Murat Bozkurt
Halil İbrahim Açar
Editors

Clinical Anatomy of the Shoulder

An Atlas

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ISBN 978-3-319-53915-7 ISBN 978-3-319-53917-1 (eBook)
DOI 10.1007/978-3-319-53917-1

Library of Congress Control Number: 2017939585

Printed on acid-free paper

This Springer imprint is published by Springer Nature
The registered company is Springer International Publishing AG
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

Dedicated to our fathers …

Murat Bozkurt and Halil İbrahim Açar

Preface

The shoulder joint continues to be one of the most remarkable and challenging joints in the human body. My primary goal in editing *Clinical Anatomy of the Shoulder—An Atlas* is to create a valuable resource that includes a rich visual content for those physicians, residents, fellows, or students practicing or interested in orthopedic shoulder pathologies.

My belief is that the anatomical knowledge is crucial to maintain an appropriate approach for any orthopedic disorder. For this reason, the anatomy is intended to constitute the basis of this book. In addition to the anatomy, this book includes intensive radiology content, physical examination, and some basic requirements for shoulder arthroscopy.

I greatly appreciate the contributions of all the authors. Their work in the field of musculoskeletal system related to the shoulder has been invaluable for the understanding and treatment of shoulder pathologies.

May this book help anyone interested in the shoulder to discover more about this unique human joint with its complex functional structure and interrelations.

Ankara, Turkey — Murat Bozkurt, M.D.

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Functional Anatomy of Shoulder

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Halil İbrahim Açar, Nihal Apaydın, İbrahim Tekdemir, and Murat Bozkurt

The shoulder joint, commonly known as the glenohumeral joint, is very important as it is the joint with the body highest mobile capability. The ability of movement restriction of the passive structures of the joint (joint surfaces and ligaments) is very low. The articular surfaces of the bones which take part in the joint allow a wide range of movement; on one side is the shallow glenoid cavity and on the other side, the wide humeral head. The thin and loose joint capsule, again allows a wide range of movement.

How is stability provided together with this ability for wide range of movement?

As the passive structures of the joint provide limited support for stability, active structures come into operation to be able to provide both movement and support to the joint. The active structures are the muscles surrounding the joint.

The muscles which participate actively in stability and support to the weak capsular ligaments are the rotator cuff muscles. The rotator cuff is formed by the tendons of the scapulohumeral muscles which pass anterior, posterior and superior to the joint to insert on the lesser and greater tubercles of the humerus together with the joint capsule. Thus, they support the shoulder joint anteriorly, posteriorly and superiorly. The only part of the joint capsule that has no tendonious support is the inferior part.

Another significant structure of the joint is the glenoid labrum, which increases compatibility between the small, shallow glenoid cavity and the large spheric humeral head. The glenoid labrum is a fibrocartilaginous structure attached to the edges of the glenoid cavity. The coracoacromial arch is also a very important structure for the joint. This structure is a strong osteofibrous arch formed by the acromion, coracoacromial ligament and coracoid process which supports the shoulder joint from above.

There is a substantial amount of studies in literature explaining these structures in details. The aim of the Anatomy section of this book is to present the most appropriate viewpoints related to these anatomic structures which are critical to the shoulder joint and the relationships between the structures, for both open and for arthroscopic approaches. Therefore, detailed theoretical knowledge has been avoided, and the anatomic structures have been presented with the most convenient images on adult human cadavers in a simple and comprehensible manner.

In this chapter the shoulder joint will be evaluated from various viewpoints (Fig. 1.1–1.12).

In the right shoulder region, the skin and superficial fascial structures have been removed to present a wide view of the muscles around the shoulder joint. These muscles are seen from the front (Fig. 1.1).

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M. Bozkurt, H.İ. Açar (eds.), *Clinical Anatomy of the Shoulder*, DOI 10.1007/978-3-319-53917-1_1

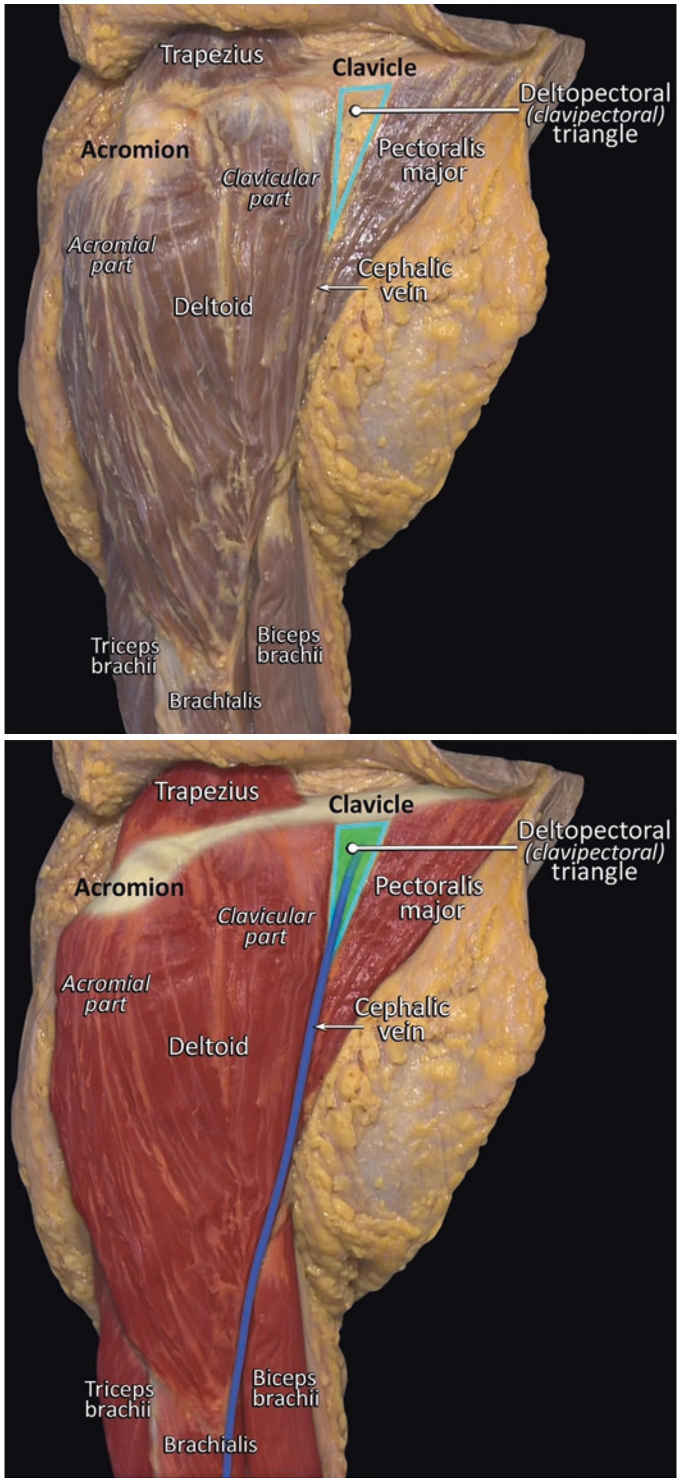

Fig. 1.1 Superficial muscles around the shoulder joint

The trapezius inserts on the shoulder girdle, and the parts of the deltoid which start from approximately the same region, insert on the deltoid tuberosity over the distal side on the lateral margin of the humerus. Only the clavicular head of the pectoralis major is observed on the figure (Fig. 1.1). Pectoralis major extends to the anterolateral side of the proximal part of the humerus and inserts on the crest of the greater tubercle.

The important area here is the deltopectoral or clavipectoral triangle which lies between the clavicle, deltoid and pectoralis major. The distal part of cephalic vein was removed together with the superficial fascia. This vein passes through the triangle and extends to the axillary fossa (Fig. 1.1).

The anterior and mid sections, namely the clavicular and acromial parts of the deltoid were cut from their attachments and retracted posterior to reach the shoulder joint (Fig. 1.2).

A very important structure encountered at this level is the subdeltoid bursa. By inflating with air, the shape has become evident and the relationship with the structures surrounding the bursa is observed (Fig. 1.2). This bursa, which functions as a pillow between the deltoid and the proximal end of humerus, by usually combining with the subacromial bursa, extends as far as the level of the acromioclavicular joint (ACJ) below the acromion and coracoacromial ligament (CAL). The subdeltoid bursa extends towards the surgical neck of the humerus to as far as 4 cm to the distal from the anterolateral corner of acromion.

The coracoid process (CP), which is located below the clavicular part of the deltoid muscle, can be palpated approximately 2.5 cm below at the lateral 1/5 of clavicle. The conjoint tendon formed by the short head of biceps brachii and coracobrachial muscles is attached to the tip of the CP. With retraction of deltoid, the distal section of the pectoralis major, which inserts on the crest of the greater tubercle is visualised. The terminal part of the anterior branch of the axillary nerve, which extends below the deltoid is seen here (Fig. 1.2).

The acromion, CAL and CP form a very strong osteoligamentous girdle by supporting the shoulder joint from above. This girdle may damage the underlying structures by compressing them. The most important structure in reducing this effect is the subacromial bursa, which shows continuity with the subdeltoid bursa.

Although not described classically; CAL, CP and the conjoint tendon should be evaluated as an important osteotendinoligamentous arch supporting the shoulder joint anterosuperiorly. While the supraspinatus inserting on greater tubercle can be compressed by acromion, subscapularis inserting on the lesser tubercle can be compressed by CP in abduction. The relationships of the structures compressing under these osteofibrous arches may partially change with rotation during abduction.

The topographical relationships and structures attaching to the coracoid process (CP) are seen. The short head of the biceps brachii and coracobrachialis form the conjoint tendon which inserts on the tip of the CP. The pectoralis minor which originates from the 3rd-5th ribs inserts over the medial edge of the CP. A little more posteriorly, a small tendon of the subclavius is also seen attaching over the medial edge of the CP. The coracoacromial ligament (CAL), which is a strong, wide structure attaches to the lateral edge of the CP. More posteriorly, two important ligaments connect the clavicle and CP and attach to the superior surface of the CP. These two ligaments are the trapezoid ligament (TL) and the conoid ligament (CL).

The infraclavicular part of the brachial plexus and the axillary vessels are seen medial to the CP (Fig. 1.3).

The entry point of anterior arthroscopic portal is immediately lateral the CP. After palpating the CP, insertion of the portal can be made through the pit just lateral to the tip of the CP without damaging the axillary neurovascular structures and the conjoint tendon attaching here.

The relationship of the subdeltoid bursa and the rotator cuff muscles is shown in the figure. Pectoralis major is seen at the anterior wall of the axillary fossa and immediately below this muscle is the pectoralis minor, and above is the subclavius (Fig. 1.3).

To better demonstrate the anterior relations of the shoulder joint, pectoralis major tendon was retracted medially by cutting its humeral insertion. The conjoint tendon was also retracted medially to reveal the subscapularis muscle and

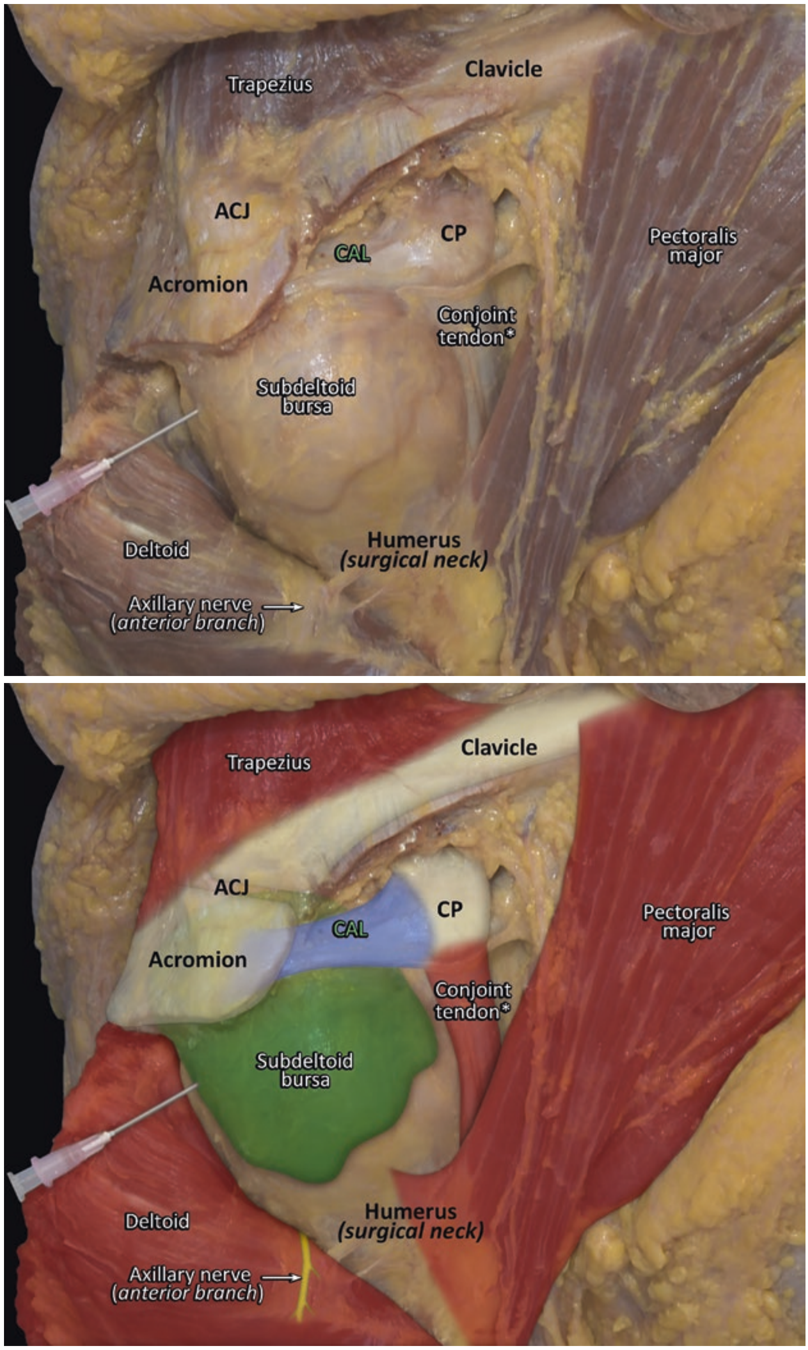

Fig. 1.2 Subdeltoid bursa and related structures. *ACL* acromioclavicular joint, *CAL* coracoacromial ligament, CP coracoid process

the related structures at the posterior wall of the axillary fossa. More laterally, the tendon of long head of biceps brachii running in the intertubercular groove is seen. Thus the anterior part of the shoulder joint was reached through the interval between the short and long heads of the biceps brachii (Fig. 1.4).

The biceps tendon is located in the intertubercular groove wrapped with an intertubercular tendon sheath, then enters the joint cavity.

The musculocutaneous nerve courses inferolaterally after branching out from the lateral cord then passes within the coracobrachialis muscle

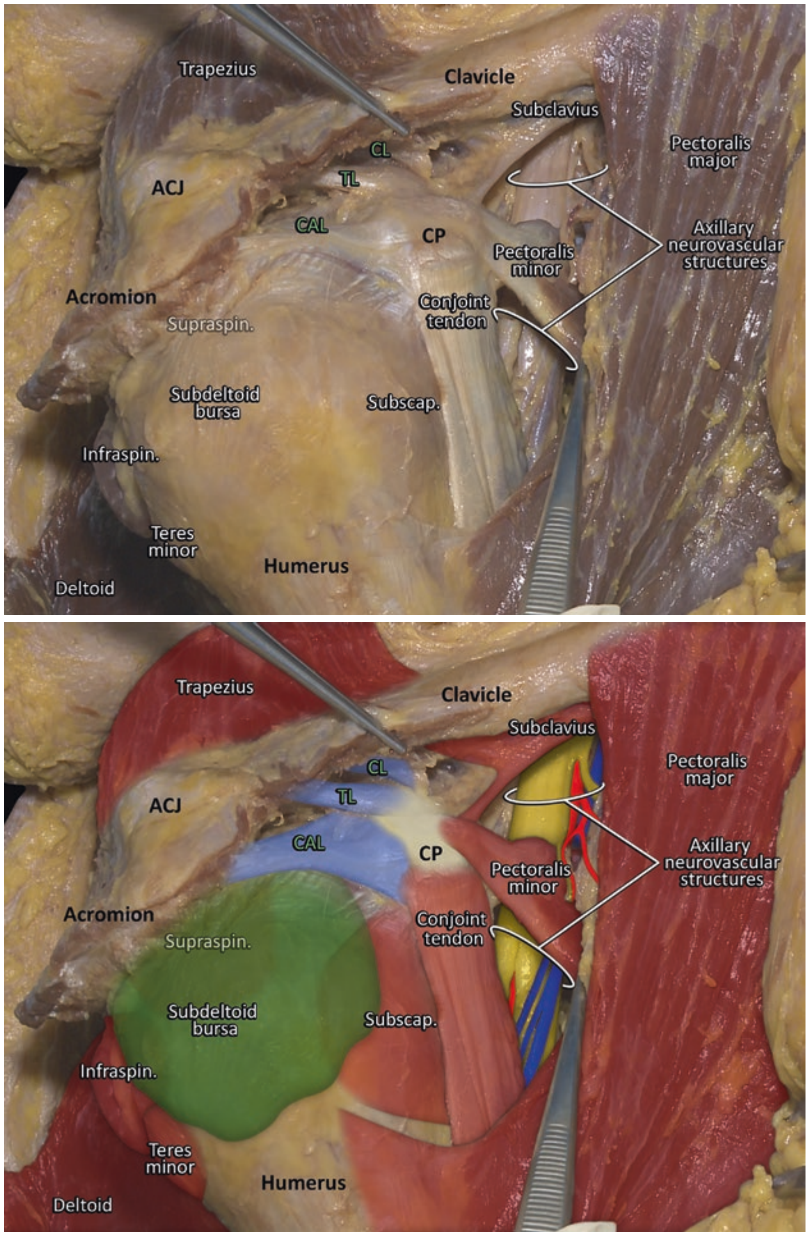

Fig. 1.3 Coracoid process and related structures. *ACL* acromioclavicular joint, *CAL* coracoacromial ligament, *TL* trapezoid ligament, *CL* conoid ligament, *CP* coracoid process

and extends to the anterior compartment of the arm (Fig. 1.4). This nerve was moved away from the joint by pulling the conjoint tendon medially.

The subscapularis muscle, which originates from the subscapular fossa on the anterior surface of the scapula, inserts on the lesser tubercle. This muscle, which forms the anterior section of the rotator cuff is one the most important supporting structures of the shoulder joint. The posterior cord and its terminal branches are the closest neural structures located at the posterior wall of the axillary fossa. The axillary and radial nerves are the most important nerves separating from this cord. The axillary nerve runs just anterior to subscapularis leaning on it and passes through the quadrangular space (also known as the lateral axillary or quadrilateral space) at the posterior wall of the axillary fossa. Posteror circumflex humeral vessels pass through the space together with the axillary nerve (Fig. 1.4).

The anterior and posterior circumflex vessels emerge from the axillary artery. They may also be separated as a common trunk as seen here. The anterior circumflex artery is smaller and runs in front of the surgical neck. The posterior circumflex artery is bigger and by passing through the quadrangular space together with the axillary nerve comes underneath the deltoid. The axillary nerve and posterior circumflex vessels separate into branches while they

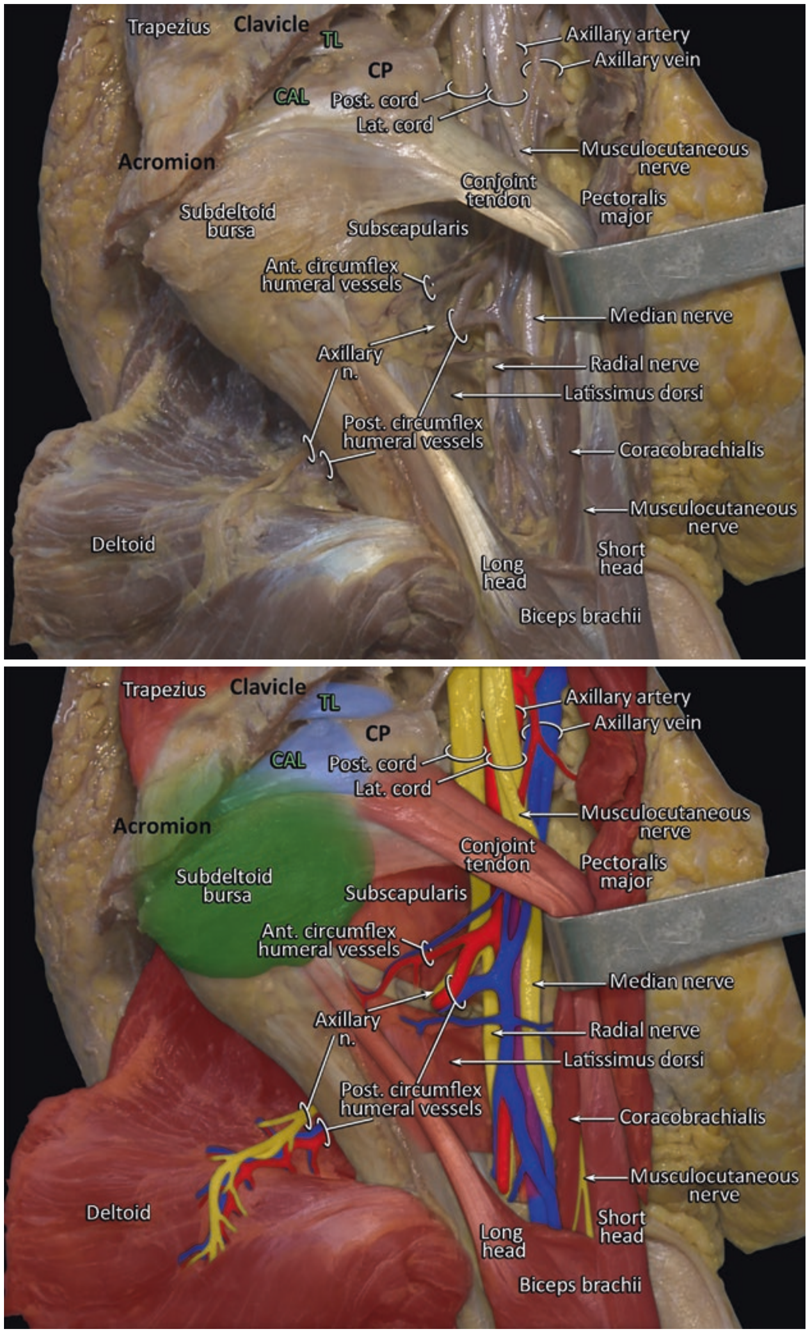

Fig. 1.4 Posterior wall of the axillary fossa. *CAL* coracoacromial ligament, *TL* trapezoid ligament, *CP* coracoid process

pass through the space. The anterior branches course posterior to anterior around the surgical neck within the fascia of the deltoid muscle (Fig. 1.4).

The radial nerve, which is seen as a continuation of the posterior cord, course distally close the tendon of the latissimus dorsi below the subscapularis (Fig. 1.4).

The pectoralis minor was retracted medially by cutting its attachment from the coracoid process (CP). Thus, by elevating the anterior wall of the axillary fossa, the neurovascular structures within were made visible. Some of the axillary vein tributaries were cut and pulled medially (Fig. 1.5).

The relationship between the infraclavicular part of the brachial plexus and the axillary artery is seen (Fig. 1.5).

The lateral cord is located anterolateral to the axillary artery. One of its terminal branches which runs close to the shoulder joint is the musculocutaneous nerve. Its other terminal branch forms the median nerve together with fibers coming from the medial cord (Fig. 1.5).

The medial cord is located posteromedial to the axillary artery. Apart from the fibres joining

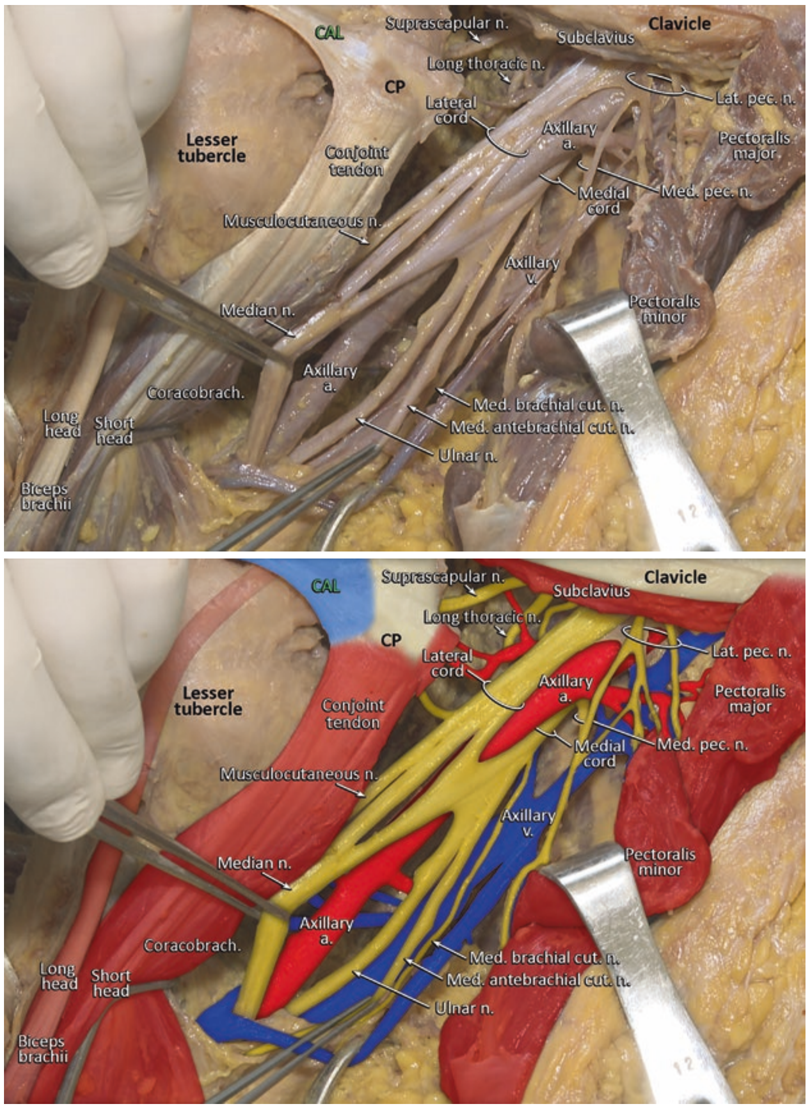

Fig. 1.5 Axillary neurovascular structures. *CAL* coracoacromial ligament, *CP* coracoid process

the median nerve, the majority of the fibres continue as the ulnar nerve. The medial antebrachial and brachial cutaneous nerves, which provide sensory innervation of the medial surfaces of the arm and forearm, also separate from the medial cord (Fig. 1.5).

More proximally, the lateral and medial pectoral nerves separate from the lateral and medial cords respectively and innervate the pectoral muscles (Fig. 1.5).

Two important branches of the supraclavicular part of the brachial plexus are seen here. These branches are the suprascapular and long thoracic nerves (Fig. 1.5).

When the artery and overlying lateral cord are pulled medially, the posterior cord with posterolateral location can be seen (Fig. 1.6). The axillary nerve and the radial nerve are the important branches of this cord. On a deeper plane, the subscapular nerves and the thoracodorsal nerve separate from the posterior cord (Fig. 1.6).

The subscapular muscle originates from the subscapular fossa and inserts on the lesser tubercle. It forms the anterior section of the rotator cuff and has a significant place in the anterior support of the shoulder joint (Fig. 1.6). Superior and inferior subscapular nerves innervate the muscle.

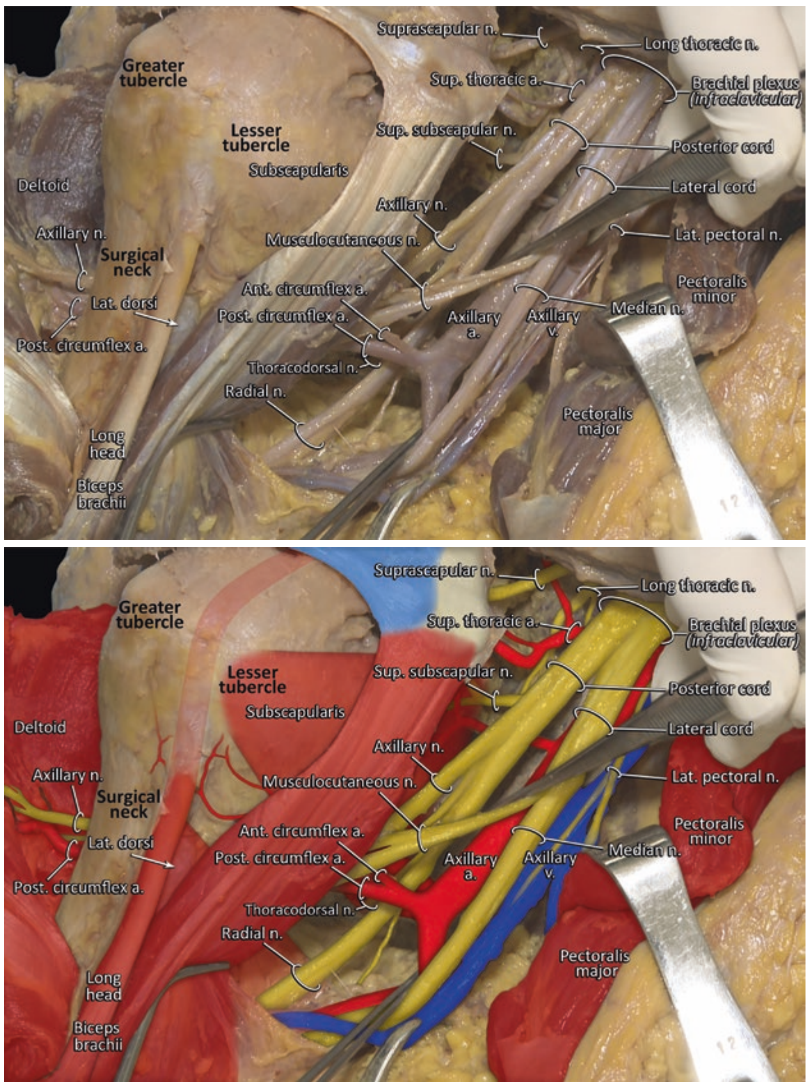

Fig. 1.6 Posterior cord and shoulder

More superiorly, the long thoracic nerve and the supraclavicular nerve are seen (Fig. 1.6).

The subdeltoid/subacromial bursa was removed. Now the rotator cuff surrounding the shoulder joint, coracoacromial girdle over the joint and the ligaments connecting the clavicle to the coracoid process (CP) (trapezoid ligament [TL] and conoid ligament [CL]) are seen (Fig. 1.7).

At the anterosuperior part of the shouder joint, there is a triangular interval lying between the subscapularis and supraspinatus muscles with the base formed by the root of the CP. In the figure, the borders of the interval are drawn with dotted lines. This space between the rotator cuff muscles is known as the rotator interval (Fig. 1.7).

The anterior arthroscopic portal passes through this interval. After palpation of the CP, the pit immediately lateral to this must be used to enter the joint cavity. Here is the corner of the angle formed by the coracoacromial ligament (CAL), coracoid process (CP) and conjoint tendon. If entry is attempted immediately below the CP, the trochar slipping medially over the conjoint tendon may damage the axillary neurovascular structures. As emphasised previously, the closest structure to this point which is at risk is the musculocutaneous nerve. This nerve enters the coracobrachialis medially and is located more superolateral than the other branches of the brachial plexus.

Within the rotator interval, there is coracohumeral ligament (CHL) superiorly and at a deeper plane the biceps tendon within the joint space. In addition, the superior glenohumeral ligament (SGHL) can be seen over the joint capsule (Fig. 1.7).

The CAL extends below the acromion. Despite the subacromial bursa being in between the supraspinatus tendon and acromion, it contacts the area below the acromion during abduction. The inferior surface of the CAL can be eroded and the supraspinatus tendon may injure due to repetetive trauma (Fig. 1.7).

By entering from the posterior portal approximately 2 cm below the posterior corner of the acromion, transillumination is made with the arthroscopic light source. The borders of the rotator interval, which is a weak part of the joint capsule are seen (Fig. 1.8).

The structures within the rotator interval are demonstrated with transillumination. The joint capsule lying between the subscapularis muscle and the coracohumeral ligament (CHL) in this space is thinner (Fig. 1.8).

When examined arthroscopically, it is noticeable that the intracapsular biceps tendon lies immediately below the supraspinatus tendon, and the thin, weak part of the capsule is located between this tendon and the subscapularis. It can be noted that, this place is the part of the capsule which is located just below the coracoid process (CP). This weak area is below the angle formed by the coracoacromial ligament (CAL), coracoid process (CP) and conjoint tendon and it is supported by this osteoligamentotendinous girdle.

A tear on the supraspinatus tendon which is attached to the top of the greater tubercle (GT) is shown with arrowheads (Fig. 1.8).

The trapezoid ligament (TL) and conoid ligament (CL), which attach the clavicle to the CP are also observed here (Fig. 1.8).

The posterior part, namely the spinal part of the deltoid was retracted by cutting from its attachment on the spine of scapula. The infraspinatus and teres minor muscles, which originate from the posterior surface of the scapula below the spine, are seen (Fig. 1.9). These muscles form the posterior section of the rotator cuff. Three muscles, the supraspinatus, the infraspinatus and the teres minor, are attached to the greater tubercle (GT) from above to below respectively. Thus, the humeral head is supported posterosuperiorly. The supraspinatus is involved in abduction of the arm, and the infraspinatus and teres minor in external rotation.

The axillary nerve together with posterior circumflex vessels are observed emerging from the lateral axillary space and passing underneath the deltoid. The anterior branch of the axillary nerve (black arrow heads) and the branches of the accompanying posterior humeral circumflex vessels are seen on the deep surface of the deltoid (Fig. 1.9). These branches, which course within the fascia of the deltoid encircle the surgical neck of the humerus from posterior to anterior.

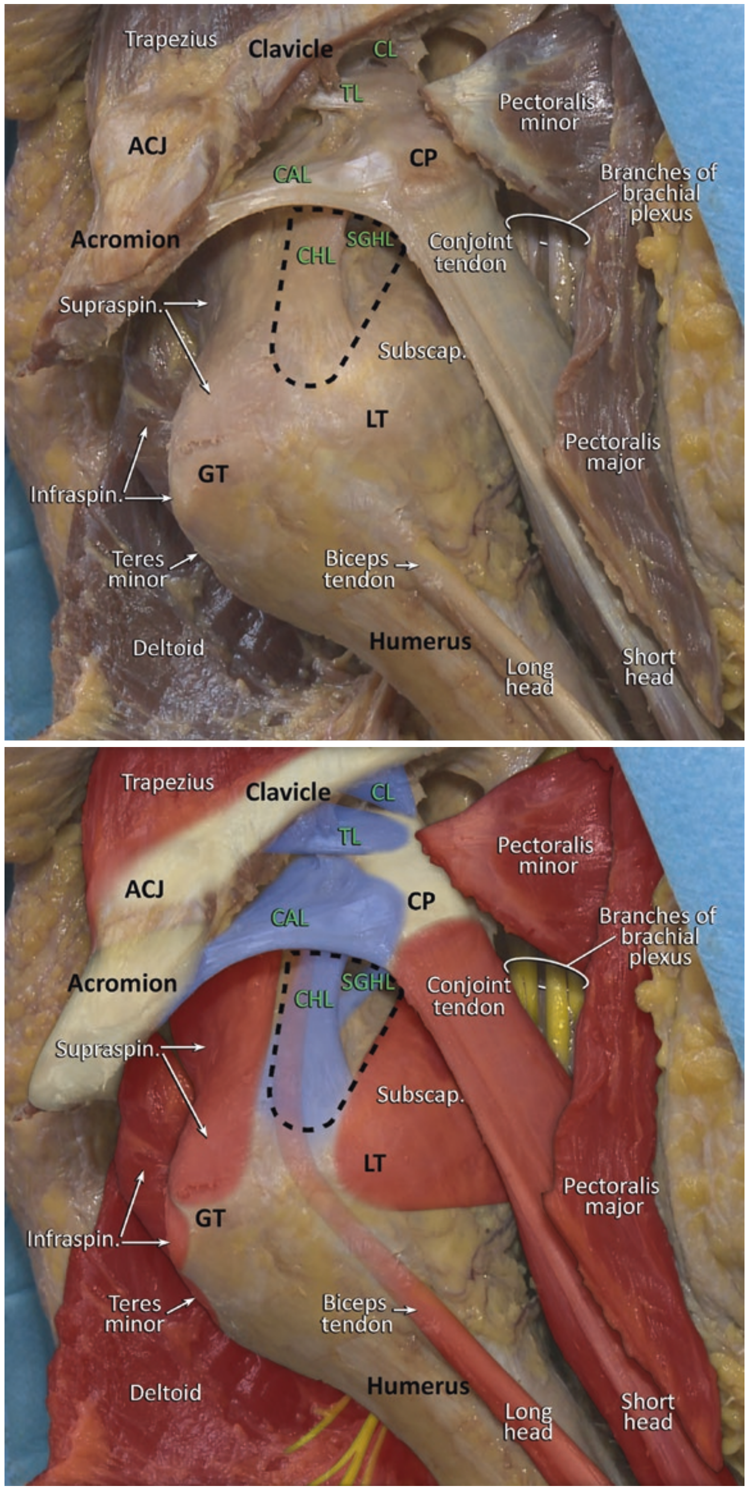

Fig. 1.7 Rotator interval. *ACL* acromioclavicular joint, *CAL* coracoacromial ligament, TL trapezoid ligament, *CL* conoid ligament, *CHL* coracohumeral ligament, *SGHL* superior glenohumeral ligament, *CP* coracoid process, *GT* greater tubercle, *LT* lesser tubercle

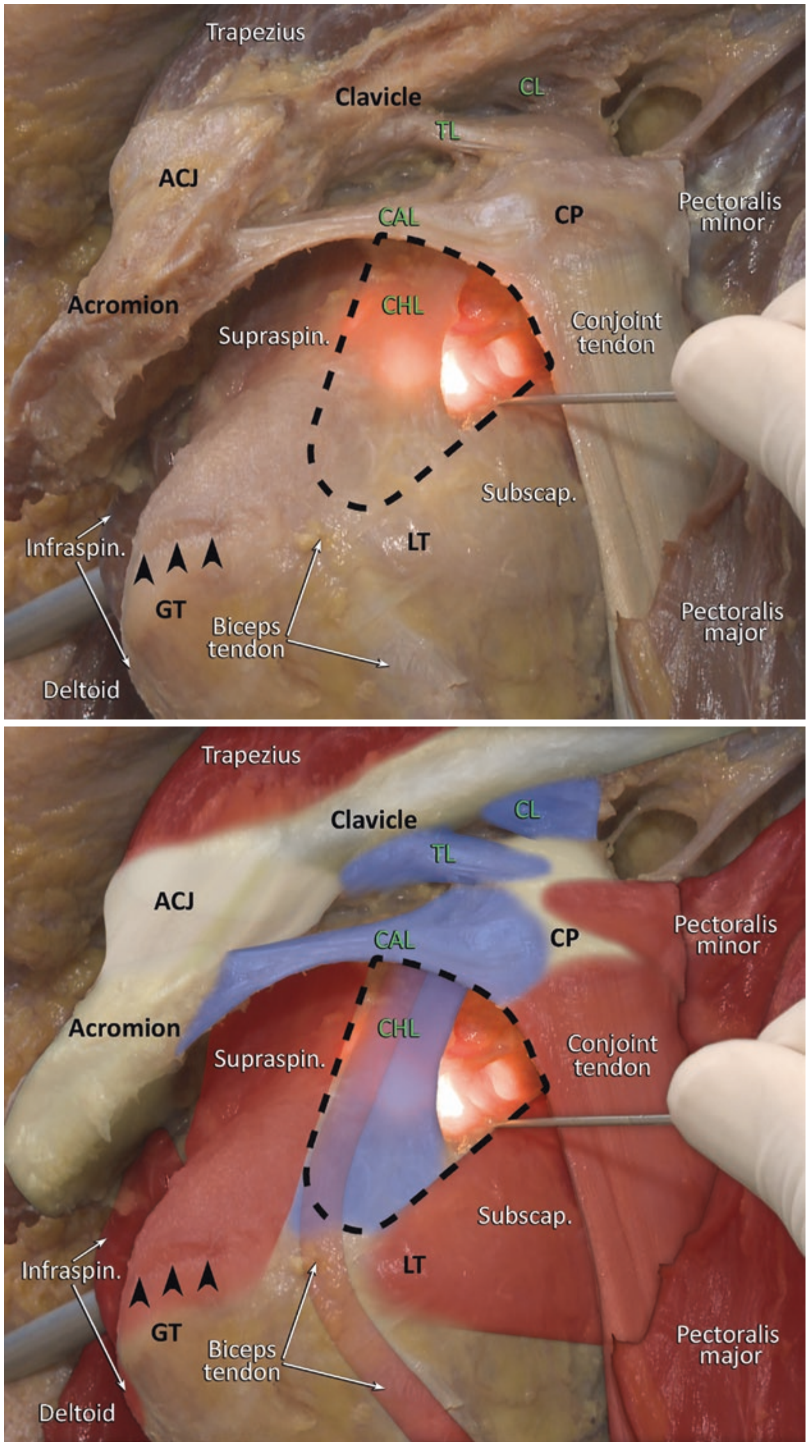

Fig. 1.8 Rotator interval with transillumination. *ACL* acromioclavicular joint, *CAL* coracoacromial ligament, *TL* trapezoid ligament, *CL* conoid ligament, *CHL* coracohumeral ligament, *CP* coracoid process, *GT* greater tubercle, *LT* lesser tubercle

Innervation of the teres minor is provided by the axillary nerve branches passing through the quadrangular space. The nerve branches innervating teres minor runs underneath the muscle. Innervation of the infraspinatus is provided by the suprascapular nerve coming from above. The internervous plane used for a posterior approach to the shoulder joint is between the infraspinatus and the teres minor (black arrow) (Fig. 1.9). The posterior section of the joint capsule which is revealed in the space between these two muscles is extremely weak.

The posterior arthroscopy portal entry is made approximately 2 cm below and 1 cm medial the posterior corner of the acromion (*, acromial angle). The pathway of the portal is approxi-

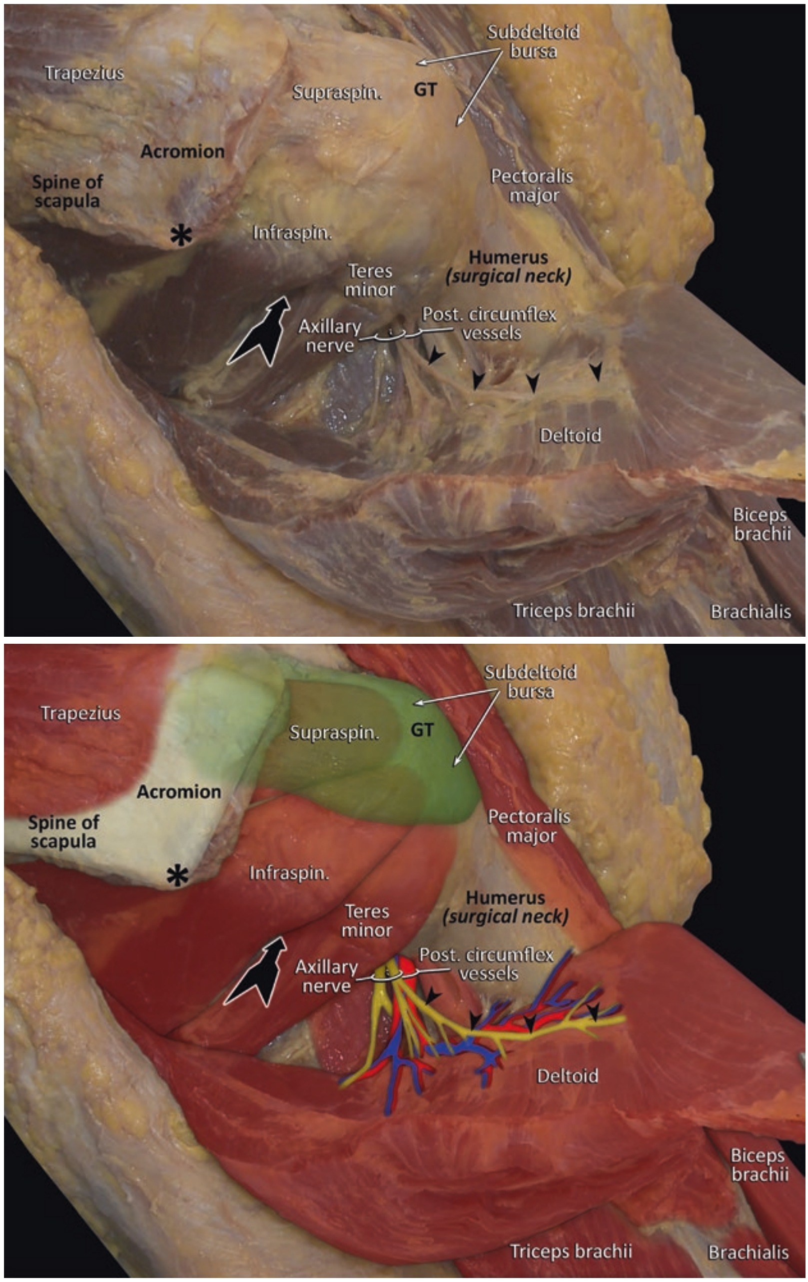

Fig. 1.9 Posterior view of the shoulder joint. *GT* greater tubercle, * acromial angle

mately the internervous plane between the infraspinatus and the teres minor as described above (Fig. 1.9).

We are looking at the shoulder joint and related structures from above. The clavicular and acromial attachments of the trapezius were cut and retracted. The supraspinatus and surrounding important structures were exposed (Fig. 1.10).

The suprascapular vessels and nerve extending towards the supraspinatus from the cervical region are seen (Fig. 1.10). The suprascapular nerve course in a deeper plane than the vessels. By originating from the upper trunk of the brachial plexus, the suprascapular nerve passes through suprascapular notch below the superior transverse scapular ligament (STSL).

The suprascapular artery is a branch of the thyrocervical trunk. Together with the accompanying vein, it runs parallel to clavicle. It cross the trunks of the brachial plexus anteriorly in this region. When approaching the STSL, it gives superficial branches to supply the surrounding muscles such as trapezius and omohyoid. Its acromial branches extend towards the acromioclavicular joint (ACJ) over the supraspinatus. Then the artery runs underneath the supraspinatus passing over the STSL. Here, it is close to the bone. From this point on, they start to run together with the suprascapular nerve. Passing below the coracoacromial girdle (acromion and coracoacromial ligament, CAL), supraspinatus inserts at the top of the greater tubercle (Fig. 1.10).

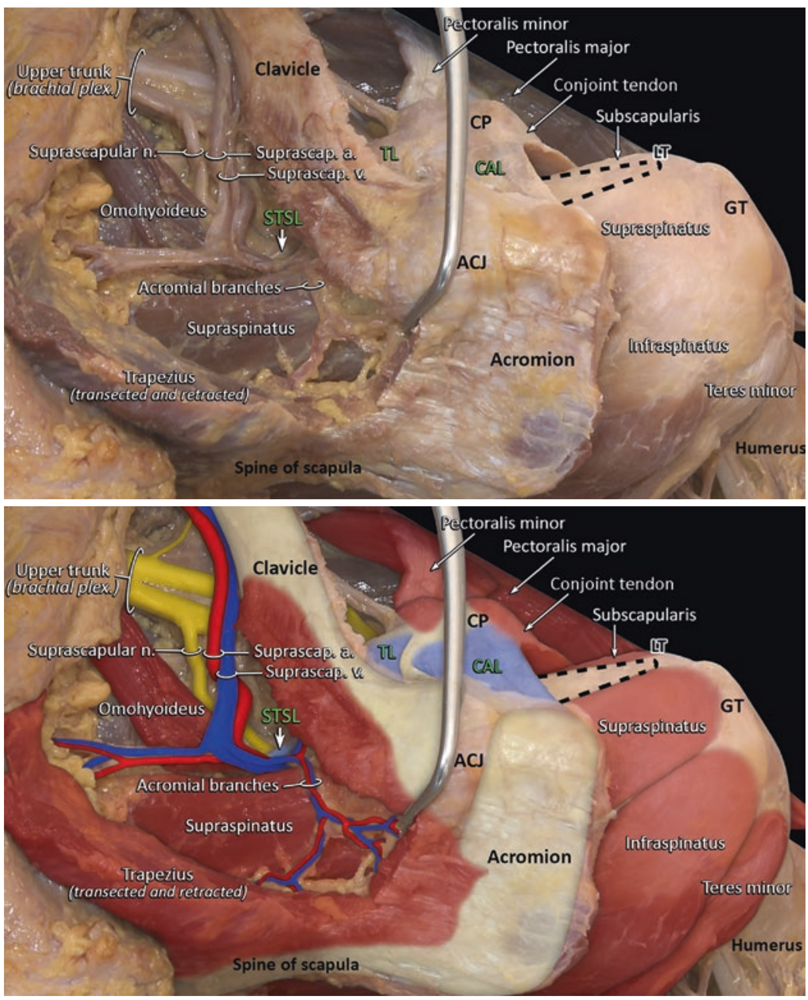

Fig. 1.10 Superior view of the shoulder joint. *ACL* acromioclavicular joint, *CAL* coracoacromial ligament, *TL* trapezoid ligament, *STSL* superior transverse scapular ligament, *CP* coracoid process, *GT* greater tubercle, *LT* lesser tubercle

The right shoulder is seen from above (Fig. 1.11).

The mid-section of the supraspinatus was removed to be able to demonstrate the suprascapular notch (black arrows) and supraspinous fossa (Fig. 1.11). The branches of the suprascapular vessels and nerve continuing below the supraspinatus (the branches to the supraspinatus were removed by cutting together with the muscle) progress close to the bone. They come to the fossa infraspinatus by winding below the acromion immediately lateral to the spine scapula and posterior to the scapula neck. The branches separate below the infraspinatus muscle.

The suprascapular notch is adjacent the coracoid process (CP). The conoid ligament (CL) extends to the inferior surface of the clavicle (conoid tubercle) from the root of the CP located on the immediate lateral to the notch. As seen in the figure, the notch is bridged by the superior transverse scapular ligament (STSL). It can be clearly seen that the suprascapular vessels run over the STSL and the suprascapular nerve passes

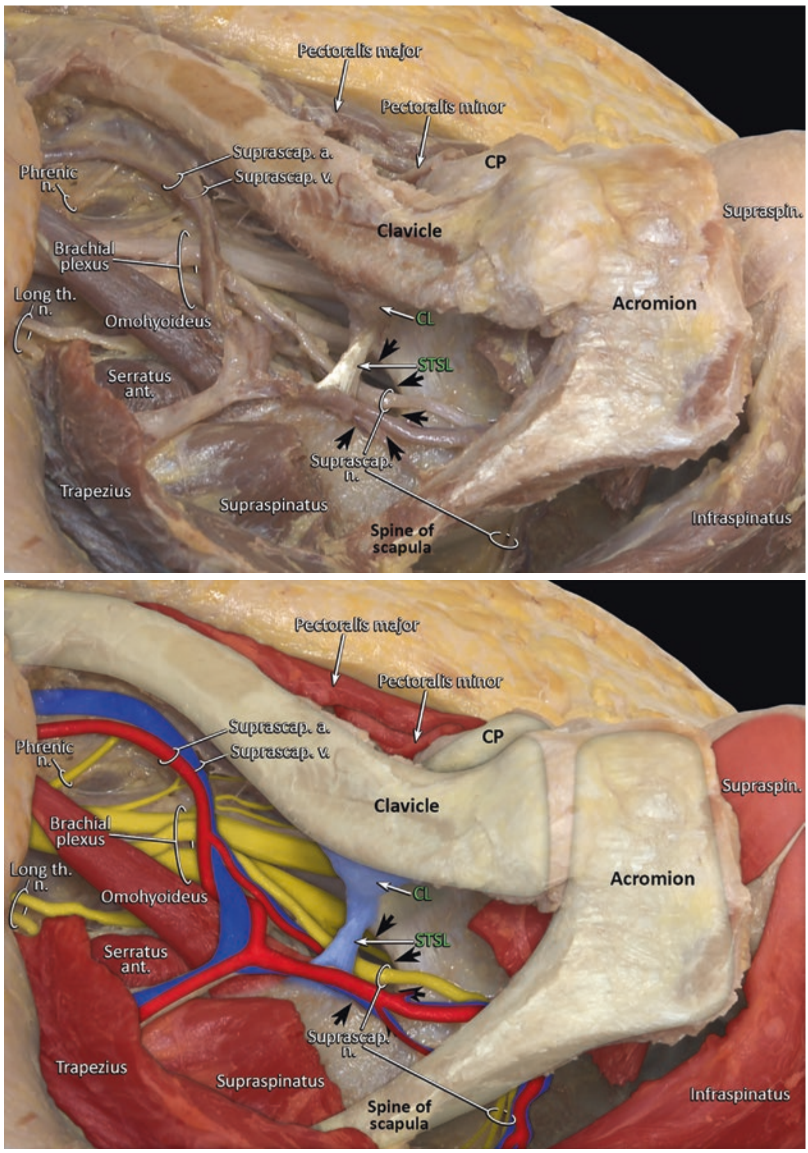

Fig. 1.11 Suprascapular notch and related structures. *CL* conoid ligament, *STSL* superior transverse scapular ligament, *CP* coracoid process, black arrows suprascapular notch

underneath the STLS, through the notch. In normal conditions, the suprascapular nerve is protected from the pressure of the surrounding structures in this osteofibrous passageway. However it can be compressed in this passageway in the cases where the connective tissue is increased (Fig. 1.11).

In the right shoulder joint, the joint capsule was opened posteriorly to expose the glenoid cavity and related structures (Fig. 1.12).

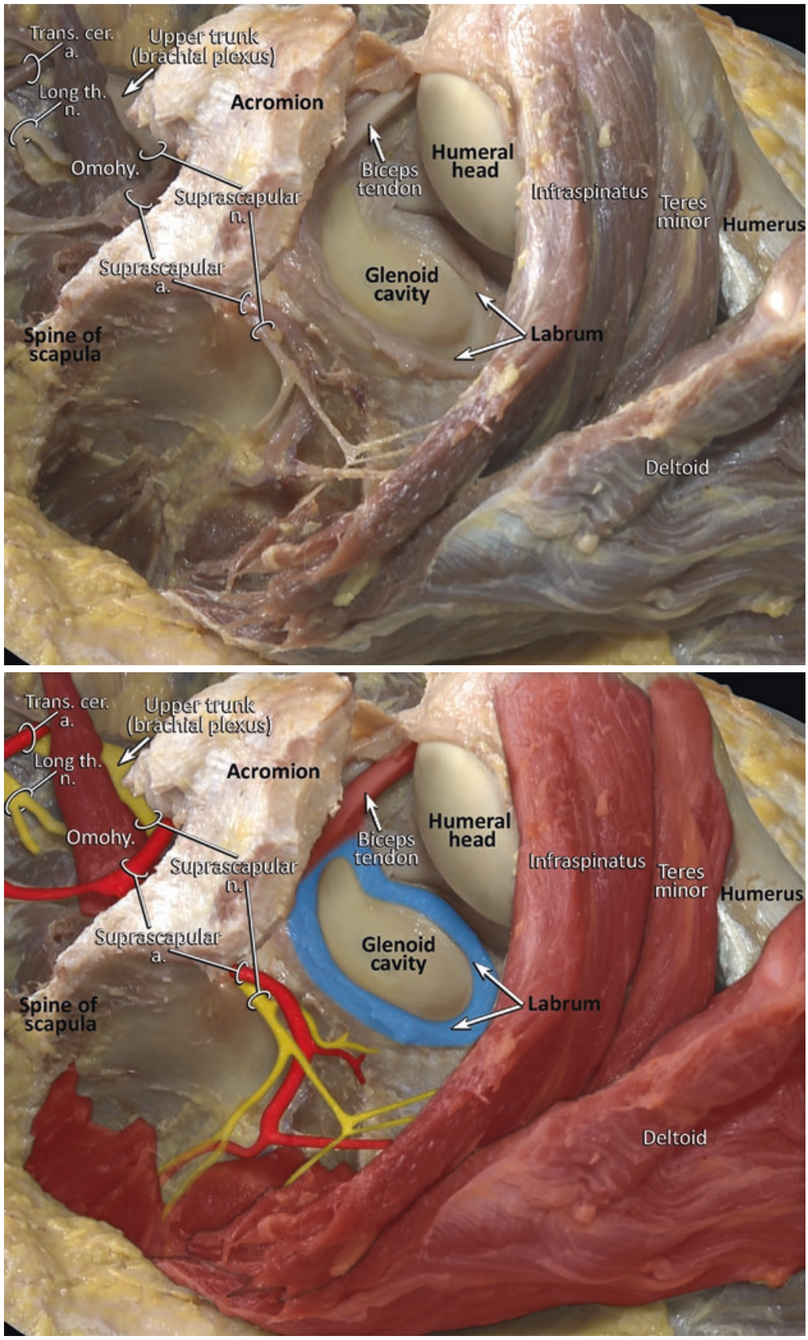

Fig. 1.12 Glenoid cavity and labrum

The labrum is a fibrocartilaginous structure that attaches to the edges of the glenoid cavity for to increase the depth and surface area of the shoulder joint. Superiorly, it is fused to the biceps tendon (Fig. 1.12).

The biceps tendon originates from the supraglenoid tubercle immediately above the glenoid, and comes to the anterior compartment of the arm by passing through the intertubercular groove (bicipital groove).

The suprascapular vessels and the nerve run together after passing the suprascapular notch. By passing spinoglenoid notch behind the neck of scapula they come to the infraspinous fossa and provide branches to the infraspinatus. The proximity of these neurovascular structures to the glenoid must be kept in mind during arthroscopic or open surgery (Fig. 1.12).

2 Arthroscopic Anatomy of Shoulder

Murat Bozkurt, Mehmet Emin Simsek,
and Halil İbrahim Açar

2.1 Introduction

In the last 30 years, shoulder arthroscopy has become of greater importance in the diagnosis and treatment of shoulder diseases. An increasing number of arthroscopic techniques together with innovations in surgical equipment have resulted in several surgical procedures which were applied as open surgery in the past now being applied as arthroscopic procedures. The aim of arthroscopic surgery is to provide rapid, accurate diagnosis and treatment during surgery together with the least morbidity possible to the patient. Therefore, the most important factor increasing the success of arthroscopic surgery is the ability to identify natural-healthy anatomic structures.

In this section, it is aimed to identify natural-healthy anatomic structures in shoulder arthroscopic surgery.

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2.2 Surgical Technique

In our hospital, arthroscopic shoulder operations are performed in the beach chair position. The patient is placed on the operating table seated in 70° flexion, and as deep vein thrombosis prophylaxis, both lower extremities are wrapped in elastic bandages. A hip support is placed below the hips to prevent the patient slipping on the table. The head position of the patient is fixed with a head holder. All patients are administered hypotensive anaesthesia under neuromonitorisation. The shoulder that is to be surgically treated is placed at the edge of the table. Epinephrine is routinely included in the isotonic fluid to be used in the arthroscopy. After entry to the joint, fluid pressure is adjusted to an initial pressure of 40 mmHg with automatic pressure control.

We routinely use the posterior portal at the start of arthroscopy, and the surgical procedure begins with intra-articular diagnostic arthroscopy. Respectively, the skin, subcutaneous tissue, deltoid muscle, teres minor and infraspinatus interval, then the capsule are passed with the trochar. Adjacent to this area are the quadrangular and triangular gaps. In the first entry to the glenohumeral joint space, a blunt-end obturator is used, and the arthroscopic cannula is placed over the obturator.

To be able to identify pathological structures in shoulder arthroscopy, it is necessary to be able to identify the natural appearance of non-pathological intra-articular structures. During

M. Bozkurt, H.İ. Açar (eds.), *Clinical Anatomy of the Shoulder*, DOI 10.1007/978-3-319-53917-1_2

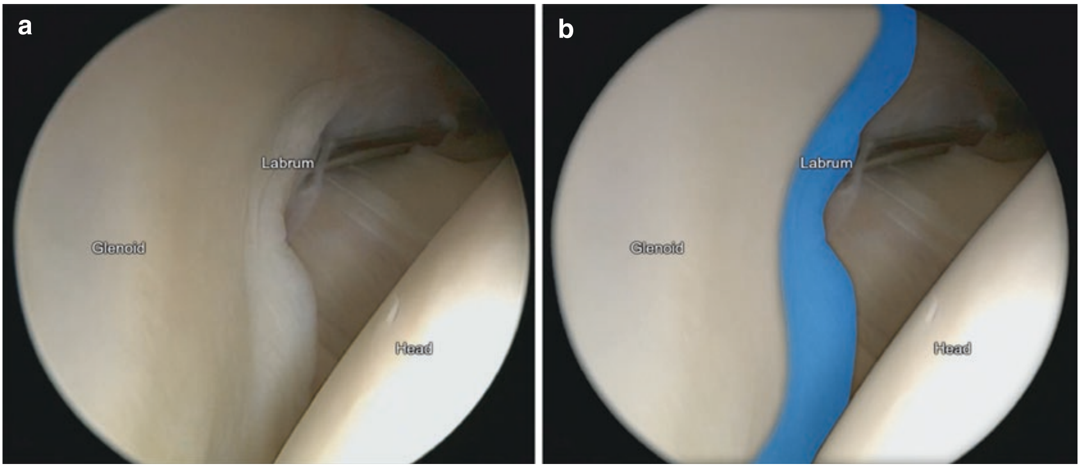

Fig. 2.1 (**a**) Arthroscopic evaluation with the posterior portal (**b**) Glenoid, labrum and humeral head

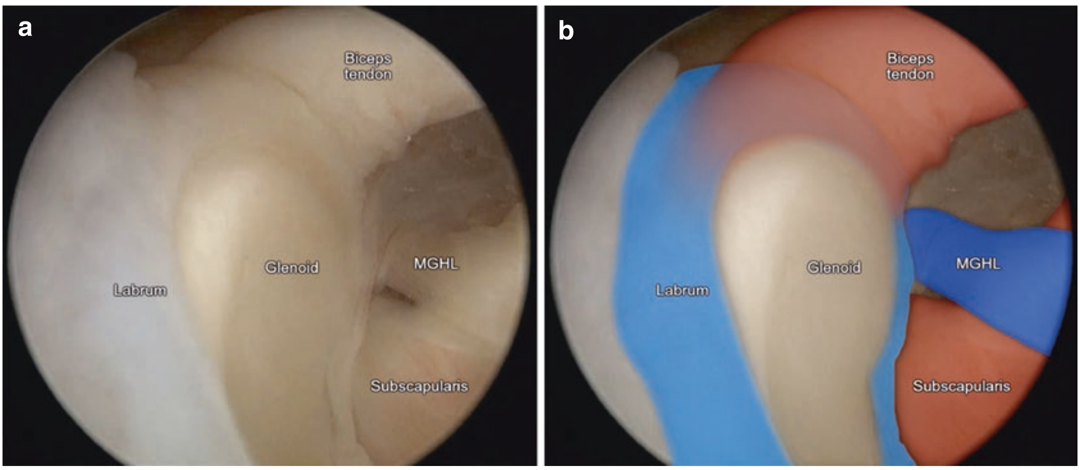

Fig. 2.2 (**a**) Anatomical structures seen from posterior portal (**b**) Labrum, glenoid, biceps tendon, MGHL and subscapularis tendon

arthroscopy, examination of the intra-articular anatomic structures in the same order will help in making a correct diagnosis. In diagnostic arthroscopy, we place the camera parallel to the floor perpendicular to the glenoid with the end of the camera superomedial to the humerus head (Fig. 2.1a, b).

By turning the camera viewing angle to the glenoid, it is attempted to understand whether or not there is chondral damage and whether or not the glenoid bone edges intact. Degeneration of the glenoid superior articular surface is evaluated in respect of cartilage loss. It is thicker than the central section. The central glenoid cartilage may sometimes be thin and can therefore be observed as cartilage defect (Fig. 2.2a, b).

The first things to be visualised within the joint are the triangle formed by the biceps tendon in the superior and the humerus head in the lateral and the subscapularis in the inferior. Of the intra-articular structures, the first to be located is the biceps tendon. On first entry to the joint, the biceps tendon must be identified for orientation purposes. The biceps tendon is visualised from the attachment known as the biceps anchor in the supraglenoid tubercle and superior labrum, along the rotator interval as far as the point where it emerges from the shoulder (Figs. 2.2a, b and 2.3a, b).

Then the first area to be identified should be the rotator interval region. Structures in this area are

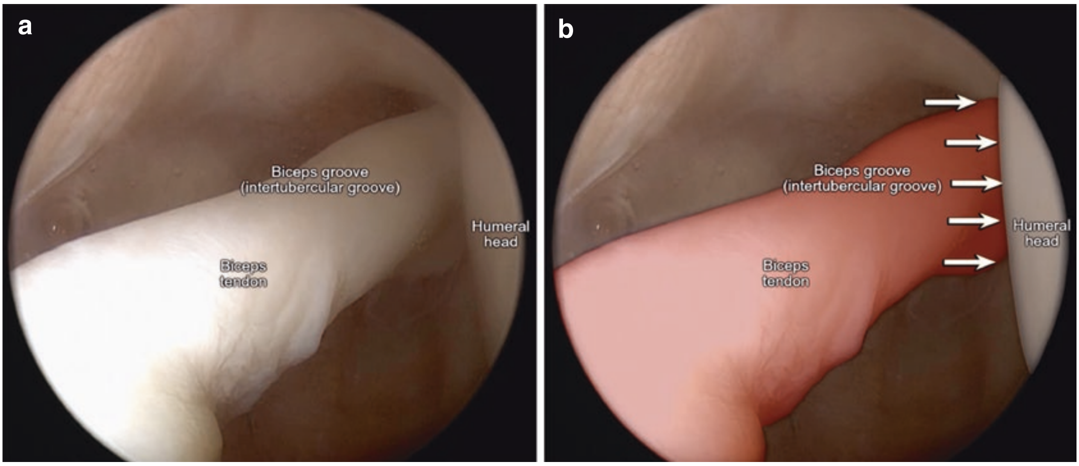

Fig. 2.3 (**a**) Visualization of biceps tendon (**b**) Biceps groove of humeral head

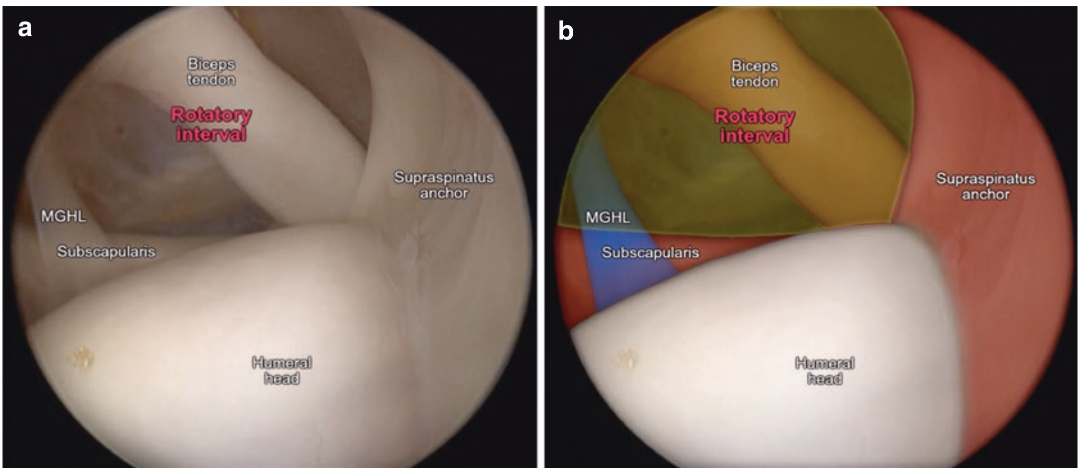

Fig. 2.4 (**a**) Identification of the rotator interval (**b**) Anatomic structures of the rotator interval

the upper intra-articular tendinous section of the subscapularis muscle, the middle glenohumeral ligament (MGHL), the superior glenohumeral ligament and the subscapular recess. After posterior portal entry, we use a guide needle in the identification of the site of the anterior portal entry in the rotator interval. The anterior portal is located approximately 1 cm lateral to the coracoid process. After opening the anterior portal, a cannula can be placed by widening the portal (Fig. 2.4a, b).

With the aid of a prop, it is necessary to examine whether or not the biceps tendon has separated from the biceps anchor and whether or not there is full continuity in the bicipital groove at the point of emergence from the joint. Stability of the biceps tendon within the groove is provided by the support formed by the supraspinatus and the subscapularis attachment sites. This structure is also held by the superior glenohumeral ligament and the coracohumeral ligaments. By acting as a pulley, this structure provides stability to the biceps tendon. Treatment should be planned by pathological evaluation of degeneration, tears or dislocations which may be encountered in this area (Figs. 2.5a, b and 2.6a, b).

For evaluation of the intra-articular labrum and capsule attachments in the next stage, a 360° examination is made around the glenoid to check attachment of the labrum to the glenoid and

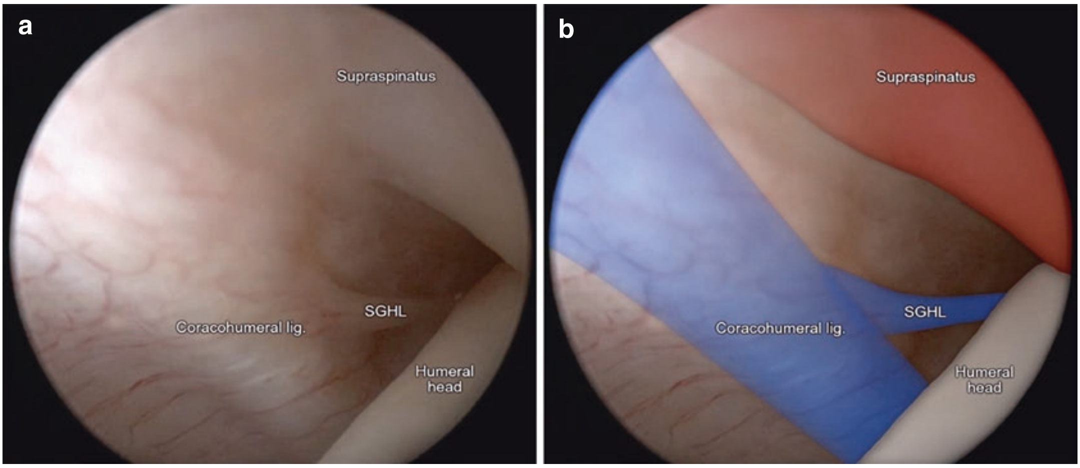

Fig. 2.5 (**a**) View of the coracohumeral ligament and superior glenohumeral ligament (**b**) Colored view of the coracohumeral ligament , superior glenohumeral ligament , supraspinatus tendon and humeral head

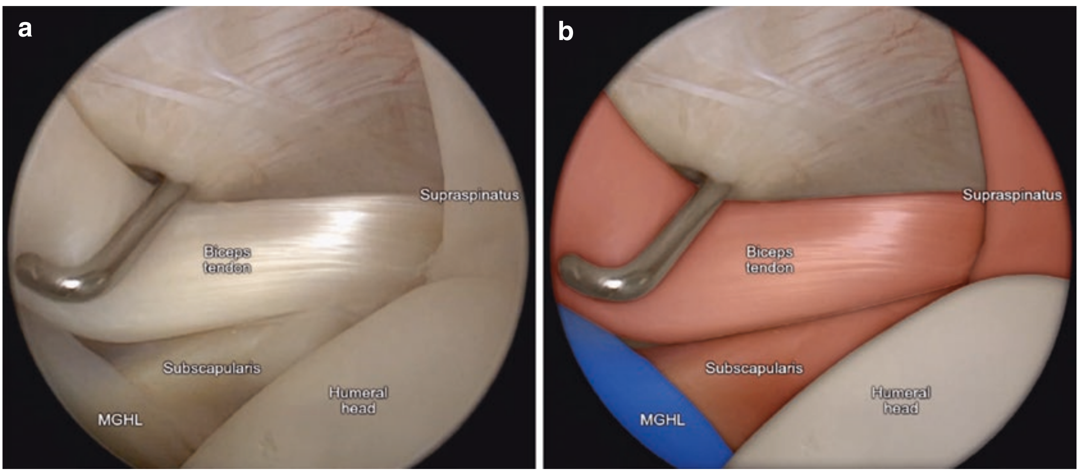

Fig. 2.6 (**a**) Arthroscopic evaluation of biceps tendon with prop (**b**) Colored view of the anatomic structures

whether or not there is capsular separation. Intra-articular loose bodies can generally be determined in the inferior recess of the capsule.

Examination continues of the ligaments and tendons starting from the anterior structures of the shoulder. Evaluation continues of the anatomic structures forming the rotator interval which is formed by the glenoid edge, the biceps tendon and the subscapularis tendon in the anterior. The attachment site of the subscapularis muscle and tendon integrity are observed. It can be seen that 30% of the subscapularis tendon is inside the joint. It forms the lower border of the rotator interval. It is particularly difficult to see the humerus attachment site, but this is extremely important in respect of the evaluation of tears. The subscapular recess is a site where loose bodies could be hidden (Fig. 2.7a, b).

The middle glenohumeral ligament crosses the subscapularis tendon at an angle of 60°. Starting from the supraglenoid tubercle from the medial and superior glenoid edge, the anatomic neck section is held to the medial of the tuberositas minor. Due to variations in the structure, identification is not always possible. Just as it may not be possible to visualise at all, it may also be seen in the form of a cord. The MGHL tightens in external rotation and loosens in internal rotation. In 45°abduction, it is resistant to anterior translation. When the MGHL is seen, the intactness of the attachment site in the anterior superior labrum is examined. (Figs. 2.8a, b and 2.9a, b).

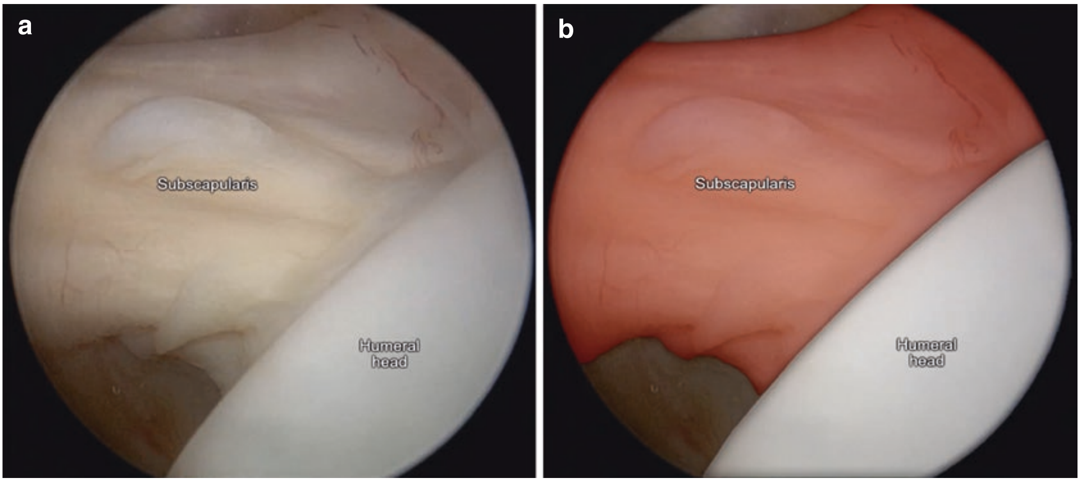

Fig. 2.7 (**a**) The subscapularis recess and attachment (**b**) Colored view of subscapularis tendon attacment

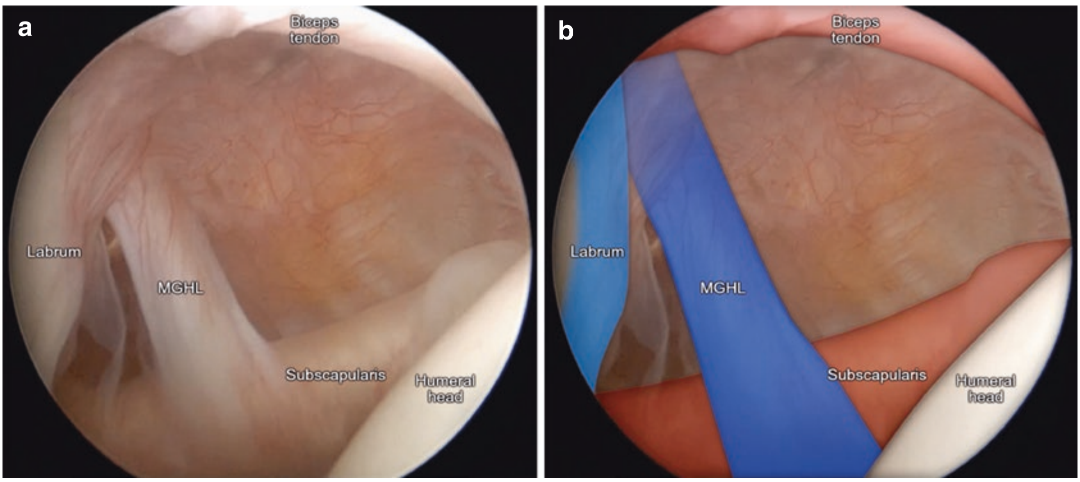

Fig. 2.8 (**a**) Anatomic relationship with subscapularis tendon and MGHL (**b**) Colored view of anatomic structures around of MGHL

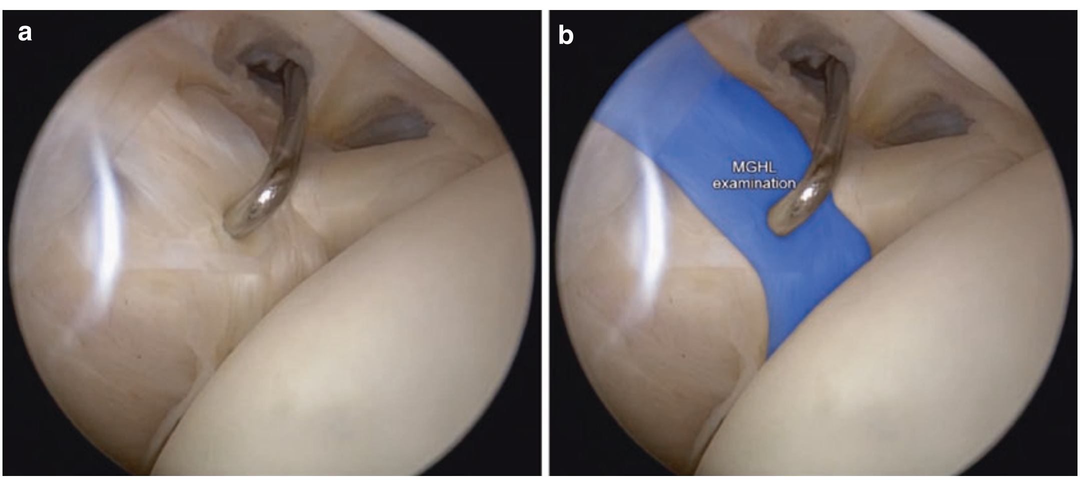

Fig. 2.9 (**a**) Examination of MGHL (**b**) Colored view of MGHL

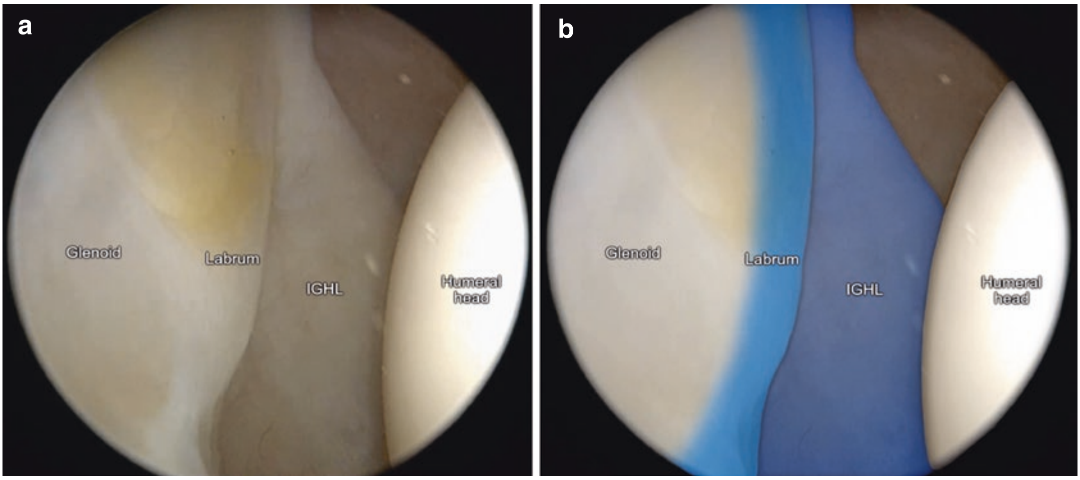

Fig. 2.10 (**a**) Arthroscopic evaluation IGHL (**b**) Colored view of IGHL

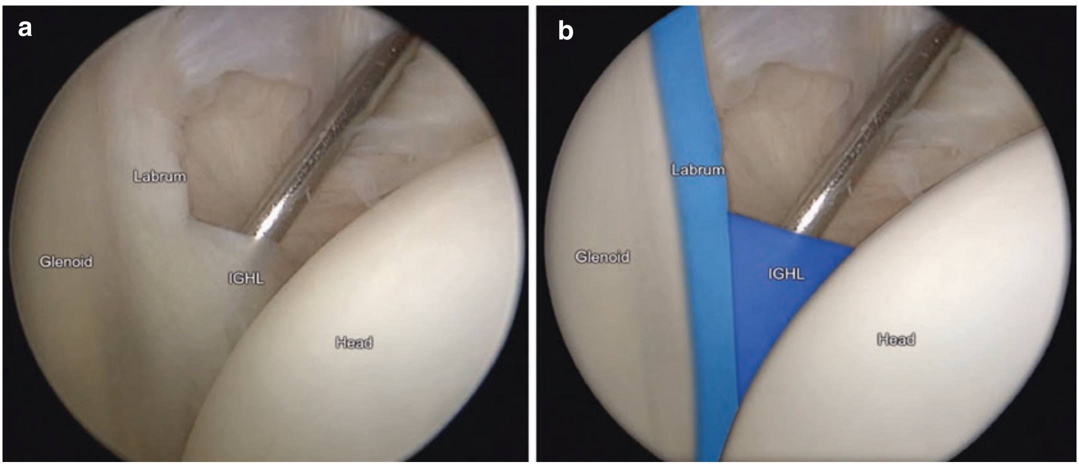

Fig. 2.11 (**a**) Examination of IGHL (**b**) Colored view of examination of IGHL

In the next stage, the inferior glenohumeral ligament and inferior labrum are examined. In 90° abduction and external rotation, the posterior band of the inferior glenohumeral ligament prevents inferior translation of the humerus head. With traction in 20°–30° abduction, the anterior band of the inferior glenohumeral ligament is more easily observed. In 90° abduction and external rotation, it prevents anterior translation of the humerus head and resists inferior translation. It extends from the glenoid towards the anatomic neck. When damage occurs in these structures, humeral avulsion glenohumeral ligament (HAGL) lesions should be kept in mind (Figs. 2.10a, b and 2.11a, b).

To evaluate the rotator cuff, the end of the arthroscope is turned along the attachment sites over the

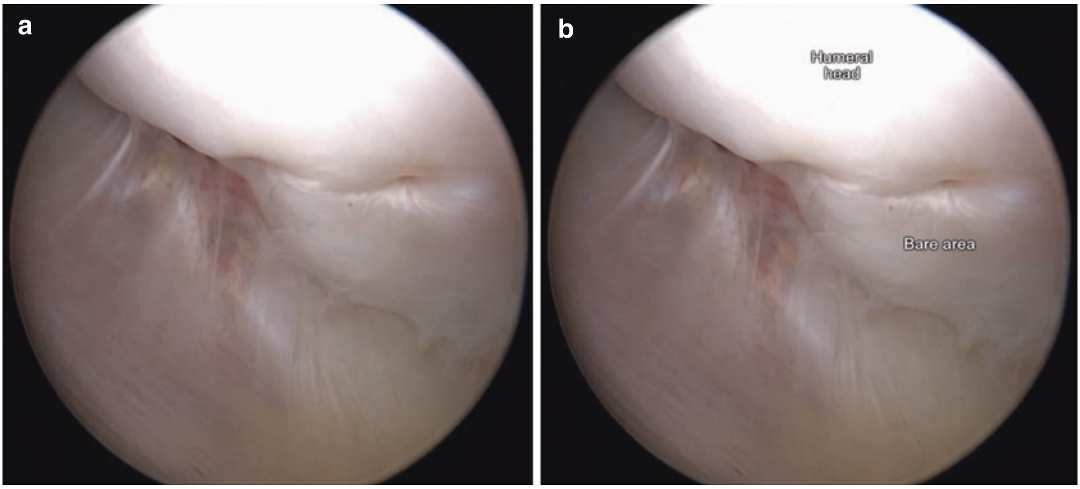

Fig. 2.12 (**a**) Bare area of humeral head (**b**) Infraspinatus footprint on bare area

humerus head (rotator cable) including anterior and posterior of the biceps from the anterior and the continuity of the rotator cuff is evaluated. When there is total separation in this area, the subacromial area which can be observed may cause an incorrect diagnosis. In the posterior humerus, the bare area formed of vessel entries remaining from the foetal period can be observed. Old vascular channels are located here. The bare area is compatible with the infraspinatus tendon attachment site and is an important anatomic point for the identification of the infraspinatus footprint (Fig. 2.12a, b).

3 Shoulder Radiology

Berna Dirim

Imaging is an important tool for the differential diagnosis of many shoulder pathologies. A variety of imaging studies are available that are appropriate in different shoulder lesions. Plain film radiography is the first imaging modality in the evaluation of traumatic shoulder pain. Plain radiographs can identify the glenohumeral dislocation, the acromioclavicular joint injury, and the fractures of the humerus, scapula, and clavicle [1]. Computed tomography (CT) is useful for characterizing fractures, if more information is needed before the operation. It can demonstrate complexity and displacement of the fracture, especially with the use of reconstructed images [2]. The possibility of the rotator cuff lesion may be investigated by ultrasonography (US) or magnetic resonance imaging (MRI). MRI is currently the preferred imaging modality for the evaluation of the occult fractures and also traumatic pathologies of the shoulder soft tissues, including the tendons, ligaments, muscles, and labrocapsular structures [1, 3, 4].

Plain radiographs of the shoulder have limited benefit in the evaluation of nontraumatic shoulder pain. This modality, which is effective in assessing glenohumeral arthritis and acromioclavicular joint pathology, allows verification of calcification in calcific tendonitis cases. If the complaint keeps existing despite the normal radiograph, MRI or US examinations may be applied. MRI and magnetic resonance arthrography (MRA) are the modalities to be chosen in evaluation of patients with instability and questionable labral pathology [5]. US may be utilized in rotator cuff diseases and bursitis assessments [6, 7].

This chapter presents the anatomical structures found on different imaging modalities. When looking at any imaging of the shoulder, it is important to understand the anatomy. Firstly, we are going to review the radiographic anatomy of the shoulder on radiographs. Then the cross-sectional anatomy of the shoulder joint is being demonstrated on CT and MRI images.

3.1 Plain Film Radiography of the Shoulder

Direct radiography should be performed as the initial imaging method in patients presenting with a clinical problem related to the shoulder. Anteroposterior view in neutral position (Fig. 3.1), anteroposterior oblique view (Fig. 3.2), axillary view (Fig. 3.3), and lateral scapula view (Fig. 3.4) are routine radiographic projections. Special positions such as anteroposterior view in internal rotation (Fig. 3.5), anteroposterior view in external rotation (Fig. 3.6), Garth view (Fig. 3.7), Stryker notch view, and

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M. Bozkurt, H.İ. Açar (eds.), *Clinical Anatomy of the Shoulder*, DOI 10.1007/978-3-319-53917-1_3

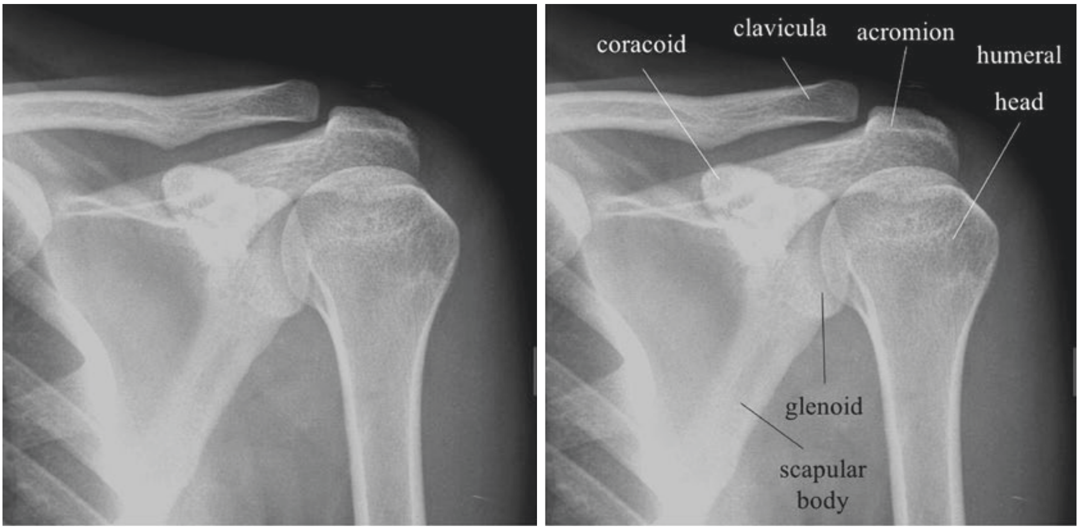


Fig. 3.1 Anteroposterior shoulder radiograph. While achieving anteroposterior shoulder X-ray in neutral position, the patient is erect or in supine position. Central X-ray should be directed to 2.5 cm inferior to the coracoid process. Anteroposterior shoulder view allows assessment of especially the humeral head lesions and clavicular fractures. Because the posterior glenoid rim and humeral head overlap, glenohumeral joint space cannot be assessed in optimum way

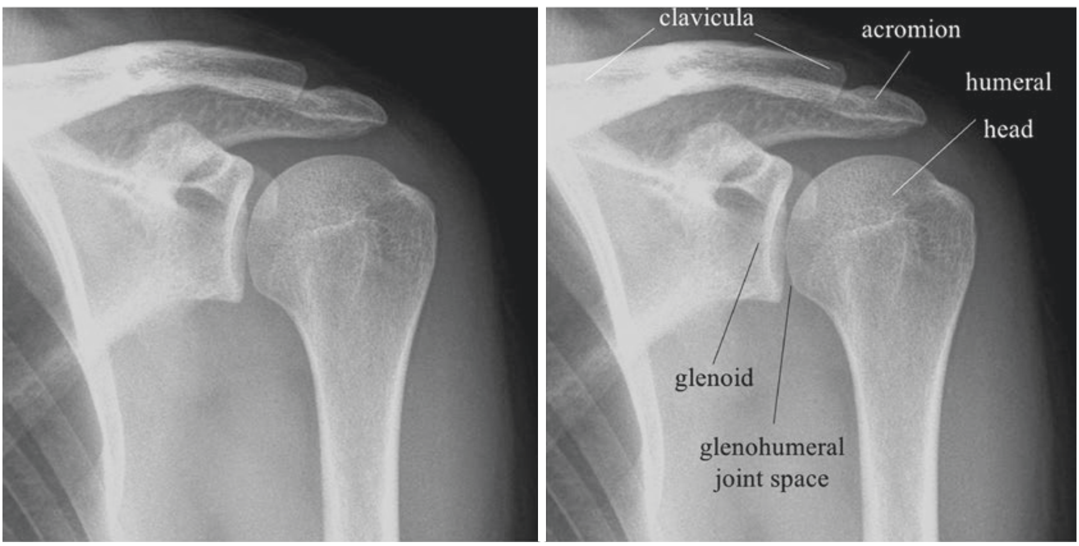


Fig. 3.2 Grashey view (anteroposterior oblique shoulder radiograph). Grashey position is also named true anteroposterior shoulder radiograph. Central ray is centralized into glenohumeral joint space with 35° angle. This position allows optimum imaging of the glenohumeral joint space

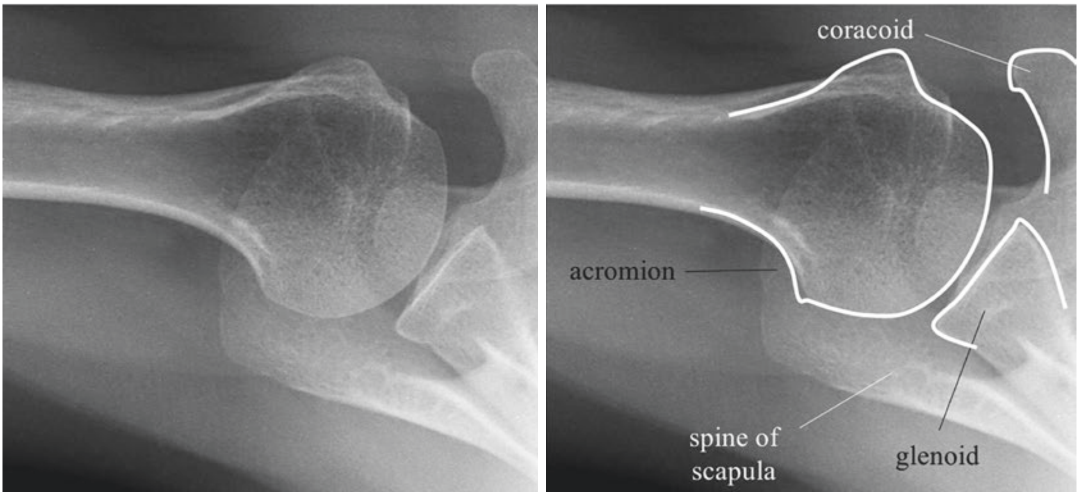


Fig. 3.3 Axilla-superoinferior shoulder radiograph. In order to obtain axilla-superoinferior radiograph, the patient abducts the arm to a nearly right angle to the long axis of the body while sitting. The elbow of patient is flexed 90° and placed their hand in the prone position. Central ray is angled 5–15° toward the elbow. Axillary superoinferior position allows optimum imaging of joint space between the humeral head and the glenoid. It is helpful for detecting the anterior and posterior glenohumeral dislocations. The coracoid process is seen projecting above the clavicle

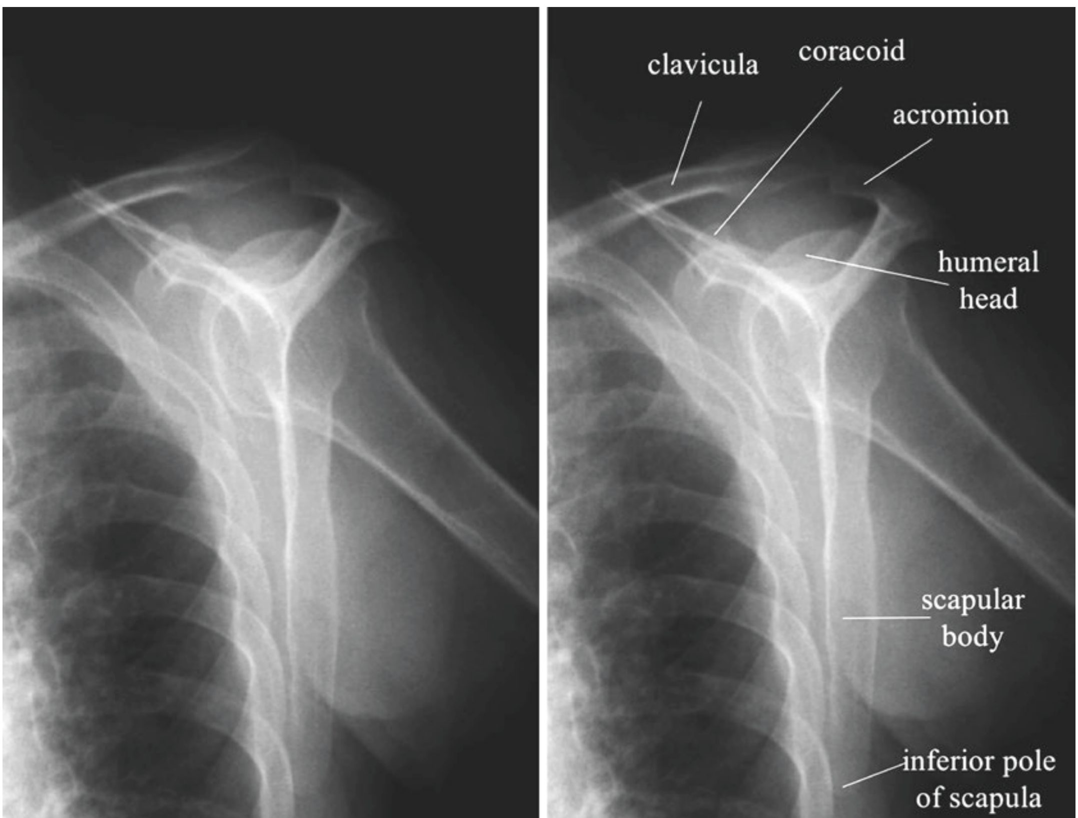


Fig. 3.4 Lateral scapular Y radiograph. While achieving lateral scapular Y position, the patient's body is taken to anterior oblique position. Central ray is aimed from posteriorly along the scapular spine. This view demonstrates the lateral projection of the scapular body and humeral head overlapping the glenoid. The body of the scapula constitutes the body of "Y," while the acromion and the coracoid constitute the arms. Lateral scapular Y radiograph is helpful for detecting the anterior and posterior glenohumeral dislocations and the fractures of the scapula

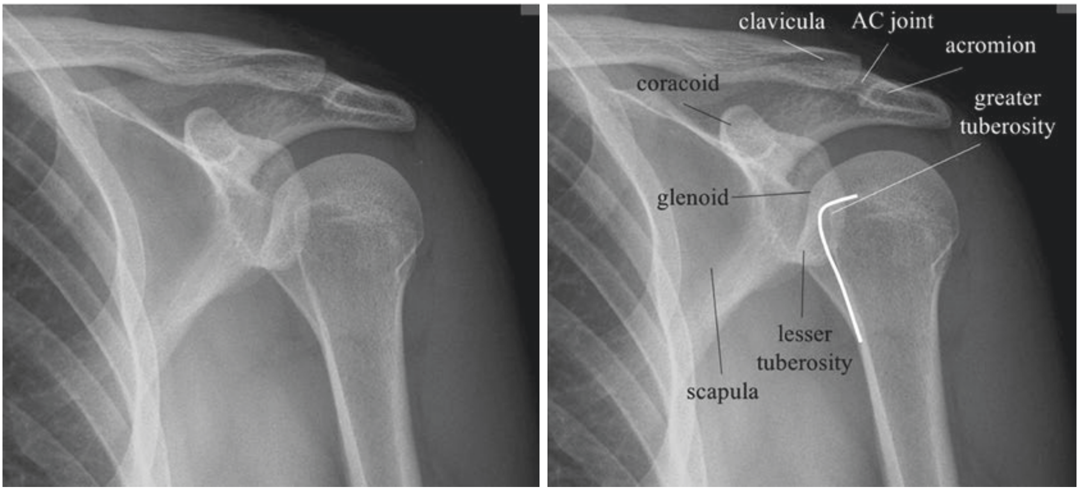


Fig. 3.5 Anteroposterior shoulder radiograph in internal rotation. Patient is either erect or in supine position. In order to position the shoulder in internal rotation, the posterior aspect of the hand is placed against the hip. Anteroposterior shoulder radiograph in internal position shows a lateral position of the humerus. The lesser tuberosity is seen medially in profile. This position is one of the positions utilized in order to evaluate the Hill-Sachs deformity (AC., acromioclavicular)

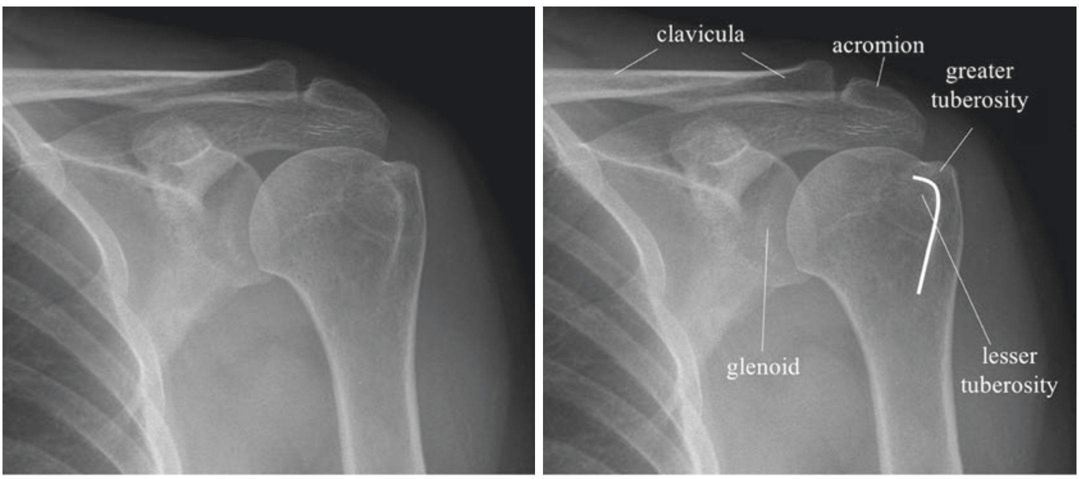


Fig. 3.6 Anteroposterior shoulder radiograph in external rotation. Supinating the hand will position the humerus in the external rotation. With the external rotation position, the greater tuberosity is positioned in profile laterally. This view is helpful for detecting the compression fracture of the humeral head, glenohumeral arthritis, and the fractures of the proximal humerus and the glenoid

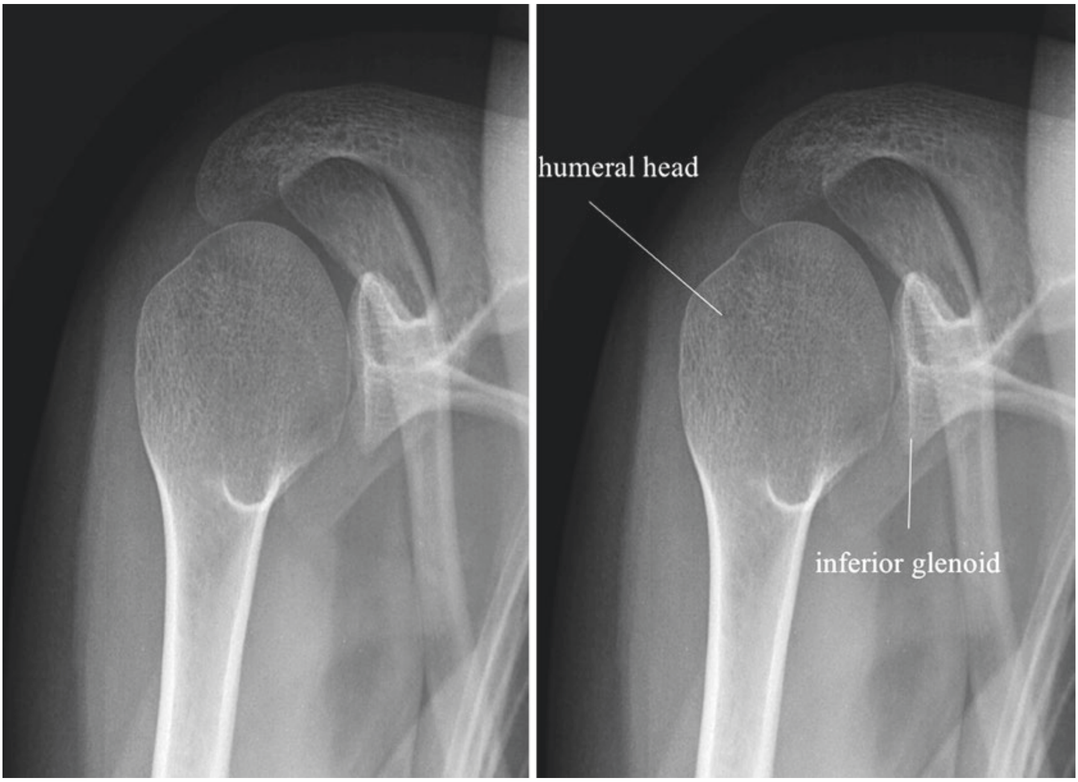


Fig. 3.7 Apical oblique shoulder radiograph. Apical oblique shoulder radiograph, is also named as Garth view shoulder radiograph. Patient is seated. Patient's arm is adducted and internally rotated. Chest is rotated 45°. Central ray is directed through the anterior-inferior glenoid rim and posterosuperior humeral head toward the cassette at angle of 45° to the plane of the thorax and directed 45° caudally. This position is helpful for detecting the glenoid fracture, shoulder instability, bony Bankart, and Hill-Sachs lesions

West point view allow more detailed assessment of some regions [7]. Shoulder trauma series should include at least AP oblique shoulder and axillary and lateral scapula views [1]. Complete trauma series includes AP shoulder, AP oblique shoulder, AP shoulder in internal rotation, AP shoulder in external rotation, and axillary and scapula lateral radiographs. In the evaluation of nontraumatic shoulder pain, X-ray series includes AP oblique shoulder, AP shoulder in external rotation, lateral scapula, and axillary views.

3.2 Computed Tomography of the Shoulder

CT is most helpful in the evaluation of shoulder trauma but gives limited information on the soft tissues. It is superior to plain radiographs in evaluation of complex fractures and fracture dislocations involving the proximal humerus. CT allows planning of treatment of complex proximal humeral fractures [1]. CT provides better detail of cortical and trabecular bone structures than MRI. Therefore it is optimal for visualization of bony defects [8]. The ability to visualize images in the axial, sagittal, and coronal planes and in three-dimensional (3D) format can help in preoperative planning of complex proximal humeral fractures. 3D reconstructions are also useful to visualize glenoid version for total shoulder arthroplasty.

The patient is most commonly in the supine position during CT scanning, with the arm in neutral rotation. The important anatomical structures of the normal shoulder joint are shown in axial, coronal, and sagittal CT images below (Figs. 3.8a–s, 3.9a–j, and 3.10a–l). The open arrow is showing the physiological concavity at the posterolateral margin of the humeral head on Fig. 3.8l. The bicipital groove is being seen between the lesser tuberosity and greater tuberosity (arrow).

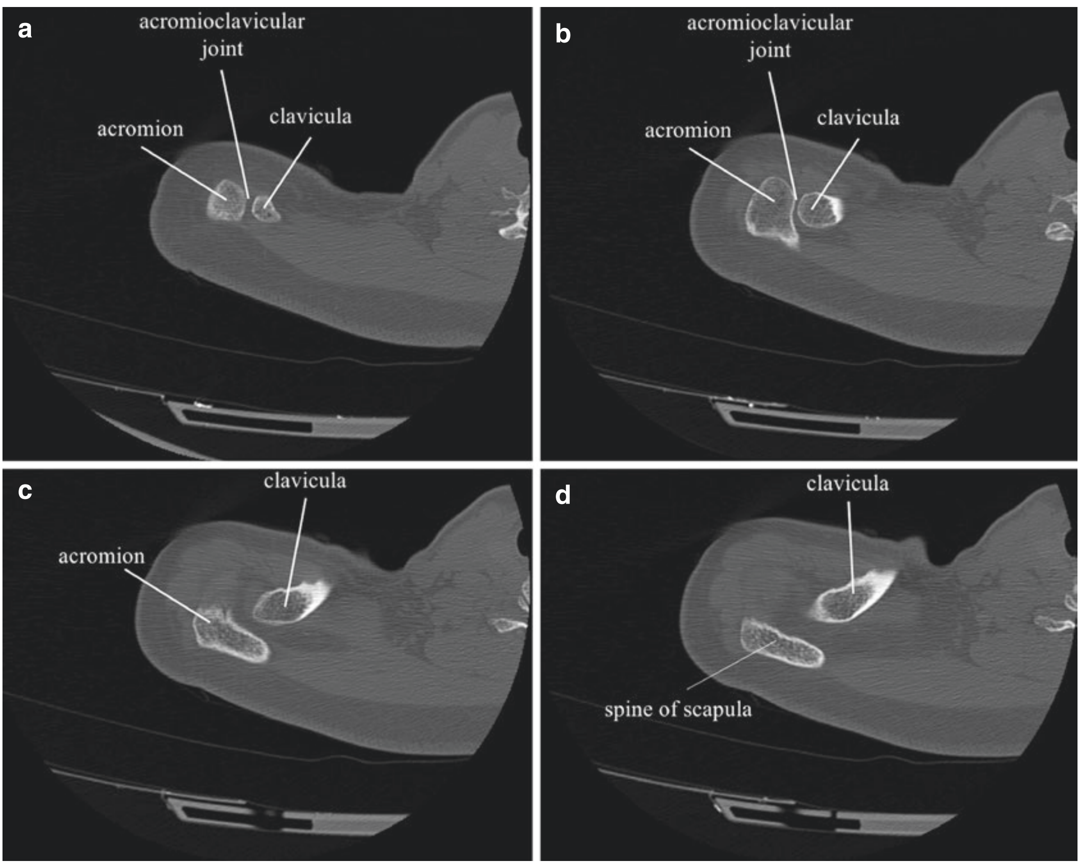
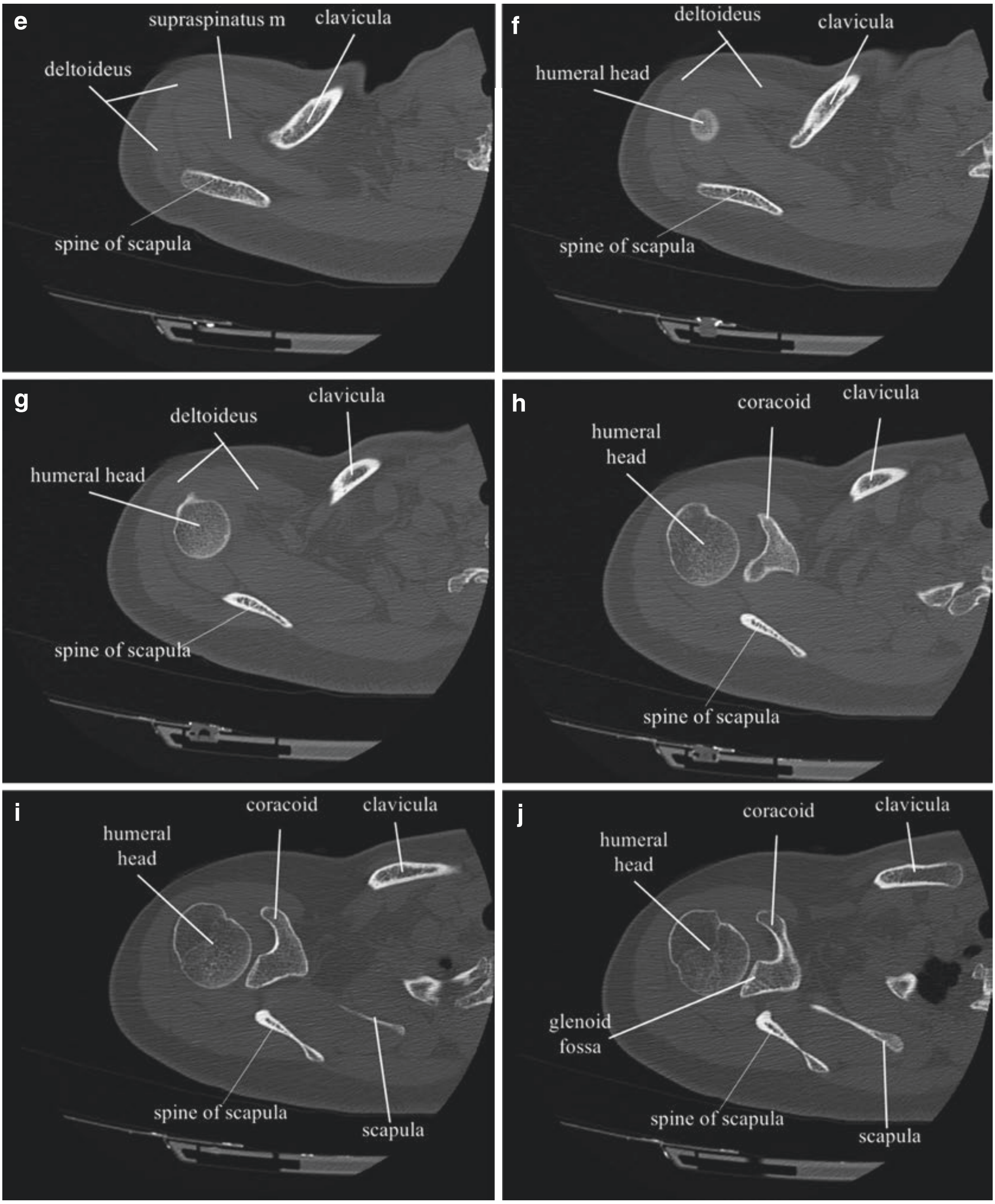


Fig. 3.8 (**a**–**s**) Axial CT images; bone window (*m* muscle; *t* tendon)



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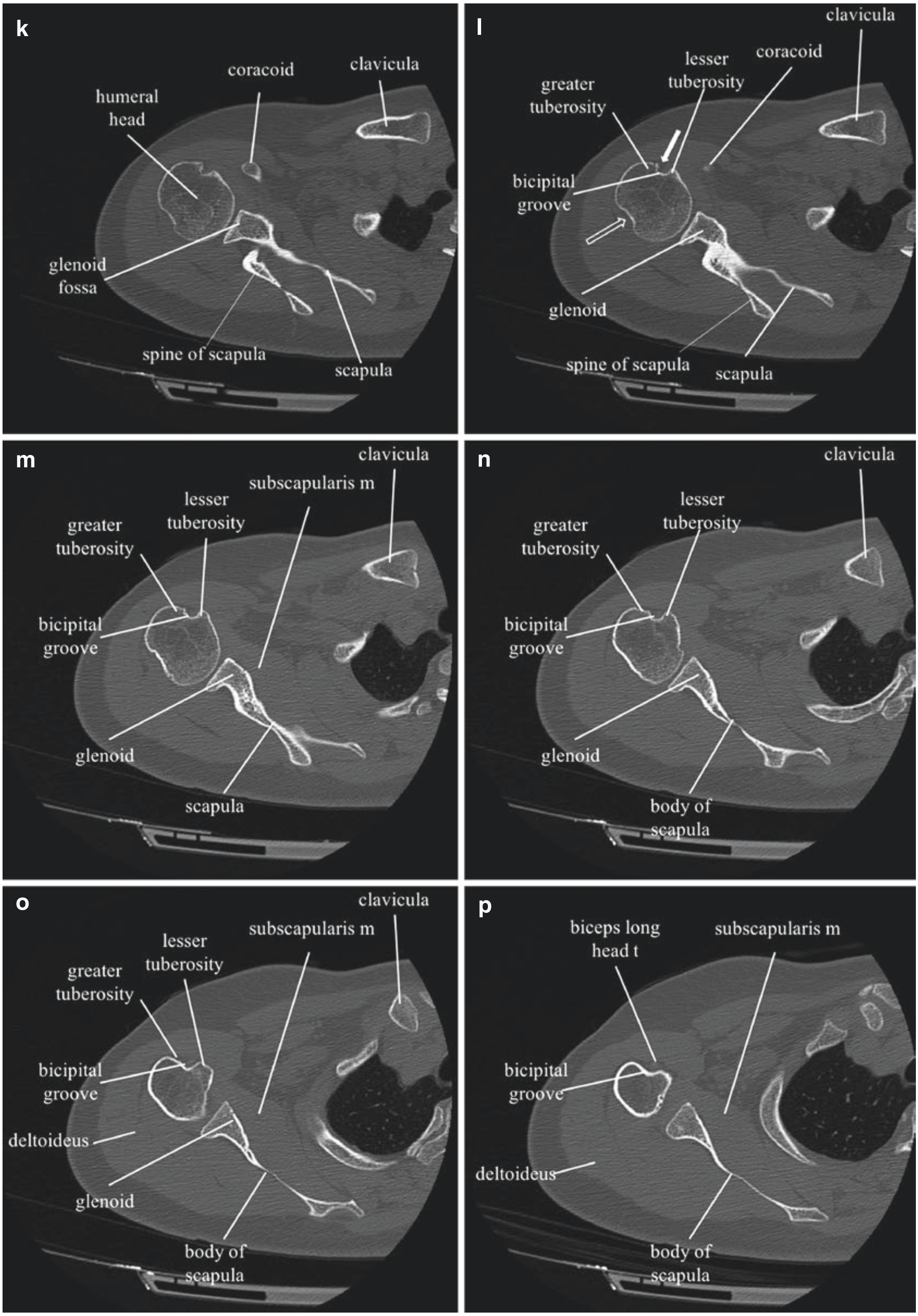

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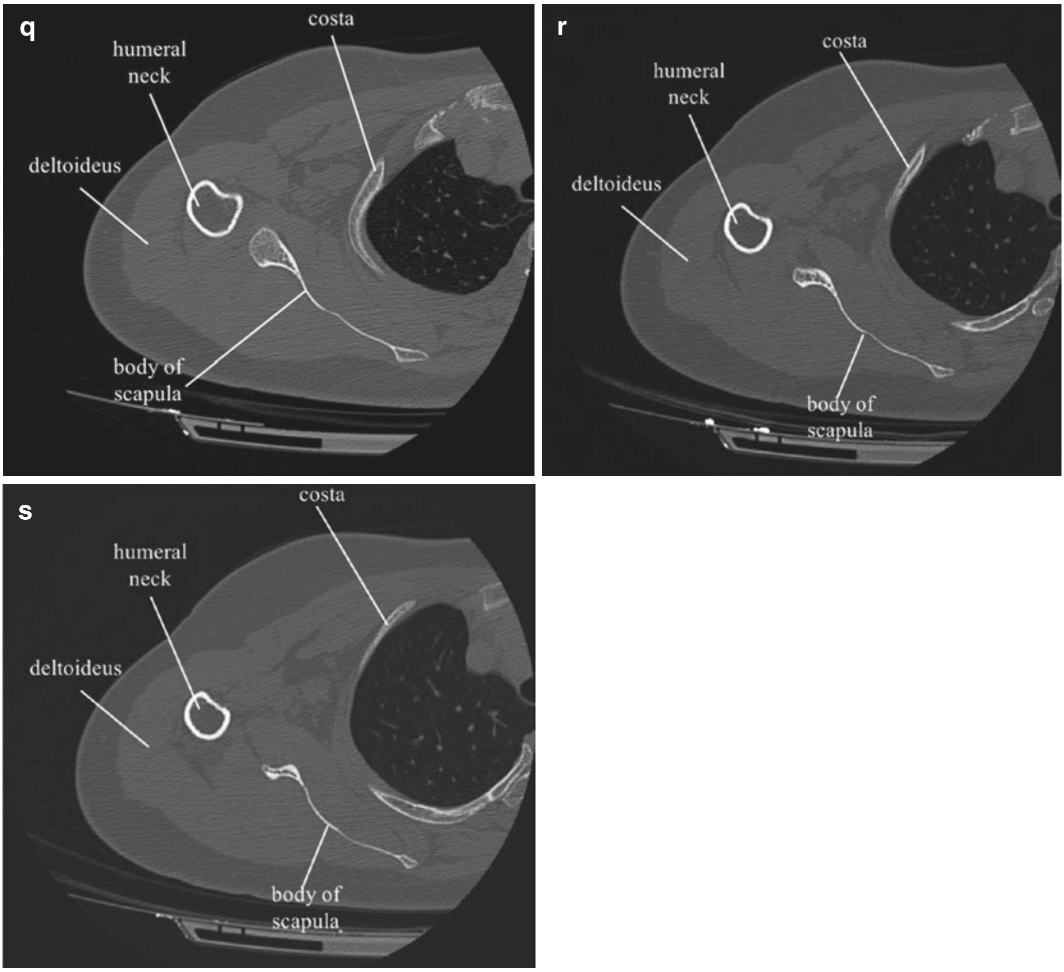

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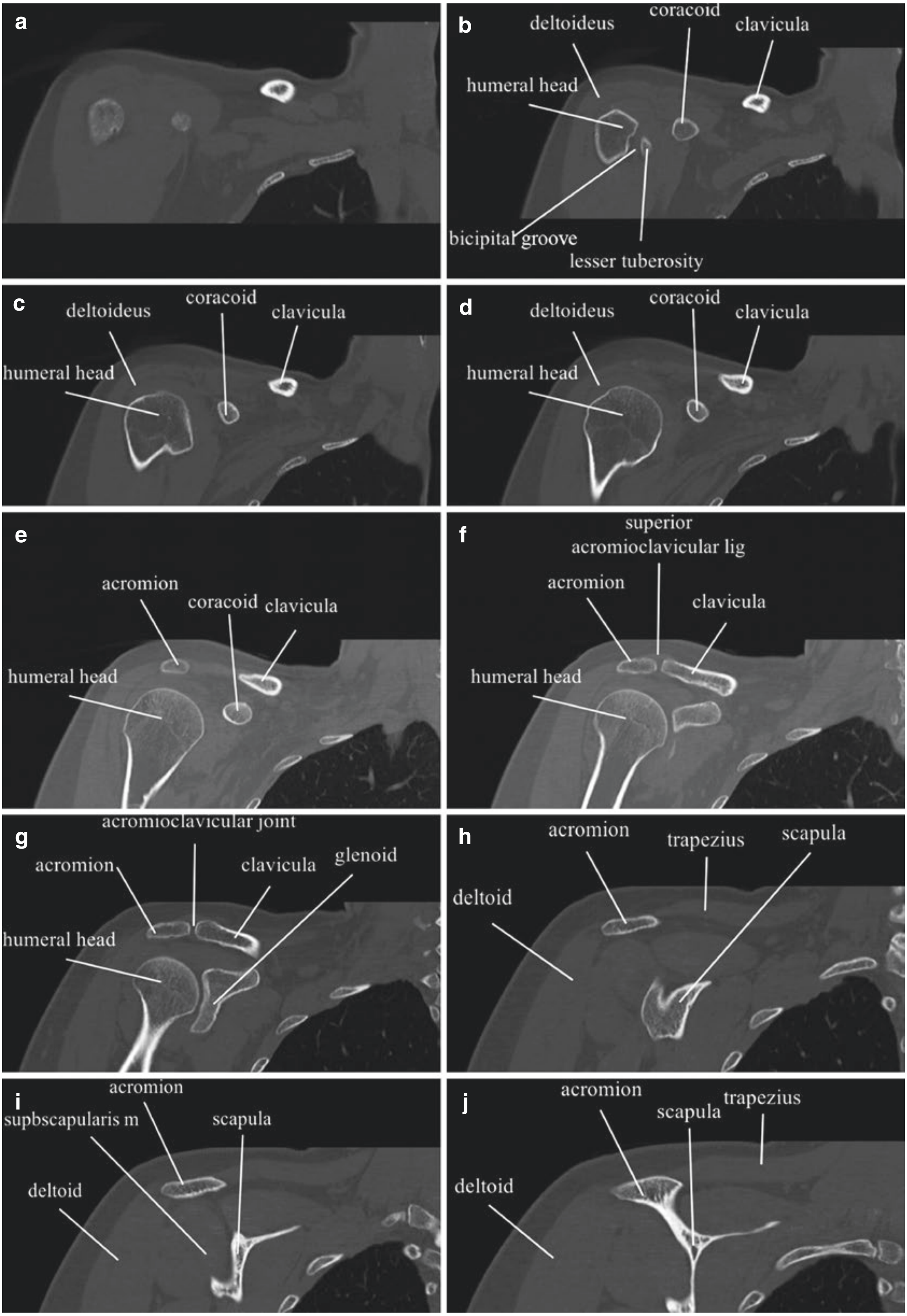


Fig. 3.9 (**a**–**j**) Coronal CT images; bone window (*m* muscle; *lig* ligament)

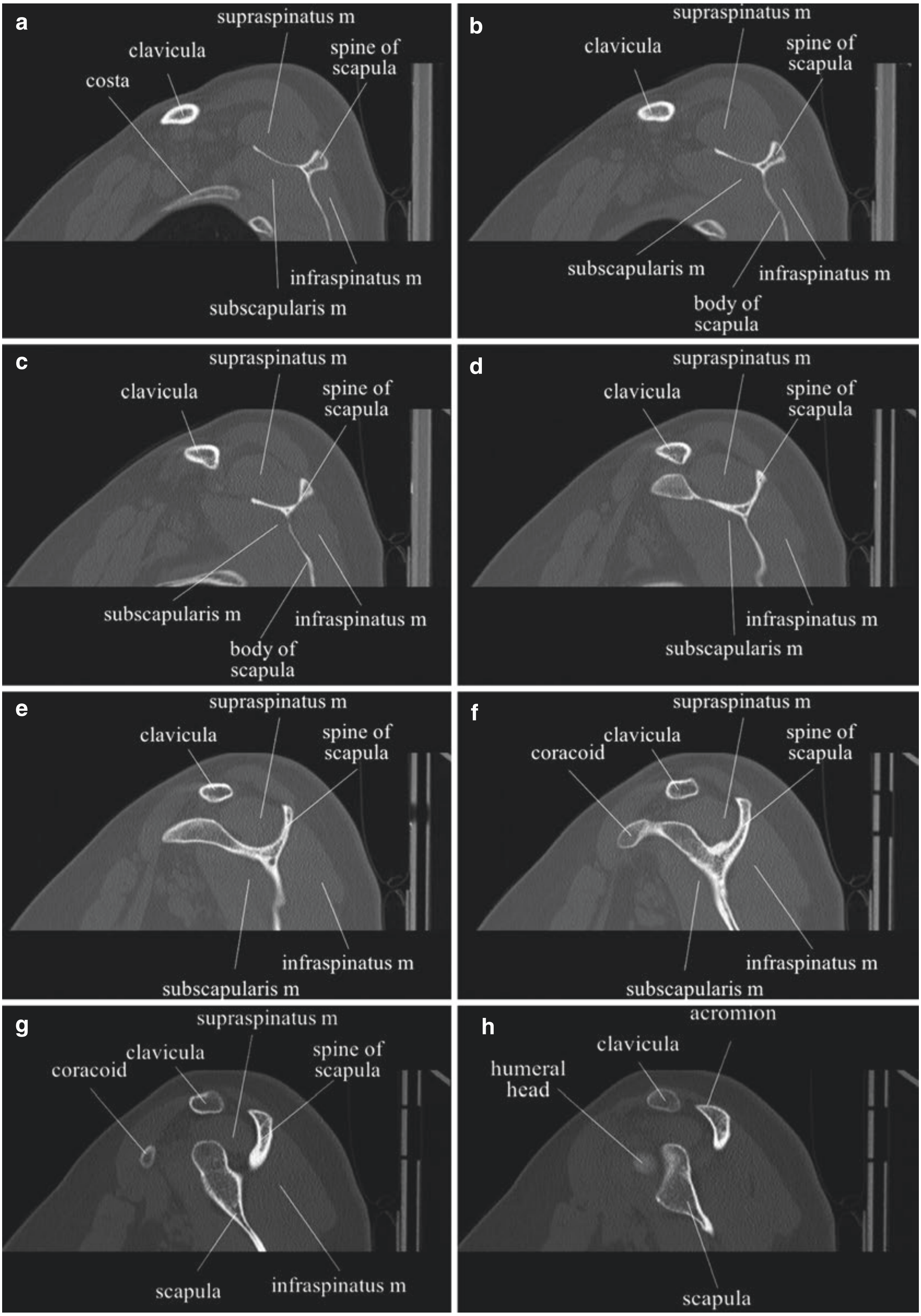
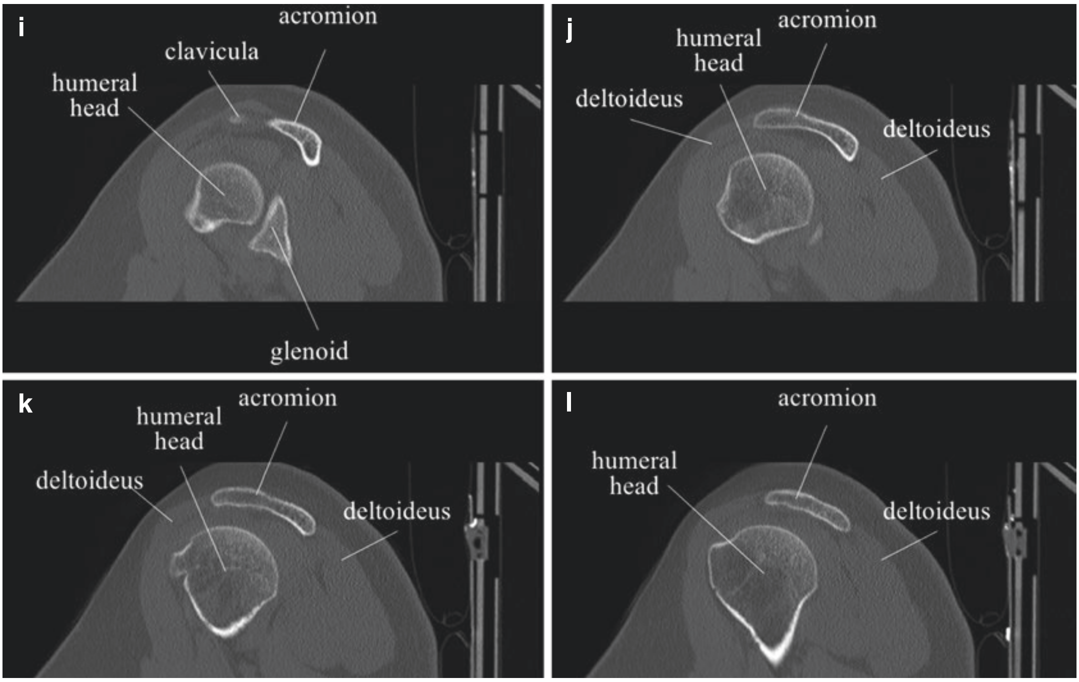


Fig. 3.10 (**a**–**l**) Sagittal CT images; bone window (*m* muscle)



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3.3 Magnetic Resonance Imaging of the Shoulder

MRI of the shoulder is a highly accurate imaging study for evaluation of rotator cuff pathologies [4]. MRI also demonstrates the pathologies of the labrum and the ligaments [1, 3]. It is useful in detection of occult fractures, bone marrow abnormalities, synovial disorders, cartilaginous defects, and characterization of bone and soft tissue tumors.

Routine MRI examination of the shoulder joint includes axial, coronal oblique, and sagittal oblique sections. Scout images are obtained in three planes to serve as localizer for subsequent pulse sequences. The axial slices are planned on the coronal localizer. The axial slices must be sufficient to cover all shoulder joint from top of acromioclavicular joint to below the inferior glenohumeral ligament. Coronal oblique slices are planned on the axial localizer. They are obtained parallel to the supraspinatus tendon. Slices must be sufficient to cover the whole shoulder joint from anterior portion of coracoid process to two slices posterior to the humeral head. Oblique sagittal plane oriented parallel to the glenoid delineates the cross section of the rotator cuff muscles and tendons, and also the acromion shape. The sagittal oblique images are obtained perpendicular to the supraspinatus tendon. Sagittal oblique images must be sufficient to cover the whole shoulder joint from the deltoid muscle to two slices medial to the glenoid.

The important anatomical structures of the normal shoulder joint are shown in MR images below (Figs. 3.11a–u, 3.12a–o, and 3.13a–t). T1-weighed images are at the right side of the image, and fat-saturated proton density images are at the left side of the image. The important anatomic structures are marked on T1-weighted images.

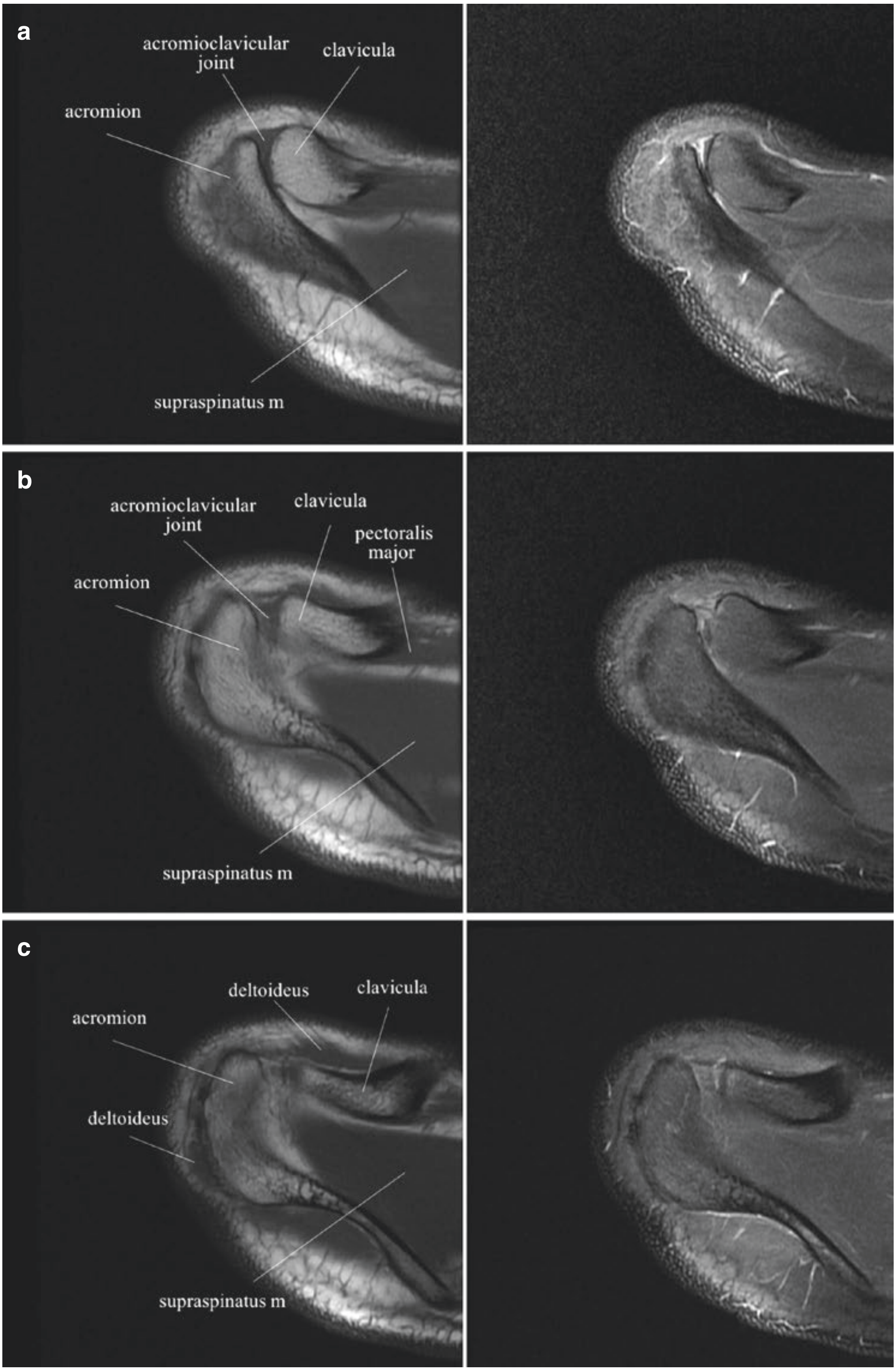
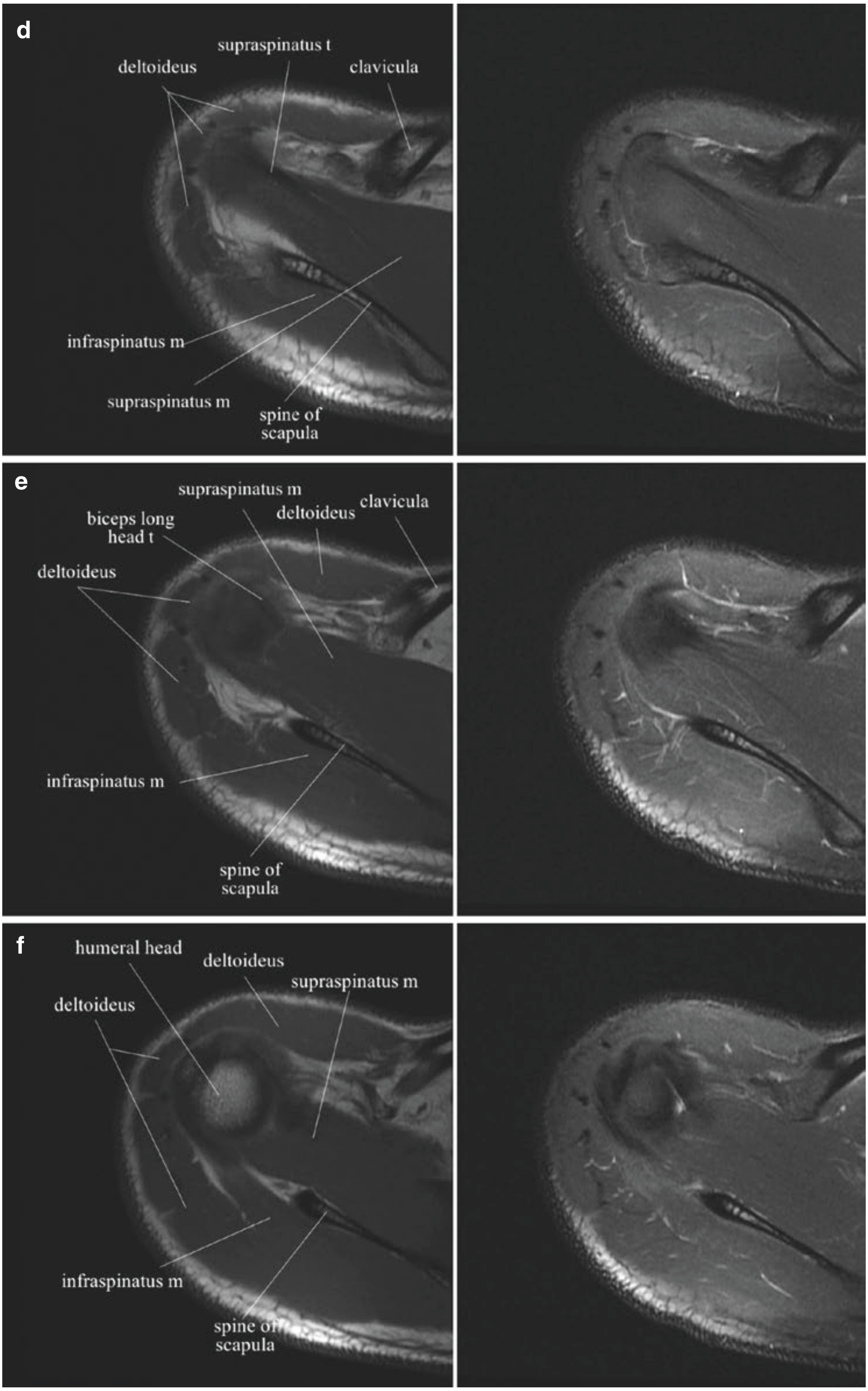


Fig. 3.11 (**a**–**u**) Axial MR images (*m* muscle; *t* tendon; *a* artery; *v* vein; *n* nerve; *pos hum circumflex a* posterior humeral circumflex artery)



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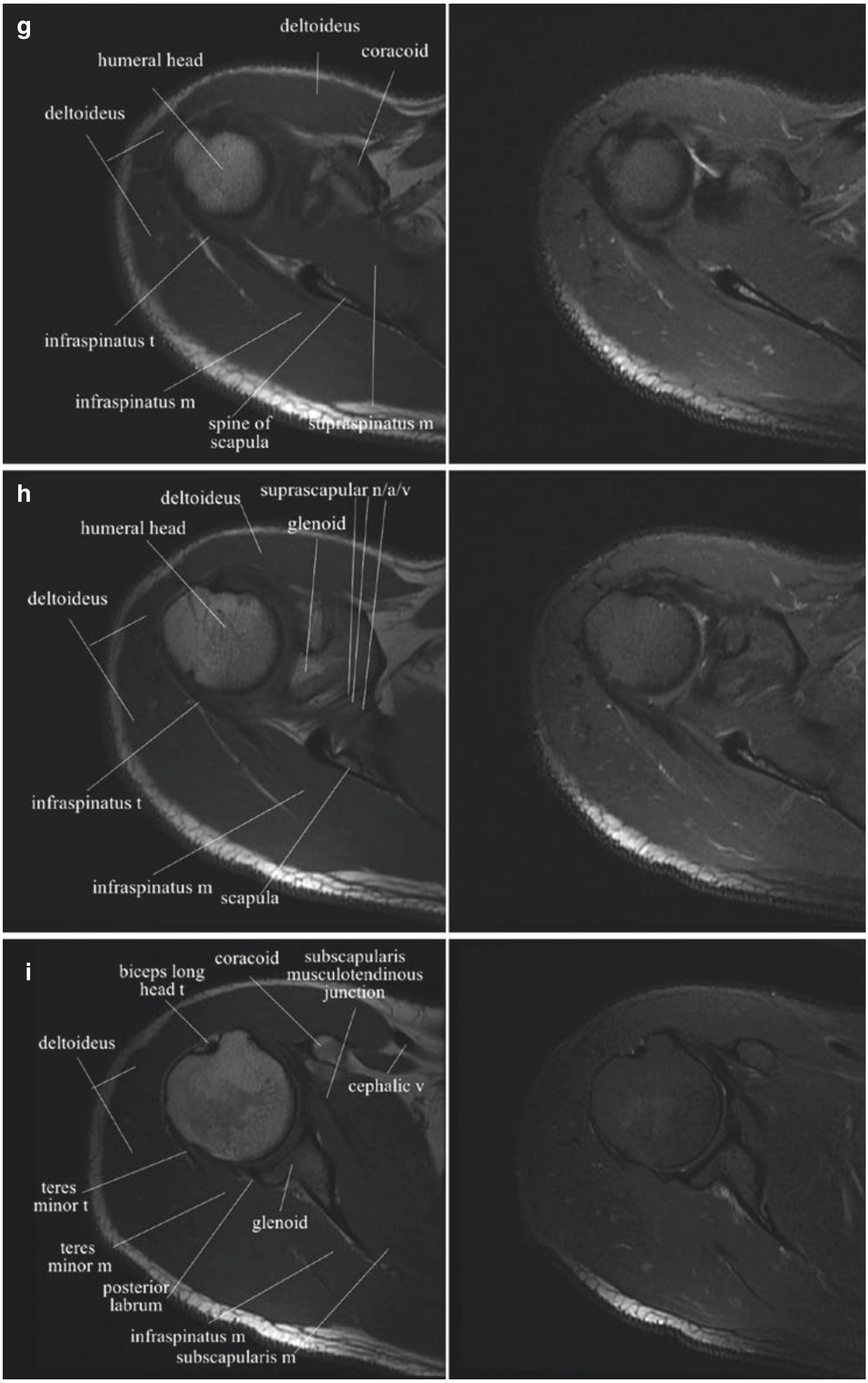

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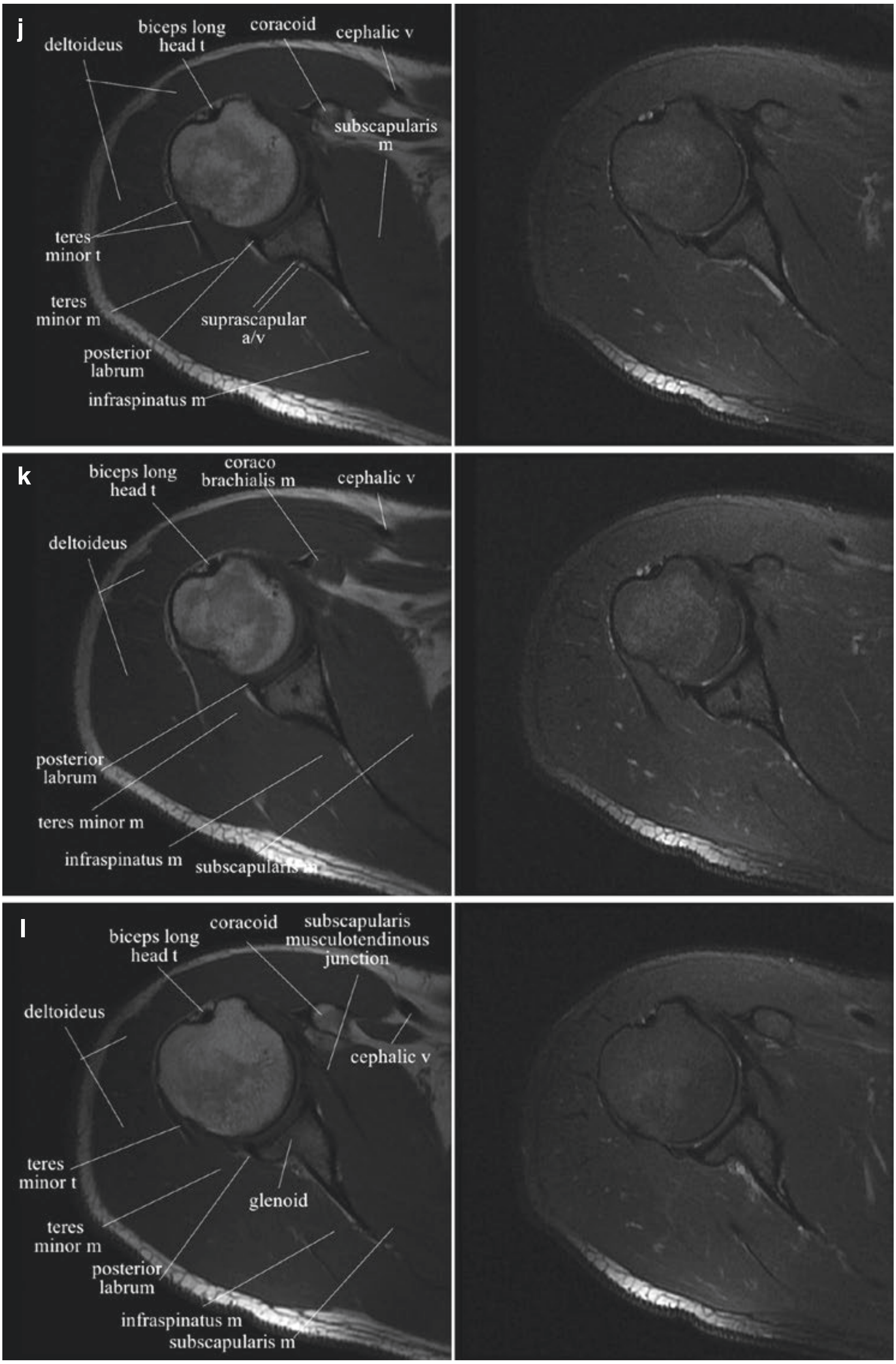

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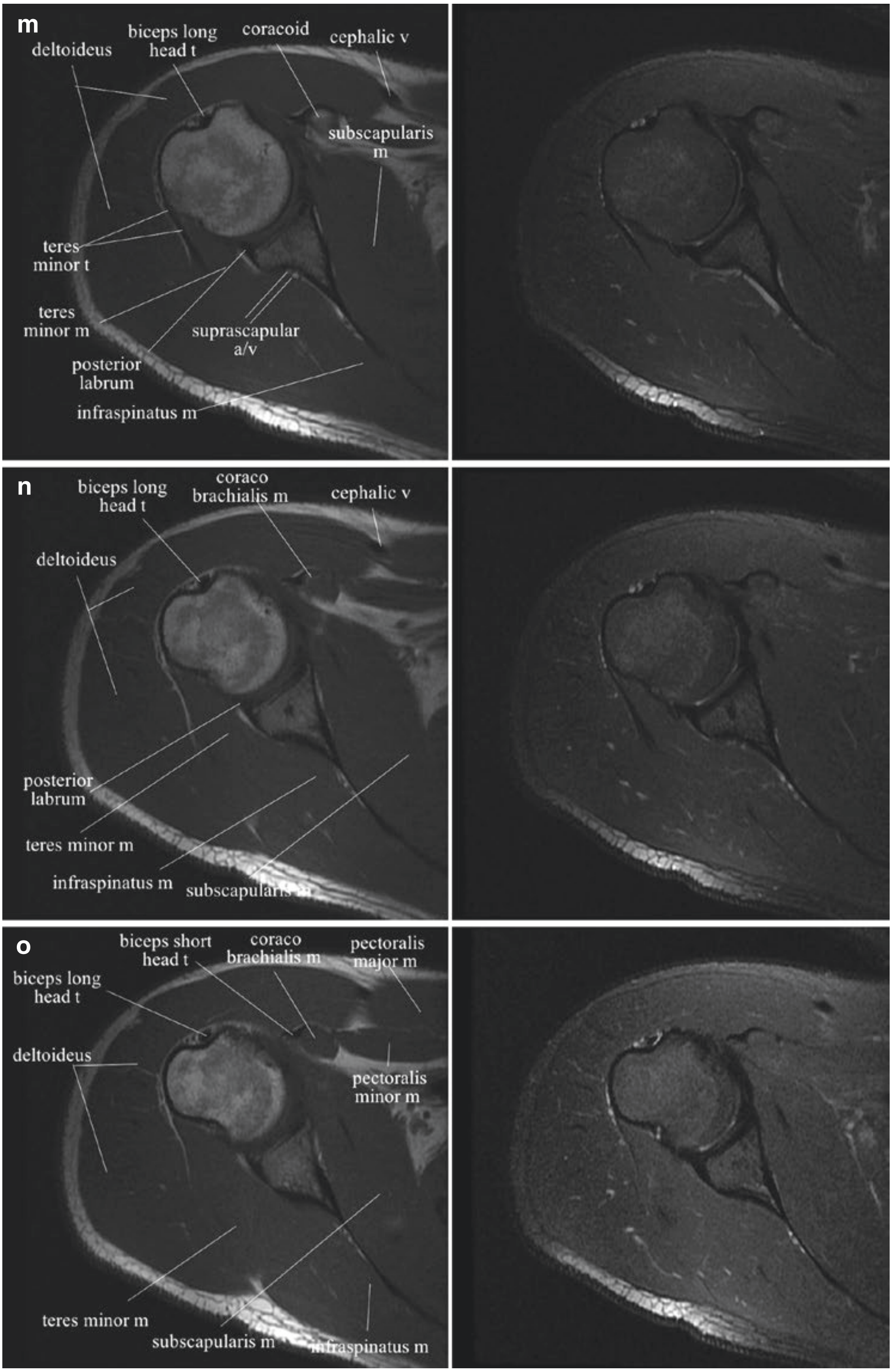

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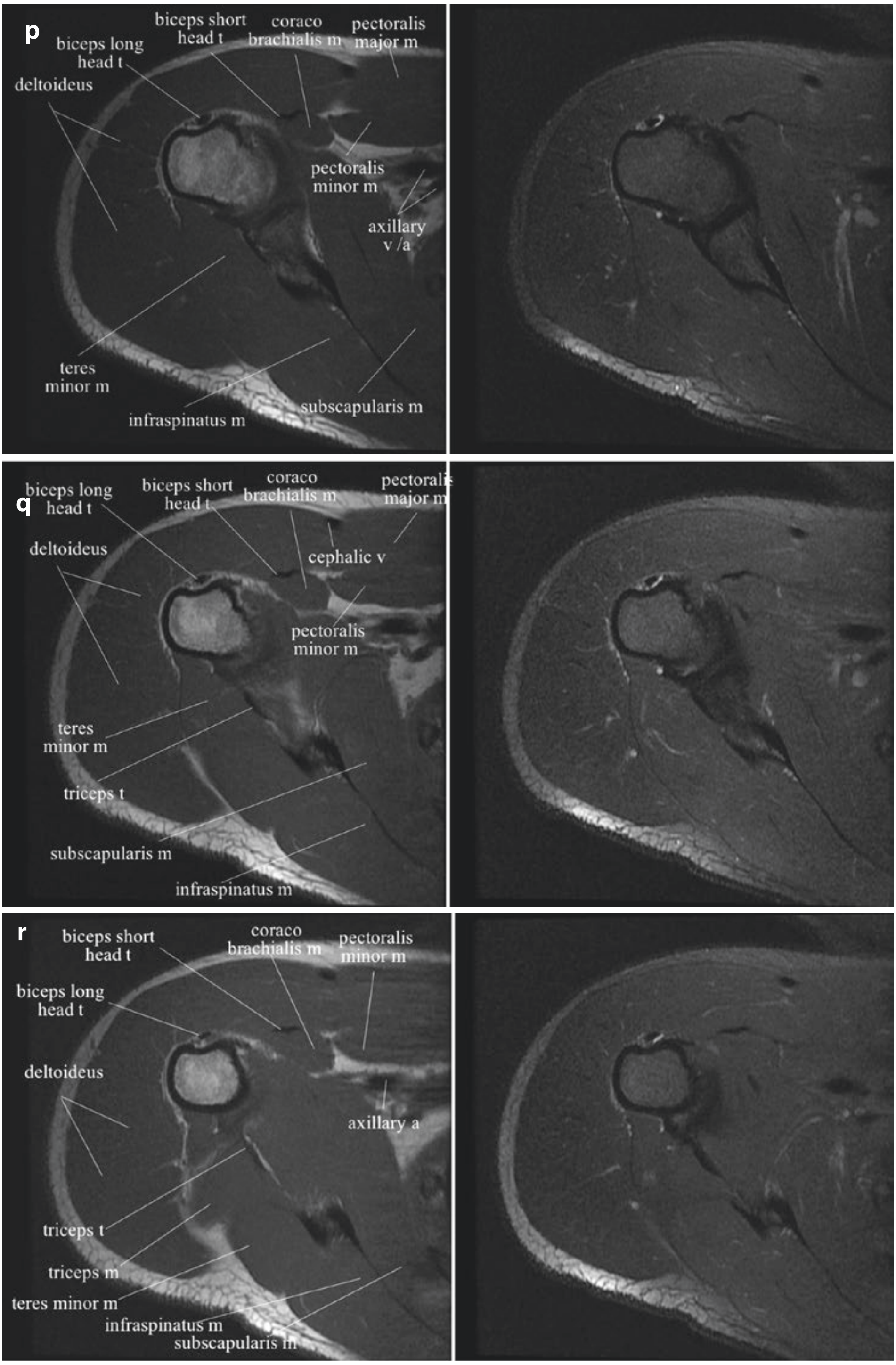

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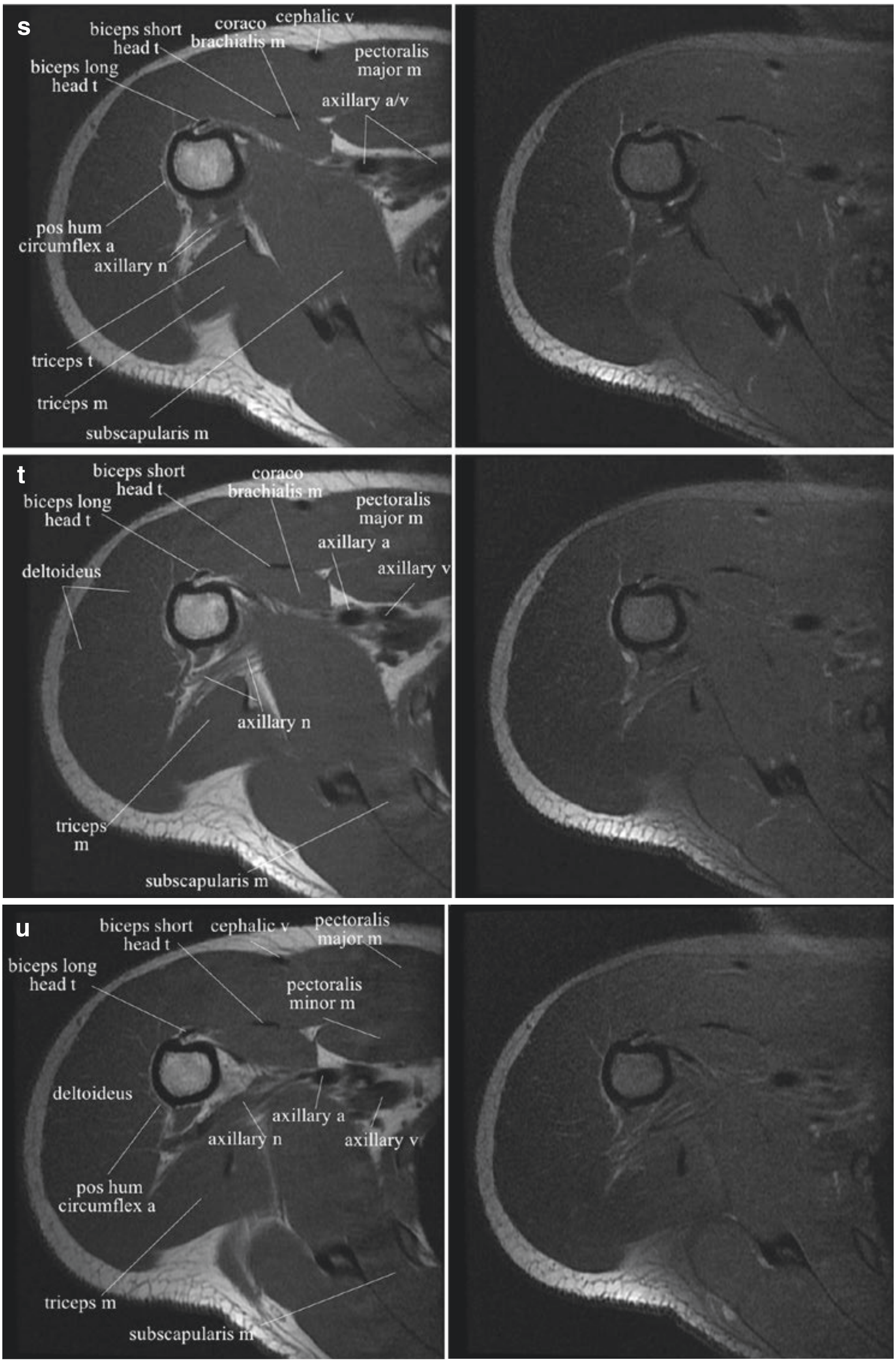

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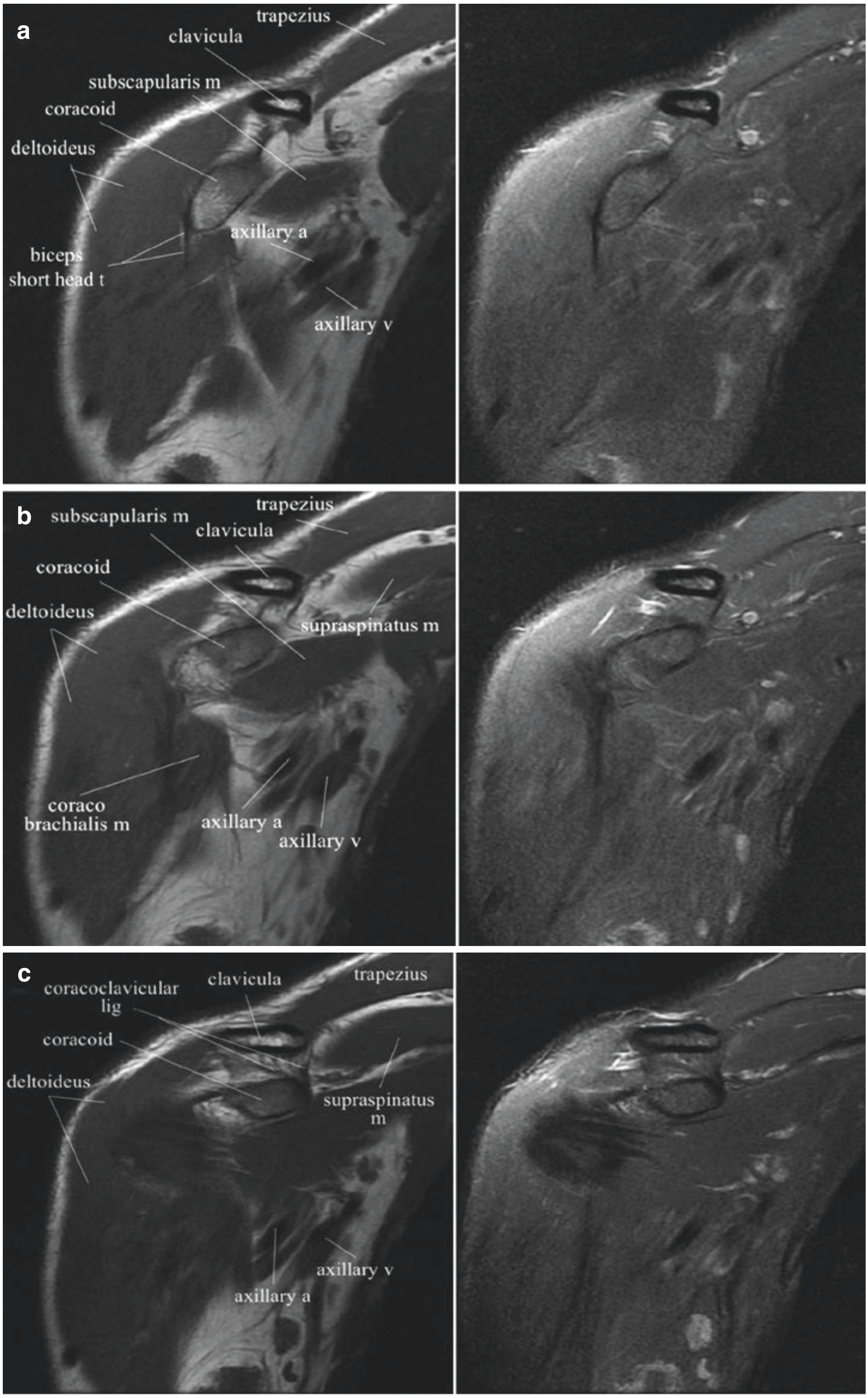
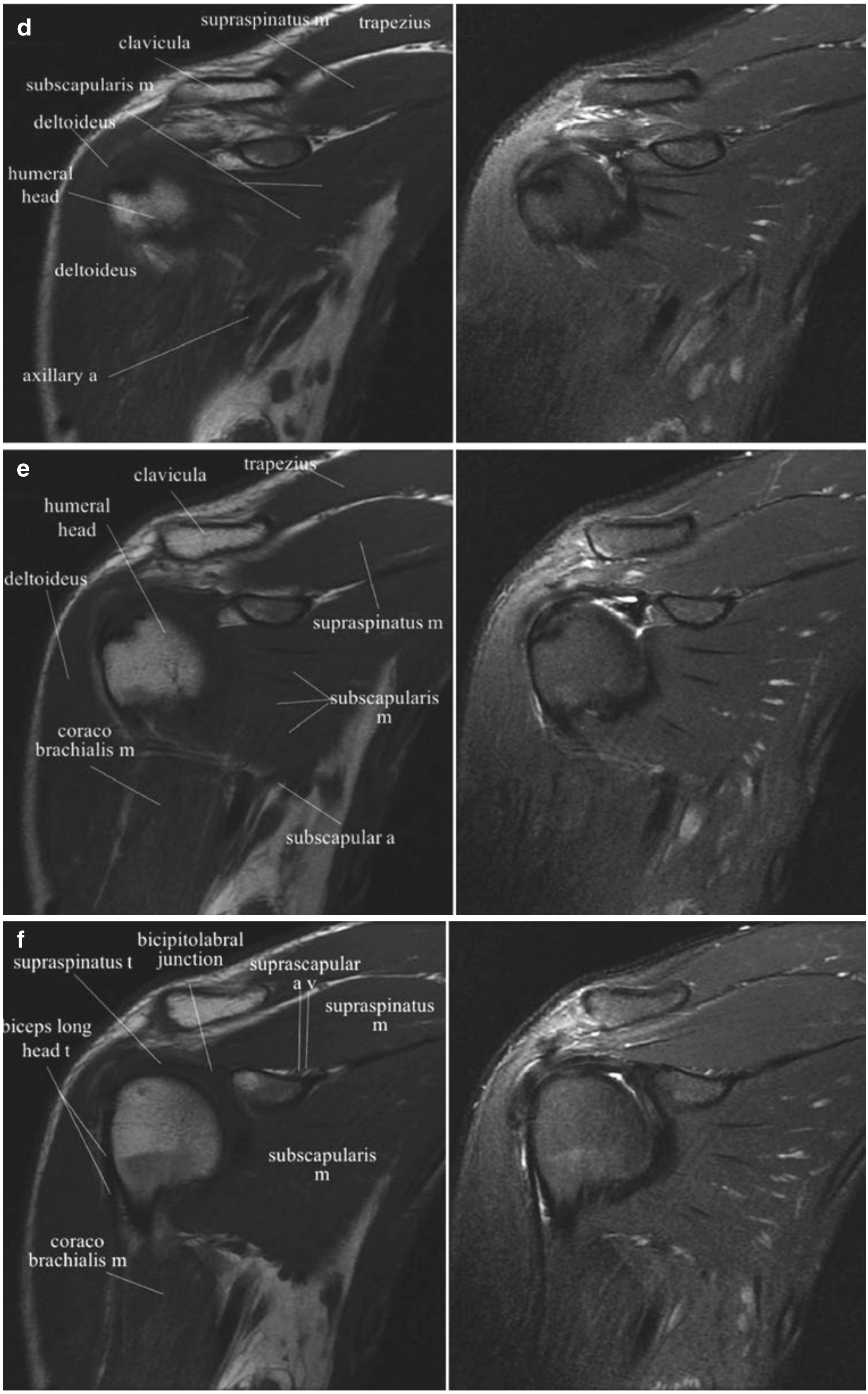


Fig. 3.12 (**a–o**) Coronal oblique MR images (*m* muscle; *t* tendon; *lig* ligament, *a* artery; *v* vein; *n* nerve; *pos* posterior; *inf* inferior)



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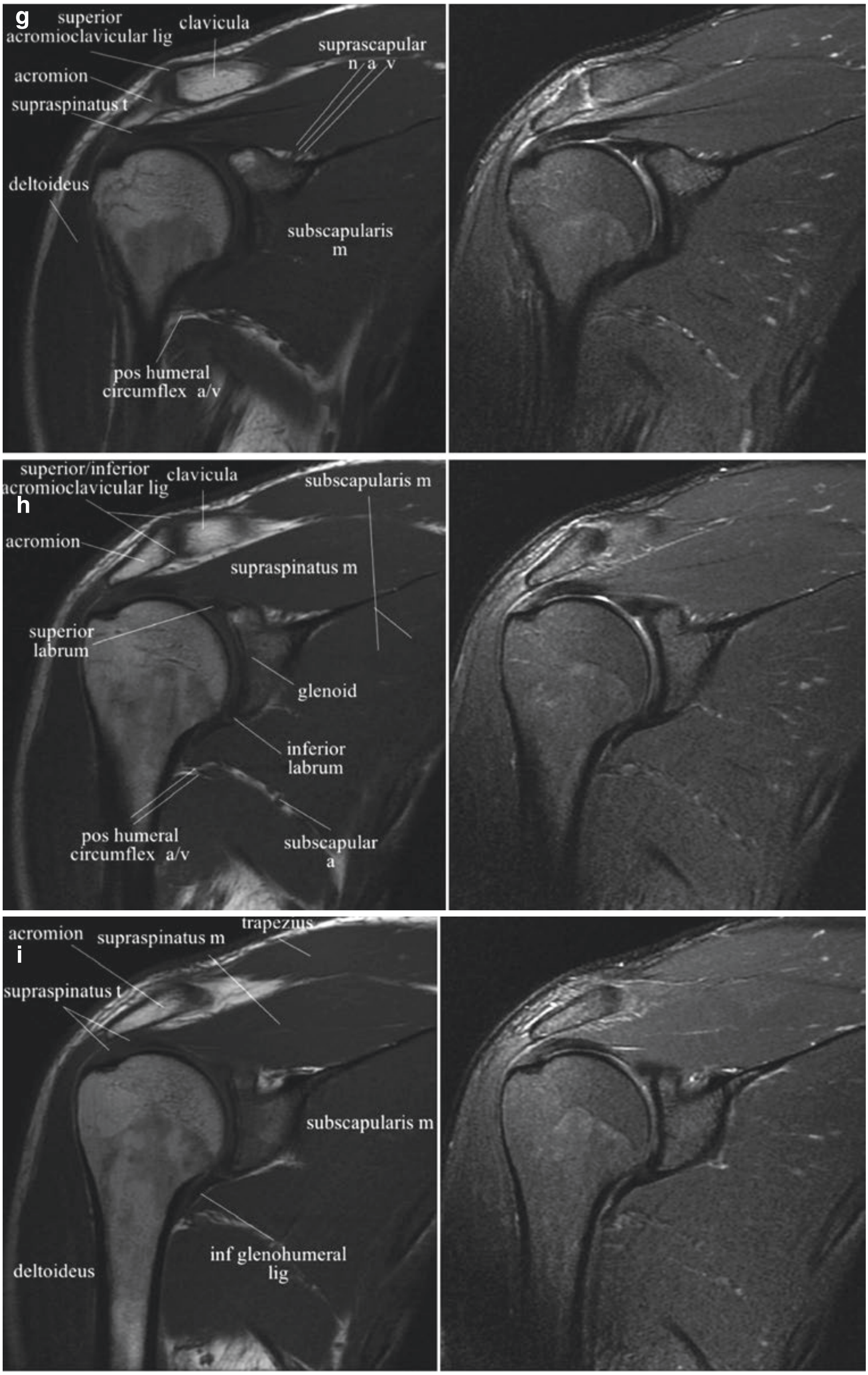

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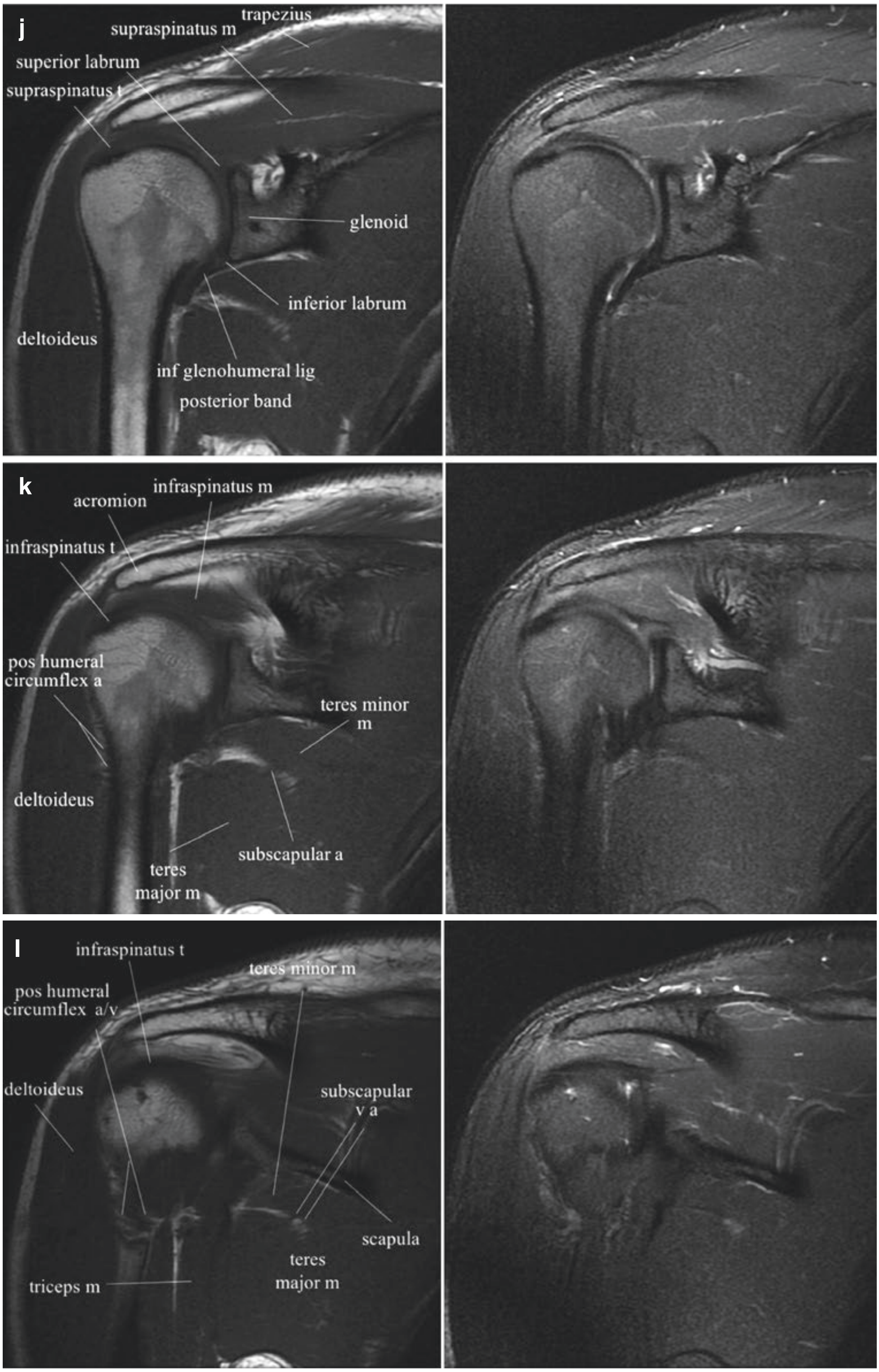

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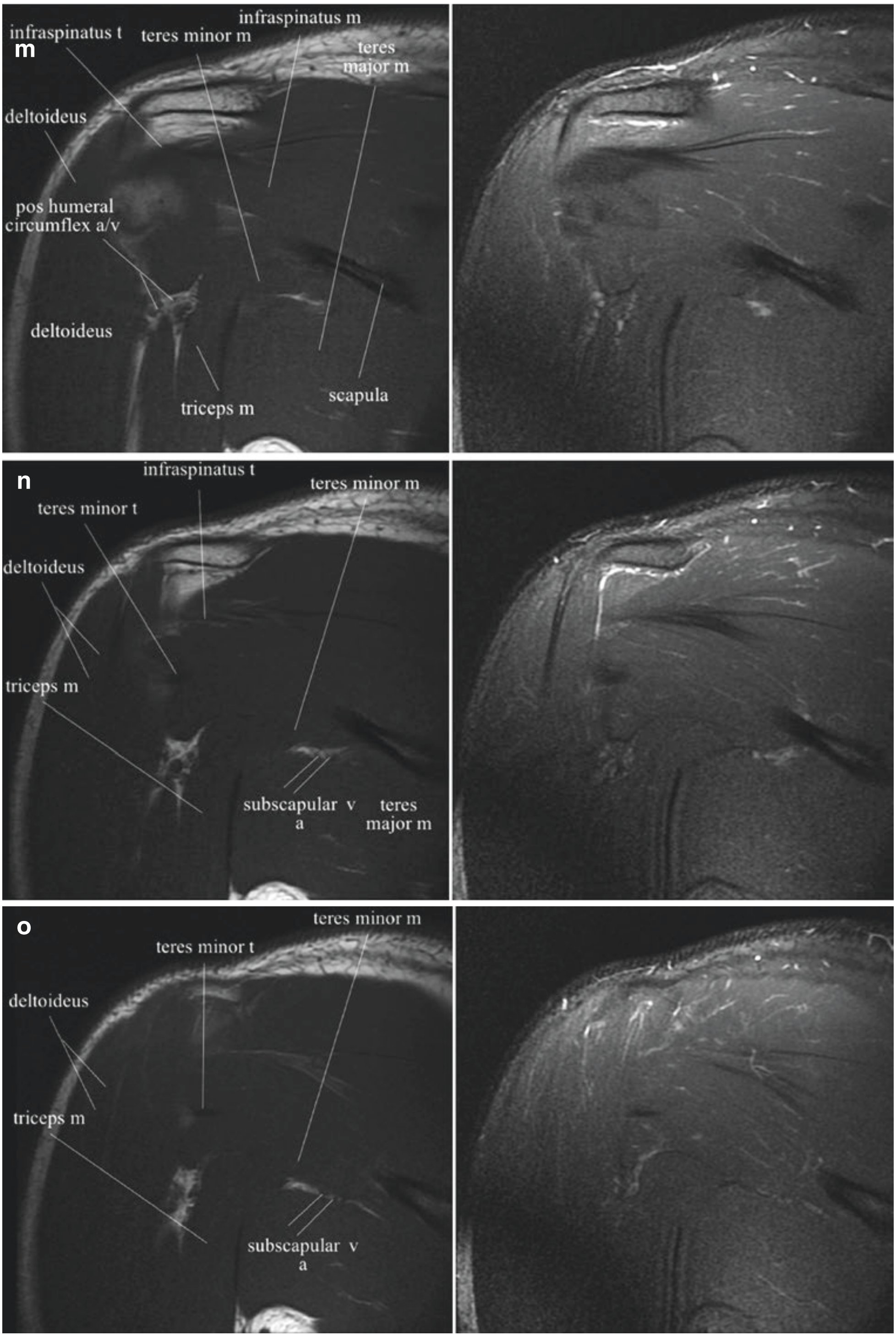

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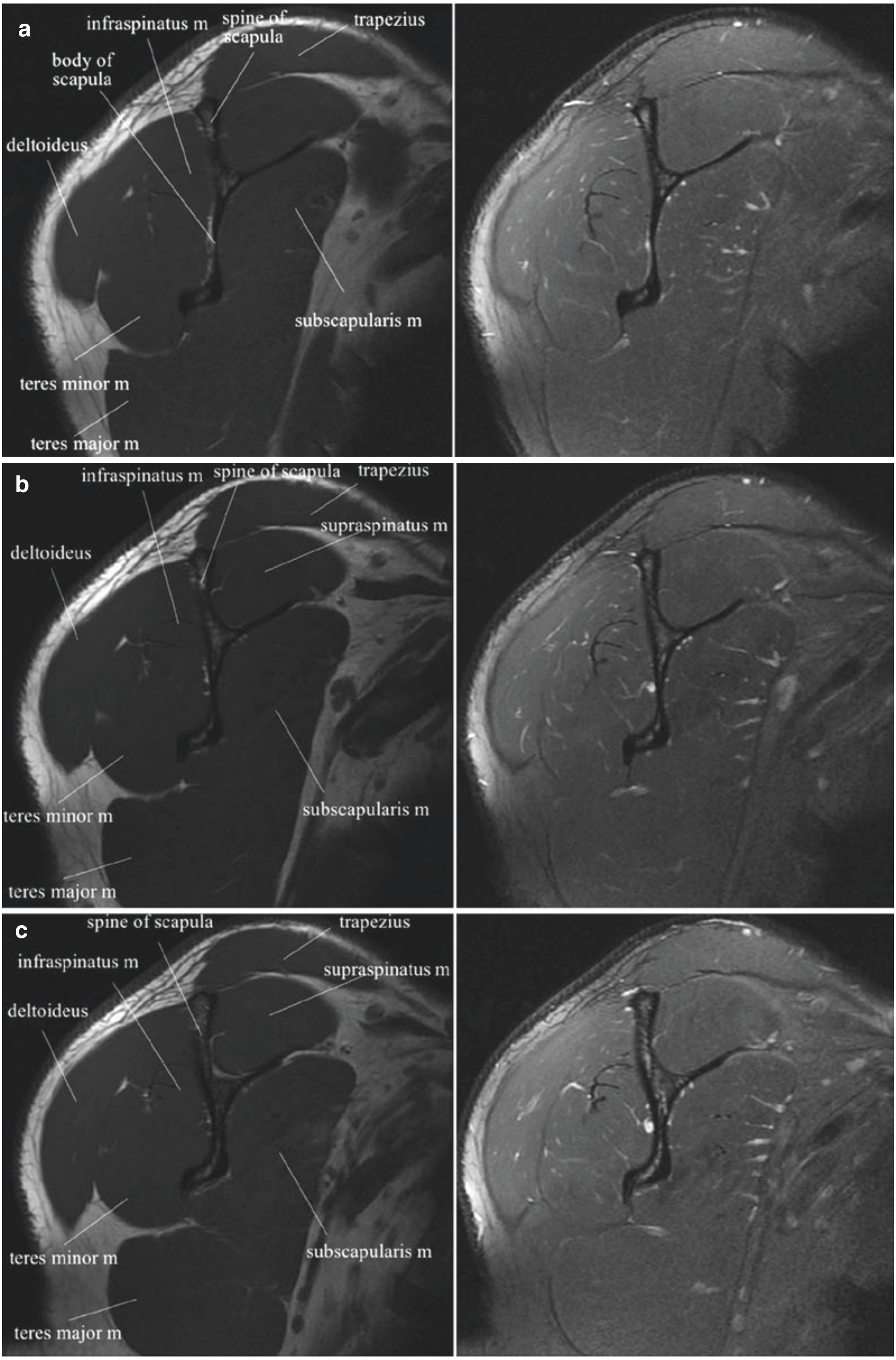
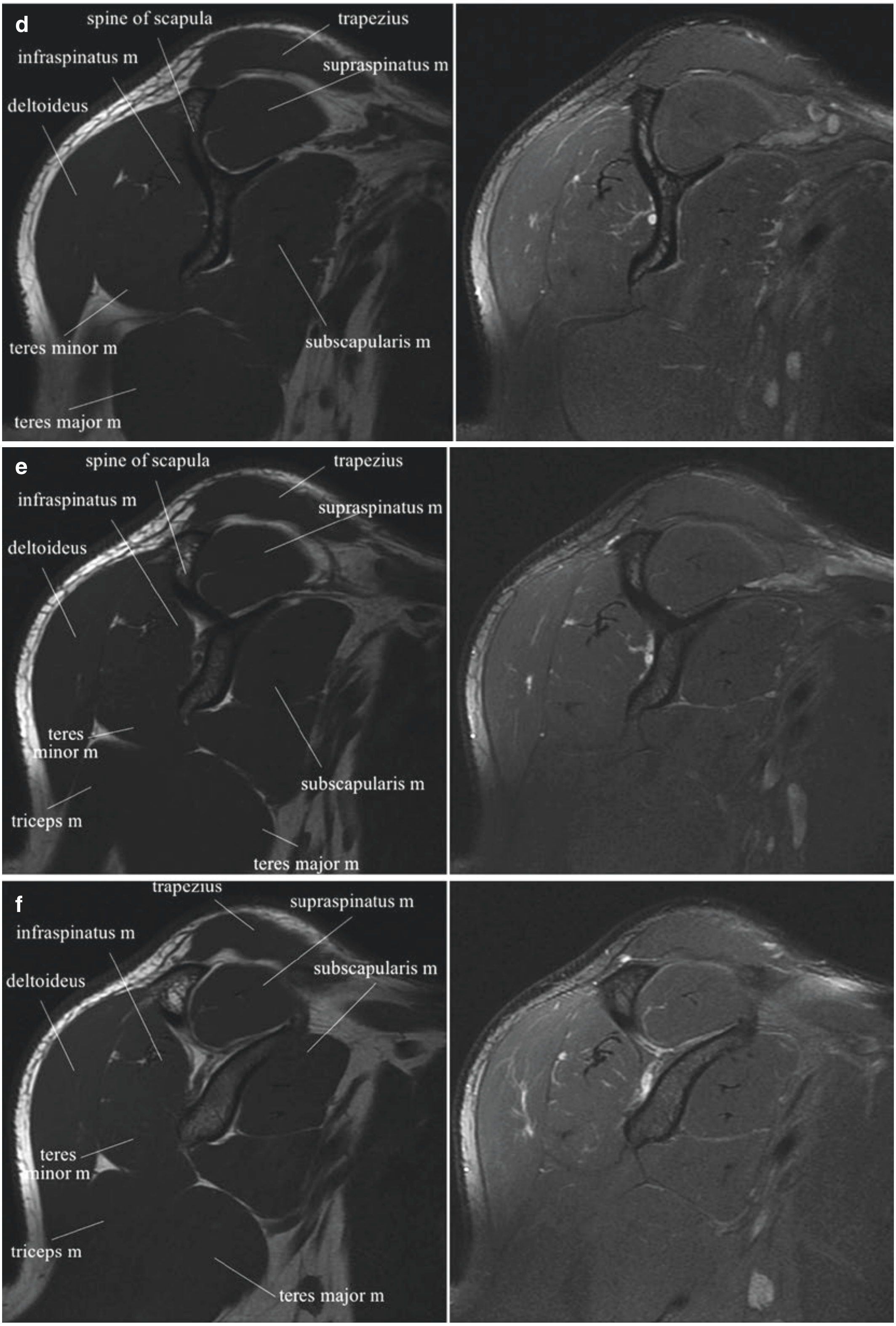


Fig. 3.13 (**a**–**t**) Sagittal oblique MR images (*m* muscle; *t* tendon; *lig* ligament; *a* artery; *v* vein; *n* nerve; *inf* inferior; *sup* superior; *ant* anterior; *post* posterior)



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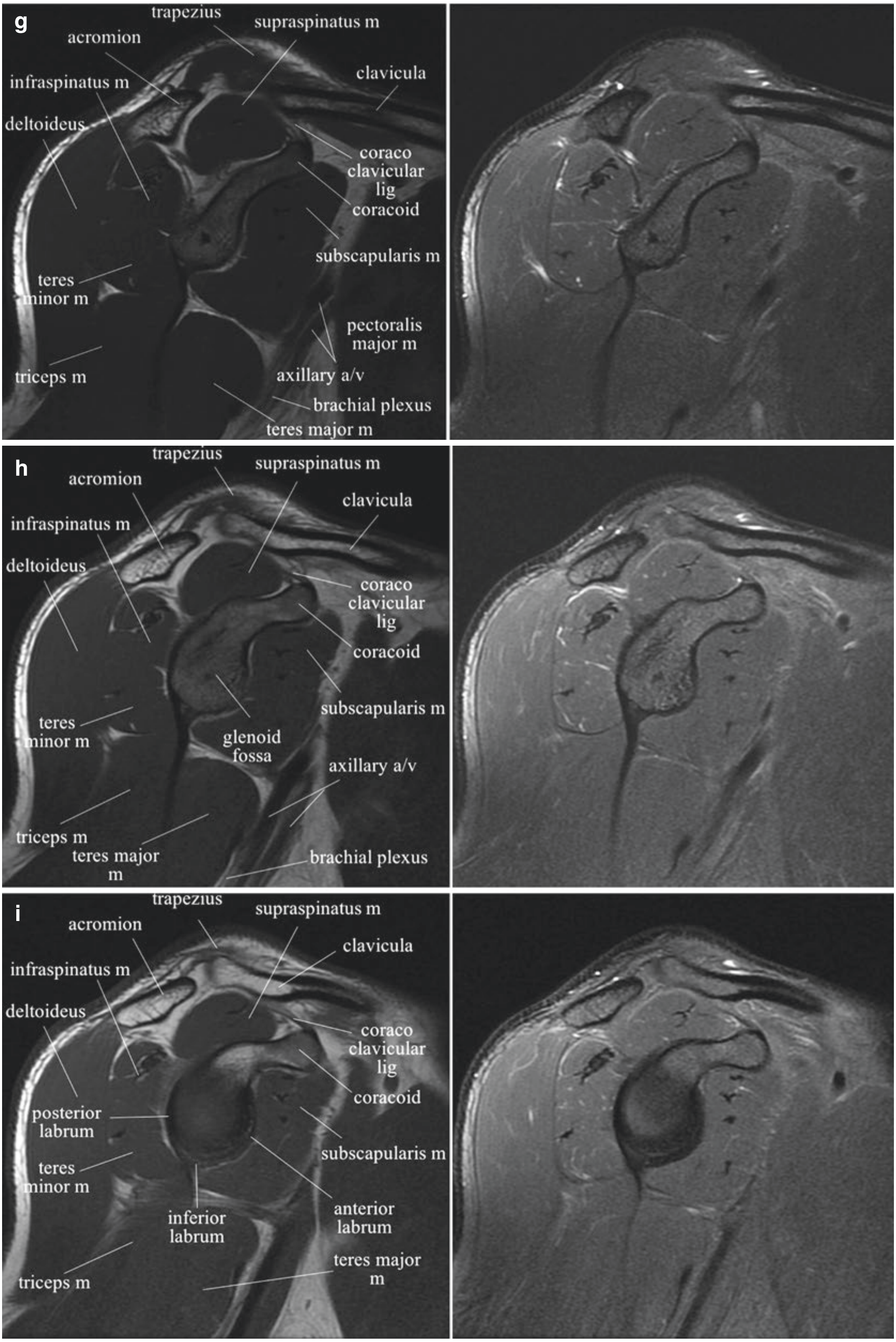

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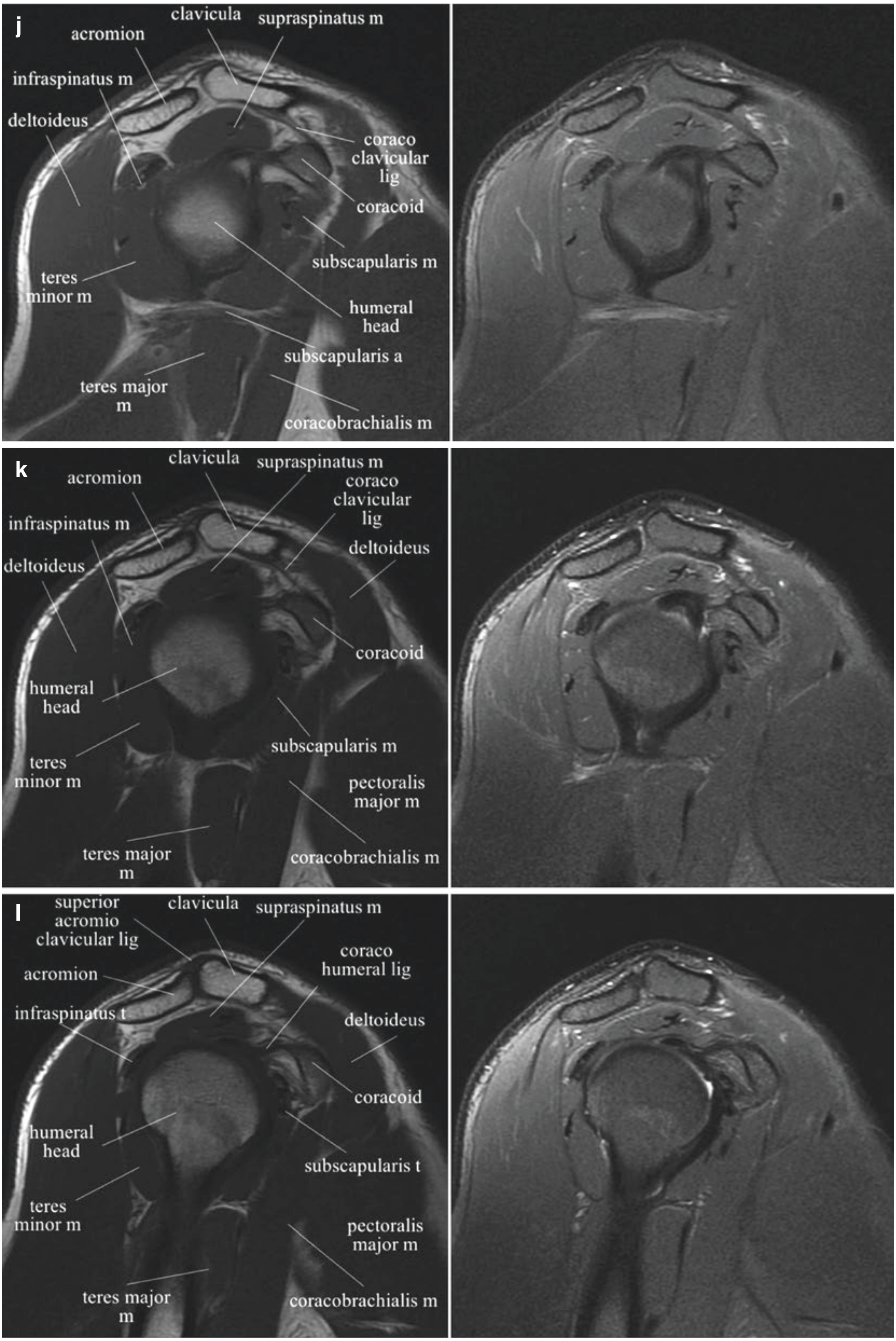

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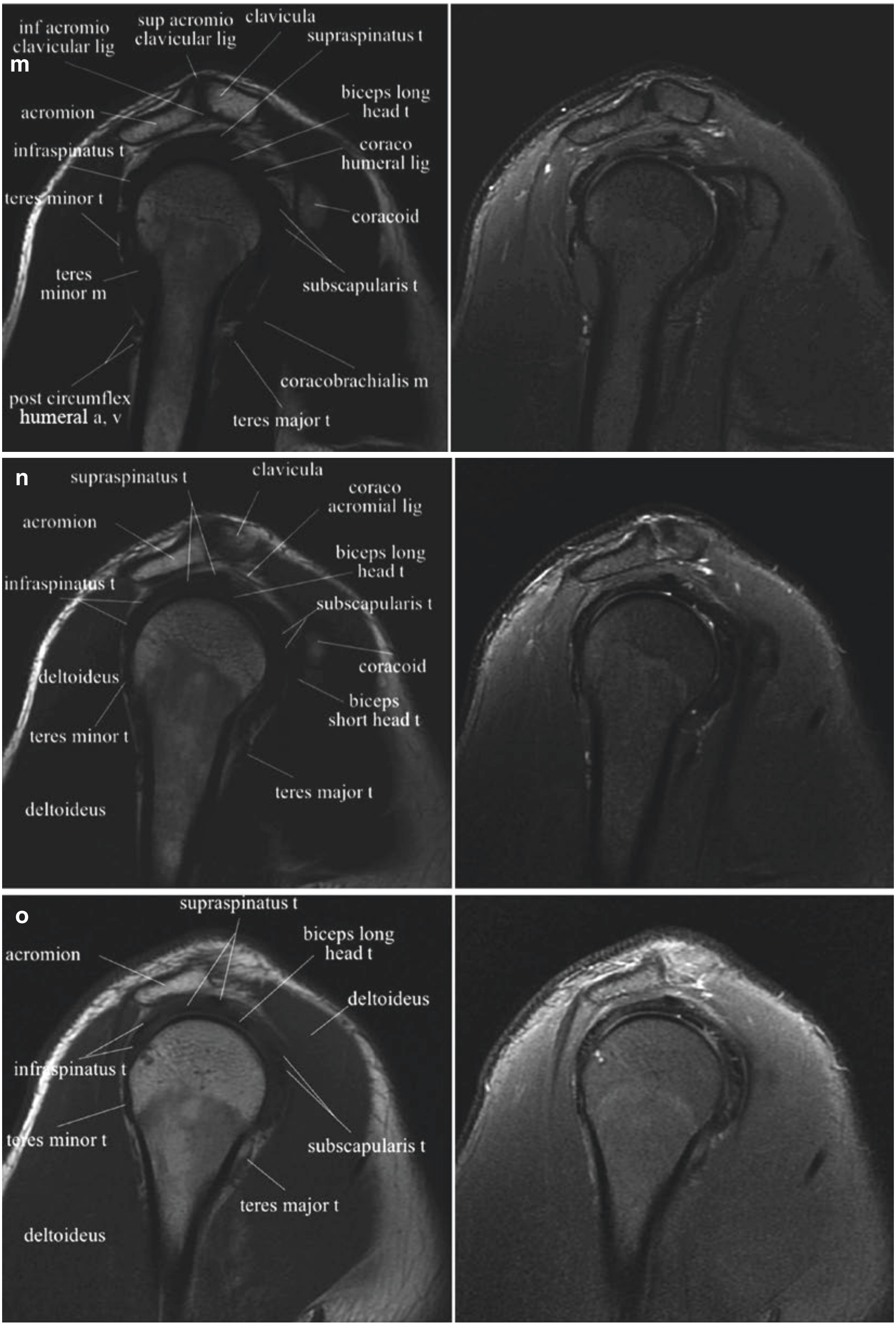

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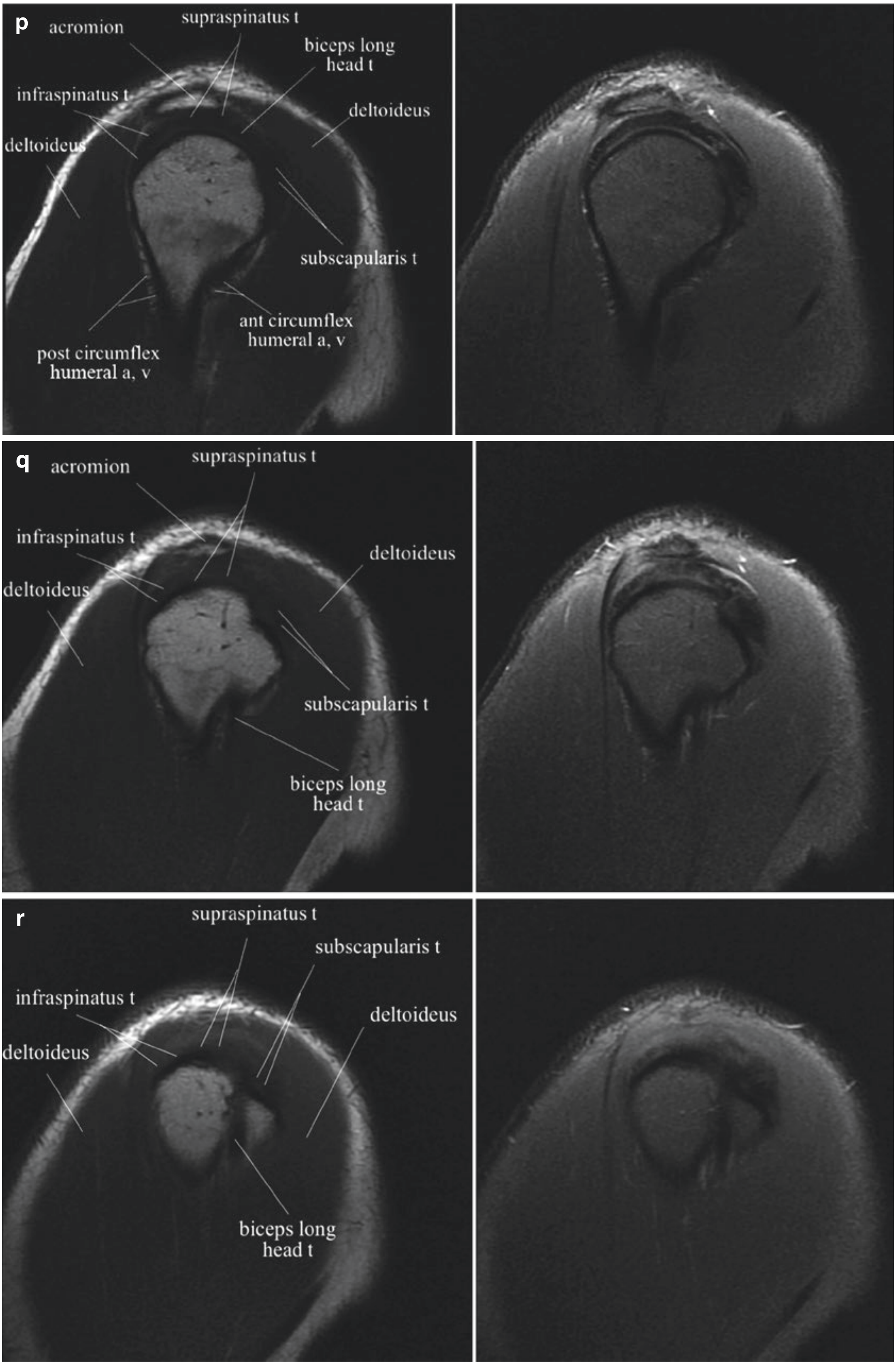

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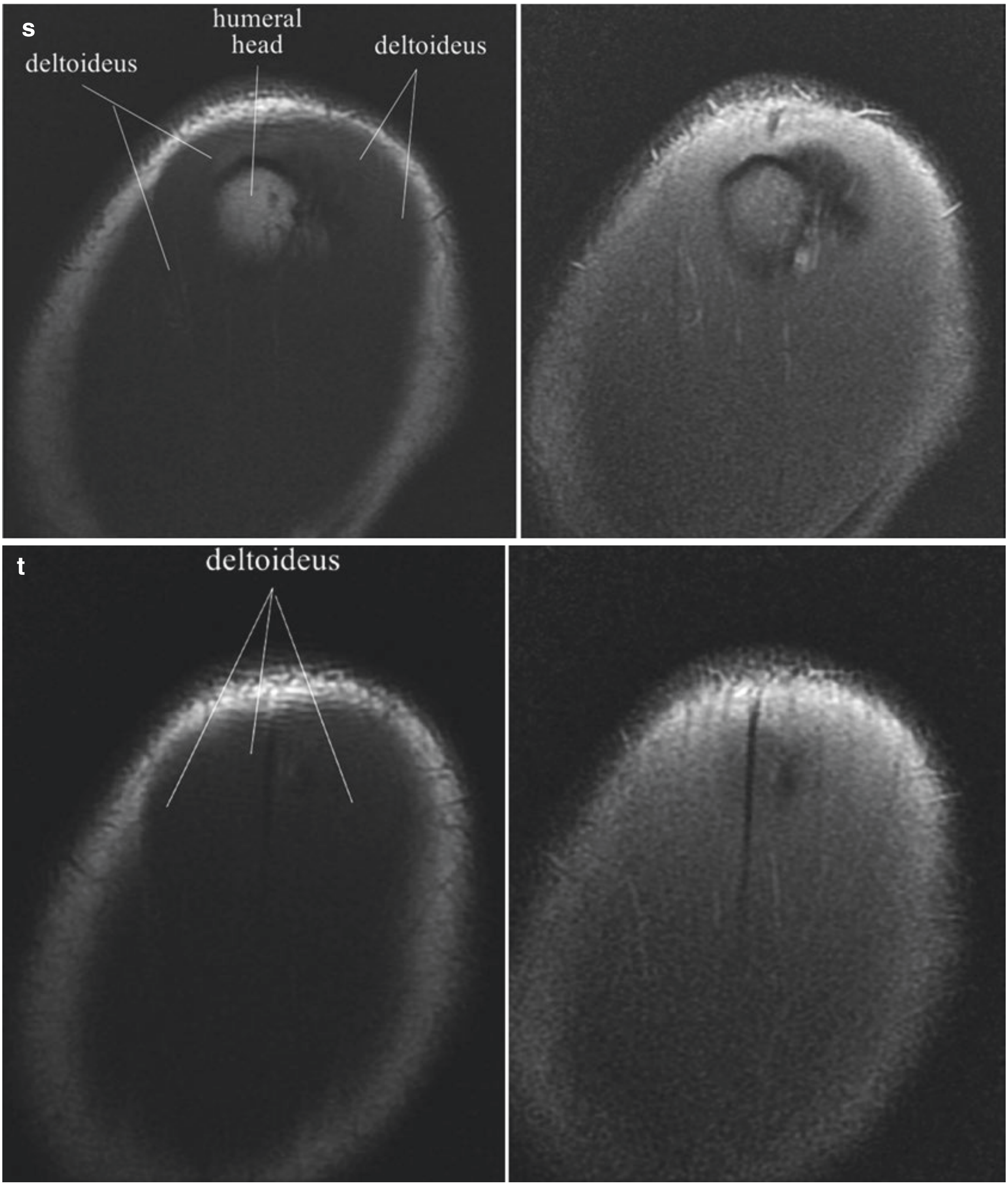

Fig. 3.13 (continued)

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4 Physical Examination

Safa Gursoy

The shoulder joint is the most complex joint in the body. The range of movement and the complexity of the structures forming the joint are the most important factors in the complex structure of this joint. The high level of activity of individuals engaged in sports, their high expectations, and the complex injuries to which they are exposed have resulted in shoulder joint pathologies becoming a significant and challenging problem. A good physical examination plays an important role in the diagnosis of shoulder joint pathologies.

The great number of shoulder examination techniques, the majority of which are named after the physician who identified them, can be confusing. In addition, even if these maneuvers for a specific pathology are learned pathognomically, the diagnostic accuracy of these maneuvers is usually unclear. Furthermore, it is difficult to interpret studies made to evaluate the examination characteristics of these techniques [1].

Physical examination of the shoulder joint must be made systematically [2]. Following a careful inspection of the shoulder, palpation is made and the range of movement of the joint is evaluated. Stretching tests are then applied. When there are indications, functional and neurological evaluations are made. Then, specific tests are applied according to the pathologies.

There is more than one joint forming the shoulder structure. The majority of different tests focussed on different joints together may cause positivity in different pathologies of the same test in the complex structure of the joint. The largest joint in the shoulder is the glenohumeral joint. However, the tests described below include the acromioclavicular or sternoclavicular joint at the same time. The junction of the scapula and the rib cage is accepted as a joint and can be evaluated with some specific examination techniques.

The aim of this section of the book is to review the physical examination of the shoulder joint by including particular examination techniques which have been developed to determine specific pathologies.

4.1 Neer's Impingement

In the Neer's impingement test, the amount of subacromial arch impingement by the rotator cuff, primarily the supraspinatus, is evaluated during forward flexion of the arm. During the test, while one hand brings the arm of the patient into forward flexion, the other stabilizes the

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M. Bozkurt, H.İ. Açar (eds.), *Clinical Anatomy of the Shoulder*, DOI 10.1007/978-3-319-53917-1_4

Fig. 4.1 Neer's impingement

Fig. 4.2 Hawkins-Kennedy impingement test

Fig. 4.3 Yocum sign

scapula (Fig. 4.1). Pain in the anterior of the shoulder during forward flexion indicates test positivity.

4.2 Hawkins-Kennedy Impingement Test

This test is used to evaluate impingement of the subacromial bursa and rotator cuff. The test can be applied with the patient seated or standing. While the arm is in 90° forward flexion and the elbow bent at 90°, the scapula of the patient is stabilized with one hand, and with the other hand holding the forearm, it is forced into internal rotation (Fig. 4.2). The arm must not be taken into abduction during the test. Pain in the anterior shoulder during internal rotation indicates test positivity.

4.3 Yocum Sign

Another test useful in the evaluation of rotator cuff impingement is the Yocum sign. In the test, the patient is told to put one hand on the opposite shoulder and raise the elbow (Fig. 4.3). Pain in the anterior shoulder and an increase in the symptoms of the patient indicate test positivity.

4.4 Coracoid Impingement Sign

The arm being examined is taken into abduction and anterior flexion toward the other side. Then the arm of the patient is forced into internal rotation (Fig. 4.4). Pain over the coracoid and limitation in internal rotation are accepted as positive for coracoid impingement syndrome.

Fig. 4.4 Coracoid impingement sign

Fig. 4.5 Lift-off sign

4.5 Lift-Off Sign

This shows damage to the inferior section of the subscapularis muscle in particular. When the patient's arm is positioned on the back, it is difficult to remove the hand from the back when in maximum internal rotation (Fig. 4.5).

4.6 External Rotation Lag Sign

This test is used to show pathologies of the supraspinatus and infraspinatus muscles. The shoulder of the patient is held from the elbow with one

Fig. 4.6 External rotation lag sign

hand. While the patient's elbow is in 90° flexion, the shoulder is taken into external rotation with the other hand, and the patient is requested to hold this position (Fig. 4.6). If the patient cannot maintain external rotation, test positivity is shown.

4.7 Drop Sign

With the elbow in 90° flexion and the shoulder in 90° abduction, the shoulder is taken into external rotation and the patient is told to hold this position (Fig. 4.7). Pain and weakness which may cause the arm to fall indicate test positivity. The sensitivity and specificity of this test are very high for highly degenerated infraspinatus tears in particular.

4.8 Speed Test

This test is used to evaluate pathologies of the proximal tendon of the long head of the biceps. With the elbow in extension and the forearm in

Fig. 4.7 Drop sign

Fig. 4.8 Speed test

supination, the shoulder of the patient is taken to 60° anterior flexion. Force is applied to the patient's forearm to take it into extension (Fig. 4.8). Pain felt in the bicipital groove indicates biceps pathology.

Fig. 4.9 Whipple test

4.9 Whipple Test

This test, which can be applied with the patient seated or standing, has high specificity for partial tears of the anterior supraspinatus tendon in particular [3].

With the shoulder in 90° flexion, it is taken into hyperadduction toward the other shoulder. Downward pressure is applied to the arm of the patient (Fig. 4.9). Pain in the shoulder and falling of the arm indicate test positivity.

4.10 Drop Arm Sign

Another test showing rotator cuff pathologies is the drop arm sign. The arm of the patient is taken to 90° abduction and the elbow to 90° flexion, and the patient is told to hold the position (Fig. 4.10). Dropping of the arm or pain indicates test positivity.

4.11 Jobe Sign

This test shows weakness or impingement of the supraspinatus tendon. The arm is taken to 90° abduction and 30° anterior flexion, and the elbows are brought to flexion in internal rotation. Downward pressure is applied to the arms and the patient is told to resist this pressure (Fig. 4.11). Pain or weakness indicates test positivity.

Fig. 4.10 Drop arm sign

Fig. 4.11 Jobe sign

4.12 Jobe Sign "Full Can" and "Empty Can"

This test can be applied with the patient seated or standing. The arm of the patient is taken into abduction and flexion. If the test is made while

Fig. 4.12 Jobe sign "empty can"

Fig. 4.13 Jobe sign "full can"

the arm is in internal rotation, it is named "empty can" (Fig. 4.12) and, if made while in external rotation, "full can" (Fig. 4.13). Downward pressure is applied to the forearm of the patient. If there is only pain without weakness, there could be different shoulder pathologies, so specificity is low. The presence of actual weakness demonstrates supraspinatus tendon pathology.

4.13 Infraspinatus Strength Testing

With the elbows in 90° flexion, both hands are positioned facing each other and brought into internal rotation. Holding the outer part of the patient's hand, the arm is forced into internal rotation, and the patient is told to resist against this force (Fig. 4.14).

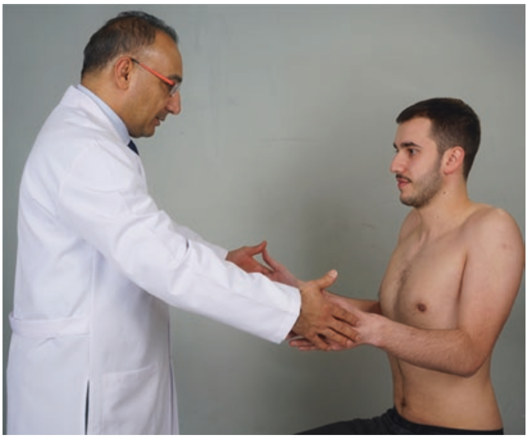

Fig. 4.14 Infraspinatus strength testing

Fig. 4.15 Yergason sign

4.14 Yergason Sign

With the shoulder in adduction, the elbows are taken to 90° flexion. Holding the patient's hand or forearm, the forearm is forced into pronation while the patient tries to make supination (Fig. 4.15). When there is pain along the bicipital groove, the test is positive for suspected biceps tendon pathologies.

4.15 Load and Shift Test

With one hand stabilizing the scapula, translation forces are applied with the other hand in an anterior and posterior direction over the humeral head which forms the joint with the glenoid (Fig. 4.16).

Fig. 4.16 Load and shift test

Fig. 4.17 The sulcus sign

When the humeral head is more mobile than the contralateral shoulder, the test is accepted as positive, and shoulder instability is suggested.

4.16 The Sulcus Sign

In this test the gap formed between the humeral head and the acromion inferior surface is evaluated according to the extent of the space. With the arm in a neutral position, while the patient's scapula is stabilized with one hand, longitudinal traction is applied with the other hand to the patient's arm (Fig. 4.17). The gap formed is expected to be <1 cm. If the gap is >1 cm, it is evaluated as a positive sulcus sign.

Fig. 4.18 Apprehension test

4.17 Apprehension Test

This test, which can be applied with the patient standing or in a supine position, is a significant indicator of shoulder anterior instability. The shoulder is taken to 90° abduction and the elbow to 90° flexion. The arm of the patient is then carefully brought to external rotation (Fig. 4.18). A feeling of instability occurring during external rotation indicates test positivity.

4.18 Adson Test

In this test, the patient takes a deep breath and the head is turned toward the affected side (Fig. 4.19). Loss of radial pulse in the arm when the neck is brought into hyperextension or when the arm is raised indicates test positivity. This test is used as an indicator of thoracic outlet syndrome (TOS).

Fig. 4.19 Adson test

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5 Arthroscopic Knot-Tying Techniques

Cetin Isik and Mehmet Emin Simsek

5.1 Introduction

We benefit from knowledge of knots many times in our daily lives, from tying a shoelace to wrapping a present. The advances and developments in shoulder arthroscopy and surgical thread, especially in the last two decades, have made it necessary to have a good knowledge of knot techniques to achieve successful surgery. The basic information needed to tie arthroscopic knots is given in this section. Correct communication and standardisation of training will only be possible if the basic concepts are known.

5.1.1 Terminology and Basic Concepts

Limb: the free end of the thread used in the knot.

Wrap: turning one limb of the thread over the other.

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Knot: the structure made by winding the two free limbs of thread round each other at least twice.

Half hitch loop: the structure made by winding one limb of the thread round the other once. This is not a knot and is easily undone.

Post limb: when making the knot, it is the limb over which the loop is formed.

Loop limb: loops are formed over the post limb with this limb.

Overhand half hitch loop: the loop formed by winding a circle of loop limb over the post limb.

Underhand half hitch loop: the loop formed by winding a circle of loop limb below the post limb [1] (Fig. 5.1).

Interference: The relationship between the loops of the knot and the loops of the post limb. This is a parameter showing the strength of the knot. A knot made with opposite loops and changing the post limb in sequence has the property of the best interference.

Symbols: When stating the knot in international terminology, the number of wraps included in the loop and the sequence of parallel or opposite loops are taken as the basis. With the number of wraps, parallel loops are stated as '=' and opposite loops as '×'. In sliding knots, for each loop, the letter 'S' is used instead of a number. If the fixed limb is changed, the '//' sign is used (Table 5.1 and Fig. 5.2).

M. Bozkurt, H.İ. Açar (eds.), *Clinical Anatomy of the Shoulder*, DOI 10.1007/978-3-319-53917-1_5

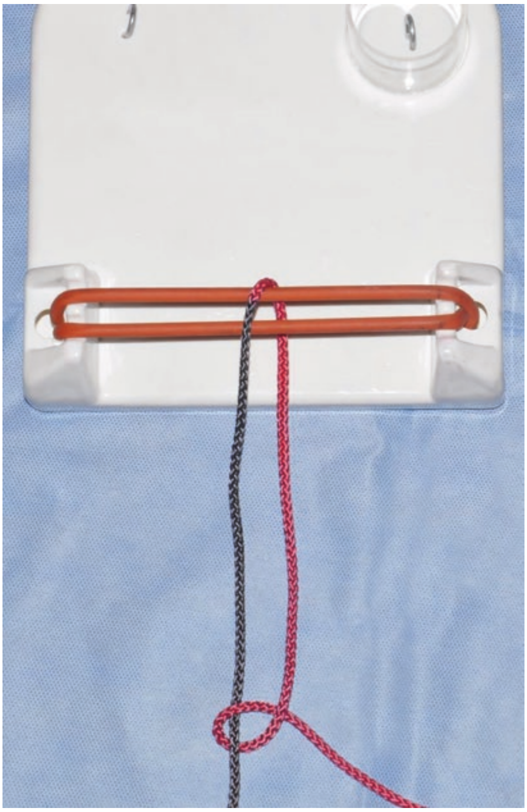

Fig. 5.1 Post limb (*black thread*) and loop limb (*red thread*)

Table 5.1 Knots symbols

	Symbol
Examples of open non-sliding knots	
Granny knot	1×1
Square knot	1=1
Surgeon knot	2=1
Examples of sliding knots	
Post limb and loops are the same	S=S
The same post limb and different loops	S×S
Different post limbs and the same loops	S//S
Different post limbs and different loops	S//×S

Granny knot and square knot are formed from two consecutive loops with single wraps. The basic difference differentiating the two is that the sequence of loops is not opposite. In a surgeon knot, a double-wrapped loop follows a single-wrapped loop which is not opposite. The numbers included in the sequence of loops state the number of wraps. The signs between the numbers state whether the loops are opposite or not. In sliding knots, the letter 'S' is used instead of numbers. The other signs are the same. If the post limb is changed, this is indicated with the sign, '//'.

In a square knot (1=1), rather than applying equal tension to both limbs, if tension is applied to only one limb, it becomes a sliding knot formed of an overhand and underhand half hitch loop (S×S). The reverse is also possible; in other words a sliding knot formed of an overhand and underhand half hitch loop can be changed to a square knot by applying tension to both limbs (Fig. 5.3).

Post flipping can be performed in two ways. The post limb is loosened by tightening the loop limb, and the post limb can be changed when it is felt that the loop limb has passed over. To facilitate the passing over of the loop, the post limb can be oriented towards the front of the loop when applying this procedure. With this passing over, an overhand half hitch loop becomes an underhand half hitch loop. In other words, with the changing of the limbs, the loops also change. The post flipping procedure can be made easily by first choosing the post limb before the loop is prepared. In all knot configurations, the most important step which provides knot security is the stage of changing the post limb.

Knot security is stated as the resistance of a knot to sliding. Friction and interference play important roles in knot security.

Friction: This is the resistance shown by the suture thread when the knot is formed. Therefore, the suture material used is the basic determinant of friction. In monofilament thread, friction is low, the risk of tissue damage is low, but it is difficult to manipulate, and there is a greater risk of gaps between loops, which cause loosening. Another two reasons for gaps between loops are crossing the limbs over each other and pastpoint (constriction by passing a newly made loop over a previously settled loop). Braided multifilament threads have high friction and a high risk of tissue

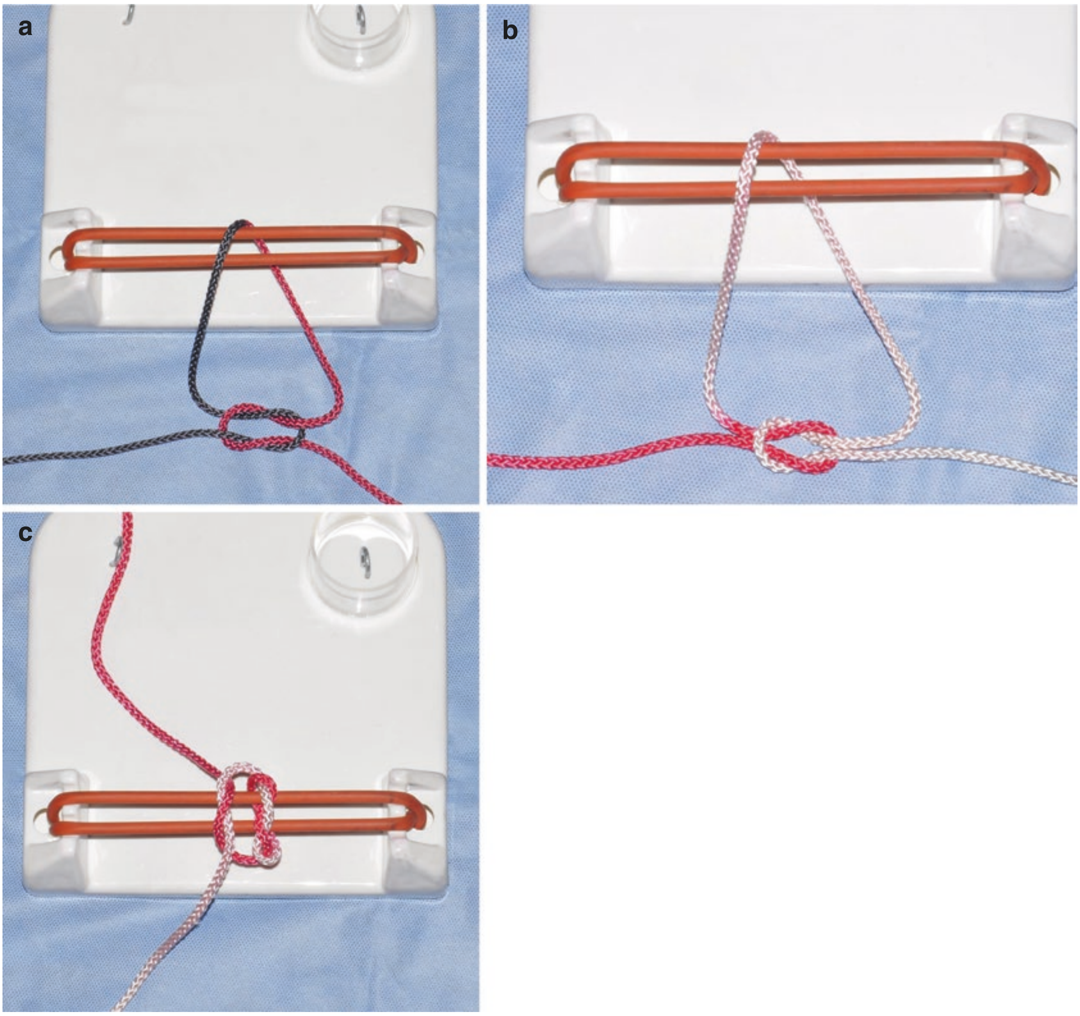

Fig. 5.2 Granny (**a**), square (**b**) and surgeon knot (**c**)

damage but can be easily manipulated and form tight knots.

Suture threads are manufactured to be resistant to tensile forces. The basic force tearing a thread is shear force. While tensile forces are effective over the knot, shear forces are effective at the knot-loop junction. Therefore, in a knot which cannot be undone, the weakest point is the junction [2]. Monofilament threads are more resistant to shear force, and braided threads are more resistant to tensile forces. If the thread breaks, the fault does not lie in the knot but in the thread. If the tissue is torn, or the anchor is dislodged, the problem is not in the knot, but rather that the soft tissue or bone quality is poor. The aim of a correct knot is that it should be able to maintain good tension over the tissue, the application should be easy, it should be small in size and resistance should be good [3, 4]. For a successful result in the knot, it is not necessary to know all the knot configurations, but there should be familiarisation with effective knot manipulation [5].

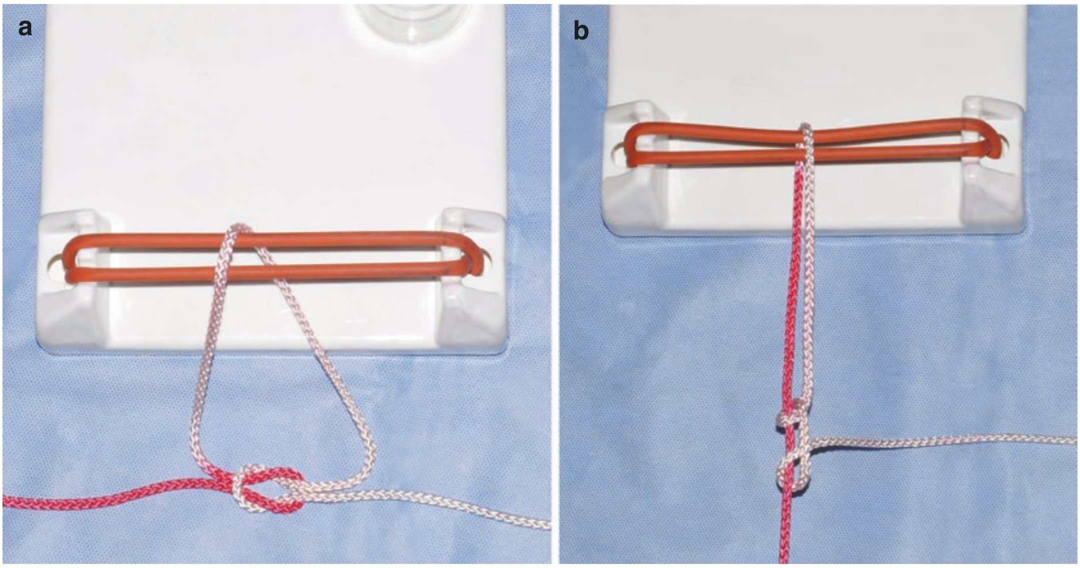

Fig. 5.3 Transforming a square knot (**a**) to a sliding knot (**b**)

Table 5.2 A general overview of open and arthroscopic knots

Open knots	Arthroscopic knots
Granny	Non-sliding knots
Square	Square, Revo, SCOI, etc.
Surgeon	Sliding knots
	Locking (SMC, Nicky's, Dines, Snyder, Pretzel, Giant, Tennessee, Midshipman's, etc.)
	Non-locking (Hangman's, Lafosse, Duncan, Fisherman, etc.)

5.1.2 Knot Options (Table 5.2)

It has been previously said that open knots are the most used. When so desired, open knots can be applied more comfortably using a clamp. The aim of arthroscopic knots is for the knot or loops prepared outside the tissue to be placed in the tissue in a manner which will provide sufficient tension in the tissue.

5.1.3 Non-sliding Arthroscopic Knots

Threads are selected according to the status of the soft tissue and fixation material which will not permit easy sliding. The type of knot is that which sits directly in the tissue without sliding over the tissue and is directly tightened. The loops are prepared individually outside the joint and advanced to the joint over the post limb with a knot pusher. A square knot, for which a double hole is required arthroscopically, is not preferred as much as open. It is difficult to adjust the tension in non-sliding arthroscopic knots, and the risk of loosening is high [2–7] (Fig. 5.4).

5.1.4 Sliding Arthroscopic Knots

The knot is completely prepared outside the joint and is advanced over the post limb. When the post limb is pulled, the knot advances into the

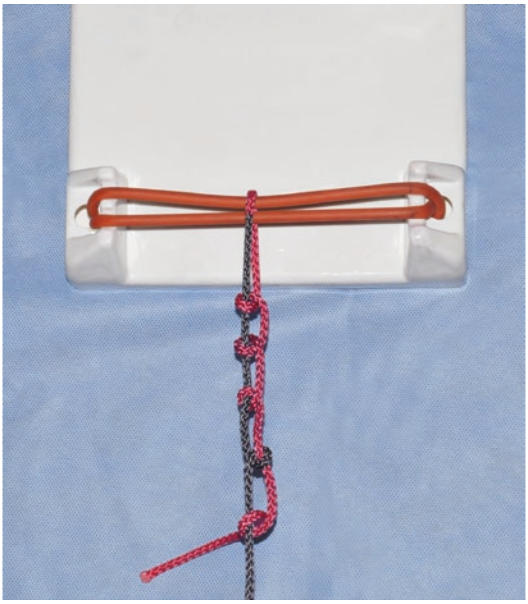

Fig. 5.4 Revo knot: First, two overhand half hitch loops are formed. In the third step, an underhand half hitch loop is made. As the post limb is not changed up to this step, the loops formed can be advanced over the post limb even if evident resistance is met. This is because the resistance against loosening of two consecutive opposite loops is greater than that of two loops in the same sequence. If the tension in the tissue is good, in the fourth step, the post limb is changed and an opposite loop is made. At this stage, as the post limb is changed, the knot is locked. Then, in the fifth step, again the post limb is changed, and an opposite loop is made as in the fourth step

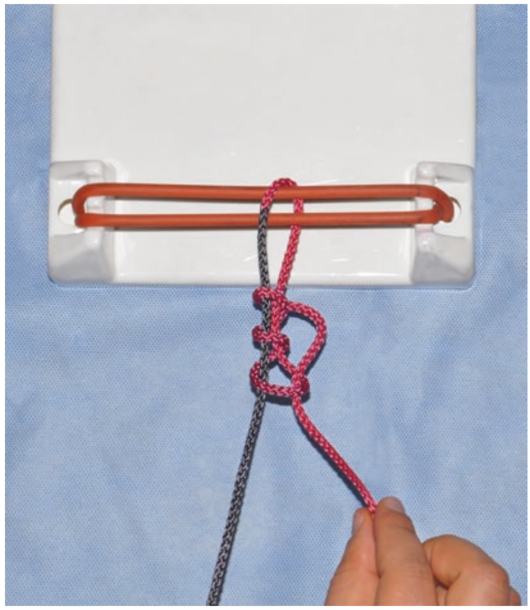

Fig. 5.5 Hangman's knot

joint or towards the tissue. Therefore, the post limb must be kept short. After being seated in the tissue, when traction applied to the post limb is loosened, the knot cannot slide back. In sliding knots there is also a reduction-pull effect. If the thread passing through the tissue is selected as the post limb, the tissue can be compressed by the knot formed of the loop and limb (like the pull effect in screws).

Non-locking sliding arthroscopic knots: These are applied easily. The tension can be adjusted by pressure on the knot. When they move back with loosening, they can be advanced again; in other words, they are tolerant of errors. Whichever knot is selected, all non-locking sliding arthroscopic knots are formed by changing the post limb twice with opposite loops to lock the knot at the appropriate tension (S//×S//×S) (Fig. 5.5).

Locking sliding arthroscopic knots: These knots are unforgiving and require experience. Tension can be adjusted with greater control. They can slide back, although not as much as non-locking knots. Knot security must be provided in these knots with opposite loops on different post limbs (S//XS//XS). Some surgeons have stated that sufficient knot security is obtained with these knots alone without the need for additional locking loops (Fig. 5.6).

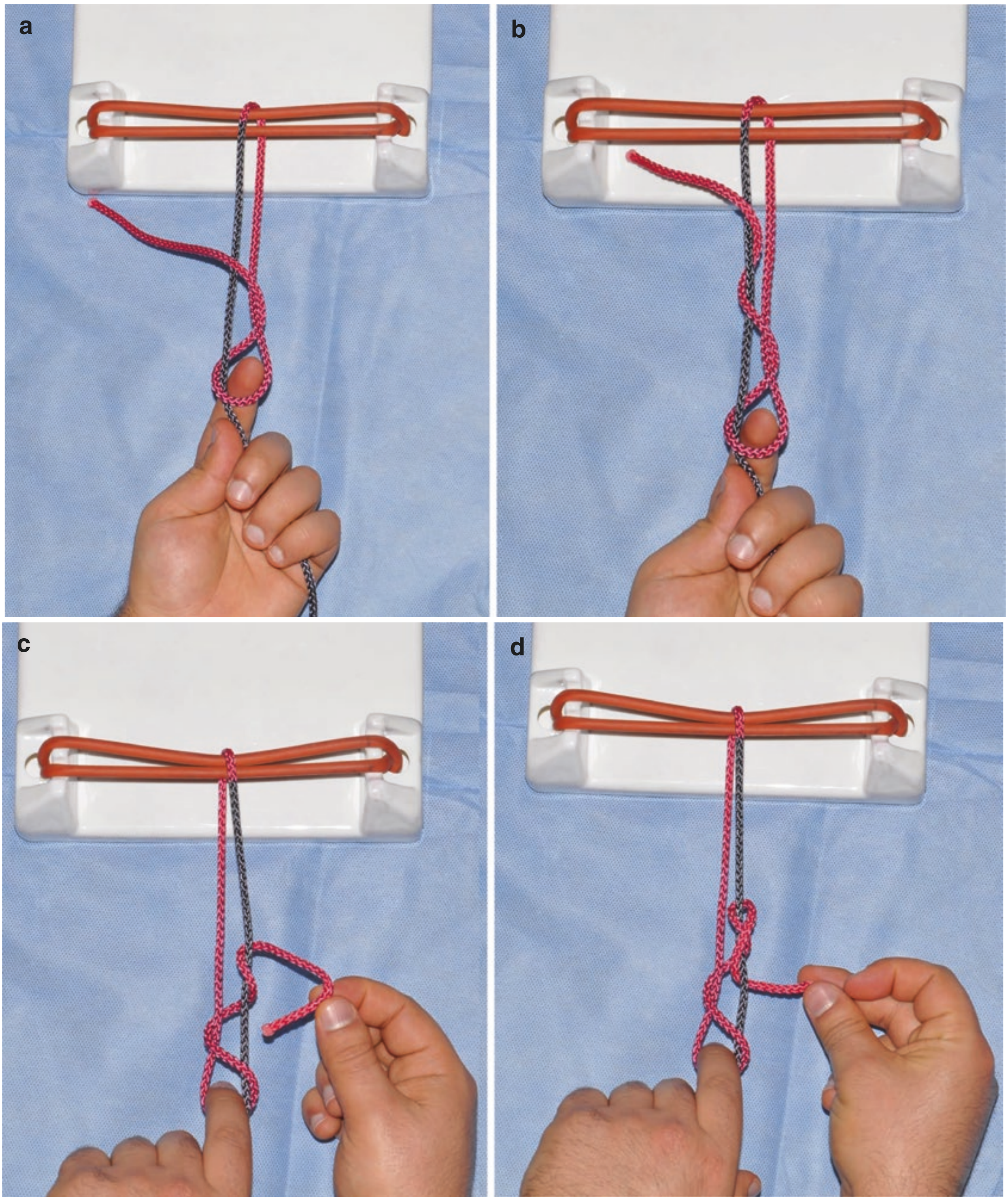

Fig. 5.6 (**a**–**d**) SMC knot: The knot mass is less than that of the Duncan or Hangman's knot which are non-locking sliding arthroscopic knots. That the smaller knot body allows the possibility of locking the knot is the reason for its selection

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6 Operation Room Setup and Patient Positioning

Mustafa Akkaya

6.1 Operation Room Setup

6.1.1 General Requirements

Just as in all surgical cases, in shoulder arthroscopy the first step towards increasing the success of the operation starts with the setting up and organisation of the operating theatre. The ideal working environment can be provided with the creation of the conditions of a fully equipped operating room by a team specialised in the subject. A standard operating room can be made appropriate for shoulder arthroscopy equipment with organisation by an experienced team (Fig. 6.1). The operating room must be of a size into which the necessary equipment can fit and in which the operating team can comfortably move.

6.1.2 Patient Table and Apparatus

The patient table should be located in the centre of the operating room and immediately below the room lighting system. All the instruments and devices required by the anaesthesia team should be placed close to the head section of the patient table (Fig. 6.2).

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Standard surgery table: many specialists prefer a shoulder table for shoulder arthroscopy. However, it is possible to implement this procedure on a standard surgery table, but the midsection of the table must be adjustable and able to be raised mean 40–60° (Fig. 6.3). When using a standard surgery table, some additional apparatus is required to fix the patient to the table and provide a safe surgical procedure. In cases where a standard surgery table is to be used, the stage of fixing the head of the patient to the table is critical. Care and attention must be given to this stage.

Side support bars: these are necessary to hold the patient stable on the table during the surgical procedure (Fig. 6.4).

Trunk attachment belt: this is necessary to keep the patient stable on the table during the shoulder manipulation by holding the trunk during the surgical procedure (Fig. 6.5).

Leg attachment belt: these are necessary to hold the patient stable on the table during the surgical procedure by binding the legs (Fig. 6.6).

Silicone support below the thigh and calf: by providing support below the thighs and calves during the surgical procedure, these are necessary to prevent the patient from slipping down (Fig. 6.7).

Forearm holder: this is necessary to provide patient comfort when the vascular route is opened by the anaesthetist and during monitoring and fixing of the non-operated upper extremity to the table (Fig. 6.8).

M. Bozkurt, H.İ. Açar (eds.), *Clinical Anatomy of the Shoulder*, DOI 10.1007/978-3-319-53917-1_6

Fig. 6.1 Standard operating room

Fig. 6.2 Standard anesthesia equipment

Fig. 6.3 Standard surgery table

Fig. 6.4 Side support bars

Fig. 6.5 Trunk attachment belt

Fig. 6.6 Leg attachment belt

Fig. 6.7 Silicone support below the thigh and calf

Fig. 6.8 Forearm holder

Shoulder table: this is used by many specialists for shoulder arthroscopy procedures. It is assembled by removing the adjustable head section of a standard surgery table and placing a shoulder table into the grooves (Fig. 6.9a–c).

The shoulder table can comfortably accommodate the patient in a sitting position (Fig. 6.10a, b); with apparatus which can be removed, the shoulder to be operated on can be easily taken into the space (Fig. 6.11a, b), and because of the adjustable head apparatus, the patient experiences less postoperative head and neck pain, and thus the case is more comfortable for both surgeon and patient.

Head holder: this is a fixed part of the shoulder table. With the head holder apparatus, the head of the patient can be distanced from the shoulder to be operated on, and the cervical region is fixed in a safer manner. The apparatus is held with loops below the chin and across the

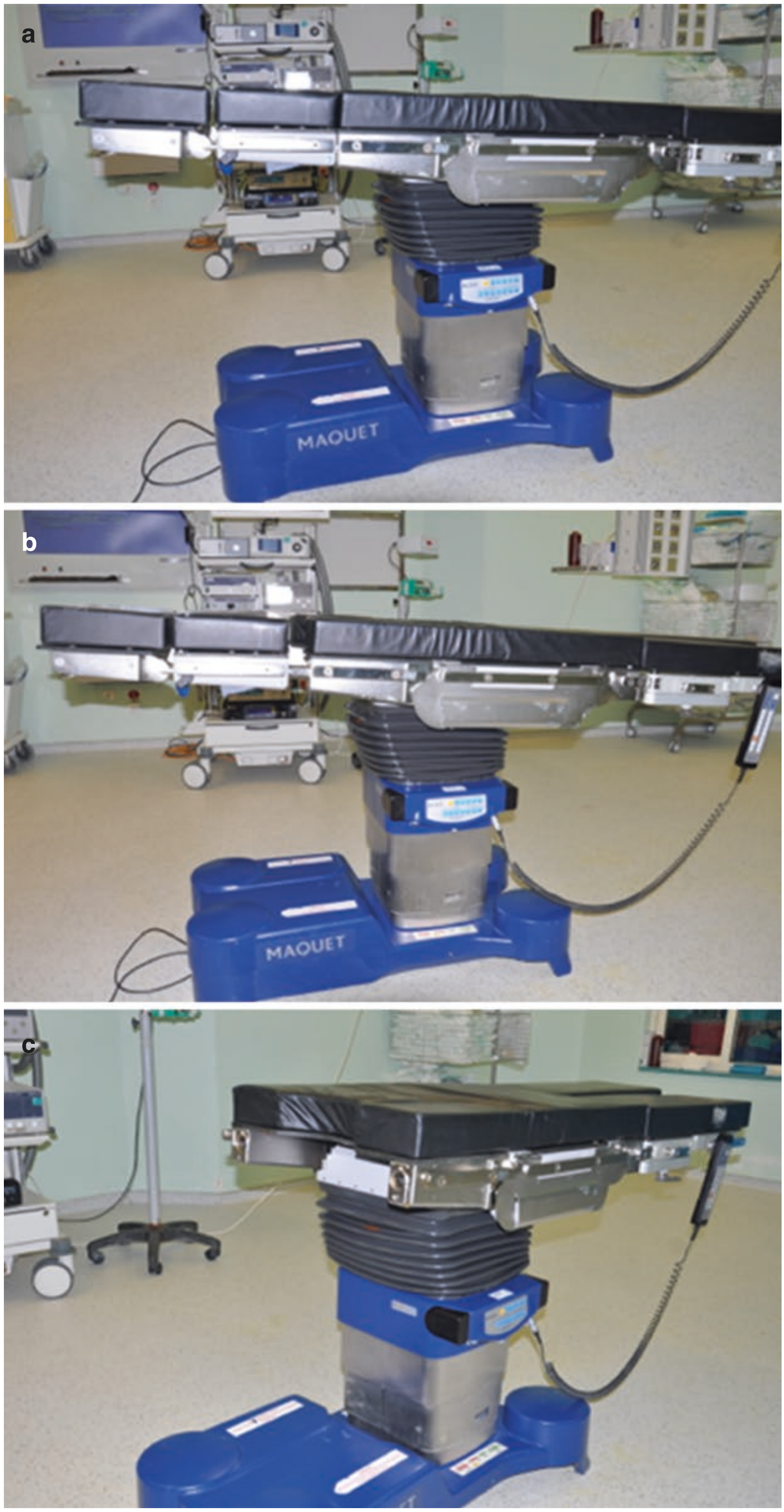

Fig. 6.9 Shoulder table

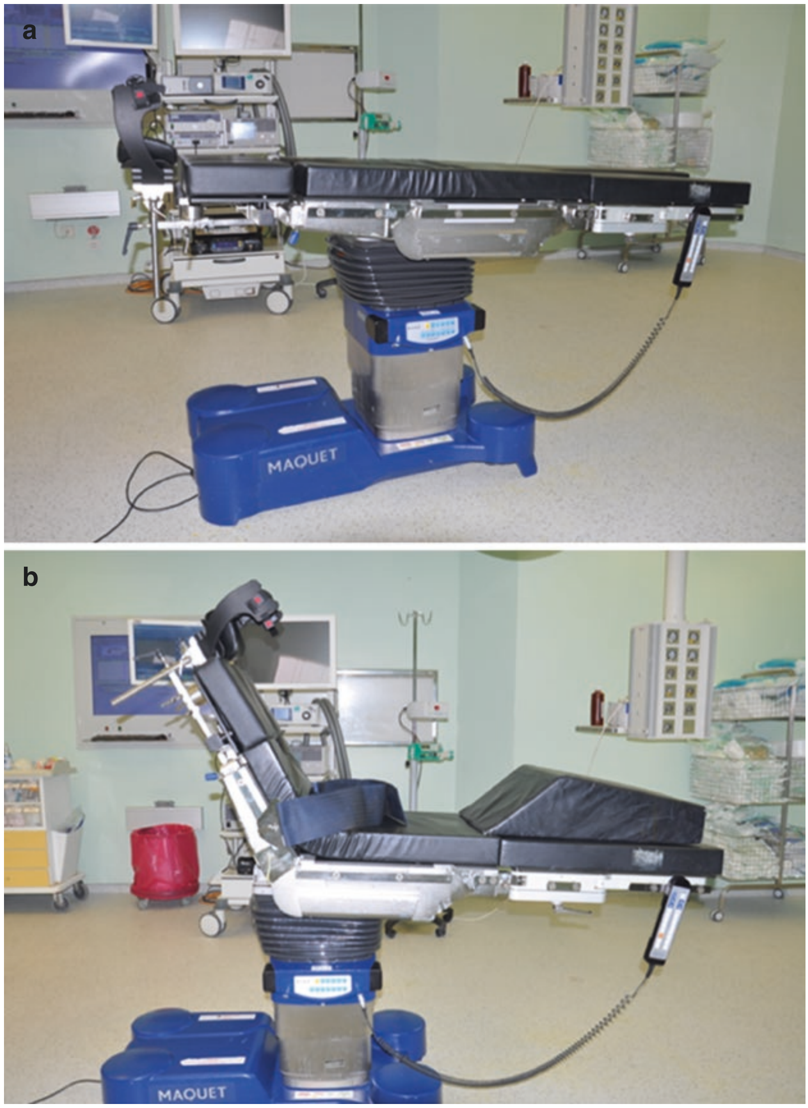

Fig. 6.10 The shoulder table taking into a sitting position

cheeks (Fig. 6.12). Thus, the head of the patient is prevented from slipping within the apparatus during shoulder manipulation in the surgical procedure.

Trunk attachment belt: this is necessary to keep the patient stable on the table during the shoulder manipulation by holding the trunk during the surgical procedure (Fig. 6.13).

Leg attachment belt: these are necessary to hold the patient stable on the table during the surgical procedure by binding the legs (Fig. 6.6).

Silicone support below the thigh and calf: by providing support below the thighs and calves during the surgical procedure, these are necessary to prevent the patient from slipping down (Fig. 6.7).

Shoulder traction apparatus: this is an apparatus compatible with both a standard surgery table and a shoulder table. With the shoulder traction apparatus, the arm of the patient to be operated on can be bound in a sterile manner, and the arm can be held in an appropriate position during the surgical procedure. Thus, during the case, the need is reduced for a second assistant for manipulation of the upper extremity to be operated on. Fixed traction and positioning can

Fig. 6.11 Remove the back shoulder support aparatus of the shoulder table

Fig. 6.12 Head holder

Fig. 6.13 Trunk attachment belt

Fig. 6.14 Shoulder traction apparatus

also be applied to the shoulder joint due to this apparatus (Fig. 6.14).

6.1.3 Operation Tables

A standard Mayo orthopaedic stand should be used in the operating room during shoulder arthroscopy. In routine procedures two Mayo stands are used. The first, the main Mayo stand, is close to the surgical team and used by the nurse immediately behind the first surgeon who is to perform the case. These basic instruments must be available on this table: marker pen, graspers, clamps, examination probe, manual suture instrument, knot pusher, hammer, pincers and cutting

Fig. 6.15 The first Mayo stand

Fig. 6.16 Basic instruments for shoulder arthroscopy

Fig. 6.17 The second Mayo stand

instruments in a kidney dish (no. 11 scalpel), scissors and a long spinal needle tip to determine portals (Figs. 6.15 and 6.16).

The second Mayo stand should be placed close to the patient's trunk in front of the patient table. The hand instruments most used during the surgical procedure are placed on this table. These are the light source, trochar, optic and camera, fluid pump system connection, shaver, radiofrequency probe and, for situations when it is necessary, an aspirator end and connection (Fig. 6.17).

6.1.4 Placement of the Surgical Team

During the operation, the first surgeon stands on the side of the shoulder to be operated on close to the head-trunk section of the patient table. The second surgeon stands next to the first surgeon on the side of the shoulder to be operated on, close to the forearm to be able to comfortably apply manipulation. The anaesthetist is at the head section of the patient table. The nurses are placed one immediately behind and to the right of the first surgeon and the other on the opposite side of the patient table next to the arthroscopy tower (Fig. 6.18).

6.1.5 Arthroscopy Unit Tower

The arthroscopy unit tower is furnished with standard equipment to be able to complete the arthroscopic shoulder surgical procedure in an appropriate and correct manner. The main equipment placed on the tower are, from top to bottom, the monitor, video camera box, light source, camera recording device, shaver console and radiofrequency console (Fig. 6.19).

The arthroscopy unit tower is placed exactly opposite the surgeon. In this way, all the monitor imaging and working procedure of the tower equipment are kept under the control of the surgeon.

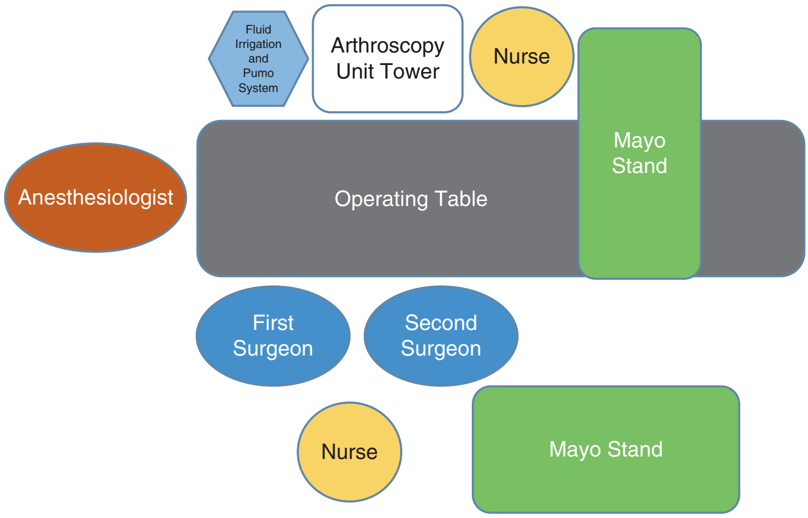

Fig. 6.18 Placement of the surgical team

Fig. 6.19 Arthroscopy unit tower

Fig. 6.20 Arthroscopic fluid pump system

6.1.6 Arthroscopic Fluid Pump System

The arthroscopic fluid pump system is placed next to the arthroscopic unit tower. However, to prevent the possibility of fluid leakage reaching electrical equipment, a suitable distance must be left. The pump system is operated on the fluid pumping principle at a specific pressure in the shoulder joint. With this system, the surgeon can increase or decrease the intra-articular fluid pressure. Therefore, the fluid pump system monitor must be facing the surgeon (Fig. 6.20a, b).

6.1.7 Fluid Collection on the Floor

The automatic aspirator systems in the room are generally sufficient for the rapid and large amount of fluid during arthroscopic shoulder surgery. Nevertheless, there may be an amount of fluid leakage on the floor. For the surgical team to work safely and comfortably and to facilitate room cleaning between cases, devices for the aspiration of fluid from the floor can be useful (Fig. 6.21). The ends are attached to the aspirator system, with one end at the head of the table and the other placed along the back. Thus, the working area of the surgical team can be kept as dry as possible.

6.1.8 Operating Room Personnel

As arthroscopic shoulder surgery is a procedure which includes specific equipment and techniques, it is a more comfortable procedure in the presence of qualified personnel. However, surgeons often have difficulty finding permanent qualified personnel for the operating theatre. In this context, it is extremely important that job definitions and responsibilities are defined from the beginning, and standardisation is applied to all personnel who are to work in the operating room. Thus, team spirit can be engendered in all the team members.

Fig. 6.21 Floor fluid collector

6.2 Patient Positioning

6.2.1 Beach Chair Orientation

Arthroscopic shoulder surgical procedures have recently been increasingly made in the beach chair position, which was first described by Skyhar et al. in 1988. For the technique in this position, generally shoulder tables are used which are compatible with the head section that can be removed from standard operating room tables (Fig. 6.22).

The patient is prepared in the supine position, and following intubation in cases applied with general anaesthesia, the head of the patient is placed in the head holder of the shoulder table (Fig. 6.23). Then the patient is moved into a sitting position, and a silicone cushion is placed as support under the thighs and calves to prevent the patient from slipping downwards (Fig. 6.24).

With the head and neck of the patient supported by the head holder of the shoulder table, the patient is slowly moved into a sitting position. The shoulder table can be raised to make an angle of mean 60–70° between the trunk of the patient and the floor (Fig. 6.25).

When the patient position is satisfactory, the head and neck are gently removed from the operation area and the head holder apparatus is fixed. Then the shoulder to be operated on is freed together with the shoulder support apparatus

Fig. 6.22 Beach chair position

Fig. 6.23 Head position after intubation

Fig. 6.24 Leg elevation with thigh support

Fig. 6.25 The shoulder table taking into the beach chair orientation

Fig. 6.26 Preparation of shoulder to be operated

Fig. 6.27 The shoulder is sterile covered

Fig. 6.28 Preparing arthroscopic portals

which can be removed from the shoulder table (Fig. 6.26). At this point, the contralateral upper extremity is fixed with the arm holder apparatus. Then the trunk belt is used to fix the trunk of the patient to the operating table.

The shoulder to be operated on is then sterile stained and draped. Holding the wrist of the patient, the surgeon positions the arm so that the whole upper extremity can be stained. After staining, the prepared shoulder joint arthroscopic surgery drapes are placed in position with attention given to leave an opening for the portal entry of the shoulder joint (Fig. 6.27). The shoulder joint and portal entries are marked with a skin pen, and the positioning of the patient for surgery is completed (Fig. 6.28).

Shoulder Arthroscopy Portals

7

Alper Deveci and Metin Dogan

7.1 Bony Landmarks

Before starting shoulder arthroscopy, the patient must be positioned and draping applied. Then the bony landmarks are identified with a skin marker. Lateral decubitus positioning is important, especially at this stage. Soft tissue swelling and traction which develop during an arthroscopic procedure are significant problems which can cause difficulties in the identification of the location of new portals to be opened because of variations in the position of existing portals. In these cases, the bony landmarks will be an indicator as there will be no significant change in the position of the bony landmarks. It is therefore of great importance to draw and identify the bony landmarks. The bony landmarks which are the easiest to palpate are the spina scapula and the posterolateral and anterolateral corners of the acromion (Fig. 7.1a). These are marked in the order of spina scapula, acromion posterolateral corner, acromion lateral edge, and anterolateral edge (Fig. 7.1b). Then the clavicular anterior and posterior borders are marked. The acromioclavicular joint can be easily palpated and identified. The coracoid process is identified by palpation. Finally, with the marking of the coracoacromial ligament, which extends between the acromion and the coracoid process, the marking of the bony landmarks is completed (Fig. 7.1c).

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7.2 Portals

The portals for the regions to be operated on are identified and named.

7.3 Glenohumeral Joint Portals

7.3.1 Posterior Portals

7.3.1.1 Posterior Portal (Soft-Spot Portal)

In all shoulder arthroscopy procedures, firstly a viewing portal is used. This is also used as a working portal in reverse Bankart repair and the remplissage procedure. It is 2 cm inferior and 1–2 cm medial from the acromion posterolateral corner (Fig. 7.2a). Known as the soft spot, an incision is made from this point below the acromion posterior edge as far as to allow entry of the arthroscopic trochar. The end of the trochar is advanced to show the tip of the coracoid process [1]. If the

M. Bozkurt, H.İ. Açar (eds.), *Clinical Anatomy of the Shoulder*, DOI 10.1007/978-3-319-53917-1_7

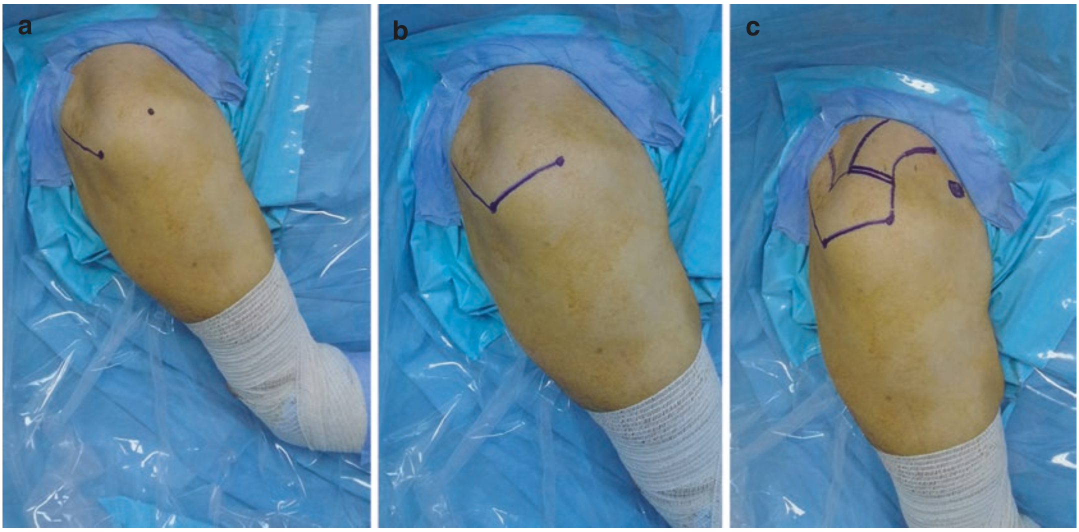

Fig. 7.1 Bony landmarks. (**a**) First the spina scapula, and the posterolateral and anterolateral corners of the acromion are identified. (**b**) In order, the spina scapula, acromion posterolateral corner, the lateral edge of the acromion and the anterolateral edge of the acromion are joined. (**c**) The clavicular nerves, acromion medial nerves and the acromioclavicular joint are marked. The coracoid process is identified and the coracoacromial ligament is marked

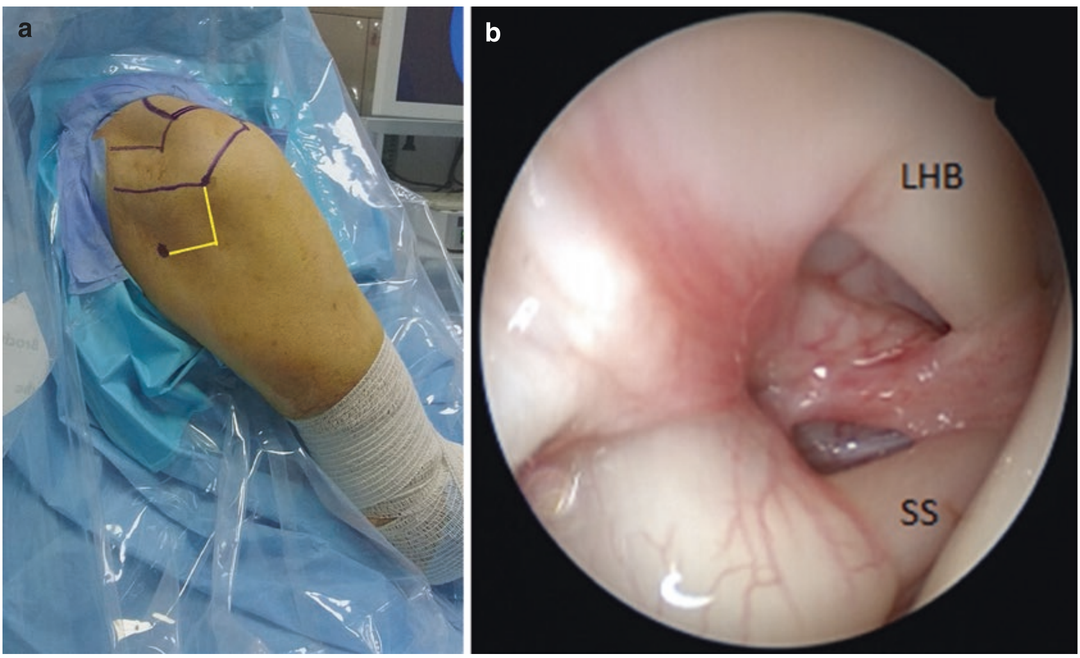

Fig. 7.2 Posterior portal. (**a**) Placement of the posterior portal is seen. It is 2 cm inferior and 2 cm medial from the acromion posterolateral corner. (**b**) After distending the joint with air, the rotator interval is seen from the posterior portal. *LHB* long head of biceps, *SS* subscapularis

patient is in the beach-chair position, the posterior capsule is drawn back by the assistant applying lateral traction to the arm.

Thus, the glenohumeral joint cavity can be felt better. The trochar is placed inside the joint by passing within the infraspinatus muscle or between the infraspinatus and the teres minor. The trochar is withdrawn within the arthroscopic sheath and is replaced by the scope. After placement of the scope, the joint is inflated with 30–50 cc air via the arthroscopic sheath. Air-distended diagnostic arthroscopic examination is then made (Fig. 7.2b). After this stage, while there is air in the joint or after distension of the joint with water, the anterior portal is opened.

Structures at risk: axillary nerve, suprascapular artery and nerve

7.3.2 Posteroinferior Portal (7 O'clock Portal)

This is used in posterior Bankart repairs. It is located 1 cm inferior and 1 cm lateral to the standard posterior portal [2].

Structures at risk: axillary nerve, suprascapular nerve

7.4 Anterior Portals

7.4.1 Anterior Central Portal (Matthews Portal)

The location of the portal is marked to be lateral to the coracoid process and anterior to the acromioclavicular joint [3] (Fig. 7.3a). Entry is made with a 19G spinal needle. A triangle is formed of the glenoid in the medial, the humerus head in the lateral and the biceps tendon superior and the posterior portal route is observed. The spinal needle is advanced from this entry point marked on the skin into this triangle in such a manner as to remain over the subscapularis tendon. The spinal needle is seen within the joint to be in the centre of this triangle (Fig. 7.3b). If the needle position and orientation are appropriate, the needle is withdrawn. The portal is opened on the same axis using a scalpel and haemostasis forceps. This portal is used in procedures such as anterosuperior labral repair, biceps tenotomy and tenodesis, subscapular

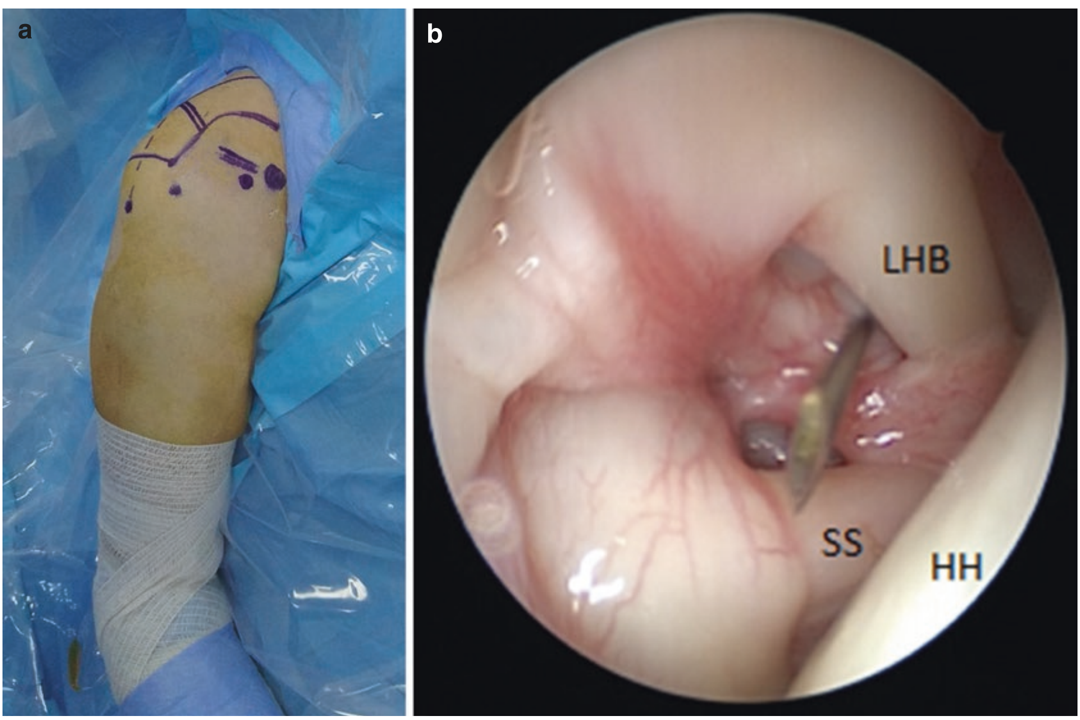

Fig. 7.3 (**a**) Anterior central portal. (**b**) The intra-articular projection of the anterior central portal. *LHB* long head of biceps, *SS* subscapularis, *HH* humeral head

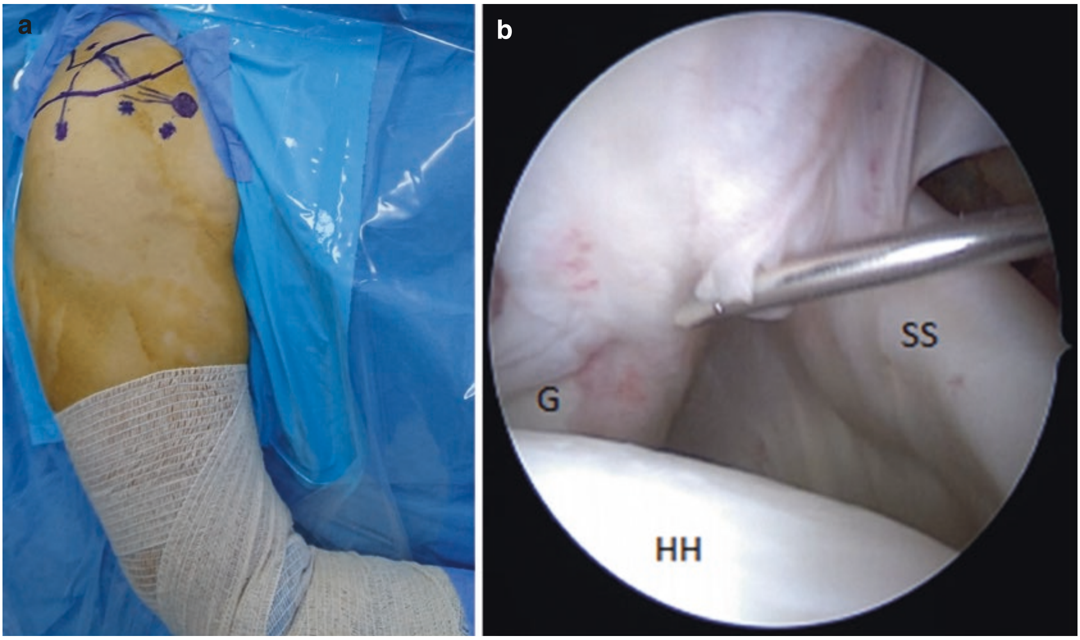

Fig. 7.4 (**a**) Anteroinferior portal. (**b**) The intra-articular projection of the anteroinferior portal. The image taken from the superolateral portal. The spinal needle is advanced within the joint to be immediately over the subscapular tendon. *SS* subscapularis, *HH* humeral head, *G* glenoid

tendon repair, Bankart repair and coracoplasty. To avoid neurovascular complications, the bony landmarks, especially the coracoid process, must certainly be marked before the portal is opened.

Structures at risk: axillary nerve and artery, cephalic vein, musculocutaneus nerve

7.4.2 Anteroinferior Portal (Wolf's Portal)

The entry point is inferolateral to the coracoid process [4]. Placement within the joint must be immediately over the subscapular tendon. This portal is used in anchor placement, knot management and capsular plication in repairs of the anterior labral and anteroinferior capsulolabral complex. (Fig. 7.4a and b).

Structures at risk: axillary nerve and artery, musculocutaneus nerve, cephalic vein

7.4.3 Anterosuperior Portal

This is immediately anterior to the long head of the biceps tendon (Fig. 7.5a and b). This portal is generally used as a viewing portal during capsulolabral repair. It can also be used as a retrieval portal if needed.

7.4.4 Five O'clock Portal

This has been named taking the right shoulder as the basis. It is marked on the anteroinferior of the glenoid and is opened with the inside-out technique. The formation of this is extremely risky. The posterior portal is used as a viewing portal. The optic is advanced at the level of 5 o'clock towards the anteroinferior [5]. When the arthroscopic sheath is resting on the anterior capsule, the optic is withdrawn from the arthroscopic

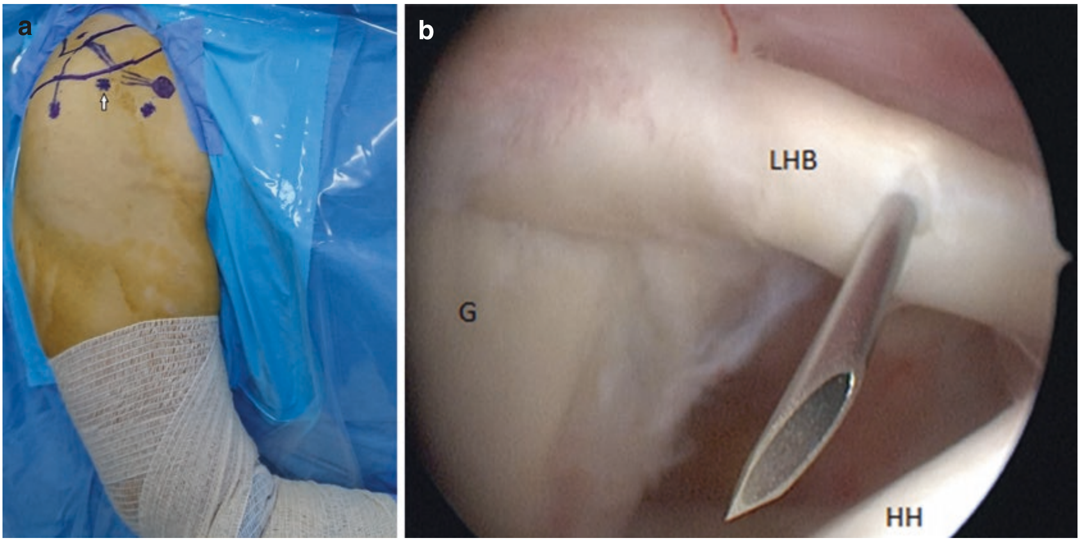

Fig. 7.5 (**a**) Anterosuperior portal. (**b**) The intra-articular projection of the anterosuperior portal. *LHB* long head of biceps, *HH* humeral head, *G* glenoid

sheath and a Wissinger rod is advanced inside the sheath. It is passed by perforating the anterior capsule, and then by making a skin incision, the end of the Wissinger rod is withdrawn out of the skin. A cannula on the Wissinger rod, which has been withdrawn from the skin, is advanced to the joint. When applying these procedures, the shoulder must be positioned in full adduction and thus the anterior neurovascular structures are medialised. This portal is the least reliable and most dangerous approach which is used in shoulder arthroscopy in operations related to the glenohumeral joint.

Structures at risk: axillary nerve and artery, musculocutaneus nerve, cephalic vein

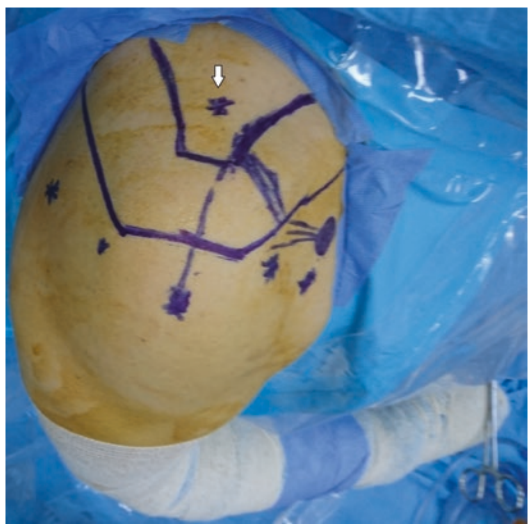

Fig. 7.6 Neviaser's portal (supraclavicular fossa portal)

7.4.5 Neviaser's Portal (Supraclavicular Fossa Portal)

This is known as the supraspinatus portal or the superior portal [6]. It is bordered by the clavicle in the anterior, the spina scapula in the posterior and the medial edge of the acromion in the lateral (Fig. 7.6). It is used in SLAP repair, in retraction of the nerve during suprascapular nerve loosening and in supraspinatus cuff tear repair.

Structures at risk: suprascapular nerve and artery

Fig. 7.7 Port of Wilmington

Fig. 7.8 Superolateral portal

7.5 Lateral Portals

7.5.1 Port of Wilmington

It is located 1 cm lateral and anterior to the acromion posterolateral corner (Fig. 7.7). It is used for posterior SLAP repair. Cannula use is not recommended because of damage to the infraspinatus tendon.

Structure at risk: axillary nerve

7.5.2 Superolateral Portal

It is immediately lateral to and below the anterolateral margin of the acromion [7] (Fig. 7.8). This portal is used in Bankart repair.

Structure at risk: Axillary nerve

7.6 Subacromial Portals

7.6.1 Posterior Portals

7.6.1.1 Posterior Central Portal

It is within the soft spot and is generally used as a viewing portal. It is opened as in glenohumeral joint evaluation. After incisions to the skin and subcutaneous tissue with a scalpel, a blunt trochar, making contact with the lower surface of the acromion, is advanced towards the coracoid tip over the joint capsule and the rotator cuff (Fig. 7.2a).

Structures at risk: axillary nerve, suprascapular artery and nerve

7.6.2 Posterolateral Portal

It is 2 cm lateral to the posterolateral edge of the acromion (Fig. 7.9). It greatly facilitates rotator cuff repair and the visualisation of the acromioclavicular joint. This portal enables ease of movement of the arthroscopic instruments, manual instruments and the scope. In respect of neurovascular structures, it is an extremely safe portal. The closest neurovascular structure at risk is the axillary nerve (55 mm).

7.7 Anterior Portal

It is between the lateral of the coracoid process and the acromion anterolateral corner (Fig. 7.10).

Fig. 7.9 Posterolateral portal

Fig. 7.10 Opening of the anterior portal with the inside-out technique

This portal is immediately lateral to the coracoacromial ligament. If it is inside the coracoacromial ligament and if this ligament is damaged, bleeding will occur and movement of the instruments will be restricted.

Structures at risk: axillary nerve, cephalic vein

Fig. 7.11 Lateral portal

7.8 Lateral Portals

7.8.1 Lateral Portal

The line drawn from the posterior edge of the acromioclavicular joint is extended as far as 2 cm lateral of the lateral acromion, and the finishing point is the lateral portal entry (Fig. 7.11). It can be used as both a viewing portal and a working portal.

Structure at risk: axillary nerve

7.8.2 Anterolateral Portal

At the level of the anterolateral corner of the acromion, it is 2 cm lateral from the line of the acromion anterior edge. It is a safe portal in respect of neurovascular structures [8]. This is an important portal in acromioplasty and acromioclavicular joint interventions (Fig. 7.12).

Structure at risk: axillary nerve

Fig. 7.12 Anterolateral portal

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