The anterior part forms a "myotactile unit" with the coracobrachialis, the clavicular head of pectoralis major....The posterior part of deltoid forms a "myotactile unit" with the long head of biceps, latissimus dorsi and teres major. (Travell JG, 1998)

[333] From our experience the majority of pain in shoulder tendons (70%) is of cervical origin. If examination highlights suffering of one or more tendons (supraspinatus, infraspinatus...) and the cervical examination presents signs of minor intervertebral dysfunction... (Maigne R, 1979)

The ante-latero-digiti spiral

The ante-latero-digiti spiral begins over the ulnar part of the transverse carpal ligament. Together, the motor schemes of ante-latero-digiti and ante-medio-pollex effectuate the gripping action of the hand. The transverse carpal ligament[334] synchronises the two mf units of this motor scheme and many muscles, which effectuate these movements, originate from this ligament as well.

The an-la-di spiral, due to the traction that the hypothenar muscles exert on the transverse carpal ligament, proceeds toward the radial side of the wrist and joins with the flexor retinaculum (or superficial part of the transverse carpal ligament)[335]. This is really the only structure that is able[336] to glide freely and to connect to the extensor retinaculum. The spiral proceeds over the collagen fibres formed by the stimulus of extension-adduction of the carpus, passing over the extensor carpi ulnaris muscle to reach the medial third of the forearm. From here it joins with the collagen fibres that are aligned by traction of the bicipital aponeurosis (Figure 148) and passes to the ante-lateral part of the elbow. The spiral then follows the biceps up to the deltoid insertion where it is subjected to the traction of the posterior, extensor part of deltoid[337]. The pathway of these muscular fibres directs the spiral into the infraspinatus fossa and to the medial border of the scapula.

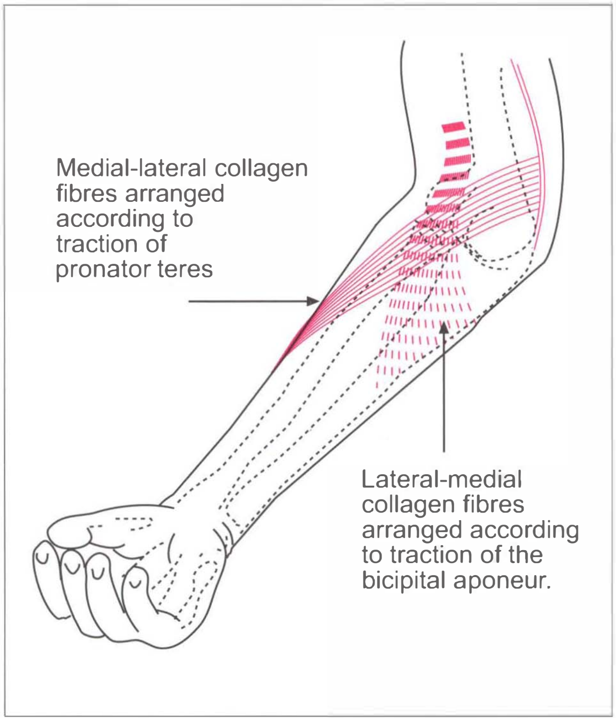

Figure 148. Endofascial fibres arranged according to traction.

At this point the spiral joins:

1. with the horizontal fibres of the trapezius, which move the scapula in the same direction as the humerus (retro-medio-scapula);
2. with the descending fibres of the trapezius, which connect to the latissimus dorsi on the opposite side and hence with the contralateral lower leg (re-la-cx).

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[334] The distal extremity of the antebrachial fascia continues into the hand and presents three thickened bands: the palmar carpal ligament, the transverse carpal ligament and the dorsal carpal ligament. The palmar carpal ligament has a quadrilateral form; located over the radiocarpal joints it is continuous below with the transverse carpal ligament. The transverse carpal ligament is stretched between the bony protuberances that limit the carpal space. Some muscles of the hypothenar and thenar eminence originate from its anterior surface and it is closely related to the tendon of palmaris longus. Its inferior margin is continuous with the palmar aponeurosis. (Baldoni CG, 1993)

[335] Superficial part of the transverse carpal ligament: thickened band of the antebrachial fascia that extends laterally to the pisiform. This superficial lamina is quite distinct from the transverse carpal ligament. (Gray H, 1993)

[336] The single tendons are kept in place by the robust transverse carpal ligament (retinaculum flexorum), which is stretched between the trapezium and the hamulus of the hamate bone. It is doubled superficially by transverse, circular fibrous bundles, an extension of the antebrachial fascia that forms the palmar annular carpal ligament. (Fazzari I, 1972)

[337] The joint capsule of the glenohumeral joint is strengthened by ligaments interwoven with the joint capsule itself and situated: one superiorly, the superior glenohumeral ligament and one inferiorly, the inferior glenohumeral ligament. The third, the middle glenohumeral ligament is situated on the anterior surface of the capsule. The coracohumeral ligament is to be added to this group. As well as these ligaments the tendons of those muscles inserted onto the humerus near the joint capsule are to be considered: long head of biceps, long head of triceps, subscapularis, supraspinatus, infraspinatus, teres minor. It is also to be noted that part of pectoralis minor can thicken the coracohumeral ligament. (Fazzari I, 1972)

Mf unit of the an-la-di spiral

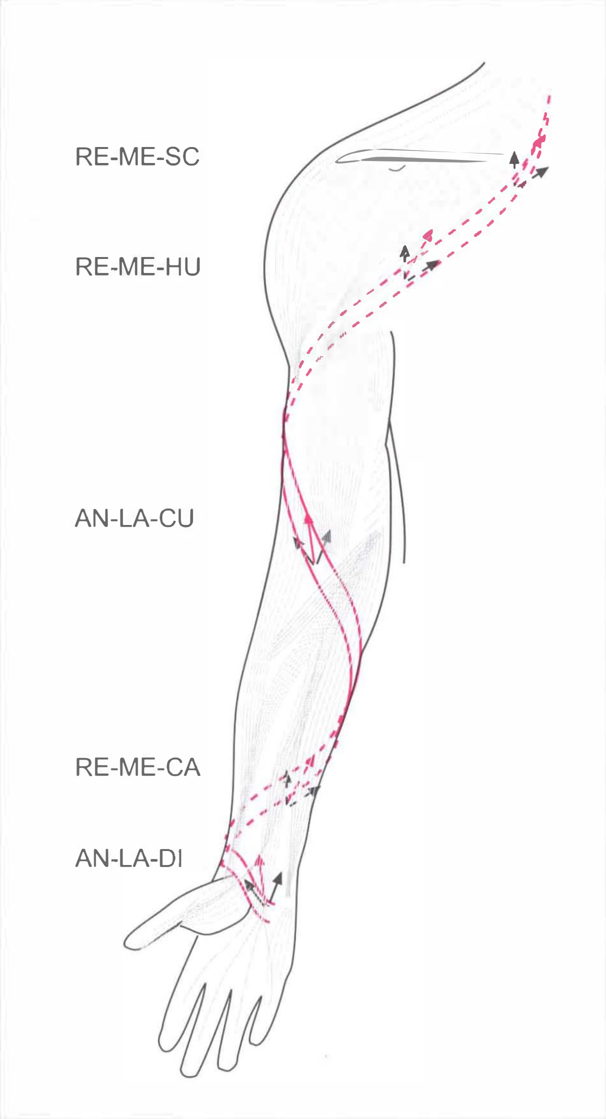

Figure 149. Cc(s) of fusion of the an-la-di spiral.

Antero-latero-digiti (an-la-di) cc of fusion

– This point is located over the wrist crease where the tendons of flexor digitorum superficialis and profundus pass. These muscles flex the fingers (ante) with a slight radial deviation (latero) (Figure 149) (Table 34).

– This cc corresponds to the acupuncture point PC 7 (which receives a transverse Luo vessel from the TE meridian). It corresponds to the site indicated by Cyriax for tendinitis of both the flexor carpi ulnaris (near the pisiform) and flexor digitorum.

Retro-medio-carpus (re-me-ca) cc of fusion

– This point is located over the extensor digitorum tendon in the proximal part of the extensor retinaculum. Traction of the extensor digitorum (retro) and the extensor carpi ulnaris (medio) converge at this point.

– This cc corresponds to the acupuncture point TE 7, the TP of the extensor indicis and the point indicated for micro-poly-traumatism of the wrist extensor tendons[338].

Ante-latero-cubitus (an-la-cu) cc of fusion

– This point is located in the lateral part of the elbow crease. The vectorial forces of the brachioradialis (latero), which stabilises the elbow, biceps, brachialis (ante) and pronator teres (intra) all converge at this point.

– This cc corresponds to the acupuncture points LI 12 and LU 5 (point of diffusion which passes Qi from the Lung to the Kidney meridian) and the lateral TPs of brachialis and biceps.

Retro-medio-humerus (re-me-hu) cc of fusion

– This point is located in the infraspinatus fossa where the vectorial forces of the extensor, adductor and rotator muscles of the humerus converge.

– This cc corresponds to the acupuncture point SI 11 and the three TPs of the infraspinatus muscle.

Retro-medio-scapula (re-me-sc) cc of fusion

– This point is located over the scapular insertion of rhomboid minor (retro) and where the horizontal fibres of the trapezius insert onto the scapula (they effectuate mediomotion of the scapula).

– This cc corresponds to the acupuncture point SI 13 (crossing point of the LI, TE, GB meridians) and the area indicated by Maigne for tendon-like pain in the scapula region[339].

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[338] The tendinous structures of the wrist and hand are responsible for many dysfunctions collectively known as poly-micro-traumatisms. The extensor tendons are incriminated when pain is felt on resisted wrist extension. Massage or injections can be effective. (Cyriax J, 1997)

[339] Numerous tendon-like pains in the scapula region are related to irritation of spinal nerves caused by "minor intervertebral dysfunctions" and therefore can be said to be a part of the "cellulo-tendino-myalgic nerve compression syndrome"... Having taken hold of the medial border of the scapula, the physician stretches it in different directions. (Maigne R, 1979)

Chapter 19
MYOFASCIAL SPIRALS OF THE TRUNK

In the trunk there are crosswise patterns of collagen fibres similar to those in the limbs. The spirals of the trunk begin in the head which, like the hand and the foot for the upper and lower limbs, acts as the motor guide for the trunk.

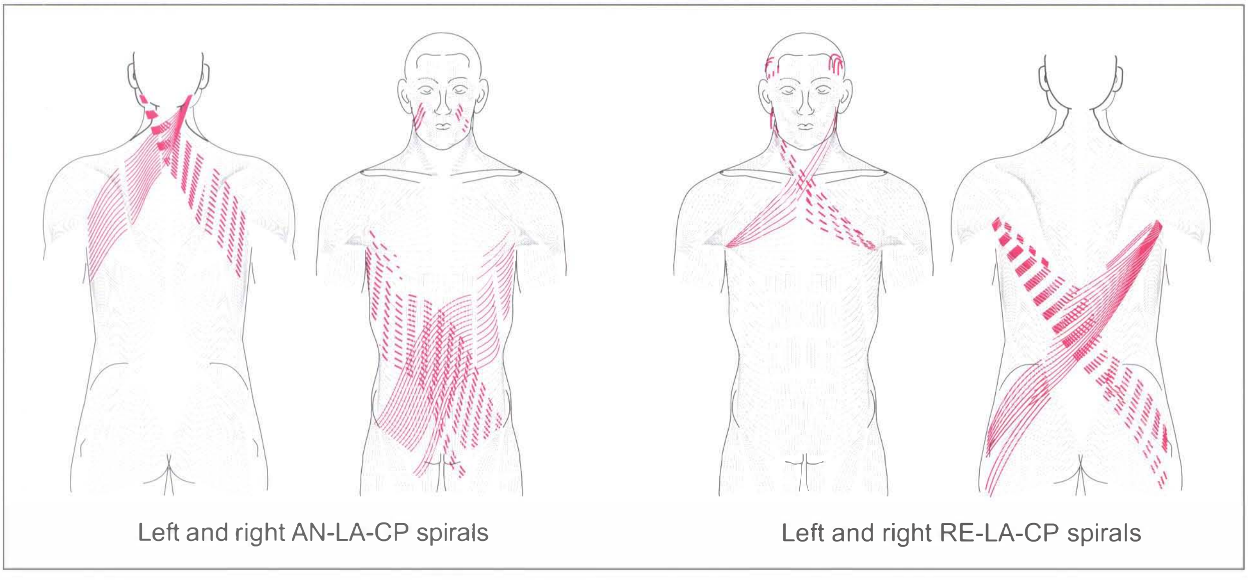
There is a spiral that begins in the anterior, zygomatic part on both sides of the face (Figure 150) (an-la-cp) and a spiral that begins from the temporal area of the head (re-la-cp). The anterior spiral passes, via the angular ligament of the mandible, over the posterior neck muscles; the posterior spiral passes, via the mastoid insertion of the sternocleidomastoid, into the anterior part of the neck.

Once they reach the neck each one of these spirals subdivides into two. The two ante spirals (an-la-cl and an-me-cl) and the two retro spirals (re-la-cl and re-me-cl) are not completely independent, having pathways that are included in the principal spiral.

The re-la-cl and re-me-cl spirals follow two pathways parallel to one another; these pathways are included within the principal spiral formed by the fascia of the splenius on one side and the fascia of the contralateral rhomboids and serratus anterior. The an-la-cl and an-me-cl spirals have parallel pathways; these pathways are included within the pathway, or single fascial structure, of the sternocleidomastoid on one side and the pectoralis major and latissimus dorsi on the opposite side. Hence, in the trunk there are four spirals for each side (4+4) that cross over each other (Figure 150). The four spirals of each limb are continuous with the four spirals of the same direction located on one side of the trunk.

The two spirals of ante-latero and ante-medio on the right cannot act together with the two spirals of ante-latero and ante-medio on the left, as this would completely block movement. This can be tested by applying adhesive paper tape to a person's body along the pathway of the two anterior spirals and it will be noted that the person is then unable to move their torso.

Furthermore, the ante-latero spiral on the right cannot intervene simultaneously with the same


Left and right AN-LA-CP spirals

Left and right RE-LA-CP spirals

Figure 150. A comprehensive view of the spirals of the trunk.

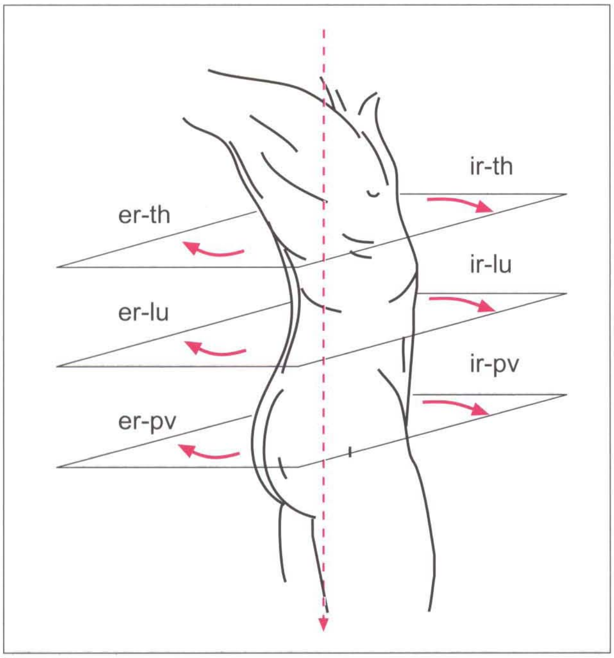


Figure 151. Synergy between intra and extra moves the segments on the horizontal plane.

force as the retro-latero spiral on the left because this type of coupled force would result in rotation on the horizontal plane. However, if a person rotates their thorax and lumbi maintaining the trunk perfectly in line, then the two sequences that form a coupled force (er, ir) intervene (Figure 151).

If a person rotates their neck, thorax and lumbi with simultaneous lateromotion and retromotion components (Figure 152), then the agonist spiral shortens and the antagonist spiral lengthens to allow for the movement. Spiral movement develops along a number of segments and it always involves more than one plane of movement.

In the case where the retro-latero spiral is the agonist then the antagonist, the ante-latero spiral, must lengthen in order to allow for movement, even though its role is not entirely passive as with all antagonist forces.

CC(s) of fusion of the trunk

Throughout the evolution of the locomotor apparatus it has been seen that the trunk rotator muscles have developed simultaneously with the progressive mastery of motor schemes. The distinction between rotator muscles and the muscles assigned to spiral activity in the trunk is, therefore, not well defined. Furthermore, the location of the segmentary cc(s) is often near to those of fusion. Nevertheless, due to differences in the myofascial tension, which develops during rotator and spiral activity, they do not superimpose on one another. The sequences of intra and extrarotation have a deep continuity whereas the spirals make use of the superficial collagen fibres (spirals), which connect with the deep muscles by means of the points of fusion of the three fascial layers of the trunk (Figure 155). The points where the fasciae merge to form the cc(s) of fusion are located: laterally to the rectus sheath (an-la-pv, lu, th), laterally to the erector spinae sheath (re-la-pv, lu, th), immediately to the side of the linea alba (an-me-pv, lu, th) and immediately to the side of the supraspinous ligament (re-me-pv, lu, th). According to the articular angle of the trunk, stretch of the fascia will facilitate a number of muscle spindles and will cause the coils of a number of Golgi tendon organs to wind themselves up. Only the deep fascia, which is connected to spe-

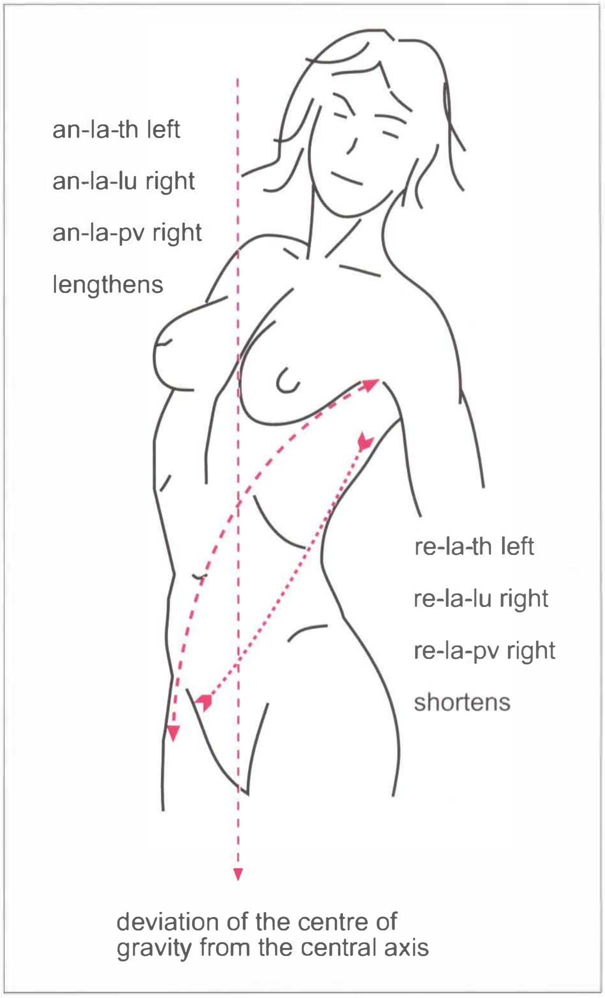


Figure 152. While one spiral shortens the antagonist lengthens.

cific muscular fibres, has a coordinating effect[340] whereas the superficial subcutaneous fascia cannot influence muscular activity.

The muscles that ensure continuity between the spirals

The sequences of the limbs connect with the sequences of the trunk in order to coordinate body equilibrium on the three spatial planes. Similarly, the spirals of the limbs are connected to the spirals of the trunk in order to synchronise complex motor activities (e.g. walking, jumping... etc.)[341]. The following list emphasises the connections between specific portions of muscles and specific motor trajectories (Figure 153).

Ante-superior:
- Ascending part of pectoralis major: connects the movement of ante-latero-humerus with the synergic movement of the collum and the scapula.
- Transverse part of pectoralis major: connects the movement of ante-medio-humerus with the synergic movement of the contralateral collum and scapula.
- Descending part of pectoralis major: connects the movement of ante-medio-humerus with the synergic movement of the contralateral coxa (hip) via the oblique fascia.

Retro-superior:
- Ascending part of trapezius: connects the movement of retro-latero-humerus with the synergic movement of the collum and the scapula.
- Transverse part of trapezius: connects the movement of retro-medio-humerus with the synergic movement of the contralateral collum and scapula.

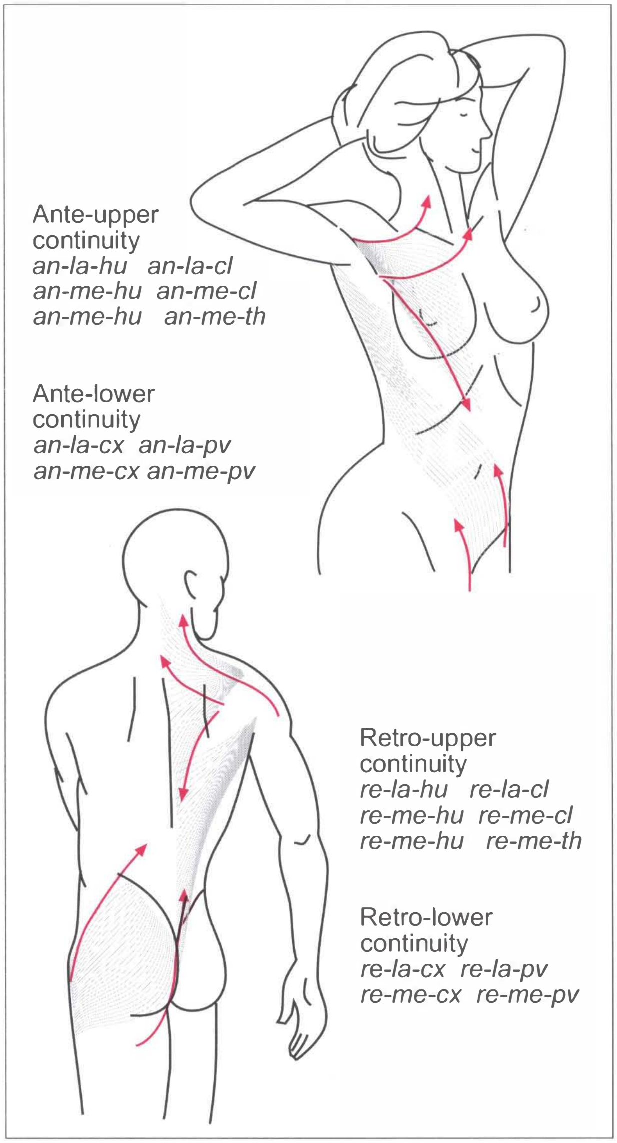


Figure 153. Continuity between limb spirals and trunk spirals.

- Descending part of trapezius: connects the movement of retro-medio-humerus with the movement of the contralateral coxa, via the thoracolumbar fascia.

Ante-inferior:
- Medial part of the external abdominal oblique: connects the movement of ante-medio-coxa with the synergic movement of the pelvis, via the intercrural fibres.
- Lateral part of the external abdominal oblique: connects the movement of ante-latero-coxa with the synergic movement of the pelvis, via the sartorial sheath.

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[340] The insertions of the interspinous ligament's collagen fibres onto the thoracolumbar fascia firmly anchor this ligament to the spinal column, as well as transmitting the tension of the thoracolumbar fascia to the interspinous ligament. For example, when a weight is being lifted the contraction of the abdominal muscles stretches the thoracolumbar fascia and, consequently, the interspinous ligament. The stabilisation of the spinal column by the erector spinae muscles is synchronised in this way. (Stecco C., 2002)

[341] The posterior part of the interspinous ligament, which inserts onto soft tissue such as the supraspinous ligament, participates in movement coordination. It perceives tension produced either by the paravertebral muscles or transmitted to the supraspinous ligament from the thoracolumbar fascia. In effect, in this region, fibres with origins from a variety of structures cross each other: fibres of the supraspinous and interspinous ligaments, fibres of the thoracolumbar fascia, fibres of the paravertebral muscles. (Stecco C., 2002)

Retro-inferior:

- Lateral part of gluteus maximus and latissimus dorsi: connection between the cc of retro-latero-coxa and the same cc of fusion of the ipsilateral pelvis and lumbi.
- Medial part of gluteus maximus and latissimus dorsi: connection between the cc of retro-medio-coxa and the same cc of fusion of the ipsilateral pelvis and lumbi.

The ante-latero-caput (an-la-cp) spiral

A percentage of each complex motor activity is controlled by the cerebral cortex and a percentage by the fascia (reflex). If the voluntary aspect prevails, the movement is more precise and individual whereas if the reflex activity prevails, it is always the same and being simpler, it consumes less energy. Exactly how the fascia intervenes in the organisation of this percentage of reflex activity in the trunk will now be considered. As already mentioned, tensioning of the trunk spirals begins in the head, whereas those of the upper limb begin in the hand and in the foot for the lower limb.

In order to look over one's shoulder the face is turned towards the posterior thoracic wall. The vectors in line with this movement correspond to the ipsilateral portion of the longissimus capitis and the splenius capitis muscles (Figure 154). Both of these muscles originate from the mastoid process area and insert into the spinous processes and interspinous ligaments of the lower cervical and upper thoracic vertebrae. Contraction of these muscles exerts equal tension on both the vertebrae and the occiput. Therefore, in order to rotate the head and not the vertebrae, contralateral muscles must fixate the vertebrae. The contralateral portion of the serratus posterior superior muscle, which originates from the same spinous processes, fixates itself to the contralateral ribs thereby acting as an anchorage point to allow the previously mentioned muscles to develop the movement of rotation. Rhomboid major and minor also originate from the same spinous processes and they insert onto the medial border of the scapula. The posterior fascia[342] of the rhomboids continues on with the infraspinatus fascia, in this way connecting the neck with the upper limb.

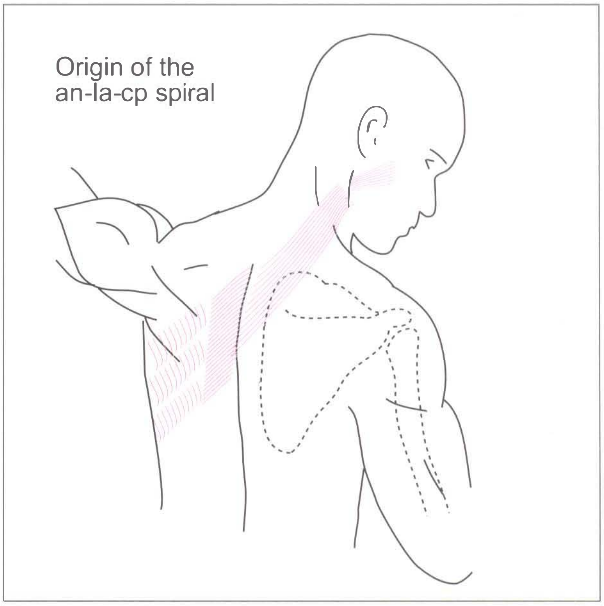

Figure 154. Continuity between the right splenius and the left serratus posterior superior m.

The anterior fascia of the rhomboids is continuous with the fascia of the serratus anterior[343]. The fascia of the serratus posterior superior is continuous with the fascia of the intercostal muscles.

Both of these fasciae continue on with the fascia of the ipsilateral external abdominal oblique. In order to accentuate this movement, rotation of the trunk has to be increased by the contraction of the lumbar portion of the external abdominal oblique together with the contralateral pelvic portion of the internal abdominal oblique[344].

The pathway of these fasciae designs a spiral that begins at the zygomatic bone, passes to the posterior thorax on the opposite side and terminates in the ipsilateral pelvis. In Figure 155, the endofascial collagen fibres, which pass from the one side of the upper trunk to the contralateral lower side of the

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[342] The cervical fascia may also be a nociceptive site, especially where it is crossed by sympathetic nerves. Therein lies another point of controversy: that of differentiating Fibromyalgia Syndrome from Myo-fascial Syndrome. Both present tender nodules and the jump sign upon pressure. (Cailliet R, 1991)

[343] At its scapular insertion the rhomboid minor has a dorsal and a ventral layer. The ventral lamina is robust and is fused with the fascia of the serratus anterior. Ventrally the rhomboid major has an extensive insertion onto the fascia, which covers the serratus anterior. This fusion between the fasciae extends vertically along the whole length of the rhomboids. (Gray H, 1993)

[344] The principal part of the external oblique is bilaminar; the superficial layer is the continuation of the deep fasciae from the opposite side and consists of a system of parallel fibres in a configuration similar to that of an elongated S, which extends downwards and laterally. Both the muscular and the aponeurotic parts of the external oblique have a superficial (more developed) and a deep fascial layer. (Gray H, 1993)

Figure 155. Dissection of the anterior abdominal wall: fascial plane (from Fumagalli - Colour photographic atlas of macroscopic human anatomy. - Published by Dr. Francesco Vallardi/Piccin Nuova Libraria).

1, a part of the fascia of the external abdominal oblique adheres to the rectus abdominis sheath and a part glides above it, crossing with the collagen fibres from the opposite side; 2, the umbilicus and the linea alba, where the superficial fascia connects with the fascia-aponeurosis of the internal oblique and transversus abdominis in order to facilitate coordination of the entire abdominal musculature; 3, endofascial collagen fibres that connect the upper limb on one side with the contralateral lower limb to synchronise reciprocal limb movements.

trunk, are clearly visible (fibres in a S shape). The same arrangement of fibres is evident on the opposite side, thus the abdominal fascia is transformed into an extensive retinaculum.

Mf unit of the an-la-cp spiral

Ante-latero-caput (an-la-cp) cc of fusion

This cc is located over the zygomatic insertion of the masseter muscle. It corresponds to the acupuncture point SI 18 (Figure 156).

Retro-latero-collum (re-la-cl) cc of fusion

This cc is located over the mastoid tendon of the splenius. It corresponds to the acupuncture point TE 17 and to the TPs of the suboccipital muscles[345].

Retro-medio-collum (re-me-cl) cc of fusion

This cc is located to the side of the ligamentum nuchae at the halfway point of the neck. It corresponds to the acupuncture point BL 10 and to the sign of central dislocation as indicated by Cyriax.

Ante-latero-thorax (an-la-th) cc of fusion

This cc is located in the passage between the serratus anterior and the external abdominal oblique muscle. It corresponds to the acupuncture point ST 17 and to the thoracic disc dislocation as indicated by Cyriax[346].

Ante-medio thorax (an-me-th) cc of fusion

This cc is located in the fifth intercostal space to the side of the sternum. It corresponds to the acupuncture point KI 22 and to the chondrocostal sprains, as indicated by Maigne[347].

Ante-latero-lumbi (an-la-lu) cc of fusion

This cc is located beneath the ribcage to the side of the rectus abdominis. It corresponds to the acupuncture point SP 16 and to the TP of the obliques.

Ante-medio-lumbi (an-me-lu) cc of fusion

This cc is located to the side of the umbilicus. It corresponds to the acupuncture point KI 16 and to the TP of the rectus abdominis muscle.

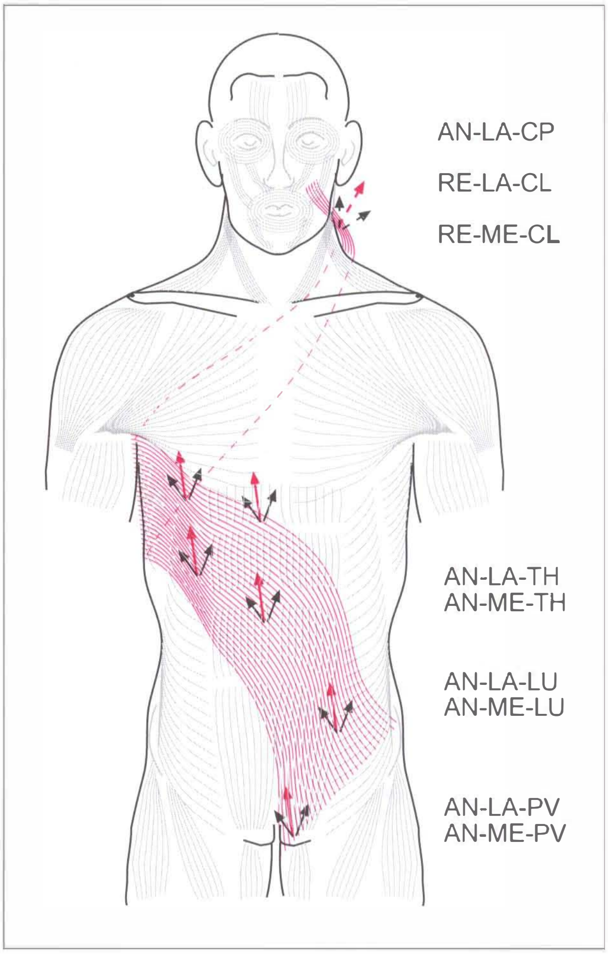

Figure 156. Cc's of fusion of the an-la-cp spiral.

Ante-latero-pelvis (an-la-pv) cc of fusion

This cc is located to the side of the rectus sheath halfway between the pubis and the umbilicus. It corresponds to the acupuncture point ST 28 and to "lumbago of the iliac crest" as indicated by Maigne[348].

Ante-medio-pelvis (an-me-pv) cc of fusion

This cc is located above the pubic insertion of the rectus abdominis. It corresponds to the acupuncture point K 11 and to the pseudo-visceral pains, as indicated by Maigne[349].

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[345] Pain evoked by the TPs of the suboccipital muscles is often confused with referred pain from the semispinalis muscle. The suboccipital muscles only rarely develop TPs without involving other posterior cervical muscles. (Travell JG, 1996)

[346] A postero-lateral dislocation causes radicular pain referred anteriorly into the sixth dermatome. (Cyriax J, 1997)

[347] It is possible to find anterior chondrocostal sprains, generally post-trauma. Frequently, sprains of the floating ribs are associated to minor, intervertebral dysfunctions of the dorsal spine. (Maigne R, 1979)

[348] Spontaneous pain at L1 is only rarely manifested whereas groin pain, along with pseudo-abdominal characteristics, is more common. (Maigne R, 1979)

[349] An anterior cellulitis may occur in the territory of the anterior branch of the same nerve, frequently causing pseudo-abdominal or gynaecological pain. This pain is perceived as being of a visceral origin. (Maigne R, 1979)

The retro-latero-caput (re-la-cp) spiral

This spiral begins at the centre of the muscle belly of the temporalis and descends towards the mastoid process, passing around and behind the ear. It then follows the sheath of the sternocleidomastoid muscle, which passes into the anterior part of the neck where the spiral divides into two: ante-latero and ante-medio collum. Near the sternal insertion, the sternocleidomastoid[350] extends a number of tendinous fibres towards the origin of the contralateral pectoralis major. Whilst the spirals of the limbs are not mentioned here, it goes without saying that the cc(s) of fusion of the scapula (upper limb) often work in synergy with the spirals of the trunk.

At the axilla the pectoralis major transmits its tension to the latissimus dorsi via their common insertions onto the axillary fascia. A bundle of muscular fibres, which connects these two muscles, can often be found in this area, confirming this transmission of forces[351]. The upper part of latissimus dorsi inserts onto the seventh thoracic vertebra, beneath the insertion of the trapezius that descends to the twelfth thoracic vertebra (Figure 157). This overlapping of fibres is also a cross roads of forces: the traction of the scapula, via the descending part of the trapezius (re-la-sc) passes here and descending endofascial, collagen fibres part from here towards the contralateral gluteus. These fibres of the thoracolumbar fascia, which perpetuate the traction of the trapezius, are visible in anatomical photographs and form their own independent layer.

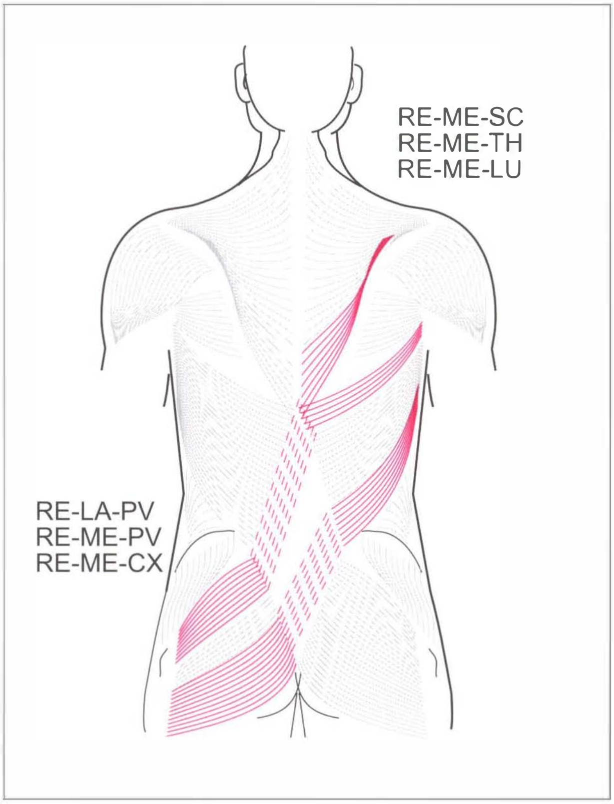

Figure 157. Intersection of collagen fibres in the thoracolumbar fascia.

The lower part of latissimus dorsi extends into the lumbar area where it inserts onto the thoracolumbar fascia[352]. The effect of this muscle's traction on the thoracolumbar fascia is manifested with the formation of endofascial, collagen fibres aligned according to the direction of the same muscle. At the interspinous ligaments a number of collagen fibres cross the midline and unite with the insertions of the contralateral gluteus maximus[353].

By following the insertions of the above mentioned superficial muscles around the trunk a certain spiral-form configuration can be noted. The reason that these myofascial insertions exist is clearly related to their activity of reciprocal coordination.

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[350] The fibres of the sternal insertions of the sternocleidomastoid are found deep below the fascia. This muscle inserts onto the first part of the sternum via a cone shaped tendon, which at the midline is partially crossed with fibres from the opposite side. (Testut L, 1987)

[351] A muscular band, the axillary arch (7 to 10 cm long and 5 to 15 cm wide) detaches itself from the margin of the latissimus dorsi in some cases and passes anteriorly to the axillary nerves to unite with the tendon of pectoralis major. (Gray H, 1993)

[352] The latissimus dorsi muscle is represented by some thick, obliquely descending bundles that are continuous with the thoracolumbar aponeurosis. Having reached the midline, a certain number of aponeurotic fibres cross over it to reinforce the thoracolumbar aponeurosis on the opposite side. (Testut L, 1987)

[353] The gluteus maximus originates from the gluteal line of the ilium, from the aponeurosis of the sacrospinalis and from the fascia that covers the gluteus medius. (Gray H, 1993)

Mf unit of the re-la-cp spiral

Retro-latero-caput (re-la-cp) cc of fusion

This cc is located at the centre of the temporalis muscle. It corresponds to the acupuncture point GB 13 (Figure 158).

Ante-latero-collum (an-la-cl) cc of fusion

This cc is located between the angle of the mandible and the sternocleidomastoid. It corresponds to the acupuncture point SI 17.

Ante-medio-collum (an-me-cl) cc of fusion

This cc is located over the sternal tendon of the sternocleidomastoid muscle. It corresponds to the acupuncture point ST 10 and to Maigne's anterior cervical alarm point[354].

Retro-latero-thorax (re-la-th) cc of fusion

This cc is located over the inferior border of the trapezius at the level of the seventh thoracic vertebra. It corresponds to the acupuncture point of BL 44.

Retro-medio-thorax (re-me-th) cc of fusion

This cc is located between the spinous processes of the 7th.- 9th. thoracic vertebrae and the bulk of the erector spinae muscles. It corresponds to the acupunture point EX 66 (BL 18).

Retro-latero-lumbi (re-la-lu) cc of fusion

This cc is located to the side of the erector spinae over the 12th. floating rib. It corresponds to the acupuncture point BL 50. The pathway of the spiral includes gluteal pain such as the nerve root pain indicated by Maigne[355].

Retro-medio-lumbi (re-me-lu) cc of fusion

This cc is located between the spinous processes of the 12th. thoracic vertebra and the bulk of the erector spinae muscles. It corresponds to the acupuncture point BL 23.

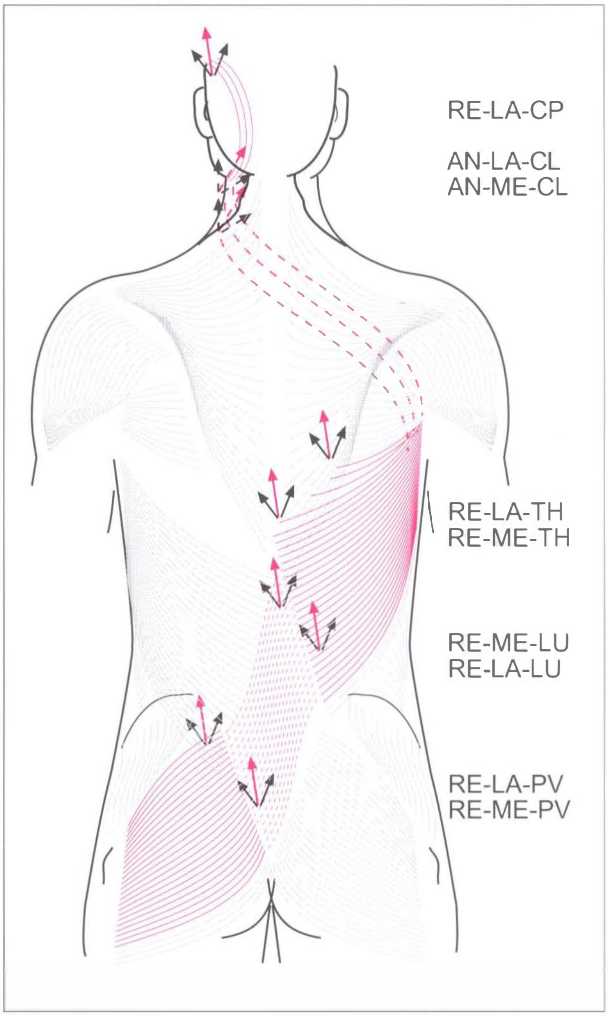

Figure 158. Cc(s) of fusion of the re-la-cp spiral.

Retro-latero-pelvis (re-la-pv) cc of fusion

This cc is located to the side of the posterior superior iliac spine. It corresponds to the acupuncture point BL 53. Treatment of this point can resolve certain cases of "sciatica"[356].

Retro-medio-pelvis (re-me-pv) cc of fusion

This cc is located above the third to fourth sacral foramen. It corresponds to the acupuncture point BL 33.

The two fundamental spirals of the trunk can have a number of variations: for example, from re-la-lu, the spiral can continue into an-la-pv via the fibres of the external abdominal oblique.

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[354] Pressure on the antero-lateral part of the inferior cervical vertebrae provokes dorsal pain. In this case a direct passage of referred pain can be noted, shedding new light on certain trigger points as described by Travell, whose pathogenetic interpretation is open to criticism. (Maigne R, 1979)

[355] Innervation of the cutaneous planes of the upper half of the buttocks: we found cases in which the innervation could be traced to T10. The levels of innervation are therefore higher than those classically described. We have frequently noted anastomoses between the posterior branches of L1 and T12. (Maigne R, 1979)

[356] Cases of recurring sciatica, or lumbago, after surgical operations are very common; manipulation can resolve such cases quickly and effectively. (Maigne R, 1979)

Chapter 20
MF SPIRALS OF THE LOWER LIMB

The structure of the fascia is of such complexity that, until now, it has been preferable to relegate it to the sole task of confining muscles.

Careful analysis reveals that in some points the fascia is formed by several layers and in other points by a single layer. In some areas the deep fascia glides freely beneath the superficial fascia whilst in other areas, such as the hands and feet, the two layers unite. In some points the deep fascia glides freely on the epimysium whereas at times the two structures unite. This leads one to consider that if the fascia was completely separate from the muscles it could not be stretched by them; if the fascia was completely united to the muscles then it could not link the various mf units; if the fascia was not inserted onto bones it could not detect the angular variations of the articulations or transmit these variations to the successive articulation.

The same type of organisation can be recognised in the various layers of the fascia. Proceeding gradually from the deeper to the more superficial layers it can be noted that the fascia is progressively freer to glide over the underlying structures. In this way it passes from its bony insertions to the septa that divide the various mf units, up to the spiral-form collagen fibres that unite the various articulations of the entire body.

To have an effect on the physiology of the muscles (i.e. to stretch muscle spindles and Golgi tendon organs) the fascial spirals must also be connected with the muscle fibres in some way. For this reason, around the articulations, the spirals unite their fibres to those of the muscles, arranged according to their own helicoidal pattern. Along the diaphysis of the bones these spirals can also be found within the loose connective tissue of the superficial fascia (Figure 159). In areas subjected to major stress these spirals have conditioned the muscular sheaths, together with the muscles, to align themselves according to their tension. Gradually, as living beings evolved and they aimed at achieving new motor strategies then new myofascial structures and new nerve connections were modelled simultaneously.

Bipedal locomotion in human beings requires asynchronous movements of the hip, knee and talus. While the hip advances (antemotion) the knee flexes (retromotion) and the talus dorsiflexes (antemotion). The longitudinal sequences synchronise movement of the various segments in the same direction, hence they cannot carry out this task. Only the fascial spirals are capable of directing

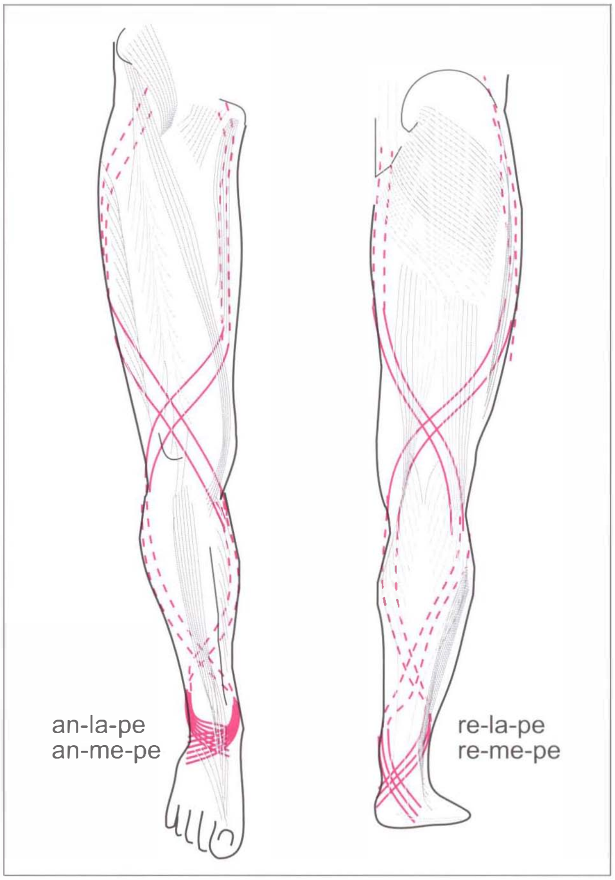

Figure 159. Comprehensive view of the spirals of the lower limb.

similar asynchronous movements. As a consequence, the two spirals of an-la-cx and an-me-cx pass behind the knee in order to synchronise retromotion and they then pass in front of the ankle to synchronise dorsiflexion (antemotion).

It is imperative that the knee does not give way during the stance phase of gait. Hence the other two spirals (an-la-ge and an-me-ge) guarantee knee stability whilst simultaneously stimulating the posterior muscles of the coxa (re-la-cx and re-me-cx) and the talus, in order to impede a fall.

The retro-latero-pes spiral

The retro-lateromotion spiral begins in the foot over the superior and inferior peroneal retinacula (external annular ligament).

The above retinacula are continuous with the deep layer of the crural fascia[357].

By following these fibres anteriorly to the Achilles tendon, the spiral passes from the lateral part of the ankle to its medial part. From the medial border of the tibia, following the collagen fibres of the superior extensor retinaculum[358] the spiral passes above the compartment of the extensor muscles.

As the spiral advances it moves towards the posterior part of the leg until it passes over the lateral head of gastrocnemius. The popliteal retinaculum[359] begins here and it consists of collagen fibres that ascend from the lateral head of the gastrocnemius towards the adductor sheath. The pathway of these collagen fibres is essentially the continuation of the lines of tension originating from the fascial insertion of the lateral head of the gastrocnemius[360].

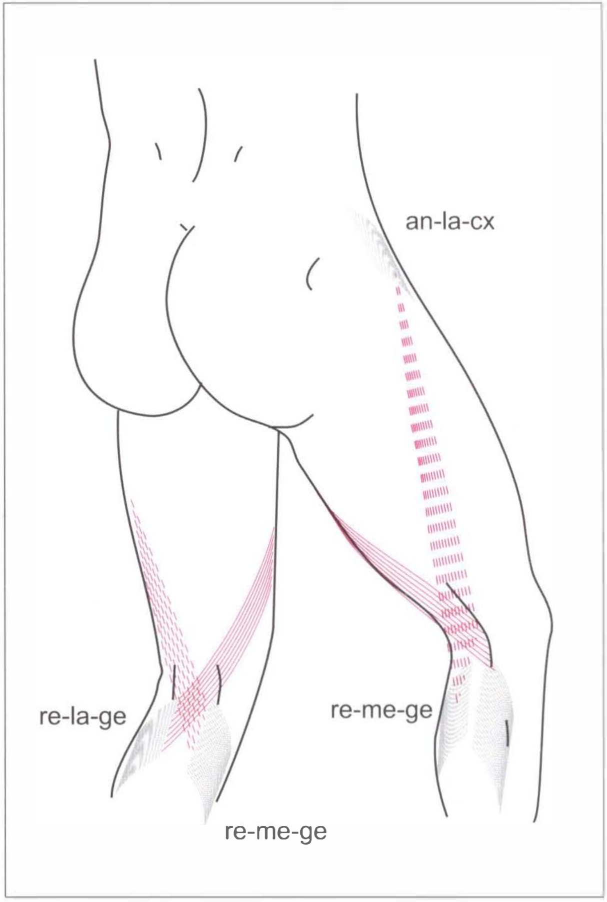

Figure 160. The popliteal retinaculum.

The popliteal fascia is a retinaculum in as much as it has fibres that cross each other in a net-like configuration. The fibres from the opposite direction are the continuation of the traction of the medial head of gastrocnemius; they then continue on into the iliotibial tract (Figure 160).

The adductor fascia continues with the pectineal fascia, which, as it ascends, doubles into two layers. One rises together with Gimbernat's ligament (lacunar ligament) above the inguinal ligament and joins with the fascia of the ipsilateral, external abdominal oblique. The other ascends posteriorly to the sper-

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[357] The deep transverse fascia of the leg is continuous with the fascia that covers the popliteus m. and it appears united to the tendon of the semimembranosus. Below it is continuous with the laciniate ligament and with the superior peroneal retinaculum. (Gray H, 1993)

[358] The tibial insertions of the proximal retinaculum of the extensor muscles are very variable: often they insert onto the medial margin of the bone, in which case the ligament is separated from the tibia by a layer of connective tissue; at other times the tibial insertions are almost completely lacking, in which case the ligament continues on with the posterior fascia of the leg. (Testut L, 1987)
A part of the fibres of the medial surface of the tibia can be traced as they pass through the periosteum and proceed on to the investing lamina of the extensors, to then pass over and above the peroneal compartment. (Lang J, 1991)

[359] The popliteal fascia, which separates the subcutaneous connective tissue from the muscles, consists of two layers of collagen fibres that cross over each other. The superficial fibres are oriented almost transversally and they continue deeply in a medial direction. (Lang J, 1991)

[360] It is difficult to separate the popliteal fascia from the underlying tendons. The degree of adherence that exists at this point derives from the fact that numerous fibrous bundles pass from the tendons into the fascia, thereby reinforcing it. These tendinous bands belong to that group of muscles known as tensors of the fascia. (Testut L, 1987)

matic cord in males, or the round ligament in females, and forms the posterior pillar, or reflected inguinal ligament of Collesi, to then continue with the aponeurosis-fascia of the contralateral abdominal oblique muscle[361].

Mf unit of the re-la-pe spiral

Retro-latero-pes (re-la-pe) cc of fusion

– This point is located behind the external malleolus. It designs a semicircle, passing beneath this same malleolus. In this way it involves the superior peroneal retinaculum and it terminates over the inferior peroneal retinaculum (Figure 161).

– This cc corresponds to the acupuncture point BL 61 (King point). Whilst only one point is mentioned BL 60 (crossing point with the curious meridian Yangqiao) and BL 62 are also located over the peroneal retinacula. Often the nearby points are not mentioned in order to avoid confusion but, in clinical practice, a fascial therapist commences palpation over the principal point and then amplifies palpation to the surrounding collagen tissues, pausing over the most sensitive and densified point.

The treatment sites indicated by Cyriax[362] and Troisier[363] are also located in this area.

Ante-medio-talus (an-me-ta) cc of fusion

– This point is located over the myotendinous conjunction of the tibialis anterior. This muscle participates both in antemotion and mediomotion of the talus.

– This cc corresponds to the acupuncture point ST 39 (ocean point of the 12 meridians).

Retro-latero-genu (re-la-ge) cc of fusion

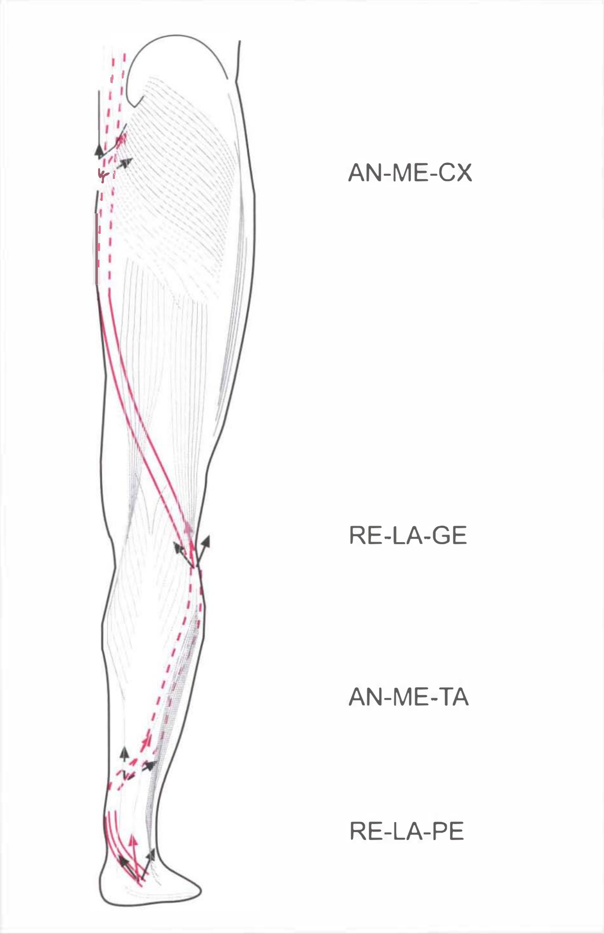

Figure 161. Cc(s) of fusion of the re-la-pe spiral.

– This point is over the proximal part of the lateral head of gastrocnemius. The lateral head of gastrocnemius participates in retromotion of the genu (knee), as well as in its lateral stability.

– This cc corresponds to the acupuncture point GB 33 (ex).

Ante-medio-coxa (an-me-cx) cc of fusion

– This point is located over the lateral margin of arcuate line of the pubis and the femoral triangle.

– This cc corresponds to the acupuncture point LR 12. Maigne suggests treatment of the sacroiliac joint when pain is present at the pubic symph-

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[361] The aponeurosis of insertion of the external oblique thickens inferiorly into the inguinal ligament. In the tract between the pubic tubercle and the symphysis, the fibres of the muscle's aponeurosis widen to form the subcutaneous inguinal ring bounded above by arched fibres. For this reason the aponeurosis is fixated to the pubis by two bands: one lateral and one medial, which arise from the aponeurosis on the opposite side. (Fazzari I, 1972)

[362] In the initial stages of ligamentous sprains ultrasound and laser accelerate healing but frictional massage is essential to impede formation of fibrous adherences. Tendinitis of the peroneal tendons is often confused with fibrous adherences and manipulated in vane. (Cyriax J, 1997)

[363] Isolated algodystrophy of the ankle is not so rare. In the beginning pain is continuous, nocturnal and aggravated either by walking or the supine position. (Troisier O, 1991)

[364] Some people would not be prepared to accept other points in favour of the existence of sacroiliac joint sprains, except that of the immediate disappearance of pubic symphysis sensitivity following manipulation of the sacroiliac joint. The major part of manipulative techniques (mostly those that claim to correct the "anterior sacrum" - according to osteopathic terminology) act on the upper lumbar vertebrae. (Maigne R, 1979)

ysis[364]. Any stretch of the pelvic girdle will naturally involve all of the fasciae, with a major effect on the more rigid fascia. Fascial Manipulation acts directly on the densified centres of coordination.

The retro-medio-pes spiral

The spiral of retro-mediomotion begins in the foot over the laciniate ligament (or medial retinaculum) (Figure 162). This ligament is a part of the medial fascia and extends a transverse septum from the medial part of the ankle towards the lateral part[365], passing deep to the Achilles tendon. In the distal third of the fibula it connects with the fibres of the anterior superior retinaculum of the leg[366].

In some anatomical texts this ligament, known as the *transversus cruris*, has fibres arranged in an oblique direction ascending from external to internal; in other texts the same retinaculum has its fibres arranged in the opposite direction.

Both illustrations can be considered correct in as much as they reproduce only one layer of these collagen fibres. In effect, just as with the cruciform ligaments, here there is also a crosswise arrangement of fibres. Having gained the medial part of the tibia the spiral continues on with the medial crural fascia until it passes over the medial head of the gastrocnemius. At the popliteal fossa there is a crossover of endofascial, collagen fibres, which run from the medial part towards the lateral intermuscular septum[367].

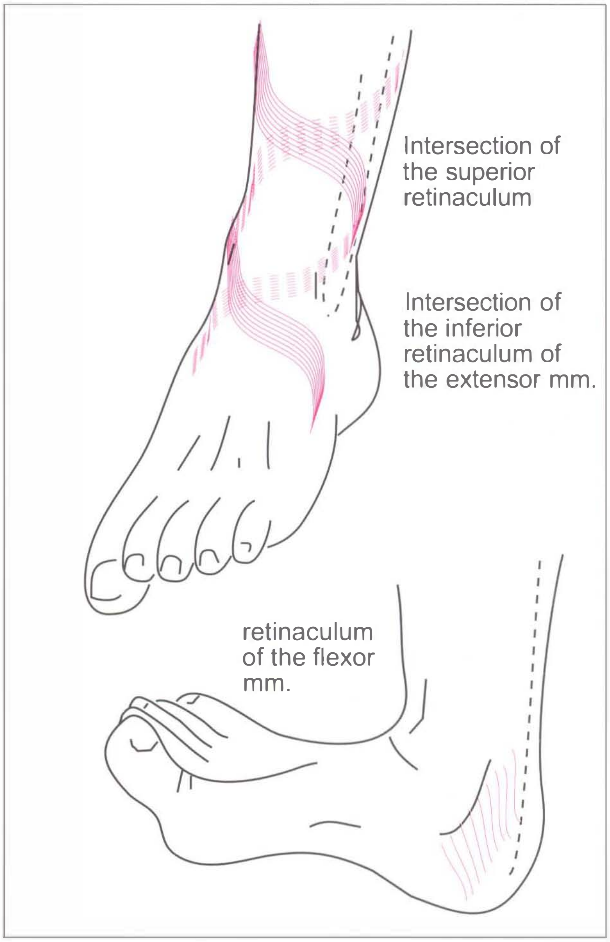

Figure 162. Retinacula or intersection of the collagen fibres.

An expansion of the iliotibial tract originates from the lateral intermuscular septum[368]. The spiral follows the iliotibial tract until it reaches the origin of the tensor fascia lata muscle. In the proximal part of the iliotibial tract expansions of the iliopectineal fascia, of the tensor fascia lata and of the gluteus maximus are to be found[369]. Hence this spiral, as well as finishing in the cc of ante-latero coxa, also connects with the cc(s) of an-me-cx and re-la-pv[370].

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[365] Beneath the Achilles tendon two fibrous septa can be noted: one extends from the superficial fascia to the posterior part of the lateral malleolus; the other, which is much greater, is the continuation of the deep layer of the fascia of the leg and extends transversally from the medial malleolus to the lateral malleolus; it is to be noted that in its medial portion it is intimately fused with the medial annular ligament. (Testut L, 1987)

[366] At the level of the distal third of the leg the posterior intermuscular septum consists essentially of fibres from the deep lamina of the crural fascia. The fibres of the anterior septum extend from the fibula in a distal and superficial direction, whilst other thinner bands run around the leg. As these fibres turn they penetrate mostly into the part of the fascia that covers the extensor compartment. (Lang J, 1991)

[367] The proximal plane consists of the popliteal fascia of the femur, which is enlarged by the rigid structure of the fibrous intermuscular septa. The lateral intermuscular septum is particularly rigid and from its anterior margin the vastus lateralis m. detaches with a part of its fibres. Via this lateral intermuscular septum, the iliopectineal fascia or band inserts onto the lateral lip with a part of its fibres. (Lang J, 1991)

[368] The tensor fascia lata and the gluteus maximus insert onto the femur via the iliotibial tract and its deep extension, the robust lateral intermuscular septum. (Gray H, 1993)

[369] The vastus lateralis muscle originates from the distal margin of the greater trochanter, the lateral surface of the femur from the gluteus maximus tendon and from the lateral intermuscular septum. (Testut L, 1987)

[370] The fascia lata thickens in the proximal and lateral part of the thigh. It inserts onto the dorsal surface of the sacrum and coccygeus, the iliac crest, the inguinal ligament, the superior and inferior pubic rami and the inferior margin of the sacrotuberous ligament. (Gray H, 1993)

Mf unit of the re-me-pe spiral

Retro-medio-pes (re-me-pe) cc of fusion

– This point is located between the medial malleolus and the Achilles tendon and it extends into a semicircle (Figure 163).

– This cc corresponds to the acupuncture point KI 4 (Luo point of the meridian: from here a longitudinal Luo and a transversal Luo vessel part towards the Bladder meridian). Cyriax locates three treatment sites for the "tibialis posterior sheath"[371] in this area.

Ante-latero-talus (an-la-ta) cc of fusion

– This point is located above the lateral malleolus, in front of the fibula, over the origin of peroneus tertius muscle.

– This cc corresponds to the acupuncture point GB 38 (Luo point of the meridian: from here a longitudinal Luo and a transversal Luo vessel part towards the Liver meridian). It corresponds to the point indicated by Maigne[372] for the mobilisation of the inferior tibiofibular articulation

Retro-medio genu (re-me-ge) cc of fusion

– This point is located over the upper medial margin of the medial gastrocnemius muscle.

– This cc corresponds to the acupuncture point BL 55. The treatment of this point has proven to be useful for pain due to suspected knee cartilage damage, often allowing for an immediate recovery of knee articularity. Similar experiences can also be found in other techniques or schools[373].

Antero-latero-coxa (an-la-cx) cc of fusion

– This point is located beneath the anterior superior iliac spine between the tensor fascia lata tendon (an-cx) and the gluteus minimus tendon (la-cx).

– This cc corresponds to the acupuncture point GB 28 (point located along the Dai Mai channel or waist channel) and to an area indicated by Cyriax[374] for the treatment of anterior thigh pain. The resolution of impeded knee extension, together with pain located behind the joint, following treatment of this anterior point can be explained by the intrinsic structure of the fascial spiral.

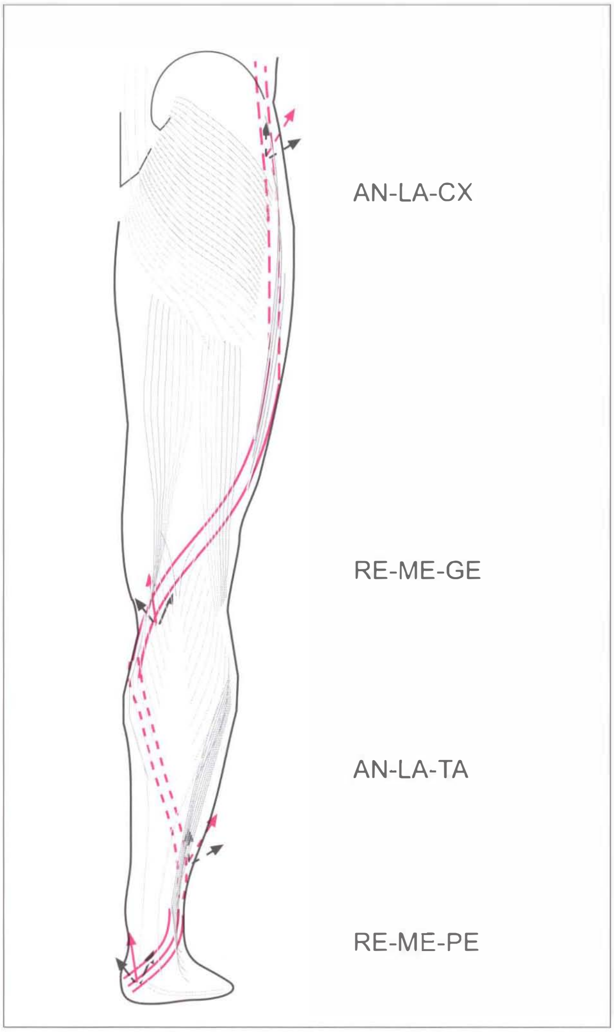

Figure 163. Cc(s) of fusion of the re-me-pe spiral.

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[371] When resisted adduction is painful but not dorsiflexion then the pain can be said to originate in the tibialis posterior. The beginner can misinterpret this condition as a lesion of the Achilles tendon. (Cyriax J, 1997)

[372] The inferior and superior tibiofibular articulations have an important role in the movements of flexion and extension of the talotibial joint. (Maigne R, 1979)

[373] A meniscus blockage can quite often be removed by means of manipulation, providing immediate relief for the patient. Frequently, patients treated in this way have never had a relapse, even though an obvious meniscus lesion has been demonstrated radiographically. (Maigne R, 1979)

[374] At times athletes suffer strains of the quadriceps (often of the rectus femoris tendon although the vasti can be damaged individually) that require deep friction. Knee extension is the most painful movement, although maximum flexion or rotation can also pinch or stretch the tissues. (Cyriax J, 1997)

The antero-latero-pes spiral

The antero-latero-pes spiral begins at the base of the fourth metatarsal and rises towards the medial part of the tibia, following the ascending fibres of the extensor retinaculum. These collagen fibres run above the tibial periosteum and they extend into the posterior crural fascia[375]. From the postero-medial crural fascia the spiral rises in a proximo-lateral direction, winding around the belly of the triceps muscle, following the fibres arranged in a configuration of eight[376]. At the halfway point on the calf, the spiral crosses over the other branch of eight-shaped fibres, which originate from the medial tibial condyle. Instead, the an-la-pe spiral ascends towards the head of the fibula and passes forwards, attracted by the expansions of the quadriceps[377]. In particular these fibres are influenced by traction produced by the part of the patellar retinaculum that is connected to the vastus medialis (Figure 164). A number of fibres of the vastus medialis originate from a membrane in common with the adductor magnus[378]. The spiral continues its path following the adductor magnus and, in particular, those fibres which insert onto the ischial tuberosity. Once it arrives at the ischial tuberosity this spiral continues, in part with the fibres of gluteus maximus and in part it connects with the joint capsule of the hip. As in the shoulder, in the hip it is also possible to find continuity of the superficial fascia, as well as a deep myofascial continuity. In this case it is the articular capsule that acts as the point of union between the various forces inserted into it[379].

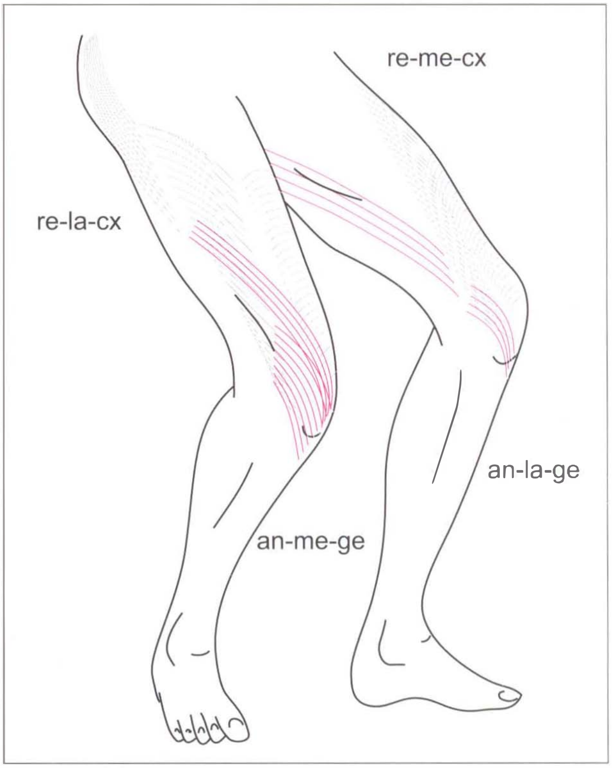

Figure 164. Intersection of the collagen fibres of the patellar retinaculum.

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[375] At the level of the tendon of the tibialis anterior muscle the proximal band of the retinaculum of the extensor muscles doubles: a part of the fibres pass behind the tendon and a part continue with the posterior fascia of the ankle. (Testut L, 1987)

[376] The collagen fibres that originate from the head of the fibula and the medial condyle of the tibia wind around the triceps surae muscle, widening into a fan shape in a dorsal distal direction. In the intermediate area these fascial fans cross each other in such a way that the superficial layers become deep layers and the deep become superficial... After having crossed each other in the medial dorsal part they penetrate into the periosteum of the medial surface of the tibia. A part of the fibres can be traced as they pass through the periosteum and proceed onto the investing lamina of the extensors. The entire pathway of these fibres can be compared to an eight, open in its upper half, with branches that wind around the tibia, firstly behind and then in front. (Lang J, 1991)

[377] The quadriceps tendon, within whose bulk the patella is formed, sends out fibrous expansions that fix themselves respectively to the medial and lateral condyles of the femur and to the lateral and medial retinacula of the patella (vertical). Other fibrous expansions (horizontal) that are derived from the tendons of the heads of vastus medialis and lateralis are added to these reinforcing the respective alar ligaments of the patella. (Fazzari I, 1972)

[378] From the muscular part of the adductor magnus muscle tendinous fibres of an aponeurotic type separate and continue on in the tendon of the vastus medialis. They are called the vastus adductor membrane. (Platzer W, 1979)

[379] The capsule of the hip joint inserts onto the neck of the femur, at a distance from the articular cartilage. It is reinforced by three ligaments that are literally woven into it: an iliofemoral ligament, which from the anterior inferior iliac spine extends below dividing itself immediately into two bands, one of which goes to the greater trochanter and the other to the lesser trochanter; a second ligament, the ischiofemoral extends from the ischium to the neck of the femur; and a third, pubofemoral, which from the iliopubic eminence extends to the lesser trochanter. (Fazzari I, 1972)

The mf unit of the an-la-pe spiral

Ante-latero-pes (an-la-pe) cc of fusion

– This point is located in the more distal part of the inferior retinaculum, around the base of the IV metatarsal (Figure 165).

– This cc corresponds to the acupuncture point GB 41 (a collateral vessel for LR 1 parts from here) and to the area treated by Cyriax for sprains of the intertarsal ligaments[380].

Retro-medio-talus (re-me-ta) cc of fusion

– This point is located medially in the hollow that exists between the tibia and the Achilles tendon. The vectors of retro and mediomotion talus, formed by the triceps surae and the flexor digitorum and flexor hallucis longus muscles, converge here. This point should be treated with caution if there are any problems of blood circulation.

– This cc corresponds to the acupuncture point SP 6 (crossing point of the three Yin meridians) and to the TPs of the flexor digitorum longus[381] and flexor hallucis, as well as to certain myalgic cords that Maigne links with vertebral dysfunctions. In Fascial Manipulation, the lumbar area may be treated by following the spiral pathways rather than the nerve roots.

Ante-latero-genu (an-la-ge) cc of fusion

– This point is located anteriorly to the head of the fibula.

– This cc corresponds to the acupuncture point ST 36. It also corresponds to the treatment site indicated for patellar subluxations, or pseudo-blockages of the knee due to disturbances of the patellar retinacula[382].

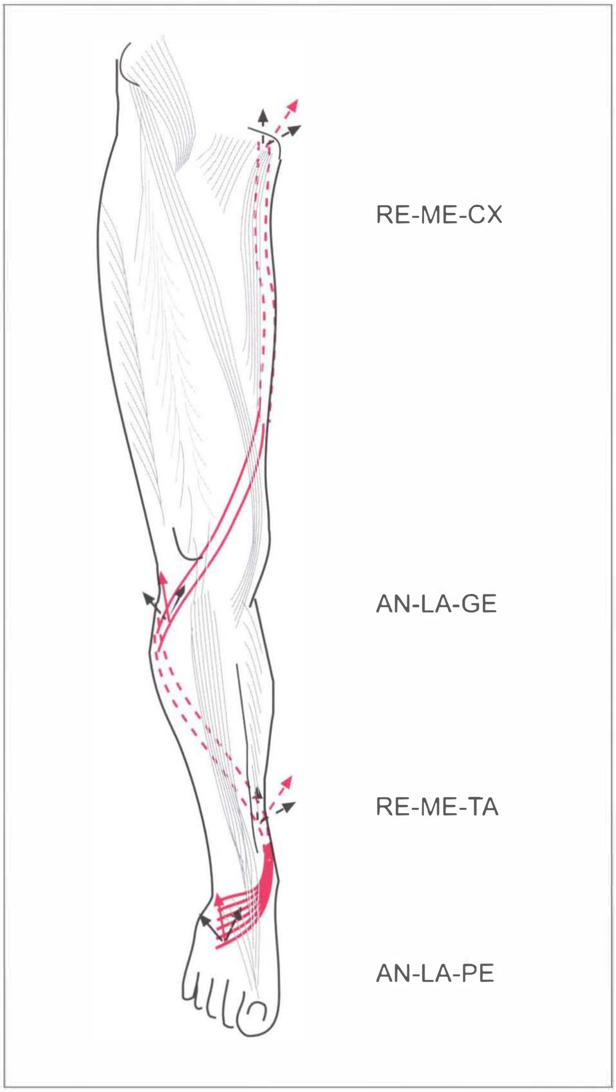

Figure 165. Cc's of fusion of the an-la-pe spiral.

Retro-medio-coxa (re-me-cx) cc of fusion

– This point is located to the side of the sacrococcygeus articulation.

– This point corresponds to the acupuncture point BL 35 and to the indications of Cyriax[383] for the hamstring muscles.

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[380] Limitation of movement in the intertarsal ligaments can derive from a contracture of a ligament following several months of plaster. The intertarsal ligaments of the dorsum of the foot are found to be retracted and hypersensitive and mobilisation is not effective. (Cyriax J, 1997)

[381] In order to palpate the TPs of the flexor digitorum of the toes the patient must lie on the same side and the physician palpates with a flat hand applying pressure between the tibia and the soleus/gastrocnemius muscles on the medial side of the leg. (Travell JG, 1997)

[382] It needs to be noted that an error sometimes occurs in attributing to a lesion of the meniscus the painful "giving way" symptom that an athlete, afflicted by a slight patellar subluxation, may suffer. Usually no locking occurs with a patellar subluxation but, if it is accompanied by collateral ligament or patellar retinaculum injury, the last grades of knee flexion can become very painful. (Maigne R, 1979)

[383] The hamstring muscles can be effected either at their origin from the ischium or over their muscle bellies. Either a direct trauma or a sudden stretch can be responsible and the pain intensifies over a 24-hour period. The massage is carried out with a transverse traction. It can be useful if an assistant stabilises the wrist of the operative hand. (Cyriax J, 1997)

The ante-medio-pes spiral

The spiral of ante-mediomotion begins in the medial part of the foot (Figure 166) in proximity of the tibialis anterior and over the distal band of the cruciform, or inferior extensor retinaculum[384]. As the name suggests this retinaculum has a cross-like shape with the two superior branches that embrace the ankle. This spiral follows the fibres that pass to the lateral malleolus[385] to continue in the postero-lateral part of the leg (Figure 167). From the sheath of the peroneal muscles[386] the spiral ascends towards the medial tibial condyle following the 8-shaped fibres of the posterior crural fascia. These fibres then follow the retinaculum of the knee[387] and, in particular, traction coming from the vastus lateralis. The collagen fibres of the arciform tract of the fascia lata are aligned according to the same lines of force as the vastus lateralis. Both of these structures are continuous with the lower fibres of the gluteus maximus. In particular, the proximal fibres of the vastus lateralis originate from the tendinous membrane of the gluteus maximus. By following the helicoid formed by these myofascial tractions the spiral continues on to the gluteal fold, where the gluteal retinaculum or "cavesson or halter system" of fibres[388] is found. These collagen fibres, which wind around the lower part of the gluteus maximus, connect this spiral medially with the urogenital fasciae[389] and laterally with the fascia of the tensor fascia lata. The pelvis is like the scapula in as much as the spirals of the lower limbs can continue with any of the spirals of the trunk even though the preference tends to be for the spiral of the same direction (re-la-pv).

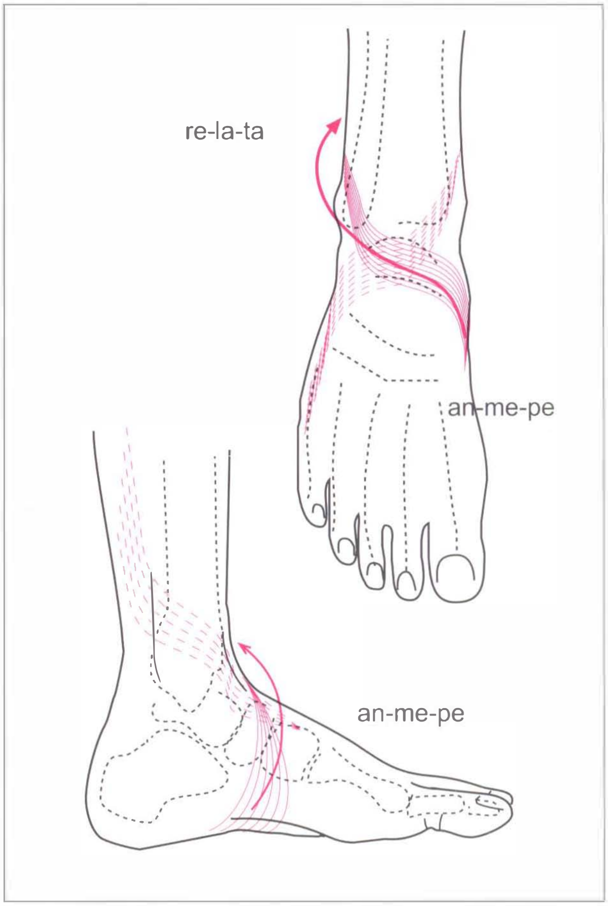

Figure 166. Distribution of tension between the two branches of the cruciform or inferior extensor retinaculum.

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[384] The distal band of the extensor retinaculum, which descends obliquely, distances itself from the previous acute angle and terminates on the medial margin of the foot where it continues with the medial plantar aponeurosis. (Testut L, 1987)

[385] The cruciate ligament is a band in the shape of a y that originates from the lateral face of the calcaneus and divides into a proximal and a distal branch. From the point of bifurcation a third branch extends toward the external malleolus. (Fumagalli Z, 1972)

[386] Hence the fibres have, at first, a superficial path and then they run deeply over the triceps surae. In the successive part they cross the compartment of the peroneal muscles and continue on with the investing lamina of the compartment of the extensors. (Lang J, 1991)

[387] The alar ligaments or the patellar retinacula are divided into lateral and medial. The lateral alar ligament originates from bands of the vastus lateral and rectus muscles and it joins with the medial collateral ligament; the medial retinaculum originates from the vastus medialis and it passes below and posteriorly to join the lateral collateral ligament. (Gray H, 1993)

[388] "Cavesson or halter system". Distally, from the line which connects the ischial tuberosity to the apex of the greater trochanter the transverse bands of the fascia lata irradiate towards the skin and the underlying musculoskeletal plane; due to the presence of a rigid system of "retinacula" they invest the distal margin of the gluteus maximus with a type of cavesson. (Lang J, 1991)

[389] The muscles and the fasciae of the perineum in both sexes can be divided into two groups: anal and urogenital. The deep fascia of the anal region includes the inferior fascia of the pelvic diaphragm and part of the obturator fascia; the fascia of the urogenital diaphragm includes the inferior fascia or perineal membrane and the superior fascia, which is continuous with the obturator fascia. (Gray H, 1993)

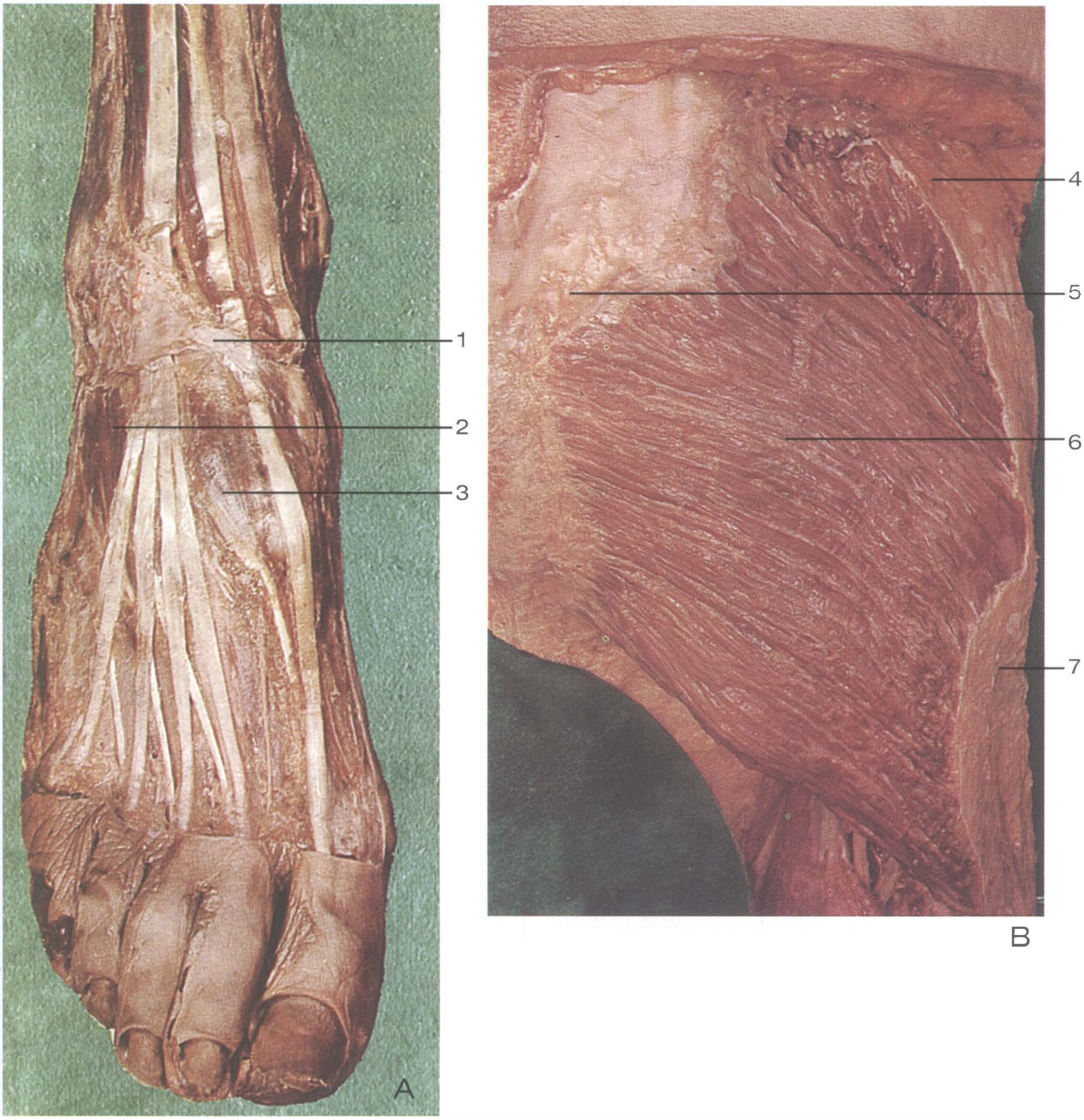

Figure 167. A - Dissection of the dorsum of the foot; B - Dissection of the gluteal region (from Fumagalli - Colour photographic atlas of macroscopic human anatomy. - published by Dr Francesco Vallard/Piccin Nuova Libraria); 1, inferior extensor retinaculum; here the anatomist has placed the collagen fibres that correspond to the an-me-pe spiral (the part that goes from an-me-pe toward the cc of fusion of re-la-ta) in evidence; 2, extensor digitorum brevis, connected to the peroneal retinaculum and involved in the extrarotation sequence; 3, extensor hallucis brevis whose fascial compartment is comprised between extensor hallucis and extensor digitorum (ante sequence); 4, the fascia lata fused with the epimysial fascia of the gluteus medius; muscular fibres insert onto it; 5, the superficial layer of the thoracolumbar fascia onto which a number of gluteus maximus fibres insert; 6, fibres of gluteus maximus; white bands formed by the perimysium between the muscular fascicles are visible here. The perimysium absorbs the traction of the endomysium and the muscle spindles and transmits it to the epimysial fascia onto which it is inserted. On the inferior border of the muscle the anatomist has removed the "halter" formation or collagen fibres that wind around the lower part of the gluteus maximus (re-la-cx, cc of fusion); 7, the fascia lata onto which a number of gluteus maximus fibres are inserted; traction of these fibres passes into the fascia lata to form the iliotibial tract. By following this tract the spiral, once it has passed the knee, extends into the retro-lateral region of the ankle where it connects with the previously mentioned cruciform ligament, or inferior extensor retinaculum.

The mf unit of the an-me-pe spiral

Ante-medio pes (an-me-pe) cc of fusion

– This point is located in the medial border of the tibialis anterior insertion (Figure 168).

– This cc corresponds to the acupuncture point SP 4 and to the indications given by Cyriax for lesions of the ant. tibiotalar ligament[390].

Retro-latero-pes (re-la-pe) cc of fusion

– This point is located behind the lateral malleolus, over the tendons of the peroneal muscles.

– This cc corresponds to the acupuncture point GB 39 (Luo point of the three Yang meridians of the lower limb). Densification of this point can result in rigidity of the ankle joint, which Maigne suggests to reduce with a swift traction manoeuvre[391].

Ante-medio-genu (an-me-ge) cc of fusion

– This point is located beneath the tibial condyle over the tendons that insert into the upper part of the medial surface of the tibia. The antemotion vector of the vastus and the mediomotion vector of the gracilis converge at this point.

– This cc corresponds to the acupuncture point SP 9 and to the cellulitis plaque that forms in correspondence to the L3-4 dermatome (Maigne)[392].

Retro-latero-coxa (re-la-cx) cc of fusion

– This point is located between the lateral part of the ischial tuberosity and the greater trochanter.

– This cc corresponds to the acupuncture point BL 36. Treatment of this cc of fusion can alleviate infra-gluteal bursitis, treated by Cyriax with injections, as well as trochanteric bursitis, which Maigne[393] treats with passive stretching. These techniques certainly give good results, however, they are aimed at the inflammation, which is often a consequence of an imbalance originating from another area altogether. If the origin of the compensation is actually in the gluteal area itself then it is possible to intervene with a manipulation directly over the fibrous connective tissue.

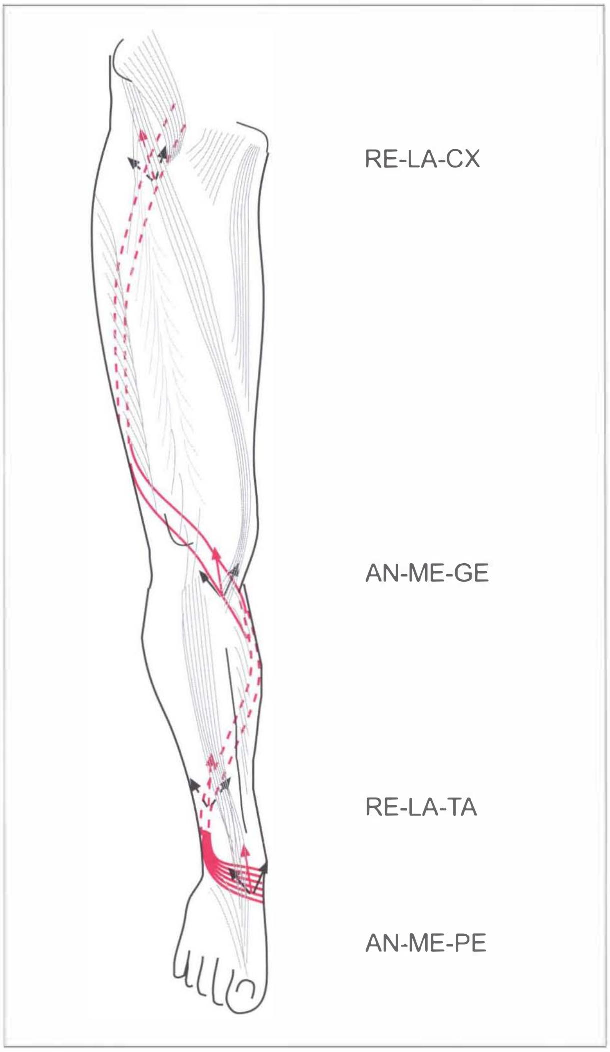

Figure 168. Cc's of fusion of an-me-pe spiral.

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[390] A sprain in this site is an uncommon consequence of a simple plantar flexor stretch. Pain may persist for years but it is never acute; symptoms are felt in the anterior part of the ankle with maximum plantar flexion. Massage is the treatment of choice. (Cyriax J, 1997)

[391] Painful articulations in the foot do not normally present radiographic lesions as is frequent in minor articular derangements that obtain good results with manual techniques. The therapist exerts a sudden traction on the tibiotarsal articulation whilst the patient, breathing deeply, relaxes. (Maigne R, 1979)

[392] The majority of these patients present pain in the internal part of the knee, almost always exacerbated by hyperextension and hyperflexion. Examination reveals a painful hardening of some of the fibres of the vastus medialis and a tenderness of the spinous processes of L3 and L4. (Maigne R, 1979)

[393] Trochanteric bursitis and tendinitis can be found either alone or in association with osteoarthritis of the hip. In the chronic forms the thigh can be mobilised into adduction. These stretches are useful in alleviating pain due to hardened, myalgic cords located in the abductor muscles. (Maigne R, 1979)

Chapter 21
MANIPULATION OF THE MF SPIRALS

Fascial tissue extends throughout the whole body without interruption. Based on this fact, a stimulus applied to any part of the fascia will naturally have repercussions in other parts of the body. Only if a stimulus is directed at the appropriate point[394] will it be able to resolve a problem definitively. Unfortunately, this point is never located where the pain is manifested. There are three ways to trace back to this point:

- if the problem is localised in a single articulation then, from the site of pain (cp), it is possible to trace back to the centre of coordination (cc) of the mf unit (Figure 182);
- if pain is distributed in a number of segments and it is exacerbated by movements on one plane then the sequences of that plane will be selected;
- if the imbalance is in a number of sites and is exacerbated by a number of movements then an involvement of one, or more, spirals can be hypothesised.

Segmentary pain has its origin close to the painful area. Pain on one plane has its origin in a number of points that are aligned with the painful area. Spiral related pain often has its origin in a number of points distributed on more than one plane.

Every single treatment is guided by purpose or intention. In segmentary treatment the aim is to restore the gliding component between the various fascial structures (endomysium, perimysium, epimysium). With treatment of the spirals the aim is to restore fluidity to the ground substance to allow the single bundles of collagen fibres to glide freely. The purpose, or the intention, is that which decides and adapts the pressure and the direction of treatment: "Manus sapiens potens est" (from Latin: A knowing hand is powerful).

Data

The unity of the body should always be taken into account when compiling a global assessment chart. Even though the body is a single entity there are so many specialities in medicine that it is often forgotten that each segment is a part of the whole. In particular, the fascia is the element that connects all of the locomotor apparatus' structures together:

- the fascia unites the unidirectional motor units of the mf unit;
- the fascia unites the unidirectional mf units of the mf sequence;
- the fascia unites the motor schemes of the various segments together with a spiral;
- the fascia forms the framework of the Central Nervous System (falx cerebri, dura mater)
- the fascia guides innervation in the developing embryo and forms the nerve sheaths;
- the fascia gives a directional significance to nerve afferents via the sequences;
- the fascia gives consistency to muscles via the epimysium and, via the epitendineum, it provides a gliding component;
- the fascia reinforces the articular capsules and connects with ligaments;
- the fascia signals bone derangements or fractures via the periosteum;
- the fascia surrounds veins and arteries with the vascular and nerve sheaths;
- the fascia is the site of inflammation, repair and metabolic activity;
- the fascia is the tissue that links the external temperature with the internal temperature.

The fascia is connected to all of the locomotor apparatus' structures therefore it is obvious that densification of the fascia can determine many dys-

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[394] If the cc directly involved is not considered in the presence of cervical pain and limited movements, then no results are obtained. For example, if in the case of pain provoked by neck rotation the cc of lateromotion were to be treated then no improvement would occur. Instead, treatment of the cc of er-cl would be of immediate benefit. (Stecco L, 1999)

Table 21. Structure of the locomotor apparatus

Locomotor apparatus components	*Structure*	*Dysfunctions*
Myofascial	Mf unit Mf Sequence Mf Spiral	Local pain Postural Diffuse pain
Neuromuscular	Central NS Peripheral NS Afferent NS	Paraplegia Neuritis Paraesthesia
Musculoskeletal	Muscles Articulations Bones	Muscle strain Lig. sprain Bone fracture
Autonomic	Circulation Metabolism Thermal regulat.	Oedema Dystrophy Perspiration

functions of this same apparatus (Table 21, column III). Fascial Manipulation is effective for resolving these types of dysfunctions.

How can Fascial Manipulation cure, for example, a tendinous cyst or a trigger finger?

A tendinous cyst is a form of compensation that the body creates to avoid anomalous muscle traction. The muscle, in this case, does not exert a physiological stretch on the tendon because its fascia does not coordinate perfectly all of the muscle fibres that act on that tendon. This incoordination is due to a densification of the fascia caused by a repetitive, unidirectional use (overuse syndrome). At this stage a therapy that acts on the cause (densification of the cc of the mf unit involved) is necessary, rather than any pressure to the cyst (consequence).

Once manipulation has restored fluidity to the ground substance of the fascia (which coordinates the motor units acting on that tendon) then the healing process is activated. The cyst (or the trigger finger, as it is a similar process) does not disappear immediately but will be re-absorbed within the time frame of fifteen to twenty days.

Clinical indications for Fascial Manipulation

In the seventh chapter, where manipulation of the mf unit was discussed, the sites of common segmentary pain have been listed (Tables 7, 8, 9). Amongst these, localised dysfunctions such as tendinitis, periarthritis, bursitis and many other extra-articular rheumatic disorders are listed. With segmentary treatment not only dysfunctions of the soft tissues can be cured but also articular pain attributed to osteoarthritis. Pathologies that involve the myofascial component are rarely localised in a single segment but often have a widespread distribution in the body. Pain may have a precise localisation, such as brachial pain (sequence of the upper limb), sciatic-type pain (sequence of the lower limb) and back pain (sequence of the trunk) or it may have a less defined localisation, such as in fibromyalgia or with so-called growing pains.

The nervous system component of the locomotor apparatus can benefit from Fascial Manipulation due to the fact that the fascia is structured in such a way as to provide proprioceptive information to the cerebral cortex. In neuro-rehabilitation, Fascial Manipulation stimulates the neuroreceptors by following the pathways of the mf sequences.

The musculoskeletal component benefits from Fascial Manipulation particularly in those cases of post-fracture disorders, dislocations, sprains and strains. Often post-trauma immobilisation determines a variety of densifications of the fascia. It has been observed that joint mobility and motor activity recuperate faster if treatment is carried out on the fascia rather than on the articulation itself. Once movement is no longer inhibited by pain due to fascial limitations then the patient effectuates active and passive mobilisation during daily activities.

Whilst this exposition concerns principally the locomotor apparatus, this system is not detached from the internal organs or from the psyche. The facial muscles are an example of the connection between myofascial tension and the character of a person (Table 22). According to the prevalence of either the agonist or the antagonist muscles of this segment of the body, a person manifests a hyper or a hypo state and the contractions of each facial muscle can represent particular states of mind. Whenever the tensional harmony between the myofascial sequences is disturbed then a morphological prevalence is established

- Sagittal plane: a person with hypertonic frontalis and levator palpebrae muscles has a dominating appearance; if, instead, the muscles that lower the corners of the mouth and the eyelids are more active then a person has a submissive appearance, with a tendency towards introversion.
- Frontal plane: if the muscles which increase the breadth of the face (risorius) prevail, then the person has an open appearance with a joyful dis-

Table 22. Relationship between facial muscles and the spatial planes

CC	Facial Muscles	Character / Expression
	Sagittal plane	
RE-CP 1 RE-CP 2	Levator palpebrae Occipitofrontalis mm. that raise	Amazement Interest *Dominance*
AN-CP 1 AN-CP 2	Procerus m. Depressore labii mm that lower	Preoccupation Introversion *Submission*
	Frontal plane	
LA-CP 1 LA-CP 3	Zygomaticus major Risorius, originate from masseter fasc	Gaiety Smile *Openness*
ME-CP 1 ME-CP 2	Corrugator Orbicularis oculi Orbicularis oris	Tears Sadness *Taciturn*
	Horizont. plane	
ER-CP 1 ER-CP 2	Levator palpebrae Auricularis m. that moves the ear	Cupidity Alertness *Attentive*
IR-CP 1 IR-CP 2	Zygomaticus min, Sup. incisive mm. Bare teeth in anger	Disdain Sneer *Distracted*

position; if instead the orbicularis muscles are hypertonic then the person's face will have a closed type of appearance (mediomotion) with a tendency towards a taciturn disposition.

- Horizontal plane: in animals the muscles around the ear have the function of directing the auricle in the direction of sounds, whereas in humans these muscles stimulate the state of alertness; the zygomaticus and the superior incisive muscles are activated in moments of anger.

Fascia modifies the network of its collagen fibres not only due to muscular stress but also due to psycho-emotional tension (psychosomatic sequence). This plasticity of the fascia is fortunately reversible and it can be remodelled through manipulation (somatopsyche sequence).

Any dysfunction of the autonomic nervous system (sympathetic and parasympathetic) and the internal organs can be indicative of a compromised plane of movement because the fasciae, which surround these structures, are connected to the mf sequences. These connections will be examined in a future study but, for now, it is sufficient to note that it is possible that a patient suffering from lumbar pain, for example, may find immediate relief from treatment applied to an appendectomy scar. In such a case, adherence between the muscular planes of ante-pelvis may be impeding the action of the antagonist unit retro-pelvis (re-pv). The more one comprehends the connections between the fasciae then the more useful elements available, during data collection, to enable the therapist to trace back to the origin of the imbalance.

Contraindications for Fascial Manipulation

If this technique is applied scientifically and knowingly then there are no contraindications. It is sensible not to subject a person with a fever to any ulterior inflammatory reactions, particularly considering that Fascial Manipulation itself can, at times, determine a rise in body temperature.

Being a superficial treatment Fascial Manipulation can be applied in cases of suspected fracture because it does not act on the traumatised point itself but above or below it. In the case of a complete resolution of the pain a radiographic examination may become superfluous.

In the case of tumour, Fascial Manipulation is not contraindicated (metastases due to tissue massage have not been demonstrated) and at times the relatives of the patient ask that the patient's treatment be continued as a type of moral support.

Hypotheses

Quite often, in cases of diffuse pain, the part that is most painful at the time of examination is the segment that has had to adapt most in order to compensate for other imbalances. In other words, that which worries the patient most can actually be a healthy segment.

In order to elaborate a hypothesis, data should be classified according to the following criteria:

- according to dominance: which pain, amongst all of those present, has the most importance in this imbalance?
- according to chronological order: which pain, amongst those present, initially caused the imbalance?
- according to pathways of compensation: is the pain is distributed over one plane or along a spiral?

It should also be asked whether there might be

Table 23. Hypotheses of points to be treated

Dominance	Maximum pain Concomitant pain.
Chronology	Previous pain, First trauma, operation.
Compensation	Manifest compensations Silent compensations

Table 24. Hypotheses of treatment aims or therapeutic plan

What does the patient expect?	To be pain free To return to his/her normal activity
How can this be achieved?	Dissolution of the cc(s) Correct combination of cc(s)
How will the sessions be programmed?	In the first session..., in the second ..., in the third session...

other silent or dormant pain sites, aside from the actual pain that the patient presents.

Because Fascial Manipulation is a therapy that benefits the patient then the previous hypotheses must also be integrated with the patient's expectations (Table 24). When establishing a therapeutic plan the aim of the first session and how to complete these results in the other treatment sessions needs to be clear.

- If a patient presents with pain in a knee, for example, therapeutic analysis could trace back to the first cause, say a lumbar pain, provided that ultimately the knee pain is resolved.
- The fascial therapist does not have to treat all of the painful cc(s) but should choose which cc(s) to treat by following the indications given in this book. In order to re-balance a postural imbalance, the cc(s) on one plane are chosen. In order to re-balance or harmonise a motor activity or gesture, the cc(s) of fusion of one spiral should be selected.
- In the case of an acute back pain, for example, where it is impossible to establish the most painful movement, a treatment of the cc(s) of fusion (e.g. re-me-th) could be planned in the first session. Then, in the second session, the therapist could formulate an appropriate ongoing treatment plan for re-balancing the fascial tensions.

Verification

During the segmentary movement assessment passive, active and resisted movements are examined.

During movement assessment of a plane the static posture (compensations) is examined.

During the motor assessment of the spirals dynamic movement (neutralising strategies, differences in movement between the left and the right) is examined. Indications of the most painful movement are difficult to deduce from complex motor activities. If the grid system were used, as suggested in a previous chapter, then asterisks would be recorded in all of the boxes. If the graph system were used then it would be apparent that pain in segments such as collum, thorax and lumbi manifest themselves with the same intensity during all of the movements on the three planes.

By comparing Figure 169, with that of the sequences (Figure 119) it can be seen that, in the first, the pain is accentuated in all directions (spiral) and that, in the second, the pain is accentuated most of all on the frontal plane.

Even if indications drawn from the movement assessment do not point out which spiral to treat it is always useful for a comparison during post-treatment assessment.

With treatment of the fascial spirals it is, above all, the comparative palpation of the cc(s) of fusion of a segment that assists in the choice between the various hypotheses that have been formulated.

- How to choose a spiral: once a hypothesis has established that it is a spiral-type of dysfunction it is necessary to decide which spiral to inspect. The comparative palpation between the four cc(s) of fusion of a segment can help in this task (diagnostic or indicative cc(s)).
- How to choose which cc(s) of a spiral: once the spiral to be treated has been chosen then it is necessary to select which cc(s) of fusion to treat along this spiral. It is often useful to treat a cc located at a distance from the site of pain. This cc can only be selected with comparative palpation, as often the patient is unaware that this cc is implicated.
- How to combine the spirals of the limbs and the trunk: only the distribution of the dysfunctions and the confirmation by palpation can indicate which pathways have been established between the spirals of the limbs and the trunk. In anatomy

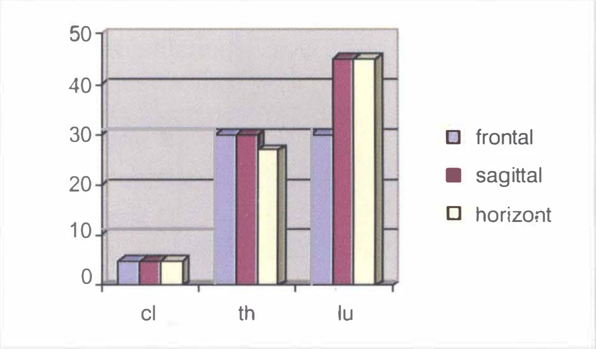

Figure 169. Percentage of pain provoked by movement on the three spatial planes.

it can be observed that the pelvic and scapular girdles allow for all possible combinations. In case of uncertainty, treatment should be extended into the spirals of the same direction (an-la-cx, an-la-pv).

Treatment

A spiral can be treated either singularly or together with another spiral.

In the trunk, the two opposite spirals are often involved simultaneously: an-la-cl on one side and re-la-cl on the other side.

In the upper limb, the gripping action of the hand is a resultant of an-me-po and an-la-di, whilst opening out the hand is a resultant of re-la-po and re-me-di. Repetition of these synergic movements creates a combination that is then implicated when a dysfunction occurs.

Manipulation of the spiral cc(s) of fusion (Table 25) presents a number of variations with respect to treatment of the segmentary cc(s).

- Treatment of a spiral is carried out by combining a number of points, in order to reduce tension along the entire spiral simultaneously. Often the solution of a key point reduces the sensitivity of all of the other cc(s) of fusion. Around one segment treatment of a cc of fusion can be combined together with two segmentary cc(s) (e.g. an-la-hu + an-hu, la-hu);
- Cc(s) of fusion are more superficial than the segmentary cc(s) and they are associated with the fluidity of the ground substance of the retinacula. Segmentary cc(s) are associated with the fluidity of the endomysium, perimysium and the epimysium[395].
- A minor but constant pressure is required during treatment of the cc(s) of fusion. Figure 170 illustrates how, over time, the application of a constant pressure produces a sudden decrease in pain and a simultaneous increase in the perception of the segment being treated.
- During the manipulation the therapist "tunes in" to the patient's problem in such a way that the therapist's hand is guided by the needs of the patient's body. In order to achieve this it is necessary that patients are questioned throughout the manipulation with regards to sensations of benefit, or relief from their symptoms.
- It is better to press along the retinacula, searching out the stiffer fibres and those that radiate pain. This back and forth movement is to be confined within the tendinous structures linked to the mf unit of fusion in question.

Table 25. Comparison between segmentary cc(s) and cc(s) of fusion

	Segmentary CC(s)	*CC(s) of fusion*
Site of pain	The pain is local and constant e.g. me-ge	The pain moves e.g. me, an, ir ge
Painful movement	Only one movement is painful e.g. me	Numerous movements are painful e.g. me, an,
Concomitant pain	Pain is distributed on one plane	Pain is distributed along a spiral.
Palpation assessment	Densification located in/over muscle belly Compare 6 movts.	Densification in the retinaculum Compare 4 diagonals
Treatment	Restores fluidity to perimysium, epimysium Deep action	Frees the reticular collagen fibres More superficial
Results	Inflammation and initial increase in	Sense of liberation of movement

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[395] The colloidal gel makes up the ground substance of connective tissue. Trauma, disuse, lack of movement with its diminished circulation, repetitive motion, poor posture over time eventually causes the gel (ground substance) to dehydrate, contract and harden resulting in a kinking of the collagen bundles. This results in shortening and malfunction of tendons, muscles and fascia. Also toxins and metabolic waste products accumulate in the connective tissues, especially in areas that have become densified... (Scientific American, January 1998)

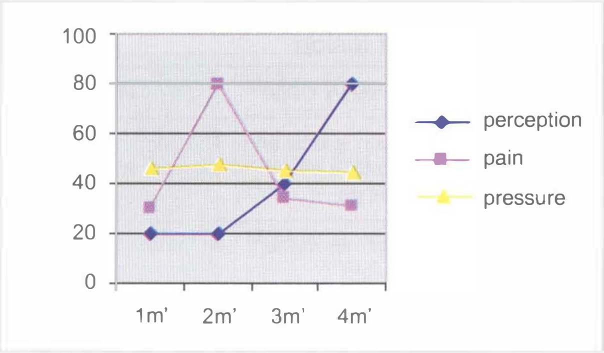

Figure 170. A constant pressure produces a decrease in pain and a progressive increase in perception of the body.

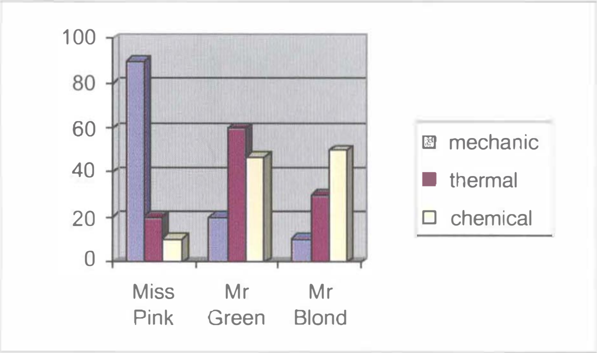

Figure 171. In each patient the mechanical, thermal and chemical factors will contribute to any one dysfunction in varying degrees.

Patients' questions

Whilst Fascial Manipulation often provides excellent results it does not answer all of the questions that a patient may have in mind (Table 26). Even though at times it may seem to be repetitious it is always worthwhile to dedicate some time for discussion. A clear explanation of the factors involved is often more reassuring than a complete fascial liberation without any explanation.

Often patients are convinced that by knowing the cause of their disturbance then they will be able to avoid relapses in the future. Hence the following type of questions are often asked:

- "What was causing the pain?"
  An appropriate reply could be worded as follows: In the point where this deep massage or manipulation was applied the fascia had become rigid and this prevented the body from carry out its normal activity. Fascia becomes rigid due to a number of concomitant factors such as microtraumas, strains, cold, metabolic disturbances etc.
  In each patient these factors will contribute to any one dysfunction in varying degrees.
- "How did this manipulation actually work?"
  The manipulation created heat by friction, modifying the consistency of the ground substance of the fascia.
  According to the patient's level of education this concept can be made clearer using different metaphors (for example, thick soup that densifies when it is cold and thins out when heated etc.)
- "Why has the pain disappeared?"
  When the fascia was rigid it was pulling excessively on the free nerve endings whereas now the endofascial, collagen fibres can glide freely over each other without involving the nociceptors, or pain receptors. The pain that was felt previously signalled a tensional and postural imbalance of the body, whereas the present sensation of well-being indicates a return to normality.
- "Do I have to do other tests, X-rays or exams?"
  When a patient does not have any disturbances or pain after manipulation then further tests are not necessary. If, however, no benefit is obtained from manipulation it is common sense that further tests need to be considered.
- "Do I have to take medication or have any other type of therapy?"
  If the post-manipulation inflammatory reaction is too intense then anti-inflammatory medication is not contraindicated however, if possible, it would be better to avoid as it can confuse the outcome of the treatment as well as the on-going treatment plan.
- "Should I have preventative treatment?"
  This is not necessary because it is not predictable when the fascia will densify again. One patient can have a relapse after six months and another after six years. The causes and the conditions can apparently be the same but in one patient metabolic disturbances cause the fascia to densify earlier than in the other patient.
- "Having had this treatment what do I have to do at home?"
  For the first five days after treatment it is prefer-

able to avoid undertaking strenuous activities. The manipulation removes certain holding points of the fascia therefore the body needs time to integrate these new patterns into its global equilibrium.

- "What should I do with regards to work or sport?"
  If, after one week, the body is well balanced then there is no reason to limit its activity and there is no need to adopt precautions that could impede the use of certain parts. If a mechanic has repaired the car properly then there is no need to drive it in a lower gear! Each person should feel free to move and to assume the most comfortable posture.
- "How can I improve the situation?"
  By developing awareness of the body's needs: only by improving awareness does one's lifestyle adapt to the body's physiological needs. These are different from person to person and cannot be imposed by predetermined rhythms and suggestions. This entails becoming aware of when the body is exceeding its capacity to adapt to a stressful situation and stopping to allow for recovery time.

Clinical cases

The fascial spirals are continuous throughout all of the body just like the unidirectional sequences. These two myofascial structures often work together because in many complex motor activities both the directional component and the dynamic alternation between segments are present.

With locomotor dysfunctions it is often necessary to calibrate the tensional play of a spiral first and then to normalise a sequence.

Table 26. Common questions that patients ask or would like to ask.

Explain	What was causing the pain? How did the manipulation work? Why has the pain disappeared?
Reassure	Do I have to have other tests? Do I have to do other therapies? Do I need preventative treatment?
Advise	What must I do/not do at home? What about work? How can I avoid relapses?

A spiral imbalance

A female athlete (an orienteering champion) had been forced to give up her sporting career due to a pain behind her right knee that, over the last eight months, always presented itself after a few minutes of running. A diagnosis of sciatic pain had been made but various investigations had not revealed anything abnormal[396].

The patient claimed that her pain was localised behind the knee (Table 27) and that she did not have any other pain nor had she had any in the past. There was not one daily activity that worsened her pain and no cramps or paraesthesia had been felt.

No concomitant pain has been recorded because none was reported (Table 27). The painful movement was not specific for any one plane or direction. In fact the scarcity of the recorded data did not allow for the formulation of a hypothesis.

The movement assessment of the left and right knees demonstrated equal articularity and strength. The only difference was a slight pain on retromotion of the right knee. The coxa was also tested but was pain-free hence a possible involvement of a sequence or the presence of any proximal, or distal, referred pain was excluded.

The next step was the palpation of the six segmentary cc(s) of the knee and the four cc(s) of fusion of the spirals. Note that at this stage it is necessary to avoid stopping to treat the first cc that is sensitive, even though the large numbers of variables to take into consideration could induce such behaviour.

Table 27. Assessment of a spiral dysfunction

SiPa	GE re rt 8m *
PaMo	running
PrevPa	
Paraesthesia	
Visceral	
Treatment.	Re-me-ta, an-la-ge, ++

---

[396] There are insufficient elements for prescribing X-rays for patients with back pain with or without sciatic pain, before having tried manipulation. (Britannic clinical standards advisory group, London, 1994)

Due to the fact that the pain was exacerbated by running (dynamic movement) an imbalance of a spiral was hypothesised. The palpation assessment of the cc(s) of an-la-ge and re-la-ge was carried out in order to determine whether the incoordination occurred during the stance phase or the swing phase. The first cc was much more sensitive than the second therefore, having previously excluded the segmentary cc(s), it was decided to treat the spiral containing the an-la-ge cc of fusion (the an-la-pes spiral).

The cc of re-me-ta (Figure 172) was also sensitive and densified, much like the cc of an-la-ge. With the post-treatment movement assessment, following the dissolution of these cc(s), the athlete claimed that her leg was freer and lighter than she had felt in months.

Twenty days later her trainer confirmed that the athlete had continued to maintain a good result.

A global imbalance

A forty-year old English woman presented with a continuous pain, which she had had for three months, between her right scapula and her neck. A diagnosis of repetitive stress injury or overuse syndrome had been given. She complained that the pain accentuated with retromotion collum and with lateromotion to the left side. The woman had not previously suffered from any musculoskeletal pain. She also complained of a tremor in her left eyelid.

She denied having had any internal problems but when questioned more specifically she admitted to having had, at times, shooting pains in the right hypochondrium area, over her liver (Table 28).

Table 28. Assessment of a global imbalance

SiPa	SC er *rt* 3m * *
PaMo	RE, LA CL *lt*
PrevPa.	
Par.	Tremor left eyelid
Visceral	Shooting pain, Liver 3*y*
Treatment	Re-la-cl *lt*, an-la-th, lu *rt* + +

Since this pain in the right hypochondrium area had been present for the last three years it was hypothesised that the right-sided interscapular pain, which had only been present for three months, could be the consequence of compensation along the re-la-cl spiral.

The movement assessment of the collum (neck) demonstrated a painless limitation of lateromotion, a slight pain on retromotion without joint limitation and a slight pain on extrarotation to the left.

The palpation assessment of the cc(s) of fusion of the collum (neck) and the scapula confirmed the hypothesis of the involvement of the spiral of re-la-cl and re-me-cl on the left (Figure 173).

Treatment of the cc(s) of fusion of re-la-cl *lt*, an-la-th, lu *rt* was carried out and the post-treatment assessment revealed a reduction in pain in the interscapular area and a sensation of lightness in the anterior thoracic region.

After one week these results had been maintained (// ++) and the shooting pains in the right hypochondrium area had not been felt at all. The choice was then made to suspend treatment and the patient was advised to book a second session if, or when, her symptoms returned.

These schematic examples are only to be considered as indicative and are not to be taken as treatment models for similar cases. Each case should be studied and treated according to its individual components.

Figure 172. Palpation-manipulation using the fingers.The palpation assessment and the treatment of cc(s) in the extremities (head, ankle-foot, wrist-fingers) are carried out with the three central fingers (index, middle, ring). The fingers exert less pressure than an elbow but they can penetrate in a precise and incisive manner between the tissue layers. In this photograph the cc of fusion RE-ME-TA is being treated.

Figure 173. Palpation-manipulation using the thumb. The thumb can be used in the extremities both for the palpation assessment and the actual manipulation. According to the patient's build and their pain tolerance it is possible to use either the fingers (including thumb) or the knuckles or else the elbow. In this photograph the cc of fusion RE-ME-CL is being treated.

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CONCLUSION

Some readers may be disappointed that this book does not provide precise indications for specific points to be used in the treatment of each type of dysfunction. Other readers may be disappointed that specific modalities for applying this method have not been included. Nevertheless, from the contents of this book one can deduce that every dysfunction is the consequence of tensional imbalance between various points and that this combination of points varies from one case to another. In order to learn how to apply this method appropriately therapists will have to attend courses in Fascial Manipulation, as only direct contact with a teacher can pass on the technique of palpation, where to palpate, what sort of pressure is needed and how to position oneself during treatment.

Daily practice will improve one's ability to penetrate between the soft tissues with sensitivity, as well as to understand and to adapt to the needs of these tissues. In fact the body does not heal itself with force but with the sensitivity of the therapist. This method requires complete involvement of the therapist from the beginning to the end of the session: data must be recorded, the possible solutions contemplated, the various densifications searched out, work on the fascia itself completed and, in the end, one's hypothesis has to be compared with the results. Mostly it is this last part of the process which causes problems for anyone starting out with this method because, at the end of the treatment, there is always an immediate evaluation of one's work. The therapist needs to take full responsibility for the solution of the problem, as only a positive result will mean that the work has been carried out correctly. Fascial Manipulation is one of those techniques that require courage, as each case is an unknown quantity and there is no instruction book that provides the whole solution. It requires conviction to treat points that for the patient have little or no importance, to continue working on a person when the technique itself is a cause of discomfort and to deal with criticism from those patients who, initially, have not felt any benefit.

This method can be difficult, both for the patient who has to tolerate it and for the therapist who has to apply it. However, in the end both patient and therapist are satisfied. In the first case because he/she has found a solution to his/her problem and in the second because he/she have become aware that his/her hands can be a powerful instrument at the service of those who suffer.

This book has been written under the impetus to share this therapeutic possibility with others. It could have been documented further with histological specimens that demonstrate the densification of the fascia and with certain statistical researches that attest to the validity of the method, however some of these aspects have been left to the initiative of future readers.

This work is not finished here. It is only at the beginning. Hopefully there are fascial therapists who, inspired by the motivation to collaborate in improving this method, will correct any eventual errors disseminated in this book without using them as a pretext to reject all of it.

Once fascial therapists have experimented the validity of the proposals presented in this book then they have a certain duty to share this knowledge with others and not to keep it to themselves.

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SYNOPTIC TABLES

Table 29. Segmentary CCs andTPs of the upper limb

Cc	Acup.	Monoart. muscular TPs
An-sc	Lu 1	Pectoralis minor m.
An-hu	Lu 3	Deltoid m.
An-cu	Lu 4	Brachialis, biceps mm.
An-ca	Lu 6	Flexor carpi radialis m.
An-po	Lu 10	Flexor pollicis brevis m.
Re-sc	Si 14	Rhomboid mm.
Re-hu	Si 9	Teres major m.
Re-cu	Te 12	Short head of Triceps
Re-ca	Si 7	Extensor carpi ulnaris
Re-di	Si 4	Abductor digiti minimi
Me-sc	Sp 21	Serratus anterior m.
Me-hu	Ht 1	Coracobrachialis m.
Me-cu	Ht 2	Flexor carpi ulnaris m.prox
Me-ca	Ht 4	Flexor carpi ulnaris m.dist
Me-di	Ht 8	Flexor digiti minimi m.
La-sc	Li 17	Omohyoid m.
La-hu	Li 15	Deltoid m.
La-cu	Li 11	Brachioradialis m.
La-ca	Li 9	Extensor carpi radialis m.
La-di	Li 4	1° dorsal interosseus m.
Ir-sc	Ki 27	Subclavius m.
Ir-hu	Pc 2	Subscapularis m.
Ir-cu	Pc 3	Pronator teres m.
Ir-ca	Pc 4	Pronator quadratus m.
Ir-di	Pc 8	Lumbrical mm.
Er-sc	Te 15	Serratus anterior inf m.
Er-hu	Te 14	Infraspinatus m.
Er-cu	Te 10	Supinator m.
Er-ca	Te 9	Abductor poll. longus m.
Er-di	Te 3	Lumbrical mm.

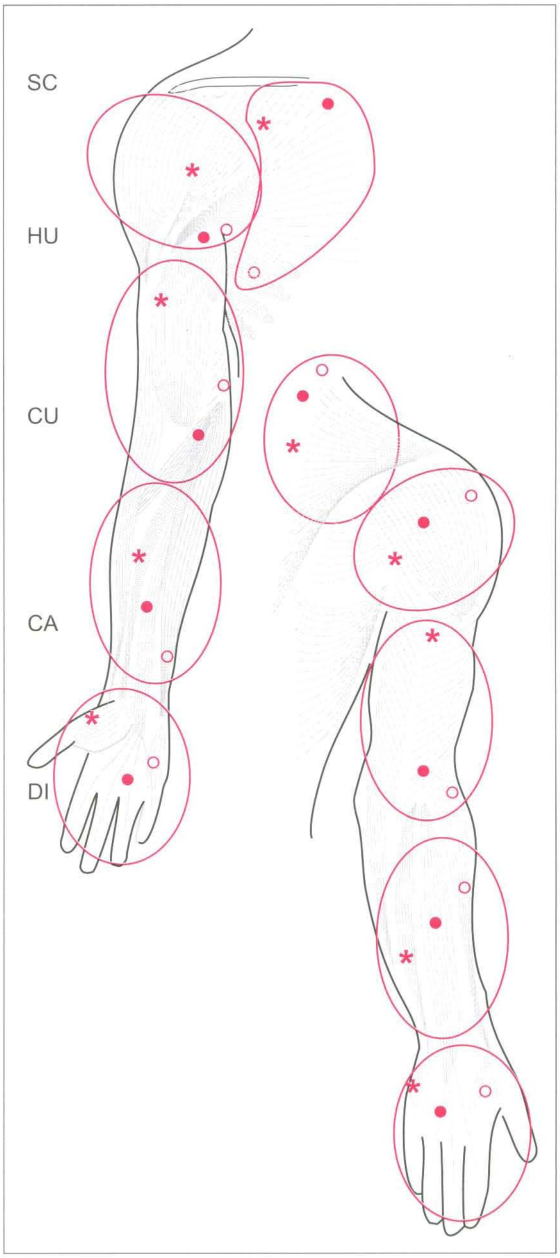

Figure 174. Summary of segmentary cc(s) of upper limb.

The red circles enclose the functional units (muscle, fascia, articulation) of the segments of the digiti (DI), the carpus (CA), the cubitus (CU), the humerus (HU) and the scapula (SC).

This last unit includes the sternoclavicular articulation anteriorly and the scapulothoracic articulation posteriorly.

Symbols of the anterior part
○ cc of mediomotion
* cc of antemotion
• cc of intrarotation
Symbols of the posterior part:
○ cc of lateromotion
* cc of retromotion
• cc of extrarotation

Table 30. Segmentary CCs and TPs of the trunk

An-cp 1	St 1	Inf. rectus m. of the eye
An-cp 2	St 3	Zygomaticus m.
An-cp 3	St 5	Ant. belly of digastric m.
An-cl	St 9	Longus colli m.
An-th	St 18	Sternalis m.
An-lu	St 25	Recto abdominis m.
An-pv	Sp 14	Iliacus m.
Re-cp 1	Bl 2	Sup. rectus m of the eye
Re-cp 2	Bl 4	Frontalis m.
Re-cp 3	Bl 9	Occipitalis m.
Re-cl	Si 16	Longissimus cervicis
Re-th	Bl 14	Longissimus thoracis
Re-lu	Bl 22	Longissimus lomborum
Re-pv	Bl 26	Quadratus lomborum m.
Me-cp 1	Bl 1	Med rectus m.of the eye
Me-cp 2	Cv 23	Raphe of mylohoid m.
Me-cp 3	Gv 16	L nuchae
Me-cl	Cv 22	L sternalis
Me-th	Cv 16	L xiphoid
Me-lu	Cv 9	L umbilicus
Me-pv	Cv 3	Linea alba
Me-cl r	Gv 14	Interspinous lig.VII c
Me-th r	Gv 12	Interspinous lig.IV t
Me-lu r	Gv 4	Interspinous lig.II l
Me-pv r	Gv 2	Coccygeus lig.
La-cp 1	Gb 1	Lat. rectus m. of the eye
La-cp 2	St 8	Temporalis m.
La-cp 3	St 6	Masseter m.
La-cl	Li 18	Lat. scalenus m.
La-th	Bl 46	Iliocostalis thoracis m.
La-lu	Bl 52	Quad.lomborum m.(lat)
La-pv	Bl 54	Gluteus medius m.
Ir-cp 1	Te 23	Inf.oblique m. of the eye
Ir-cp 2	Te 21	Lateral pterygoid m.
Ir-cp 3	Gb 2	Medial pterygoid m.
Ir-cl	St 11	Scalenus anterior m.
Ir-th	Lr 14	Intercostals mm.
Ir-lu	Lr 13	Abdominal oblique mm.
Ir-pv	Gb 27	Prox. part of sartorius m.
Er-cp 1	Gb 14	Sup.oblique m. of eye
Er-cp 2	Gb 8	Superior auricularis m.
Er-cp 3	Gb12	Posterior auricularis m.
Er-cl	Te 16	Levator scapulae m.
Er-th	Bl 42	Serratus poster sup.
Er-lu	Gb 25	Serratus posterior inf. m.
Er-pv	Gb 29	Gluteus medius m.

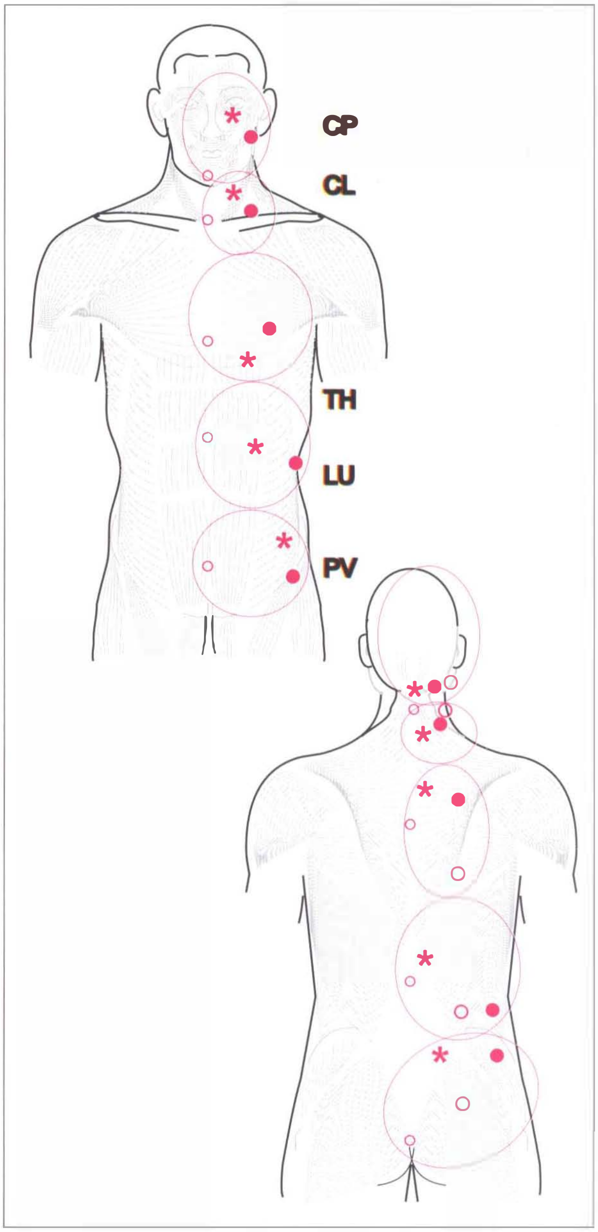

Figure 175. Segmentary CCs of the trunk.

Symbols pertaining to the anterior wall:
- ◦ mediomotion
- * antemotion
- • intrarotation

Symbols pertaining to the posterior wall:
- ◦ mediomotion (r)
- * retromotion
- o lateromotion
- • extrarotation

Table 31. Segmentary CCs and TPs of the lower limb.

Cc	Acup.	Monoart. muscular TPs
An-cx	Sp 12	Pectineus, sartorius (prox)
An-ge	St 32	Vasti mm. of quadriceps
An-ta	St 37	Tibialis anterior m.
An-pe	Lr 3	Extensor hallucis brev. m.
Re-cx	Bl 30	Gluteus max –sacrotuber.
Re-ge	Bl 37	Semitendinosus m.(distal)
Re-ta	Bl 58	Soleus m.
Re-pe	Bl 64	Abductor digiti minimi m.
Me-cx	Lr 10	Gracilis (prox) Adductor
Me-ge	Sp 11	Gracilis (dist) m
Me-ta	Ki 9	Medial soleus m.
Me-pe	Ki 2	Flexor hallucis brevis m.
La-cx	St 31	Tensor fascia lata m.
La-ge	Gb 31	Tensor mm.- iliotibial tract
La-ta	St 40	Peroneus tertius m.
La-pe	St 43	Dorsal interossei mm.
Ir-cx	Lr 11	Adductor magnus m.
Ir-ge	Lr 9	Mm. of medial tib. condyle
Ir-ta	Lr 5	Tibialis posterior m.
Ir-pe	Sp 3	Abductor hallucis m.
Er-cx	Gb 30	Piriformis m.
Er-ge	Gb 32	Short head biceps fem. m.
Er-ta	Gb 35	Peroneus brevis m.
Er-pe	Gb 40	Extensor dig. brevis m.

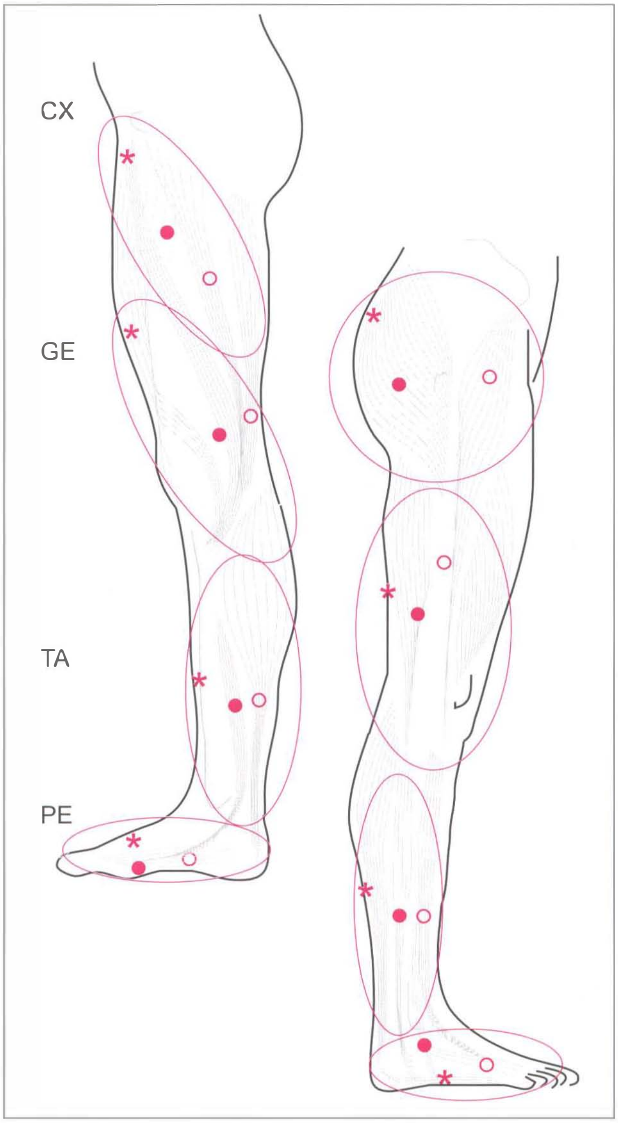

Figure 176. Segmentary CCs of the lower limb.

The circles around each segment enclose the three mf units involved in a motor scheme i.e. the medially placed circles of the coxa, genu, talus and pes encircle the scheme of ante-medio-intrarotation; the laterally placed circles enclose the scheme of retro-latero-extrarotation. The cc(s) of fusion coordinate the motor schemes.

Symbols:

○ mediomotion, lateromotion
* antemotion, retromotion
• intrarotation, extrarotation

The perfect symmetry between the positions of the agonist and antagonist cc(s) should be noted. For example the cc of an-ge is over the quadriceps and the cc of re-ge is to be found in the diametrically opposite position over the hamstrings. The cc of la-ge is.....

RETRO DIAGONALS

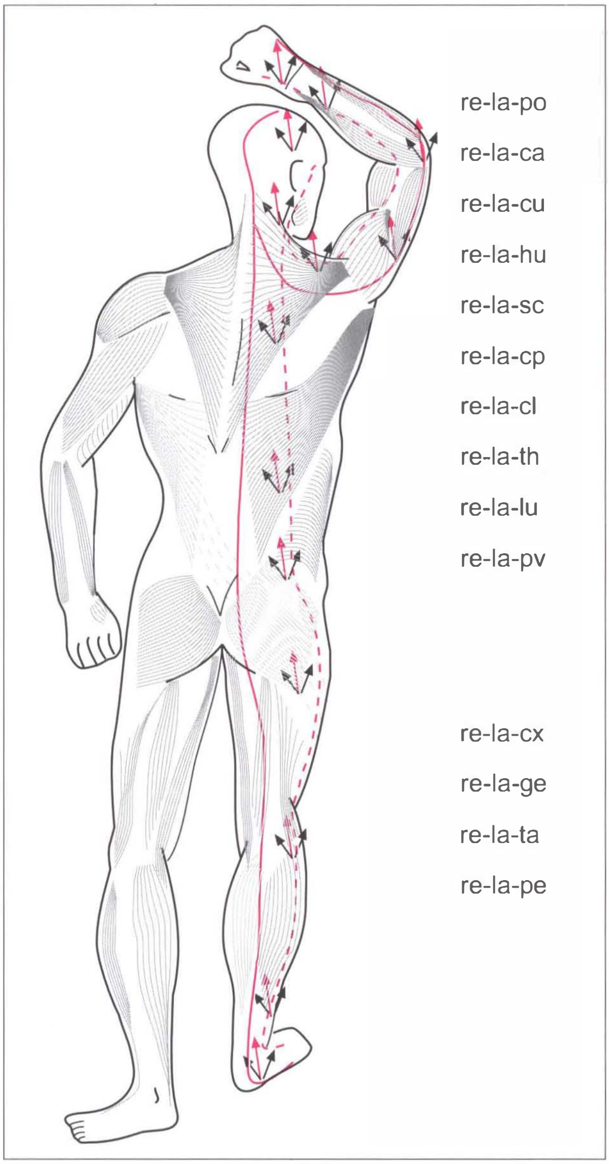

Figure 177. CCs of fusion of the retro-latero diagonal.

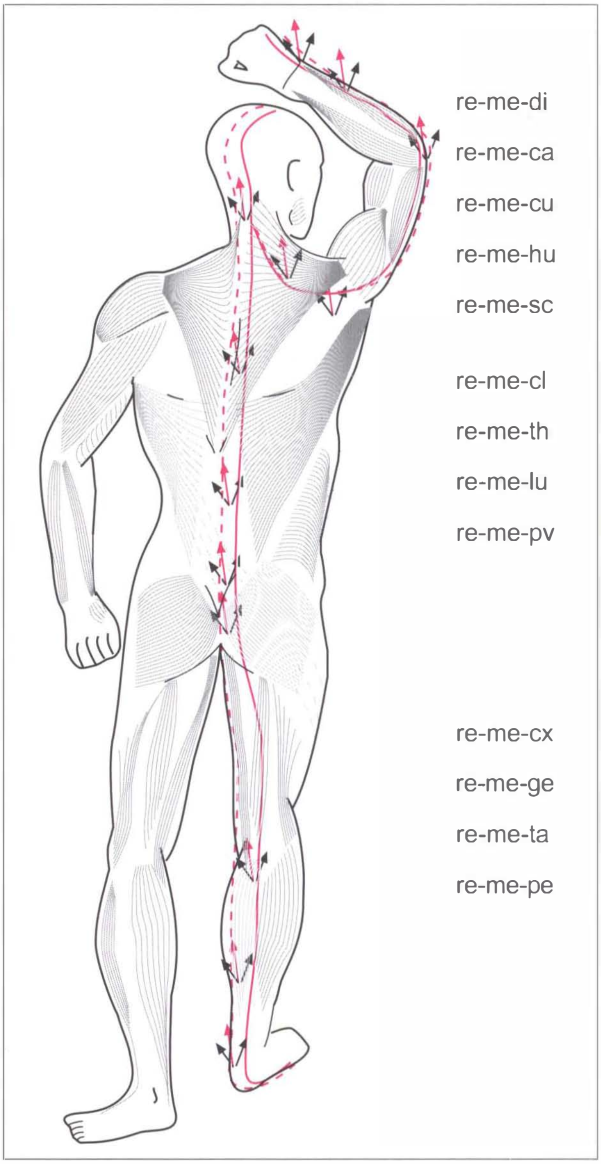

Figure 178. CCs of fusion of the retro-medio diagonal.

Table 32. CCs di fusion re-la acupuncture points

	Re-la-pv Bl 53	Re-la-sc Gb 21
Re-la-cx Bl 36	Re-la-lu Bl 50	Re-la-hu Te 13
Re-la-ge Gb 34	Re-la-th Bl 44	Re-la-cu Li 12
Re-la-ta Gb 39	Re-la-cl Gb 12	Re-la-ca Te 5
Re-la-pe Bl 61	Re-la-cp Gb 13	Re-la-po Li 5

Table 33. CCs of fusion re-me and acupuncture points

	Re-me-pv Bl 33	Re-me-sc Si 13
Re-me-cx Bl 35	Re-me-lu Ex 60	Re-me-hu Si 11
Re-me-ge Bl 55	Re-me-th Ex 66	Re-me-cu Si 8
Re-me-ta Sp 6	Re-me-cl Bl 10	Re-me-ca Te 7
Re-me-pe Ki 4		Re-me-di Si 5

ANTE DIAGONALS

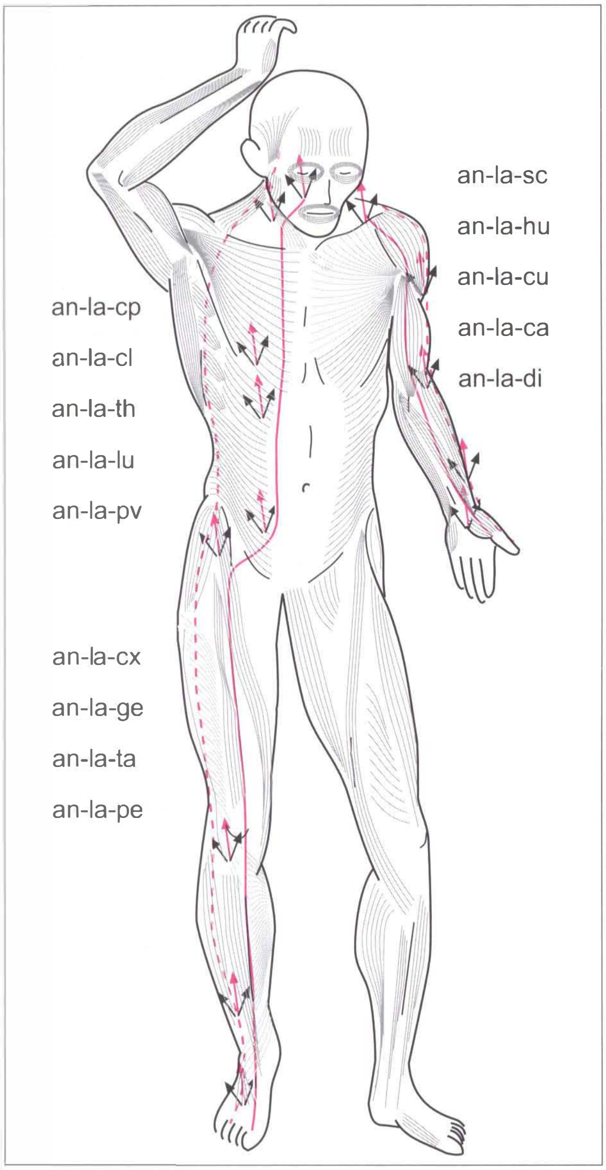

Figure 179. CCs of fusion of the ante-latero diagonal.

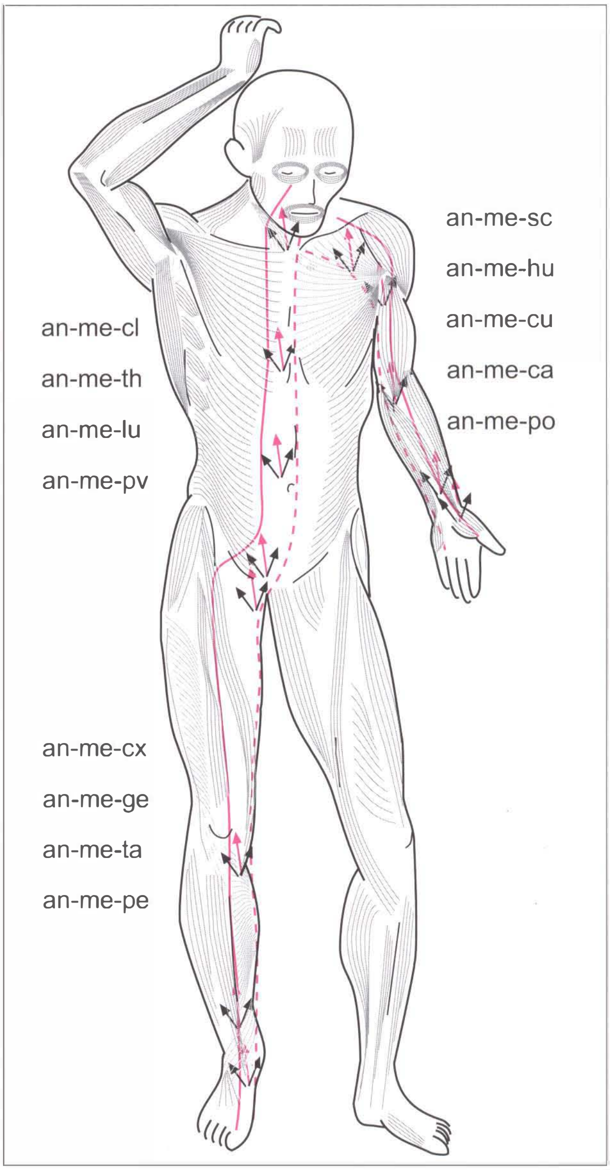

Figure 180. CCs of fusion of the ante-medio diagonal.

Table 34. CCs of fusion an-la and acupuncture points

	An-la-pv St 28	An-la-sc St 12
An-la-cx Gb 28	An-la-lu Sp 16	An-la-hu Li 14
An-la-ge St 36	An-la-th Gb 24	An-la-cu Lu 5
An-la-ta Gb 38	An-la-cl Si 17	An-la-ca Lu 7
An-la-pe Gb 41	An-la-cp Si 18	An-la-di Pc 7

Table 35. CCs of fusion an-me and acupuncture points

	An-me-pv Ki 11	An-me-sc St 15
An-me-cx Lr 12	An-me-lu Ki 16	An-me-hu Gb 22
An-me-ge Sp 9	An-me-th Ki 22	An-me-cu Ht 3
An-me-ta St 39	An-me-cl Si 10	An-me-ca Pc 5
An-me-pe Sp 4		An-me-po Lu 9

MYOFASCIAL RELATIONSHIPS

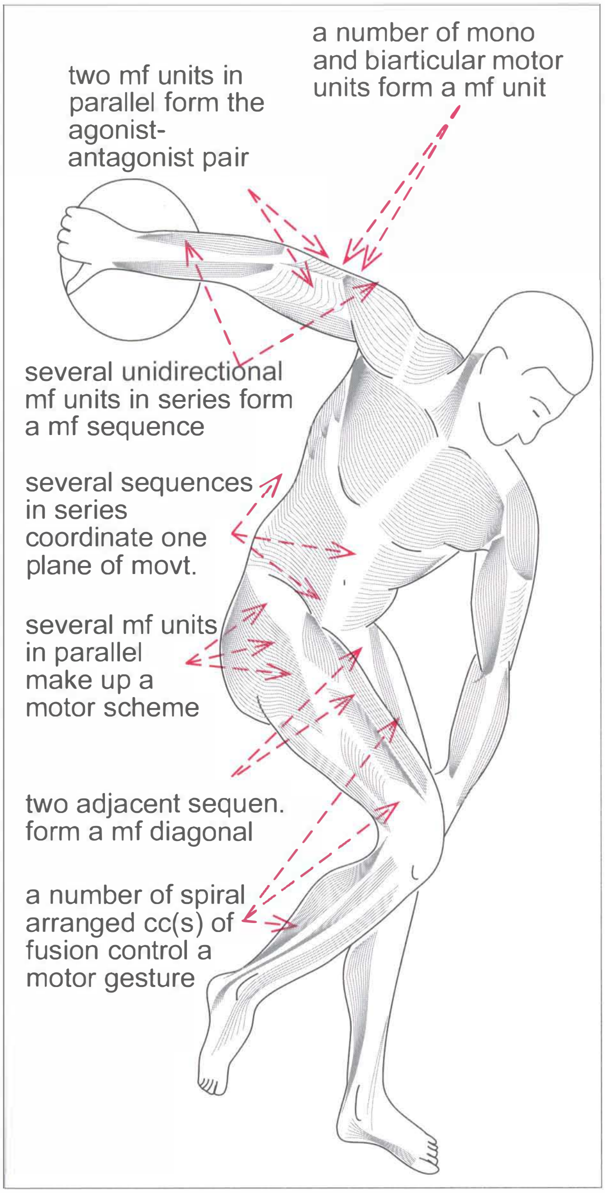

Figure 181. Fascia and locomotor apparatus structure

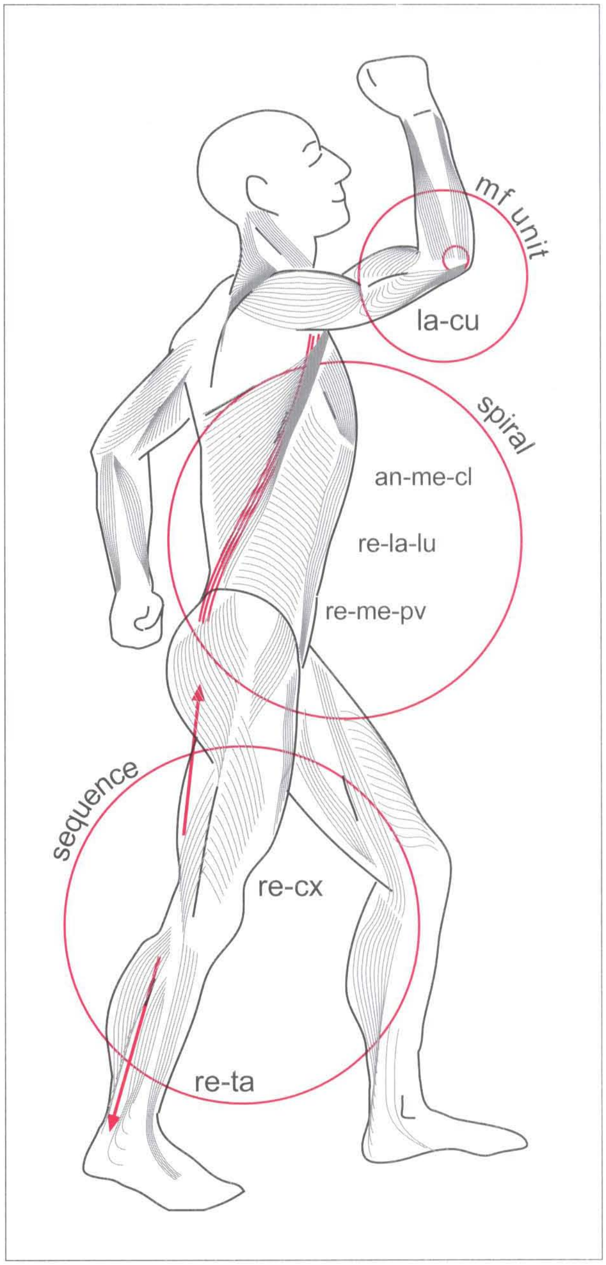

Figure 182. Modality of fascial manipulation.

Table 36. Fasciae and structure of locomotor apparatus

The endomysium + perymisium unite the motor units of the mf unit	**Re-hu**
The intermuscular septa separate the antagonist mf units.	**Re-hu** **An-hu**
The fascial compartments link the unidirectional mf units: sequences	**Re sc, hu, cu, ca**
The annular ligaments and retinacula connect the mf units of spiral schema	**Re-la-cx**
The S fibres 8-form, cruciate… unite the motor schemes: spirals	**Re-la-cx** **An.me.ge**

Table 37. Modality of fascial manipulation.

Upper limb	*Segmentary dysfunction* epicondilitis Cc of one direction and of one segment + antagonist cc
Trunk	*Spiral dysfunction* diffuse back pain Cc of fusion left-right and ante-retro.
Lower limb	*Sequence dysfunction* sciatica. CC of one plane and of a number of segments

PARALLELISM BETWEEN ACUPUNCTURE POINTS AND CCs

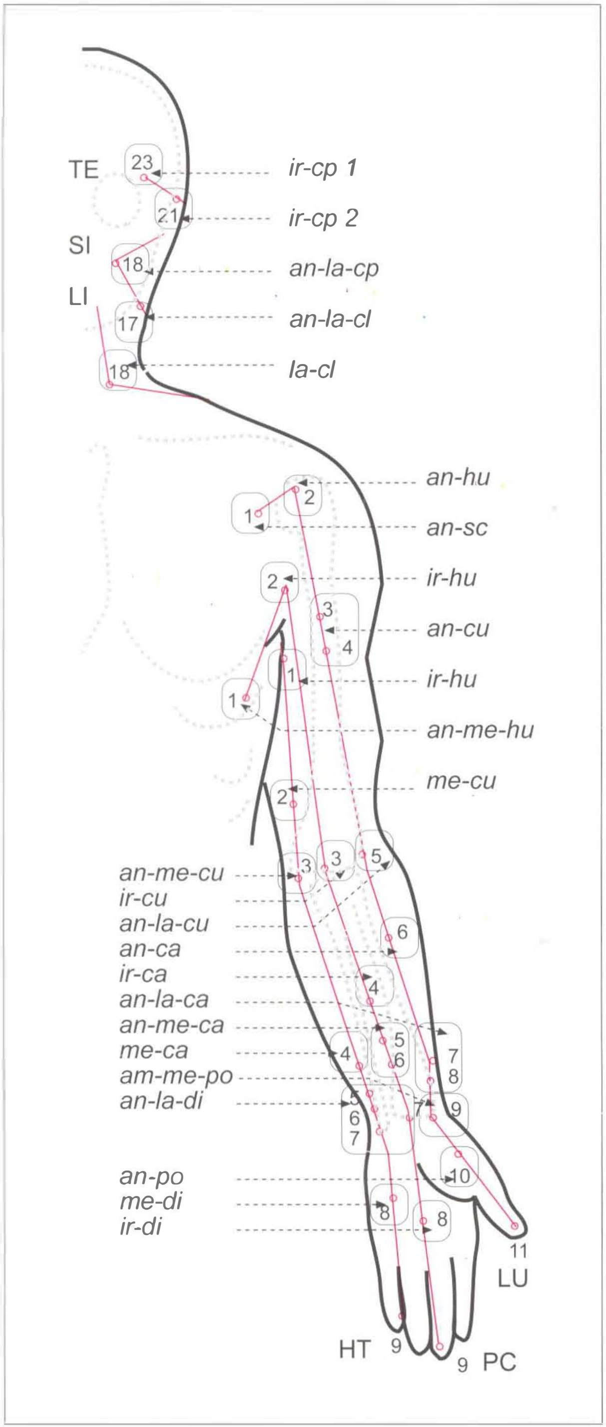

Figure 183. Yin Meridians of the upper limb: Lung (LU), Pericardium (PC), Heart (HT)

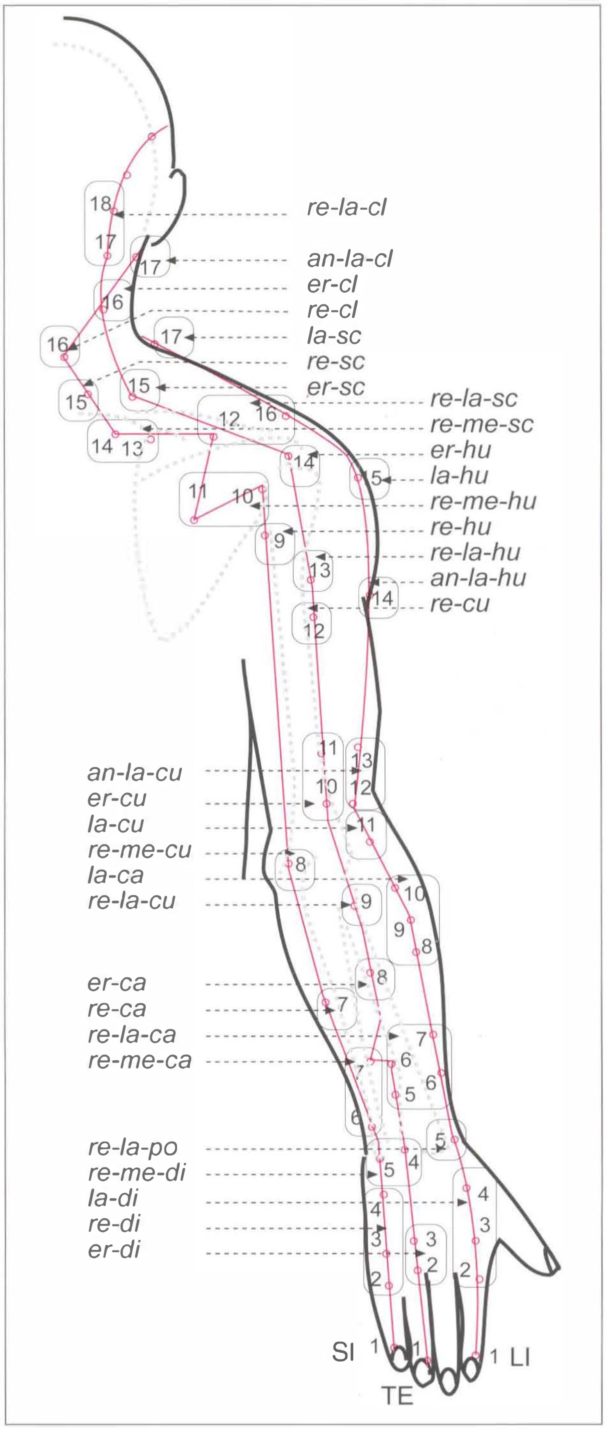

Figure 184. Yang Meridians of the upper limb: Large Intestine (LI), Triple Energizer (TE), Small Intestine SI).

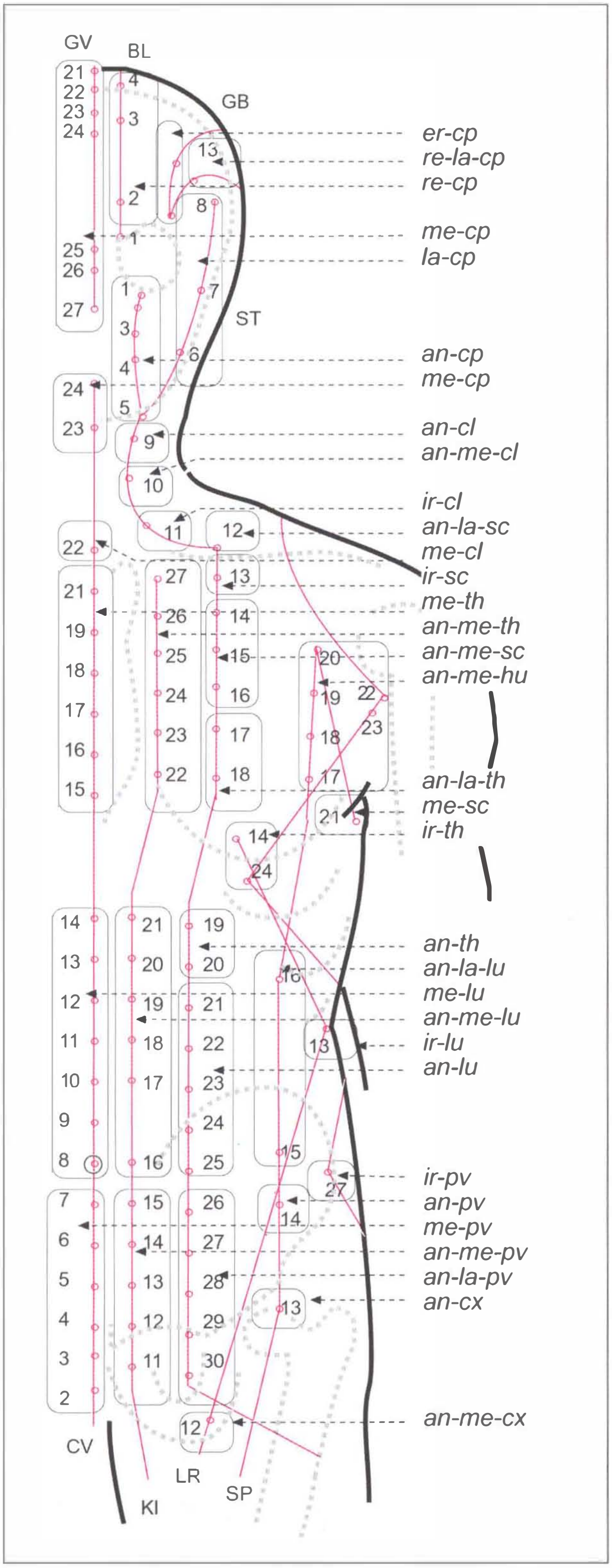

Figure 185. Anterior Meridians of the trunk: Conception Vessel (CV), Kidneys (KI), Stomach (ST), Spleen (SP), Liver (LR).

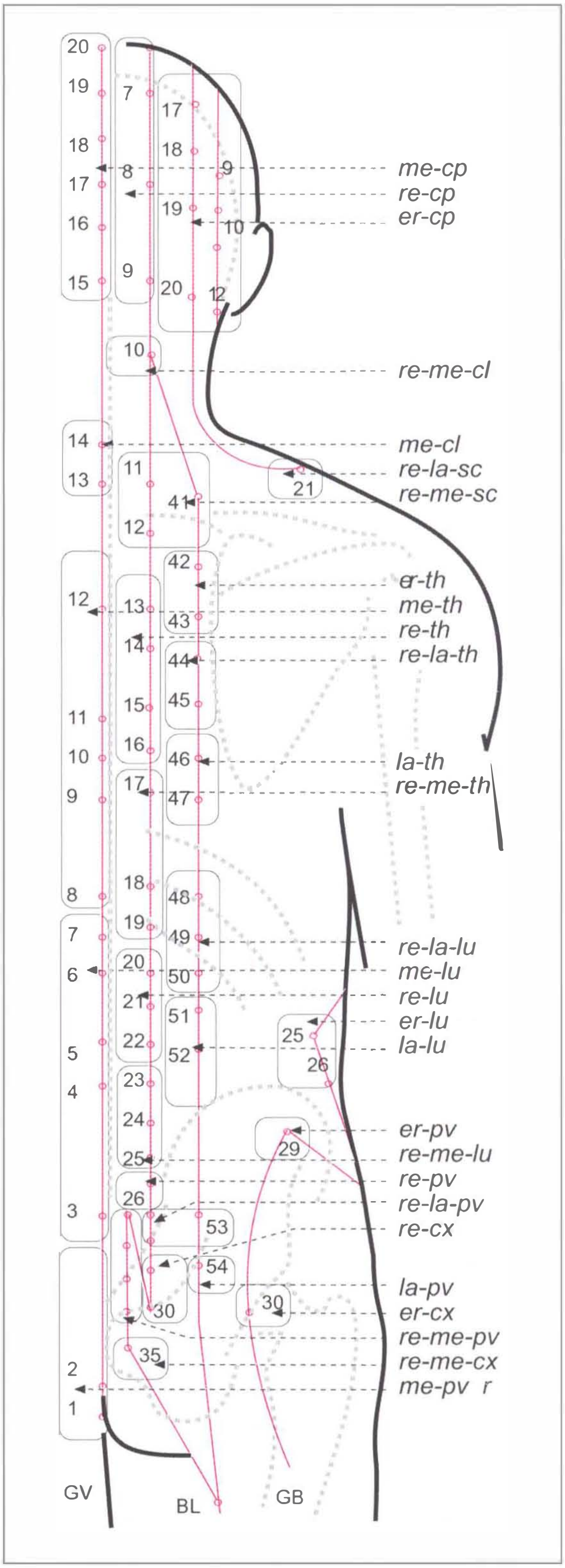

Figure 186. Posterior Meridians of the trunk: Governor Vessel (GV), Bladder (BL), Gallbladder (GB).

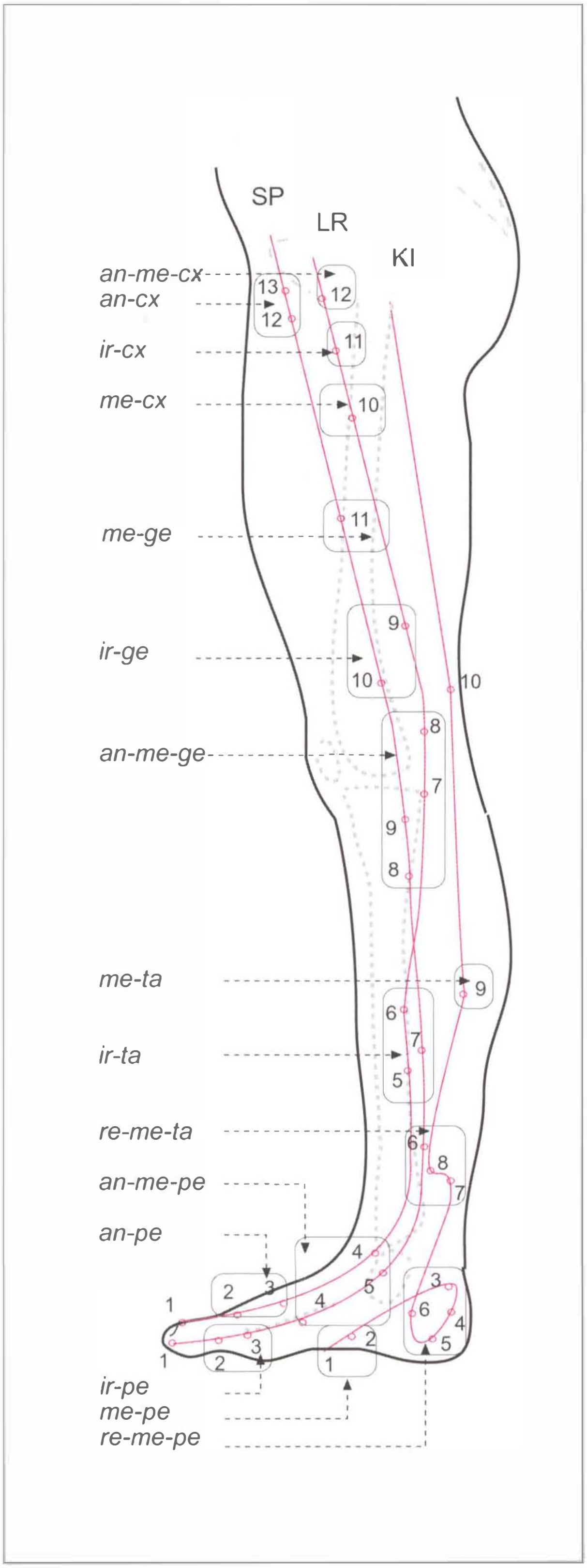

Figure 187. Yin Meridians of the lower limb: Spleen (SP), Liver (LR), Kidney (KI).

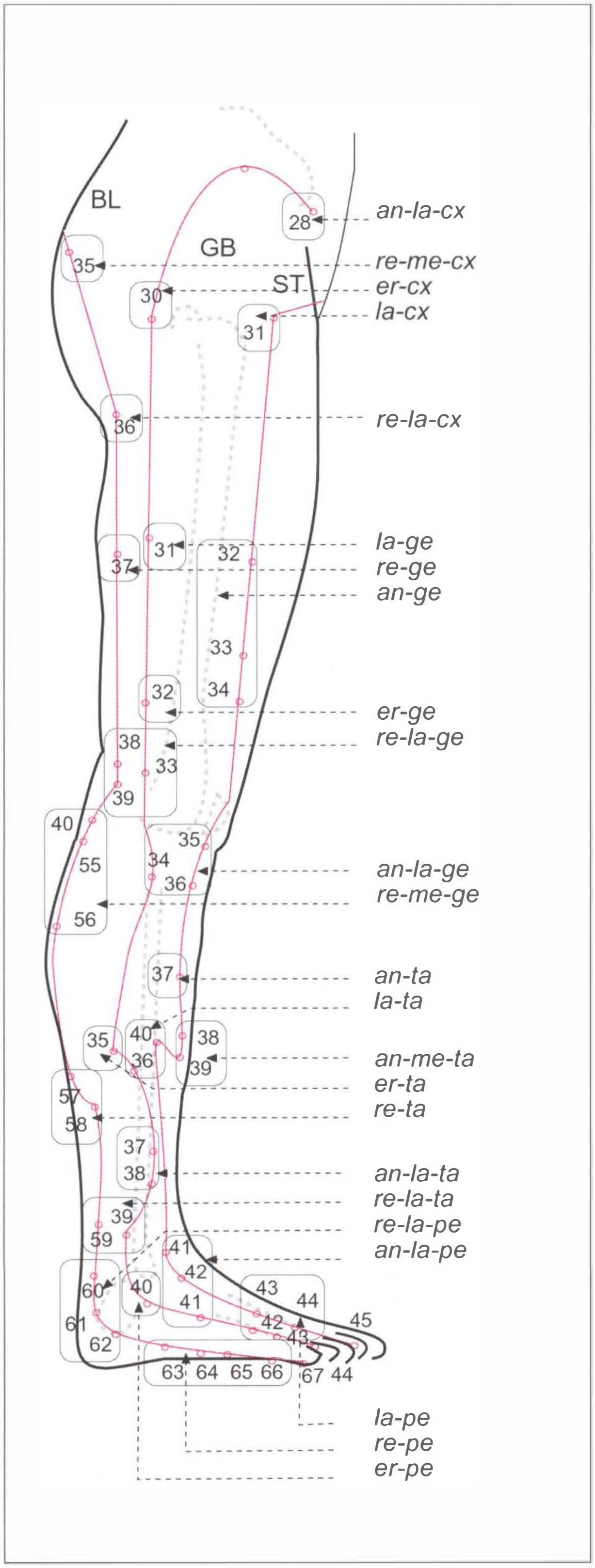

Figure 188. Yang Meridians of the lower limb: Stomach (ST), Gallbladder (GB), Bladder (BL).

ASSESSMENT CHART FOR FASCIAL MANIPULATION

Name
Address
Date of birth

Occupation
Sport
Telephone

Symptoms
present pain..
previous pain..
initial pain ....

Locomotor Apparatus Anamnesis
traumas..
fractures..
surgery..

Paraesthesia
cp..
di ....
pe..

Internal Disorders

Medical Diagnosis

SiPa PaMo
1°..
2°..
3°..

Treatment
1°..
2°..
3°..

ASSESSMENT CHART FOR FASCIAL MANIPULATION

Name
John Smith

Address
84 Fascial St. London

Date of birth
dd\mm\yy

Occupation
Pensioner

Sport
Trekking, tennis 10m

Telephone
000 00000

Symptoms
present pain..........Periarthritis ....
previous pain..
initial pain .... Cervical pain ....

Locomotor Apparatus Anamnesis
traumas........ Whiplash 5y ....
fractures........ Humerus 10y ....
surgery........ meniscus ge rt 8y ....

Paraesthesia
cp...... TMJ rt click ....
di ...... II° rt pins & needles ....
pe...... coms IV° ....

Internal Disorders
Gastritis, appendec 20y

Medical Diagnosis Periarthritis

SiPa PaMo
1° hu la rt 3m ** nt, cl re-la bi 3a
2° hu re-la re **
3°..

Treatment
1° la-hu rt +, re-la-cl bi \\ + cl = hu
2° re-la-hu, sc rt ++, an-me-cu rt
3°..

Figure 189. Assessment chart.

REFERENCES

1. Akeson W, Amiel D, Woo S: Immobility effects on synovial joint: The pathomechanics of joint contracture. Biorheology 17:95-110, 1980
2. Albe-Fessard D. Les douleurs maladies et les structures nerveuses mises en jeu. Ann. Kinésithér. T. 28, n° 2, pp. 65-87, 2001
3. Alberts B, Biologia molecolare della cellula. Zanichelli, Bologna, 1996
4. Amonoo-Kuofi HS, The density of muscle spindles in the medial, intermediate and lateral columns of human intrinsic postvertebral muscles. J. Anat, 136, 3, 509-519, 1983
5. Aube-Fessard D. Giamberardino MA. Il Dolore, Masson ed. Mi, 1997
6. Baldissera F et al. Fisiologia e biofisica medica, Poletto ed. Milano 1996
7. Baldoni C. G e coll. Anatomia Umana, edi.ermes, Milano 1993
8. Basmajian J.V., Anatomia regionale del Grant, ed. Liviana, Padova 1984
9. Basmajian JV. Nyberg R. Rational manual Therapies. Williams&Wilkins Baltimore 1993
10. Bauer J. Heine H. Akupunkturpundte and Fibromyalgie. Biologische Medezin, 6, 1998
11. Bellon JM, Bajo A et all. Fibroblasts from the transversalis Fascia of young patients wth direct inguinal hernias show constitutive MMP-2 overrexpression. Ann Surg Feb; 233 (2) 287.91, 2001
12. Benninghoff G, Trattato di anatomia umana, Piccin ed, Padova 1972
13. Bernard SG, Biology of Collagen, Academic Press, 1968
14. Bernier J. N. Perrin D, Effect of Coordination Training on Proprioception of the Functionally Unstable Ankle. JOSPT, Vol. 27, 264-275, 1998
15. Bogduk N, Macintosh J, The anatomy of the thoracolumbar fascia, J Anat, n° 139, 1984
16. Bronek MB. Boszczyk A. Putz R. Comparative and Functional Anatomy of the Mammalian Lumbar spine. Anat. Rec. 264: 157-168, 2001
17. Brourman S. Walk Yourself well. Hyperion, NewYork, 1998
18. Cailliet R. Neck and arm pain. F.A. D. Company, Philadelphia, 1991
19. Chiarugi G., Bucciante L. Istituzioni di Anatomia dell'uomo. Vallardi-Piccin: Padova 1975
20. Chusid JG. McDonald JJ. Neuroanatomia Correlazionistica e neurologia funzionale, Piccin ed. Padova, 1993
21. Cinnamon Y, Kahane N, Kalcheim C Characterization of the early development of specific hypaxial muscles from the ventrolateral myotome. Development. Oct;126 (19):4305-15 1999
22. Clarkson H.M. Gilewich G. B. Valutazione cinesiologica, edi Ermes, Milano 1996
23. Conte G. Marcacci M. Spinelli M. Girolami N. Caporali R. Rossi A. Meccanorecettori nel ligmaneto collaterale mediale del ginocchio umano. Ital. J. Sports Traumatol. 1984, 1, 63-72
24. Cossu M, Sias N. Colombo I, Problemi riabilitativi nel musicista, La Riabilitazione, 33, n°4, pp 151-155, 2000
25. Cromer AH, Fisica, Piccin editore, Padova, 1980
26. Cyriax J. Medicina Ortopedica, Piccin ed. Padova, 1997
27. Darwin J. Prockop N. Collagen Dieseases and the Biosynthesis of Collagen, Hospital Practice, 12 (2), 1977
28. Di Concetto G, Sotte L, Muccioli M, Trattato di agopuntura e di medicina cinese, UTET Scienze Mediche, 1992
29. Ebner M, Connective Tissue Manipulations, Robert E. Krig. Publishing, Florida 1985
30 Esnault M, Stretching et prépatation musculaire à l'effort, Ann Kinés, t. 15, 49-62, 1988
31. Fazzari I, Anatomia Umana Sistematica, UTET, Torino, 1972
32. Ferrari S. Pillastrini P. Vanti C. Riabilitazione integrata delle lombalgie, Masson ed. Milano, 1998
33. Fetcho JR. A review of the organization and evolution of motoneurons innervating the axial musculature of vertebrates. Brain Res, Jul; 434(3):243-80. 1987
34. Fulkerson JP, Gossling HR, Anatomy of the knee joint lateral retinaculum.Clin Orthop, Nov-Dec;(153):183-8, 1980
35. Fumagalli Z, Marinozzi G, Nesci E, Agatino S, Atlante fotografico a colori di Anatomia macroscopica dell'uomo. Vallardi-Piccin nl, Milano, 1994

36. Gagey, PM. Weber B. Entrées du système postural fin. Masson, Paris, 1995
37. Gerwin RD, Baillieres Clin Rheumatol Neurobiology of the myofascial trigger point. Nov;8(4):747-62, 1994
38. Gray H., Anatomia, Ed. Zanichelli, Bologna 1993
39. Grimaldi L. Marri P. Lippi P. Fantozzi M. Catelani G. Ecocazione di componenti motorie assenti nelle lesioni del sistema nervoso centrale. Giardini ed. Pisa, 1984
40. Hammer W, Genitofemoral entrapment using intergrative fascial release. Chiropr Tech, Vol 10, n° 4, Novem, 1998
41. Hasler E.M., J. Denoth, A. Stacoff, W. Herzog, Influence of hip and knee joint angles on exitation of knee extensor muscles, Electromyogr. Clin. Neurophys. 34: 355-361;1994
42. Hayes W. C., Nachemson A. L., Forces in the Lumbar Spine. The Lumbar Spine, M. Camins and P. O'Leary. Raven Press, New York, 1987
43. Heine H, Struttura anatomica dei punti d'agopuntura, Minerva refless. pp. 93-98, 1988
44. Helmuth H, Biomechanics, evolution and upright stature, Anthropol Anz , Mar;43(1):1-9. 1985
45. Heylings D. J. Supraspinous and interspinous ligaments in dog, cat and baboon. J. Anat. 130, pp. 223-228, 1980
46. Hodges P, Richardson C: Inefficient muscular stabilisation of the lumbar spine associated with low back pain: A motor control evaluation of transversus abdominis. Spine 21 (22): 2540-2650, 1996
47. Houk J.C. Rymer W.Z. Neural control of muscle length and tension. Handbook of Physiology, Section 1, VB Brooks ed. Bethesda, 1981
48. Imatani J, Ogura T, Morito Y, Hashizume H, Inoue H, Anatomic and histologic studies of lateral collateral ligament complex of the elbow joint. J Shoulder Elbow Surg Nov-Dec;8(6):625-7, 1999
49. Jiang H. Moreau M. Greidanus N. Russel G. Bilo J. The spatiotemporal development of innervation in spinal ligaments of chickens. J. Anat. 189, pp. 57-64, 1996
50. Kandel E.R. Schwartz J. H. Jessell T. M. Principi di Neuroscienze, 2° edizione, ed. Ambrosiana, Milano 1994
51. Kapandji I.A: Fisiologia Articolare, Marrapese ed. Roma 1983
52. Karnath HO, Shendel P, Fiscer B. Trunk orientation as the determining factor of the "controlateral" deficit in the neglect syndrome and as physical anchor of the internal representation of the body orientation in space. Brain; 114: 1997-201, 1991
53. Kavounoudias A. Gilhodes JC. Roll R. Roll JP. From balance regulation to body orientation: two goals for muscle proprioceptive information processing? Exp. Brain Rec. 124: 80-88, 1999
54. Kavounoudias A. Roll R. JP. The plantar sole is a 'dinamometric map' for human balance control. NeuroReport 9, 3247-3252. Williams & Wilkins. 1998
55. Kelly RE, J Theor Biol, Tripedal knuckle-walking: a proposal for the evolution of human locomotion and handedness. Dec 7;213(3):333-58, 2001
56. Kent C G. Anatomia comparata dei vertebrali. Ed. Piccin, Padova 1997
57. Klein DM, et al. Histology of the extensor retinaculum of the wrist and the ankle. J. Hand Surg. Jul; 24, 799-2, 1999
58. Kozma EM, Olczyk K, Glowacki A. Dermatan sulfates of normal and scarred fascia.Comp Biochem Physiol Biochem Mol Biol, Feb; 128 (2):221-32, 2001
59. Kromberg M. et al. Characterization of Human Deltoid Muscole in Patients with Impingement Syndrome. J. of Orthop. Resaerch, 1997, 15, 727-733
60. Lang J. Clinical Anatomy, Thieme Medical Pub. 1991
61. Lebarbier A. Principes élémentaires d'acupuncture. Maisonneuve éd., 1980
62 Licht S. L'esercizio Terapeutico, Longanesi, Milano, 1971
63. Light HG, Hernia of the inferior lumbar space. A cause of back pain. Arch Surg, Sep; 118 (9), 1077-80, 1983
64. Lockart R.D. Hamilton G.F. Fyfe F. Anatomia del corpo umano. Ed Ambrosiana, Milano 1978
65. Maeda N, Miyoshi S, Toh Hmar, First observation of a muscle spindle in fish.3;302 (5903) pag 61-2 , Nature 1983
66. Maigne R. La terapia manuale in patologia vertebrale e articolare. Ed. Cortina, Torino 1979.
67. Mann F. Riscoprire l'agopuntura, Marrapese ed. Roma, 1995
68. Marcelli S. Agopuntura in tasca. Nuova Ipsa ed. Palermo, 1996
69. Mazzocchi G, Nussdorfer G, Anatomia funzionale del sistema nervoso, Ed Cortina, Padova 1996
70. McCombe D, Brown T, Slavin J, Morrison WA, The histochemical structure of the deep fascia and its structural response to surgery. J Hand Surg [Br] Apr;26(2):89-97, 2001
71. McQuade KJ. Smidt GL. Dynamic Scapulohumeral Rhythm: the effects of external resistance during elevation of the arm in the scapular plane. JOSPT, 27, n°2, 1998
72. Mense S. Peripheral Mechanisms of Muscle nociception and Local Muscle Pain. J of Mus. Pain, Vol. 1, 133-170, 1993
73. Mesure S. Organisation des stratégies sensori-motri-

ces, ontogenèse et apprentissage. Ann. Kinésithér. N 1, 1996 pp 28-37,

74. Monesi V, Istologia, Piccin, Padova, 1997
75. Nakao T, An electron microscopic study of the neuromuscular junction in the myotomes of larval lamprey, Lampetra japonica. Jan 1;165(1):1-15 J Comp Neurol, 1976
76. Niemiz C, Kinematics and ontogeny of locomotion in monkeys and human babies, S Morphol Anthropol, n°83, 383-400, 2002
77. Nitatori T, The fine structure of human Golgi tendon organs as studied by three-dimensional reconstruction. J Neurocytol Feb;17 (1):27-41, 1988
78. Pans A, Albert A, Lapiere CM, Nusgens B, Biochemical study of collagen in adult groin hernias, J Surg Res Feb;95 (2):107-13, 2001
79. Pernkopf E. Atlante di anatomia umana, Piccin ed. Padova, 1986
80. Petty N.J. Moore A. P. Esame clinico e valutazione neuromuscoloscheletrica. Ed. Masson, Milano 2000
81. Piazza SJ, Delp SL, The influence of muscles on knee flexion during the swing phase of gait. J Biomech, Jun;29(6):723-33, 1996
82. Pirola V, Cinesiologia, Edi-ermes, Milano, 1998
83. Platzer, W.: Apparato locomotore. Ambrosiana ed. Milano, 1979
84. Proske U, Gregory JE, Neurosci. The discharge rate: tension relation of Golgi tendon organs. Lett Mar;16(3):287-90, 1980
85. Raunest J, Sager M, Burgener E, Proprioception of the cruciate ligaments: receptor mapping in an animal model. Arch Orthop Trauma Surg;118(3):159-63, 1998
86. Reimann R, Variable extensor apparatus of the small toe. Opposing muscle groups in competition for extensor function of the fifth involutional metacarpal ray of the lower extremity. Gegenbaurs Morphol Jahrb;127(2):188-209 1981
87. Reynolds MD, Myofascial trigger point syndromes in the practice of rheumatology. Arch Phys Med Rehabil Mar; 62(3):111-4, 1981
88. Rohen J.W. Yokochi C. Atlante fotografico di anatomia descrittiva e topografica. Piccin ed. Padova, 1997
89. Romer P. Anatomia Comparata dei Vertebrati. Edi. Medicina-Salute, 1996.
90. Rubin E. Farber JL. Pathology, Lippincott Co. Philadelphia, 1993
91. Schultz R.L. Feitis R. The Endless Web, North Atl Books, Berkeley, 1996
92. Sherrington C.S. Selected Writings (di Denny Brown) New York, 1940
93. Soulié de Morant G. Agopuntura cinese. IPSA ed. Palermo 1988
94. Staubesand J. Li Y. Zum Feinbau der Fascia cruris mit besonderer intrafaszialer nerven, Manuelle Medizin, Pringer Verlag, 34: 196-200, 1996
95. Stecco C. Studio anatomico dei legamenti interspinosi lombari dell'uomo. Tesi di laurea, Padova 2002
96. Stecco L, B.Brigo, M.Michaux, La manipulation du fascia dans le traitement des douleurs situées dans la région du cou Annales de Kinésithérapie; 26: 322, 1999
97. Stecco L, Il dolore e le sequenze neuro-mio-fasciali, Palermo, IPSA, 1991
98. Stecco L, La manipolazione neuroconnettivale. Marrapese ed. Roma 1996
99. Stecco L, La riabilitazione neuro-connettivale nelle lombalgie; La Riabilitazione, 1994, T.27, n°1, pp 15-25
100. Stecco L, Neuro-myo-fascial Unit, 1st, International Symposium on Myofascail Pain, Minneapolis, 1989
101. Stecco L, Riabilitare secondo le sequenze nmf. La Riabilitazione, 1991, T.24, n°2, pp.113-120
102. Stecco L, Séquences neuro-myo-fasciales, An. Kinésithér., 1991, T.18, n° 5, pp. 270-272
103. Stecco L. Neuro-Myo-Fascial Pain, Scandin. J. of Rheumat., N°94 Sup. 61. 1992
104. Stecco L. Neuro-myo-fascial Sequences and acupunc. meridians; II World Conference on Acup. Mox. Paris, Dec. 1990
105. Stedman's Medical Dictionary, 26th ed. Williams &W. Baltimore, 1995
106. Stefanelli A. Anatomia comparata. Ed dell'ateneo, Roma 1968
107. Stover SA et al. Augmented soft tissue mobilization in the treatment of chronic achilles tendinitis. A case study. JOSPT, 27, N° 1, pp. 80, 1998
108. Testut L. Jacob O. Trattato di anatomia topografica. UTET, Firenze 1987
109. Teyssandier MJ, Brugnoni G, Quelques aspects de l'ostéopathie moderne aux Etats-Unis d'Amerique. La Riabilitazione 33 (4): 141-150, 2000
110. Thesh DE, Evans J, The strucure and function of the thoracolumbar fascia. Presented at the Meeting "Society for Back Pain" Bournemouth, 1985
111. Todesco S, Gambari PF, Malattie Reumatiche, McGraw-Hill, Mi, 1998
112. Travell JG, Simons DG, Dolore muscolare, Ghedini ed, Milano 1998
113. Troisier O. Diagnostic Clinique en Pathologie ostéo-articulaire. Masson ed. Paris, 1991
114. Turvey M.T. Fitch H. L. Tuller B. The Bernstein Perspective: The problems of degrees of freedom and context- conditioned variability. Lawrence Erlbaum Associates. 1982
115. Viel E. JG Garros. Reprogrammation neuromotrice après lésion des ligaments croisés du genu. Ann.

Kinésithér 1991; 18 : n° 10, 513,5

116. Viel E. Une Profession rénovée, à lâge de l'Information, Ann.Kinésithér. t.28, 2001
117. Westergaard GC, Kuhn HE, Suomi SJ, J Comp Psychol, Bipedal posture and hand preference in humans and other primates. Mar;112(1):55-64, 1998
118. Wheater PR. Istologia e anatomia microscopica, Ed. Ambrosiana, Milano, 1994
119. Wirhed R. Abilità atletica e anatomia del movimento. Edi.ermes, Milano, 1992
120. Yahia et al. Collagen Structure in Human Anterior Cruciate Ligment and Patellar Tendon. J. of Materials Sci. 23, 2750-3755, 1988

GLOSSARY

Ante; Forward movement of a segment of a limb or the trunk. Syn. Flexion, antemotion.

Ante-medio; Combination of movements that form the motor scheme coordinated by the cc of fusion of a spiral or a diagonal.

Assessment Chart; Form used during assessment to record data on which treatment hypotheses and plans are based. An accurate record of cc(s) manipulated and treatment effectiveness.

Basal tension; Tension of the fascia at rest; maintained by the insertions of tensor muscles onto the fascia.

Caput; Orbit, tympanic and temporomandibular articulations with their respective muscles as well as the facial and cranial fasciae, which comprise the various mf units of the head. Abbr. CP

Carpus; The combination of bones and articulations, ligaments, fasciae and muscles that together effectuate wrist movements. Abbr. CA

CC of fusion; Centre of coordination of a mf unit that moves a segment within a motor scheme.

Centre of Perception; Centre of perception of the mf unit, font of the articular afferents: normally directional afferents become pain afferents in cases of dysfunction. Abbr. CP

Collum; Body segment that, by means of the seven cervical vertebrae plus the muscles and the fasciae therein comprised, unites the head to the trunk. Abbr. CL

Concomitant pain; Pain present simultaneously with the predominate pain that often the patient does not report spontaneously. It can indicate compensations on one plane or along a spiral. Abbr. PaConc

Comparative palpation; Palpation of the six unidirectional cc(s) and of the four cc(s) of fusion of a segment in order to select the most painful.

Coxa; Segment of the body that comprises the hip joint together with the muscles and the fascia that move it. Abbr. CX

Cubitus; The combination of bones (ulna, radius, humerus), ligaments, fasciae and muscles that together effectuate elbow movements. Abbr. CU

Data; Elements that emerge from the initial subjective examination of the patient; they include the site of maximum pain, concomitant pain, the most painful movement or activity, chronicity and pain behaviour.

Densification; Modification of the consistency of the ground substance and of the arrangement of the endofascial collagen fibres. At times a form of granulation tissue is apparent on palpation.

Diagnostic CC; A cc di fusion that can indicate which spiral contains a tensile imbalance; it is selected by comparative palpation.

Digiti; The four appendages into which the palm of the hand terminates. Syn. II°, III°, IV°, V°, or index, middle, ring, little finger. Abbr. DI

Epimysial fascia; The part of the deep fascia that surrounds muscle. Syn. Epimysium

Extra; Rotation of a segment of a limb or the trunk towards the retro-lateral part of the body. Syn. Extrarotation, eversion. Abbr. ER

Fascia; Fibrous connective tissue membrane that surrounds muscles with fascial compartments, separates them with intermuscular septa, connects them in sequences and synchronises them by means of retinacula.

Fascial compensation; The way in which the body attempts to eliminate a pain; it reduces the tension of one point of the fascia in the search for elasticity along a sequence and/or a spiral.

Fascial Manipulation; Manual technique, the aim of which is to restore normal fluidity to the ground substance and to eliminate adherences between collagen fibres by exploiting the malleability of the fascia. Abbr. FM

Fibrosis; Painful inflammation (?) of the fibrous tissue of the muscular fasciae that causes stiffness and loss of movement.

Gel to sol point; Moment in which the densified ground substance of the fascia passes from the gel state to the sol state due to the rise in temperature produced by the friction of manipulation.

Genu; Segment of the lower limb that comprises the knee joint and the mf units that move it. Abbr. GE

Humerus; Glenohumeral articulation, ligaments, fasciae and muscles that effectuate movement of the distal part of the shoulder. Abbr. HU

Hypothesis; Outcome of the analysis of data, which aids in the formulation of an individual therapeutic plan for each single patient.

Intra; Rotation of a segment of a limb or the trunk towards the ante-medial part of the body. Syn. Intrarotation, inversion. Abbr. IR

Intermuscular septum; Fascial formation interposed between two mf units; it provides insertions for many muscular fibres that are antagonists to one another.

Latero; Movement of a segment of a limb or the trunk away from the median line. Syn. Lateral flexion, lateromotion, abduction. Abbr. LA

Lumbi; Segment located between the thorax and the sacrum, which includes the dorsal and abdominal muscles that move that segment. Abbr. LU

Medio; Movement by which a segment of a limb or the trunk is returned to the median line. Syn. Mediomotion, adduction. Abbr. ME

Mf sequence; Chain of unidirectional mf units united by the overlying fascia and tensioned by the biarticular muscular fibres.

Mf Spiral; A continuous helicoidal line of fascial fibres that winds around a limb or the trunk without ever crossing over itself. It unites the cc(s) of fusion.

Mf unit; A group of motor units that move a segment in one specific direction. They are coordinated by the cc situated in the same fascia that surrounds them.

Movement assessment; Test that verifies the validity of one's initial hypothesis. In treatment of the spirals the movement assessment is also used to verify the validity of the outcome.

Neuroconnective Manipulation; Connective tissue manipulation of the fascia of a segment with the intent to disentangle the free nerve endings blocked by densification of the same fascia.

Painful movement; The movement indicated by the patient as being that which exacerbates his/her pain most of all. Abbr. PaMo. It is recorded in the same way as the site of pain (e.g. LA).

Palpation assessment; Test which verifies or otherwise the deductions drawn from the movement assessment.

Pelvis; The two hip bones united anteriorly by the pubic bone and posteriorly by the sacrum and coccyx. Together with the relative muscles and fasciae, these bones form the pelvic girdle. Abbr. PV

Pes; Segment of the lower limb, which comprises the five toes, dorsum, sole, plantar arch and lateral border of the foot. Abbr. PE

Post treatment assessment; Evaluation of the same movements that were painful prior to treatment.

Postural compensation; Tensile adjustment adopted by the body in order to avoid pain either in the static position (upright position) or during dynamic activity (motor gesture).

Previous pain; Pain no longer felt in as much as the body has been able to compensate for it. It can however help to define the history of the present imbalance. Abbr. PaPrev

Pollex; The first finger of the hand (I°), which has been assigned its own mf unit due to its independence with respect to the other fingers. Syn. Thumb, pollicis. Abbr. PO

Retinaculum; Fascial structure, formed by an intersecting network of collagen fibres, which transmits tension from right to left, from above to below and visa versa.

Retro; Backward movement of a segment of a limb or the trunk. Syn. Extension, retromotion.

Scapula; Scapula-thoracic articulation (+ sternoclavicular), fasciae and muscles that effectuate the movement of the proximal part of the shoulder. Abbr. SC

Segmentary CC; Centre di coordination of a mf unit that moves a segment in one direction on one plane.

Silent CC; Centre di coordination of a mf unit that does not manifest signs of dysfunction, but which is involved in maintaining a state of imbalance of the fascial framework.

Site of the pain; The painful area of the body indicated by the patient. It is defined by the abbreviation of the segment (e.g. CX) together with the location of the pain (e.g. LA).

Talus ; Muscles of the leg together with the bones (talocrural, talus) and fasciae that effectuate movement of the ankle. Abbr. TA

Thorax; Segment situated between the 7th. cervical vertebra and the 1st. lumbar vertebra consisting of 12 thoracic vertebrae and the 6 mf units that effectuate movement of this segment. Abbr. TH

Treatment; Therapeutic act of manipulating a densified centre of coordination in order to restore its physiological elasticity.

Vectorial centre; The point on the fascia where vectors (forces or traction) formed by the muscular fibres of the segmentary mf units and the mf units of fusion converge.

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