Sanghoon Park
Editor

Facial Bone Contouring Surgery

A Practical Guide

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ISBN 978-981-10-2725-3 ISBN 978-981-10-2726-0 (eBook)
DOI 10.1007/978-981-10-2726-0

Library of Congress Control Number: 2017953022

Printed on acid-free paper

This Springer imprint is published by Springer Nature
The registered company is Springer Nature Singapore Pte Ltd.
The registered company address is: 152 Beach Road, #21-01/04 Gateway East, Singapore 189721, Singapore

Preface

Surgery on the facial bone, which was introduced by Dr. Tessier, has evolved through Dr. McCarthy in the last 60 years. From this background, facial bone contouring surgery has evolved from Dr. Se-Min Baek in the last 30 years. In both fields, I have been a witness to the progress of this discipline in Korea and in New York. Facial bone contouring surgery has gained popularity recently in many Asian countries, including Korea. Sequentially, it has become increasingly popular in Western countries, especially with the increase in surgical demands among the Asian populations who live in Western regions. Thus, it is about time for facial surgeons who are in clinical practice in either Asian or Western countries to learn and master the various surgical techniques for facial bone contouring surgery.

Meanwhile, previous publications on facial bone surgery are mainly textbook based and thus have limitations on covering the various surgical procedures for cosmetic purposes. Moreover, they lack in-depth information and state-of-the-art knowledge on facial bone contouring surgery because most books are written simply as an introduction to the fields of facial bone surgery. Facial bone contouring surgery has its basic techniques and procedures based on conventional craniofacial techniques. However, its unique techniques and procedures have been developed because patients require more-aesthetic results, a shorter operation time, and faster recovery. The development in anesthesiologic techniques and nursing support also contributed greatly to the development of a more patient-oriented surgical environment. For facial surgeons interested in facial bone contouring surgeries and willing to practically perform the surgeries, these changes and challenges must be fully understood and adequately prepared for.

This guidebook is aimed at providing a practical and detailed guide on how to perform various surgical techniques for facial bone contouring. Most textbooks are too principle oriented and too thick to read during preparation for surgery. I discovered that many fellow surgeons in my institute read copies of different articles on facial bone surgery for preparation of surgery. This book has been written and edited in separate chapters according to the unit of facial bone surgery so that surgeons can obtain all the knowledge required to perform the unit surgery without reading other chapters or reading the book cover to cover. Based on clinical experiences of over 10,000 cases of facial bone surgeries performed by the authors in our institute, this book describes accurately and in detail how the authors actually performed each surgical procedure. Guidance is provided on preoperative patient assessments,

step-by-step procedures for various surgical techniques, case studies, and complications and their management. Our institute has treated more than 6000 patients from more than 30 countries worldwide. Different needs and surgical variations are described according to ethnic and national variations.

The authors had no hesitation in exposing and describing the most up-to-date and undivulged practical techniques. We owe most of our current knowledge to our predecessors and other active surgeons. We hope this guidebook will lead surgeons across nations to safely achieve optimal surgical outcomes in their clinical practices. We also hope that facial bone contouring surgery will be a good solution for people who suffer from pain caused by their facial appearance and allow them to live happily.

Lastly, we thank all the contributors from ID Hospital and especially Professors Rong-Min Baek and Baek-Kyu Kim. I personally thank all the members of ID Hospital (called “Idius”) for their devotion and my family, Junghyun and Jihyun for their invaluable support.

Seoul, South Korea Sanghoon Park, M.D.

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Part I

General

Why Facial Bone Contouring Surgery?: Backgrounds

1

Sanghoon Park

Beauty Is Bone-Deep

The Western proverb says that "beauty is only skin-deep." So, is it true? I do not agree. If that is true, plastic surgery might be only a single chapter in dermatology. Moreover, many plastic surgeons complain that even after a successful operation on one's eyes or nose, the overall change on the patient's aesthetics is not that big at all. Now we all know very well that without any change on this shape of the face, there are limitations with any other kind of cosmetic surgeries. The shape of one's face is constructed with bone. The marked differences between Caucasian and Asian face mainly come from the facial bone structure. Now we can say that "beauty is bone-deep."

Beautiful Facial Structure

Ethnicity is one of the major factors that create difference in the facial bone structure. For example, as most Caucasians are dolichocephalic, the majority of Asians are brachycephalic (Fig. 1.1). This can be understood by considering the development of the skull based on sutures. We all know the difference in shapes of the skull and face between brachycephaly and scaphocephaly. As the dolichocephalic features of the face of Caucasians resemble to that of scaphocephaly, the brachycephalic Asian face corresponds to the features of brachycephaly. Facial shape in the frontal view also differs between racial groups. The faces of Caucasians tend to be long and narrow, while the faces of Asians tend to be wide and short. Consequently, Asian face usually gives a square impression (Fig. 1.2). When we travel around the world, we can easily differentiate people from Asia and Europe, because their facial structures are totally different. Now, the following question should be asked, "which face is beautiful?"

Studies on Facial Structure

Studies have been done to describe, compare, and present the shape of the face. In general, one of the ways of describing a face is based on the profile of the face. It measures the position, length, and angle of the upper, middle, and lower face. This may be based on surface anatomy (anthropometry) or on X-ray (cephalometry). Especially, cephalometry based on the lateral X-ray led to more accurate and objective measurements. And finally, many researches established the standard of a beautiful and ideal face type. For example, the ideal ratio of the upper, middle, and lower face is 1:1:1, and the position of the chin should be

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S. Park (ed.), *Facial Bone Contouring Surgery*, DOI 10.1007/978-981-10-2726-0_1

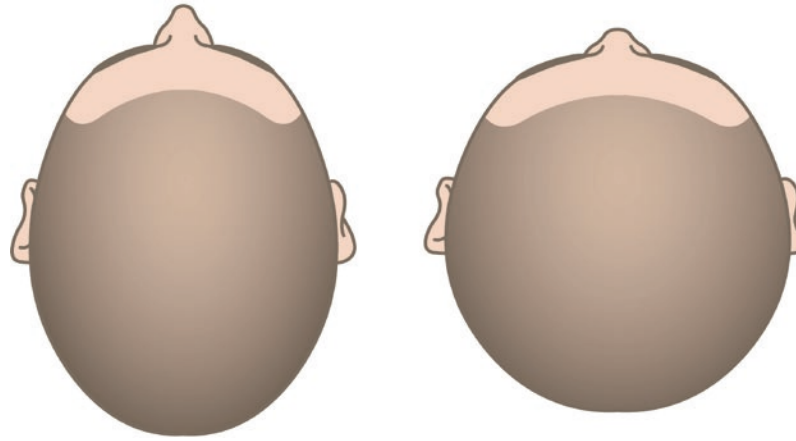

Fig. 1.1 Comparison of face in head shape. Dolichocephalic head shape in Caucasians (*left*) and brachycephalic head shape in Asians (*right*)

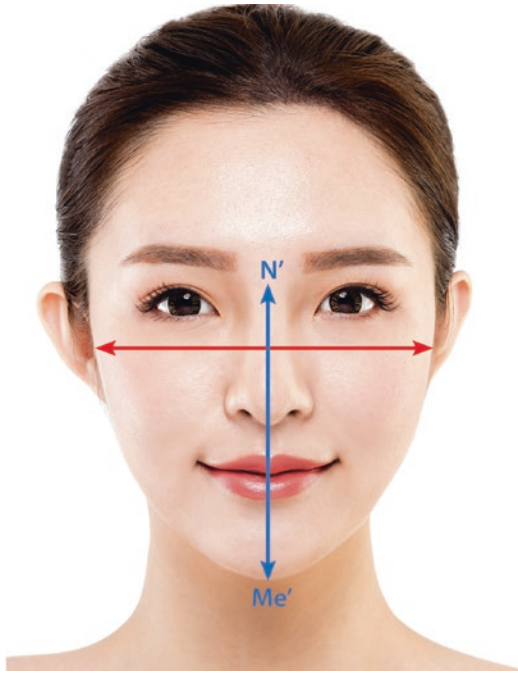

Fig. 1.2 Facial index. Facial shape in frontal view is different in terms of length/width ratio. Caucasian face tends to be long and narrow while Asian face tends to be wide and short. Asian face gives a square impression

placed slightly behind the vertical perpendicular line from nasion. Another way of describing the facial shape is from the frontal view. The facial index is a ratio of length and width of the face in a frontal view. Frontal cephalometry is also used, but less frequently. Recently, studies are done on three-dimensionally by using 3-D CTs (Table 1.1).

Table 1.1 Comparison of facial shape between Caucasians and Asians

	Asians	Caucasians
Facial shape	Brachycephalic	Dolichocephalic
Facial index	0.98	1.09
Ideal facial profile	Convex profile	Apollonian face
Ideal facial proportion	1:1:0.8	1:1:1

Beauty Keeps Changing

Studies on the ideal face showed there is a huge difference between Asians and Caucasians [1]. Regarding the vertical proportion of the face, Asians prefer a short chin compared to Caucasians. However, this kind of aesthetic preferences also differs between nations. For example, as Japanese people usually prefer a round and short chin, Chinese people prefer a sharp long chin. It is quite natural that these aesthetic standards keep on changing for decades. You will easily find the beauties in old painting are not appealing to you anymore. Cultural trends also play an important role in the standards of beauty. For example, after a hit of a movie, the movie star becomes a trendy beauty icon. With the developments of communication and transportation, beauty standard tends to be globalized and synchronized. As SPA brands lead the fashion trends, beauty standards are also commercialized by mass media and global companies.

Aesthetic Facial Bone Surgery

Various problems cause the needs for correction of facial bone. For example, injury to facial bone due to motor vehicle accidents requires the correction or reconstruction. Congenital anomaly and tumor are other common reasons. Surgeries on the facial bone and craniofacial surgery have been developed by pioneers such as Tessier, Obwegeser, and others since the 1940s. However, it is quite recent that aesthetic surgical corrections of the facial bone was started to be performed. Whitaker and other craniofacial surgeons started to perform the aesthetic contouring of the face [2]. However, history of facial bone contouring surgery which is popular these days started with the introduction of mandible reduction by Baek [3]. As you can easily suspect, the aesthetic facial bone surgeries performed in Asia and Western countries are different in many aspects.

Why Facial Bone Surgery Became so Popular in Asia?

Authors classified the chin shape in frontal view and investigated the incidence and preference [4] (Fig. 1.3). In Asia, many people have round chins but want to have a more sharp and V-shaped chin. This discrepancy explains for the needs of plastic surgery on the chin. As mentioned before, there is a big difference in facial morphology between Asians and Westerns. In the profile and overall facial shape, there are also big discrepancies in the actual shape and ideal shape in Asian countries including Korea, China, Japan, and Southeast Asia. And commonly, patients who undergo facial bone surgery seeks for a more soft and feminine impression. These characteristics are favored especially in Asian countries. Some transgender patients also seek for facial feminization through facial bone surgery. The fact that facial bone surgery can make a typical Asian face to a small and soft one is the most appealing reason for its popularity. Also the profile changes accompanied by facial bone surgery make people look younger. Looking young and healthy is universally admired, especially when people get rich and surgery became affordable and popular.

Advances in Facial Bone Surgery

With the advances in surgical skills and anesthesiologic techniques, patients stay only a few days in hospital and can get back to work after short break. Most of the techniques used in facial bone surgery have originated from craniofacial surgery. However, more specific techniques have been developed recently and new devices were also invented. Uses of oscillating saw greatly improved the quality of mandible contouring surgery. Patients, who previously spent a day in ICU, now have a surgery in outpatient basis. Surgery gets shorter and speedier and the amount of bleeding becomes less. Intermaxillary fixation is rarely required in orthognathic surgery. Orthodontic treatment became more powerful to control the teeth, and surgery-first orthognathic surgery becomes more popular. Final huddles to facial bone surgery were overcome.

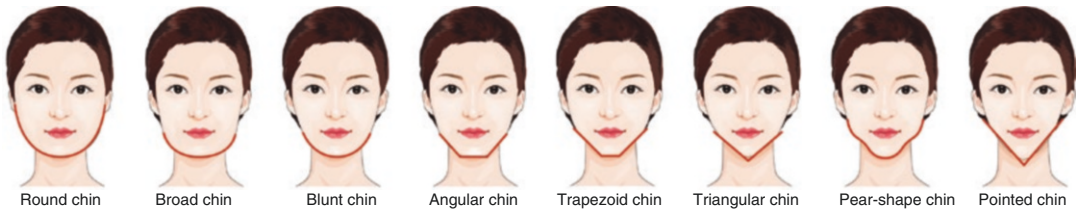

Fig. 1.3 Classification of chin. Chin shape may differ and its preference also may differ among ethnic groups and nations. Asian people has relatively round or broad chin, but want to have triangular or trapezoid chin

Why Global?

More and more facial bone surgeries are performed globally. The authors have patients coming from all over the world. In some countries, facial bone surgery is not that popular and only few doctors are accustomed to it. Patients told that they had difficulties in communicating with doctors in their countries. Asians living in Western countries still have their own tradition and culture. They still want to have a feminine and softer look. They complain that doctors in their countries do not understand exactly what they want. Surgeons should first understand the ethnic characteristics of their faces and later understand the cultural aesthetic standard and patient's motivation for surgery.

Surgeon's Mission

By reading this book, authors expect the readers and surgeons from all over the world would understand this goal and background as well as surgical skill itself. In aesthetic surgery, patient satisfaction can only be guaranteed through surgeon's empathy with the patients' inner motivation.

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Essential Surgical Anatomy for Facial Bone Contouring Surgery

2

Jongwoo Lim

Pearls

1. In this chapter, reader can be reminded of the essential anatomy that should be respected when performing facial bone contouring surgery.
2. Inferior alveolar nerve is the most important anatomic structure during mandible reduction surgery. Because the course is variable by individuals, surgeon should keep in mind the entire course before and during mandible reduction surgery.
3. Infraorbital nerve is the most important nerve in midfacial region during malar reduction or augmentation surgeries. Therefore surgeon should check the location of infraorbital foramen before surgery and pay attention in order not to irritate the nerve during surgery
4. Facial nerve palsy after facial bone contouring surgery is uncommon, but it can cause significant, persistent symptoms. The temporal branch and the marginal mandibular branch are the most vulnerable branches during facial bone contouring surgery. Thus, surgeon should be cautious in dangerous zones.
5. Major vessels such as facial artery, vein, and retromandibular vein could be damaged during mandible reduction surgery. It leads to profuse bleeding which cannot be controlled easily by electrocauterization. Therefore, prevention is the best way for these major vessel injuries.
6. Because mentalis muscle is the only elevator of the lower lip and chin, it must be carefully reattached after anterior vestibular approach. If this muscle is not properly repositioned during closure, the chin will droop and the lower lip will take on a sagging appearance.

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Introduction

Clear knowledge and understanding of facial anatomy is crucial for safe and reliable facial bone contouring surgery. Because important anatomic structures can be influenced or damaged during facial bone contouring surgery, surgeon must respect the critical structures such as nerve and vessels. If irreversible damage to these structures happens, it will be a disaster to both patient and surgeon. Thorough understanding of anatomy is important not only for the safety but also for the good result of surgery.

In malar reduction surgery, the frontal branch of facial nerve is at significant risk of injury in the area right above the zygomatic arch. Pitanguy's line is an accurate description of the course of the largest and more significant branch of the temporal division of the facial nerve [1].

In mandible reduction surgery, the inferior alveolar nerve and the mental nerve is at high risk

S. Park (ed.), *Facial Bone Contouring Surgery*, DOI 10.1007/978-981-10-2726-0_2

of injury during the osteotomy for genioplasty or angle reduction. Therefore preoperative evaluation of the course of inferior alveolar nerve is very important to determine safe and optimal osteotomy levels.

Facial artery and vein and retromandibular vein should be protected while performing osteotomy in order not to cause excessive bleeding and related complications. Although it can be managed in most cases, it would be very embarrassing to the beginning surgeons and might led to disastrous complications without skilled surgeon's help. So, prevention is the best way especially for major vessel injury.

Musculature and fat components are thought to be relatively less important than nerves and vessels. However these are also important because patients can feel discomfort and surface contour dissatisfaction such as chin ptosis and cheek hollowness.

In the following, you can remind of important anatomic structures in orders.

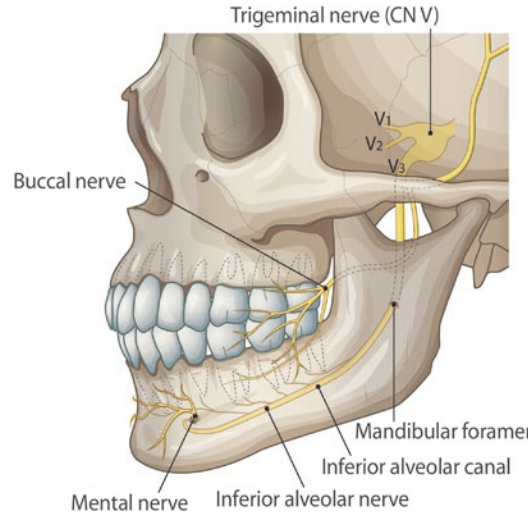

Fig. 2.1 The course of inferior alveolar nerve and mental nerve. The inferior alveolar nerve is the largest branch of the mandibular division of the trigeminal nerve (CN V) and carries sensory and motor fibers. The IAN travels through the inferior alveolar canal which is positioned at a variable vertical height. The mental nerve exits the mental foramen that is located midway between the alveolar and basal borders of the mandible and is usually below or slightly anterior to the second premolar tooth

Nerves

Inferior Alveolar Nerve (Fig. 2.1)

The inferior alveolar nerve (IAN) is the largest branch of the mandibular division of the trigeminal nerve (CN V) and carries sensory and motor fibers. It gives off a branch, the mylohyoid nerve, and then enters the mandibular foramen [2]. The inferior alveolar canal can be positioned at a variable vertical height that has to be assessed in the preoperative imaging. The canal may draw a downward curve below the level of the mental foramen. An anatomic study by Hwang et al. reported that the average distance from the mental foramen to the mandibular canal is 4.5 ± 1.9 mm [3]. So it is important that the osteotomy should be at least 5–6 mm below the foramen to avoid any direct nerve injuries. The IAN is accompanied by the inferior alveolar vessels in its course through the mandibular canal. Within the inferior alveolar canal, the IAN fascicle forms into inferior dental plexus. These neural structures give rise to the inferior dental branches and the inferior gingival branches providing sensation to the teeth and gums. The IAN bifurcates at the mental foramen with a major portion exiting as the mental nerve. The minor quantity of fibers continues anteriorly inside a canalicular structure as an incisal bundle to innervate the mandibular canines and incisors.

The mental nerve provides sensation to the skin and mucosa of the lower lip, the skin in the region of the chin, and the facial gingiva of the anterior teeth. The mental nerve exits the mental foramen that is located midway between the alveolar and basal borders of the mandible and is usually below or slightly anterior to the second premolar tooth. The mental nerve divides under the depressor anguli oris muscle into three main branches; one descends to the skin of the chin, and the other two ascend to the skin and mucous membrane of the lower lip and gingiva [4].

Infraorbital Nerve (Fig. 2.2)

The most important neurovascular structure that must be negotiated during procedures in the

midfacial region is the infraorbital neurovascular bundle. The infraorbital nerve is the largest cutaneous branch of the maxillary division of the trigeminal nerve (CN V). The artery and vein that accompany the infraorbital nerve are surgically insignificant. The nerve exits the infraorbital foramen, 7–10 mm inferior to the infraorbital rim just medial to the zygomaticomaxillary suture, or approximately at the medial and middle thirds of the orbit [3]. After exiting the infraorbital foramen, the infraorbital nerve divides into terminal branches that spread fanlike into the lower eyelid, nose, and upper lip. Three of the four superior labial branches enter the lip between its muscles and the mucous membrane. These nerves supply not only the mucous membrane of the upper lip, but also its skin, which they reach by perforating the orbicularis oris muscle. Damage to this nerve results in loss of sensation in these areas, and possibly dysesthesia. Therefore surgeon should check the location of infraorbital foramen before surgery and pay attention in order not to irritate the nerve during surgery, especially malar reduction or malar augmentation surgery using implants. In malar reduction surgery, the position of plate and screws should be determined after confirmation that they won't disturb the infraorbital nerve. Because proximity of plate and screws to the foramen can cause irritation to the nerve, plate should be cut in case of too narrow space between the nerve and osteotomy line. In augmentation malarplasty using implant, the implant should be trimmed and positioned carefully in order not to compress or disturb the infraorbital nerve.

Zygomaticotemporal/ Zygomaticofacial Nerve (Fig. 2.2)

During the dissection of the inferior portion of the lateral orbital wall, two branches of the sensory zygomatic nerve (branch of V2), the zygomaticotemporal and zygomaticofacial nerve, are identified. They pierce the periorbital sac, traverse the opened subperiosteal space, and exit the orbit laterally. The zygomaticotemporal nerve can ascend in a groove on the lateral orbital wall and will enter a canal in the orbital surface of the zygoma, leading to the temporal fossa. The zygomaticofacial nerve also runs through a canal in the zygoma and exits laterally over the prominence of the zygomatic body.

The subperiosteal dissection of the lateral orbital wall from an inferior access usually requires division of these two sensory branches

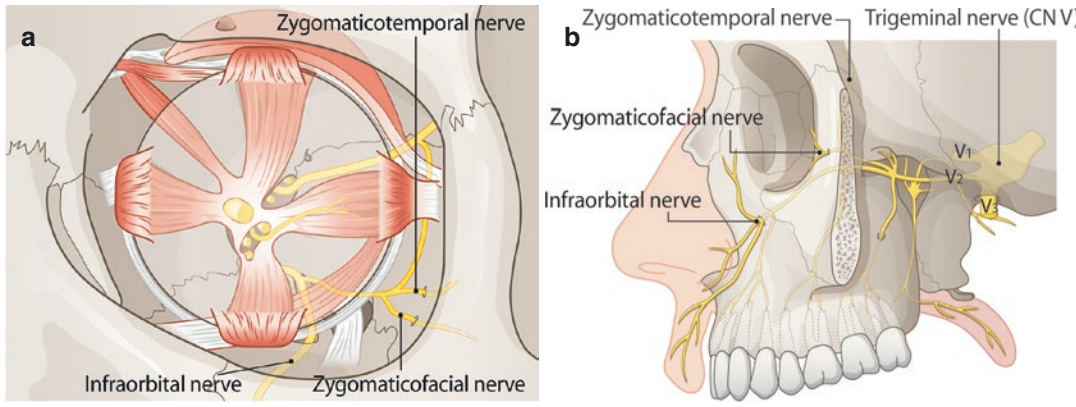

Fig. 2.2 Infraorbital nerve, zygomaticofacial nerve, and zygomaticotemporal nerve. ((**a**) Frontal view (**b**) Lateral view) The infraorbital nerve is the largest cutaneous branch of the maxillary division of the trigeminal nerve (CN V). After exiting the infraorbital foramen, the infraorbital nerve divides into terminal branches that spread fanlike into the lower eyelid, nose, and upper lip. The zygomaticotemporal and zygomaticofacial nerve pierce the periorbital sac, traverse the opened subperiosteal space, and exit the orbit laterally. They innervate sensation to the skin over their distribution in the area of the lateral orbital margin and the prominence of the zygomatic body

of the zygomatic nerve, causing loss of sensation to the skin over their distribution in the area of the lateral orbital margin and the prominence of the zygomatic body [5]. In malar reduction surgery, these two nerves can be damaged during dissection or ostectomy resulting in about a coin-sized insensate area near the lateral orbit. Therefore careful dissection should be made near the lateral orbit to identify these nerves and preserve them if it is possible.

Facial Nerve (Fig. 2.3)

The main trunk of the facial nerve (CN VII) emerges from the skull base at the stylomastoid foramen. It lies medial, deep, and slightly anterior to the middle of the mastoid process at the lower end of the tympanomastoid fissure. After giving off the posterior auricular and branches to the posterior digastric and stylohyoid muscles, it passes obliquely, inferiorly, and laterally into the substance of the parotid gland. It divides into the temporofacial and cervicofacial divisions at a point vertically below the lowest part of the bony external auditory meatus. The terminal branches of the facial nerve emerge from the parotid gland and radiate anteriorly. They are commonly classified as temporal (frontal), zygomatic, buccal, marginal mandibular, and cervical. Among these, the temporal branch and the marginal mandibular branch are significant because they might be injured during facial bone contouring surgeries.

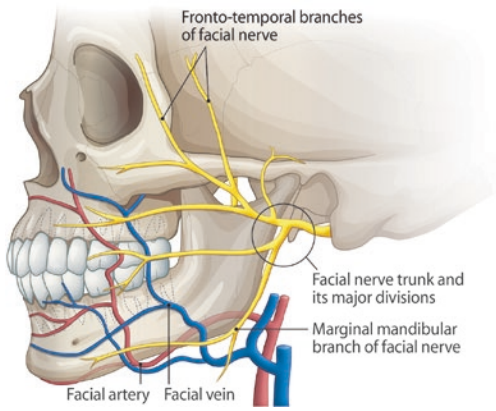

Fig. 2.3 Facial nerve, artery, and vein. The main trunk of the facial nerve (CN VII) emerges from the skull base at the stylomastoid foramen. The terminal branches of the facial nerve emerge from the parotid gland and radiate anteriorly. They are classified as temporal (frontal), zygomatic, buccal, marginal mandibular, and cervical. The facial artery originates from the external carotid artery, grooving or passing through the submandibular salivary glands as it rounds the lower border of the mandible. It is visible on the external surface of the mandible around the anterior border of the masseter muscle. The facial vein begins as the angular vein, courses along with the facial artery above the level of the inferior mandibular border. The facial vein runs across the surface of the submandibular gland to end in the internal jugular vein

The temporal branch crosses the zygomatic arch to the temporal region. This is why surgeons should pay much attention in order not to damage these branches during zygomatic arch dissection for the osteotomy in malar reduction surgery. The location of the temporal branch varies individually, but may located anywhere from 8 to 35 mm (average 20 mm) anterior to the external auditory canal [6].

The marginal mandibular branch coursed obliquely and anteriorly downward. It frequently rises from the main trunk well behind the posterior border of the mandible and crosses the posterior border in the lower one third of the ramus. It passes forward beneath the platysma and depressor anguli oris, innervating the muscles of the lower lip and chin, such as depressor labii inferioris, depressor anguli oris, and mentalis [7].

Facial nerve palsy after facial bone contouring surgery is uncommon, but it can cause significant, persistent symptoms such as drooping of eyebrow and asymmetry of mouth corner. The temporal branch is especially vulnerable to damage because it is terminal branch and have fewer communication than other branches. Therefore, the temporal branch of facial nerve should be respected during zygomatic arch dissection and osteotomy. The marginal mandibular branch can be damaged during genioplasty by reciprocating saw or during mandible contouring by oscillating saw or during hemostasis by electrocautery. Thus, surgeon should pay attention in order not to damage the marginal mandibular branch during these procedures.

Vessels

Facial Artery (Fig. 2.3)

After it originates from the external carotid artery, the facial artery follows a cervical course during which it is carried upward medial to the mandible and in fairly close contact with the pharynx. It runs superiorly, deep to the posterior belly of the digastric and stylohyoid muscles, and then crosses above them to descend on the medial surface of the mandible, grooving or passing through the submandibular salivary glands as it rounds the lower border of the mandible. It is visible on the external surface of the mandible around the anterior border of the masseter muscle. Above the inferior border of the mandible, it lies anterior to the facial vein and is tortuous.

Facial Vein (Fig. 2.3)

The facial (anterior facial) vein is the primary venous outlet of the face. It begins as the angular vein, in the angle between the nose and eye. It generally courses along with the facial artery above the level of the inferior mandibular border, but it is posterior to the artery. Unlike the facial artery, the facial vein runs across the surface of the submandibular gland to end in the internal jugular vein.

Retromandibular Vein

The retromandibular vein (posterior facial vein) is formed in the upper portion of the parotid gland, deep to the neck of the mandible, by the confluence of the superficial temporal vein and the maxillary vein. Descending just posterior to the ramus of the mandible through the parotid gland, or folded into its deep aspect, the vein is lateral to the external carotid artery. Both vessels are crossed by the facial nerve. Near the apex of the parotid gland, the retromandibular vein gives off an anteriorly descending communication that joins the facial vein just below the angle of the mandible. The retromandibular vein then inclines backward and unites with the posterior auricular vein to form the external jugular vein.

These vessels could be damaged (1) during mandible reduction surgery by too deep osteotomy with oscillating saw or (2) during cortical shaving by tearing injury with burr. Once these major vessels are damaged in their continuity, it leads to profuse bleeding which often cannot be controlled by electrocauterization. Repeated, unsuccessful hemostasis may lead to excessive blood loss. Application of a hemostatic substance like Surgicel (Ethicon) and external manual compression for at least 30 min can help to stop the bleeding in most of cases. Of course, prevention is the best way for these major vessel injuries.

Muscles

Mentalis Muscle (Fig. 2.4)

The mentalis muscles are paired, conical muscles and function as elevators of the lip and chin. The muscles are separated form on another by a firm septum and adipose tissue. They arise directly from the bony surface of the anterior symphysis in a zone between the labial sulcus and the apices of the lower incisors. Because this muscle is the only elevator of the lower lip and chin, it must be carefully reattached after anterior vestibular approach. If this muscle is not properly repositioned during closure, the chin will droop and the lower lip will take on a sagging appearance, exposing more lower teeth [3].

Buccinator Muscle (Fig. 2.4)

The bony attachments of the buccinator muscle run a course below the mucogingival junction opposite to the molars and along the oblique line ascending as the anterolateral rim of the ascending ramus. The attachments extend back into the pterygomandibular raphe. The buccinator is innervated by the motor buccal branch of the facial nerve. The muscle belongs to the mimetic muscle system and has a unique functional structure allowing for movement comparable to peristaltic motion. Its detachment can result in an impaired bolus transport [3].

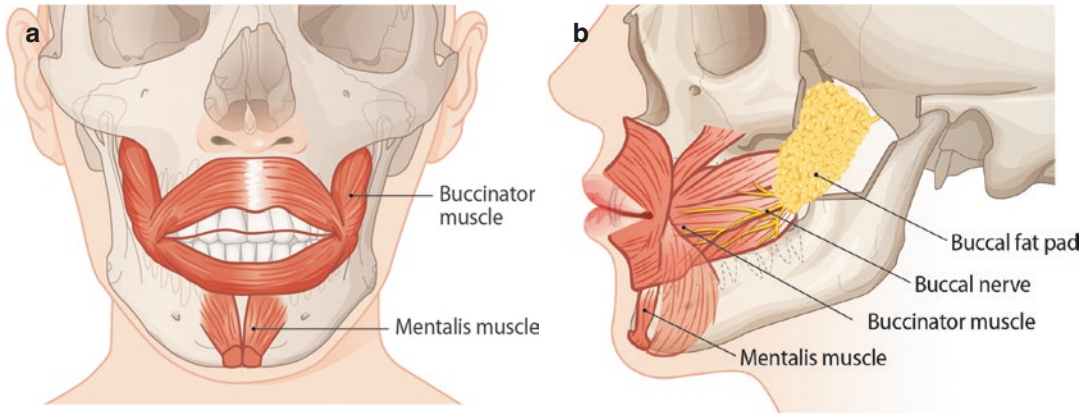

Fig. 2.4 Mentalis muscle and buccinators muscle. ((**a**) Frontal view (**b**) Lateral view) The mentalis muscles are paired, conical muscles and function as elevators of the lip and chin. They arise directly from the bony surface of the anterior symphysis in a zone between the labial sulcus and the apices of the lower incisors. The buccinator muscle runs a course below the mucogingival junction opposite to the molars and along the oblique line ascending as the anterolateral rim of the ascending ramus. The attachments extend back into the pterygomandibular raphe. The muscle has a unique functional structure allowing for movement comparable to peristaltic motion

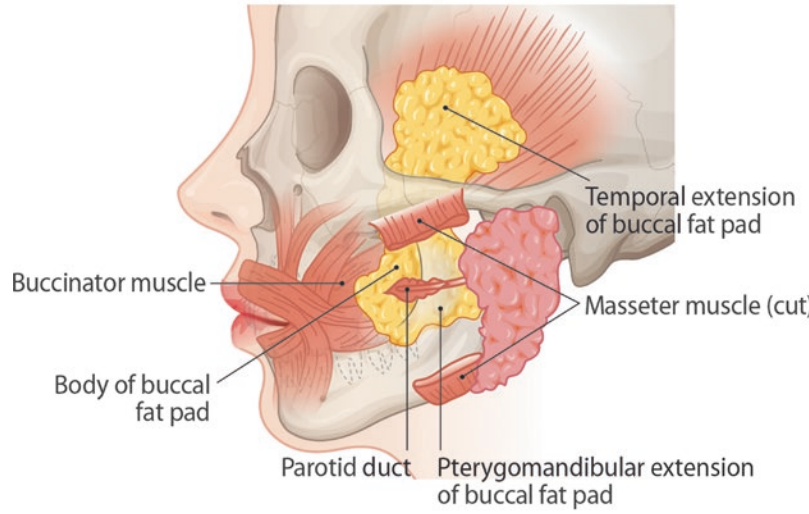

Fig. 2.5 Buccal fat pad. The buccal fat pad consists of a main body and four extensions: buccal, pterygoid, superficial, and deep temporal. The body is centrally positioned. The buccal extension lies superficially within the cheek, and the pterygoid and temporal extensions are situated more deeply

Fat

Buccal fat pad (Fig. 2.5)

The buccal fat pad consists of a main body and four extensions: buccal, pterygoid, superficial, and deep temporal. The body is centrally positioned. The buccal extension lies superficially within the cheek, and the pterygoid and temporal extensions are situated more deeply.

The main body of the fat pad is located above the parotid duct and extends along the upper portion of the anterior border of the masseter. It then coursed medially to rest on the periosteum of the posterior maxilla. In this region, the body of the fat pad overlies the uppermost fibers of the buccinators muscle and travels forward along the vestibule overlying the maxillary second molar. Posteriorly, it wraps around the maxilla and travels through the pterygomaxillary fissure, where it

is in intimate contact with branches of the internal maxillary artery and the maxillary division of the trigeminal nerve.

The buccal extension is the most superficial segment of the fat pad and imparts fullness to the cheek. It enters the cheek below the parotid duct and extends along the anterior border of the masseter as it descends into the mandibular retromolar region. It overlies the main portion of the buccinators muscle as it crosses the cheek. In the cheek, the fat pad is anterior to the ramus. Its caudal extension intraorally is on a plane tangential with the occlusal surface of the mandibular third molar. Its anterior limit is marked by the facial vessels, which are in the same plane as the buccal fat pad. The parotid duct lies superficial to the fat pad and then penetrates the buccinators to enter the oral cavity opposite the second molar. The buccal extension of the fat pad is limited by the masseteric facia. A deep extension of the masseteric facia blends with the fascia along the lateral surface of the buccinators. This facial layer lines the deep surface of the buccal fat that is in contact with the buccinators [3].

Conclusion

Thorough understanding of critical anatomy is a fundamental prerequisite when performing the facial bone contouring surgery. This chapter provides only digestive information about the important anatomic structures frequently encountered during the surgery, such as nerve, vessels, muscles, and fat. Surgeons who plan and perform facial bone contouring surgery should respect these anatomic structures and prevent possible damages to them.

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Surgical Approaches for Facial Bone Surgery

3

Tae Sung Lee

Pearls

1. Considerations on facial aesthetics, facial expression muscles, branches of the facial nerve and sensory nerves must be made before the placement of incisions on the face.
2. The intraoral approach is the main approach for most facial bone contouring surgeries, as incisions in the oral cavity allow superb exposure of most of the facial skeleton with a completely hidden scar.
3. The bicoronal approach is a versatile surgical approach to the upper and middle facial skeleton including the zygomatic arch. The scars can be hidden within the hairline while providing excellent access.
4. Transcutaneous incisions such as the Gillies' approach and incision on the sideburn region are used to excess the zygoma. Scars from the Gillies' approach can be hidden within the hairline, while sideburn incisions allow direct excess to the posterior zygomatic arch.
5. Approaches through the lower eyelid, including the subciliary incision or the transconjunctival incision, offer good exposure to the inferior orbital rim, lower part of the lateral orbital rim and the upper region of the zygoma body. Especially in transconjunctival approaches, the scar is hidden within the conjunctiva.

Introduction

The keys for success in facial bone contouring surgeries begin with adequate access and exposure of the facial skeleton. However, there must be several considerations when selecting the proper approach method for facial bone surgery. First, when determining the site for incision, facial aesthetics should be considered and not just surgical convenience. Efforts should be done by the surgeon to place incisions on the face in inconspicuous areas, sometimes distant from the underlying skeleton on which the surgery is being performed. Second, the avoidance of damage on muscles and nerves for facial expression should be done during the incision. A resulting facial paralysis is not only a severe cosmetic problem but can also cause severe functional deficits. Finally, the presence of many sensory nerves exiting the facial skeleton must also be considered during the incision procedure to avoid postoperative hypaesthesia [1–3].

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S. Park (ed.), *Facial Bone Contouring Surgery*, DOI 10.1007/978-981-10-2726-0_3

Surgical Approaches

Intraoral Approach

1. Maxillary vestibular approach

   When planning a malar reduction surgery, the body of the zygomatic bone can be easily approached through an intraoral incision. Submucosal injection of vasoconstrictor is done along the proposed incision line to reduce bleeding during incision and dissection. The incision should be made approximately 5 mm superior to the mucogingival junction. The incision may extend as far posterior as necessary to provide sufficient exposure on the operative site, which usually extends to the first molar tooth. The incision serially traverses the mucosa, submucosa, muscles, and periosteum. Periosteal elevators are used to elevate the tissues through the subperiosteal plane. The infraorbital nerve can be identified by dissecting superomedially to the location of the infraorbital foramen. Dissection proceeds superiorly to the lateral edge of the infraorbital rim and posteriorly behind the zygomaticomaxillary buttress. When closing the wound, a simple absorbable suture through the mucosa, submucosa, musculature, and periosteum may be done (Fig. 3.1) [1–4].

2. Mandibular vestibular approach

   An intraoral approach is the standard surgical approach for mandibular contouring surgeries. The incision is performed after submucosal injection of vasoconstrictor to reduce mucosal bleeding during incision and dissection. In the anterior region, the lower lip is everted by assistance of retractors, and a scalpel or electrocautery is used to incise the mucosa usually from canine to canine. The incision is either curvilinear or V shaped, preserving the frenulum and extending anteriorly toward the lip, leaving 10–15 mm of mucosa attached to the gingiva. As the incision is down through the mucosa, the underlying mentalis muscle is clearly visible. It is important to avoid the mental nerve during the incision. When approaching to the body and the ramus of the mandible, the incision is placed about 5 mm inferior to the mucogingival junction. The incision traverses the mucosa, submucosa, masseteric muscle, and periosteum. The incision is usually no more superior than the occlusal plane.

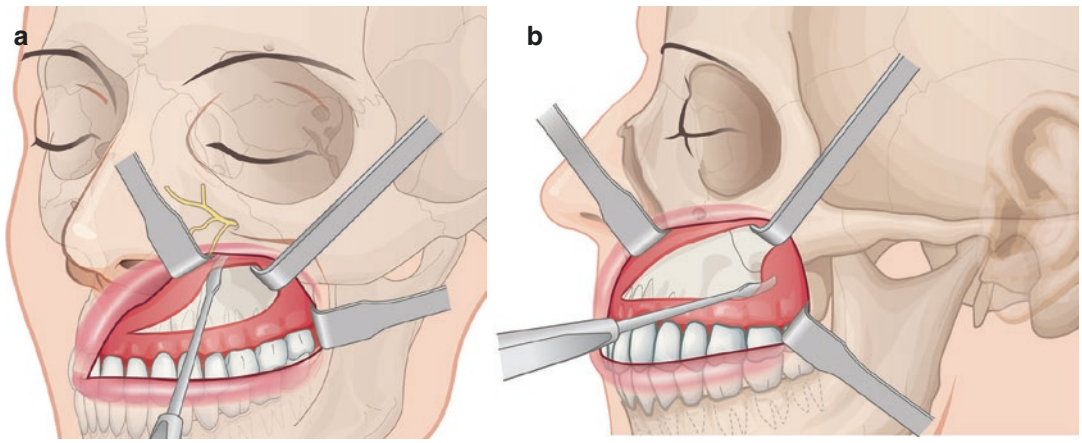

Fig. 3.1 Maxillary vestibular approach. The body of the zygomatic bone can be easily approached through an intraoral incision without leaving external scars. The dissection ranges superomedially to the infraorbital neurovascular bundle (**a**), superolaterally to the lateral edge of the infraorbital rim and laterally behind the zygomaticomaxillary buttress (**b**)

The mentalis muscle is stripped from the mandible in a subperiosteal plane. The periosteum should be carefully freed circumferentially around the mental foramen. Dissection then proceeds posteriorly along the lateral surface of the mandibular body and ramus. The dissection should proceed within the periosteal envelope to prevent laceration of any vascular structures. Subperiosteal dissection near the mandibular angle strips the masseteric attachments, leading this muscle to retract upward. While the buccal tissues are retracted laterally with a right-angled retractor, the masseter muscle is further stripped from the lateral surface of the ramus. Wound closure in the posterior region is adequate in one layer. The single layer suture should hold on the mucosa, submucosa, musculature, and periosteum. However, two-layer closure is recommended for the anterior region, because it is important to firmly reattach the mentalis muscle to its origin. Three absorbable sutures are placed in the mentalis muscle to reapproximate the cut edges. Then the mucosa is closed with absorbable sutures (Fig. 3.2) [1–3, 5–7].

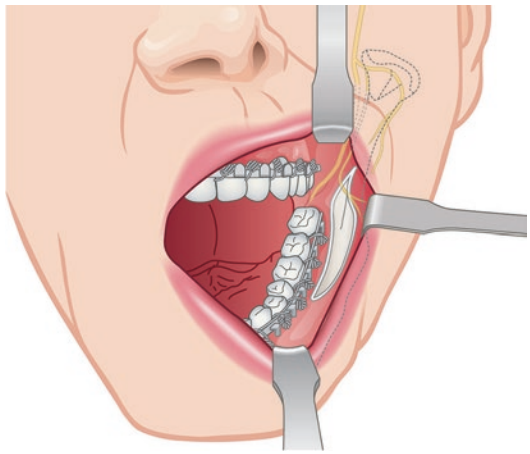

Fig. 3.2 Mandibular vestibular approach. The intraoral incision is the main surgical approach for a mandible contouring surgery. Superb visualization and access is possible while leaving no external scars and violating the facial motor and sensory nerves

Bicoronal Approach

The bicoronal approach can be used to expose the skeleton of the upper and middle face. During a facial bone contouring surgery, the bicoronal approach may be performed for a malar reduction procedure or for a forehead contouring. First of all, the hairline of the patient must be considered when designing the line of incision. The incision may be curved anteriorly at the vertex, paralleling but remaining 5 cm within the hairline. Bicoronal incisions with a zigzag design may be used to make the scars less noticeable. The bicoronal incision can be extended inferiorly to the level of the earlobe with extension by a praeauricular incision. This approach allows direct exposure of the zygomatic arch and the infraorbital rims.

Bleeding from the incision site can be reduced by injecting vasoconstrictors into the proposed incision line. Incision is made with a scalpel extending from one superior temporal line to the opposite side. The incision is deepened pass through the skin, subcutaneous tissue and galea, revealing the subgaleal plane of loose areolar tissues which overlies the pericranium. The flap can be easily lifted and dissected above the pericranium. The skin incision below the superior temporal line should extend to the depth of the superficial layer of the temporalis fascia and into the subgaleal plane which has continuity with the dissection above the superior temporal line.

After elevation of the anterior and posterior wound margins by 1–2 cm, haemostatic Raney clips may be applied or bleeding vessels may be isolated and electrocauterized. Extensive cauterization of the edge of the incision sites damages the hair follicles and produces alopecia. The flap may be elevated above the pericranium with manual finger dissection, with blunt periosteal elevators. On the lateral aspect of the skull, the temporalis fascia becomes visible as it merges with the pericranium at the superior temporal line. The plane of dissection is just superficial to this thick fascia. Once the flap has been dissected anteriorly and inferiorly several centimetres, it should be possible to evert the

flap so that the galeal is superficial. If it is not possible to evert the flap, further dissection inferiorly along the superficial layer of the temporalis fascia, and possibly extending the skin incision more inferiorly, may be necessary. Dissection of the flap continues anteriorly in the subgaleal fascial plane until 3–4 cm superior to the supraorbital rim. A horizontal incision is made through the pericranium from one superior temporal line to the other. The subperiosteal dissection then continues downward to the supraorbital rims. The lateral portion of the flap is dissected inferiorly above through the temporalis fascia. As the dissection extends inferiorly near the ear, the superficial layer of temporalis fascia is incised at the root of the zygomatic arch, just in front of the ear. The incision continues anterosuperiorly to join the cross-forehead incision previously made through the pericranium at the superior temporal line. Dissection made inferiorly should be just deep to the superficial layer of the temporalis fascia. This layer provides a safe route of access to the zygomatic arch because the temporal branch of the facial nerve is always lateral to the superficial layer of the temporalis fascia. Blunt scissors are used to dissect just under the superficial layer of the temporalis fascia. Once the superior surface of the zygomatic arch and the posterior border of the body of the zygoma are visible, an incision is made through the periosteum along their superior surface. The incision is continued superiorly along the posterior border of the body of the zygoma and the orbital rim, ultimately meeting the cross-forehead horizontal incision through the pericranium. Then the subperiosteal elevation totally exposes the lateral surfaces of the zygomatic arch, the body of the zygoma and the lateral orbital rim.

When closing the bicoronal incision, suture resuspension of the soft tissues is recommended. Closure of the periosteum around the orbital rims is performed with absorbable sutures. The scalp incision is closed in two layers using absorbable sutures through the galea and subcutaneous tissues and non-absorbable skin sutures or staples (Fig. 3.3) [1–3].

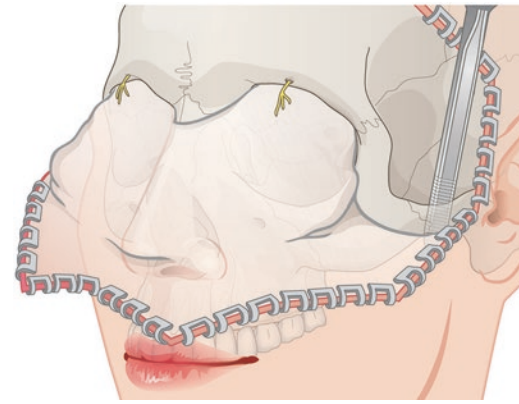

Fig. 3.3 Bicoronal approach. The bicoronal approach is performed to directly expose the upper and mid face skeleton. Especially, full access to the zygomatic body and arch and the lateral and inferior orbital rims is possible

Transcutaneous Approach

1. Sideburn approach

   An incision can be made on the sideburn area for direct access to the posterior portion of the zygomatic arch. At the level of the zygomatic arch, an 8–10 mm length incision should be made with a scalpel on the midline of the sideburn. The incision is deepened carefully as the incision site is adjacent to the frontal branch of the facial nerve. For such reasons, blunt dissection for the subcutaneous fatty layer is recommended rather than cutting by electrocautery or sharp scissors. When the dissection is deepened to the periosteal layer of the zygomatic arch, a sharp incision is made on the periosteum. Then using a periosteal elevator, subperiosteal dissection is continued for exposure of the osteotomy and fixation site. Later for wound closure, absorbable sutures should be done at two points for the subcutaneous layer, followed by simple non-absorbable sutures for skin closure (Fig. 3.4) [4, 8].
2. Gillies' approach

   The Gillies' approach describes a temporal incision made 2.5 cm superior and anterior to the helix, within the hairline. As a 2 cm length temporal incision is made, care is taken to

avoid the superficial temporal artery. Then the dissection continues through the subcutaneous tissue and superficial temporal fascia down to the deep portion of the deep temporal fascia. This fascia is then incised to expose the temporalis muscle. Through this plane, a periosteal elevator is inserted deep to the temporalis fascia and superficial to the temporalis muscle. Using a back-and-forth movement of the elevator, the elevator is advanced until the posterior portion of the zygomatic body is reached. Later for wound closure, the scalp can be simply closed with staples (Fig. 3.5) [4].

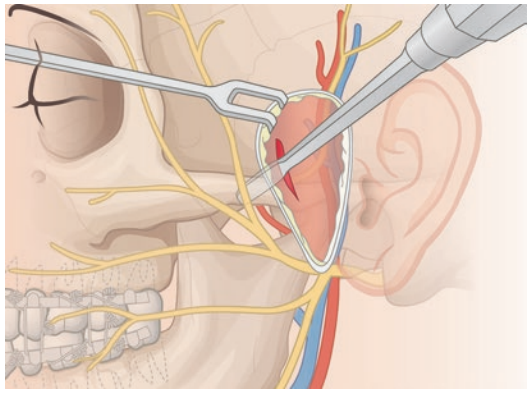

Fig. 3.4 Sideburn approach. For direct access to the posterior portion of the zygomatic arch, an incision can be placed at the level of the zygomatic arch and on the midline of the sideburn. Care should be taken as the incision site is adjacent to the frontal branch of the facial nerve

Periorbital Approach

1. Subciliary incision

Subciliary approaches may be done to directly access the lateral and inferior orbital rim and the upper portion of the zygomatic body and maxilla. First, protecting the cornea during surgical procedures around the orbit may reduce ocular injuries. A temporary tarsorrhaphy or corneal shield may be useful. The incision for a subciliary approach is made approximately 2 mm inferior to the eyelashes, along the entire length of the eyelid. The incision may be extended laterally approximately 1 cm past the lateral canthus preferably in a natural skin crease. After the incision line is marked, infiltration of a vasoconstrictor is done. Injections of vasoconstrictors not only promote haemostasis but can also separate the tissue planes facilitating incision in the thin eyelids. The depth of the initial incision should be through the skin layer only. The underlying muscle should be visible when the skin is incised completely. Subcutaneous dissection toward the inferior orbital rim proceeds for a few millimetres using sharp dissection with scissors. The skin should be separated from the pretarsal portion of the orbicularis oculi muscle along the entire extent of the incision. Approximately 4–6 mm of subcutaneous dissection is adequate. Blunt scissors are used to dissect through the

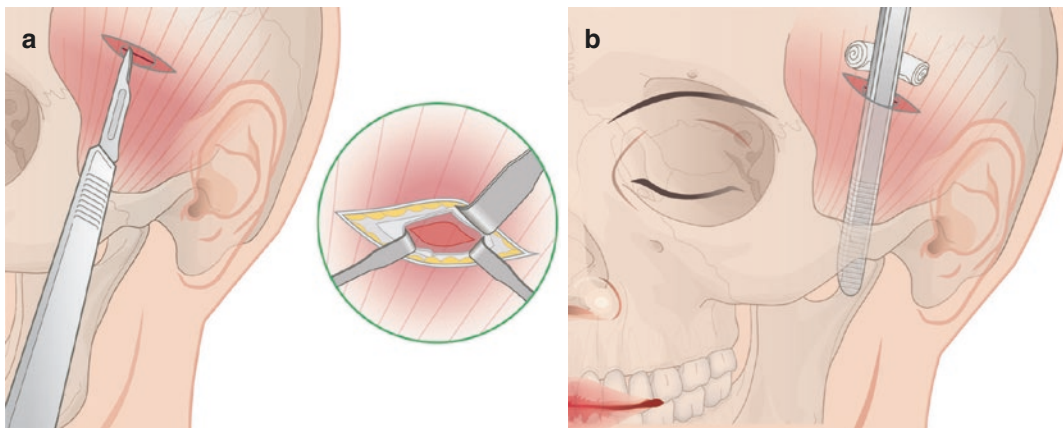

Fig. 3.5 Gillies' approach. Through a plane between the deep portion of the deep temporal fascia and the temporalis muscle (**a**), the posterior portion of the zygomatic body is accessible for the osteotomy (**b**)

orbicularis oculi muscle to the periosteum overlying the lateral orbital rim. The muscle is then incised with scissors placed inferior to the level of the initial skin incision. Once the skin-muscle flap of tissue is elevated from the lower eyelid, it can be retracted inferiorly, extending below the inferior orbital rim. An incision is made with a scalpel on the periosteum of the anterior surface of the maxilla and zygoma, about 3–4 mm below to the inferior orbital rim. The infraorbital neurovascular bundle is approximately 5–7 mm inferior to the orbital rim and should be avoided when the periosteal incision is made. Periosteal elevators are then used to strip the periosteum from the underlying bone along the anterior surface of the maxilla and zygoma. Closure is usually performed in two layers by closing the periosteum and then the skin and suturing the orbicularis oculi muscle is usually unnecessary (Fig. 3.6) [1–3, 9–12].

2. Transconjunctival incision

Similar to the subciliary approach, the transconjunctival approach allows direct exposure of the lateral and inferior orbital rim and the upper portion of the zygomatic body and maxilla. After a corneal shield should be placed to protect the globe, vasoconstrictor is injected under the conjunctiva to promote haemostasis. The lower eyelid is everted with forceps, and two or three traction sutures are placed through the eyelid. When a lateral canthotomy is indicated, the canthotomy itself is the initial incision, as one tip of the pointed scissors is inserted within the palpebral fissure, extending laterally to the depth of the underlying lateral orbital rim. The scissors are used to cut horizontally through the lateral palpebral fissure. The structures that are cut are the skin, orbicularis oculi muscle, orbital septum, lateral canthal tendon and conjunctiva. The previous traction sutures are used to evert the lower eyelid. The lateral canthal tendon, which is easily visualized with eyelid retraction, is released with a sharp vertical cut. Then the lower eyelid is immediately freed from the lateral orbital rim, making the eversion more effective. Blunt scissors are used to dissect through the small incision in the conjunctiva made during the lateral canthotomy, inferiorly toward the infraorbital rim. The scissors are spread to clear a pocket posterior to the orbital septum, ending just posterior to the orbital rim. Scissors are used to incise the conjunctiva and lower eyelid retractors midway between the inferior margin of the tarsal plate and the inferior conjunctival fornix. The incision can be extended medially but must not violate the lacrimal sac as the lacrimal punctum is easily visible. After retracting the orbital contents

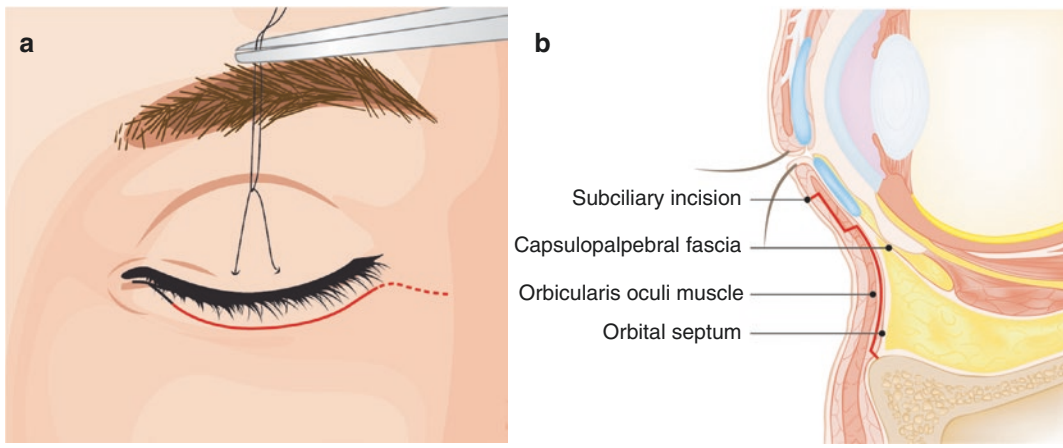

Fig. 3.6 Subciliary approach. The subciliary incision is placed approximately 2 mm below the lashes and may be extended laterally along the natural skin crease (**a**). Sagittal plane through the orbit showing the dissection plane of the subciliary approach (**b**)

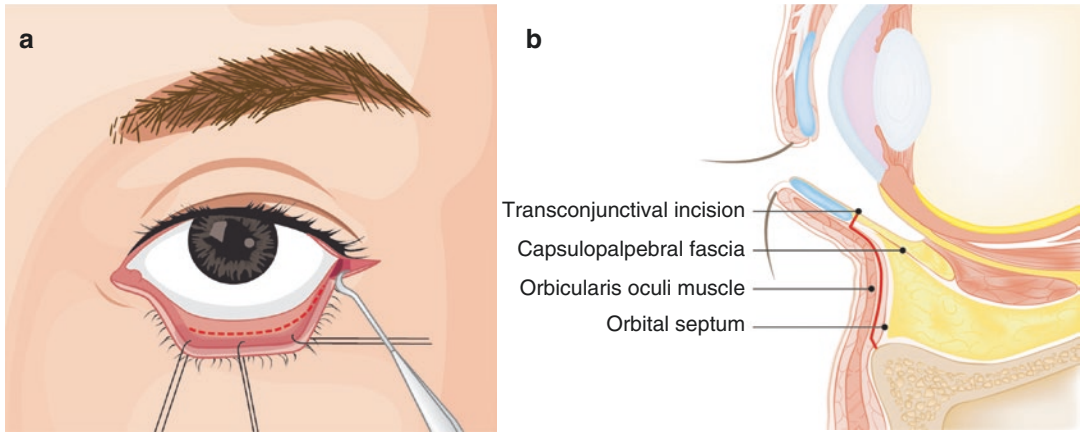

Fig. 3.7 Transconjunctival approach. After the initial canthopexy incision, the incision of the conjunctiva is placed just below the tarsal plate and not farther medially than the lacrimal punctum (**a**). Sagittal plane through the orbit showing the dissection plane of the transconjunctival approach (**b**)

internally and the lower eyelid externally, using retractors, the periosteum is sharply incised, avoiding the lacrimal sac medially. The incision through the periosteum is immediately posterior to the orbital rim. Periosteal elevators are then used to elevate the periosteum over the orbital rim and the anterior surface of the maxilla and zygoma. During the procedures, a broad malleable retractor should be placed as to protect the orbit and to confine any herniating periorbital fat. Before closing the conjunctiva, inferior canthopexy suture is used to reattach the lateral portion of the inferior tarsal plate to the residual superior portion. The conjunctiva should be closed with a running absorbable suture. The ends of the suture may be buried. Finally, subcutaneous sutures and skin sutures are placed along the horizontal lateral canthotomy site (Fig. 3.7) [1–3, 10, 12, 13].

Key Technical Points

1. Either during a maxillary or mandibular vestibular approach, the incision should be placed approximately 5 mm off the mucogingival junction. This latterly facilitates the wound closure.
2. When approaching intraorally, cautious subperiosteal dissection should be done not to interrupt the infraorbital nerve and mental nerve.
3. Using electrocautery during a bicoronal approach may irreversibly damage the hair follicles and cause alopecia which may be an aesthetically disturbing problem.
4. Shaving of the hair before a bicoronal incision is not medically necessary for sterility. The presence of hair helps to determine the direction of the hair shafts and helps to minimize damage to the follicles.
5. During the subcutaneous dissection for subciliary approaches, the lower lid tissues should be tented in an upward direction rather than pulling it back because this may lead to skin dehiscence.

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Standard Surgical Instruments for Facial Bone Surgery

4

Tae Sung Lee

Pearls

1. By standardizing the instruments used during a surgery, it is possible to decrease complication rates and achieve more predictable surgical outcomes, thereby increasing patient satisfaction.
2. Use of double-bladed saws and pre-bent plates to perform reduction malarplasty reduces the chances of postoperative asymmetry or under- or overcorrection of the zygoma contours due to technical faults.
3. Inferior alveolar nerve injury and postoperative jawline asymmetry or irregularity can be diminished when using a guarded saw during mandibular angloplasty.
4. During genioplasty, the final placement of the chin in accordance with preoperative quantitative analysis can be easily done with pre-bent plates, and a double-bladed saw allows more procedural accuracy during osteotomies.
5. Efforts by the surgeon to avoid unintentional faults are keys to achieving satisfactory results and reducing the incidence of complications.

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Introduction

As facial bone contouring surgery has become increasingly popular, great improvements in surgical techniques and outcomes of facial bone contouring surgery have been made in recent years [1]. The keys to achieving satisfactory results after a cosmetic surgery are to meet each individual's aesthetic expectations and to diminish the risk of complications. However, to achieve aesthetically gratifying operative results, steps to avoid unintentional faults, including personal errors by the surgeon, should be put in place during the surgical procedure. For such reasons, efforts must be done on how to standardize surgical methods used in facial bone contouring surgery. The goals that are achievable by standardizing surgical techniques are procedural ease for the surgeon, which allows him or her to carry out the surgery impeccably, and ultimately the patient's satisfaction with his or her aesthetic outcomes. Here, several standardized surgical instruments are introduced that can be used during a facial bone contouring surgery.

Surgical Instruments

Reduction Malarplasty

The L-shaped osteotomy technique is currently widely used to perform reduction malarplasty [1–8]. Also a dual approach is frequently used, as an

S. Park (ed.), *Facial Bone Contouring Surgery*, DOI 10.1007/978-981-10-2726-0_4

ostectomy followed by posteromedial repositioning of the zygomatic body is done through the intraoral approach, and an osteotomy and inward repositioning of the zygomatic arch are done through an additional preauricular or sideburn incision. During this operative procedure, several important details should be decided by the surgeon [1].

First, the amount of bone resection in the zygomatic body should be determined. The width of the bone resection determines the decrease in bimalar width, because the zygomatic bone is medially repositioned according to the amount of bone resection. Therefore, it is important for the surgeon to uniformly resect the zygomatic bone in a predictable manner. A 'double-bladed' reciprocating saw can be used to carry out this procedure. Premanufactured double-bladed saws with distances of 2, 3, 4, 5, 6 or 7 mm between blades can be used to perform the ostectomy equally (Fig. 4.1). In cases with an asymmetry in the zygomatic region, different saws should be used according to the preoperative analysis.

Secondly, the amount of posterior setback of the zygomatic body should be decided. Usually, the point that indicates the maximum malar projection is anterolaterally malpositioned in patients with a prominent zygoma [3]. Accordingly, not only a medial repositioning of the zygomatic body but also a posterior setback should be done together when correcting a projecting zygomatic bone. During this step, pre-bent titanium plates may be used to precisely perform the setback procedure. The size of the step (i.e. the amount of bending) in each plate ranges from 0 to 5 mm (Fig. 4.2). If the projection of the zygomatic bone is more extensive, a pre-bent plate with a larger-sized step should be used and vice versa. By using these pre-bent titanium plates, it is easier to equally reposition the zygomatic body in cases with a symmetric feature. Also in asymmetric cases, it is easier to correct the asymmetry by using different sized plates and differentially reposition the zygomatic body.

The third factor that should be determined during a reduction malarplasty is the amount of medial repositioning of the zygomatic arch. Most of the patients with a prominent zygoma also have a prominence in the arch region that should be repositioned inwardly to reduce the outward projection. As mentioned above, the zygomatic arch is cut through an incision in the sideburn. Then, the arch portion anterior to the osteotomy site is pushed inwardly and rigidly fixed. The amount of medial repositioning required can be precisely achieved using a linear three-hole pre-bent titanium plate. The step size of these plates ranges from 0 to 4 mm; choice of plate depends on the lateral prominence of the arch region (Fig. 4.2).

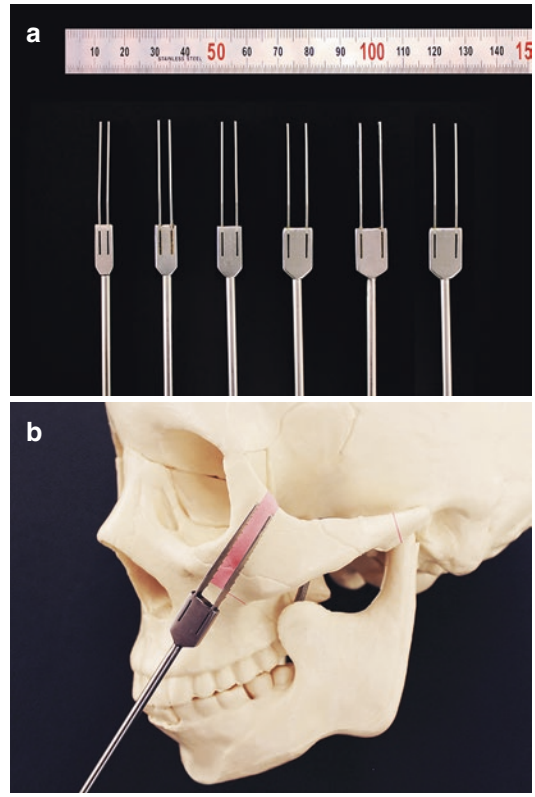

Fig. 4.1 'Double-bladed' reciprocating saws used in reduction malarplasty (**a**). The width between the blades may vary, ranging from 2 to 7 mm. The saws are used for precise and equal bone resection in the zygomatic body region (coloured in *red*) during an L-shaped osteotomy (**b**)

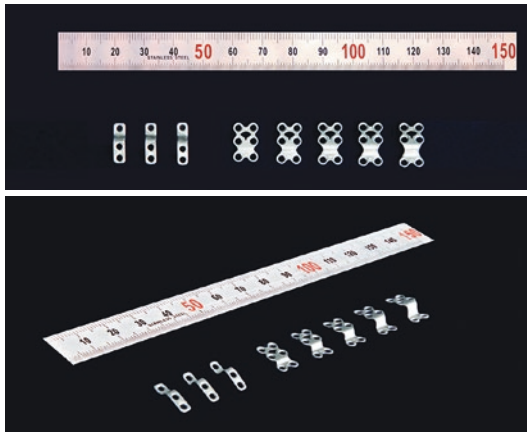

Fig. 4.2 Pre-bent titanium plates used in reduction malarplasty. The three-hole plates are used for fixation of the zygomatic arch, and the six-hole plates are used for the zygomatic body. Different sizes are available for rigid and accurate bone repositioning

Mandible Reduction

The conventional mandible angle reduction technique involves an oscillating saw through an intraoral approach [9–11]. However, before carrying out the main osteotomy procedure, a 'guarded' oscillating saw can be used to mark the proposed osteotomy line [1, 12, 13]. The guarded saw which has a small oscillating saw blade that is shielded at different distances of 2, 3, 4, 5 or 6 mm (Fig. 4.3). Size of the guarded saw to be used is determined by considering the amount of resection that should be done in the mandibular body and the path of the inferior alveolar nerve (i.e. the distance between the lower mandible border and the route of the nerve). By using these guarded oscillating saws, it is possible to perform the bony resection precisely in a more uniform fashion. More importantly, by using a guarded saw, unintentional over-resection can be avoided, and the possibility of a nerve injury can be decreased. Furthermore, in cases with pre-existing jawline asymmetry, bone resection can be differentially carried out using different-sized guarded saws. After the osteotomy is initiated with a guarded saw, larger oscillating saws are serially used to complete the bone resection.

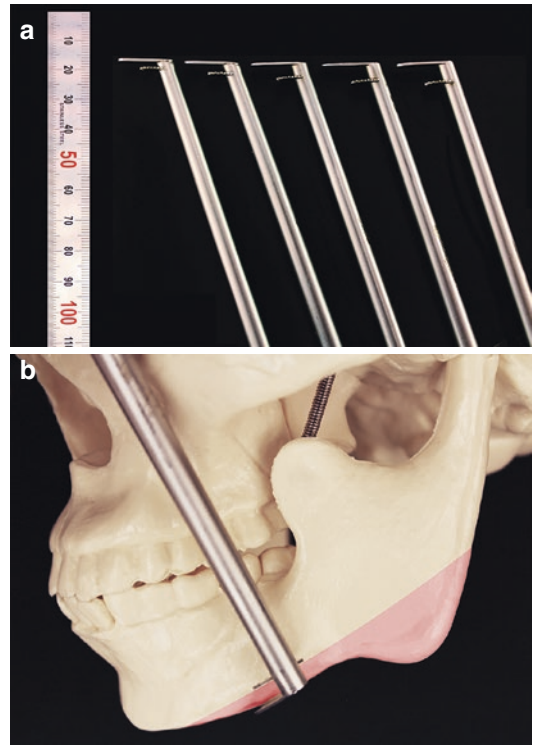

Fig. 4.3 'Guarded' oscillating saws used in mandibular angloplasty (**a**). Each saw has a small oscillating saw that is shielded at various distances. The saw guides precise bone resection in the mandibular body region (coloured in *red*) while avoiding over-resection and nerve injury (**b**)

Genioplasty

Genioplasty is decidedly the most versatile and practical surgical tool in the field of facial bone surgery. Genioplasty can be done in an isolated manner or, more frequently, in combination with other facial bone surgeries such as orthognathic surgery or facial bone contouring surgery [14]. For example, genioplasty can be carried out independently in patients with either a small and weak chin or a protruding chin by repositioning the chin in an anteroposterior dimension [15, 16]. If a patient has a disproportionately short lower face, elongation of the chin may be needed in addition to shortening of the lower face [12, 15]. Genioplasty can also be done as a part of a chin narrowing procedure [13, 17].

When a bone resection is required, for example, during a chin narrowing or vertical shortening

procedure, the abovementioned double-bladed reciprocating saw can be used for a precise and equal osteotomy (Fig. 4.4) [1]. When planning a chin advancement or setback, a pre-bent plate can be used to precisely control the amount of anteroposterior adjustments, each plate differing in size by steps from 0 to 10 mm (Fig. 4.5). The plate that is used should be selected based on preoperative cephalometric analysis [14, 15]. By using pre-bent plates, the exact amount of chin advancement or setback determined preoperatively can be achieved.

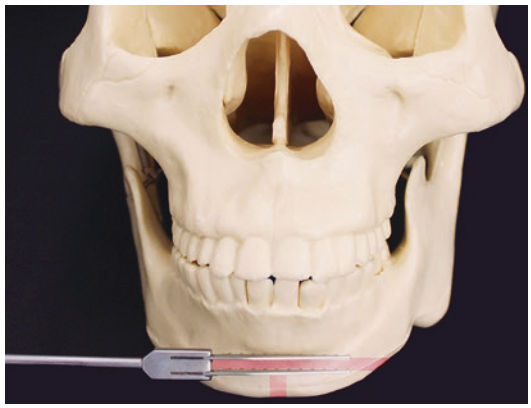

Fig. 4.4 A double-bladed reciprocating saw used in genioplasty. During a chin narrowing or vertical shortening procedure, the saw can be used for precise and equal bone resection (coloured in *red*)

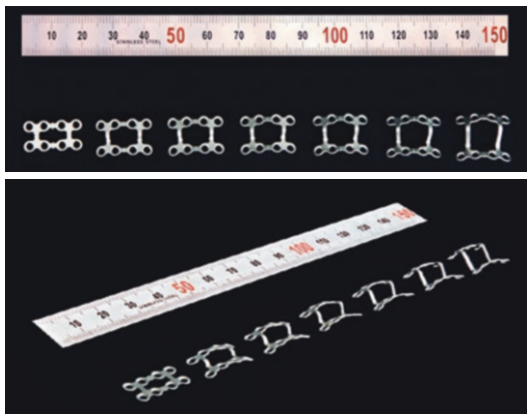

Fig. 4.5 Pre-bent titanium plates used in genioplasty. The plates are used for controlling the degree of anteroposterior adjustment during chin advancement or setback in accordance with preoperative measures

Discussion

Complications in facial bone contouring surgery may occur either due to errors in judgment during patient evaluation or during the operative procedures [1]. Standard surgical techniques and instruments that are described here can be used to avoid unfavourable outcomes due to operative technical errors. Possible complications after facial bone surgery include oedema, haematoma and infection. In addition to these general complications, soft-tissue sagging, transient sensory disturbance, asymmetry and under-correction or overcorrection of zygoma contours are relatively common complications that occur after a reduction malarplasty [4]. Double-bladed reciprocating saws are used to make osteotomies more accurate and predictable. This can decrease postoperative asymmetry and the possibility of under- or overcorrection. Furthermore, by using different-sized double-bladed saws on each side, the surgeon can precisely correct pre-existing asymmetry. While rigid osteofixation is essential to achieve complete bone union and reduce soft-tissue sagging, the use of pre-bent plates on both the zygomatic body and arch allows more precise repositioning [1, 3, 6]. Comparing the incidence of complications with previous studies using the proposed surgical instruments, or not, resulted in a lower incidence of postoperative asymmetry (0.8% versus 2.9%) and overcorrection (0.4% versus 0.6%) [1, 2, 18]. Also, the incidence of neurosensory deficit was markedly lower compared in studies which the same intraoral and sideburn approach and L-shaped osteotomy was used for reduction malarplasty (6.7% versus 9.4%) [1, 2, 4].

Complications such as inferior alveolar nerve injury, jawline contour irregularity and unexpected postoperative asymmetry in the jawline are problems that are unique to the mandibular angloplasty procedure but are mostly preventable if the surgeon takes certain precautions [1, 2, 18]. If the osteotomy in the mandibular body is made too high, the inferior alveolar nerve can be directly injured, which can result in regional sensory deficits [1, 4, 18, 19]. The osteotomy line should be designed accurately based on preoperative panoramic radiograms. By using guarded oscillating

saws, the inferior border of the mandible can be defined, and the osteotomy line can be marked simultaneously. Therefore, unintentional nerve injury can be easily avoided by initiating the osteotomy procedure with a guarded saw. In previous studies, the incidence of transient neurosensory deficit after mandibular contouring ranged from 6.5 to 55.9% [1, 4, 18, 20, 21–25]. However, in a study when the guarded oscillating saws were used, the incidence rate of immediate neurosensory deficit after mandibular angloplasty was 9.1%; the rate of persistent deficit was negligible (0.2%) [1]. Furthermore, the use of a guarded saw allows the osteotomy to be performed in a uniform manner. This can prevent postoperative contour irregularities of the jawline. Meanwhile, in patients with pre-existing asymmetry of the mandible contour, the osteotomy can be carried out differentially according to preoperative cephalogram measurements and medical photographs. Different-sized guarded saws make this procedure more accurate and allow the surgeon to improve asymmetry with more technical ease.

During a genioplasty procedure, the final placement of the chin in the anteroposterior dimension is ultimately based on the intraoperative clinical appearance. The position of the chin should be assessed relative to the entire face, nasal tip and lips [14–16]. However, due to soft-tissue swelling during the operation, especially that of the lower lip and chin region, the surgeon should not rely solely on intraoperative measures; preoperative quantitative analysis should be considered as the objective criterion in such circumstances. Pre-bent plates can be used as a guide by the surgeon to reposition the chin either anteriorly or posteriorly in a more precise way to achieve more predictable surgical outcomes [1]. Inherent errors due to intraoperative bending of the plate can be avoided. Meanwhile, when performing a reduction genioplasty for vertical shortening of the chin, two horizontal osteotomies parallel to each other and to the occlusal plane are made, and the segment between the osteotomies is removed [9, 15]. By using a double-bladed reciprocating saw during this procedure, parallel osteotomies with an accurate distance apart from each osteotomy line are possible in accordance with the preoperative plan [1]. This also holds true when performing a narrowing genioplasty procedure using the 'T-osteotomy' technique [13, 17]. Because a bone segment in the centre portion is resected, the double-bladed saw can be used during this step for procedural accuracy.

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Part II

Lower Face

5 The Aesthetic Lower Face Analysis Diagnosis Selection of Surgical Procedures

Seungil Chung and Sanghoon Park

Pearls

1. A prominent mandibular angle that gives a squared face in Asians is considered unattractive as it imparts a coarse and masculine image. Mandibular contouring surgery allows slender oval faces.
2. "Angle reduction" is the old name of this procedure and a major misconception regarding what the surgery is for. The purpose of mandible reduction is to make the lower face appear slim in the frontal view and to have a smooth contour in the lateral view. Changing the mandibular plane and contouring the whole lower border of the mandible are critical steps. On the contrary, angle reduction with removal of triangular bone will inevitably leave an unnatural lower contour of mandible with secondary angle.
3. As shaping the lateral contour of the mandible alone may result in minimal improvement in the frontal view, surgical techniques to reduce the width of the lower face via narrowing genioplasty and sagittal resection of the lateral cortex should be combined.
4. Successful mandible reduction begins with careful preoperative preparation and planning. Three-dimensional analysis of the photographs and the radiographs in the frontal, sagittal, and transverse planes are important.
5. Examination of the shape and symmetry, the relationship between the maxilla and the mandible, overlying soft tissue contribution, and understanding the overall balance of the face are mandatory.
6. The ideal facial shapes may be different upon personal preference, as well as ethnic or cultural background. Especially when consulting patients with different national or ethnic backgrounds, careful attention should be paid during consultation for their ideal or desirable facial shape in mind.

Introduction

The width of the lower third of the face is determined by the width of the mandible itself, which is surrounded by muscles and subcutaneous fat tissues. Generally, the cause of prominent mandibular angle in Asians is the lateral protrusion of the mandibular angle rather than soft tissue contribution such as hypertrophied masseter muscle [1, 2]. Anthropologic studies have shown significant quantitative facial anthropometric differences among different ethnic backgrounds; one

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S. Park (ed.), *Facial Bone Contouring Surgery*, DOI 10.1007/978-981-10-2726-0_5

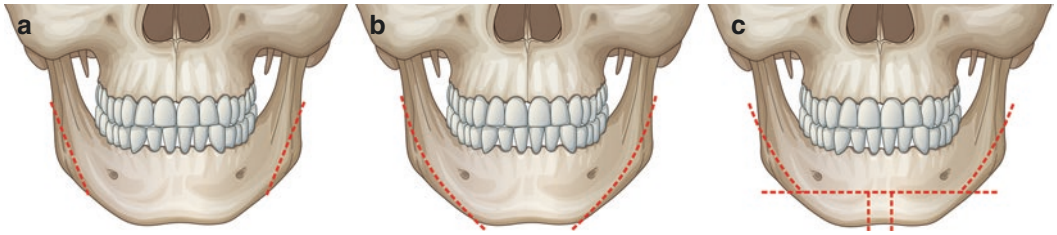

Fig. 5.1 Evolution of mandible reduction surgery. Mandible reduction surgery has evolved from (**a**) simple resection of the angular portion to (**b**) contouring of the total mandible shape as the desire for a slim and small face has increased. Recently, (**c**) V-line surgery not only narrows the width of the mandible and contours the jawline but also reduces the size and controls the position of the chin was introduced to achieve a slim and oval-shaped jaw

Fig. 5.2 Classification of mandibular shape and the patient's preference of mandibular shape. The chin should be designed based on individual needs and demands. For this, the patient can freely compare the shapes of the mandible, especially chin and consult with the surgeon in detail

such difference being that Koreans, in comparison to Caucasians, tend to have a more developed lower face [3]. In addition, the average bigonial distance of Caucasian women is 105–109 mm [4, 5], whereas in Korean women, the average distance is 118–125 mm [3]. Since Koreans have a wider bigonial distance and a more flared mandibular angle, they will often undergo mandible reduction in order to slenderize the lower facial contour, whereas Caucasians prefer mandible augmentation to correct weak jawlines [6, 7]. Since Baek introduced mandibular angle reduction for Asian patients via intraoral approach in 1989, a variety of surgical techniques from conventional mandibular angle ostectomy to "V-line surgery" has been developed [8–14] (Fig. 5.1).

On the basis of technical perfection, establishment of appropriate surgical indication for each technique is mandatory in order to achieve aesthetically pleasing results. Analysis of the individual's entire face should come from a thorough understanding of lower facial type. Authors classified the shape of lower face according to the shape of the chin, which is helpful in establishing the treatment plan in practice [15] (Fig. 5.2).

Patient Consultation and Assessment

Patient Selection and Consultation

Mandibular contouring surgery that we perform mainly consists of two types; (1) simple resection of the angular portion and (2) V-line surgery which includes narrowing genioplasty combined with mandibular border resection. All of these may be combined with sagittal resection of the lateral cortex. Simple resection of the angular portion is recommended for a patient who has a prominent mandibular angle only. However, in most cases, V-line surgery is more required to change the overall shape.

Before operation, the reason for surgery must be carefully assessed and clearly understood by the surgeon because a patient may be enthusiastic

and quickly consult a plastic surgeon and make a decision impulsively to undergo the surgery, especially when a patient encounters someone who has already undergo this surgery. However, her or his expectation may be much higher than the reality of the outcome, and for this reason they are not the ideal candidate. For example, a patient with a thick and abundant facial soft tissue, the surgical outcomes may be below expectations in spite of successful bony reduction of mandible.

Therefore, the patients' desire are evaluated in detail and discussed, so that the result we hope to obtain in that particular patient can be previewed. Also, skin quality such as elasticity, subcutaneous fat, and buccal fat are very important in predicting the result. Blood tests, urine analysis, heart exams, chest x-rays, and a consultation with an anesthesiologist are required. Medications that the patient is taking are also discussed and noted.

Patient Assessment

1. *Diagnosis*

   The condition may easily be diagnosed by clinical findings and radiological examination. The degree of protrusion of the mandible, asymmetry, masseter muscle hypertrophy, and the amount of the subcutaneous fat should be evaluated. The degree of hypertrophy of the masseter muscle can be identified by palpating the tightened and relaxed status of the jaw. Hyperostosis, mostly around the mandible angle, is noted in the radiologic studies. Two-thirds of the cases show mild to moderate increase in bigonial distance due to lateral flaring of the mandible angle. However, the remaining one-third shows total mandibular hypertrophy and accentuated square contour of the whole lower face. The shape and width of the lower face in the frontal view can be classified as in Fig. 5.2. The profile as well as the height of the chin should be taken into consideration. The status of soft tissue including muscle and fat should be considered as well.

2. *Evaluation*

   The author routinely obtains the patient's photographic documentation and radiologic examination that includes panoramic view, skull lateral view, PA cephalogram, and 3D CT image. Photographs obtained using standardized techniques include frontal, lateral, oblique, basal, and overhead views. These are essential for detailed aesthetic analysis and accurate preoperative planning. For precise surgical planning and prevention of postoperative asymmetry, three-dimensional analysis of the photographs and the radiographs in the frontal, sagittal, and transverse planes are important. Examination of the shape and symmetry and understanding the overall balance of the face is mandatory. Attractive faces have certain proportions and relationships in common. To make an accurate diagnosis and establish the best treatment plan, these proportions and relationships must be thoroughly analyzed.

   – Frontal Plane

     Using the PA cephalogram and 3D CT, the degree of protrusion or flaring of the mandible angle, symmetry, convexity of the body, deviation, and shape of the chin should be examined. Though PA cephalogram is useful in analyzing skeletal transverse discrepancy and asymmetry, it has a disadvantage of difficulty in establishing a precise head position while shooting an x-ray. However, with the use of reliable vertical baseline (a vertical line that is connected to the chin, which is started from crista galli (Cg) and crossing ANS) and horizontal reference line (Z plane, ZA plane, J plane, a line connecting the left and right antegonial notch, a parallel line to Z plane at the level of menton), degree of parallel of each of the horizon and symmetry of the facial structure can be assessed.

     First, in order to analyze the facial vertical proportion, facial height (trichion–menton) is divided into three categories: upper facial height (trichion–glabella) midfacial height (glabella–subnasale), and lower facial height (subnasale–menton).

Its ideal ratio is 1:1:0.8 to 1.0 in Asian women, but recently lower facial height has a decreasing tendency toward 1:1:0.8. In lower facial analysis, the ratio between upper lip length (from subnasale to stomion) and chin length (from stomion to menton) is normally 1:2. However, when upper lip length (subnasale–stomion) is out of range (normal: 20 ± 2 mm), it is difficult for surgeons to undergo surgery at a rate of above. Surgeons need to confirm the patient's need through thorough preoperative consultation. Horizontally, facial height (Tr–Me): bizygomatic width (Za–Za) is 1.3:1 (female), 1.35:1 (male). It is recommended that bigonial width should be reduced 70% of bizygomatic width (Fig. 5.3).

The amount of narrowing and lateralization (considering the degree of asymmetry) and the amount of angle and inferior border resection are determined after checking the course of the inferior alveolar nerve. Panoramic view is helpful in determining the amount of ostectomy of the mandibular angle and body, as well as the position of its ostectomy line (Fig. 5.4).

– Sagittal Plane

Using the lateral cephalogram, facial vertical proportion, gonial angle, the mandibular plane–sellar nasion angle (MP–SN angle), and the vertical and anterior–posterior position of the chin should be identified. The ideal gonial angle is within the range of 105–115°, and MP–SN angle is 30–40°. After measuring and understanding the accurate balance of the upper and midface, the amount of reduction, lengthening, and vertical/horizontal advancement or retrusion (setback) of mandible in anterior–posterior direction will be decided. The anterior–posterior position of Po (pogonion) is determined by Ricketts line (Fig. 5.5).

– Transverse Plane

3D CT in cervical vertex view is used to identify transverse shape of mandible. The angle of divergence and convexity of the mandible is observed. Also the position of centerline of the chin is identified. This may be helpful to determine the direction and amount of midline shifting of the chin while performing T-osteotomy. In cases with inward curled angle with convex transverse shape, sagittal resection of the body will help to reduce the width of mandible more effectively (Fig. 5.6).

Consideration in Surgical Planning

Chin

The term "chin" refers to both the bone and the surrounding soft tissues. The chin is a very important component in lower facial morphology, and full attention should be given to the procedure of lower facial contouring surgery. In some patients, resection of the mandibular angle and inferior border alone does not make the face appear slender. The main reason for this is attributed to a wide, flat chin and a U-shaped lower facial morphology. Therefore, to create a slim and attractive face, reducing the width of the chin and modifying its shape and position is necessary in addition to resection of the mandible. The amount of central resection, advancement, or setback should be individualized depending on the width of the chin. Most of all, critical decisions with regard to the chin position are made when viewing the patient "face-to-face" considering the varying perspectives in repose and with broad smile.

Abnormal Skeletal Relationship Between the Maxilla and Mandible

Relationship of the mandible with the maxilla should be understood, because not all patients have a normal intermaxillary skeletal relationship. In cases with protruding mandible showing Class III occlusion or those with relative underdevelopment of the lower jaw showing Class II occlusion, orthognathic surgery may be needed to improve this disorder. If mandibular

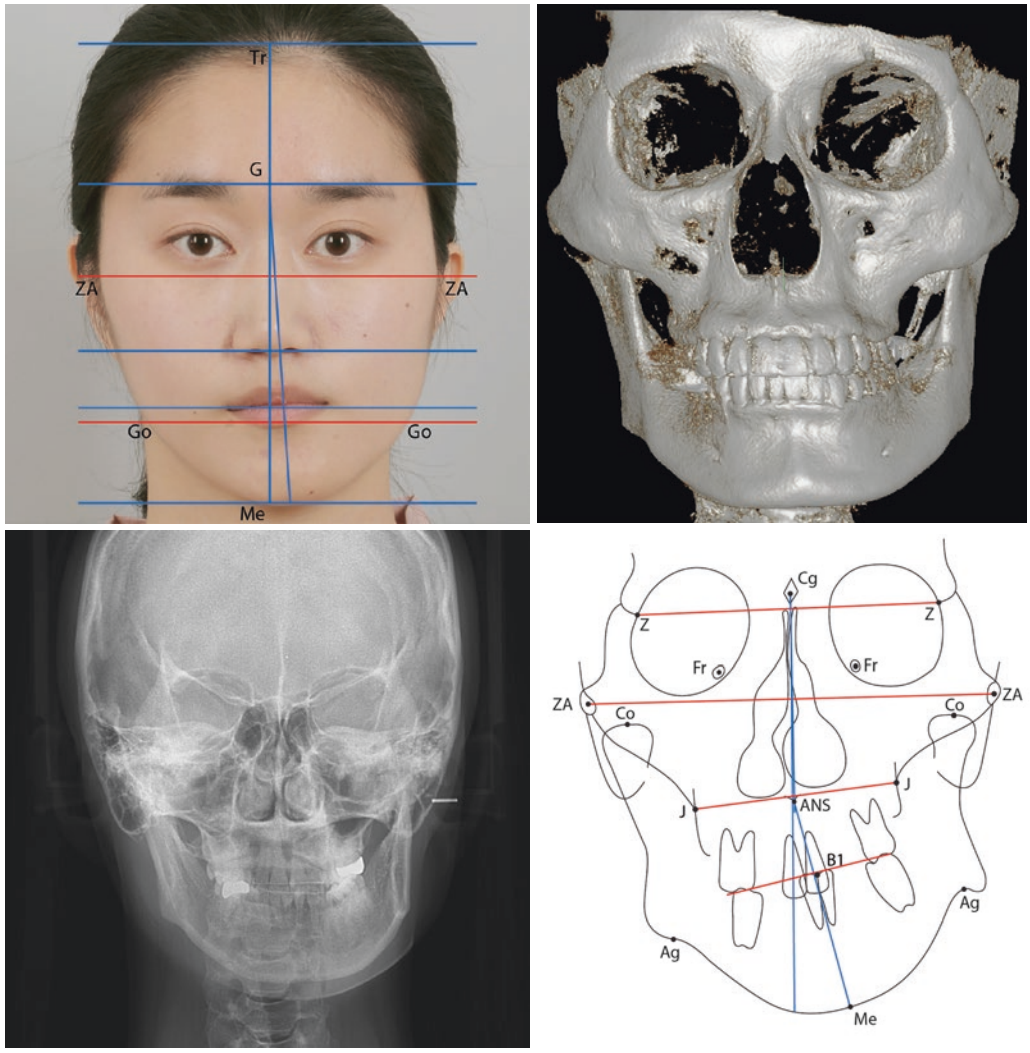

Fig. 5.3 Analyzing skeletal asymmetry and facial proportions. With the use of reliable vertical baseline (a vertical line that is connected to the chin, which is started from crista galli (Cg) and crossing ANS) and horizontal reference lines (Z plane, ZA plane, J plane, a line connecting the left and right antegonial notch, a parallel line to Z plane at the level of menton), degree of parallel of each of the horizon and symmetry of the facial structure can be assessed. The face is divided into thirds by horizontal lines drawn adjacent to the menton (Me), the nasal base, the brows (Glabella, supraorbital notch level), and the hairline (Tr). The lower third is further divided into an upper third and lower two-thirds by a line drawn through oral commissures. Horizontally, facial height (Tr–Me): bizygomatic width(Za–Za) is 1.3:1 (female) and 1.35:1 (male). It is recommended that bigonial width should be reduced 70% of bizygomatic width

contouring surgery should be done without correcting Class II or Class III skeletal problems, certain characteristics should be considered not to aggravate the intermaxillary problems. In cases with prominent mandible showing skeletal Class III relationship, long jawline may appear more accentuated if the angle is resected too much during mandible reduction. Therefore, the angle

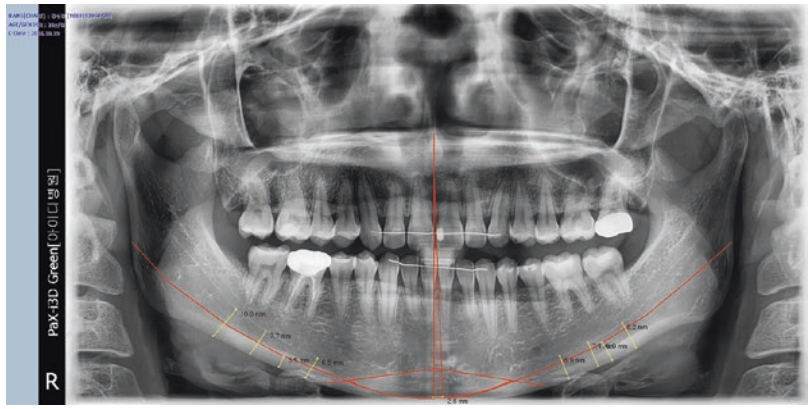

Fig. 5.4 Determination of the amount of mandibular border ostectomy. Based on panoramic view, the amount of mandibular border ostectomy can be determined considering the inferior alveolar nerve course. In case of asymmetry, a disproportionate ostectomy is mandatory. For example, in this case, the midline of the chin is shifted 2.8 mm toward right side. About 3.5 mm of mandible border is resected on the right side, and 6.0 mm mandible border is resected on the left side. However, angular resection is done on a similar amount

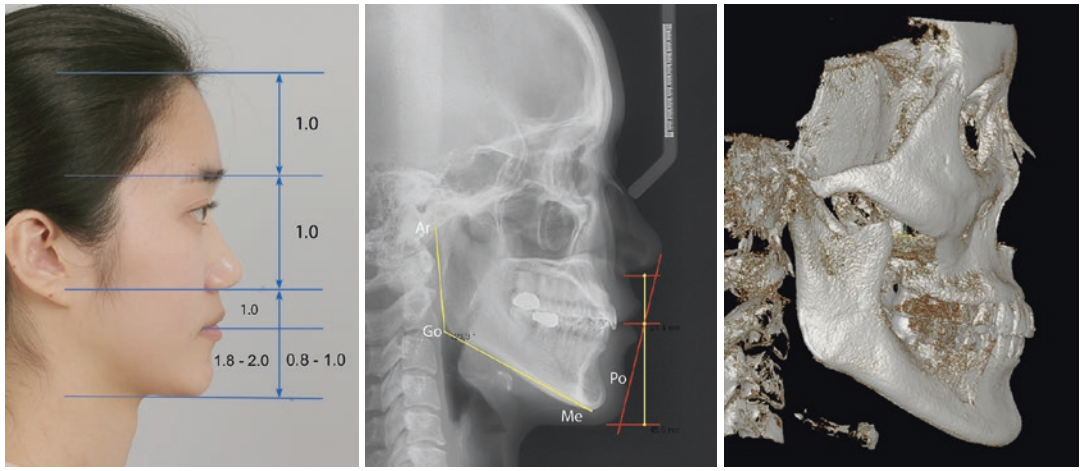

Fig. 5.5 Analyzing vertical facial proportion and determination of the chin position. The lateral view is drawn aesthetic proportions showing the face divided into horizontal thirds on profile. The position of chin (Pg) in vertical and horizontal direction is determined from this view considering facial proportions and Ricketts line. In this case, 3.5/3.0 mm of vertical reduction of the chin is planned without any anterior–posterior movement. It should be kept in mind as only vertical reduction decreases anterior projection of the chin to some extent

should be conservatively resected and sagittal shaving should be properly performed to minimize aggravation of prognathic appearance. In a long face, angle resection should be performed in a limited way to prevent the aggravation of steep mandibular plane. Instead, we need to focus on the vertical reduction of anterior mandible. In case of steep mandibular plane, mini V-line surgery without resecting mandibular angle is more preferred rather than V-line surgery which includes resection of whole mandibular inferior border and angle. In patients with retruded mandible showing Class II profile, excessive resection of the mandible angle causes more obscure cervicofacial line. Therefore, conservative mandible resection and maximal sagittal shaving

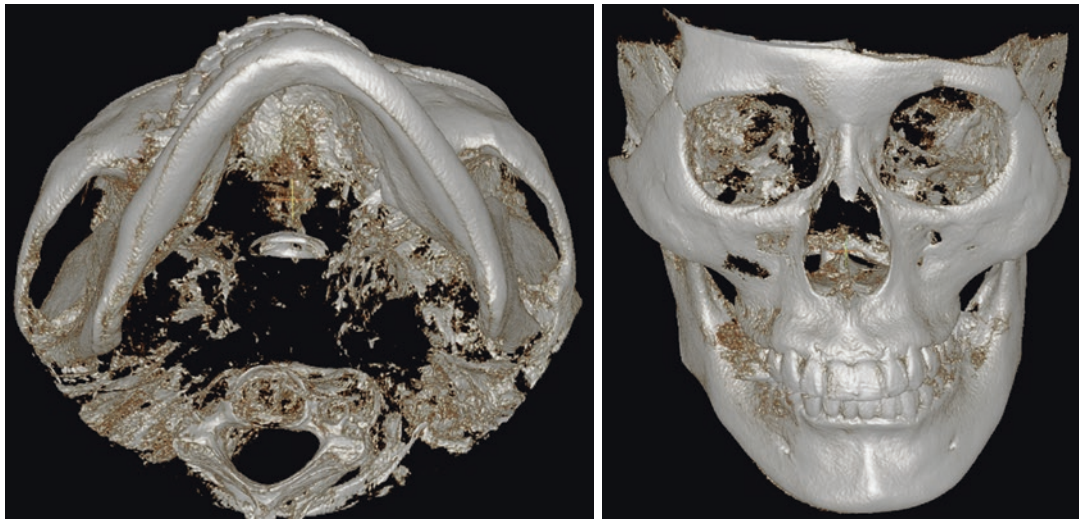

Fig. 5.6 Analysis of transverse plane: basal and overhead views. The exact region and amount of sagittal resection can be determined by thorough evaluation of the angle of divergence and convexity of the mandible from this view. In addition, the position of the midline of the chin regarding asymmetry is easily identified from this view. The *red lines* indicate facial deviation and *dashed lines* indicate the midline of the face. In this case, more sagittal resection of the body is planned on the left side

of the body of the mandible, combined with advancement genioplasty are recommended.

Asymmetry

Dental occlusion and overall facial conformation should be considered to analyze asymmetry of the face. Special care should be taken if a mismatch is observed between the actual photographs and the radiographs. If facial asymmetry is due to skeletal reason, the degree and extent of asymmetry should be evaluated. If there is a canting due to maxillary vertical discrepancy, the patients should fully understand the limitation of mandibular contouring surgery. It should be evaluated whether facial asymmetry is entirely caused by asymmetric morphologic abnormalities of a lower jaw or caused by entire facial asymmetry including the upper jaw. For this, the position of a nose tip and a midsymphysis relating to mid-sagittal plane, a midline of upper and lower incisor teeth, a relationship between the midline of the lower incisor teeth and midsymphysis, and symmetry of both mandibular angle contours relating to mid-sagittal plane should also be evaluated. Mandibular asymmetry of mild to moderate degree can be improved by disproportionate resection of mandible border and elaborate three-dimensional shaving. Asymmetries confined to the chin relative to the face are most frequently encountered. For individuals whose chin shifts to one side, mandible reduction makes chin asymmetry more obvious and concomitant horizontal osteotomy of the chin and transverse movement may be required.

Soft Tissue Contribution

Hypertrophied masseter muscle, which is a critical factor for determining the width of the face, should be corrected. Generally, detachment of the masseter from its insertion to the mandible alone can reduce the volume of the muscle and additional resection of the muscle is not recommended. In cases with severe hypertrophy of masseter muscle, botulinum toxin injection or a partial resection of the medial aspect of masseter muscle can be done. However, keep in mind that this increases swelling and the risk of nerve injury or inflammation by necrotic muscle

debris. Regarding overlying skin and subcutaneous fat tissues, if the patient has thin fair skin with minimal subcutaneous fat, the changes after bone surgery are obvious, and the chance of soft tissue drooping is minimal. This patient is a good candidate for mandible contouring surgery. If the patient has abundant soft tissue or thick skin, there is a high risk of soft tissue sagging. The patient should be informed about the possibility of aggravation of jowl (irregular jawline) and appropriate adjunctive measures, including liposuction or lifting procedures. If the patient has a thick malar fat pad, the zygomatic body should be slightly overcorrected to prevent under-correction. Buccal fat removal may be combined for excessive cheek fat (Fig. 5.7).

A lifting procedure is required for skin and soft tissue sagging, upon checking the patients' age and skin elasticity. The high-risk factors for skin and soft tissue sagging are (1) age over 40, (2) abundant cheek fat, (3) thin skin and skin laxity, and (4) Class II occlusion or ill-defined mandible-neck line.

Ethnic Variation and Cultural Background

The ideal facial shapes may be different upon personal preference, as well as ethnic or cultural background. Especially when consulting patients with different national or ethnic backgrounds, careful attention should be paid during consultation for their ideal or desirable facial shape in mind. For example, Chinese patients prefer relatively long and pointed chin. On the other hand, Japanese prefer rather short and round chin. Koreans prefer moderate trapezoid chin. In the case of feminization surgery for transgenders, in

Fig. 5.7 Soft tissue contribution. (*Left*) The patient has thin fair skin with minimal subcutaneous fat. The changes after bone surgery are obvious, and the chance of soft tissue drooping is minimal. (*Right*) The patient has abundant soft tissues and thick skin. There is a high risk of soft tissue sagging. The patient should be informed about the possibility of aggravation of jowl (irregular jawline) and appropriate adjunctive measures, including liposuction or lifting procedures

order to satisfy their special needs, maximizing the feminine characteristics, rather than simply reducing the width and size of the mandible is essential.

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The Standard Mandible Reduction with Intraoral Approach

6

Sanghoon Park

Pearls

1. For precise surgical planning and prevention of postoperative asymmetry, three-dimensional analysis of the photographs and the radiographs in the frontal, sagittal, and transverse planes is important.
2. The inferior alveolar nerve is the most important structure during mandible reduction, and it should be carefully examined preoperatively in panoramic view as well as in a computed tomography (CT) scan.
3. The superior limit for resection is the occlusal plane; the anterior limit is the convergence of the mandibular oblique line with the lower mandibular border and mental nerve.
4. The resected segment typically has an elongated semilunar shape instead of being triangular; when removed, it leaves a gently curved lower mandibular border.
5. If an osteotomy is too straight and fails to form a smooth transition, it will leave a "secondary angle." The secondary angle can be palpated or sticks out externally. If secondary angle is obvious, it may require burring or additional osteotomy.
6. In cases of an inward-curled angle with a convex transverse shape, sagittal resection of the body is required to reduce the width of the mandible more effectively.

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Introduction

The overall Asian facial structure is typically classified as brachycephalic or mesocephalic, with a widened mandibular arch and broad lower facial skeleton. In countries such as Korea, China, and Japan, these characteristics are often viewed as masculine and unattractive; thus, both men and women often wish to make their faces appear more slim and slender. Generally, the cause of prominent mandibular angle in Asians is the lateral protrusion of the mandibular angle rather than soft tissue contribution such as hypertrophied masseter muscle [1, 2].

In 1949 Adams introduced a surgical technique for resecting mandibular bone and masseter muscle via the transcutaneous approach, and Converse performed the same procedure through an intraoral approach in 1959 [3]. In 1989 Baek introduced mandibular angle reduction for Asian patients via the intraoral approach. In 1991 Yang and Park introduced a surgical technique for contouring the mandibular body and the symphysis with a sequential resection of the bone. Since the late 1990s, one-stage, long curved ostectomy has been widely used to contour the mandible [2].

S. Park (ed.), *Facial Bone Contouring Surgery*, DOI 10.1007/978-981-10-2726-0_6

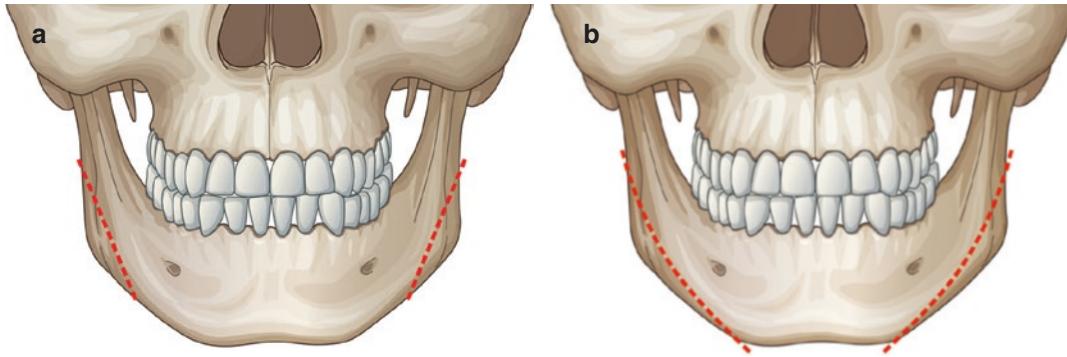

Fig. 6.1 Evolution of mandible reduction surgery. Mandible reduction surgery has evolved from (**a**) simple resection of the angular portion to (**b**) contouring of the total mandible shape as the desire for a slim and small face has increased

The conventional ostectomy, which resects the inferior border of the mandibular angle and body, can bring a satisfactory contour from the side view; however, it fails to show improvement in the frontal facial contour due to its inability to narrow the broad lower face. To achieve the desired appearance of the frontal view facial contour, a variety of surgical techniques were developed. In 1997, Deguchi et al. reported that the width of the lower face could be narrowed by a technique that shaves the lateral cortex anterior to the inferior alveolar nerve and splits the angle posterior to the nerve [4]. In 2001 Han and Kim effectively reduced the bigonial width through lateral cortex ostectomy without a mandibular angle reduction [5]. In 2004, Hwang et al. introduced simultaneous utilization of the two different techniques [6]. The evolution of mandible reduction surgery is summarized in Fig. 6.1.

Patient Assessment

Preoperative patient evaluation consists of physical examination and radiologic evaluation. The degree of protrusion of the mandible, asymmetry, masseter muscle hypertrophy, and amount of the subcutaneous fat should be evaluated by the physical examination at initial consultation.

Frontal Plane

Using the PA cephalogram and 3D CT, the degree of protrusion or flaring of the mandible angle, symmetry, convexity of the body, deviation, and shape of the chin should be examined. The amount of angle and inferior border resection are determined after checking the course of the inferior alveolar nerve. A panoramic view is helpful in determining the amount of ostectomy of the mandibular angle and body, as well as the position of its ostectomy line.

Sagittal Plane

Using the lateral cephalogram, the gonial angle and the mandibular plane-sellar nasion angle (MP-SN angle) should be identified. The ideal gonial angle is within the range of 105–115°, and the MP-SN angle is 30–40°.

Transverse Plane

Three-dimensional CT or the cervical-vertex view is used to identify the transverse shape of the mandible. The angle of divergence and convexity of the mandible are observed. In cases with an inward-curled angle with a convex

transverse shape, sagittal resection of the body will help to reduce the width of the mandible more effectively.

Surgical Technique

The general procedure is as follows (Fig. 6.2.):

1. Mandibular reduction is performed under general anesthesia. Either nasotracheal or endotracheal intubation can be used. The authors generally use endotracheal intubation.
2. The patient is positioned supine with a transverse roll beneath the shoulders to extend the neck. The entire face is prepped with Betadine solution. The oral cavity and the teeth are brushed with dilute aqueous Betadine solution. The operative field is draped to assist with intraoperative evaluation of symmetry. Surgery is performed in the intraoral area in a dark field; hence, wearing a headlight is helpful in performing the surgical procedure.
3. A mouth gag is placed between the upper and the lower teeth. The incision line is designed using gentian violet solution. A buccal vestibular incision design is made from the ramus extending anteriorly to the first molar or second premolar while leaving a 7- to 8-mm mucosal cuff. This mucosal cuff helps to close the suture in an easy manner. The operative field is infiltrated with 0.25% lidocaine with 1:200,000 diluted epinephrine solution.
4. Through a subperiosteal elevation with the periosteal elevator, the lateral aspect of the mandibular body is exposed. The dissection continues superiorly along the vertical ramus to adequately expose the area of resection. The masseter fibers are stripped from the lower border of the body, angle, and posterior border of the ramus with an angle stripper to secure a good operative field. Subperiosteal dissection prevents bleeding from the masseter muscle. During the dissection the mental nerve, the marginal mandibular branch of the facial nerve, the retromandibular vein, and the facial artery should be protected.

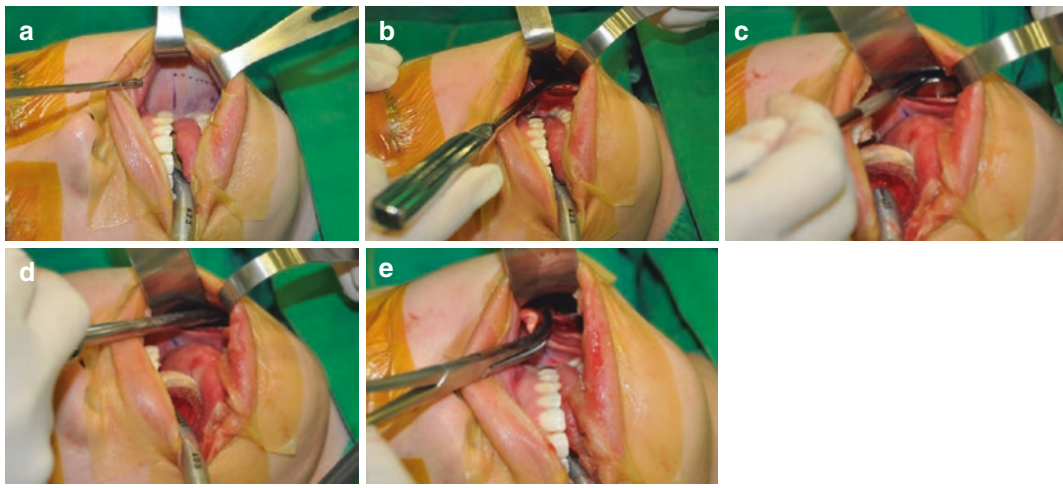

Fig. 6.2 Operative procedures. (**a**) The incision line is designed. (**b**) Subperiosteal elevation with periosteal elevator. The lateral aspect of the mandibular body is exposed (**c**) The desired level of the osteotomy line is marked on the bone with a marking pencil. The marked line is checked by use of dental mirrors. (**d**) Long curved osteotomy is performed. A 110° oscillating saw is used for the ostectomy. (**e**) Dividing the attachment of muscle to the medial part of the mandible. A large elevator or Bovie electrocautery is used to divide any remaining medial pterygoid muscle fibers from the medial surface of the osteotomized segment

5. Using a specialized angle retractor, the mandibular angle is hooked, and the desired level of the osteotomy line is marked on the bone with gentian violet solution or sterilized pencil. The marked line is then checked with dental mirrors. In general, the upper limit of osteotomy should not be beyond the occlusal plane, and the anterior limit should not violate the chin. If the osteotomy goes vertical beyound occlusal plane, there is a increased risk of condylar fracture. Usually the anterior limit is right under the mental foramen. But the upper and anterior limit of osteotomy can be adjusted case by case.
6. Before the main osteotomy procedure is performed, "guarded" oscillating saw is used to mark the proposed osteotomy line [7]. The guarded saw has a small oscillating saw blade that is shielded at distances of 2, 3, 4, 5, or 6 mm (Chap. 4). The size of the guarded saw to be used is determined by considering the amount of resection to be performed in the mandibular body and the path of the inferior alveolar nerve, that is, the distance between the lower mandible border and the route of the nerve. By using these guarded oscillating saws, it is possible to perform the bony resection precisely in a more uniform fashion. More importantly, by using a guarded saw, unintentional overresection can be avoided, and the possibility of nerve injury can be decreased.
7. After the osteotomy is initiated with a guarded saw, larger oscillating saws were serially used to complete the bone resection. After ostectomy is done with full thickness, the bone segment moves freely. In this step, thorough full-thickness ostectomy can cause soft tissue injury in medial surface of the mandible, so surgeon should pay attention in order not to place oscillating saw too deeply.
8. After ostectomy, the attachment of muscle to the medial part of the mandible usually remains. A large elevator or Bovie electrocautery is used to divide any remaining medial pterygoid muscle fibers from the medial surface of the osteotomized segment, allowing its removal.
9. Finally, a high-speed bur is used to remove any additional bone from the lateral cortex and to make a smooth transition. This procedure prevents the chance of secondary angle.
10. An identical procedure is performed on the contralateral side. Here any preoperative asymmetry in the degree of angle prominence should be taken into account and a relatively greater or lesser amount of mandibular bone resected.
11. The bilateral wounds are irrigated by saline and hemostasis secured. The wounds are closed in two layers (periosteum and mucosa) with a 4–0 absorbable suture. Bilateral suction drains are left in place overnight. Compression with a facial bandage is used.

Key Technical Points

1. Important anatomic structures must be respected. Preoperative evaluation of inferior alveolar canal by panoramic view and CT can help surgeon know the course of inferior alveolar canal and the exact distance from the inferior border of mandible to the canal. According to the preoperative evaluation, surgeon should prevent opening of the canal and direct injury to inferior alveolar nerve.
2. The surgeon should determine the position and quantity of mandibular bone to be removed before surgery and perform osteotomy accurately by the plan.
3. The superior limit for resection is usually the occlusal plane; the anterior limit is the convergence of the mandibular oblique line with the lower mandibular border.
4. The resected segment typically has an elongated semilunar shape instead of being triangular; when removed, it leaves a gently curved lower mandibular border. The oblique height of this segment is typically in the range of 10–20 mm, with length ranging 30–70 mm.
5. If an osteotomy is too straight and fails to form a smooth transition, it will leave a "secondary angle." The secondary angle can be palpated or sticks out externally. If secondary angle is obvious, it may require burring or additional osteotomy.

Case Study

Case 1

A 20-year-old woman complained of her prominent mandibular angles (Fig. 6.3). She desired a slender and smooth lower facial contour. The intergonial distance was large, and this, in combination with lateral flaring of the angle, made her lower face appear broad, square, and strong. After a full-thickness ostectomy of a lower border of the mandibular body-angle region, shaving of the outer cortex was accomplished. After the mandible-contouring surgery, the gonial angle and the mandibular plane angle increased (Fig. 6.4). Two months following the operation, the contour of her lower face appeared soft and slender (Fig. 6.3).

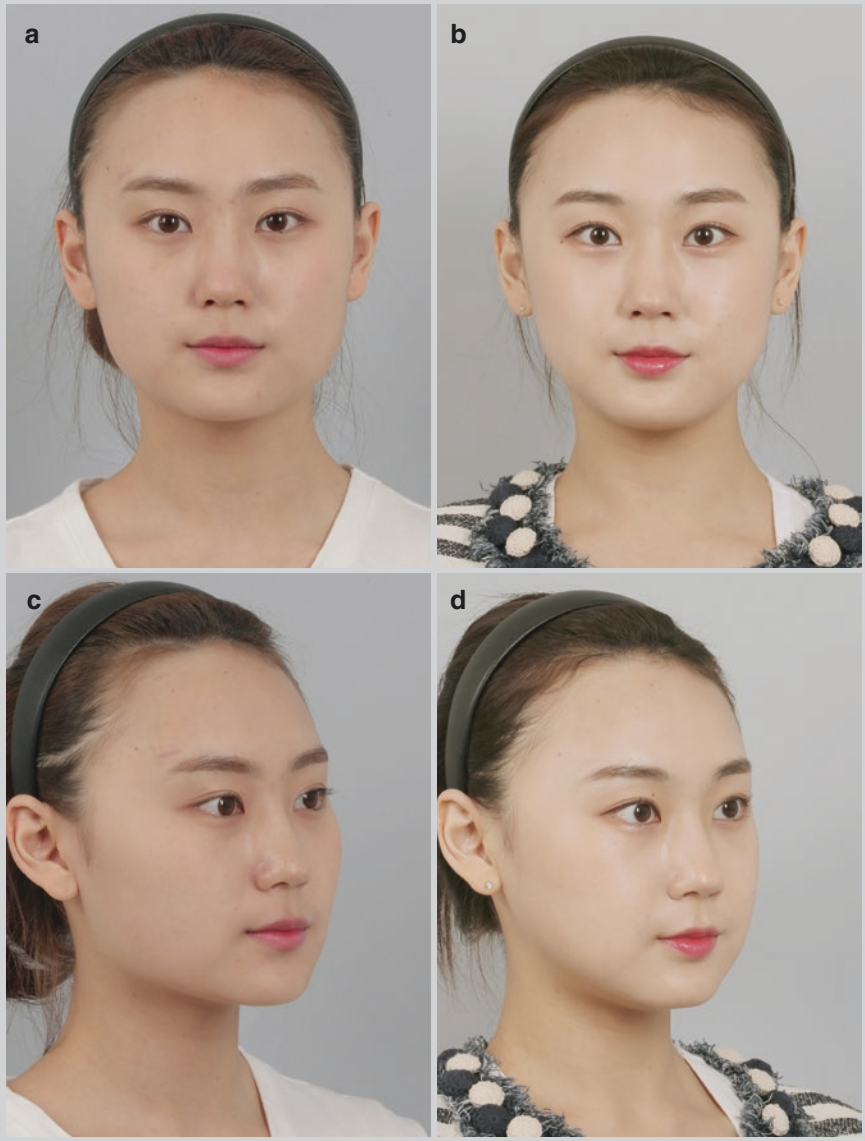

Fig. 6.3 Case 1: Pre- (*left*) and postoperative (*right*) frontal and oblique views

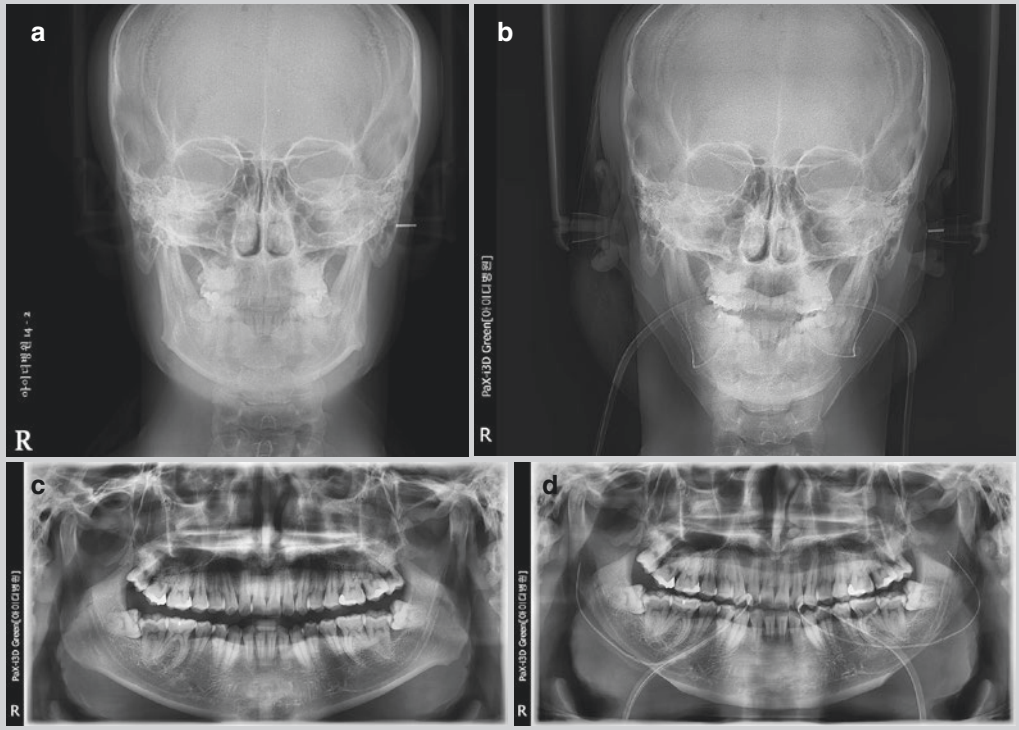

Fig. 6.4 Radiologic findings of case 1. Pre- (*left*) and postoperative (*right*) cephalograms and panoramic views

Case 2

A 28-year-old woman requested that her prominent mandibular angle and zygoma be corrected (Fig. 6.5). The zygomatic complex was protruded and the mandible was angulated, which made her look muscular. She underwent mandible and zygoma reduction surgery simultaneously. After the mandible-contouring surgery, the gonial and mandible plane angle increased (Fig. 6.6). Two months following the operation, the contour of her lower face appeared soft and slimmer (Fig. 6.5).

Fig. 6.5 Case 2: Pre- (*left*) and postoperative (*right*) frontal and oblique views

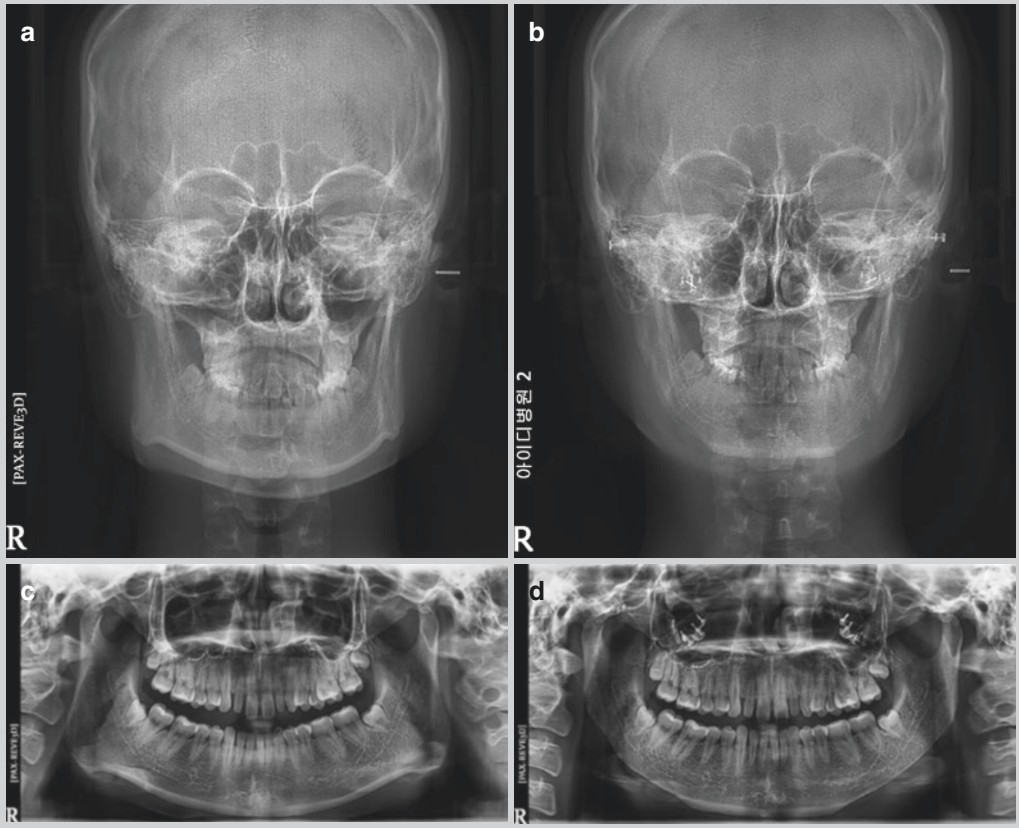

Fig. 6.6 Radiologic findings of case 2: Pre- (*left*) and postoperative (*right*) cephalograms and panograms

Complications and Management

Hemorrhage and Hematoma

The incidence of major intraoperative hemorrhage has decreased over the years, principally because of advances in surgical technique and the use of hypotensive anesthetic protocols (mean systolic blood pressure lower than 65 mm Hg). Hypotensive anesthesia coupled with injection of local anesthetic with vasoconstrictor minimizes blood loss and increases visualization of the operative field. A saw blade or sharp bony edge may injure the vessel. If the retromandibular vein or facial artery is torn during the procedure, attempts to secure hemostasis often fail because electrocauterizing the bleeding vessel is not easy. The main cause is that bleeding vessel is retracted to behind the mandible bone. Repeated, unsuccessful hemostasis may lead to excessive blood loss. Further resection or completing the resection may help visualize the bleeding vessel. Decision is mandatory whether to continue or stop the attempt. Application of a hemostatic substance like Surgicel (Ethicon) and external manual compression for at least 30 min can help to stop the bleeding in most of cases [8]. So for the beginning surgeon, never attempt excessive trial of electrocauterization. Following the completion of surgery, the soft tissue of the cheek and the neck should be checked for any signs of bleeding or swelling. Any signs of swelling or bleeding near the throat should prompt extreme awareness and alarm because it may cause airway compomise, possibly leading to a fatal outcome.

Nerve Injury

If the curved osteotomy is made too high on the mandibular body, the inferior alveolar nerve may be injured. Prior to surgery, a panoramic X-ray is taken to locate and check the course of the inferior alveolar nerve. The surgeon must accurately define the course of the inferior alveolar nerve during the surgery by measuring its course from the lower border of the mandible. The osteotomy should be at least 3 mm away from the inferior alveolar canal and mental foramen because of its upturn exit through the mental foramen [9]. Special care should be taken when performing osteotomy cuts, and drilling should be accompanied by copious irrigation to prevent heat injury. If it appears that the nerve has been damaged or amputated, then a 7–0 nylon neurorrhaphy needs to be performed to secure possible recovery of the nerve. If the nerve is retracted to the canal, opening the canal by burring and exposing the enough length of nerve are required for optimal neurorrhaphy.

Infection and Inflammation

Though wound infection following surgery is uncommon, problematic issues may arise due to the following conditions: poor pre- and postoperative oral hygiene, improperly sealed wound, insufficient flushing, bone fragments or dust left behind in the wound, damaged salivary glands, or periodontal disease. The mandible reduction surgery is considered as clean-contaminated surgeries because of mucosa disruption in oral cavity. Therefore prophylaxis against gram-positive and anaerobic bacteria (amoxicillin-clavulanate, cefazolin + anaerobicid (clindamycin or metronidazole) is recommended [10]. In ID hospital, Bactacin 1.5 g (ampicillin sodium 1000 mg, sulbactam sodium 500 mg) is administered in intravenous infusion preoperative and postoperative period in every 8 h during admission period; then Augmentin (amoxicillin sodium 250 mg, clavulanate potassium 125 mg) is prescribed for oral antibiotics after discharge. If there are signs of infection such as persistent swelling, local heat, and pus-like discharge through incision site, we perform aspiration percutaneously and compression at first time. Intravenous antibiotics including ceftriaxone and clindamycin are administered to the patients. In case of mild infection, daily follow-up and serial aspiration and IV antibiotics therapy can control the infection. But in case of severe infection, the patient should be admitted in hospital, and wound irrigation in operating room is required. If the residual wound is not clean enough after irrigation, external drain is put in retromandibular area. In this case, care should be taken to oral wound in order not to make orocutaneous fistula.

Discussion

Approach: Intraoral Versus External Approach

Mandible reduction can be done using the intraoral approach or the external approach. Traditionally, mandible contouring ostectomy has been performed using the intraoral approach with an oscillating saw. This approach involves minimal space to work along with poor visibility, and it requires technical skill in manipulating the oscillating saw. Because somewhat blind removal of the mandible is required, ostectomy may be facilitated by burring the ramus area or by using indirect mirrors, especially in patients with inwardly curved angles.

An external approach was previously used because it was easy and allowed direct access to the mandibular angle [11]. Recently, submandibular incision is rarely used for ordinary mandible reduction. In minimally invasive mandible surgery, the external approach can be used with chin incision or postauricular incision. With the postauricular approach, scar is hidden and the operation time is shorter. Because poor visibility of the anterior part of the mandible causes unsatisfactory outcomes, this approach should be applied only to a limited population of patients who have mandible angle prominence.

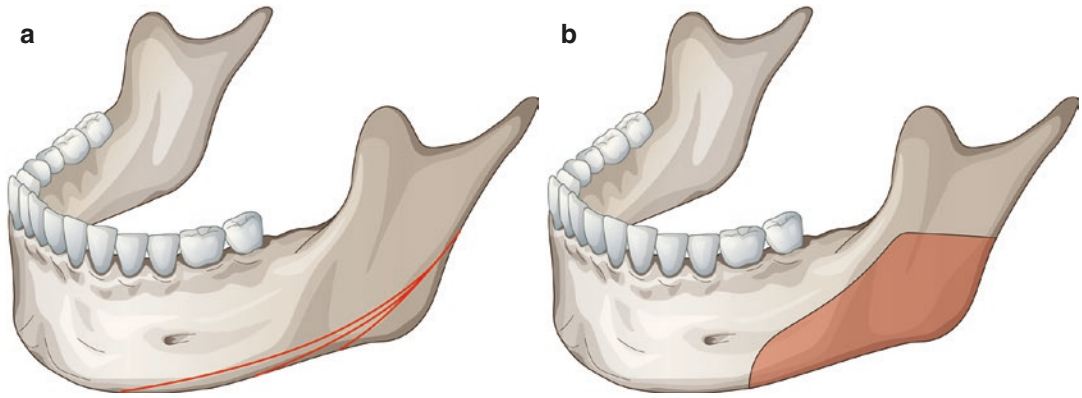

Fig. 6.7 Types of osteotomy for mandible reduction. (1) Curved ostectomy with an oscillating saw. (2) Tangential ostectomy with a reciprocating saw (lateral cortex ostectomy)

Types of Ostectomy: Curved Ostectomy Versus Tangential Ostectomy (Fig. 6.7)

Curved Ostectomy with an Oscillating Saw

This procedure can be applied to most patients with prominent mandibular angle or wide lower face. It reduces the posteroinferior mandibular portion in the lateral view. The anterior extent of a curved ostectomy may be extended to just below the mental foramen depending on a patient's facial morphology. Simultaneous reduction of the mandibular angle and body can result in a much smaller lower facial contour.

Tangential Ostectomy with a Reciprocating Saw (Lateral Cortex Ostectomy)

This procedure removes the external cortex of the mandibular ramus by means of a reciprocating saw. It is performed to narrow the bigonial distance in the laterally flared angles of the mandible or to reduce the thickness of the body of the mandible in the frontal view [4, 5, 6]. However, this procedure is not recommended due to the high risk of nerve injury, soft tissue adherence to the bony medulla, and difficulty in shaping. The authors recommend sagittal resection with burring, leaving a thin film of outer cortex, in which it is easy to control the shape of the mandible and a natural healing process is ensured.

Asymmetry

Dental occlusion and overall facial conformation should be considered to analyze asymmetry of the face. Special care should be taken because a mismatch is observed frequently between the actual photographs and the radiographs. If facial asymmetry is due to skeletal factors, the degree and extent of asymmetry should be evaluated. If there is canting due to maxillary vertical discrepancy, then the patient should fully understand the limitations of mandible-contouring surgery. Mandibular asymmetry of mild to moderate degree can be improved by disproportionate resection of the mandible border and elaborate three-dimensional shaving. Asymmetries confined to the chin relative to the face are most frequently encountered. For individuals whose chin shifts to one side, mandible reduction makes the chin asymmetry more obvious, and concomitant horizontal osteotomy of the chin and transverse movement may be required.

Soft Tissue Contribution

A hypertrophied masseter muscle, which is a critical factor for determining the width of the face, should be corrected. Generally, detachment of the masseter from its insertion to the mandible

alone can reduce the volume of the muscle, and additional resection of the muscle is not recommended. In cases with severe hypertrophy of the masseter muscle, botulinum toxin injection or a partial resection of the medial aspect of the masseter muscle can be done. However, this increases swelling and the risk of nerve injury or inflammation by necrotic muscle debris. Buccal fat removal may be combined for excessive cheek fat. A lifting procedure is required for skin and soft tissue sagging, upon checking the patients' age and skin elasticity. The high-risk factors for skin and soft tissue sagging are [1] age over 40, [2] abundant cheek fat, [3] thin skin and skin laxity, and [4] class II occlusion or ill-defined mandible neckline.

Ethnic Variation and Cultural Background

The ideal facial shape may differ depending upon personal preference, as well as ethnic or cultural background. Especially when consulting patients with different national or ethnic backgrounds, careful attention should be paid to their ideal or desirable facial shape. For example, Chinese patients prefer a pointed chin, Japanese prefer a round chin, and Koreans prefer a moderately trapezoidal chin. In the case of feminization surgery for transgenders, to satisfy their special needs, maximizing the feminine characteristics, rather than simply reducing the width and size of the mandible, is essential.

Abnormal Skeletal Relationship Between the Maxilla and Mandible

The relationship of the mandible with the maxilla should be understood, because not all patients have a normal intermaxillary skeletal relationship. In cases with protruding mandible showing class III occlusion, or those with relative underdevelopment of the lower jaw showing class II occlusion, orthognathic surgery may be needed to improve this disorder. If mandible contouring surgery is to be done without correcting class II or class III skeletal problems, certain characteristics should be considered to avoid aggravating the intermaxillary problems. In cases with prominent mandible showing a skeletal class III relationship, a long jawline may appear more accentuated if the angle is resected too much during mandible reduction. Therefore, the angle should be conservatively resected, and sagittal shaving should be properly performed to minimize aggravation of prognathic appearance. In patients with a retruded mandible showing a class II profile, excessive resection of the mandible angle causes a more obscure cervicofacial line. Therefore, conservative mandible resection and maximal sagittal shaving of the body of the mandible, combined with advancement genioplasty, are recommended. In a long face, angle resection should be performed in a limited way to prevent the aggravation of steep mandibular plane.

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Sagittal Resection of the Mandible: Are We Doing Right?

7

Sanghoon Park

Pearls

1. Sagittal resection of mandible has an important role in reducing the lower facial width.
2. Conventional method of sagittal resection focused on removing the lateral mandibular cortex in the posterior ramus and mandible angle region, which has the problems and leads to the misunderstanding.
3. The widest part of the mandible is the gonial area in straight or outcurved mandible type, but maximal ramus point in incurved mandible type. After contouring ostectomy, this maximal ramus point is 1–2 cm anterior to the posterior border of the mandible.
4. The thickest portion of the mandible is the junctional area between the ramus and body along the oblique line.
5. Instead of splitting angular part of the mandible, geographic sagittal resection of the mandibular body should include the maximal body point (MBP) and maximal ramus point (MRP) to maximize the effect.

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Introduction

For Asian women with a large, square-shaped mandible, mandible reduction is a popular operation to make one's face more slender. The two most popular methods for mandibular bone reduction are mandibular contouring and sagittal mandibular resection [1–6]. Recently, it was reported that sagittal mandibular resection was important for reducing lower facial width in the frontal view [4–8]. According to previous reports, sagittal mandibular resection focused on removing the lateral mandibular cortex in the posterior ramus and mandible angle region [4, 5] (Fig. 7.1). However, we encountered some problems in performing sagittal mandibular resection.

1. This posterior part of the mandible is very thin, and the amount of bone reduction is very small. Under these conditions, overzealous sagittal mandibular resection in the posterior part may result in complications, such as nerve and soft-tissue injury and an unfavorable condylar fracture.
2. Frequently, this angular part is inwardly tilted, and the effect of reducing facial width in the frontal view is minimal.
3. In most cases of mandibular reduction, sagittal mandibular resection is combined with mandibular contouring. The posterior part, which includes the prominent and protruding

S. Park (ed.), *Facial Bone Contouring Surgery*, DOI 10.1007/978-981-10-2726-0_7

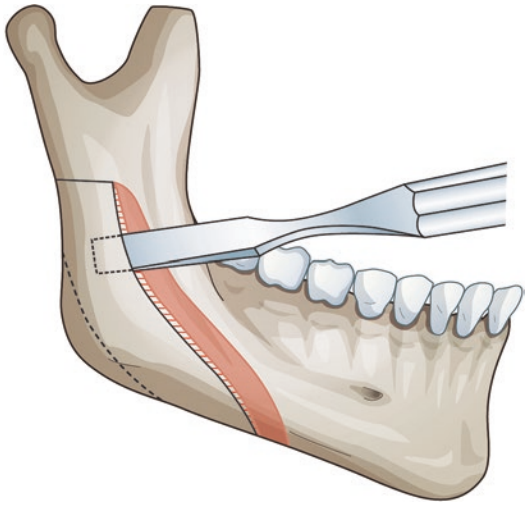

Fig. 7.1 The previous surgical design for mandibular sagittal-splitting ostectomy: Ostectomy is done on the mandibular angle and body area

mandible angle and gonion, is removed by mandibular contouring, leaving only the minimal angular part. So, the most prominent part in the remaining mandible is the mandible body rather than the angle.

Authors want to correct misunderstandings related to sagittal resection of the mandible in previous literature. Authors also want to devise a safe and effective sagittal mandibular resection method, for effective mandibular reduction.

Patient Assessment and Consultation

Among the ordinary preoperative evaluation of the patients, the degree of protrusion of the mandible, in frontal view is important. First, amount of masseter muscle hypertrophy, and amount of the subcutaneous fat should be evaluated by the physical examination at initial consultation. Using the PA cephalogram and 3D CT, the degree of protrusion or flaring of the mandible angle is evaluated. Shape and convexity of the body should be examined carefully. A panoramic view does not give a good information in terms of sagittal resection. Imagine the three dimensional shape of sagittal resection in your mind before the surgery.

Indication for sagittal resection of mandible is thick mandibular body especially around oblique line. However, in our institute, sagittal resection of mandible is usually combined with mandible contouring in ordinary mandible reduction patient. There is a group of patients who does not get good effect from sagittal resection, such as patient with thin mandible and scarce bucal fat.

Surgical Techniques

Our mandible reduction surgery was performed with both mandibular contouring and sagittal mandibular resection. The prominent mandible angle's gonion and lower mandible body were removed by mandibular contouring. Then, the remaining most prominent part of the mandibular area was removed by sagittal mandibular resection by shaving the outer cortex, leaving the inferior alveolar nerve safe. Our sagittal mandibular resection focused on removing the thickest mandible body area (Fig. 7.2).

Sagittal mandibular resection focused on removing the mandible body area. All patients were discharged 1 day after the operation without a suction drain. Most patients who underwent mandibular reduction were satisfied with their aesthetic results. There were no serious complications.

In the axial computed tomography view, there are two types of outer contour of the mandible. In the straight or outcurved type of the mandible (Fig. 7.4), the gonial area protrudes out. In this type of patients, the bigonial distance is the widest area (W2). However, in the incurved type of the mandible (Fig. 7.5), the posterior angle area tilts inwardly, and the most protruded area of the mandible is 1–2 cm anterior to the posterior border of the mandible (P2). Authors name this point as maximal ramus point (MRP) (Figs. 7.5 and 7.6). This area is the widest ramus area, and, in this type of patient,

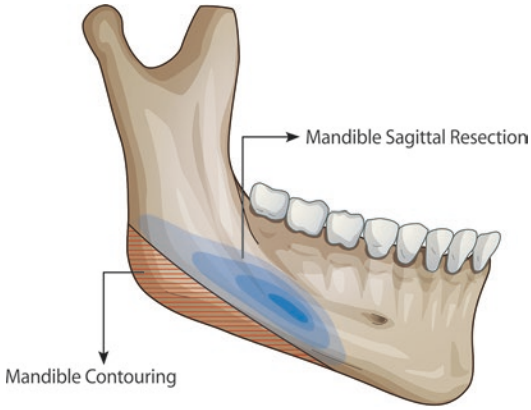

Fig. 7.2 Author's design and actual resection. Author's design for mandibular sagittal resection. Compare the area of resection with conventional description

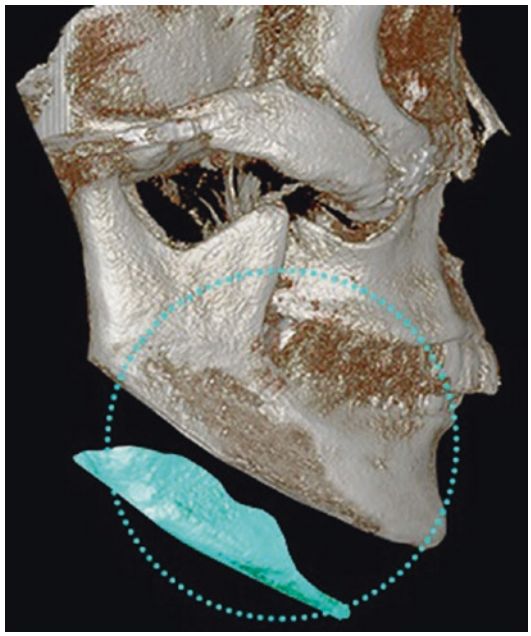

Fig. 7.3 Our surgical outcome for mandibular sagittal resection combined with mandible contouring: the sagittal resection focuses on removing the abundant mandible body area

bi-ramus width (W2) is wider than bigonial distance (W3), representing the facial width.

Regarding the mandibular body when viewed on computed tomography, the widest point is the intersection of the surface line of the mandibular body (A) and ramus (B) (Figs. 7.3, 7.4 and 7.5). This point (P1) is usually the thickest area, the average thickness of which is 17.8 mm, while that at the posterior angle area was 6.4 mm. This point is named as the maximum body point (MBP).

Three lines, two points, and three widths are used to describe the shape of the mandible on computed tomography (Figs. 7.4, 7.5 and 7.6). The line on the mandibular body surface is the body surface line (A), and the one on the ramus surface is the ramus surface line (B). In incurved type of the mandible, there is the third line in the posterior ramus, named as posterior ramus surface line (C). The maximal body point is marked by the widest and usually the thickest point on computed tomography and the intersection of the body surface line and ramus surface line (P1). The maximal ramus point is described as the intersection of the ramus surface line and posterior ramus surface line in the submento-vertex view (P2).

Two points are important clinically in sagittal resection of the mandible. The maximal ramus point is the widest point in the mandible and should be resected to reduce the width of the face. In incurved type, even after contouring ostectomy, the width of the face does not change at all, resulting in patient's dissatisfaction. In this case, sagittal resection of the mandible to reduce this maximal ramus point accomplishes a good reduction of facial width, resulting in satisfactory slimming effect. The maximum body point of the mandible is usually the thickest area in the body of the mandible. Maximal resection is possible during the sagittal resection. It is also the widest area in the body of the mandible, and appropriate reduction of this area is critical in shaping the slim and attractive jawline.

When viewed on postoperative computed tomography, sagittal mandibular resection is performed including these two points in a geographic pattern. This area was primarily the mandibular body along the oblique mandibular line (Fig. 7.3).

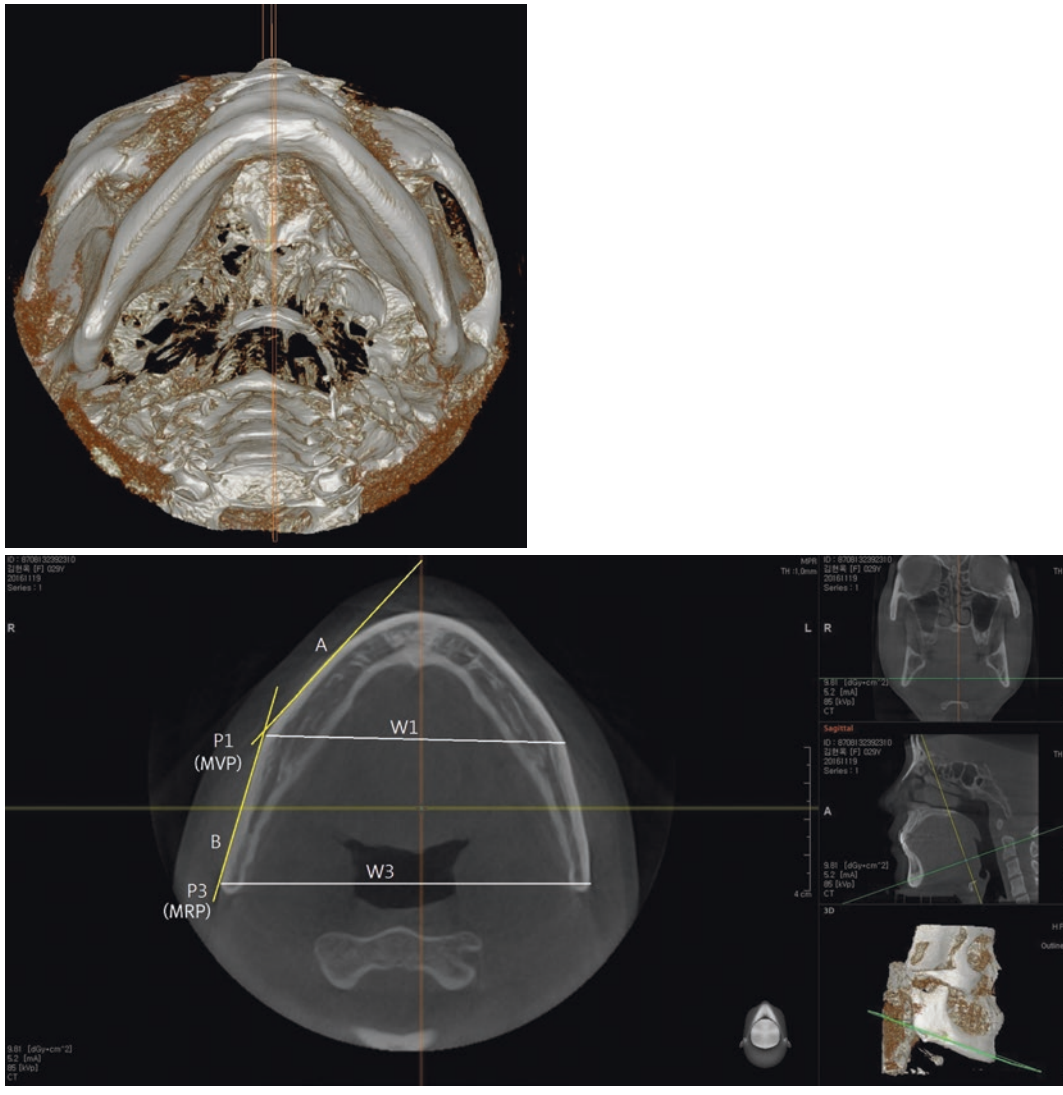

Fig. 7.4 The mandible of staight or outcurved type. (*Upper*) Three-dimensional submento-vertex view of the mandible. (*Lower*) Axial view. The gonial area is the most protruded area, and the bigonial distance is the widest (*W3*)

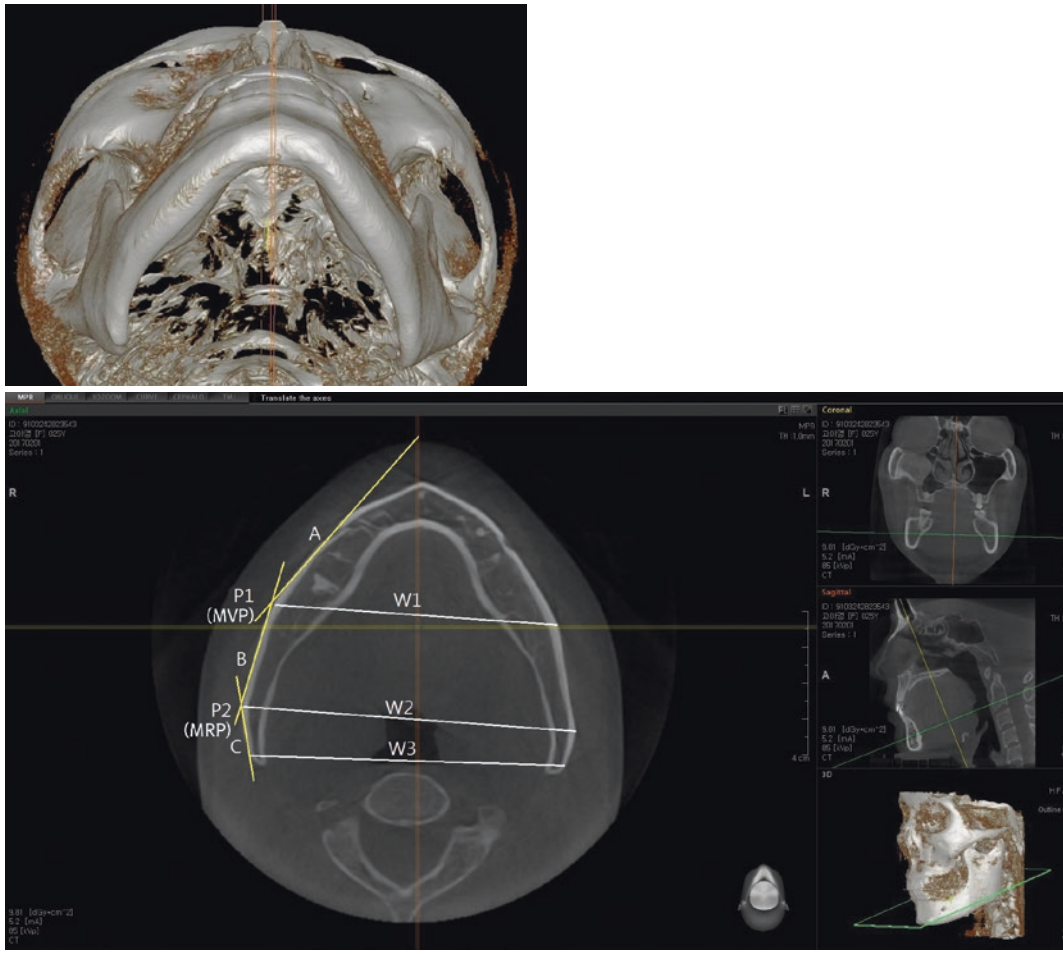

Fig. 7.5 The mandible of incurved type. (*Upper*) Three-dimensional submento-vertex view of the mandible. (*Lower*) Axial view. The posterior ramus tilts inward. The maximum ramus point is the most protruded area, and the bi-ramus (*W2*) distance is the widest area comparing bigonial distance (*W3*)

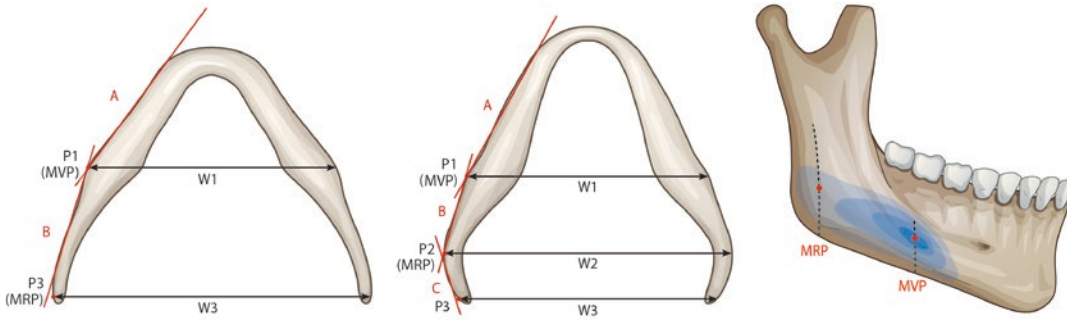

Fig. 7.6 Schematic presentation of the shape of the mandible in axial view. (*Left*) Straight or outcurved type. (*Center*) Incurved type. Body surface line (*A*), ramus surface line (*B*), and posterior ramus surface line (*C*) are marked. Compare which part of the mandible represents the facial width: bigonial distance (*W3*) in straight or outcurved type while bi-ramus distance (*W2*) in incurved type (*Right*) MRP and MBP in the actual mandible surface

Key Technical Points

1. Sagittal resection is usually combined with contouring ostectomy.
2. Sagittal mandibular resection was performed in an area including MBP and MRP in a geographic pattern. This area was primarily the mandibular body along the oblique mandibular line.
3. Sagittal splitting of outer cortex increase a risk of nerve injury and does not give better effect in reduction. Shaving the outer cortex with bur is safe and effective.
4. Do not obliterate cortical bone and do not expose the medulla while shaving.

Case Study

Case 1

A 25-year-old woman complained of her wide and strong lower face. She had broad and thick mandibular body. To achieve more slender look in frontal view, cortex of mandibular body need be reduced with shaving after narrowing of the chin and contouring of the mandible. The result was very successful making her lower face converted from U-shaped to V-shaped (Fig. 7.7).

Fig. 7.7 Patients who underwent mandible sagittal resection and narrowing genioplasty

Case 2

A 27-year old woman desired slimming of the lower face. She had broad, asymmetric chin and thick mandibular body. Sagittal shaving of the thickest point of mandibular body was performed simultaneously with the narrowing genioplasty, mandible contouring and zygoma reduction. The patient was very satisfied with the result (Fig. 7.8).

Fig. 7.8 Patients who underwent mandible sagittal resection, contouring and genioplasty

Complications and Management

Nerve Injury

Complications due to sagittal resection are very rare in mandible reduction. Prior to surgery, a panoramic X-ray is taken to locate and check the course of the inferior alveolar nerve. The surgeon must accurately define the course of the inferior alveolar nerve during the surgery by measuring its course from the lower border of the mandible. Shaving in the cortical bone is safe, but when obliteration of cortical bone exposing medulla is necessary to maximized the reduction, be careful not to open an inferior alveolar canal and injure the nerve.

Discussion

Mandible reduction surgeries have developed from masseter muscle reduction to bone reduction surgery [1–5]. Mandible bone reduction surgery was first initiated as mandibular contouring. Then, sagittal mandibular resection was introduced as a new and effective technique for reducing facial width in the frontal view [4–8]. Previous sagittal mandibular resection methods were reported to remove lateral mandibular cortex in the posterior ramus and angle region to reduce mandibular bigonial distance (Fig. 7.1). Its boundary was from 10 mm below the sigmoid notch to 10 mm lateral to the mental foramen. However, in the three-dimensional view, the posterior part of the mandible angle is inwardly tilted and this posterior part of the mandible is very thin with little medulla (Fig. 7.1). Thus, the amount of bone reduction is very small, and the effect of reducing facial width in the frontal view is minimal. Additionally, this technique carries a high risk of nerve injury or unfavorable fractures. Previous reports on sagittal mandibular resection contributed to the basic concept of sagittal mandibular resection; however, they led to a fatal misconception in terms of the area of resection for actual surgical practice.

In the frontal view, the most prominent part of the mandible is the gonion, so the bigonial distance was thought to be the widest. However, our study shows that the outer contour of the mandible is a different shape at different planes when viewed on computed tomography. In the lower border plane, the gonial area was the most prominent. At the mid-level of the mandibular body, the posterior angle area was inwardly tilted, and the most protruded mandibular area was along the oblique line. This point was the widest area, which was the intersection of the ramus surface line and posterior ramus surface line. We named this point the maximal ramus point. After reducing the gonion area by mandibular contouring, this maximal ramus point is the widest part.

In surface anatomy, the most prominent part of the lower face is 3–4 cm anterior to the posterior border of the ramus [8] (Figs. 7.4 and 7.5). The widest point in a bony anatomy and a surface anatomy usually matches well. Thus, sagittal mandibular resection should focus on this area for maximal effect.

The thickness of the mandible is also important in sagittal mandibular reduction. If there is minimal bone to remove, the facial-reduction effect is minimal. In the submento-vertex view on computed tomography, the thickest bone area was the intersection of the body surface line and ramus surface line (Figs. 7.4 and 7.5). We named this point the maximal body point. Sagittal resection should target the maximal body point, and areas should be determined in a geographic pattern along the oblique line for maximum reduction. In practice, the area of sagittal mandibular resection includes the maximal body point and the maximal ramus point.

Sagittal resection of mandible can be performed solely to produce a reasonably good result in selected patients. However, mandibular contouring and sagittal resection are usually combined to produce a maximal result [9, 10]. Authors' standard treatment of choice is, after mandibular contouring, the hypertrophied thick portion of the mandibular body

along the oblique mandibular line is resected sagittaly [11, 12].

Our preferred method for sagittal mandibular resection is shaving with a bur. A sagittal splitting technique has been described, which is a modification of sagittal split ramus osteotomy. However, if we do sagittal splitting ostectomy, there is an increased risk of nerve and soft tissue injury. We also cannot control the depth of resection precisely, and gradual geographic resection is almost impossible. Furthermore, skin may adhere to the irregular surface of cancellous bone after sagittal splitting ostectomy, which produces an irregular sunken surface. Shaving with a bur is a highly reliable and easier to control method and produces a better jaw line.

A previous sagittal mandibular resection technique was described to focus on the resection of angle and ramus of the mandible, which led to misconceptions and ineffective reduction with possible complications. Sagittal mandibular resection should be performed in the mandible body area in a geographic pattern, which is the thickest part in volume and widest part in the frontal view. For more effective reduction and better aesthetic results in the frontal view, we found that the prominent gonion should be removed by mandibular contouring and then sagittal mandibular resection should be performed, focusing on removing the mandible body area (Fig. 7.8).

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The Osseous Genioplasty

8

Sanghoon Park

Pearls

1. Genioplasty is the most frequently performed facial bone surgery which is done as an isolated manner or as a combination with other surgeries such as orthognathic surgery or bone contouring surgery.
2. The versatility of the procedure allows the chin to be adjusted either forward or backward in the anteroposterior dimension, vertically shortened or lengthened in accordance with the frontal proportionate analysis, and to be narrowed to achieve a more slender facial contour.
3. Although a simple procedure it may be, the genioplasty is error prone and frequently leaves complications and unsatisfactory results.
4. Surgeon should focus on several key technical points such as positioning the chin segment in an ideal position, avoiding nerve injury, predicting soft tissue changes, and achieving a smooth jaw contour.
5. The chin deformity is frequently accompanied with conditions such as class II profile, long-face syndrome, asymmetry, and other facial dysmorphologies, so such conditions should be preoperatively evaluated.

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Introduction

The chin is the main component of the lower part of the face and plays an important role in the overall facial appearance and harmony [1]. An aesthetically and visually pleasing chin provides balance and symmetry to the rest of the face. It also works as a major determinant in facial characteristics. A short and weak chin, for example, gives an impression of a soft feminine look, while a prominent chin gives a strong and decisive impression. People have different preferences on the shape of the chin. These preferences may differ from time to time, from nation to nation, and from race to race. For these reasons, the chin is considered as a critical component of facial aesthetics and a symbol of ethnicity.

Since Trauner and Obwegeser introduced the osseous genioplasty through an intraoral approach in 1957, genioplasty has been used for more than half a century for solving various chin problems [2]. The surgical technique is well described and highly established for the treatment of tumors, traumas, deformities, and cosmetic reasons. Despite its popularity and simplicity, however, the genioplasty is error-prone procedure, frequently leaving complications and unsatisfactory results. Having good knowledge to the anatomy and comprehensions on ethnicity which is supported with excellent surgical skills, satisfactory results can be guaranteed with a genioplasty. And its versatility will

S. Park (ed.), *Facial Bone Contouring Surgery*, DOI 10.1007/978-981-10-2726-0_8

lead this surgical procedure to be a great armamentarium in improving the facial aesthetics of Asians [1].

Patient Assessment

The genioplasty can be done as an isolated manner or more frequently as a combination with other facial bone surgeries such as orthognathic surgery or bone contouring surgery. Before determining the appropriate surgical approach, it is important to find out whether the problem is limited to the chin itself or involves the whole face. Occlusal examinations are also important, because generally in patients with a normal occlusion, the chin deformity can be corrected with a genioplasty, but in cases of malocclusion, combinations of an orthognathic surgery may be required. The chin itself must be evaluated for proportion and symmetry in all planes, anteroposteriorly, transversely, and vertically [1].

The deformities of the chin can be classified practically based on its volume and spatial position (Fig. 8.1) [1, 3, 4]. In "microgenia," the chin is small horizontally or vertically or even in

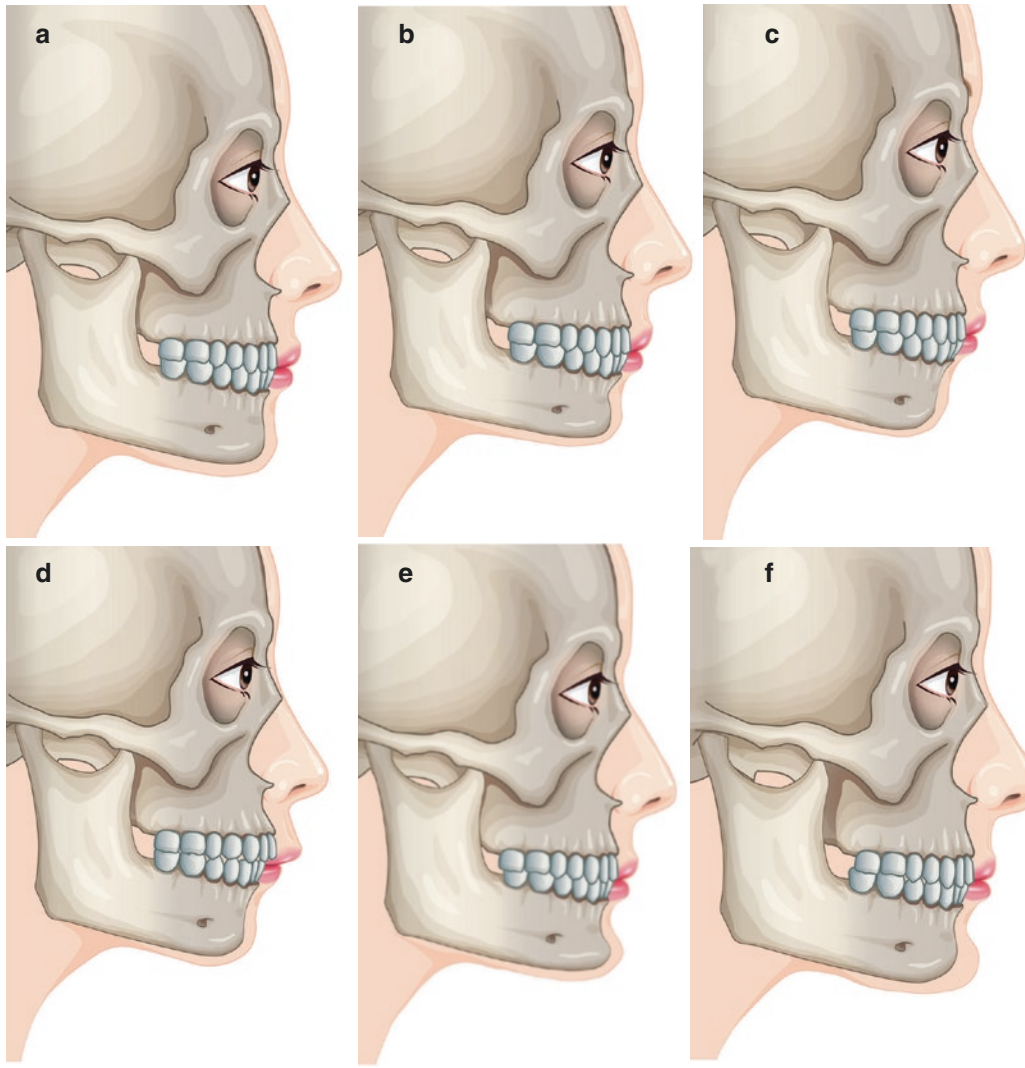

Fig. 8.1 Classification of chin deformities. (**a**) Normal chin, (**b**) microgenia, (**c**) retrogenia, (**d**) pseudoretrogenia, (**e**) macrogenia, (**f**) pseudomacrogenia

combinations. If the chin is positioned posterior to its ideal position whether it is small or not, the term "retrogenia" is used. However, retrogenia secondary to mandibular retrognathia can be called as "pseudoretrogenia." In "macrogenia," the chin is large in horizontal or vertical planes or even in both planes. Large chin caused by soft tissues alone can be termed as "pseudomacrogenia." Long-face deformity producing clockwise rotation of a normal mandible may cause "pseudomicrogenia." These classifications of chin dysmorphology can be useful to guide the appropriate surgical approach to the surgeon.

The height of the lower face is important when evaluating the chin and selecting the appropriate surgical approach. For example, if the patient has a short lower face, elongation of the chin may be needed, while shortening is required in a long lower face. The assessment can be done with a proportionate analysis by dividing the face along anatomic landmarks such as the trichion, glabella, subnasale, and menton. With these landmarks, the face can be divided into three parts. When the three divisions are in equal thirds, the proportion of the face has been said to be ideal [4]. However, especially in Asians, recently a ratio of 1:1:0.8 is considered to be more aesthetically ideal (Fig. 8.2).

Various analyzing methods were introduced to assess the facial profile, which the surgeon can use as a guide in evaluating the chin relative to the overall face, nose, and lips. For example, in the McNamara analysis, a line perpendicular to the Frankfort horizontal plane is drawn through the nasion, and the distance from the pogonion to the line is assessed (Fig. 8.3). The Arnett analysis is for soft tissue cephalometric analysis. Distance is measured between the soft tissue pogonion and a line placed through the subnasale perpendicular to the natural horizontal head position called the "true vertical line (TVL)" (Fig. 8.3) [5]. Another method to analyze the chin position is by assessing the projection of pogonion from the N to B line (cephalometric line from nasion to B point) [6]. The authors find the McNamara analysis and the Arnett analysis quite useful.

Surgical Technique

Operations are performed under general anesthesia through orotracheal intubation. Local anesthesia solution containing 1% lidocaine and 1:100,000 epinephrine is infiltrated along the proposed incision line and dissection area, submucosally and also subperiosteally. A labial incision midway between the labial sulcus and the lower lip vermilion is made from the canine to the opposite canine, avoiding division of the frenulum. Subperiosteal

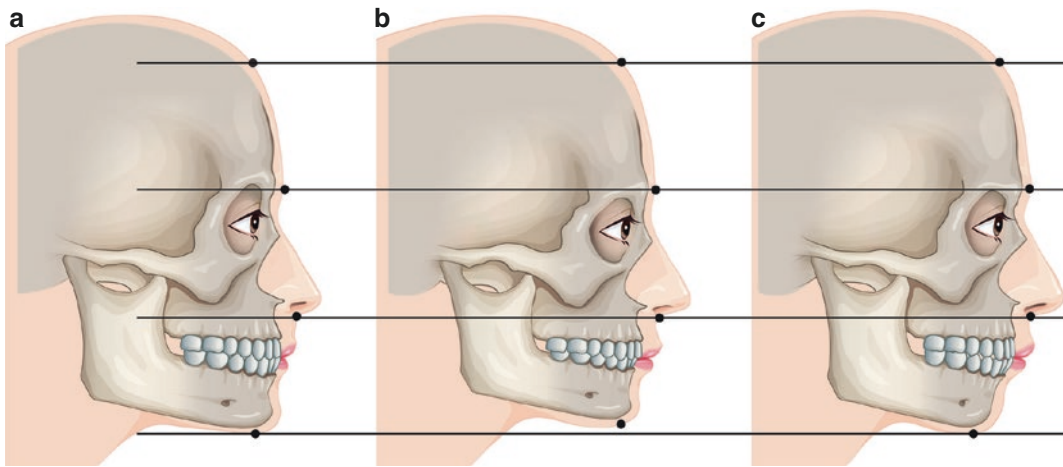

Fig. 8.2 Proportionate analysis of the chin. (**a**) The aesthetic facial proportion of 1:1:0.8. (**b**) In microgenia, the lower face is vertically deficient. (**c**) In retrogenia, the proportions may be the same as in a normal ideal face

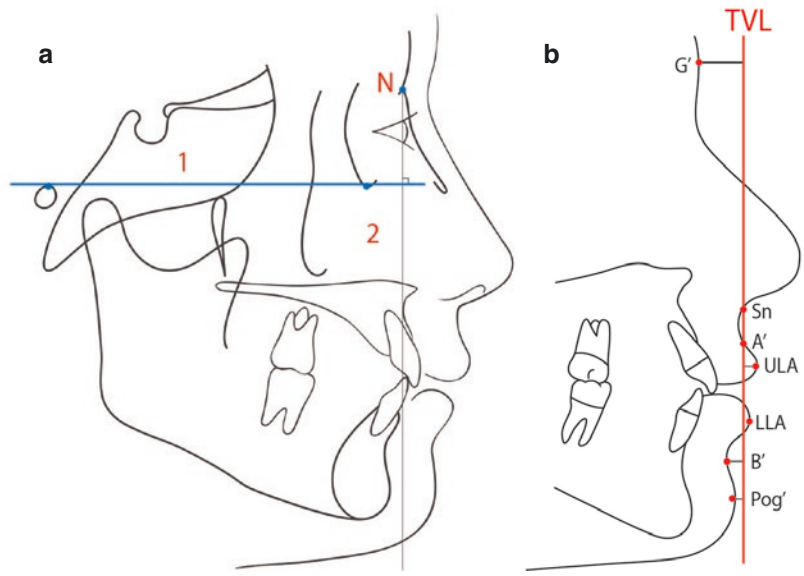

Fig. 8.3 Profile analysis of the chin. (**a**) In the McNamara analysis, a line perpendicular to the Frankfort horizontal plane (*line 1*) is dropped through the nasion (*line 2*, nasion perpendicular line). (**b**) In the Arnett soft tissue cephalometric analysis, a line perpendicular to the natural horizontal head position is dropped through the subnasale (*true vertical line*)

dissection is then performed to expose the mid-symphyseal region. The dissection should not be done to totally deglove the inferior border of the mandible which may disturb blood supply to the bone segment. Great care should be taken to identify the mental nerves and to protect them during dissection. Dissection should be performed sufficiently posterior for adequate visualization and access for the osteotomy [1].

After dissection is completed, the symphyseal midline should be marked above and below the planned osteotomy. The osteotomy line should be designed at least 5 mm below the mental foramen, and the horizontality of the line should be double-checked. Then the osteotomy is completed with a reciprocating saw. As the distal bone segment gains mobility to allow manipulation, the segment should be advanced or set backed as planned according to preoperative profile analysis and rigidly fixed with plates and screws (Fig. 8.4) [7].

Meanwhile, a reduction or lengthening genioplasty can be performed to correct the chin deformity either with vertical excess or shortness. Usually when chin shortening is needed by a vertical reduction procedure, a horizontally parallel bone segment is removed from the chin (Fig. 8.5). After a reduction genioplasty, an additional marginal osteotomy or shaving is required as a step deformity can be noticed on each side of the chin. The steps may be approached through the same genioplasty incision with or without an extension, but an additional incision may be needed in cases with large steps. When the patient has a short lower face, a lengthening genioplasty may be planned to achieve ideal facial proportions [8]. The osteotomy for the lengthening genioplasty procedure contains a horizontal osteotomy with two vertical osteotomies in an upside-down trapezoidal shape [8]. While designing the line for the horizontal osteotomy, it is important to leave a small amount of the bone in the middle portion. The vertical height of the bony portion left in the center is in accordance with the amount that the chin is to be lengthened vertically (Fig. 8.6).

For correcting deformity of transverse excess and to make a slim lower face, a narrowing genioplasty is indicated [9, 10]. Horizontal osteotomy and two vertical osteotomies are designed as the amount of resection in the middle bony segment should be determined preoperatively. In cases with asymmetry, the center of the middle segment should be lateralized to the more prominent side. After the osteotomy is completed, the middle segment is removed, and the two lateral segments are fixed in the center (Fig. 8.7). To obtain a more natural-looking and smooth curvature in the lower border of the mandible, further osteotomy or shaving on the lateral steps is usually required [10]. Resection of bony steps can be extended to the mandible angle when performed as a combination with the mandible contouring procedure [11].

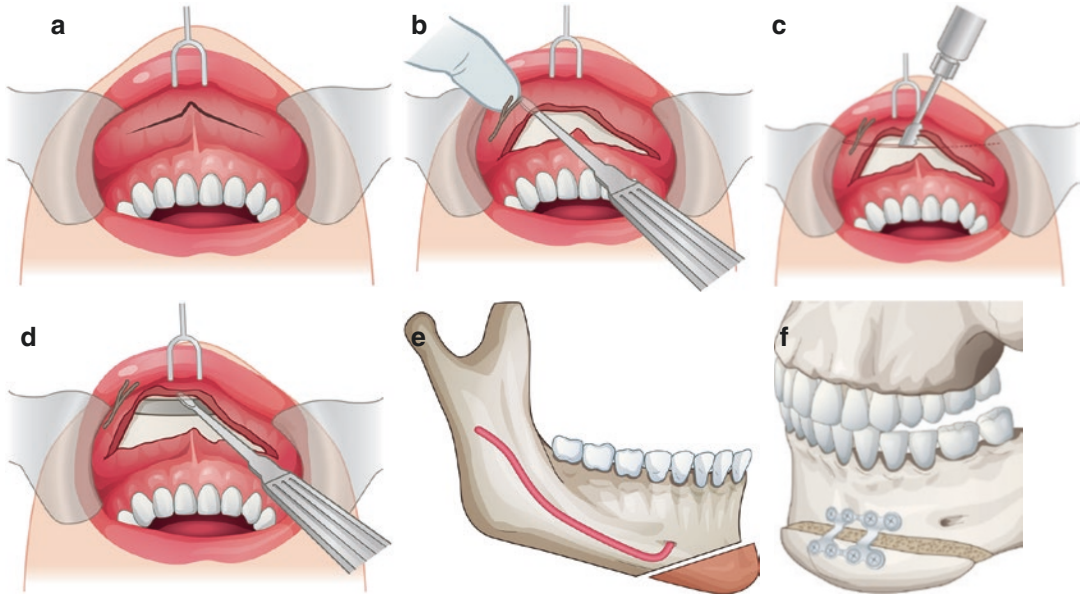

Fig. 8.4 Operative procedures of genioplasty. (**a**) Labial incision is made at least 5–6 mm inferior to the sulcus avoiding division of the frenulum. (**b**) The mandible is exposed below the mental foramen and lateral along the inferior mandibular border. (**c**) Horizontal osteotomy is made with a reciprocating saw. (**d**, **e**) Distal bone segment is mobilized according to the preoperative plan. (**f**) Fixation is done with plate and screws

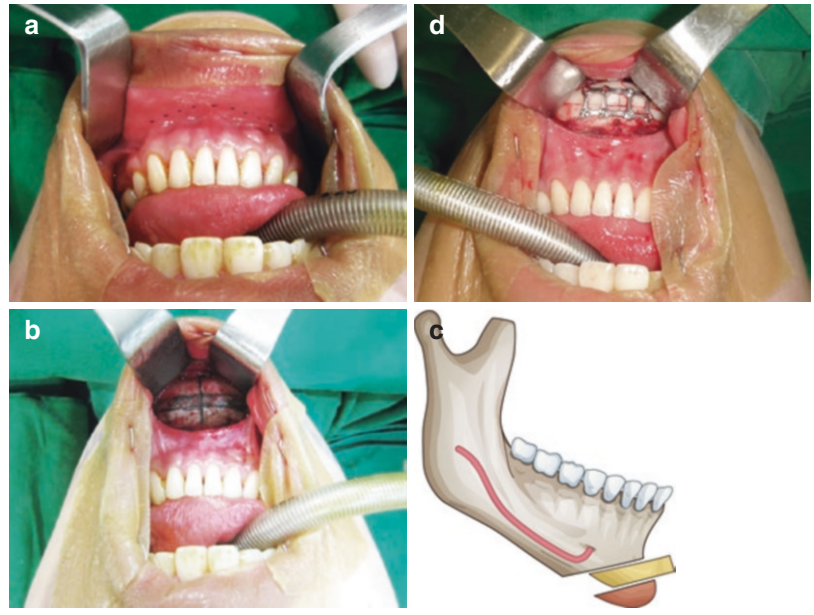

Fig. 8.5 Operative procedures of reduction genioplasty. (**a**) Labial incision is done. (**b**) Mid-symphyseal exposure and design of osteotomy line. Note that the shaded part is to be removed and the midline is marked. (**c**) Removal of the middle bone segment. (**d**) Fixation is done with plate and screws

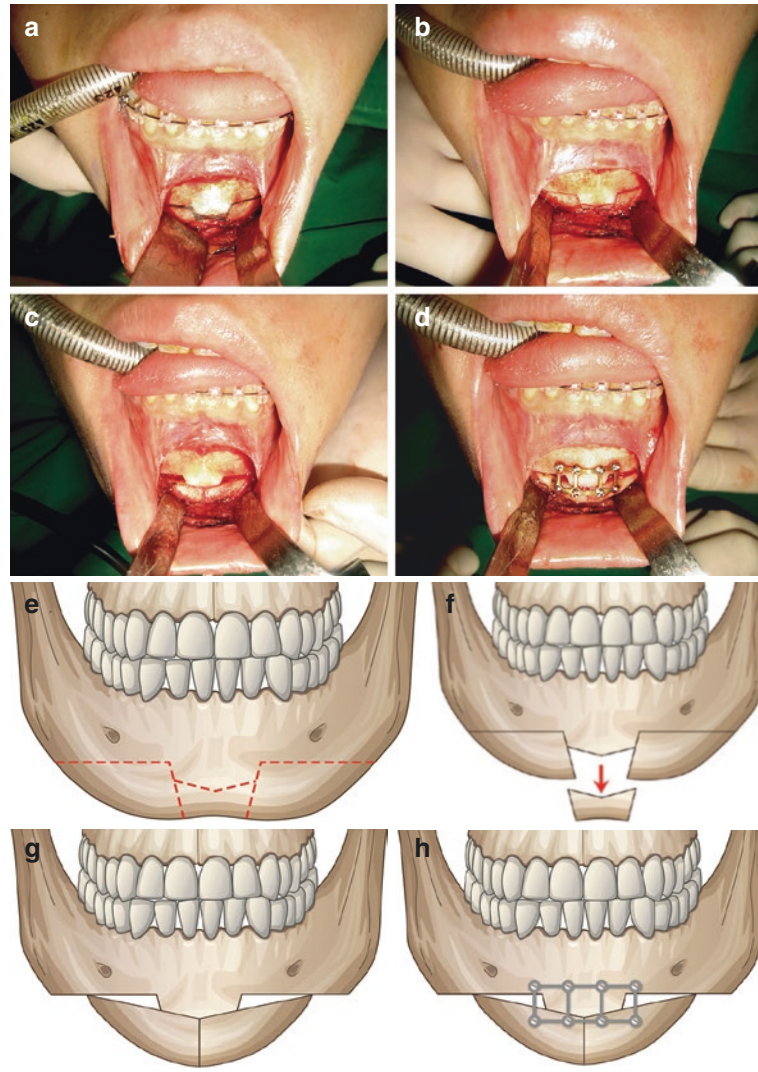

Fig. 8.6 Operative procedures of lengthening genioplasty. (*Left*) (**a**) A *horizontal osteotomy line* and two *vertical osteotomy lines* are designed with a small segment left in the center. (**b**) Osteotomies are carried out with a reciprocating saw. (**c**) After removing the distal bone segment in the midportion, the two lateral bony segments are approximated in the center. (**d**) Bone segments are fixed with a microplate and screws. (*Right*) Illustration of operative desing. (**e**) Bony design. (**f**) Central bony segment is removed. (**g**) Lateral segment is approximated. (**h**) Fixation is done with microplastes

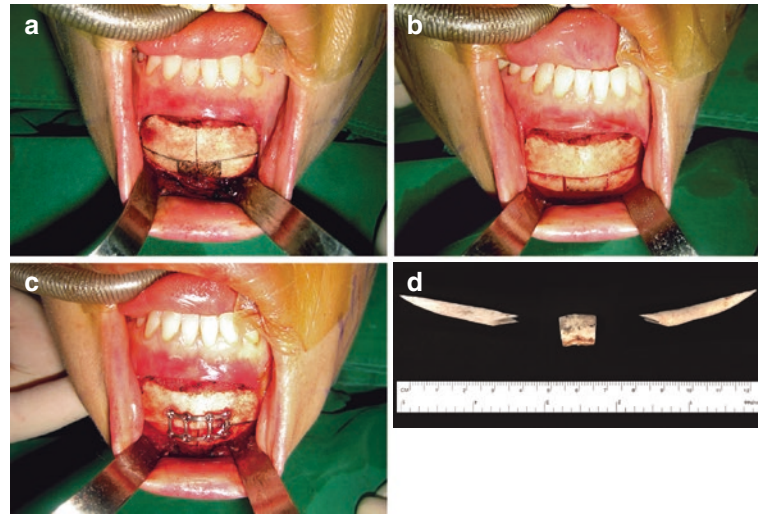

Fig. 8.7 Operative procedures of narrowing genioplasty. (**a**) A horizontal osteotomy line and two vertical osteotomy lines are designed. (**b**) Osteotomies are carried out with a reciprocating saw. (**c**) After removing the middle bone segment, the two lateral bony segments are fixed with a microplate and screws in the center. (**d**) Bone segments are removed during surgery

Key Technical Points

1. When adjusting the genial segment in an anteroposterior dimension, a pre-bent plate is preferred to precisely control the amount of advancement or setback (Fig. 8.8) [7]. At least two screws should be placed in each mobile segment as postoperative stability is essential for aesthetic refinements.
2. During reduction genioplasty, the lower osteotomy should be done prior to upper osteotomy in order not to lose control of the distal segment. Also, as surgeons tempt to reduce more during the surgery, the chance of nerve injury might increase. It is important not to jeopardize the nerve in order to reduce more height [1].
3. The amount of lengthening during a lengthening genioplasty procedure is 2–3 mm in most cases [8]. Far exceeding this average may cause problems such as bone instability, extra tension across the wound, lip tightness, lip eversion, or mouth closure disturbance.
4. When planning the narrowing genioplasty procedure, the amount to be narrowed depends on several factors such as the width of the chin, patient's desire, and the course of the mandibular canal, usually ranging between 6 and 12 mm [10].
5. Though easy to overlook, soft tissue control is one of the most important factors when performing genioplasty. By using an absorbable suture, the muscles and periosteum can be pulled in an upward direction and fixed to the plate. Such procedures would avoid soft tissue sagging and ptosis secondary to the bone reduction [1].

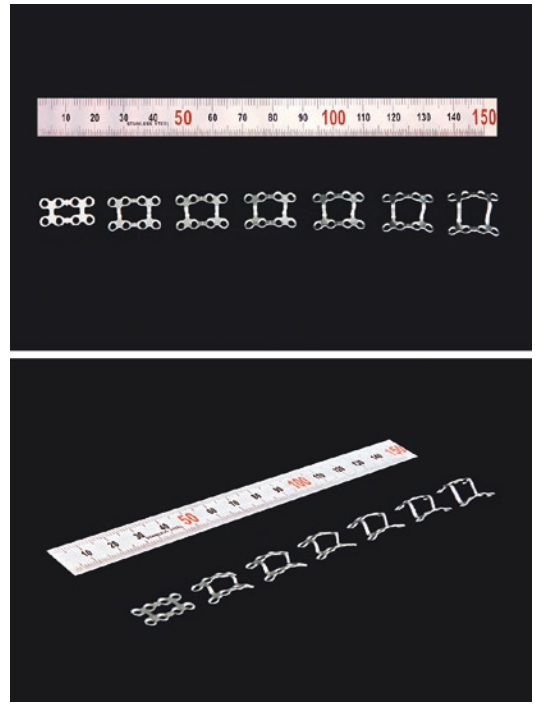

Fig. 8.8 Pre-bent titanium plates used in genioplasty. Plates are used for controlling the degree of anteroposterior adjustment during chin advancement or setback in accordance with preoperative measures

6. After a genioplasty is completed for chin advancement, vertical chin reduction, or chin narrowing, the bony steps on each sides of the chin-mandible junction may be troublesome. In such cases, either shaving the steps with a bone rasp through the genial incision or ostectomy with an oscillating saw through an additional lateral incision intraorally may be required [7, 10].

Case Study

Case 1

A 20-year-old man has undergone advancement genioplasty to correct his weak-looking chin. 5 mm were advanced and the retrogenia was significantly improved. The patient was satisfied with the result. Surgical results after 6 months were compared with preoperative views (Fig. 8.9).

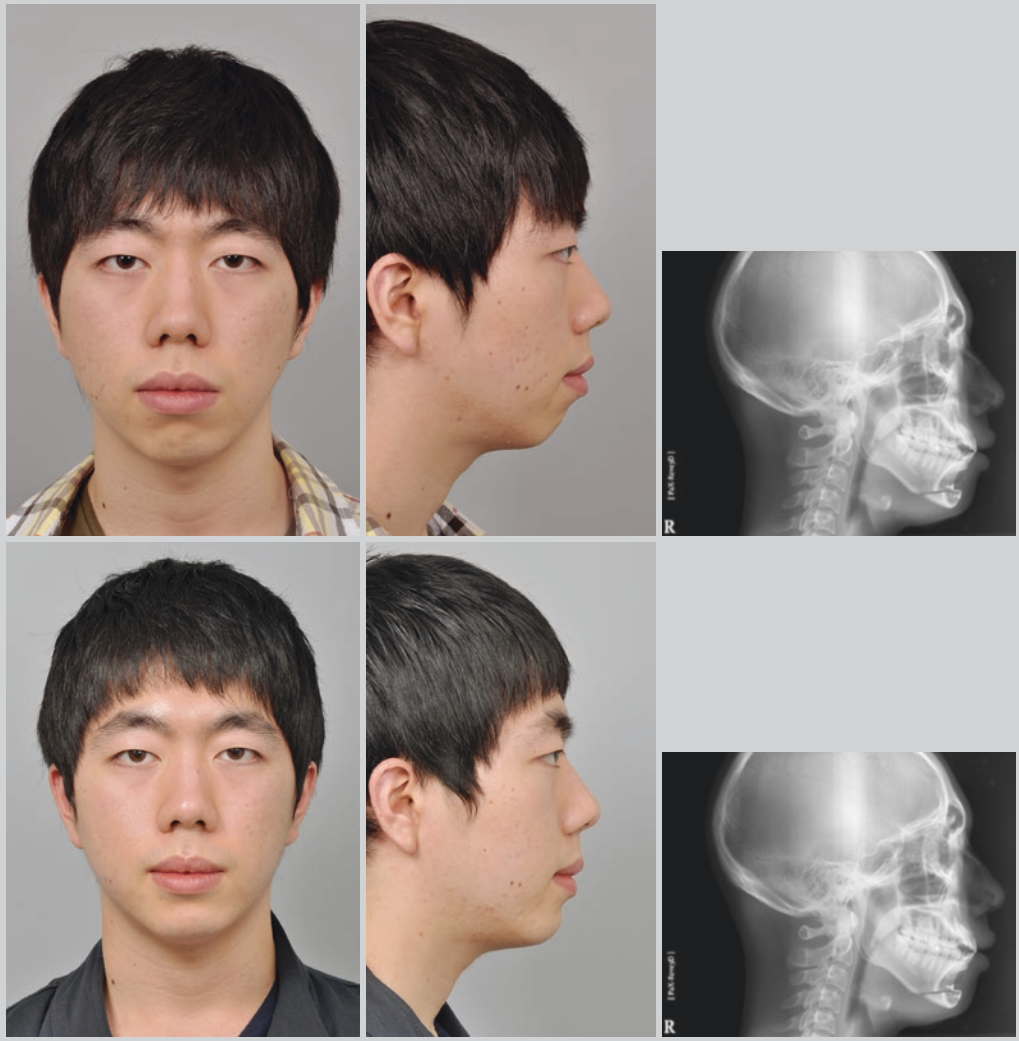

Fig. 8.9 Advancement genioplasty in a 20-year-old man. Chin was 5 mm advanced. (*Above*) Preoperative images. (*Below*) Postoperative images

Case 2

A 28-year-old woman had setback genioplasty to correct the profiles of her protruding chin. The chin was retruded 2 mm posteriorly and optimal profiles were achieved. She was satisfied with the surgical results. Postoperative views of 6 months after the surgery were shown (Fig. 8.10).

Fig. 8.10 Setback genioplasty in a 28-year-old woman. Chin was setback 2 mm with a concomitant narrowing procedure. (*Above*) Preoperative images. (*Below*) Postoperative images

Case 3

A 42-year-old woman has undergone reduction genioplasty to reduce the vertical length of her chin. Four millimeters were reduced vertically to achieve an optimal facial proportion. The patient was pleased with the result, and the surgical results after 6 months were compared (Fig. 8.11).

Fig. 8.11 Reduction genioplasty in a 42-year-old woman. Chin was vertically reduced 4 mm. (*Above*) Preoperative images. (*Below*) Postoperative images

Case 4

A 23-year-old woman underwent a lengthening genioplasty procedure to correct her short chin. The lengthening genioplasty was combined with a narrowing procedure and a mandible angle reduction surgery. Twelve millimeters of chin narrowing and 2 mm of vertical lengthening were performed (Fig. 8.12).

Fig. 8.12 Lengthening genioplasty in a 23-year-old woman. Chin was lengthened 2 mm with a concomitant narrowing procedure. (*Left*) Preoperative images. (*Right*) Postoperative images

Case 5

Narrowing genioplasty was performed to a 27-year-old woman. The patient desired for a slender-looking appearance, and reduction malarplasty was done simultaneously with the genioplasty. The chin was narrowed to 11 mm. The patient was pleased with the result, and the surgical results after 6 months are compared (Fig. 8.13).

Fig. 8.13 Narrowing genioplasty in a 27-year-old woman. Chin was narrowed 11 mm. (*Above*) Preoperative images. (*Below*) Postoperative images

Complications and Management

Neurosensory Deficits

Neurosensory loss of the lower lip is a common postoperative complication after genioplasty [1]. However, this is usually a transient condition. Previous studies on the neurosensory alteration after genioplasty report that the incidence of temporary paresthesia ranges widely from 12 to 70% [12–14]. But the reports commonly conclude that the temporary conditions nearly do not leave any permanent numbness, and the risks for permanent deficits are ignorable. The transient neurosensory deficits after genioplasty usually result from neurapraxia of the mental nerve during retraction. This kind of complication can be reduced by minimizing dissection and exposure near the mental foramen but is often unavoidable. Also if the osteotomy is too close to the mental foramen, the chance of nerve injury would increase. The surgeon should be aware of the course of the mandibular canal especially near the mental foramen.

Deepened Labiomental Sulcus and Mentalis Overaction

Many patients have abnormal morphology of the labiomental folds even before the surgery. Patients with decreased lower facial height tend to have exaggerated and deep sulcus with an acute angle, while those with increased lower facial height have shallow and effaced sulcus. Isolated advancement of the chin tends to deepen the sulcus and close the angle between the chin pad and the lower lip [1].

It is good to explain to the patients before the surgery about the hypertrophy of the mentalis muscle. After the surgery, there is a tendency of exaggeration, but these conditions will improve as time goes by. However, the surgeon should avoid stripping the mentalis during surgery to minimize this problem. Also if certain amounts of chin shortening are planned, some amount of chin setback should be considered simultaneously. If advancement of the chin is to be performed, chin lengthening might be considered at the same time, and this will de-emphasize the sulcus. During wound closure, it is important not to pull the mentalis too tightly and avoid over-tension on the muscle. Occasionally if the labiomental sulcus still remains to be deep, an AlloDerm graft to the deepened fold will help. After subcutaneous dissection, a narrow strip of AlloDerm® is inserted and sutured. Botulinum toxin injections to the mentalis might also be helpful.

Step Deformities and Border Irregularities

Step deformities and border irregularities can be caused either by the soft tissue origin or by the bony origin [1]. If there is a bony step exceeding 3 mm after the osteotomy and fixation, further contouring should be done to diminish the steps. Such situations usually occur after a reduction genioplasty or narrowing genioplasty. A step deformity caused after setback genioplasty can be prevented by a simultaneous narrowing genioplasty or by controlling the divergence of the distal bone segments. In patients with class II malocclusion or severe micrognathia, depression at the genioplasty-mandible junction can happen after chin advancement. It is proper to limit the amount of advancement in such circumstances. Sometimes an additional bone graft or alloplastic graft such as a Gore-Tex® sheet could be required to reduce the contour deformity.

Asymmetry

In general, asymmetry after a genioplasty results from either a technical error or a failure of detecting preexisting asymmetry before the surgery [1]. It is important to assess the asymmetry of the chin routinely before the surgery. Especially in patients with a small chin, as in macrogenia, asymmetry is quite evident, but the asymmetry can be camouflaged by the small chin and cannot be noticed easily. The patients themselves usually do not recognize the asymmetry before surgery which will make a dispute in postsurgery complaint.

Asymmetry caused by malposition of the bony segments can be prevented by marking the midline before the osteotomy. In cases when different amounts of reduction are required to correct any asymmetry, the surgeon should take the greatest possible care. If asymmetry is in the anterior surface of the chin, shaving the surface can be helpful but should be aware not to make injuries on the incisor teeth. Usually, shaving the lower border of the mandible is not recommended, but if it is required for the correction of any asymmetry in the lower borders, muscle stripping should be carried out minimally.

Chin Ptosis

Chin ptosis is the consequence of either excessive soft tissues or a failure in reattaching the mentalis muscle during wound closure [1]. Chin ptosis is more common after a shaving osteotomy or a setback genioplasty as the removal of the prominent symphysis leaves the chin pad unsupported leading to chin ptosis [15]. Aged patients with excessive skin redundancy or edentulous mandible have more possibilities to this problem. It is important to reapproximate and secure the mentalis muscle when closing the soft tissues. If the mentalis muscle is not properly approximated, foreshortening of the residual muscle takes place. The inferior portion of the muscles will progressively get lower, resulting in postoperative chin ptosis. The lip positions may drop and dimpling can occur at the chin pad with lip closure. This condition is often aesthetically displeasing. A proper incision and reapproximation of the mentalis during closure are preventive. Delayed management of this problem involves stable, superior resuspension of the mentalis muscles to the alveolus at the appropriate level, with wide undermining of the soft tissues to allow redraping.

Discussion

The chin is an important component of the lower face because it provides balance and symmetry to the rest of the face while also working as a major determinant in facial characteristics. For such reasons, various genioplasty techniques were introduced to correct the proportionate and profile abnormalities related with the chin region. Meanwhile, when facial analysis identifies a patient's profile with facial disharmony, underlying occlusal and skeletal deformity should be determined. Deformity of the chin may be a part of a dentofacial deformity (Fig. 8.12). For example, a small and weak chin may be a sign of class II malocclusion, while other features such as a procumbent lower lip, steep mandibular plane, accentuated labiomental fold, and a long facial height with vertical maxillary excess may coexist. A heavy chin may be a part of mandibular prognathism or prominent mandible. It is important to assess the whole dentofacial deformity not just the chin problem, and approaches for an appropriate treatment should be made. When no skeletal malformation is present except for the chin, the genioplasty can be considered as the treatment of choice. Therefore, when selecting candidates for the procedure, alertness for the high-risk patients is crucial. Conditions such as class II profile, long-face syndrome, asymmetry, and other facial dysmorphologies should be screened and carefully evaluated.

Meanwhile, during the surgery, direct injury to the mental nerve during genioplasty is relatively rare but may occur when the surgeon puts an osteotomy too high in attempting a large vertical reduction or trying to dissect the nerves off from the foramen for a better view on the

osteotomy. Conservative placement of the osteotomy is definitely advocated especially for the unexperienced surgeons. Also, the osteotomy should not be beveled high in the lateral sides because it may also increase the risk of nerve injury to the marginal mandibular branch of the facial nerve. In addition, retraction injury to the nerve during the surgery should be avoided.

When planning the surgery, soft tissue changes induced by bony movements must be considered. The response rates of the soft tissues after bone movement depend on the vectors of movements and the type of osteotomy. For instance, the response rate is nearly 90–100% in advancement genioplasty and 50% in setback genioplasty. But the responses of the soft tissues are extremely low in reduction genioplasty, nearly down to 25% [16, 17]. Therefore certain amounts of overcorrection may be required when performing reduction genioplasty and especially during correction for any asymmetry. Additionally, when completing the genioplasty procedure, the mentalis muscle and the soft tissue envelope surrounding the chin are key factors for a successful outcome [18].

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The V-Line Surgery: Narrowing Genioplasty with Mandible Reduction

9

Sanghoon Park and Jongwoo Lim

Pearls

1. Asians tend to exhibit a brachycephalic head and a broad lower face. In East Asia, a square mandible and prominent jaw line are considered unattractive, too strong, and masculine. Therefore, these populations complain about prominent angles and wide chins and desire slim and slender lower faces with an "egg-like oval shape" or the so-called "V-line."
2. Narrowing the chin and modification of chin shape can be accomplished by narrowing genioplasty with central strip resection. This mid-symphyseal sectioning procedure produces safe and very satisfactory results. This procedure not only augments the narrowing effect by leaving soft tissues attached but also enables modification of chin shape by altering the shape of resection.
3. The preference about the shape of chin and mandible differs among nations and regions; for example, a weak and round chin is favored in Japan; a pointed, triangular chin is favored in Thailand; and trapezoid or blunt chin is favored in China.
4. Based on comprehensive understanding of the patient's present shape and desired shape of chin and mandible, surgeon should plan specific surgical strategy in customized manner.

Introduction

A prominent mandible that gives a squared contour to the face is considered unattractive in Korea and in many other Asian countries, because it gives the face a muscular appearance and thus diminishes the appearance of femininity. Many people who have prominent mandibles are likely to have broad lower faces. The conventional procedure used to fix a square contour into an oval one is resection of the mandibular angle or reduction of the mandible itself, termed either "mandibular angle resection" or "mandible reduction." However, in some patients, resection of the mandible alone does not make the face appear slender [1, 2]. The main reason for this failure is attributable to a wide, flat chin and a U-shaped lower facial morphology. Therefore, to create a slim and attractive face, reducing the width of the chin and modifying its shape are necessary in addition to resecting the mandible and mandibular angle [3, 4]. Nowadays, many surgeons recognize the importance of considering the mandible as a whole, and numerous efforts, for example, the "V-line ostectomy" or "V-line surgery," have

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S. Park (ed.), *Facial Bone Contouring Surgery*, DOI 10.1007/978-981-10-2726-0_9

been made to reduce the lower face, more balanced and aesthetically pleasing [5–10].

The chin is a critical component of the lower third of the human face and plays an important role in the overall facial appearance and harmony. It also determines one's impression of an individual. For example, the impression for an individual with a small chin would be weak and indecisive, while that for an individual with a prominent, angular chin would be strong and masculine. An esthetically pleasing chin provides balance and symmetry to the rest of the face, and most individuals have their own preference regarding the shape of their chin. These preferences may differ from time to time, nation to nation, and race to race. Therefore, the chin is considered a critical component of facial esthetics and a symbol of ethnicity.

To begin with, it is necessary that the classification of the chin in terms of its shape and width be established. The chin is defined superiorly by the labiomental sulcus, inferiorly by the gnathion, and laterally by a curvilinear line bounded by the right and left marionette lines. The chin was analyzed on the basis of several facial subcomponents and their relationships with each other. According to the distinct features of the subcomponents, including the lower central border, lower lateral border, central–lateral border junction, geniomandibular junction, lower facial line, and soft tissue component, we classified the frontal chin shape into eight categories (Figs. 9.1 and 9.2) [11].

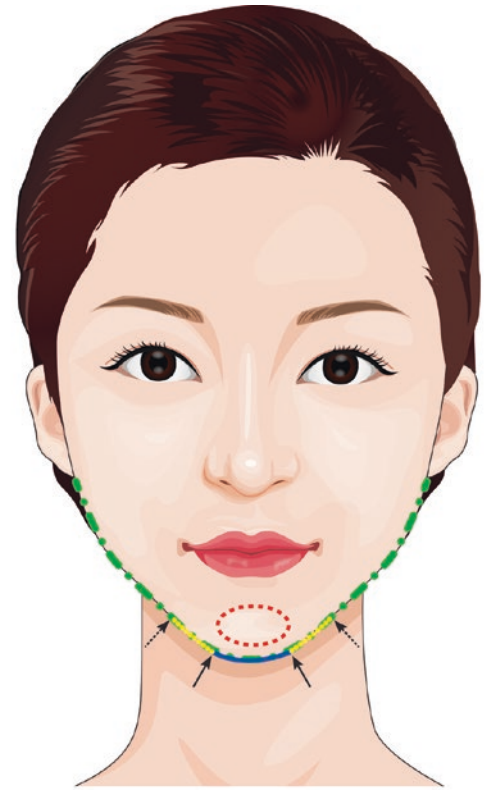

Fig. 9.1 Facial subcomponents used to derive our classification for the chin shape in the frontal view. Lower central border (*blue line*), lateral borders (*yellow dotted line*), central–lateral junction (*arrow*), geniomandibular junction (*dotted arrow*), lower facial line (*green dotted line*), and soft tissue overlying the chin (*red dotted circle*)

Classification of Chin

1. A round chin has a smooth, curved lower chin border without a definite central–lateral or geniomandibular junction, and the overall contour of the lower facial line is circular. Thus, the chin appears to be part of a circle.
2. A broad chin exhibits a curved to flat lower central border without a definite central–lateral junction and with a convex geniomandibular junction. This is the vertically elongated variation of the round type, giving a U-shaped appearance to the lower face.
3. A blunt chin exhibits a curved lower chin border and a smooth and clear central–lateral junction. Because this type has a developed chin pad, it looks blunt in the frontal view.

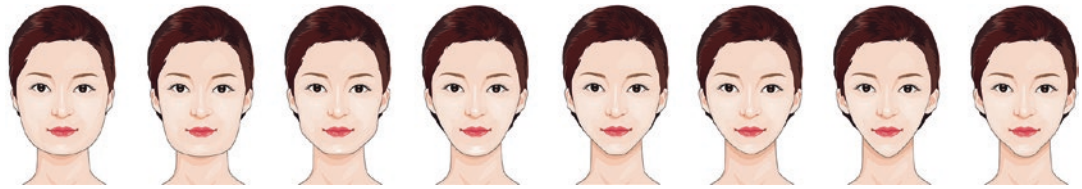

Fig. 9.2 Classification of the chin shape in the frontal view. From left to right: round chin, broad chin, blunt chin, angular chin, trapezoid chin, triangular chin, pointed chin, and pear-shaped chin types

Fig. 9.3 Typical clinical photographs of representative cases with each chin type as per our classification

4. An angular chin shows a characteristic linear, wide lower central border with a less developed chin pad. It also exhibits a sharp, acute central–lateral junction, an angular geniomandibular junction, and a developed mandibular angle; consequently, the lower facial line looks like part of an octagon.
5. A trapezoid chin exhibits a curved, narrow lower central border, smooth central–lateral junction, and straight geniomandibular junction. The difference from a triangular chin is the presence of a horizontal component in the lower central border.
6. A triangular chin is defined by a negligible lower central border with an indefinite central–lateral junction and a straight geniomandibular junction, thus appearing as an inverted triangle.
7. A pointed chin exhibits a narrower bigonial width and/or a vertically more elongated chin height compared with the triangular type. Therefore, the width–height ratio of the lower third of the face is smaller than that with a triangular chin.
8. A pear-shaped chin is defined by a concave geniomandibular junction, thus looking like a pear. For a better understanding, typical clinical photographs of each type are shown in Fig. 9.3.

Patient Assessment

In ID hospital, this classification is used when assessing each patient's chin shape and their preference about the chin shape. Our investigation results indicated a discrepancy between the

actual prevalence and the patient preference; patients prefer narrower chin shape (triangular, trapezoid), while the actual shapes in Koreans and Asians comprise broad, round, and angular types. Therefore surgeon should customize the correction surgery for the frontal chin shape according to the actual shape and patient preference.

The width of chin is the most important factor to determine the amount of narrowing. When surgeons consult with patient, careful assessment of the present width of chin and desired width of chin is critical. The amount of narrowing central segment ranges from 4 to 12 mm in most cases.

The height of chin is also important because the width–height ratio eventually determine the impression of slender. Ideal height of chin is considered as double the height of upper lip, in other words, the distance from the subnasale to the stomion. If the height is too long or too short compared with the ideal one, vertical reduction or lengthening should be performed simultaneously with narrowing genioplasty (Chaps. 10 and 11).

Then, asymmetry should be considered. Significant asymmetry of chin can be corrected by midline shift and asymmetric central segment resection (Fig. 9.4).

Finally profile view of chin should be assessed as introduced in Chap. 10. If the position of the pogonion is backward or forward compared to the ideal one, advancement or setback of the two distal segments is required.

Surgical Techniques

1. The approach to the mid-symphyseal area was accomplished with a conventional intraoral vestibular incision and subperiosteal dissection. Soft tissue attachment of the chin was maintained to produce a maximum narrowing effect and maintain the blood flow to bony segments.
2. Horizontal osteotomy and two vertical osteotomies were designed as shown in Fig. 9.2. The amount of resection in the central segment was determined preoperatively, depending on the width of chin and the patient's desire. In proportion to the shape of the chin, the shape of the central segment to

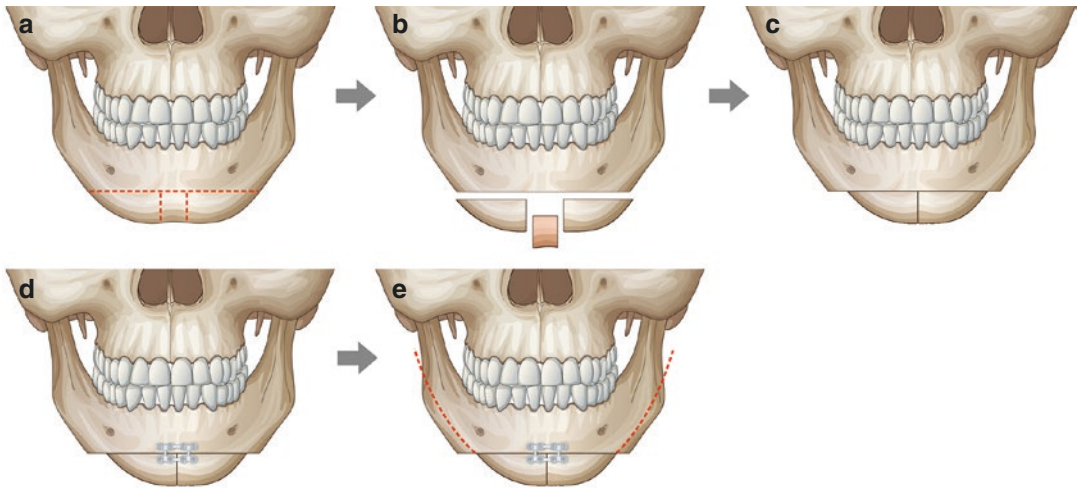

Fig. 9.4 Illustrations of surgical procedures of the V-line surgery. (**a**) Avoiding the inferior alveolar canal and mental foramen, one horizontal and two vertical osteotomies were performed. (**b**) The central strip was removed. (**c**) Two distal segments were approximate centrally. (**d**) Fixation with plate and screws was performed. In order to prevent possible loosening and rotation, at least two screws were used to fix each distal segment. (**e**) Mandible contouring starts from the anterior step to the posterior ramus according to the planning. It is important to preserve inferior alveolar canal

be resected can be altered from a triangle to a trapezoid or rectangle.

3. After osteotomy was completed, the muscular attachment was stripped off, and the central segment was removed. Two segments were approximated centrally and fixed with plates and screws.
4. Advancement or setback of the two segments is also possible if correction of the profile is required. In case of asymmetric chin, midline shift and asymmetric central segment resection are required.
5. After fixation of distal segments, the bony edge of the lateral and proximal mandible remains. This is the different feature from conventional angle resection. So, the surgeon should check the exact amount of the bony step between the lateral edge of distal segment and proximal mandible by direct vision and manual palpation.
6. Then, mandible contouring is started from the nearest point between inferior alveolar nerve canal and lower border of the mandible. To avoid damage to the inferior alveolar nerve, guarded saw is used at this point at least 2–3 mm apart from the lower border of inferior alveolar canal.
7. Once the level of osteotomy is decided with guarded saw, serial larger oscillating saws are used to deepen osteotomy. If ostectomy is done with full thickness, the bone segment moves freely.
8. After ostectomy, the attachment of muscle to the medial part of the mandible usually remains. A large elevator or Bovie electrocautery is used to divide any remaining medial pterygoid muscle fibers from the medial surface of the osteotomized segment, allowing its removal.
9. If bony step is under-resected, it is rather better than over-resection. But the bony step can be palpated over the skin and even can be seen. So, the remained bony step should be trimmed until achieving smooth transition from geniosegment to contoured mandible by rasping or additional osteotomy with oscillating saw.
10. A high-speed bur is used to reduce thickness of mandible cortex and achieve overall smooth contour. When using bur, it is important to avoid soft tissue damage because damage by bur is disastrous and cannot be forgiven. If the operating space is too narrow, surgeon should use retractors effectively to obtain enough space to work with bur.
11. Before wound closure, massive irrigation with normal saline is recommended to remove any bone debris and to prevent infection.
12. After meticulous hemostasis with bipolar electrocautery, wound closure begins with periosteum approximation. It is important to approximate mentalis muscle to proper position to avoid chin ptosis or irregular muscle contraction, resulting in multiple folding of skin over the anterior chin.

Key Technical Points

1. In genioplasty, horizontal osteotomy line should be lower than the level of inferior alveolar canal. Surgeon must confirm the course of inferior alveolar canal in panoramic cephalogram and computed tomography because there are variations by individual.
2. The osteotomy line of mandible contouring should be convex rather than straight or concave. If the osteotomy line from anterior end to posterior end is too straight or concave, the soft tissue appearance will be unnatural after few months later.
3. It is very important to avoid over-resection of the bony step at anterior end of osteotomy. Because if the bony step is over-resected, lateral border of distal segment of genioplasty get loss of bony contact, resulting in bony resorption and soft tissue depression that can cause unnatural pear-shaped appearance around the chin.

Case Study

Case 1

A 22-year-old woman complained about her broad, fatty lower face. Her lower facial contour was flat which, in combination with her wide mandibular body, made her face appear broad, rectangular, and U-shaped. Narrowing of the chin with reduction of the mandibular body made her chin appear slender, and her overall lower facial morphology converted from U-shaped to V-shaped (Figs. 9.5 and 9.6).

Fig. 9.5 (*Case 1*) Preoperative (*above*) and 6-month postoperative views (*below*) of a 22-year-old patient who had a U-shaped face and flat chin border

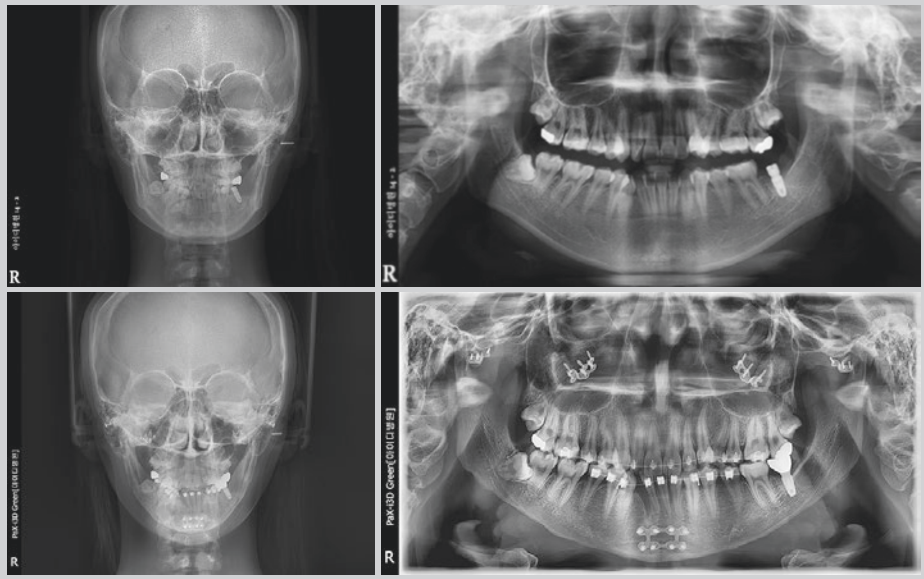

Fig. 9.6 (*Case 1*) Preoperative radiograph (*above*). Follow-up radiograph 6 months after surgery (*below*)

Case 2

A 29-year old woman had a heavy lower face, soft-tissue fullness of the chin, and masculine features. She desired slimming of the lower face and a more feminine appearance, with a pointed chin. Narrowing genioplasty was cresection followed by an additional resectionvof the lower mandibular border to the angle. To create this new shape, soft tissue of the chin was released in this case and properly redraped to reduce bunching (Fig. 9.7). The patient was very satisfied with the result.

Fig. 9.7 (*Case 2*) Preoperative (*above*) and 6-month postoperative views (*below*) of a 29-year-old woman who had a heavy lower face, soft-tissue fullness of the chin, and masculine features

Fig. 9.7 (continued)

Complications and Management

Neurosensory Deficits

Neurosensory loss of the lower lip is a common postoperative complication after genioplasty. However this is usually a transient condition. Previous studies on the neurosensory alteration after genioplasty report that the incidence of temporary paresthesia ranges widely from 12 to 70% [12, 13]. But the reports commonly conclude that the temporary conditions nearly do not leave any permanent numbness, and the risks for permanent deficits are ignorable. The transient neurosensory deficits after genioplasty usually result from neurapraxia of the mental nerve during retraction. This kind of complication can be reduced by minimizing dissection and exposure near the mental foramen but is often unavoidable. Also if the osteotomy is too close to the mental foramen, the chance of nerve injury would increase. The surgeon should be aware of the course of the mandibular canal especially near the mental foramen. Comparing simple genioplasty, incidence of neurosensory problems might be higher because surgeons are required to resect the bone just beneath the mental foramen. Direct injury to cutaneous course of mental nerve as well as injury to the intramandibular course poses a higher risk.

Hemorrhage

Hemorrhage can be the most life-threatening complication after genioplasty and mandible reduction, as a hematoma extending into the floor of the mouth may result in tongue elevation and airway obstruction. Hemorrhage can be prevented with meticulous hemostasis of the soft tissues and bone. Most of these bleeding results from direct injury to vessels; significant bleeding can occur from the exposed cancellous marrow especially in patients with high bleeding tendencies or hypertension. When patient looks dyspneic, beginning surgeon may try to remove the sutures to decompress the airway. However, this may compromise the airway with gushed-out blood; you should be cautious in opening the suture due to excessive pressure. If the hematoma rapidly expands, the airway must be controlled with a nasopharyngeal airway or

occasionally with endotracheal intubation. Fortunately, most hematomas in the floor of the mouth are small and self-limiting.

Unsatisfactory Chin Shape

Some patients might complain that their chin shape looks too sharp after surgery. This is why preoperative consultation is so important. Surgeon should explain various shapes and degree of narrowness, sharpness of chin, and the mandible as a whole to patient before surgery and then should make a consensus between the preference of patient and the planning of surgeon. Although it is very rare, too sharp chin should be corrected by surgery. Additional bone graft to central portion of chin is very difficult. Vertical reduction can help improve the sharpness by reducing the height of chin. Soft tissue release around distal bone segments also can help improve sharpness by increasing the width of chin.

Double Contour in Geniomandibular Junction

Some patients might show double contouring or depression in geniomandibular junction. This problem can be made mainly by bony step between the lateral edge of distal geniosegment and the medial edge of mandible contouring. The reasons of the bony steps are surgeon's technical error or too much narrowing of chin that may leave no space to contouring the medial edge of mandible unless injuring the inferior alveolar nerve. Soft tissue injury around lateral aspect of geniosegment during genioplasty or mandible contouring can also result in thinning of soft tissue and adhesion around there, eventually appearance of double contouring. Another reason of double contouring is soft tissue sagging from the cheek along the mandibular border while on recovery after surgery.

If double contouring happens by bony step, it can be corrected by augmentation with fat graft or alloplastic materials such as silicone, Gore-Tex and Medpor. If it happens by soft tissue adhesion, it can be improved by releasing the adhesion. Author uses layers of goretex to camouflage the bony gap or depress soft tissue. If the reason of double contouring is soft tissue sagging, laser-assisted liposuction and lifting procedure is recommended. This procedure is explained in another chapter (Chap. 14) in details.

Discussion

The decision whether to just reducing mandible angle or to performing V line surgery is difficult for surgeons. First of all, surgeons should differentiate the patients whose chin must be corrected. If chin is too wide, short or long, or retrogenia or progenia, concomitant genioplasty is recommended in mandible reduction surgery. If geniomandibular junction is flat to concave, mandible angle reduction alone can improve overall lower facial line. So this is a relative indication of V-line surgery. If patients request more slender chin shape according to their preference, it is also a relative indication. Overall facial harmony regarding the width–height ratio is another important consideration.

The central strip of chin with horizontal osteotomy and two vertical osteotomies is very easy and safe procedure to perform. This approach leaves lateral muscular attachments intact and enhances the narrowing effect. The amount of central resection should be individualized depending on the width of the chin and the patient's need. In our practice, it ranged from 6 to 12 mm. Resection is usually symmetric in width and shape. However, in case of asymmetry, the center of the strip was lateralized to the more prominent side. The design of central strip resection can also be altered from rectangular to trapezoidal and made to modify the shape of the chin narrower. Advancement or setback of the chin is also possible if a change of profile is required.

Making a smooth transition from the genioplasty segment to the lateral contouring part, leaving no bony step-off or protuberance, is an essential part of this combined genioplasty and mandibular contouring procedure.

In some cases, soft-tissue bunching was noticed, and some patients, especially those with fatty faces and chins, complained about it immediately postoperatively. However, this complication improved with time, and partial redraping of the soft-tissue attachments in the chin obviated the problems and improved the result.

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The Mini V-Line Surgery

10

Tae Sung Lee

Pearls

1. Conventional mandible contouring surgery usually involves the chin narrowing procedure that is combined with mandible angle reduction, which is renowned as the "V-line surgery."
2. In cases with a disproportionately wide chin without an excessive mandible angle, it is possible to achieve a well-balanced lower face by narrowing only the anterior portion of the mandible and leaving the mandible angle.
3. Patients with unsatisfactory results after previous mandible contouring surgeries can also be considered eligible for this "mini V-line surgery" procedure.
4. Under general anesthesia, narrowing genioplasty is performed by the T-osteotomy technique followed by further reduction of the bony steps at the chin-mandible junction.
5. Postoperative complications such as transient neurosensory loss, soft-tissue sagging, surgical site infections, and hematoma are reported, while other complications such as asymmetry, over- and under-correction, unexpected fractures, malunion or nonunion of the bone segments, and facial paralysis may occur.
6. Surgeons planning lower face contouring surgery should consider the "mini V-line surgery" to achieve aesthetically harmonic and pleasing results in properly selected cases.

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Introduction

In the eastern Asian region, a broad lower face is regarded unattractive and aesthetically unpleasing, especially for females, because it gives the face a masculine appearance. Ever since its introduction in 1989, the mandible reduction surgery is one of the most commonly performed facial bone contouring surgeries nowadays [1]. And now, many surgeons recognize the importance of considering the mandible as a whole, and numerous efforts, for example, the "V-line ostectomy" or "V-line surgery," have been made to reduce the lower face, more balanced and aesthetically pleasing [2–7]. However, some surgeons and patients still focus overly on the posterior part of the mandible including the mandible angle, which may be one of the most common reasons for unsatisfactory results after mandible contouring surgery [8, 9]. In certain cases, simply adjusting the chin without conventional mandible angle reduction may lead to a more balanced and harmonious feminine lower face contour [10]. In patients without a wide angle when seen from the side or the front, the angle reduction may be unnecessary. Furthermore, in patients who do not

S. Park (ed.), *Facial Bone Contouring Surgery*, DOI 10.1007/978-981-10-2726-0_10

want to undergo extensive surgery that includes the mandible angle, or in those patients with dissatisfactory results after prior mandible reduction surgery, simple chin narrowing surgery may be ideal. The so-called "mini V-line surgery" can be an effective surgical approach to achieve a slim and feminine face in these properly selected patients [10].

Patient Assessment

Preoperative patient analysis is based on thorough physical examinations together with clinical photographs, cephalometric and panoramic radiographs, and three-dimensional computed tomography. Indications for the mini V-line surgery are as follows: (1) patients who want to leave their mandible angle unchanged, (2) patients with a U-shaped face in which the chin is broad but without an excessive mandible angle either from the lateral view or the frontal view, and (3) patients with a dissatisfactory aesthetic outcome after previous mandible reduction surgery [10].

Surgical Technique

Operations are performed under general anesthesia through orotracheal intubation. A conventional intraoral vestibular incision is made after infiltration of a solution containing 1% lidocaine and 1:100,000 epinephrine. Subperiosteal dissection is then performed to expose the mid-symphyseal region. It is important to leave a sufficient amount of soft tissue attached to the bony chin to guarantee ample blood supply to the bone segments and later enhance the narrowing effects. Then the T-osteotomy technique is performed for chin narrowing [6]. The osteotomy was performed as shown in Figs. 10.1 and 10.2. Taking the route

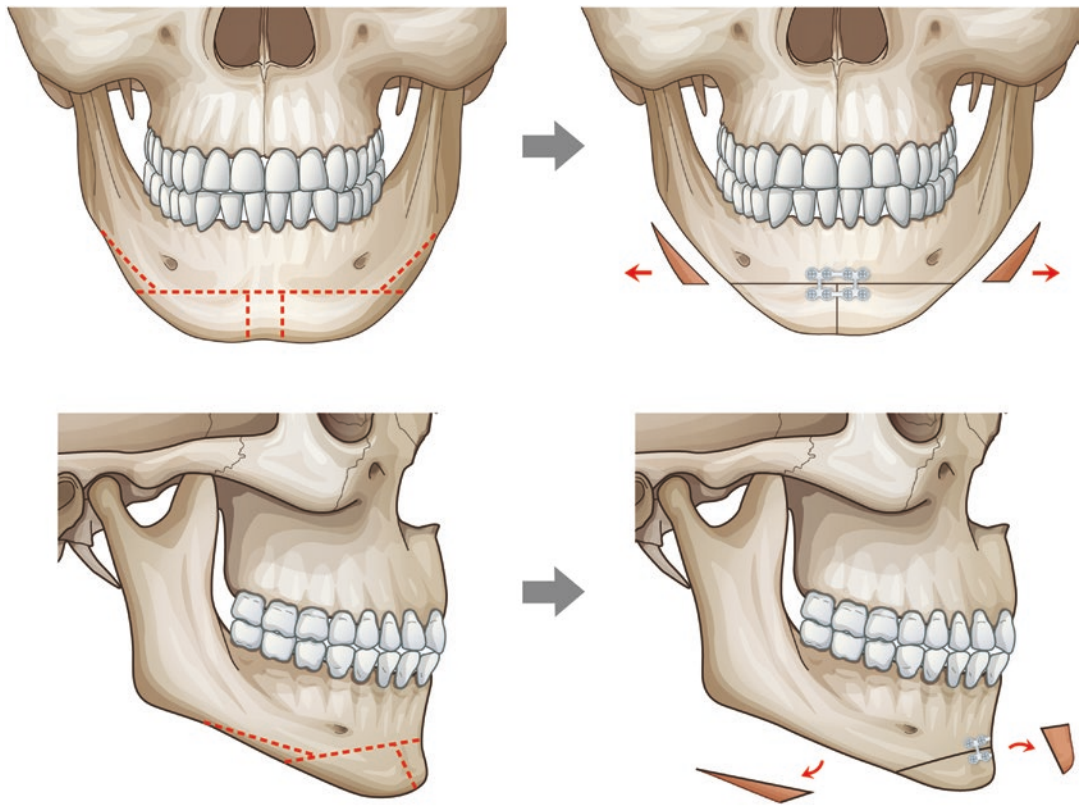

Fig. 10.1 Surgical procedures of the mini V-line surgery

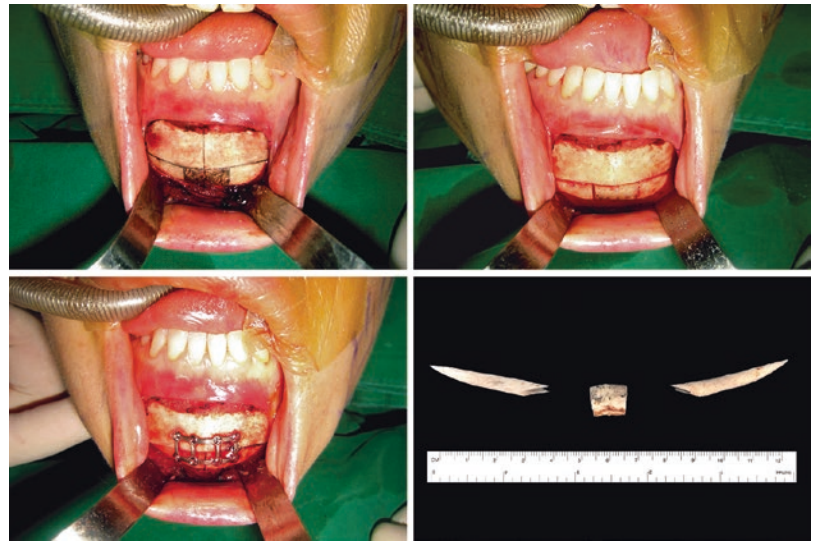

Fig. 10.2 Intraoperative photographs of the mini V-line surgery. A horizontal osteotomy line and two vertical osteotomy lines are designed (*top left*). Osteotomies are carried out with a reciprocating saw (*top right*). After removing the middle bone segment, the two lateral bony segments are fixed with a microplate and screws in the center (*bottom left*). Bone segments removed during surgery (*bottom right*)

of the inferior alveolar nerve on the panoramic radiograph into consideration, the horizontal osteotomy line is designed at least 5 mm below the mental foramen to avoid any unintentional nerve injury. Then, two vertical osteotomy lines are designed perpendicular to the horizontal osteotomy line. The use of a reciprocating saw is recommended to perform the osteotomies. The average amount of horizontal narrowing in a previous study from the authors' institute was 9.7 mm, while the maximum amount was 16 mm. After the central bone segment is removed, the remaining two lateral bone segments are fixed in the center using a titanium microplate and screws. For patients who have the desire to surreptitiously undergo the surgery and are reluctant on the use of metal fixtures, a simple and reliable method of using biodegradable screws may be a good fixation option [11]. Either anterior advancement or posterior setback of the chin may be done during the chin narrowing procedure if any correction of the facial profile is required. Furthermore, a vertical chin lengthening or shortening procedure can be carried out simultaneously if disproportionate facial ratios are noticed before or during the surgery [12, 13].

Narrowing of the chin leaves a bony step on each side of the chin-mandible junction, and this discontinuity should be diminished to reduce its palpability and for a smooth jaw line. Additional lateral incisions are made alongside the previous intraoral incision that was made for the chin narrowing procedure. These incisions are separated from each other because exposing the mental nerve increases the incidence of direct nerve injury during the operation. Subperiosteal dissection is then performed through the newly made lateral incisions to obtain direct visual access medially from the chin-mandible junction and laterally to the mandible angle. The use of a "guarded" oscillating saw to mark the proposed osteotomy line is recommended (Fig. 10.3) [10, 14]. This guarded saw has a small oscillating saw that is shielded at various distances. The size of the guarded saw to use is determined by the size of the bony step (which correlates with the amount of chin narrowing) and the distance between the lower mandible border and route of the nerve. The saw allows the surgeon to perform a precise bone resection in a uniformed manner while avoiding over-resection and reducing the possibilities of nerve injury. The extent of the ostectomy should be extended to a point posteriorly to allow a smooth jaw line. This point can be in the middle of the mandible body or just anterior to the gonion, depending on the shape of the mandible, the steepness of the mandible plane, and the amount of chin narrowing. If the posterior extent of the resection is too short, an

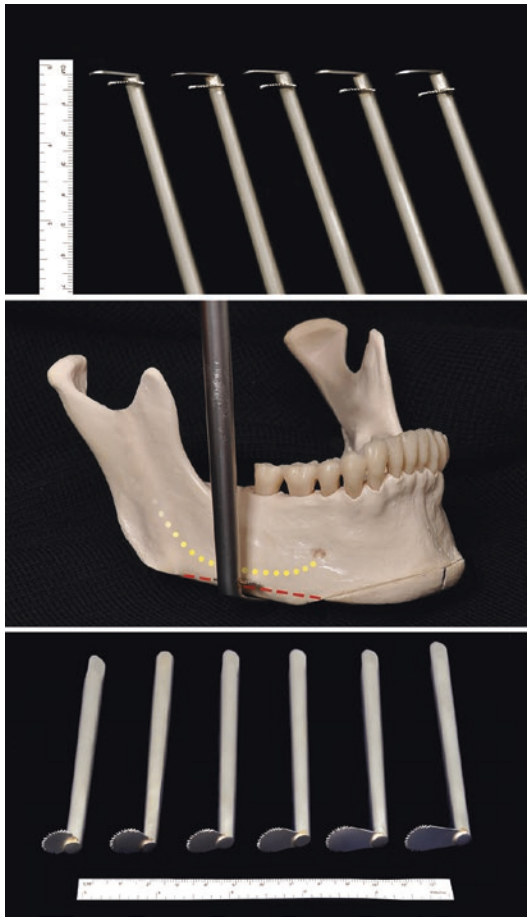

Fig. 10.3 The use of "guarded" oscillating saws. The guarded saw has a small oscillating saw that is shielded at various distances: 2, 3, 4, 5, and 6 mm (*top*). The saw helps the surgeon to perform the bony resection precisely while avoiding over-resection and nerve injury (*middle*). Further bone resections are completed by serial use of larger oscillating saws (*bottom*)

unnatural and unsmooth jaw line, namely, a "secondary angle," may form, resulting in an unaesthetic outcome [10]. After the osteotomy line is marked with the guarded saw, larger oscillating saws are serially used to complete the bone resection. Additional mandibular corticectomy can be performed if further narrowing of the width of the mandible body is required (Fig. 10.4).

Key Technical Points

1. During the T-osteotomy procedure for chin narrowing, the horizontal osteotomy should be perpendicular to the facial midline and at least 5 mm inferior to the mental foramen.
2. The width of the central chin narrowing portion is determined based on factors such as the wideness of the chin, the course of the inferior alveolar nerve, and the patient's preferences. According to the authors' clinical experience, the average amount of horizontal narrowing was about 10 mm, ranging from 0 to 16 mm.
3. Anteroposterior adjustment of the chin or vertical chin lengthening or shortening procedure can be carried out simultaneously with the chin narrowing procedure.
4. It is important to smoothen the bony step on each side of the chin-mandible junction and reduce its palpability. The bony steps are reduced by using oscillating saws. The "guarded" oscillating saw leads to a precise bony resection in a uniform fashion while avoiding over-resection and reducing the possibilities of nerve injury.

Fig. 10.4 Preoperative panoramic radiograph (*left*). Follow-up radiograph 1 day after surgery (*right*)

Case Study

Case 1

A 26-year-old woman was planned for the mini V-line surgery. Although her mandible angles were not very prominent with a gonial angle of 130°, the accentuated chin broadness gave her a rather masculine appearance. The chin was narrowed by 10 mm and simultaneously vertically shortened by 2 mm to achieve good facial proportions. Additional upper blepharoplasty was performed concomitantly. Her relatively broad lower face had a more slender and feminine postoperative contour after surgery (Fig. 10.5).

Fig. 10.5 Preoperative view of a 26-year-old woman (*left*). Postoperative view at 6 months after mini V-line surgery (*right*)

Case 2

A 33-year-old woman with a prior surgical history of a conventional mandible angle reduction was planned for the mini V-line surgery. Despite the previous surgery, there is asymmetry in the lower face. Chin was narrowed by 11 mm of and set back by 2 mm. A concomitant reduction malarplasty was done. After surgery, the patient's disproportionately wide lower face contour had a more harmonious and feminine appearance (Fig. 10.6).

Fig. 10.6 Preoperative view of a 33-year-old woman with a prior surgical history of a conventional mandible angle reduction (*left*). Postoperative view at 6 months after mini V-line surgery (*right*)

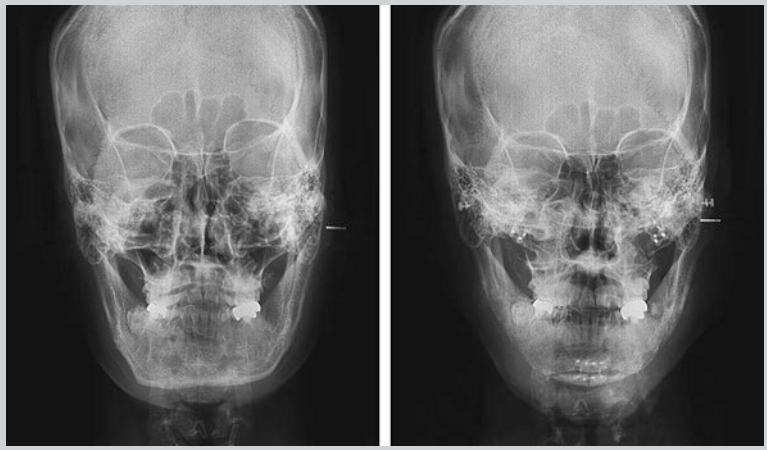

Fig. 10.6 (continued)

Complications and Management

The most frequently noted complication after surgery was transient neurosensory loss [10]. In a previous study from the authors' institution, decreased sensation in the lower lip region was reported by 27.0% of all patients immediately after the operation. However, all sensations normalized during the follow-up period, and permanent neurosensory deficits were not reported. However, efforts such as separating the intraoral incision into three parts, performing the horizontal osteotomy at least 5 mm below the mental foramen during genioplasty, and using the guarded oscillating saws during the ostectomy at the chin-mandible junction should be done to avoid any unintentional nerve injury. According to the same clinical report, surgical site infection occurred in 2.0% and was managed successfully in a conservative manner in all cases. Other possible severe complications such as hematoma requiring surgical intervention, unexpected fractures, malunion or nonunion of the bone segments, facial paralysis, or trismus were not observed throughout the previous study.

Meanwhile, some cosmetic problems can be reported after the surgery. For example, jowl redundancy can be problematic. In these cases, additional submental laser-assisted liposuction can be successfully carried out to correct the problem. Mentalis hyperactivity, which was noticed in 4.8% of the patients, was a temporary problem that resolved in all cases within a 3-month period. Focal injection of botulinum toxin into the hyperactive muscle may be helpful. Some patients underwent adjunctive facial contouring surgery together with chin narrowing surgery. Reduction malarplasty, autologous fat grafting, laser-assisted liposuction, and thread lifting are commonly carried out concomitantly [10].

Discussion

When planning mandible reduction surgery in a patient who wants a more slim and feminine face, it is important to consider the lower face contour as a whole. However, the role of the mandible angle is often overemphasized by both the surgeon and the patient. Simply reducing the volume of the mandible by a conventional bone contouring surgery that includes the mandible angle may result into an irreversibly unaesthetic and unsatisfactory surgical outcome. Mandible contouring surgery should be more focused on the chin, and whether or not to include the posterior part of the mandible should be optional [2, 6, 8, 10]. Therefore, it is

essential for the surgeon to determine whether to concomitantly reduce the mandible angle or not when performing chin narrowing surgery.

Meanwhile, the main complaint of patients with a history of prior mandible contouring surgery with dissatisfactory results was that their faces were not slim as much as they wanted even after the surgery [10]. Furthermore, the disharmony between the lower face and accentuated chin broadness was troublesome in many of these cases. The reason for this is the inherent limitations of conventional mandible angle reduction surgery. Reducing the mandible angle alone has a limited effect, especially when seen from the front, and leaves the chin unchanged, which can lead to disproportions in the lower face aesthetics. Mini V-line surgery is a good solution for these patients. When planning revisional mandible contouring surgery in these cases, it is important not to reduce the mandible angle excessively. Further resection of the mandible angle can yield an aesthetically unnatural result, and chin narrowing surgery alone may often be the treatment of choice in such situations [8, 10]. Surgeons should be very cautious when performing revisional surgeries because the lower borders of the mandible may be irregular, the outer cortex may be thin, and the inferior alveolar nerves may pass through a low-lying route due to previous surgery.

Mini V-line surgery requires a relatively smaller intraoral incision and a more limited subperiosteal dissection area in the mandible region when compared with conventional mandible angle reduction surgery or regular V-line surgery. Therefore, it is associated with a shorter operative time and reduced chances of bleeding during the operation. This in turn leads to reduced postoperative swelling or bruising and prompt recovery after surgery. Surgical drains are not required which means that additional hospital stay is not required, increasing the cost-effectiveness of the procedure. The mini V-line surgery is the ideal surgical solution for those patients who would like to recover rapidly from surgery and who do not wish to undergo extensive surgery that includes reduction of the mandible angle.

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Treatment of Long Face with Facial Bone Contouring Surgery and Philtral Reduction

11

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Pearls

1. Long face is not a distinctive diagnosis but a very subjective term. However, patients who complain of long face and seek for balanced proportion are rapidly increasing.
2. The features of long face are diverse, which include prognathism, vertical maxillary excess, chin hyperplasia, and long face with normal vertical proportion.
3. Depending on the causes of the long face, improvements through varied surgical strategies can be considered. If the long maxilla and mandible is the cause of the long face and patient has concurrent malocclusion, the most effective improvement is possible through double-jaw surgery with facial bone contouring surgeries. However, many patients want simple and less invasive way, and thus, authors focus on improvement through facial bone contouring surgeries and soft tissue management in this chapter.
4. Facial bone contouring surgery such as mini V-line surgery and V-line surgery adopting T-osteotomy for vertical reduction is a simple and effective way to improve long lower face with or without prognathism.
5. Management of sagging and redundant soft tissue is as important as bone reduction for effective shortening of face. Suspension of muscle, liposuction, and face lifting can be applied solely or concomitantly to maximize the effect of bone reduction.
6. A long midface can be reduced most effectively by reducing the length of the maxilla, but if the philtrum is long with lack of incisor show, reducing the length of the philtrum is also effective and is an alternative way of making the midface look shorter and balanced.

Introduction

Facial proportions are described in various ways. Vertically, the face is divided into three. The upper face is from the hairline to the glabella. The middle one-third is from the glabella to the subnasale and the lower one from the subnasale to the menton (Fig. 11.1). These vertical facial proportions vary with race, and preferred proportion depends on the race, sex, culture, and so on. Although ideal proportions are different according to factors described above, considering these ideal proportions in surgical planning is very important for pleasing result.

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S. Park (ed.), *Facial Bone Contouring Surgery*, DOI 10.1007/978-981-10-2726-0_11

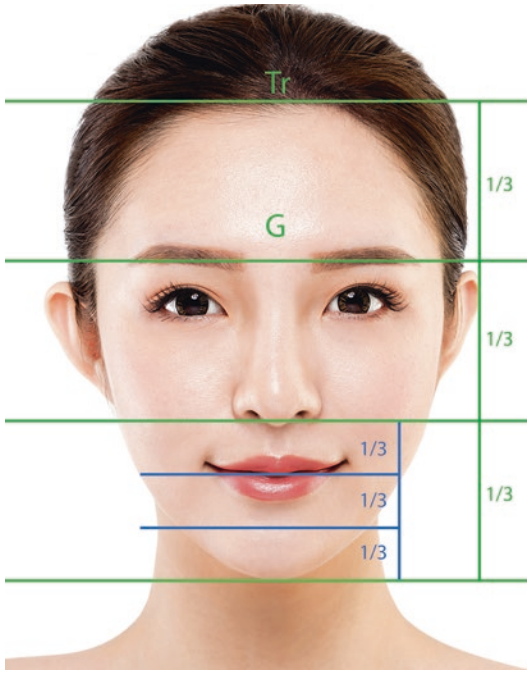

Fig. 11.1 Face is divided into horizontal thirds. The upper third extends from the hairline to glabella, the middle third from glabella to subnasale, and lower third from subnasale to menton

However, even if the vertical proportion of the face is ideal, the face may look longer depending on the ratio of the width-to-height ratio of the face. In general, the width-to-height ratio of the face is typically 3:4, with an oval-shaped face being the aesthetic ideal [1, 2]. Therefore, long faces are highly subjective; the indications for surgery cannot be absolute. For example, some Koreans or Japanese people having normal range of chin in good proportion sometimes want shorter chin. Moreover, the lower face, which is shorter than the ideal proportion, is recognized as a younger face in Asian countries [3, 4]. Surgeon needs to know exactly what the patient wants to improve through careful consultation and should take comprehensive consideration of various factors to improve the long face effectively and harmoniously.

In this chapter, authors focus on the improvement of a long face using shortening of soft tissue for the midface and vertical reduction of the mandible for a lower face.

For the shortening of the midface, as is well known, the only way to shorten actual length and correct malocclusion is double-jaw surgery adopting Le Fort I osteotomy. However, patients who have (1) normal or near-normal occlusion or who do not want correction of occlusion, (2) who want less invasive surgery and quick recovery, and (3) who have concomitant redundant soft tissue (philtrum) with minimal incisor show philtrum reduction surgery is an effective and alternative method of making the midface look shorter.

For the shortening of lower face, facial contouring surgeries such as mini V-line surgery and V-line surgery adopting T-shape osteotomy for reduction genioplasty are the most common and effective methods. Furthermore, control of soft tissue along with shortening of the vertical length of the mandible is a very important factor in lower face shortening. As redundant soft tissue still make shortened mandible after facial bone contouring surgery look still longer, suspension of soft tissue such as geniohyoid/digastric muscle, liposuction, and face lifting should be considered.

Patient Assessment and Consultation

Direct physical examinations and clinical photos are the key processes to evaluate the patient's problems and establish a surgical plan. Cephalometric/panoramic radiographs and three-dimensional computed tomography are also necessary. Among them, the lateral cephalogram is a profile X-ray of the skull and soft tissues and is most useful to assess the vertical proportions and the relation of the soft tissues to the jaws. Although there is no absolute definition of long faces as mentioned above, it is worthwhile to consider aesthetic "ideals" when analyzing the face preoperatively and making a surgical plan.

For the midface, patients having long and thin upper lip with the incisor show of less than 2 mm and hooding of the lateral lip are good candidates for the philtrum reduction.

Considering the ideal facial for reference and patients' demand, surgeons decide which operation would be applied to shorten the long face.

Surgical Techniques

Facial Bone Contouring Surgeries: V-Line and Mini V-Line Surgery

Surgical techniques are not far different from prevalent facial bone contouring surgeries described at previous chapters. The major difference is the axis of osteotomy and additional osteotomy for vertical shortening. Various osteotomy designs can be considered depending on the position of the nerve, the amount of reduction, and the patients' needs.

Two Parallel Osteotomy

Chin shortening using two parallel osteotomy lines is a commonly used technique when the nerve runs high enough or amount of reduction is not so much. This method is technically an easy and time-saving method as surgeons can make two parallel osteotomy lines with double-bladed saws. These parallel osteotomy lines may be applied horizontally, but it may also be applied as an inverted V shape to obtain additional shortening effects (Fig. 11.2). If the location of the nerve is too low to limit the reduction and if the risk of subsequent nerve injury is likely to increase, or if the patient wants the maximum pointed chin with a reduction in length, surgeons should consider safe and alternative osteotomy line.

Inverted V-Shape Osteotomy

In cases where the position of the inferior alveolar nerve line is too low, if there is not enough margin to the nerve line due to the previous operation, and if only a small degree of vertical reduction is required, the length of the chin can be reduced through oblique deformation of the osteotomy line without removal of the bone (Fig. 11.3). Although the amount of vertical reduction is limited, it is the most commonly used method of osteotomy because the risk of nerve damage is relatively low and the method of osteotomy is simple and not technically challenging as it is not much different from the transverse osteotomy. In

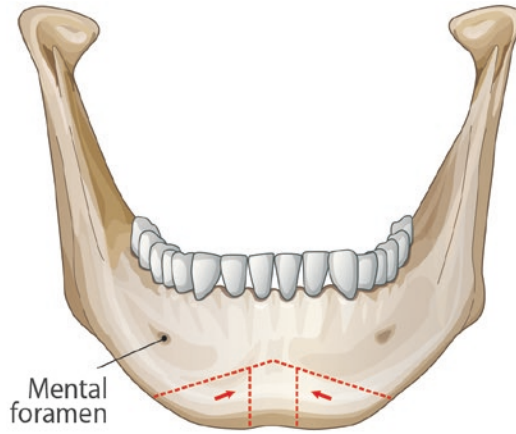

Fig. 11.3 Inverted V-shape osteotomy. Length of the chin can be reduced through oblique deformation of the osteotomy line without removal of the bone

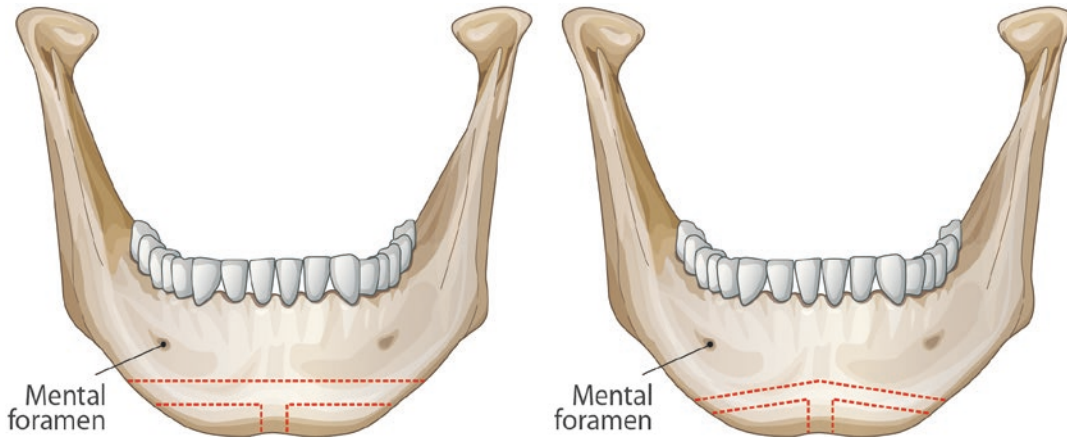

Fig. 11.2 Two parallel osteotomy. It is most commonly used reduction technique

general, to maintain the shape of the chin, it is necessary to remove the central strip, which is twice the amount of vertical reduction.

Trapezoidal-Shape Osteotomy

If the patient does not prefer a pointed chin and wants a round chin and a maximum length reduction, osteotomy should focus mainly on shortening (Fig. 11.4). By maximally removing the bones in the central portion and minimally removing the bones at both ends, the length of the chin can be reduced sufficiently even if the position of the nerve is low.

Bow-Tie-Shape Osteotomy

If the patient's chin is not too long and the patient wants shorter but more pointed chin, the purpose can be done through combination of transverse and oblique osteotome line (Fig. 11.5). The design of osteotomy is opposite to that of trapezoidal-shape osteotomy. By minimally removing the bones in the central portion and maximally removing the bones at both ends, a more pointed chin can be achieved although the reduction of length is somewhat limited. However, when using bow-tie-shape osteotomy, there should be enough space for the nerve line as there would be a lot of bony steps at both ends.

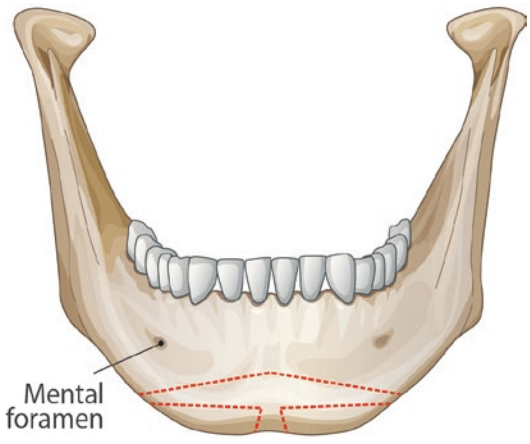

Fig. 11.4 Trapezoidal-shape osteotomy. It enables maximum length reduction

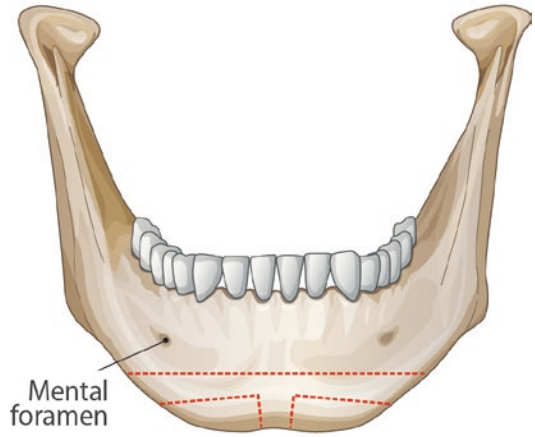

Fig. 11.5 Bow-tie-shape osteotomy. The shape of the tip of the chin can be made more sharp while reducing the length of the chin

While reducing the length of chin, surgeons also can control projection of the chin. In the case of long and protruding chin, the degree of protrusion can be improved by reducing the length itself.

When additional control of protrusion is required, setback genioplasty can be considered.

Furthermore, surgeons have to control remnant soft tissue for more effective shortening of the chin as soft tissue sagging makes the face look longer even after bone contouring surgeries, and there are various strategies of managing soft tissue. Representative methods are liposuction of the lower cheek and double chin, suspension of geniohyoid/digastric muscle, and face lifting. As remaining muscle after bone reduction is a cause of double chin and may decrease the effect of bone shortening, suspension of muscle is helpful to improve soft tissue sagging.

Philtrum Reduction

Philtrum reduction only can be operated under intravenous sedation, but if it is with facial bone contouring surgeries, general anesthesia with orotracheal intubation is needed. Local anesthetic (2% lidocaine with 1:100,000 epinephrine) is injected into the upper lip, nasal mucosa, and

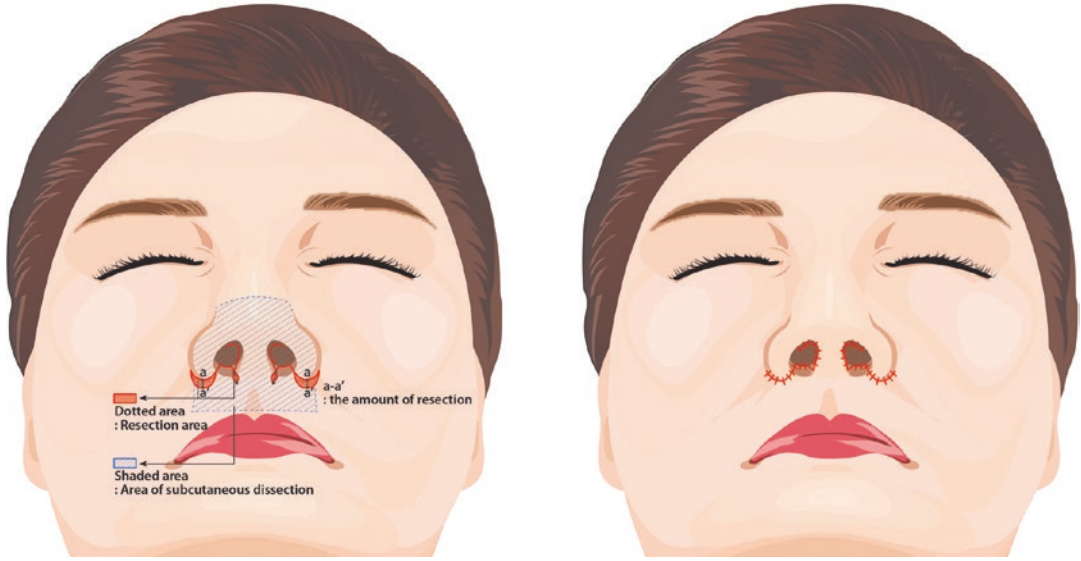

Fig. 11.6 Incision design and extent of dissection of philtrum reduction

nasal tip skin under intravenous sedation. An intranasal incision without a transcolumellar incision was made to separate the columellar skin from the medial crura (Fig. 11.6 and 11.7a). This incision was carried along the subalar crease. Through the incision, tenotomy scissors were used to identify the caudal septal end and dissect in the subcutaneous plane just above the orbicularis oris muscle in the upper lip so as not to disturb the function of the orbicularis oris muscle (Fig. 11.7b). The dissection area was limited to the width of the nasal base and half of the distance to the white roll of the lip. A limited dissection of the nasal tip and dorsum was approached through the infracartilaginous portion of the same incision (Fig. 11.7c). After elevation of the upper lip skin and subcutaneous tissue from the orbicularis oris, the columellar subunit was freely mobile. A 3-0 nylon suspension suture was passed via the intranasal incision into the previously dissected subcutaneous plane to grab the superficial orbicularis oris muscle (1–1.5 cm wide) and fascia at approximately one-half the height of the upper lip. The suture was then anchored to the lower caudal septum and tightened carefully to shorten the central upper lip, allowing the surgeon to elevate the lip to the desired level without tethering or inhibiting orbicularis oris muscle function. The key anchoring suture was secured to the caudal septum, not the anterior nasal spine, to prevent disruption of suture fixation during maxillary dissection. Any signs of notching on the lip after suspension suture placement were addressed by additional placement of plication sutures on the orbicularis oris muscle until there was a smooth transition. At this point, the columella-labial angle was decreased, providing the added benefit of a less-upturned nose tip (Fig. 11.7d). For patients with a retracted columella or a less projected tip, a tip plasty, including a plumping graft, can be performed to increase tip projection. For patients with a hanging columella, the caudal septum may be shortened. The redundant skin over the columella was not resected but redraped around the nasal tip. The excess upper lip skin was redistributed upward into the nasal vestibule, where any excess tissue was excised. Next, key anchoring sutures of the endonasal flaps to the immobile supraperiosteal tissue of the vestibular floors were placed with 4-0 PDS sutures, relieving tension. A more caudal subalar resection enables some lateral lifting.

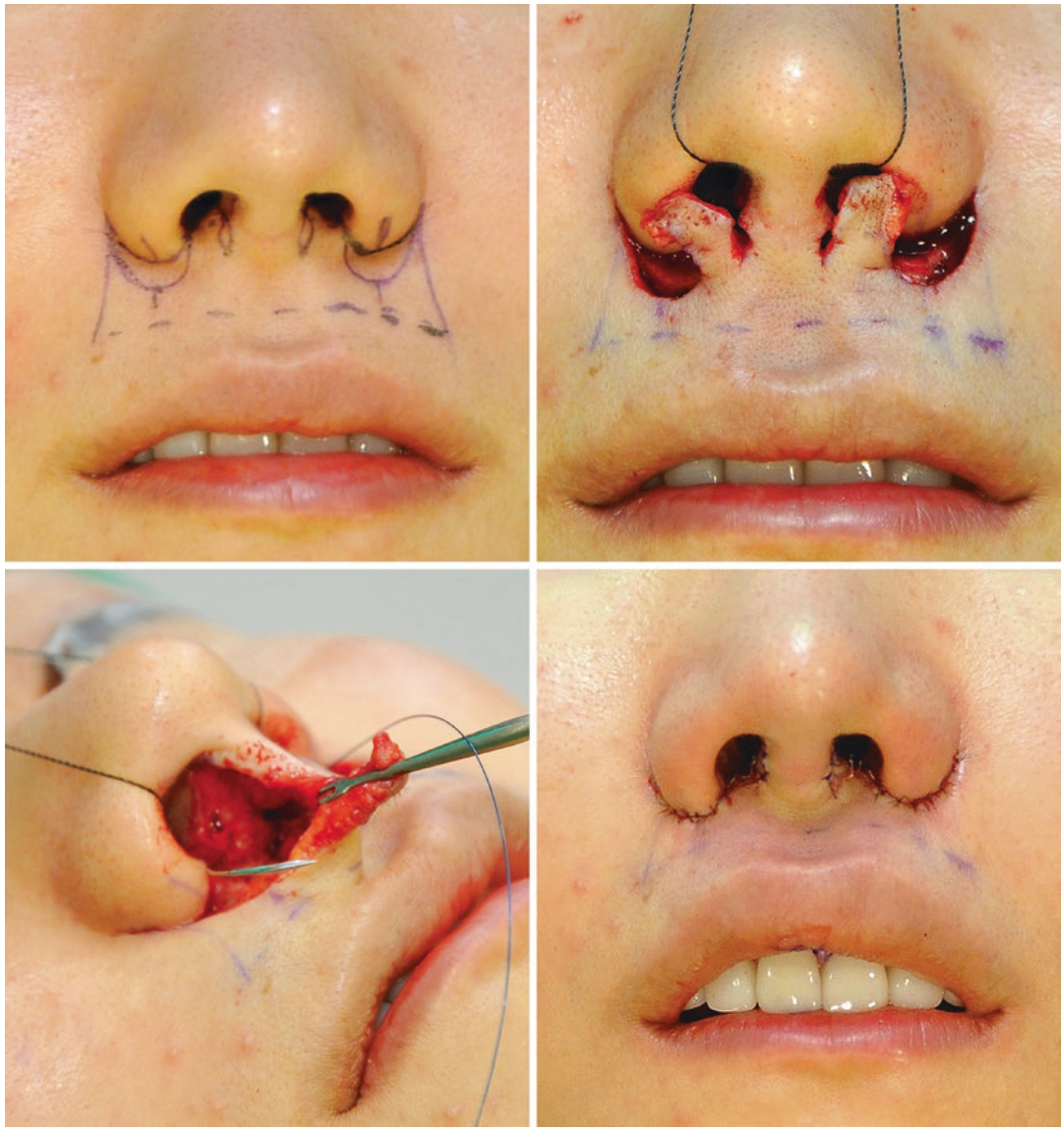

Fig. 11.7 Surgical procedures

Key Technical Points

1. Various types of osteotomy can be considered according to the position of the nerve, amount of reduction, and patients' preference.
2. Controlling soft tissue through muscle suspension, liposuction, or face lifting is as important as bone surgery as remnant soft tissue makes facial contour irregular and still longer.
3. Philtrum reduction can be an effective and alternative method of the midface shortening. With attention to detail and careful preoperative planning, philtrum reduction can allow reduction of the midface for up to 6 mm of lift with excellent scar camouflage.

Case Study

Case 1: Reduction Genioplasty

A 25-year-old woman complained of long, asymmetric, and prognathic chin (Fig. 11.8). Through reduction genioplasty using trapezoidal-shape osteotomy, the length of the chin was reduced by 5 mm, and 2 mm setback was performed using a pre-bending plate to improve the projection. Additional fixation was performed to ensure bone contact at both ends of the bone segment (Fig. 11.9). To prevent soft tissue sagging, suspension suture using PDS 3-0 was done. The length was reduced markedly and chin projection was improved at 5 months postoperatively (Fig. 11.10).

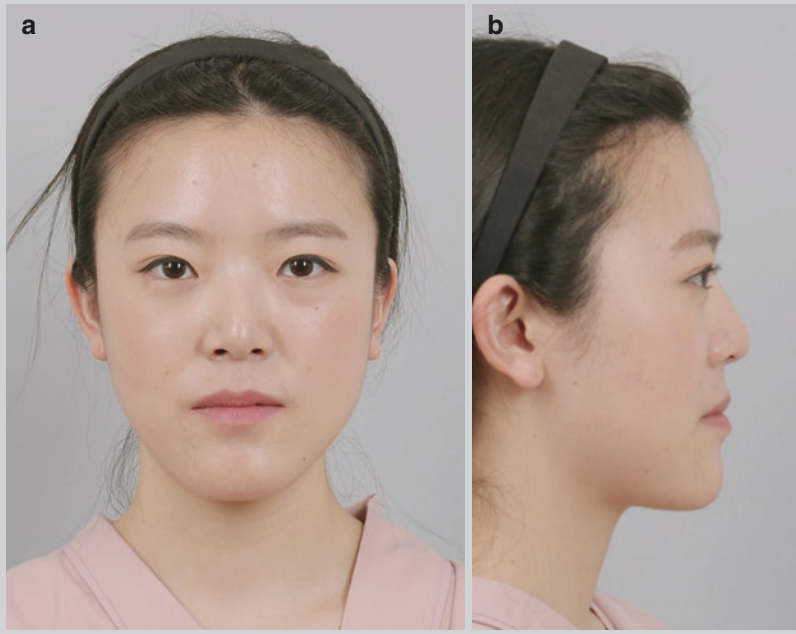

Fig. 11.8 *Case 1*. Preoperative frontal (**a**) and lateral (**b**) photographs of the patient

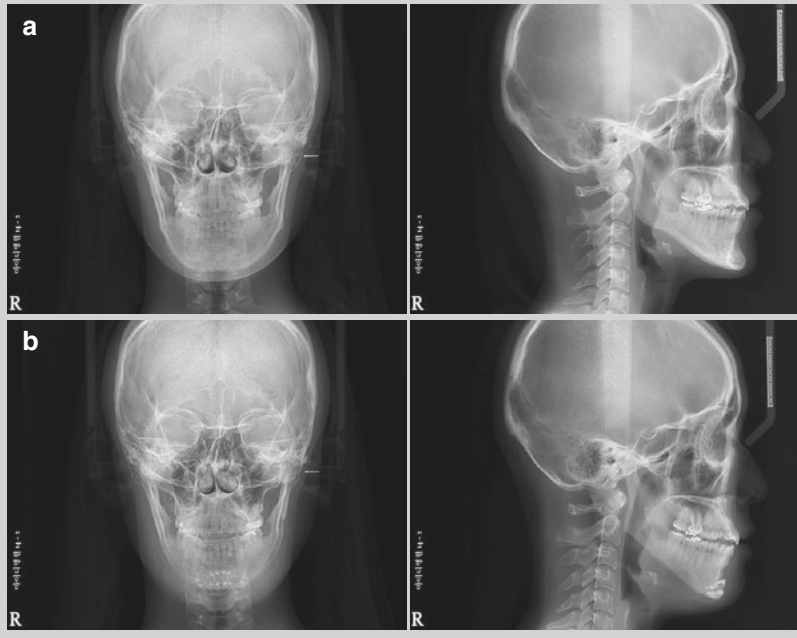

Fig. 11.9 *Case 1*. Preoperative (**a**) and postoperative (**b**) radiographs showing length reduction and improvement of prognathism

Fig. 11.10 *Case 1*. Five-month frontal (**a**) and lateral (**b**) postoperative photographs

Case 2: Philtrum Reduction

A 20-year-old woman visited ID hospital to improve her long face. She underwent forehead reduction, mandible contouring surgery, and philtrum reduction. The philtrum was reduced by 5 mm. Two months after the operation, the patient's facial contour appears short and more balanced (Fig. 11.11).

Fig. 11.11 *Case 2*. Comparison of preoperative and postoperative frontal (**a**) and oblique (**b**) photographs of the patient

Complication and Management

The most frequent complication after shortening is soft tissue sagging such as jowl redundancy. In these cases, submental liposuction and thread lifting can be a solution for cosmetic improvement. These methods are also helpful to make smooth facial contour.

One of the specific complications that can occur in reduction genioplasty is the flattening of labial sulcus groove. If the labial sulcus groove is flattened, the volume of the chin decreases relatively, and the profile may be unnatural, and the three-dimensional appearance may deteriorate. Natural chin profile can be expected by forming a labial sulcus groove through the burring of proximal portion above the pre-existing groove. When burring, tooth root damage should be prevented, and instability of fixation due to burring of excessive cortical bone should also be avoided.

Discussion

It is only recently that people are interested in surgery to reduce facial length and to find balanced proportion. Various attempts such as forehead reduction, hair transplantation, philtrum reduction, and bone surgeries have been used but only in partial satisfaction. One of the main reasons is the deficiency in bone reduction, which was improved by various designs of osteotomy. The other main reason is the obliteration of natural aesthetic landmark such as labiomental sulcus or submental line. Meticulous consideration and preservation of these landmarks improves the degree of perfection of the result.

One of most old but controversial way of vertical reduction is a direct reduction of the chin or shaving of the chin. Advantages of this procedure are its simplicity and the absence of metal screws. However, this method cannot effectively reduce the length of the chin, and unlike the T-osteotomy, the unexpected and unpredictable resorption of the bone due to the exposure of the medulla bone can result in irregular and asymmetric facial contour. In addition, excessive soft tissue detachment during direct ostectomy may cause severe soft tissue drooping and irregular soft tissue adherence. This procedure is usually done by the surgeons who do not have good experience in facial bone surgery. ID hospital neither performs nor recommends direct ostectomy of the chin for the purpose of reduction.

For philtrum reduction, a reduction of up to 6 mm is recommended as it results in natural shape and inspicuous scar. A reduction more than 6 mm is not recommended because it is usually aesthetically unpleasing due to soft tissue bunching over the philtral area. For scar, it is very important to leave a tension-free margin after key suture.

Additionally, when making a surgical plan, overcorrection of about 20% should be considered. Due to gravity and tissue tearing caused by a cheese wiring of the suspension suture, the lip tends to sag down after several months, and 20% of relapse is expected.

Many surgeons may doubt and refused to perform vertical reduction of the long face; the long face can be improved to a considerable extent by properly combining facial bone contouring surgery using diverse osteotomy and soft tissue management.

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Alloplastic Augmentation of the Chin and Mandible

12

Jaehyun Kwon

Pearls

1. Facial skeletal augmentation with alloplastic implants can improve a projection, definition, or balance of a face.
2. Alloplastic implant insertion can be a first-line option in various cases of mandibular skeletal deficiencies as it is simple and does not require donor site.
3. Selection of implant material depends on recipient site, softness, availability, and biologic behavior.
4. Pocket dissection adequate for implant is the critical step for successful augmentation.
5. Fixation is recommended in most cases to the stable structure.
6. The chin is the most popular site for alloplastic implant. Position, profile, and shape of the implant should be carefully decided according to patient need.
7. Mandible implant is used to increase the masculinity or correct the overzealous reduction.
8. Treatment of infection should be initiated preemptively with sufficient dose and duration.

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Introduction

Patients with mandibular skeletal deficiency want improvement of their appearance through various ways. Facial bone surgeries such as double-jaw surgery or genioplasty are the most effective and permanent ways to overcome skeletal deficiencies. However, many patients still seek for alloplastic implant insertion as the first option to improve their problems [1, 2, 3]. One of major reasons is its simplicity. It is also cost-effective and requires only short recovery time. It can be used for simple and localized deficiency. Alloplastic implants are more advantageous in making permanent and definite facial contour comparing autologous fat graft or fillers [4]. There is no donor site morbidity and limitation.

The chin is the most popular site for alloplastic implant. Chin implants are usually used to correct the projection and length of the chin. However, recently, they are used to correct the frontal shape, such as pointedness, width, and contour of the chin. If the hypoplasia of the mandibular deficiency is not severe and localized to the chin, implant is the preferred method by many surgeons [3].

Mandibular augmentation is usually done in male patients to augment the masculinity. However, it is not popular in Asians as slim lower face is favored. Alloplastic implant insertion to make the jawline more definite and strong is very rare in Asian woman. It is often indicated after overzealous reduction of the mandible as an

S. Park (ed.), *Facial Bone Contouring Surgery*, DOI 10.1007/978-981-10-2726-0_12

iatrogenic complication [4, 5]. Selection of implant depends on the size and quality of the defect. For congenital and developmental anomalies such as facial asymmetry and craniofacial microsomia, mandibular implant is successfully used to augment the defective side and to correct the asymmetric shape.

Various implants such as solid silicone, porous polyethylene (Medpor®), and Gore-Tex® are commonly used [3, 5]. Solid silicone implant is easily available and easy to sculpt. A capsule is formed around the implant, which may facilitate the removal, but also works as a source of infection [6]. Silicone implant is a treatment of choice in many Asian countries, especially in chin surgery.

Medpor is a stable, inert, porous implant. Porosity gives an advantage of fixation and prevention of capsule [7]. Additional advantage of Medpor® is it can be contoured and shaped by heat during the operation. Gore-Tex® is an expanded synthetic polymer [8, 9]. It is available in sheet, strip, and blocks. It is relatively soft and flexible and provides great adaptation to the surface while keeping strength. It is readily used for the augmentation of the defect that is difficult to shape or defect with thin overlying skin. Fixation of the implant is possible with sutures to adjacent soft tissue or with screws to underlying bone.

Patient Assessment and Consultation

Direct physical examination is the key process to evaluate the patient's problems and establish a surgical plan. Surgeons have to communicate with patients to ensure their accurate requirements. Bite problems should be excluded. The degree of chin hypoplasia is evaluated in terms of projection and length. Recently, frontal shape should also be evaluated in terms of width and contour. If the extent of hypoplasia reaches the mandible body or angle, surgery may need general anesthesia, and implant should be prefabricated. Function of mentalis muscle should be carefully inspected along with lip competency. Clinical photos are also necessary, and radiologic examinations are helpful for an accurate profile analysis. Jaw deformities involving TMJ should be carefully excluded, and course of inferior alveolar canal should be carefully traced. Conditions of incisor tooth root are assessed. Tooth root resorption may be aggravated after chin implant.

Surgeons should explain the possibility of complications specific to implants. Incidence of infection and possible need for removal should be carefully noticed [10, 11].

Surgical Techniques

Facial skeletal augmentation can be performed under either local anesthesia with sedation or general anesthesia. Intravenous sedation and local anesthesia are enough for simple chin implant, but general anesthesia may be necessary if complex implant or mandible implant is considered. Facial implant surgery is routinely performed on an outpatient basis.

Approach to the chin is possible through either a submental or intraoral incision; however, submental incision is not preferred as it leaves visible scar. Intraoral approach for implant insertion does not increase any chance of infection. An intraoral incision is placed about 1 cm above the sulcus to provide adequate tissue for the safety of closure [12].

The area for alloplastic implant is dissected in the subperiosteal plane. Although some surgeons prefer to place implants in soft tissue pockets, many clinical experiences have shown that insertion into the subperiosteal plane can minimize the peripheral nerve damage and bleeding. Moreover, rigid fixation is only possible when implant is placed in subperiosteal space.

Rigid fixation is preferred in all cases. First of all, it can prevent implant mobility. Chin implant is frequently found to move upward by muscle pull of the mentalis muscle, if not secured. It also can increase the adaptation of the implant to the surface of the bone and decrease the chance of dead space. The dead space may provide a potential for hematoma collection and infection. Inadequate adaptation may also result in contour problems, such as overcorrection, asymmetry, or irregularities.

The subperiosteal pocket is extended to the precise dimensions of the implant with fine

surgical instruments such as freer elevator. If the pocket is too spacious, chance of implant mobility increases and precise positioning is difficult. If it is too tight, implant may buckle or catch overlying tissue, causing contour problems. Margins of implant should be carefully inspected after placement.

Chin

When performing alloplastic implant insertion for augmentation of the chin, the position of the implant should be controlled according to the target chin shape. When implants are inserted for the purpose of lengthening the chin, the implants should be placed vertically beneath the chin (Fig. 12.1). If the patient has no problem with the length of the chin and only the improvement of projection is desired, the implant should be placed anterior to the mental protuberance (Fig. 12.2). If both length and projection need to be improved, the implant is placed at the anteroinferior of the mental protuberance (Fig. 12.3). The implant is immobilized with two titanium screws to prevent superior displacement or rotation of implant. Frontal width of implant is another critical aesthetic point. If the degree of mandibular hypoplasia is moderate to severe, wider implant extending lateral to mental foramen has better augmentation. In patients with flat and short mandible, or if patients want slim pointed chin, narrow high-profile implant is effective to make the desired lower face and chin.

Mandibular Implant

The ramus and body of the mandible is exposed through an intraoral incision that is made at about 1 cm above the sulcus. Dissection in the subperiosteal plane proceeds to detach the muscle from both the inferior and posterior border of the mandible. Fixation with multiple screws in proper position is critical (Fig. 12.4). Implant and screw failure may result from excessive pull by masseter muscle or external pressure. Selection

Fig. 12.1 Rigid fixation with screws is preferred to prevent implant mobility, over-correction, asymmetry, or irregularities

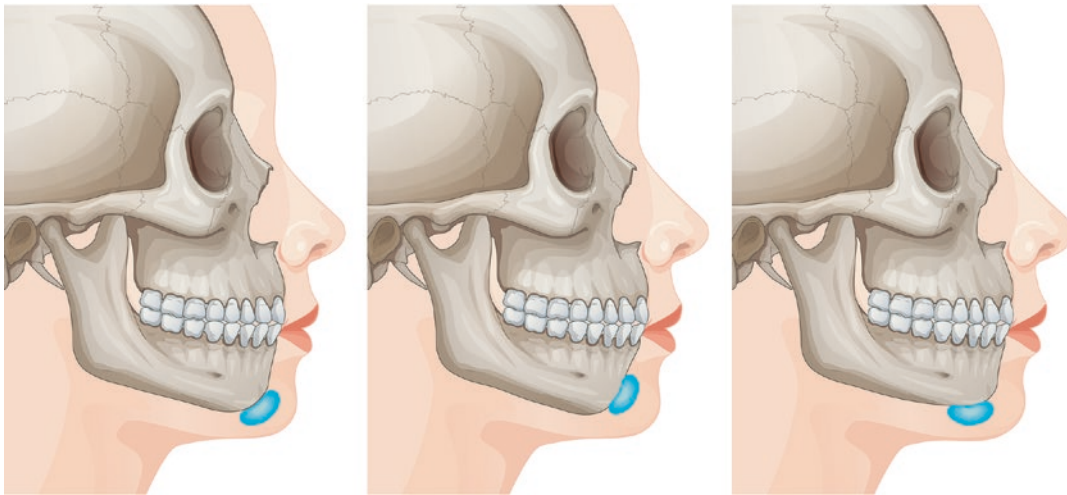

Fig. 12.2 The position of the implant is determined by the direction of the improvement to be achieved

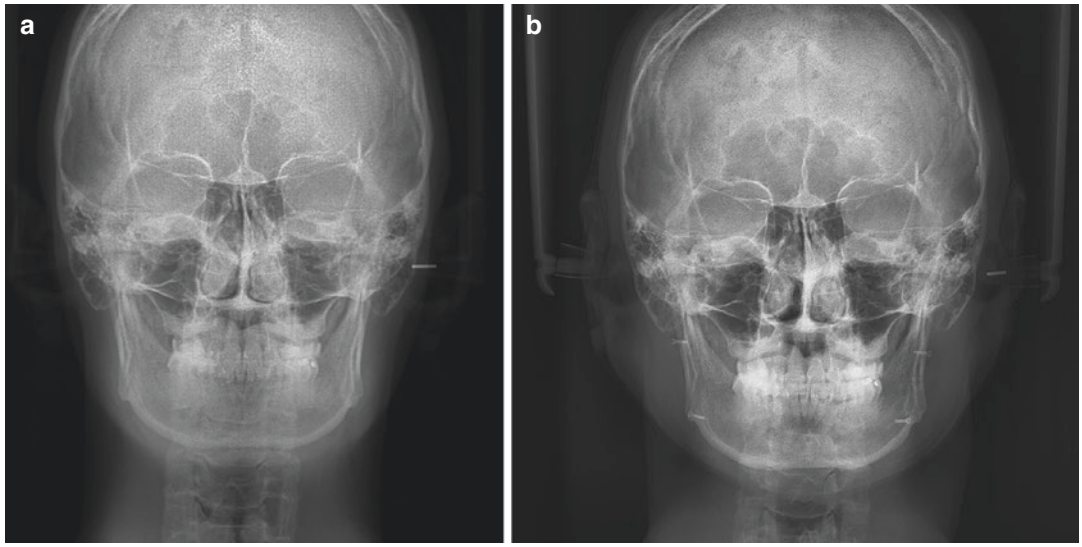

Fig. 12.3 Implants for augmentation of mandible are also fixed with multiple screws (**a**) preop, (**b**) after insertion of medpor implant and fixation with screws

Fig. 12.4 Medpor® implant with lower border sleeve

of implant shape and material is made according to the specific needs of the patient. If lateral volume is deficient, simple silicone implant is good enough. If lower border of the mandible is lost, rigid implant made of Medpor® is recommended. If there is a larger lower border defect requiring a buttress to resist the muscle pull, Medpor® implant with lower border sleeve is recommended (Fig. 12.5). Rigid fixation is critical in this case.

Suction drains are not routinely used as amount of bleeding is usually minimal. However, if there is bleeding, strict hemostasis and/or drain insertion is necessary to prevent hematoma formation and infection. Chlorhexidine gluconate mouthwashes are prescribed for use 3 days postoperatively. Intravenous antibiotics are administered perioperatively and oral antibiotics are prescribed for 1 week after surgery.

Key Technical Points

1. Rigid fixation is recommended with proper pocket dissection to prevent displacement and visible margin.
2. Aseptic technique is critical to prevent the infection. Be careful not to contaminate the implant with too many test insertions.
3. Selection of proper implant is based on preoperative evaluation and patient's request and surgeon's experience.
4. Mentalis muscle should be carefully repaired and controlled to have a natural lip and chin shape.

Case Study

Case 1

A 24-year-old woman complained of deficient projection of chin.(Fig 12.5a) She wanted improvement of the profile. Considering ideal profile through lateral X-ray (Fig 12.5b), 8mm sized silicone implant was inserted through intraoral incision and fixed with two screws. (Fig 12.6b) The chin projection was improved markedly after the surgery. (Fig 12.6a).

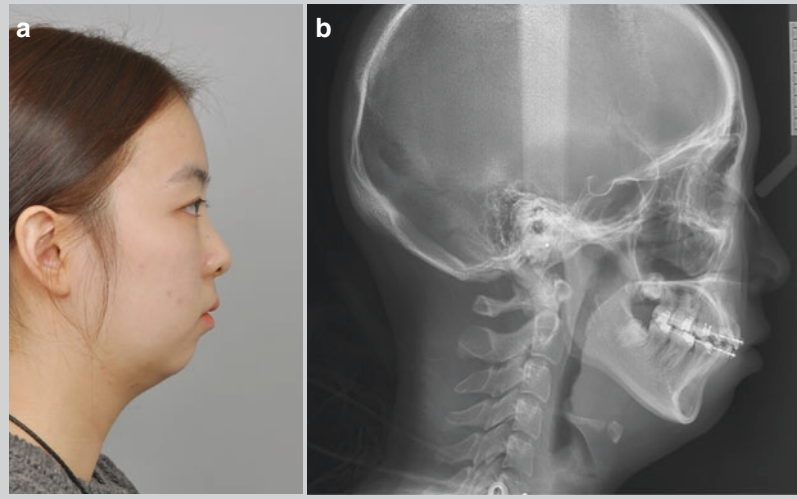

Fig. 12.5 (Case 1) Preoperative photo (**a**) and lateral X-ray (**b**) Suction

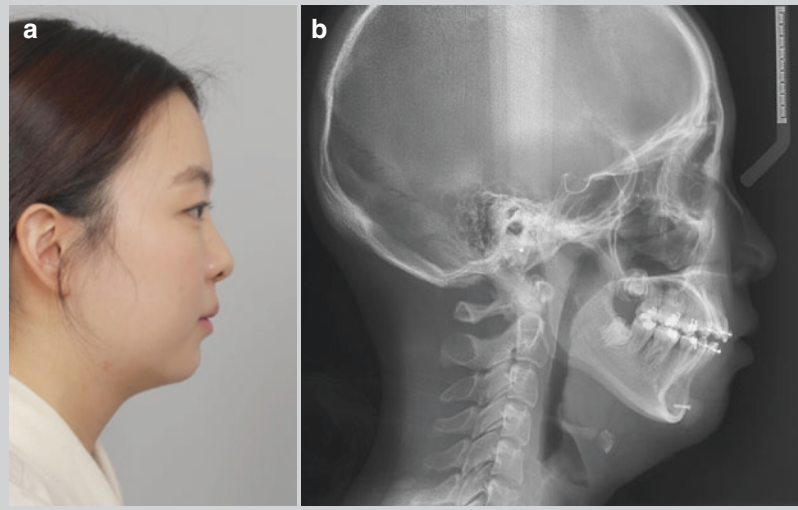

Fig. 12.6 (Case 2) Preoperative (**a**) and postoperative (**b**) photo

Case 2
Mandibular angle augmentation
A 28-year-old man complained of feminine appearance because of lack of mandibular angle and wanted more strong jaw line. (Fig 12.7a) He underwent a medpor implant insertion surgery at angle. Through the oral incision, medpor implants were inserted bilaterally and fixed with two screws to prevent instability. After the surgery, his jawline was improved definite and masculine (Fig 12.7b).

Fig. 12.7 (Case 2) Preoperative (**a**) and postoperative (**b**) photo

Complication and Management

Infection, implant extrusion, malposition or migration, irregular contour of the overlying skin, pain or discomfort, bone resorption, and hypoesthesia are possible complications of alloplastic implant insertion [10, 11].

Infection

Infection requiring removal of the implant is the most catastrophic complication of implant. Infection should be prevented with extra caution and effort. Implant should be carefully managed between trial insertion and final insertion to reduce the chance of contamination. It should be kept away from saliva and other oral secretions. Once any signs of infection are suspected, antibiotics with extra strength and dose should be started right away and followed up for sufficient duration. Infection in the setting of alloplastic implantation has always been an issue of concern, as these materials lack the vascular ingrowth seen with autologous grafts and additionally serve as a surface for bacterial colonization and biofilm formation. Implant-related infections may result in implant removal, antibiotics, and additional wound management. Reinsertion of implants may be considered in 6–12 months.

Malposition

Malposition or transposition of implants is a common complication of alloplastic implant insertion. This complication can be prevented by precise dissection and fixation using titanium screws. Selection of proper-sized implant is important. Oversized implant may cause distortion of the contour. Detection of malposition or displacement is not easily found right after surgery because of edema. Elastoplast tape is frequently used to minimize the implant displacement and

Fig. 12.8 Marked bony resortion is observed 3 years after insertion

reduction of edema. Muscle pull may play a role in implant migration. Injection of Botox may help to reduce the hyperfunction of mentalis muscle or masseter in acute postoperative time.

Bony Resorption

If chin implant over 6 mm is used to correct the problem, there is a high risk of bone resorption. Other factors include hyperfunction of mentalis muscle, lip incompetence, and narrow implant shape. However, likelihood and timing of bone resorption is highly unpredictable, and regular follow-up after chin implant is required. Removal of the implant is recommended as soon as possible if the remaining cortical bone is scarce. Osseous genioplasty is usually necessary after the removal (Fig. 12.8).

Discussion

Numerous alloplastic materials such as silicone, polytetrafluoroethylene, methyl methacrylate, Gore-Tex, and porous polyethylene are used for facial skeletal augmentation. Among them, solid silicone is the most commonly used material. It is easily carved with scissors or scalpel during the surgery. In addition, silicone implants are easily sterilized by steam or irradiation, and clinical or allergic reactions to silicone implants are rare. However, silicone implants have disadvantages such as resorption of underlying bone and formation of fibrous capsule that can be seen when placed under a thin soft tissue. Capsules, on the other hand, also have a positive effect that provides a vascularized protective barrier and enables implant removal without surrounding tissue damage if necessary. When fixed with screws, depth of screw fixation is critical to prevent tearing, loosening, and implant failure. Multiple screws are recommended.

Attention is rarely paid to the mentalis muscle during the chin surgery. However, hyperfunctioning mentalis may cause lump and active wrinkles and provides a source of dissatisfaction after implant surgery. Poorly repaired mentalis muscle may cause flattening in lower anterior surface of the chin. It may also cause the upward migration of implant.

Alloplastic implants are an effective tool for cosmetic improvement of the face. Alloplastic implants can reliably restore facial proportions and balance. For those who do not want aesthetic improvement through bone surgeries, this offers a shorter, simpler surgery with a quicker recovery time.

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Secondary and Revisional Mandibular Contouring Surgery

13

Tae Sung Lee and Jihyuck Lee

Pearls

1. More patients are willing to undergo a secondary mandibular contouring procedure due to dissatisfactory aesthetic results of the prior surgery.
2. Lack of a combined narrowing genioplasty procedure during mandibular contouring may cause a disproportionately broad chin. Additional chin narrowing surgery is required in such cases.
3. Excessive resection in the mandible angle region can result in an unnatural and hollow appearance. Implants may be used to correct the overly resected jaw contours.
4. Postoperative jawline asymmetry, irregular and uneven jaw contours and 'secondary angle' formation may result from technical faults during the surgery. Further bone contouring can improve these aesthetically unfavourable conditions.

Introduction

Mandibular contouring surgery, such as the angloplasty, is known to be the most commonly practiced procedure in facial contouring surgery especially among the Asian population [1, 2]. As the surgery gains its popularity recently, more patients are willing to undergo a secondary or revisional mandibular contouring surgery mainly because of the dissatisfactory aesthetic results of the prior surgery. These unfavourable results after a mandibular contouring surgery mainly occur because of failure to notice the importance of the balance between the chin and the rest of the mandible or the balance between the mandible and the whole face [3–6]. Such overlook in the facial harmony results in a disproportionately wide chin due to the lack of an accompanied narrowing genioplasty procedure or a hollow look in the lower face due to excessive resection of the mandibular angle. Technical faults during the surgery can also cause dissatisfactory surgical outcomes [1, 7, 8]. For example, asymmetry in the jaw contours or uneven and irregular jawlines and an unnatural and unsmooth jawline, namely, a 'secondary angle', can be formed after a mandibular contouring surgery [1, 4]. These conditions frequently need a secondary contouring surgery to correct such problems. Throughout the following texts, conditions that require an additional mandibular contouring surgery are explained by introducing actual clinical cases.

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S. Park (ed.), *Facial Bone Contouring Surgery*, DOI 10.1007/978-981-10-2726-0_13

Case Study

(A) Insufficient Narrowing Effects from the Frontal View

The most common reason for a secondary or revisional mandibular contouring surgery after a prior mandibular contouring surgery is dissatisfactory narrowing effects especially when seen from one's front [1, 2, 4, 6]. The main cause for these problems is the overlook on the importance of the chin. To achieve a slender, harmonic and well-balanced lower face, not only a conventional mandible angle reduction but also an accompanied chin narrowing procedure is required for patients especially with a broad chin. If a narrowing genioplasty is not done concomitantly in these cases, a disproportionately broad chin and poor narrowing effects will be resulted after the mandible reduction surgery. A 'mini V-line surgery' which includes a narrowing genioplasty followed by further reduction of the bony steps at the chin-mandible junction may be the solution in such cases [4].

Figures 13.1 and 13.2 show a patient who has underwent a secondary mandibular contouring surgery because of the insufficient narrowing effects from the frontal view. A 28-year-old female previously underwent a conventional mandibular angle reduction together with a reduction malarplasty procedure. However she was not satisfied with the lower face contour, as her chin was disproportionately broad looking after the prior surgery. She underwent a mini V-line surgery as the chin was narrowed by the T-osteotomy technique, and further reduction was made to smoothen the chin-mandibular junction. As seen in the postoperative radiographs and medical photographs, the broad chin was effectively reduced to result in a smooth and feminine facial contour.

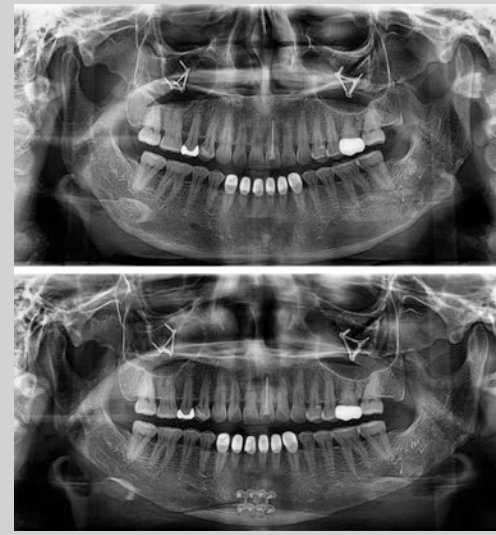

Fig. 13.1 Preoperative and postoperative panoramic radiograph of a 28-year-old female. The mandibular angles were reduced during the prior surgery. The remaining broadness in the chin region was further reduced by an additional mini V-line surgery

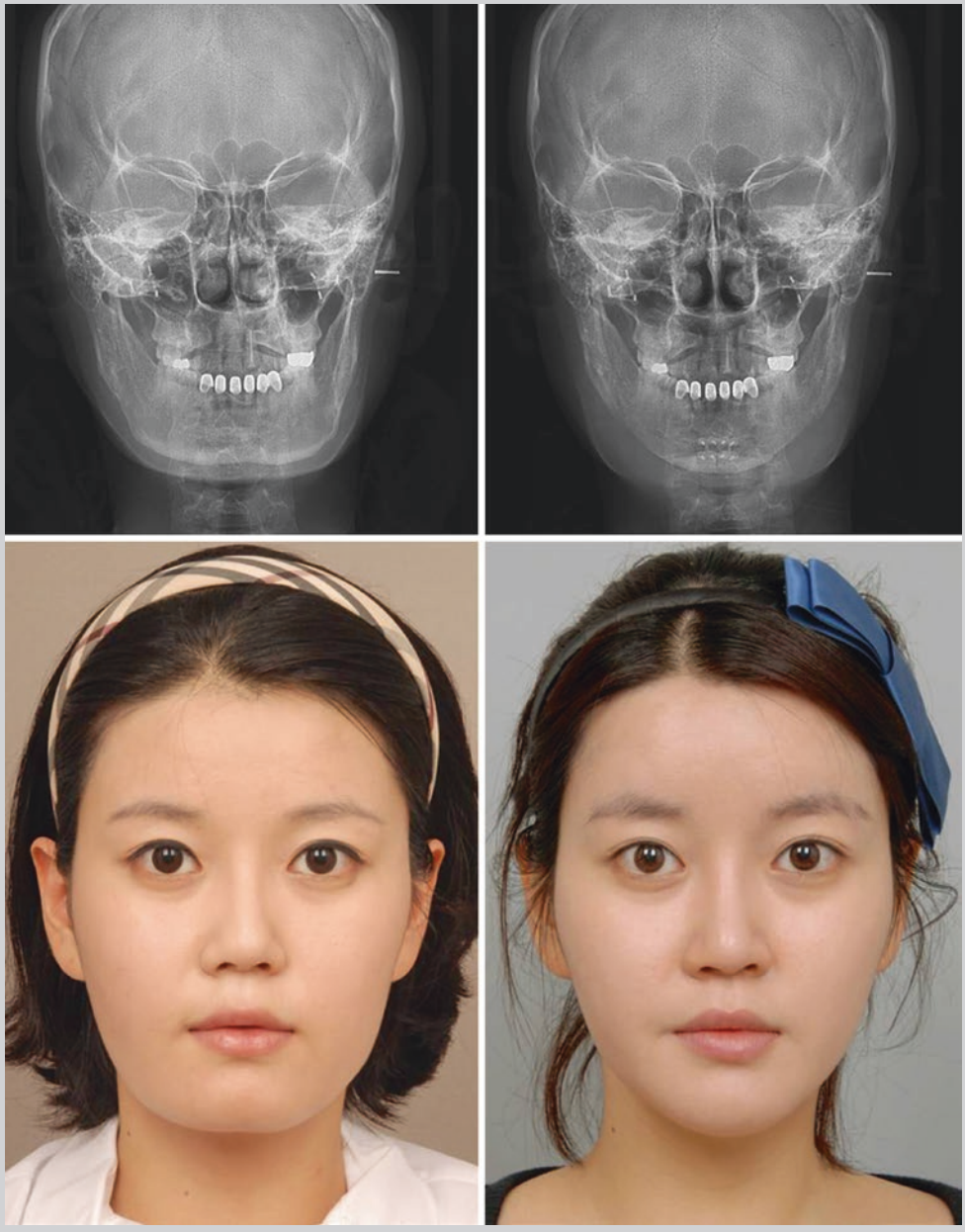

Fig. 13.2 Despite the previous surgery, a broad lower face contour was noticed. Six months after the mini V-line surgery, the broad chin was effectively reduced to result in a smooth and feminine facial contour

(B) Excessive Resection

Some patients and even some surgeons have the misconception that the narrowing effect is proportional to the amount of mandible reduction [2]. That is, some believe that if more amount of angular bone is resected, the more slimming effect will be expected. However, if the mandibular angle is excessively resected during the surgery, an unnatural or hollow lower face contour may be resulted. Also the balance between the chin and the rest of the mandible or between the lower face and the rest of the face will be lost. In some severe cases, an alloplastic implant should be inserted to the overly resected mandible site to restore its natural contour. Figure 13.3 shows examples of various ready-made Medpor® implants manufactured by Stryker® (Kalamazoo, MI, USA). Individually customized implants are also available recently.

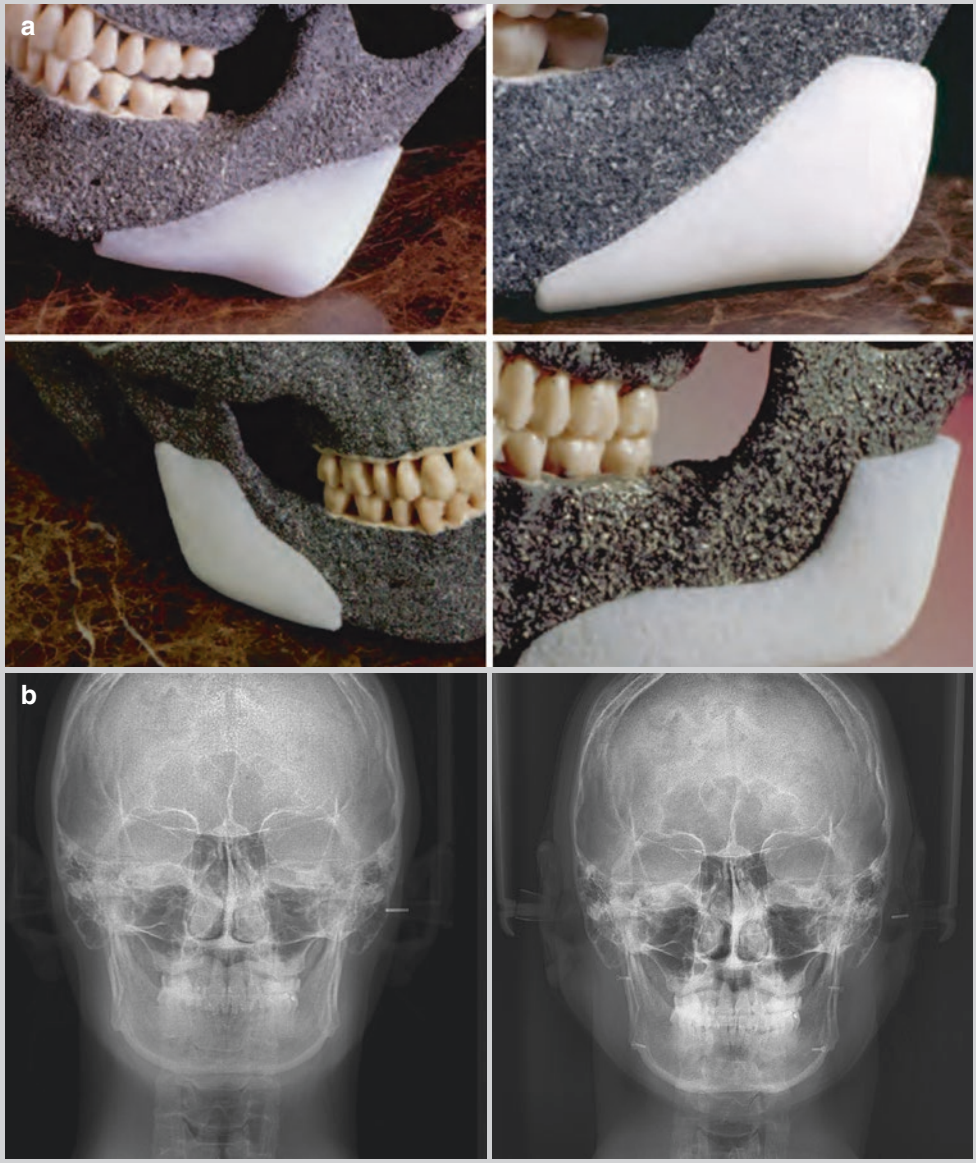

Fig. 13.3 Various ready-made Medpor® implants suited for the mandibular angle. (*Lower left*) preop x-ray, after insertion of medpor implant and fixation with screws

(C) Postoperative Secondary Angles

During a conventional mandibular angle reduction surgery, if the ostectomy is abruptly stopped somewhere in the middle of the mandible body, an unnatural and unsmooth jawline, namely, a 'secondary angle,' may form and result in an unaesthetic outcome. A long, smoothly curved ostectomy should have been performed to prevent this condition, as in some troublesome cases an additional bone contouring is required to smoothen the secondary angle. In some cases, a narrowing genioplasty may be accompanied with the procedure.

Figure 13.4 shows a 33-year-old female patient with a prior surgical history of a conventional mandibular angle reduction. As seen on the oblique view of the preoperative medical photographs, a secondary angle is formed in the middle of the mandibular body. This is caused by a short and straight-lined ostectomy that leaves an unnatural jawline. This postoperative secondary angle was improved by a secondary mandibular mini V-line surgery. As the chin was further narrowed with a T-osteotomy technique, the lower border of the mandibular body was further contoured and smoothened for a slim and smooth facial contour.

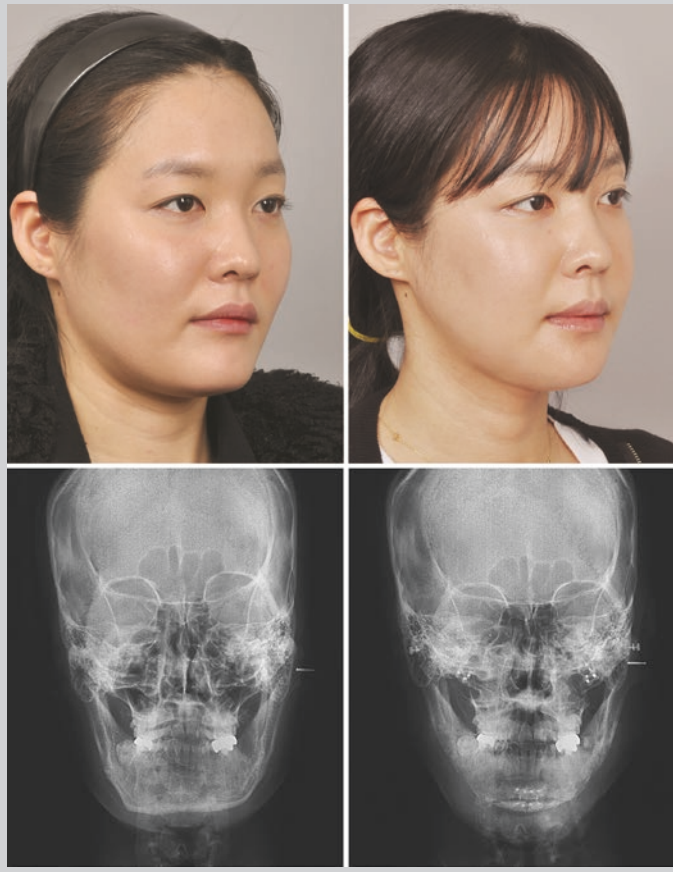

Fig. 13.4 A 33-year-old female patient with a prior surgical history of a conventional mandibular angle reduction. On the oblique view of the preoperative photographs, a secondary angle can be noticed in the middle of the mandibular body. The postoperative secondary angle was improved by a secondary mandibular mini V-line surgery

(D) Jawline Asymmetry

In patients with pre-existing jawline asymmetry, bone resection should be differentially carried out. However, if the asymmetry is failed to be noticed preoperatively, the resultant surgical outcome will also leave asymmetry. Or even in patients with a symmetric jawline, if the ostectomy procedure was carried out differentially, postoperative asymmetry and a dissatisfactory outcome will be resulted. Thorough preoperative analysis and accurate intraoperative procedures are required to avoid postoperative asymmetry, and differently sized 'guarded' oscillating saws can be helpful in such situations [1]. However, if a noticeable asymmetry is complained by the patient after a prior mandibular contouring surgery, a secondary bone contouring with or without a concomitant genioplasty should be carried out.

Figure 13.5 shows a 26-year-old female patient with a prior surgical history of the mandibular V-line surgery who visited the clinic because of a long and asymmetric chin. Six months after the first surgery, a revisional V-line surgery was carried out as the length of her chin was vertically reduced, and the asymmetric appearance was significantly improved.

Fig. 13.5 A 26-year-old female patient with a prior surgical history of the mandibular V-line surgery complained of a long and asymmetric chin. A revisional V-line surgery was carried out, and the chin was vertically reduced, and the asymmetry was significantly improved

(E) Irregular and Uneven Jawline

During a conventional mandibular angle reduction surgery, the bony resection should be precisely done in a uniform fashion. When performing the V-line surgery, the bony steps at the chin-mandible junction should be smoothened out. If these are not guaranteed during the mandible contouring surgery, the resultant jawlines will be irregular and uneven. The irregular bone contours may be noticeable externally and may be a reason for patient complaint. An additional bone contouring should be done to correct this contour irregularity, with an extra-caution by the surgeon on the path of the inferior alveolar nerve [1, 4].

Figures 13.6 and 13.7 show a 35-year-old female who underwent a two-jaw surgery and a concomitant mandibular V-line surgery. She complained on the irregular, uneven jawlines of the lower face contour. As the hardwares in the mandible were removed, further mandibular contouring was performed 1 year after the previous surgery. As seen on the postoperative panoramic radiograph and medical photographs, the lower face contours were smoothened.

Fig. 13.6 Preoperative and postoperative panoramic radiograph of a 35-year-old female. The irregular, uneven jawlines resulting from a prior two-jaw and V-line surgery were smoothened by a secondary mandibular contouring

Fig. 13.7 As seen on the oblique view of the preoperative medical photographs, the previous jaw surgery resulted in an irregular contour. After the secondary mandibular contouring surgery, the uneven jawlines were much smoothened, and a natural contour was achieved

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Soft Tissue Management in the Mandible Reduction Surgery

14

Jongwoo Lim

Pearls

1. Soft tissue management is very important because abundant soft tissue tend to be sagged after mandible reduction surgery. As a result, the effect of mandible contouring can be diminished.
2. We have applied various lifting procedures such as laser-assisted liposuction, absorbable barbed thread lifting, nonabsorbable elastic thread lifting, and face lift.
3. In practice, according to careful evaluation of the patients' soft tissue status, surgeon should choose the most suitable lifting procedures.
4. Laser-assisted liposuction cannot only improve contour by effective liposuction in the face and neck area but also facilitate more effective thread lifting by reducing the weight of soft tissue to be lifted. But caution is required because laser can cause thermal damage to important anatomic structures, such as the nerve, vessels, and salivary glands, and too much suction can cause surface irregularity.
5. Barbed thread lift is a minimally invasive lifting modality which is well known for its efficacy and limitations. It is easy to apply and absorbable materials cause less resistance from patients. But its early recurrence rate and minimal efficacy are main limitations of this procedure.
6. Elastic lift is a good alternative to barbed thread lift. Its advantages include longevity, elasticity, impalpability, and easy removal. But it also has limitations that some patients fear of nonabsorbable material placement, and it requires more time for surgeon to be skilled.

Introduction

The facial bone contouring surgeries may result in a slender, V-line facial skeleton; however, soft tissue problems such as cheek drooping and double chin often occur [1–3], due to reduced bony support and volume [1]. Thus, a correction for the soft tissue sagging after bony reduction surgery is frequently needed.

Patients who undergo facial bone contouring surgeries are usually young, sensitive to scars, have relatively good skin tension, and have abundant subcutaneous fat tissue. So they prefer minimally invasive procedures to invasive surgery such as a conventional face lift. The barbed suture lift has emerged as a minimally invasive procedure for facial rejuvenation and soft tissue ptosis correction [4–11]. However, the long-term effects of the barbed suture lift are doubted because of its early recurrence rates [12–14]. Laser-assisted liposuction is effective for facial contouring and facial rejuvenation [15–20].

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S. Park (ed.), *Facial Bone Contouring Surgery*, DOI 10.1007/978-981-10-2726-0_14

However, a laser-assisted liposuction is not the optimal solution for soft tissue sagging, because the lifting effect is too weak for soft tissue ptosis. Recently, a nonabsorbable thread lifting is gaining popularity because of the efficacy and durability. Because this lifting procedure uses elastic thread (Elasticum®, Korpo SRL, Genova, Italy), it is called "elastic lift."

We have tried many face lift procedures that were previously introduced to overcome soft tissue sagging problems after facial bone reduction surgery. Each procedure has advantages and disadvantages. By analyzing our previous treatment data, we came to know that the best result can be obtained by a combination of laser-assisted lipolysis and barbed suture lift or elastic lift. Fat tissue in the sagging soft tissue areas is removed with a 1444 nm Nd-YAG laser, and a secondary lift is promoted by collagen regeneration. In sequence, the barbed suture lift with 0–0 cogged PDO sutures or elastic lift is carried out to lift the soft tissue in a minimally invasive procedure.

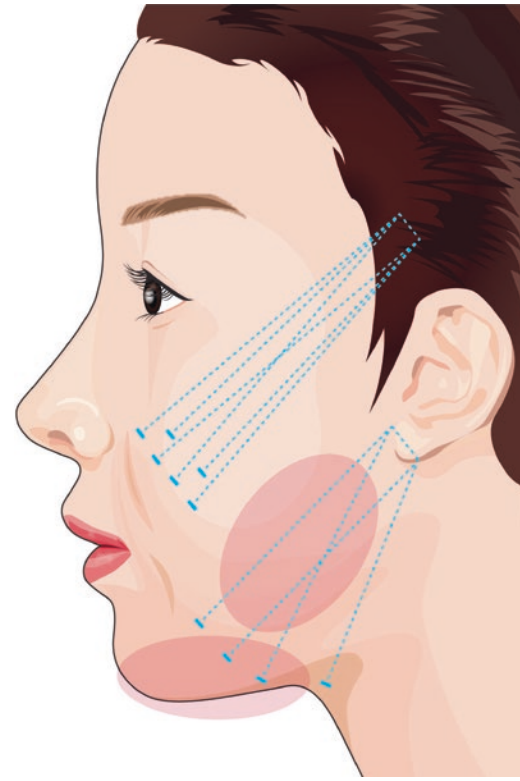

Fig. 14.1 Illustration of the laser-assisted liposuction and barbed thread lift. *Shaded area* indicates the major liposuction area, lower cheek and submental areas. *Dotted lines* indicate the course of barbed threads insertion. Note that the anchoring point for nasolabial fold and lower cheek is deep temporal fascia and Lore's fascia, respectively

Patient Assessment and Consultation

Patient assessment should be performed in an upright sitting position before the surgery because once the patient lies on a bed, soft tissue distribution is changed. Then, we marked fat removal area, the soft tissue sagging area, and lifting design on the patient's face (Fig. 14.1).

Fat removal areas are mainly cheek and submental area. Excessive fat on the jowl and cheek makes the marionette line and nasolabial fold deeper after mandible reduction and malar reduction surgery. Excessive fat on the submental area can make double chin appearance and can be worsen after genioplasty, especially vertical reduction and/or narrowing procedures.

Soft tissue sagging areas are mainly jowl, cheek, and submandibular area. After facial bone contouring surgery, previous sagging tends to worsen, and new sagging can occur because facial bone is reduced and soft tissue is extensively elevated during dissection.

The major predictive factors of high risk of sagging after mandible reduction surgery are as follows. First, abundant soft tissue of cheek area can cause sagging due to heavy weight. Second, loose skin elasticity especially in the aged patients can also cause sagging. Therefore, the indications for lifting procedures when performing mandible reduction surgery include excessive soft tissue weight of cheek area, loose skin elasticity, old age (>40 years), long face, or class II profile.

In case there is one of the high-risk factors, the surgeon should consider simultaneous lifting procedures with mandible reduction surgery. Whether performing simultaneous lifting procedures with facial bone contouring surgery or performing lifting procedures with intervals after bone surgery depends on the possibility of drooping, patients' age, preference, economic status, etc. When lifting procedures are performed simultaneously with facial bone contouring surgery, the surgeon should be cautious in order not

to violate the bone surgery layers, which may increase the risks of subcutaneous infection.

Surgical Techniques

Laser-Assisted Liposuction

The surgery was conducted with local anesthesia and propofol sedation. The two holes for inserting the canula in the chin area were made with an 18 gauge needle. A tumescent agent composed of 0.5% lidocaine and epinephrine was injected into the fat removal area with an 18 gauge canula. Usually 5–10 cc of tumescent fluid was injected into the cheek and chin area, and the laser canula was inserted. The 1444 nm Nd-YAG laser (AccuSculpt; Lutronic, Goyang, Korea) was used on multilayers for laser lipolysis such as the subdermis and superficial subcutaneous and deep subcutaneous layers. Usually, 500–800 J of energy was shot into one side of the cheek, and 500–1000 J was shot into the chin area. After the laser treatment, cold wet gauze was applied to prevent thermal damage. Then, liposuction was done with a 16 gauge canula. Liposuction was possible with the 16 gauge canula because fatty tissue was crushed into pieces by the laser. Liposuction was stopped when adequate reduction in fat thickness was achieved. Suction volume was usually the same or double the tumescent volume, ranging 10–20 cc. After liposuction, the canula insertion site was closed with 6–0 nylon. The sutures were removed 7 days after the surgery.

Barbed Suture Lift

The barbed suture lift was carried out with 0–0 bidirectional cogged polydioxanone sutures. The barbed sutures were anchored under the deep temporal fascia and tympanoparotid fascia using Owl. Then, each end of the barbed suture was reinserted with a straight canula into the area to be lifted such as the paranasal and chin areas (Fig. 14.1). The barbed sutures were passed into the deep subcutaneous layer, which is immediately above the superficial musculoaponeurotic system area that we wanted to pull up. Usually, 6–10 threads were inserted into each cheek and anchored to the deep temporal fascia. Four to six threads were inserted to improve cheek drooping and deep nasolabial folds, and 2–4 threads were inserted to improve the jowl. The exposed threads were removed with pulling of the soft tissue to prevent postoperative thread exposure. Then, the skin was stretched to prevent dimpling with the patient in the sitting-up position. Dimpling was not detected well in the supine position, so checking this aspect in the sitting-up position is important. After all procedures were completed, elastic bandages were applied to the neck and cheek area to sustain the effect of the lift and to prevent swelling. The bandages and sutures were removed on postoperative 3 days and 7 days, respectively.

Elastic Lift

The most important thing in our elastic lift is exit point and thread returning point. Firstly, draw around the soft tissue bulge in the cheek; secondly, mark the point of maximal bulging. Thirdly, mark the exit point distal to the maximal bulge, keeping in mind the depth of subcutaneous needle penetration and direction of pull.

The elastic lifting procedures were performed under conscious sedation in isolated cases and under general anesthesia in simultaneous cases with facial bone contouring surgeries. The incision sites at both scalps were infiltrated with 2% lidocaine and 1:100,000 epinephrine. Two vertical stab incisions are made with No.15 blade at the level of the highest point of the ear helix. Then a sharp mosquito was used to dissect down deep to the temporal fascia. An Owl was used to anchor an elastic thread at the deep temporal fascia. The free-end of the elastic thread was pinched with a mosquito to prevent it from pulling inside. Then the Jano needle® was inserted through the incision site opposite to the free-end. The needle was passed through the deep subcutaneous tissue plane and exits at target point. It is important not to pull out the needle entirely. There are five depth marks on the needle at each interval of 5 mm. So, the surgeon can adjust the distance from the needle exit site to the tissue which was actually to be lifted. The

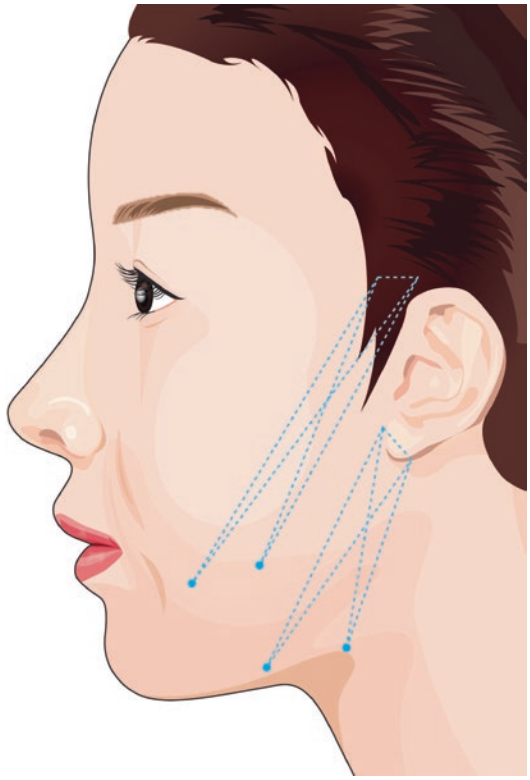

Fig. 14.2 Illustration of the elastic lift procedure

needle was pulled out until the last one or two depth marks were shown, and the elastic thread was pulled through the needle exit site as much as possible. Then the needle was rotated toward the incision site bearing the free-end. The needle was passed through the deep subcutaneous layer with the posterior tip now becoming anterior and pulled out completely at the incision site of the free-end. Now, the surgeon should evaluate if lifting layer was appropriate and lifting didn't cause any dimpling, depression, or soft tissue bunching by pulling the elastic thread with adequate power. The elastic thread was knotted under tension and placed deeply in order not to be exposed. The same procedure was carried from the opposite incision site with opposite direction use of Owl. The two-stab incisions were sutured with No. 4–0 nylon (Fig. 14.2).

Key Technical Points

1. Laser-assisted liposuction requires great care not to damage normal anatomic structures such as the marginal mandibular nerve, facial vessels, and salivary gland. To avoid such damages, the surgeon must respect anatomy and should not give too much energy around the important structures. Also, too much suction can cause excessive swelling, bleeding, and inflammation rarely. So, appropriate target amount of suction is important. If suction amount is too much, depression or surface irregularity can occur.
2. Barbed thread lift requires insertion of thread in appropriate layers. If insertion is too superficial, the barb can be palpated from the skin and can cause dimple especially in thin skin patients. In case of simultaneous lifting with facial bone contouring surgery, the surgeon should pay attention not to insert the thread too deeply under dissected plane because it can cause infection.
3. Elastic lift requires careful selection of target points to be lifted. The insertion plane is very important for maximal effect and avoidance of side effect such as dimple, depression, and soft tissue bunching. Because the Jano needle has bidirectional sharp tips, the surgeon should advance the needle gently to prevent bleeding and bruising. Finally, control of the traction force and tie is the most important factor for the successful lifting.

Case Study

Case 1

A 34-year-old woman visited the clinic for the V-line surgery to achieve a more slender face. But she had risk factors of soft tissue sagging after mandible reduction surgery, such as abundant soft tissue on the cheek and loose skin tension. Therefore, laser-assisted liposuction and barbed thread lifting were done simultaneously with the V-line surgery. The amount of aspirate was 12 cc on each cheek and 10 cc on submental area, so a total of 34 cc. Then, barbed thread lifting was performed, four threads on each side. After 2 months, the patient was satisfied with the V-line face (Fig. 14.3).

Fig. 14.3 A 34-year-old patient with history of mandible reduction operation 18 months ago. (**a**) Before the V3 lift procedure, (**b**) 1 month after the V3 lift procedure

Case 2

A 38-year-old woman with a surgical history of a conventional mandible angle reduction complained of the jowl and deep nasolabial folds. Elastic lifting was performed for the improvement of jowl and nasolabial folds. After 2 months, the patient was satisfied with the youthful appearance (Fig. 14.4).

Fig. 14.4 A 38-year-old patient who underwent mandible reduction operation complains of jowl and deep nasolabial fold. (**a**) Before the Elastic lift, (**b**) 1 month after the elastic lift

Complications and Management

Skin Depression

Both barbed thread and elastic thread can cause dimpling or depression. Too superficial placement of barbed thread and too narrow interval from the exit site to the end of remaining barbed thread can cause dimpling. The surgeon can prevent by insertion of thread in appropriate layers and cut away enough amount of the barbed thread end from the exit sites. In case dimpling already happened, gentle massage can solve the problem in most cases, but sometimes removal of barbed thread was the only way as a last resort. Elastic thread causes less dimpling because it has no barb on the surface. But too much traction force can make dimpling or depression at the target lifting site. The surgeon can avoid this complication by control of traction force and checking the result in a sitting position. In case dimpling or depression happens in elastic lifting, massage has little effect. Thus, removal of elastic thread is the only solution for these cases.

Neurapraxia

Although neurapraxia or nerve palsy happens extremely rare, its consequence might be significant. Laser-assisted liposuction gives much energy to subcutaneous plane. So, the marginal mandibular branch of the facial nerve can be damaged by the thermal energy. The patient who damaged his/her facial nerve can complain of lip twisting and the mouth corner pulled toward unaffected sides. Barbed thread lifting and elastic lifting can cause frontal nerve palsy because the canula and the needle passed through the dangerous area between the ear and eyebrows. When using Owl around the Lore's fascia, the thread could encircle some branch of the facial nerve, resulting in transient weakness of facial muscle expressions.

Conservative management with intravenous or oral steroid administration was enough to solve transient neurapraxia. In case of severe asymmetry, botulinum toxin injection on the unaffected side can help. There was no permanent paralysis in a 6-month follow-up.

Infection

In case of simultaneous procedures with facial bone contouring surgery, infection can happen because intraoral space might be connected with subcutaneous plane. The surgeon can prevent infection by paying more attention to stay in appropriate subcutaneous layer not to violate the elevated supraperiosteal plane when performing laser-assisted liposuction, barbed thread lifting, and elastic lifting. In case infection happens, the patient's symptoms are pain, heating sense, and signs which include redness, overswelling, and fluctuation due to fluid collection. The management of infection is very difficult because of its extensive territories. Intravenous antibiotics and conservative management are enough in mild infection, but surgical approaches including debridement and irrigation were required in severe cases.

Discussion

Patients with a significant amount of soft tissue in the face would get minimal changes by facial bone contouring surgery alone, because the fatty layer and hypertrophic muscle conceal the effect of facial contouring surgery. Bone contouring surgery alone is not effective to create an oval-shaped slender face in obese patients. Additionally, facial bone contouring surgery can cause soft tissue problems. One of the major concerns regarding reduction malarplasty is cheek drooping [1–3]. When the size of the supporting structure that holds the overlying tissue decreases, the overlying soft tissue drops due to gravity. Loss of connecting bony cutaneous ligaments may also contribute to the sagging after facial bone surgery. Limited dissection is advised

especially in high-risk patients. Cheek drooping also accentuates nasolabial folds. Angle reduction and orthognathic surgery can also cause soft tissue drooping such as cheek drooping along the mandible border and double chin.

We applied various lift procedures to overcome these soft tissue problems, which is a combined technique with a laser-assisted liposuction and barbed suture lift or elastic lift.

Conventional liposuction is ineffective in the face because the amount of fat is much smaller than body area such as the abdomen or thigh. Furthermore, the fatty layer is very thin and dense. Laser-assisted liposuction is effective in the face because even small amount of fat can be suctioned easily after being melted by laser, thus reducing the risk of contour irregularity mainly caused by repetitive throw of suction canula and uneven suctioning.

Laser-assisted lipolysis was first described in the 1990s by Apfelberg [15]. It has many advantages, including less bleeding, pain, recovery time, and tissue damage than those of conventional liposuction. In addition, laser lipolysis has a skin tightening effect by heating the dermal and subdermal tissues and removing fat tissue [16]. Heating of the deep dermis induces an inflammatory reaction. This leads to the creation of new collagen and elastin fibers and consequent skin tightening [16, 17]. The 1064-nm Nd:YAG laser has been the primary wavelength used for lipolytic purposes, and numerous studies have demonstrated its usefulness [18–20]. However, the 1444 nm Nd:YAG laser appears to have more than ten times the fat absorption rate than the 1064 nm wavelength Nd:YAG laser [21, 22]. Its high affinity for fat provides greater thermal confinement and reduces damage to surrounding tissues. The 1444 nm laser is a more effective and safe laser for laser lipolysis [21–24]. Laser-assisted facial contouring with a 1444 nm Nd:YAG laser improves the facial contour as a single modality as well as when combined with facial contouring surgical procedures [25, 26].

In our patients, we used the barbed suture lift in combination with laser-assisted liposuction. The barbed suture lift supplements the weak lift effect of laser-assisted facial rejuvenation, and laser lipolysis reduces the soft tissue burden in an obese and fatty face, which is difficult to lift using the thread lift alone by removing fatty tissue and skin rejuvenation with collagen regeneration. We call this lift procedure the V3 lift. V3 means that three layers (skin, fat, and muscle) are lifted to create a V-line face. The main purpose of laser-assisted liposuction is to reduce the volume of fatty soft tissue in the lower face. Additionally, a skin tightening effect is achieved with laser rejuvenation, because the laser stimulates collagen fiber fibrosis and reorganization. Then, the barbed sutures can lift the lighted soft tissue easily. Thus, after reducing the fat, which is a burden to lifting procedures, the lifting will be easier and more effective than without liposuction. Additionally, muscles that pull down the soft tissue became weakened after bone surgery, and the lifting is more effective.

The barbed suture lift is an effective minimally invasive procedure for an aging face and sagging of soft tissue [4–8]. It is useful to correct facial aging and soft tissue ptosis with limited scarring, rapid recovery, minimal complications, and less cost than those of standard rhytidectomy [9–11]. However, some reports criticize the use of the barbed suture lift because it provides only limited short-term improvement that may be largely attributed to post-procedural edema and inflammation [12–14]. Those studies also reported complications from the barbed suture lift such as pain, dimpling, visible threads, foreign body reactions, and a high rate of revision surgery. Nevertheless, the barbed suture lift is an attractive tool for facial rejuvenation and soft tissue sagging. The barbed suture lift has overcome complications and achieves superior results compared to a facial lift due to improvements in technical skill and suture materials. In particular, conventional face lift surgery is too invasive for young patients who have soft tissue ptosis such as cheek drooping and a jowl caused by facial bone contouring surgery. Furthermore, a conventional face lift produces inevitable problems such as preauricular scar.

A barbed suture was first introduced internationally in 1999 as Aptos threads and was used for elevating soft tissues of an aging face [5, 6].

These 2–0 polypropylene sutures have bidirectional barbs, and the ends of the suture are anchored in the dermis. In 2005, Lee and Isse modified Sulamanidze's Aptos suture [7]. The Isse Endo Progressive Face Lift suture was designed to be anchored in the temporalis fascia and, thus, to provide more load-bearing potential. In 2005, barbed sutures received approval from the US FDA in 2005 for lifting ptotic skin of the face and neck and were marketed as contour threads [8, 9]. Then, Angiotech Pharmaceuticals, Inc. launched the Quill Suture Retained Suspension (SRS) in January 2007. The Quill SRS suture is a bidirectional barbed suture that is available as nonabsorbable polypropylene and absorbable monoderm and polydioxanone [27, 28].

We used the 0–0 bidirectional barbed absorbable PDO suture (Quill SRS suture). In our patients, the suture material was anchored to the temporal fascia and tympanoparotid fascia (Lore's fascia). The barbed sutures were anchored to the fascia with a hooking maneuver, which sustains more power to lift the soft tissue. The temporal and Lore's fascia is the most effective fascia for anchoring and sustaining the thread lift.

Elastic lift has four advantages over barbed thread lift. First, elastic lifting can give more long-term elevation effect than absorbable barbed threads. The polyester surface of nonabsorbable elastic thread is not barbed but braided. Huggins et al. reported that the connective tissue that continues into the interstices of the braided suture has characteristics of a ligament [29]. Second, elastic thread has elasticity that gives more natural lifting effect in resting and dynamic stage. Make sure that elastic thread is pulled not too tight at the time of making a knot. Immediate postoperative appearance is much more natural than rigid barbed suture lifting. Third, the elastic thread is impalpable because it has the same consistency with soft tissue and it has no barb. Fourth, when removal of the elastic thread is required, elastic thread can easily be removed because the core of nonabsorbable thread is silicon that does not cause adhesion with surrounding connective tissues.

But elastic lift has also some limitations. First, many patients fear about the placement of nonabsorbable materials in their faces. Second, it takes time for the surgeon to learn about the insertion layers, traction force control, etc. Third, it has less data about the long-term effect and complication than barbed thread lift.

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Part III

Midface

The Aesthetic Midface Analysis: Diagnosis and Surgical Planning

15

Seungil Chung and Sanghoon Park

Pearls

1. Prominent high cheekbones are regarded as attractive and youthful by Western standards of beauty. However, they considered as less attractive by Asians as it gives a strong and aggressive impression. To attain a more slender and smooth midfacial contour, reduction malarplasty is commonly performed among Asians.
2. The successful correction of prominent zygoma first requires the identification and classification of the wide variety of the shape of cheekbone and then followed by appropriate application of surgical technique according to the subtype of zygomatic prominence as all patients have different degrees of protrusion and morphology of the zygomatic bone.
3. Based on the distinct features of several morphologic subcomponents, the prominent zygoma can be classified into six types and five types of corresponding surgical techniques including I-, L-, and high L-osteotomy combined with reduction of external orbital rim and tripod osteotomy.
4. In addition to the standard technique using L-shaped osteotomy via intraoral and preauricular approach, further refinements such as high L-shaped osteotomy and inferolateral orbital rim reduction through periocular access allow us to prevent the potential for complaints with aesthetic consequences of remaining prominence of orbital rim.
5. Critical factors including bizygomatic width, volume, and position of zygomatic body should be thoroughly evaluated. Also the new position of the point of maximal malar projection carefully planned because the zygomatic body and arch usually moves medially, posteriorly, and sometimes superiorly.
6. The thickness of overlying soft tissues including skin, subcutaneous fat, muscles, and buccal fat should be evaluated. In the patient with thin skin and minimal cheek fat, the operative results are obvious and postoperative soft tissue drooping is minimal. On the other hand, if the patient has thick skin with abundant fat, the effect is less obvious, and cheek drooping is more probable. This patient should be informed about the possibility of cheek drooping and appropriate adjunctive measures.
7. The following factors are considered high risk for skin and soft tissue sagging: (1) over 40 years of age, (2) abundant cheek fat, (3) thin skin and skin laxity, (4) class II mandible or ill-defined mandible-neck line, and (5) deep nasolabial fold or jowl.
8. Reduction malarplasty can be performed solely or in combination with mandible reduction, genioplasty, or forehead augmentation.

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S. Park (ed.), *Facial Bone Contouring Surgery*, DOI 10.1007/978-981-10-2726-0_15

Introduction

For the past three decades, various types of reduction malarplasty methods have been introduced. According to the surgical approach, main reduction techniques range from the least invasive mini-zygoma reduction through intraoral or Gillies' approach with or without preauricular approach, standard zygoma reduction using an intraoral and preauricular approach, to the most aggressive coronal approach [1–5]. Of those, current trends are advocating L-shaped osteotomy and repositioning of the osteotomized malar complex via intraoral and preauricular approach (hereafter referred to as "standard reduction malarplasty") as more effective for correcting a prominent zygoma [6–9].

In general, the standard zygoma reduction is very effective and overall outcomes are reasonably satisfying. However, some patients may be dissatisfied and would request further improvements through more complicated operations even though surgical and technical issues are absent. This is because of inappropriate application of surgical techniques without considering the individual differences of degrees and locations of the protrusion (Fig. 15.1).

Therefore, in order to meet the patients' demands, different strategies are needed according to the subtype of the zygomatic prominence as all patients have different degrees of protrusion and morphology of the zygomatic bone. In this article, detailed description of the subtype of the zygomatic prominence and its corresponding surgical techniques are presented.

Patient Consultation and Assessment

Preoperative assessment should include a history of previous malar contouring procedures, including autologous fat injection, filler injection, or alloplastic implant placement such as silicone or Medpor®. Especially, patients with prior history of fat or filler injection are more likely to have greater chance of cheek drooping. In addition, special care should be taken not to neglect the inflammatory conditions such as sinusitis or periodontal disease. This is because such conditions can be exacerbated by surgery and are therefore best treated prior to surgery. The degree of eye prominence should also be examined prior to surgery, as this can influence the optimal reduction of protruding inferolateral orbital rim. In particular, patients with enopthalmic eyeballs are at risk for undercorrection and should be considered for sufficient reduction of external orbital rim.

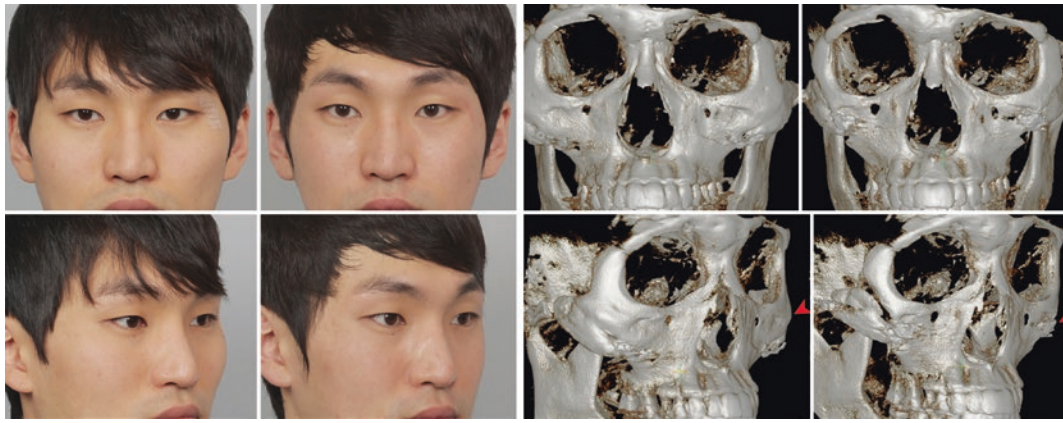


Fig. 15.1 An example of unfavorable results after standard reduction malarplasty. A 27-year-old male showing under-corrected prominent cheekbone, which was treated by conventional L-shaped osteotomy technique. (*Left*) Preoperative view, (*Right*) 3 months after reoperation

Preoperative Analysis

The evaluation of the malar area is somewhat hindered by a lack of anthropometric or cephalometric landmarks along its complex three-dimensional curvature [10]. The point zygion (Fig. 15.4, point Zy), which defines the maximum interzygomatic distance (zygion-zygion), does not correspond to the area of maximum malar prominence (area mmp). Malar contouring involves not only the zygomatic region but also the periorbital region. Pitfalls can be avoided if one is conscious about these relationships. Evaluation should include the three basic views: frontal, three-quarter oblique, and basal. Direct physical examination is the key process to evaluate the patient's problems and establish a surgical plan. Clinical photos are necessary as is radiologic examination including frontal view, lateral view, submentovertex view, and Waters' view. CT scan with 3D view is also essential to evaluate the shape of the zygomatic complex.

Frontal Evaluation

The frontal evaluation can be simplified by visualizing an anterior and posterior facial plane. The anterior facial plane is defined by the superior temporal line, lateral border of the lateral orbital rim, malar prominence, midface, and mentum (Fig. 15.2, blue line). The posterior facial plane is circumscribed by the contour line of the head (Fig. 15.2, red line). A combination of variable forms of these two planes defines a variety of facial shapes. In the case where the cheekbones protrude outwardly, the facial line connecting the temple-zygoma-cheek-mandible angle constitutes a very convoluted line (Fig. 15.2). Volume and position of zygomatic body and bizygomatic width are key variables to be considered. The volume of zygomatic body determines the amount of ostectomy during the surgery. If the volume of zygomatic body is large, wider resection of zygomatic body is planned. However, overzealous reduction results in flat or deficient look. Therefore, keeping the adequate volume of zygomatic body in anteroposterior dimension and transverse plane is essential. The position of zygomatic body is measured in both, its most lateral margin and in its maximal projection. Outer margin of zygomatic body is observed in conjunction with temple and cheek. To narrow the anterior midfacial width, lateral margin of cheekbone should be trimmed or moved inward. If the outer margin of cheekbone is placed wide, the amount of narrowing and medialization should be maximized, and ostectomy should be combined.

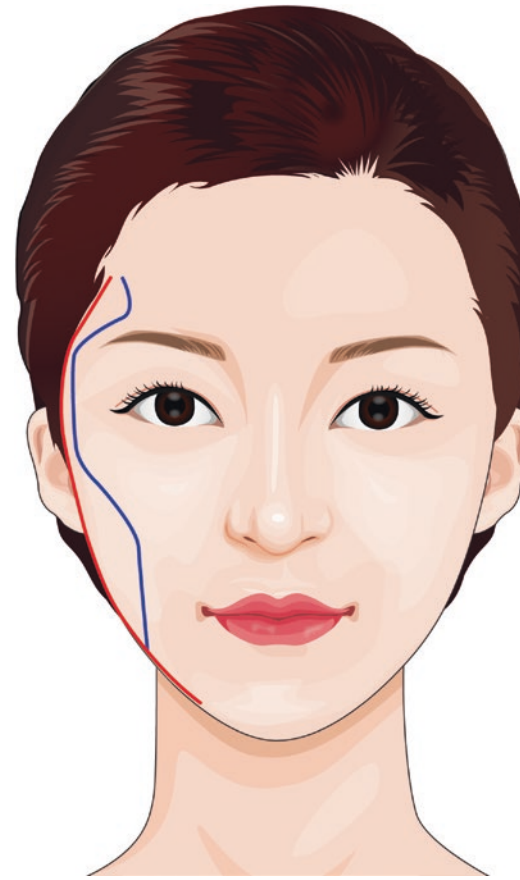


Fig. 15.2 Anterior and posterior facial contour lines. The anterior facial contour line connects the temple, zygomatic body, cheek, and mandible body (*blue line*), while the posterior facial contour line connects the temple, zygomatic arch, mandible angle, and chin (*red line*). If the anterior contour line is too convoluted, the patient gives a "strong," "offensive," "old," "tired," "masculine" impression. The posterior contour line reflects the facial width and facial size

The point of maximal malar projection (MMP) is the point where the outer contour of the zygomatic complex protrudes mostly in basal three-quarter view. If the reduction of zygomatic body is performed by shaving, or osteotomy is placed lateral to MMP, this point stays unchanged while outer margin of zygomatic body being narrowed, resulting in unnatural, boxy shape cheekbone. As stated before, the purpose of reduction malarplasty is not resection of projection; therefore adequate projection and position of maximal malar projection is the key in postoperative result. The point of maximal malar projection is marked, and the surgeon decides where to move this point three-dimensionally. The amount of medial repositioning and ostectomy is closely related to the reduction of anterior facial width. Ideal position of MMP may vary in different ethnicities; however, the following lists two simple methods of determining the ideal position of MMP (Fig. 15.3).

Hinderer Analysis

The MMP is determined at the point of intersection of two lines, where the first line connects the lateral canthus and oral commissure and the second line connects the nasal alar base and the

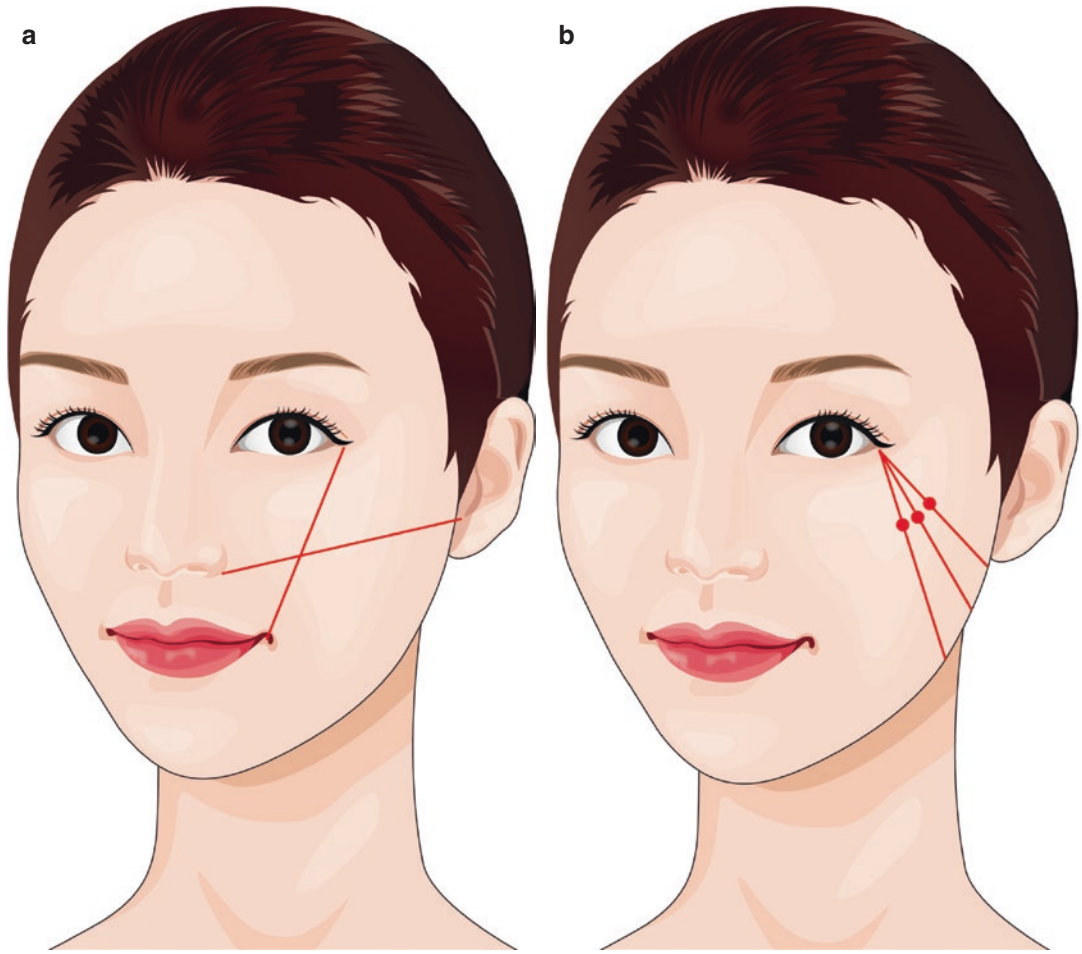


Fig. 15.3 Determining the ideal position of the maximal malar projection (MMP). (**a**) Hinderer analysis. (**b**) Wilkinson analysis

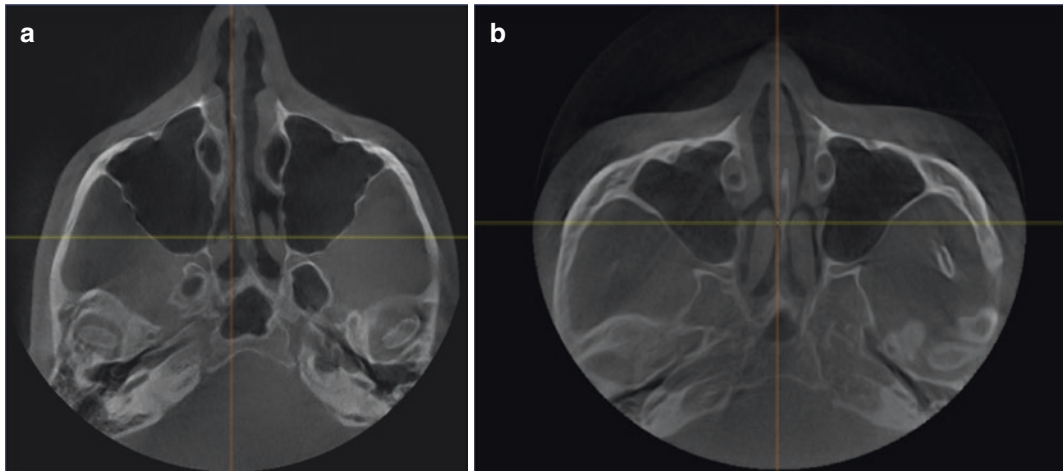


Fig. 15.4 Bony facial morphology at the level of the cheekbone in axial section. Compare the (**a**) dolichocephalic Caucasian face and the (**b**) brachycephalic Asian face

tragus line. The new location is a point placed in juxtaposition to the crossed lines in the upper-outer quadrant [11].

Wilkinson Analysis

A line is dropped vertically downward from the lateral canthus to the inferior border of the mandible. The MMP is located at one-third the distance from the lateral canthus to the angle of mandible [12].

Three-Quarter Oblique Evaluation

Malar eminence is clearest in the oblique view at approximately 34° from the sagittal plane. Therefore, several morphologic subcomponents of 45° cheekbone can be identified, which include convexity (degree and location of protrusion) of the zygomatic body and arch, innominate semi-horizontal groove between orbital rim and malar prominence (hereafter referred to as "orbito-malar groove"), and protrusion of inferolateral orbital rim, location of MMP (maximal malar point).

Basal Evaluation

In general, Asian faces have a brachyfacial characteristic with a flat suborbital area. When viewed from below, the lack of projection in the suborbital area and protruding zygomatic arch may form a 90° angle that looks boxy in appearance (Fig. 15.4). In this case, the face appears flat and one-dimensional, which makes the face appear even wider. Therefore, change in the shape and position of the zygomatic body is needed to create a midface fullness that appears more three-dimensional and youthful. This view helps in evaluating symmetry and also facilitates evaluation of the zygomatic arch.

Surgical Plannings

Basic Concept and Strategy

Once the surgical variables for the zygomatic body are evaluated, the bizygomatic width is measured, and the required amount of arch medialization which is critical in reduction of posterior facial width should be decided. The posterior basal portion of the arch, which is posterior to the osteotomy, cannot be medialized and should be carefully shaved to prevent visible step. Too much arch reduction with the remaining zygomatic body will result in a flat boxy face. In order to avoid this outcome and create full midface contour, the reduction of

zygomatic body and arch should be coordinated and balanced.

Variables of zygomatic body are (1) amount of ostectomy, (2) amount of medialization, (3) amount of setback, and (4) superior or inferior positioning. Variables of zygomatic arch are amount of arch medialization and shaving quantity of posterior area of articular tubercle [8] (Fig. 15.5).

Advanced Concept and Strategy: Classification of Zygomatic Prominence and Selection of Surgical Techniques

Based on the three-quarter oblique zygoma with several morphologic subcomponents, the prominent cheekbone is classified into five subtypes:

Type 1. Increased zygomatic arch width
Type 2. Protrusion of zygomatic body and arch
- 2A. Prominent zygomatic body below orbito-malar groove
- 2B. Broad and convex zygomatic body
- 2C. Combined with orbital rim protrusion (a: localized, b: extensive)

Type 3. Flat square face

The prevalence of the zygoma subtypes and its corresponding surgical technique are as follows. The six groups were named from type 1 to 3 representing 16.2% for type 1, 16.0% for type 2A, 34.4% for type 2B, 30.6% for type 2C, and 2.8% for type 3, respectively (Fig. 15.6). Patients' cheekbone is classified into one of the six subtypes, and then their appropriate surgical technique is determined by considering abovementioned key variables of the zygomatic body and arch (Fig. 15.7).

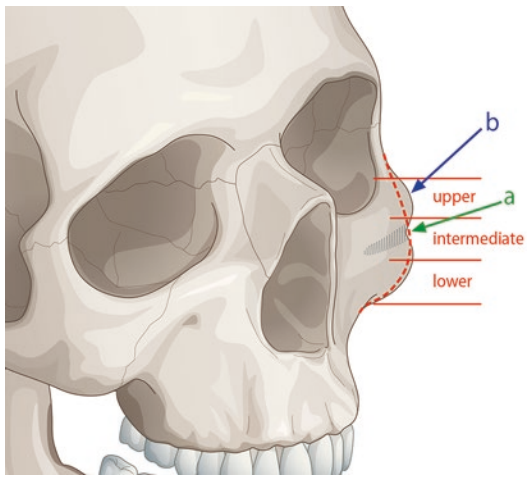


Fig. 15.5 Morphological subcomponents for classification are as follows: location of convexity of the zygomatic body (upper, intermediate, lower) orbito-malar groove (*a*), and protrusion of inferolateral orbital rim (*b*), location of MMP (maximal malar point)

The corresponding surgical techniques are as follows:

Type 1. Mini-zygoma reduction
Type 2.
- 2A. Standard L-shaped osteotomy
- 2B. High L-shaped osteotomy
- 2Ca. High L-shaped osteotomy with orbital rim shaving
- 2Cb. High L-shaped osteotomy with tripod osteotomy

Type 3. Minimal anterior repositioning with anterior augmentation.

Additional Considering Points

Soft Tissue Contribution

Facial soft tissue plays an important aesthetic component in zygoma reduction and should be considered before and during the surgery. If the patient has thin fair skin with minimal cheek fat, the changes after bone surgery are obvious, and the chance of soft tissue drooping is minimal. This patient is a good candidate for zygoma reduction. However, bony step, especially around the orbit, may be visible, and plate may be palpable through the thin skin. Surgeons should take extra effort to ensure smooth transition between bony osteotomy. If the patient has abundant cheek soft tissue, or thick skin, there is a high risk of cheek drooping. The patient should be informed about the possibility of cheek drooping and appropriate adjunctive measures, including liposuction or lifting procedures. The zygomatic appears to be much more prominent due to the presence of abundant muscular and adipose tissues in the malar area which tends to accentuate its prominence. Therefore overcorrection is advocated. If the patient has a thick malar fat pad, the zygomatic body should be slightly overcorrected to prevent undercorrection. For those over 35, facial soft tissue decreases, and skin starts to droop; malar

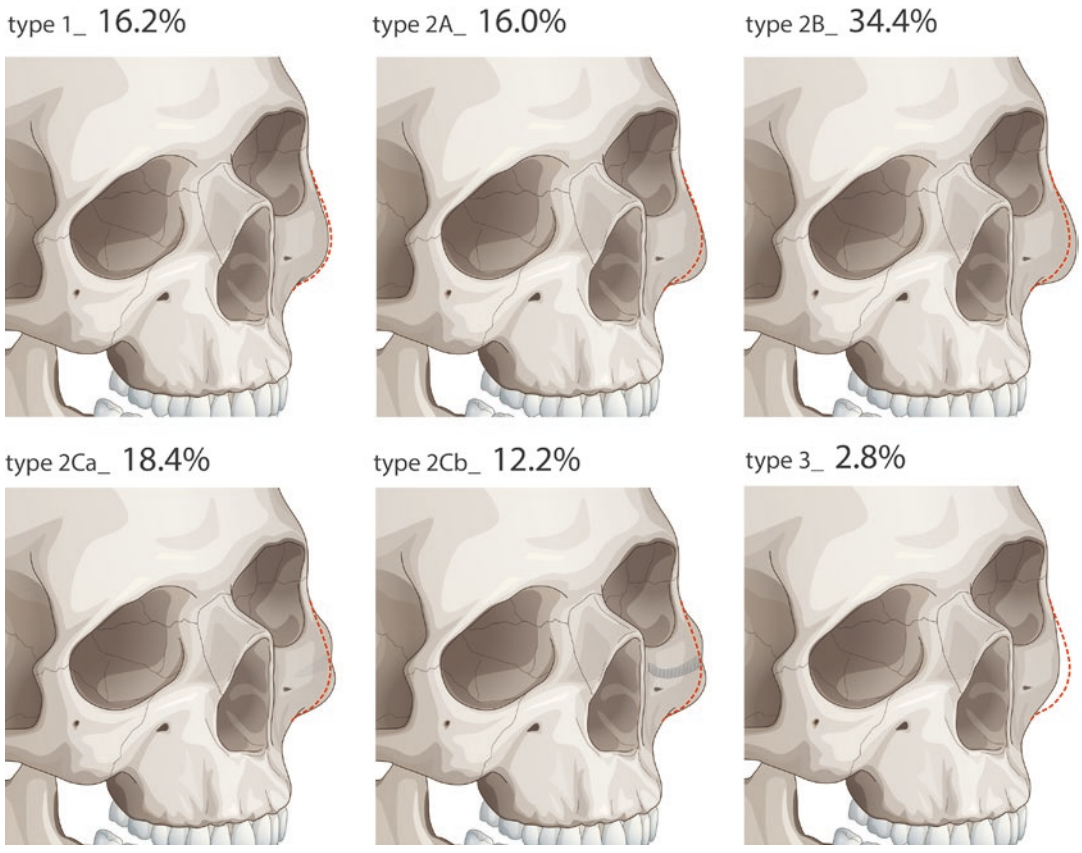


Fig. 15.6 Classification of the cheekbone and its prevalence

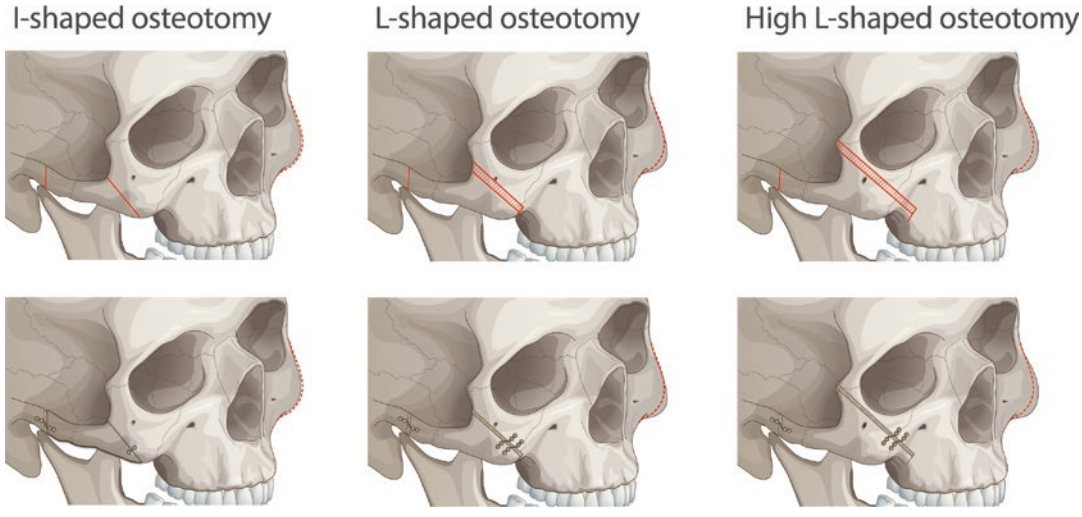


Fig. 15.7 Illustration for applied surgical techniques

Fig. 15.7 (continued)

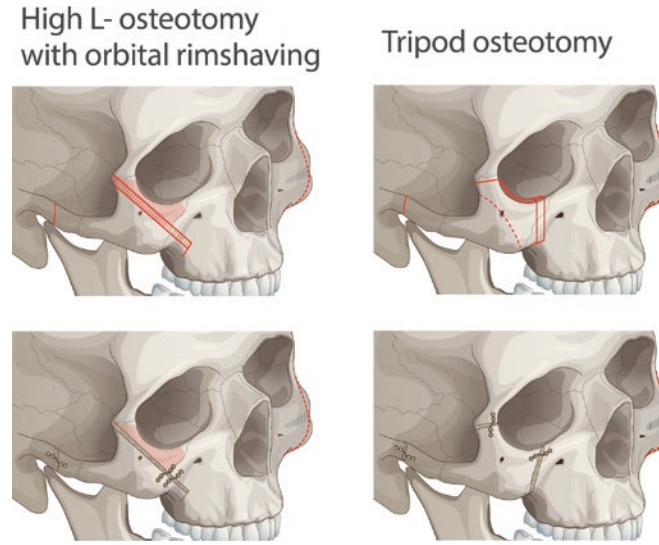
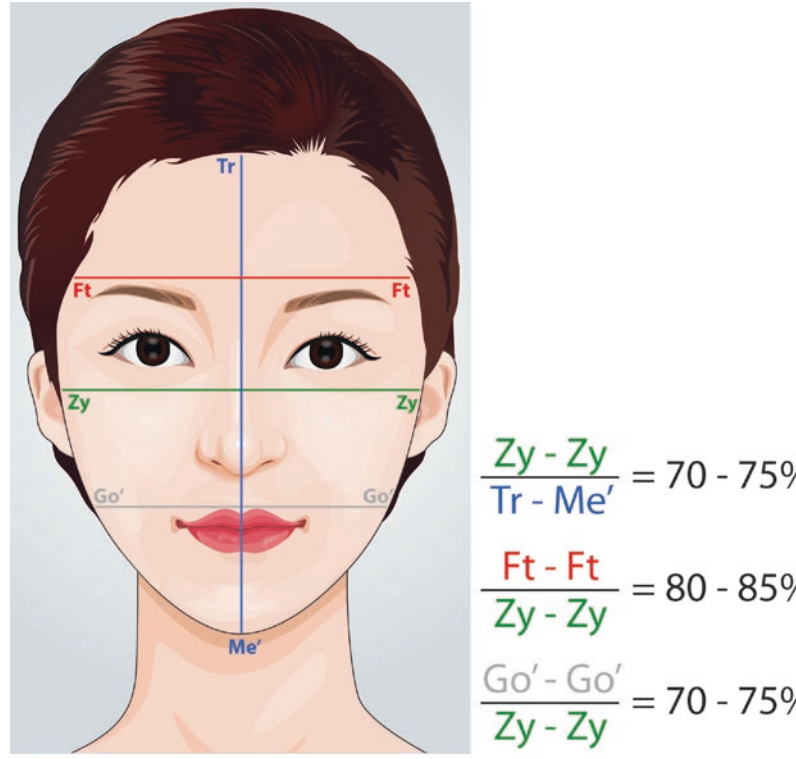


Fig. 15.8 Evaluation of facial harmony. Facial harmony should be considered between midfacial width (Zy–Zy) and lower facial width (Go–Go) and between midfacial width and upper facial width (Ft–Ft). The ratio between the height (Tr–Me') and the width of the face should be in proportion



eminence looks even more pronounced and causes grooves in the cheek and temple; this gradually results in the appearance of tired and aged look. Zygomatic reduction is a good option for the middle-aged woman who desires a youthful, soft, and feminine facial contour.

Asymmetry and Facial Balance

Overall facial shape, including mandible prominence and facial length, should be considered (Fig. 15.8). Zygoma reduction can be performed solely or in combination with mandible reduction. If the patient has a prominent mandible, reduction

malarplasty alone may not be able to balance bigonial and bizygomatic width; combined mandible reduction should be recommended. If patients have a long face with prominent cheekbones, reduction in bizygomatic distance deteriorates their excessively narrowed long face and ends up as "cucumber face." It is advisable to focus on the setback of zygomatic body instead of medialization of body and arch. In case of asymmetry, the amount of bony resection and setback as well as the vertical movement of the osteotomized lateral segment should be precisely controlled.

Discussion

There are at least four important points to be considered for a successful reduction malarplasty in Asian patients with prominent cheekbones. First is the accurate knowledge of the subtype of prominent zygoma including the infraorbital region. It is important to determine the location and degree of the aesthetic problem (the zygomatic bone prominence) and the patient's need and his or her concept of beauty by thoroughly observing the facial features and providing full counseling before surgery. Evaluation should include the four basic photographic views: frontal, lateral, three-quarter oblique, and basal. Among these views, the assessment of three-quarter oblique view is the most important. Second is the surgeons' ability of performing various types of surgical technique, especially regarding the placement of osteotomy. For example, high L-osteotomy, in which medial osteotomy is usually placed 4–7 mm from the external orbital rim, seems to be more suitable for patients with type 2B to 2C than standard L-osteotomy, given the more effective way to reduce the upper part of the zygoma, especially from the three-quarter oblique view. Third, in cases with protruding external orbital rim, reduction of the protruding orbital rim through additional transconjunctival or subciliary approach is essential. Otherwise, remaining protrusion of inferolateral orbital rim can be a source of complain, as shown in Fig. 15.1 case in our series. Fourth, an assessment of the overlying soft tissue constituents of the malar eminence is essential. This is especially true in cases where there exists an asymmetry in the bony skeleton that may be compensated by the overlying soft tissues. We acknowledge the limitation that there can be an overlap between subtypes because it is very difficult to clearly discriminate them. Nevertheless, the classification system introduced in this chapter aids plastic surgeons in assessing the zygoma shape and chooses appropriate surgical planning or technique according to individual patients' status and desires.

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Standard Zygoma Reduction with Intraoral Approach

16

Sanghoon Park

Pearls

1. The purpose of reduction malarplasty is to reduce the width of the cheekbone. However, surgeons should consider changing the boxy and flat facial contour into a three-dimensional shape and achieving a smooth, feminine facial line as a major purpose of reduction malarplasty.
2. The key variables to be evaluated are bizygomatic width, volume and position of the zygomatic body. The amount of ostectomy is determined considering volume of zygomatic body.
3. The zygomatic body and arch are usually moved medially, posteriorly, and sometimes superiorly or inferiorly during the surgery; the point of maximal malar projection (MMP) is marked and its new ideal position is carefully planned.
4. Overall facial shape including mandibular prominence and facial length should be considered in planning reduction malarplasty. Particular care should be taken for patients with a long face, as excessive reduction has risk of making the face to appear longer after the surgery.
5. Reduction malarplasty can be performed solely or in combination with other facial bone contouring surgeries such as mandible reduction, genioplasty, or forehead augmentation.
6. Soft tissue has a great effect on the results in reduction malarplasty. In patients with abundant cheek fat and sagging skin, the slimming effect might be less obvious and cheek drooping is more probable.
7. The following five factors are considered high risks for skin and soft tissue sagging generally: (1) age over 40 years, (2) abundant cheek fat, (3) thin skin and skin laxity, (4) class II mandible or ill-defined mandible neck line, and (5) deep nasolabial fold or jowl.

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Introduction

Asians have a tendency to have a shorter and wider facial contour compared with Westerners. Prominent malar complex combined with the protruding angle of the mandible creates a boxy rather than smooth and oval-shaped face. When viewed from below, the flat midface and wide cheekbones also create a boxy and two-dimensional appearance. These characteristics are typical of the Mongoloid face (brachycephalic face), while the Caucasian face is slim and protruding in an anterior-posterior dimension

S. Park (ed.), *Facial Bone Contouring Surgery*, DOI 10.1007/978-981-10-2726-0_16

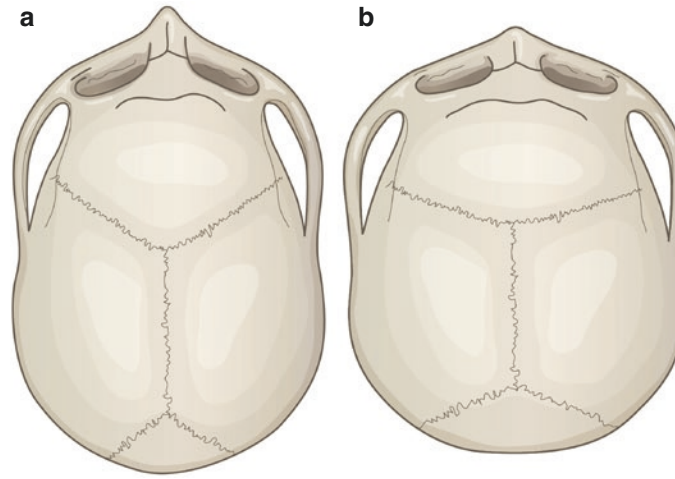

Fig. 16.1 Bony facial morphology at the level of the cheekbone in axial section. Compare the (**a**) dolichocephalic Caucasian face and the (**b**) brachycephalic Asian face

(dolichocephalic face) (Fig. 16.1). Conventional standards of beauty are different from cultures and ethnicities. However, aesthetic standards of East Asia have become more Westernized. Asians seek more slim and three-dimensional face. These differences in racial characteristics and changes in beauty standards led to a rise in demand to change their facial contour. Thus, facial contouring surgery has become very popular and commonly performed in East Asia. Furthermore, this trend is spreading to other parts of Asia and among the Asians living in Western countries.

The goals of reduction malarplasty are as follows:

1. Reduction of facial width

The main objective of reduction malarplasty is to make facial contour more slender and narrow. Usually, facial width is determined by bizygomatic distance which connects the articular tubercles on bilateral sides. Hence, reduction or transposition of the zygomatic arch is an effective method to narrow facial width. As zygomatic body is hypertrophied concurrently in most of these cases, reducing only zygomatic arch may not be able to correct boxy appearance; thus, combined and harmonious reduction of zygomatic arch and body is essential. [1]

2. Change a boxy facial contour into a three-dimensional contour

Changing in the shape and position of the zygomatic body can create a midface fullness that appears more three-dimensional and youthful.

3. Attain a smooth facial line

Individual having smooth facial line looks more feminine and young. In cases of protruded cheekbones in outward direction, the facial line connecting the temple-zygoma-cheek-mandibular angle constitutes a very rough and uneven line (Fig. 16.2). Zygomatic reduction is a good option for the patients who desire a youthful, soft, and feminine facial contour.

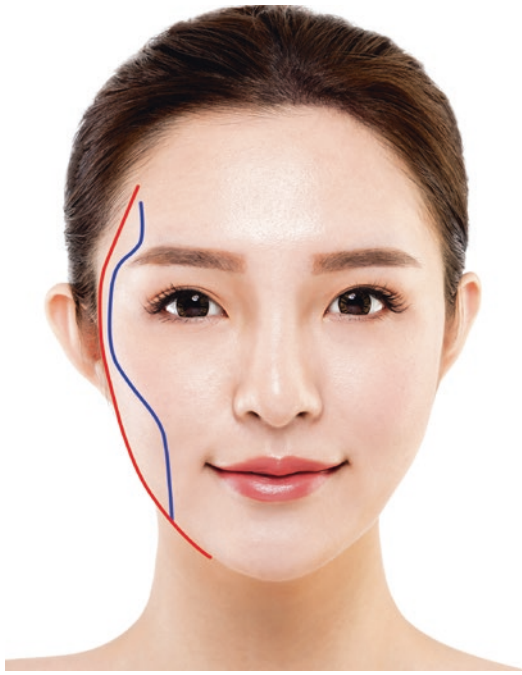

Fig. 16.2 Anterior and posterior facial contour lines. The anterior facial contour line connects the temple, zygomatic body, cheek, and mandible body (*red line*), while the posterior facial contour line connects the temple, zygomatic arch, mandible angle, and chin (*blue line*). If the anterior contour line is too convoluted, the patient gives a "strong," "offensive," "old," "tired," "masculine" impression. The posterior contour line reflects the facial width and facial size

Patient Assessment and Consultation

Direct physical examination is the most important process to evaluate the patient's problems and establish a surgical plan. Clinical photos are necessary, as is radiologic examination including frontal view, submentovertex view, and Waters' view. A computed tomography (CT) scan with 3D reconstruction is also helpful to evaluate the shape of the zygomatic complex. The key variables to consider are the volume and position of the zygomatic body and the bizygomatic width. The amount of ostectomy required during the surgery is determined according to the volume of the zygomatic body. A wider resection of the zygomatic body should be planned when the volume is large. However, excessive reduction may cause a flat or deficient look. Therefore, maintaining an adequate volume of the zygomatic body in the anteroposterior dimension and transverse plane after the surgery is essential.

To make the midfacial width narrow, the lateral margin of zygoma should be trimmed or moved medially. If the outer margin of zygoma is placed laterally, the amount of osteotomy and medialization should be maximized. The maximal malar projection (MMP) point is the most protruded portion of the outer contour of zygomatic complex in the basal three-quarters view. If osteotome line is placed lateral to the MMP point, or the reduction of the zygomatic body is performed only by shaving, this point stays unchanged although the outer margin of the zygomatic body is narrowed. It results in an unnatural, two-dimensional appearance. Therefore, making adequate projection and positioning MMP point at ideal position is the key for desirable postoperative result.

The ideal MMP point may vary among different ethnicities and subjective favors; however, the following are two simple methods of determining the ideal position of the MMP (Fig. 16.3) generally.

Hinderer Analysis

The MMP is determined at the point of intersection of two lines. One imaginary line connects the lateral canthus and the oral commissure, and another line connects the nasal alar base and the tragus. The new location of MMP is a point placed in juxtaposition to the crossed lines in the outer upper quadrant [2].

Wilkinson Analysis

An imaginary line is dropped vertically downward from the lateral canthus to the degree of the

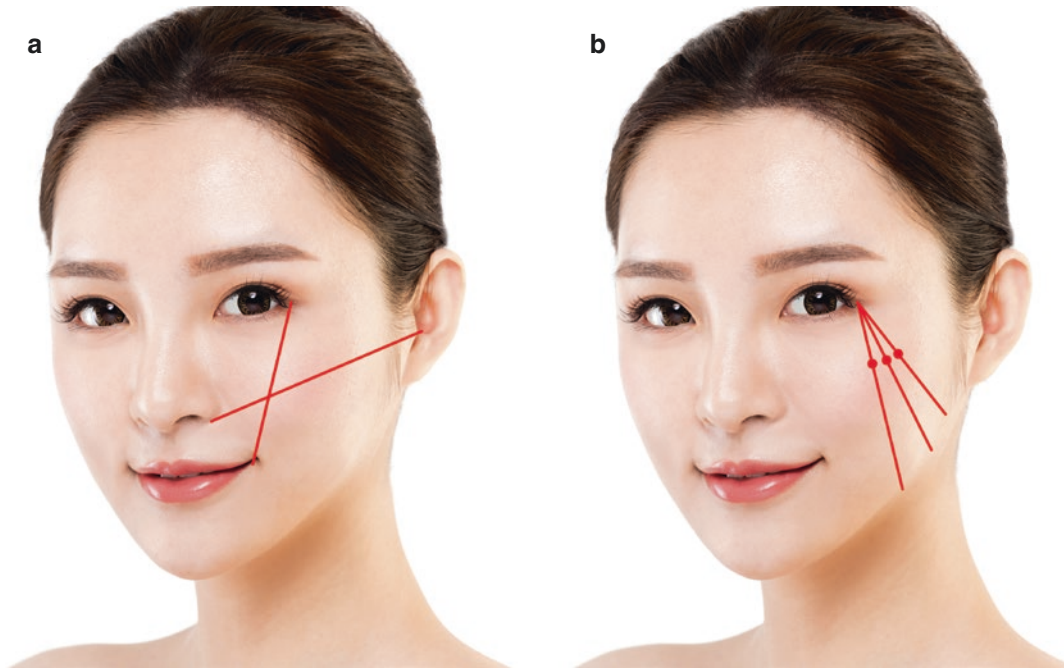

Fig. 16.3 Determining the ideal position of the maximal malar projection (MMP). (**a**) Hinderer analysis. (**b**) Wilkinson analysis

mandible. The MMP is located at one-third the distance from the lateral canthus to the angle of the mandible [3].

Once the surgical plans for the zygomatic body are determined, the bizygomatic width is measured. As arch medialization is critical in the reduction of posterior facial width, the degree of arch impaction should be decided. The posterior basal portion of the arch that is posterior to the osteotomy cannot be medialized and should be carefully shaved for less visible step. Too much arch medialization without adequate reduction of zygomatic body will result in a flat and boxy face. To prevent this outcome and create a harmonious midface contour, the degree of reduction of the zygomatic body and arch should be coordinated and balanced.

There are many variables that surgeons should consider during surgery, and these should be decided by evaluations described above. Variables in reduction of zygomatic body are amount of (1) ostectomy, (2) medialization, (3) setback, and (4) vertical repositioning. Variables of zygomatic arch reduction are the amount of arch medialization and degree of shaving of the articular tubercle posterior to the osteotomy line.

As facial soft tissue is also an important component in reduction malarplasty, it should be considered for the pleasant aesthetic result. If the patient has thin skin with minimal cheek soft tissue, changes after reduction malarplasty will be obvious with minimal possibility of soft tissue drooping. This patient is an ideal candidate for reduction malarplasty. However, problems of visible bony step around the osteotomy and palpable plate through the skin are more probable. Surgeons should put more effort to make a smoother transition between bony osteotomy. On the contrary to these cases, if the patient has abundant soft tissue or thick skin, the risk of cheek drooping has risen. Surgeons should explain about the possibility of cheek drooping and consider appropriate additional procedure such as liposuction or lifting. If patient's malar fat pad is thick, the zygomatic body should be overcorrected than generic cases to meet enough reduction.

Surgical Techniques

The surgical approach and technique for reduction malarplasty was introduced in 1983. Onizuka et al. [4] introduced chiseling and/or shaving method to reduce the protruding portion of the malar bone through intraoral incision. After that, various surgical techniques have been devised, such as bone shaving, infracture of the zygomatic arch [5], and osteotomy/ostectomy of the zygomatic body [2, 6–9]. Bone shaving method is the simplest and easily practicable method when it is used for localized protrusion of a zygomatic body. However, excessive shaving of the zygomatic body may cause exposure of cancellous bone, and it can result in postoperative irregularity [10] as cancellous bone is absorbed unpredictably. Thus, the amount of shaving is limited, and the overall size of the zygomatic body cannot be reduced only with shaving method. Furthermore, shaving method cannot be applied to the zygomatic arch as thickness of arch is not enough to be reduced through shaving [11]. The in-fracture technique [5] is one of the useful methods in reducing the protrusion of the zygomatic arch. Surgeons usually conduct osteotomy of the zygomatic arch, avoiding a full-depth cut and maintaining the continuity of the periosteum (greenstick) [10] and pushing the zygomatic segments medially. Its major advantages are simplicity and speed; however, it carries the risk of an uncontrolled amount of in-fracturing in the zygomatic arch, and it has a limited effect on a prominent zygomatic body. An L-shaped osteotomy of the zygomatic body is the preferred method for patients with moderate to severe malar protrusion due to wide zygomatic arch and prominent body. An L-shaped osteotomy is made in the anterior part of the zygomatic body, and a separate osteotomy is made in the posterior part of the zygomatic arch. With or without removal of bone [6], a zygomatic segment is moved to the desired position and fixed with wires or plates and screws. The L-shaped osteotomy technique can change both the zygomatic body and arch and has the advantage of controlling the degree of reduction as well as the shape after reduction. As patients usually desire change in the zygomatic body and arch, L-shaped osteotomy is currently the most frequently used and preferred method in zygomatic reduction (Fig. 16.4).

The approach for reduction malarplasty can be simply divided into two types: the external approach (coronal incision, temporal incision, preauricular incision) and the intraoral approach.

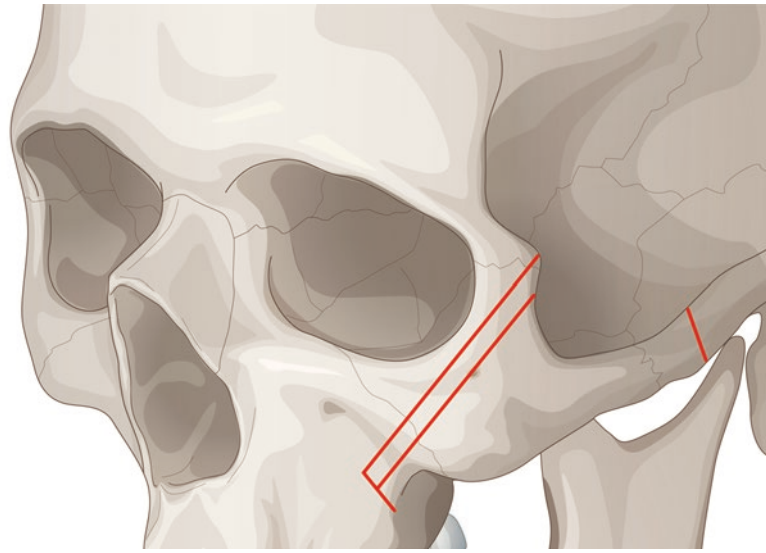

Fig. 16.4 Design of bone cuts in malar reduction. An inverted L-shaped osteotomy line is marked over the malar eminence. A second, parallel line is drawn lateral to the first line to represent the strip of bone to be resected. A posterior bone cut is made ~2 to 3 cm anterior to the tragus

The external and the intraoral approaches have their respective advantages and drawbacks [11]. As zygomatic reduction developed from the treatment of zygomatic fracture, the coronal approach was first used to expose the entire zygomatic body and arch. However, it requires a long operation time, and it may cause bleeding and visible scarring. The intraoral approach has the advantage of hidden scars, limited bleeding, and short operation time. However, it provides limited operative exposure, resulting in difficult osteotomy, limited space for fixation, and the risk of infraorbital nerve injury. Side effects include cheek drooping due to wide dissection and volume reduction, which can be avoided by minimizing the dissection. The osteotomized segment should be rigidly fixed and postoperative elastic dressing provided to prevent cheek drooping. The intraoral approach can be used solely; however, it is usually combined with preauricular incision or temple incision to minimize the dissection and the possibility of cheek drooping.

As the intraoral approach is the most widely used method these days, reduction malarplasty via the intraoral approach with an L-shaped osteotomy is the most preferred method to correct facial imbalance in patients with prominent zygomatic body and arch.

Anesthesia and Approach

All patients are given general anesthesia. Orotracheal intubation is preferred at ID hospital, but nasotracheal intubation can be used. About 3-cm-labiobuccal-vestibular incision is made on each side of the maxilla [7]. Through this incision, the soft tissues are elevated superiorly and laterally at the subperiosteal plane. Dissection is limited to the area of the zygomatic body, the anterior wall of the maxillary sinus, and the lateral and inferior orbital rim. As the dissection extends superolaterally over the malar eminence, a portion of the origin of the zygomatic major and zygomatic-cutaneous ligaments may be partially divided from the bony surface.

Anterior Osteotomy

An inverted L-shaped osteotomy line is marked over the malar eminence (Fig. 16.5). This line generally starts from the lateral border of the orbital rim and extends to just below the infraorbital foramen. Be careful not to start the osteotomy too low from where the arch changes from a vertical to a horizontal direction, which may result in insufficient volume reduction in the

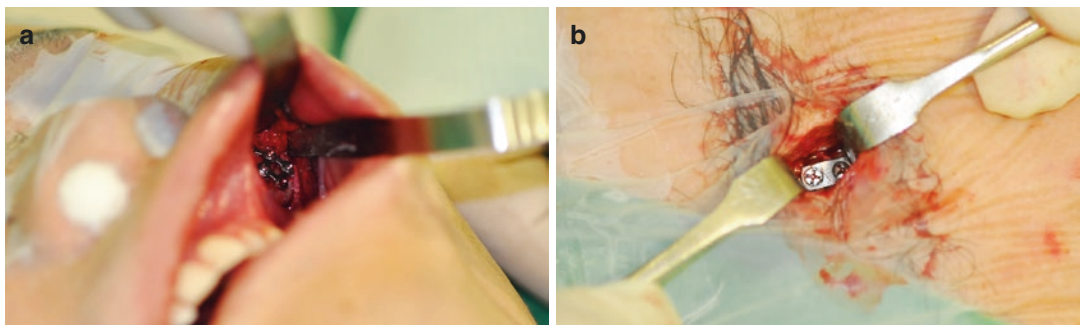

Fig. 16.5 Rigid fixation of malar complex. (**a**) Applying two miniplates to the zygoma body. (**b**) Applying a prebending miniplate to the zygomatic arch

zygomatic body. The short limb of the osteotomy then turns at about a 90° angle toward the zygomaticomaxillary buttress. Great attention must be paid to avoid injury to the orbital contents or infraorbital nerve. A second, parallel line is drawn lateral to the first line to represent the strip of bone to be resected, allowing inset of the fragment [12]. The distance of the second line from the first line depends on the patient's preference and the width of the zygomatic body. A wider parallel osteotomy can be made for greater reduction; however, the usual width of the strip at the ID hospital is 3 to 5 mm. The short limb of the osteotomy must be high enough to avoid the dental roots. Careful dissection is required in the zygomatic-pterygoid space to prevent injury to the vessel, which may lead to profuse bleeding and postoperative bruising.

Multiple retractors are placed and the cuts are made with a reciprocating saw starting from the superior lateral limb of the osteotomy. Superior medial limb and finally inferior transverse cuts are made, and the intervening bone fragment is removed.

Posterior Osteotomy

Upon exposing the posterior part of the zygomatic arch, the course of the frontal branch of the facial nerve and the zygomatic arch is marked on the skin (Fig. 16.4). About 1cm vertical incision is made within the sideburn [12], 2–3 cm anterior to the tragus. This incision should lie posterior to the course of the nerve. The arch is identified after the dissection of the periosteum, and fine elevators are passed over the top and behind the arch and as far posteriorly as possible to ensure that the osteotomy is still anterior to the temporomandibular joint. A reciprocating saw is used to make this vertical osteotomy. When the posterior osteotomy is completed, the zygomatic segment should be free to move while remaining attached to the masseter. Additional bone distal to the osteotomy may be burred if necessary.

Fixation

The osteotomized body and arch are positioned posteriorly and medially as a result of the osteotomy, and the intervening segment is removed. According to the patient's desired outcome and preoperative planning, the three-dimensional location of the segment is determined while good contact of bony surfaces is maintained. Six-hole miniplates with screws are placed to fix the anterior portion of the segment, and two- or three-hole miniplates with screws are used to fix the zygomatic arch (Fig. 16.5). Positioning of the osteotomized segment is the most critical step for postoperative results, and the final segment position is adjusted based on preexisting asymmetry and intraoperative appearance to achieve the desired final outcome. An identical procedure is then performed on the contralateral side. Standard techniques are used to close the intraoral and skin incisions.

Key Technical Points

There are two commonly used osteotomy techniques used for the zygomatic body: I-shaped osteotomy and L-shaped osteotomy [11]. Baek et al. [13] introduced I-shaped osteotomy. This osteotomy is placed lateral to the maximal malar projection and, thus, usually does not include the volume of malar projection. The osteotomized segment may be moved downward as the masseter muscle pulls the fragment. The L-shaped osteotomy has advantage of including the volume of the malar projection. Displacement of fragment can be prevented as the masseter muscle cannot drag the fragment downward because the inferior bor-

der acts as a barrier [11]. Furthermore, L-shaped osteotomy has a larger bony contact surface than the I-shaped osteotomy, and it is helpful to minimize the risk of complication such as nonunion. The biggest advantage of the L-shaped osteotomy is that it is effective in reducing the width of the zygomatic body and repositioning the MMP point. If L-shaped osteotomy is positioned low at the zygoma, it also fails to produce maximal reduction of zygomatic body. For the maximal reduction, it is helpful to position the superior osteotomy line as close to the orbital rim. In author's clinic, we call it as ' high L-shaped osteotomy' leaving only 2-3mm at the orbital rim. As insufficient reduction is one of the major causes of complaints, this technique is also useful for secondary revision.

Repositioning of the osteotomized zygomatic complex is an important step in reduction malarplasty. The MMP point is determined before surgery through detailed consultation and physical examination. If the patient's chief complaint is facial width, the zygomatic segment should be transposed medially, and if patients seek improvement in a prominent zygomatic body to give a less harsh impression, the zygomatic complex should be transposed medially and posteriorly, with more reduction in the zygomatic body than in the zygomatic arch. By controlling the amount of transposition of the zygomatic body and arch, and by combining the medial and posterior transpositions, a harmonious and balanced face can be attained.

Although fixation may not be essential in malar reduction using the in-fracture method, rigid fixation is necessary when one or more osteotomies are conducted. Only rigid fixation to both the zygomatic body and arch can guarantee precise repositioning and stability. If rigid fixation is not used after osteotomy, undercorrection, asymmetry, or relapse after surgery can occur. It is a serious shortcoming that surgeons are unable to control the exact degree and position of movement, especially in the field of aesthetic surgery. Rigid fixation is also critical to prevent nonunion and postoperative pain.

As the masseter muscle functions as a depressor and a medial rotator for the zygomatic segment after osteotomy, three-point fixation is necessary for the zygomatic body, orbital rim, and zygomatic arch to prevent three-dimensional rotation. However, fixation in the orbital rim requires additional incision. To avoid additional incision and fixation in the orbital rim, the authors recommend using double-square mid-plate in the zygomatic complex as a very simple and easy method to prevent rotation while minimizing the incisions.

Case Study

Case 1

A 26-year-old woman complained of prominent zygoma and wide midface (Fig. 16.6). An inverted L-shaped osteotomy with a 5-mm reduction of each zygoma was conducted to reduce the protrusion of her zygoma. The posterior part of the zygomatic arch was divided with complete osteotomy. After the osteotomized zygoma was shifted medially (5 mm) and posteriorly (2 mm), it was fixed with miniplates and screws. The body of the zygoma was fixed with a double-bridged plate to provide stability against the torque from the masseter muscle (Fig. 16.7a). The arch of the zygoma was fixed with a prebending plate to achieve an accurate position as well as stability (Fig. 16.7b). The malar prominence and midfacial width were reduced markedly at 6 months postoperatively (Fig. 16.8).

Fig. 16.6 *Case 1.* Preoperative frontal and oblique photographs of the patient

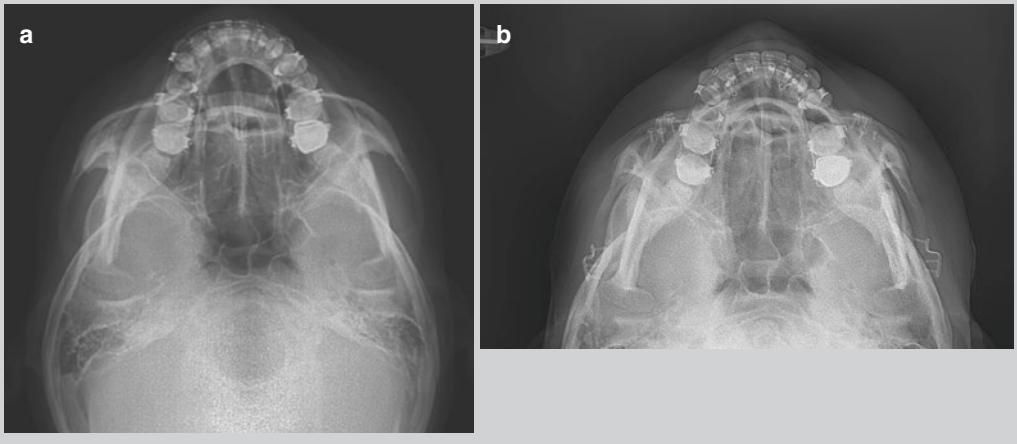

Fig. 16.7 C*ase 1.* (**a**) Preoperative and (**b**) postoperative radiographic showing posteromedial repositioning of the zygoma

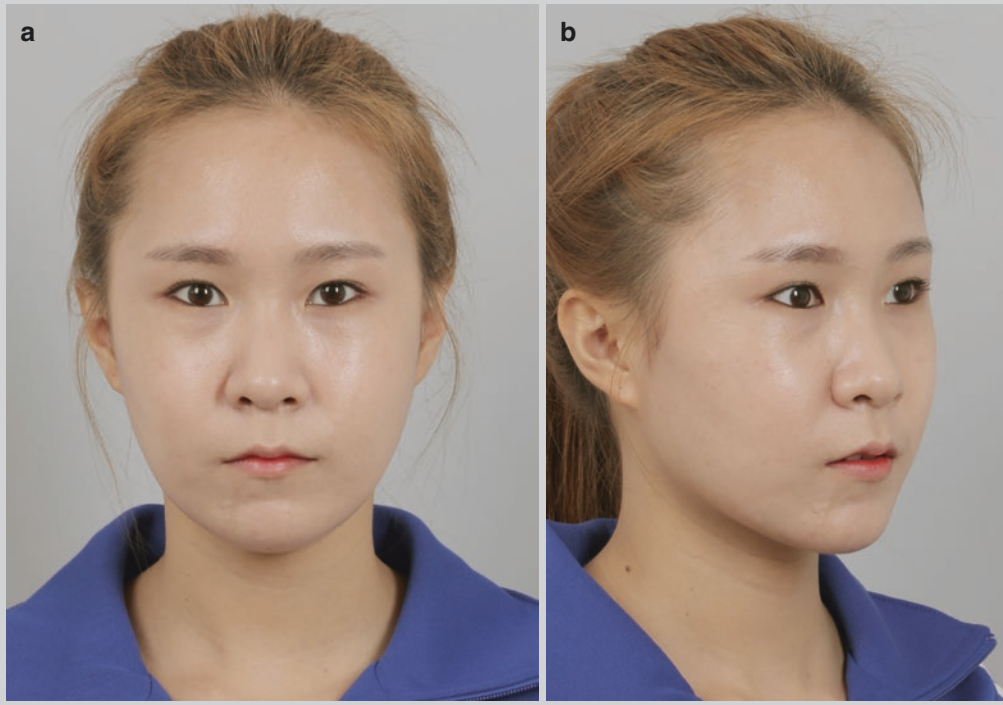

Fig. 16.8 (**a**, **b**) *Case 1.* Six-month postoperative photographs

Case 2

A 42-year-old woman complained of malar protrusion and broad lower face (Fig. 16.9). She underwent reduction malarplasty and mandible contouring surgery (Fig. 16.10). After complete osteotomy was applied to the anterior and posterior part of the zygoma, the zygoma was repositioned posteriorly and medially. Narrowing genioplasty and concomitant mandible contouring surgery were performed to correct her square lower face. Five months after the operation, the patient's facial contour appears soft and slender (Fig. 16.11).

Fig. 16.9 *Case 2.* Preoperative (**a**) frontal and (**b**) oblique photographs. Reduction malarplasty and mandible reduction surgery were done simultaneously

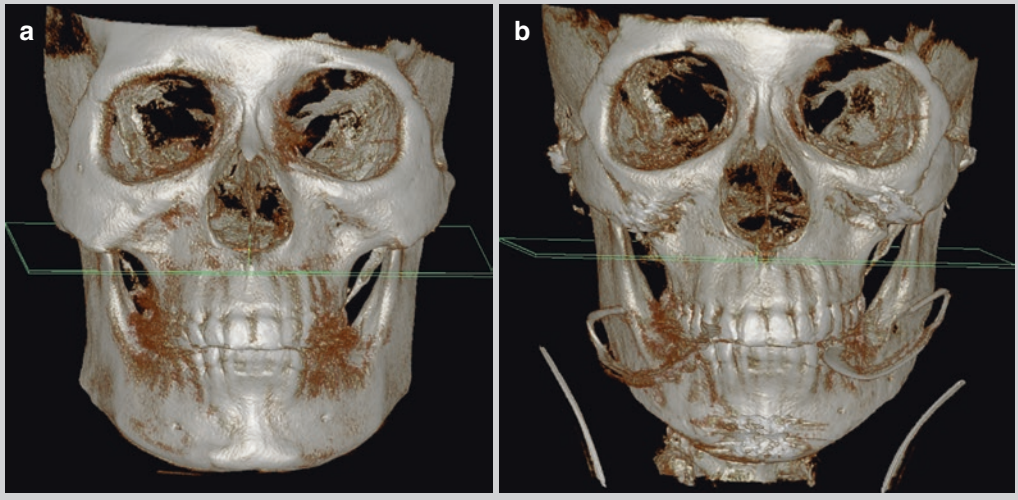

Fig. 16.10 *Case 2.* Three-dimensional CT images: (**a**) preoperative and (**b**) postoperative

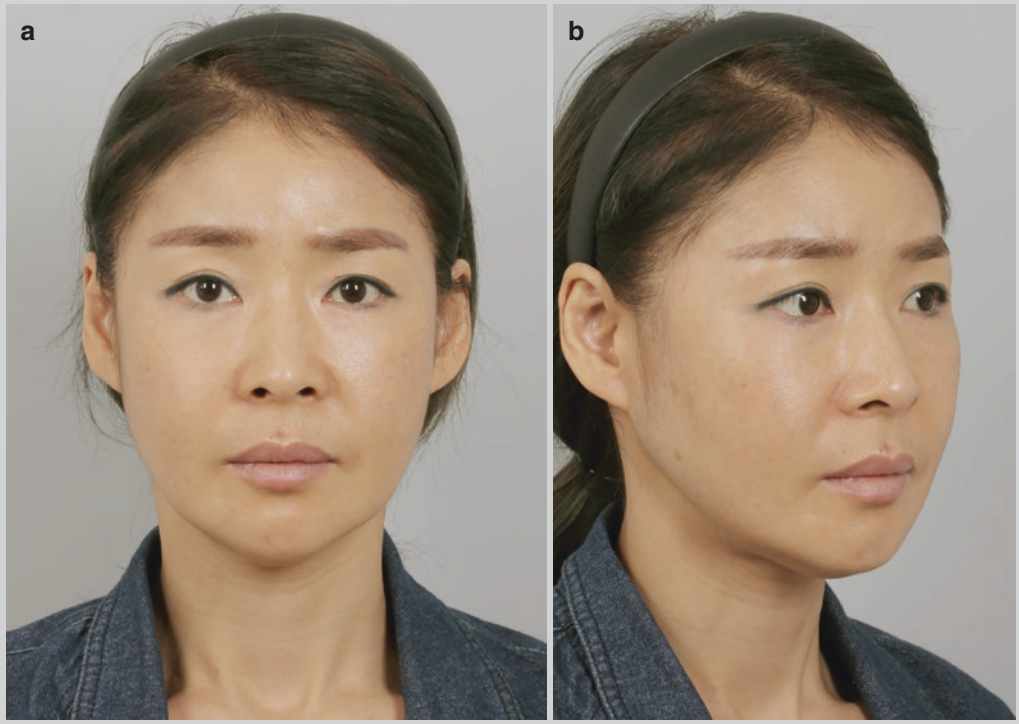

Fig. 16.11 (**a**–**b**) *Case 2.* Five-month postoperative photographs

Complications and Management

As reduction malarplasty involves reduction of bone as well as transposition, sagging of soft tissue might be inevitable and needs to be addressed during the procedure. Previously, an inferiorly positioned zygomatic complex or mobile bone segment was a major cause of soft tissue sagging. This complication can be prevented by rigid fixation.

Wide dissection and excess soft tissue are potential reasons for sagging of soft tissue. Minimizing the dissection and preserving the origin of the masseter muscle in the zygomatic body can minimize unwanted soft tissue problems. The status of soft tissue also plays a role in soft tissue sagging. High-risk factors for skin and soft tissue sagging include (1) age over 40 years, (2) abundant cheek fat, (3) thin skin and skin laxity, (4) class II mandible or ill-defined mandible neck line, and (5) predisposing deep nasolabial fold or jowl. In these high-risk groups of patients, preoperative explanations about the possibility of cheek drooping are necessary, and special attention should be paid before and during the procedure to try to overcome this complication. Midface lift, thread lift, buccal fat removal, and paranasal augmentation are helpful adjunctive procedures and can be combined or performed separately.

Nonunion is a source of undercorrection and cheek drooping. Frequently, it is one of the reasons for unidentified pain in long-term follow-up. Though radiology can reveal breakage of fixation material and separation of bony segments, examinations may at times be unable to detect definite signs of malunion. Partial separation of bone, especially in the superolateral position of the orbital rim, is often found but is not considered

nonunion if one-third of the bone is healed in continuity. Possible causes of nonunion are excessive resection of bone, unstable fixation, excessive movement (e.g., when chewing), muscle pull, and trauma in the immediate postoperative period. Conservative treatment can be tried initially to relieve pain and camouflage soft tissue depression. Soft tissue depression can be corrected with fat injections, although frequent relapse can occur. In cases of repeated relapse after fat injection, onlay Medpor (Stryker) insertion to create continuity over the gap is an option. Indications for major surgery include a severe recurrent pain and aesthetic problems such as obvious bony gap, asymmetry, and sagging of the malar complex. Repositioning of the zygoma complex is ideal, though very difficult if bone loss is extensive and additional bone graft or alloplastic material may be necessary.

During zygomatic reduction, injuries to the orbit, orbital contents, infraorbital nerve, and temporal bone are possible. To prevent injury to these structures, the surgeon must be careful and acutely aware at all times regarding the location of the saw [12]. Excessive pull by retractors are a common source of paresthesia after surgery. Plate and screws may cause the paresthesia if they are placed too close to the infraorbital foramen.

Compression of the temporalis muscle due to inward movement of the zygomatic arch can cause trismus. It will improve within 1–2 months after surgery, and mouth opening exercises are helpful to relieve those symptoms.

As most patients who complain of asymmetry postoperatively already had asymmetry prior to surgery, a careful and thorough preoperative examination is critical, followed by communication regarding the possibility of asymmetry and limitations of surgery.

From the patient's aesthetic point of view, the most common complaint after zygomatic reduction is undercorrection. Inadequate reduction of the zygomatic body or inappropriate positioning of the maximum malar projection is a common cause for dissatisfaction. Therefore, proper patient selection is required and patients' expectations should be realistically addressed and adjusted.

Discussion

The surgeon should consider many factors described above; "valid and enough bony contact" after osteotomy and "secure and solid fixation" are the most important points to prevent a series of complications derived from bony instability and nonunion.

It might be hard to decide the amount of bony resection and setback as there is no absolute guideline. In general, we remove the strip of zygoma body range from 2 to 6 mm, set the zygomatic body back range from 0 to 4 mm, and push the zygomatic arch range from 0 to 5 mm. The surgeon decides a precise amount of each element upon consideration of patients' preference and surgeons' experience.

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The Reduction Malarplasty with Coronal Approach

17

Rong-Min Baek and Baek-kyu Kim

Pearls

1. Flat and wide midface makes requests for malar reduction quite common in the East Asian population.
2. Reduction malarplasty using the coronal approach makes up for the shortcomings of the intraoral approach.
3. The coronal approach consists of medial and lateral osteotomy, repositioning of the malar complex, and rigid bony fixation.
4. To avoid facial nerve injury and temporal hollowing, temporal dissection is performed in the plane just beneath the temporoparietal fascia.
5. The coronal approach is an efficient method to produce symmetric results with adequate reduction and rigid fixation.

Introduction

Facial skeletal features commonly seen in the Oriental population are prominent malar eminences, convex lower facial profile, hypoplastic paranasal areas, and prominent mandibular angles. The facial skeleton of East Asians tends to have less anterior projection, flatter midface, greater width, and shorter vertical length compared to that of Caucasians. In the Western world, prominent and well-defined cheekbones are considered attractive, but in East Asia, such feature is regarded as undesirable and unattractive. East Asians often think malar prominence gives a masculine or emaciated look to the face and prefer an oval-shaped face. For this reason, requests for malar reduction, and not augmentation, are quite common in East Asia, including Korea.

In 1983, Onizuka and coworkers described an intraoral approach for malar reduction. However, the intraoral approach is associated with some significant problems, such as limited exposure, cheek droop, difficulty in maintaining symmetry, and difficulty in achieving adequate reduction in the zygomatic arch area [1]. To overcome such shortcomings, Dr. Se-Min Baek and others developed in 1984 a new technique with a coronal approach, which consists of medial and lateral malar osteotomy, repositioning of the malar complex, and bony fixation [2].

Patient Assessment

The purpose of malar reduction surgery is purely aesthetic, so the patient's motivation for surgery should be fully understood and must be deemed

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S. Park (ed.), *Facial Bone Contouring Surgery*, DOI 10.1007/978-981-10-2726-0_17

appropriate. Furthermore, the patient should have realistic expectations and be informed of potential complications.

Analytical planimetric photographs (frontal view, both profile views, submental view) are taken preoperatively. Cephalometric and submental vertex radiographs also may be taken. Along with analysis of photographs and radiographs, the surgeon's clinical assessment will determine the amount of malar bone to be reduced and the final position of the malar complex. Any preoperative malar symmetry should be pointed out to the patient.

The coronal incision line must be predetermined so that the patient's hair can be braided appropriately. The incision line follows the frontal hair pattern and is drawn 8 cm posterior to the anterior hairline. In the temple area, the incision curves downward acutely until reaching the junction of the superior helix of the ear with the temporal scalp (Fig. 17.1).

Fig. 17.1 Coronal scalp incision design for reduction malarplasty

Surgical Technique

The procedure is performed under general anesthesia with endotracheal intubation. Fiber-optic headlight comes in very handy when illumination of the malar area under the coronal flap is needed. The incision is made after local anesthetic solution (0.5% lidocaine with 1:300,000) epinephrine is infiltrated. An incision beveled parallel to the hair shafts is made down to the pericranium, and subgaleal dissection is performed downward to the supraorbital rims. Once reaching the supraorbital rims, dissection is changed to the subperiosteal plane to expose the malar body, zygomatic arch, lateral orbital wall, and anterolateral maxillary wall. The temporalis fascia insertion site and masseteric attachments to the malar bone are left intact except at the sites of osteotomy. The reason for this is preservation of pulling forces acting on the zygoma and bloody supply.

Medial and lateral malar osteotomies are made to mobilize the malar complex. Both osteotomies are performed with a reciprocating saw, while soft tissue is protected with retractors. The medial osteotomy line starts at the maxillary notch, which is located 5–8 mm medial to the inferior end of zygomaticomaxillary suture and extends straight upward, ending near the frontozygomatic suture while preserving the lateral orbital rim. The maxillary sinus may be opened during medial osteotomy, but this has not produced significant complications such as infection, sinusitis, or bleeding, in our experience. Placing the medial osteotomy line too far laterally out of fear for damaging the orbital contents may lead to undercorrection and stepping deformity in the anterior cheek. As far as the blade of the saw is directed in the proper axis and direction, there is no risk of entering the orbital cavity. The lateral osteotomy line is drawn just anterior to the zygomatic tubercle. The zygomatic arch is cut obliquely from posterior to anterior (Fig. 17.2). Once the osteotomies are made, the malar complex is repositioned to the desired location and is stabilized with interosseous wires or miniplates and screws. There are two options

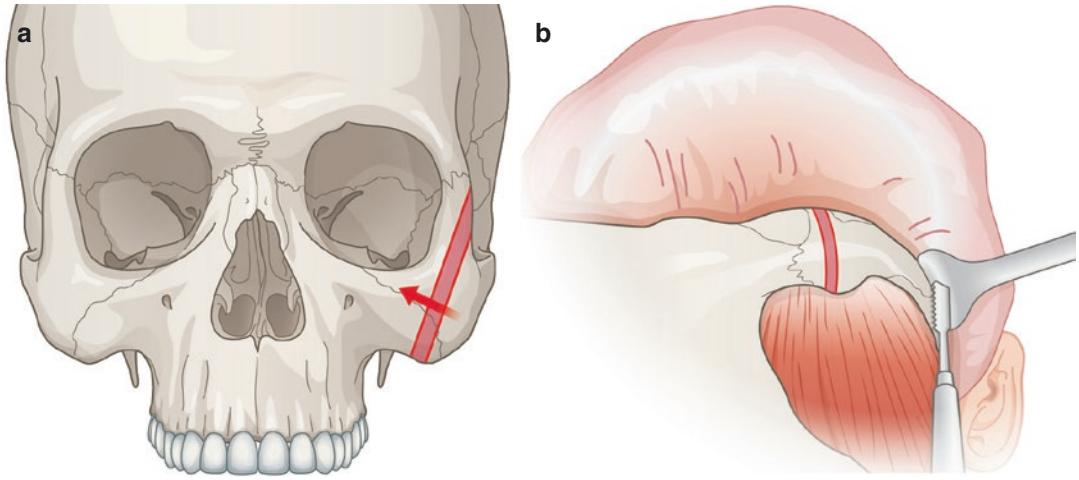

Fig. 17.2 Medial osteotomy (**a**) is made and a strip of bone is removed to reduce lateral prominence. Lateral osteotomy (**b**) is made after completing medial osteotomy

with differing indications: transpositional malarplasty or in situ reduction osteoplasty.

The transpositional malarplasty technique is employed for patients with asymmetric malar complexes, severe prominences, or descended zygomatic body complex. After osteotomy, the malar complex is completely released to mobilize for ideal position and reduced by ostectomy with sawing and marginal burring. This technique achieves the ideal repositioning of malar prominence by (1) adequate ostectomy and (2) three-dimensional transpositioning of the zygomatic complex for most attractive facial balance. After reduction, the malar complex should be secured with wires or miniplates.

The second method is termed in situ reduction osteoplasty. Indications are symmetric malar complexes, mild to moderate prominence, or zygomatic arch prominence. Medial osteotomy plane is designed to make the zygomatic complex slide posteromedially to reduce lateral excess. Next, the zygomatic arch is cut obliquely for bone Z-plasty. Finally, the malar complex is repositioned with the anterior segment of the zygomatic arch slid posteriorly and medially and is fixed in place with wires.

Bone dust is removed thoroughly by irrigation before wound closure. The galea is closed with interrupted Vicryl 4-0 sutures and the skin is closed with staples. Drains are not inserted. Compressive dressing is done with elastic net applied over the head.

Key Technical Points

1. The coronal scalp incision line follows the frontal hair pattern and is drawn 8 cm posterior to the anterior hairline. In the temple area, the incision curves downward until reaching the junction of the superior helix of the ear with the temporal scalp.
2. During dissection through the coronal approach, the temporalis fascia insertion site and masseteric attachments to the malar bone are left intact except at the sites of osteotomy, to preserve pulling forces acting on the zygoma and bloody supply.
3. The medial osteotomy line starts at the maxillary notch and extends straight upward, ending near the frontozygomatic suture while preserving the lateral orbital rim. The direction of movement of the mobilized malar complex can be determined by varying the degree of inclination of this osteotomy line.
4. The zygomatic arch is cut obliquely from posterior to anterior. After malar complex repositioning, the anterior segment of the zygomatic arch slides posteriorly and medially with respect to the posterior segment.

Case Study

Surgery was planned for a 21-year-old woman with prominent zygomatic arches and mandibular angle. Malar reduction alone would accentuate the contour of the strong mandibular angle. She underwent malar reduction with concomitant mandibular angle resection. Postoperative views show an overall smooth contour of the face (Fig. 17.3).

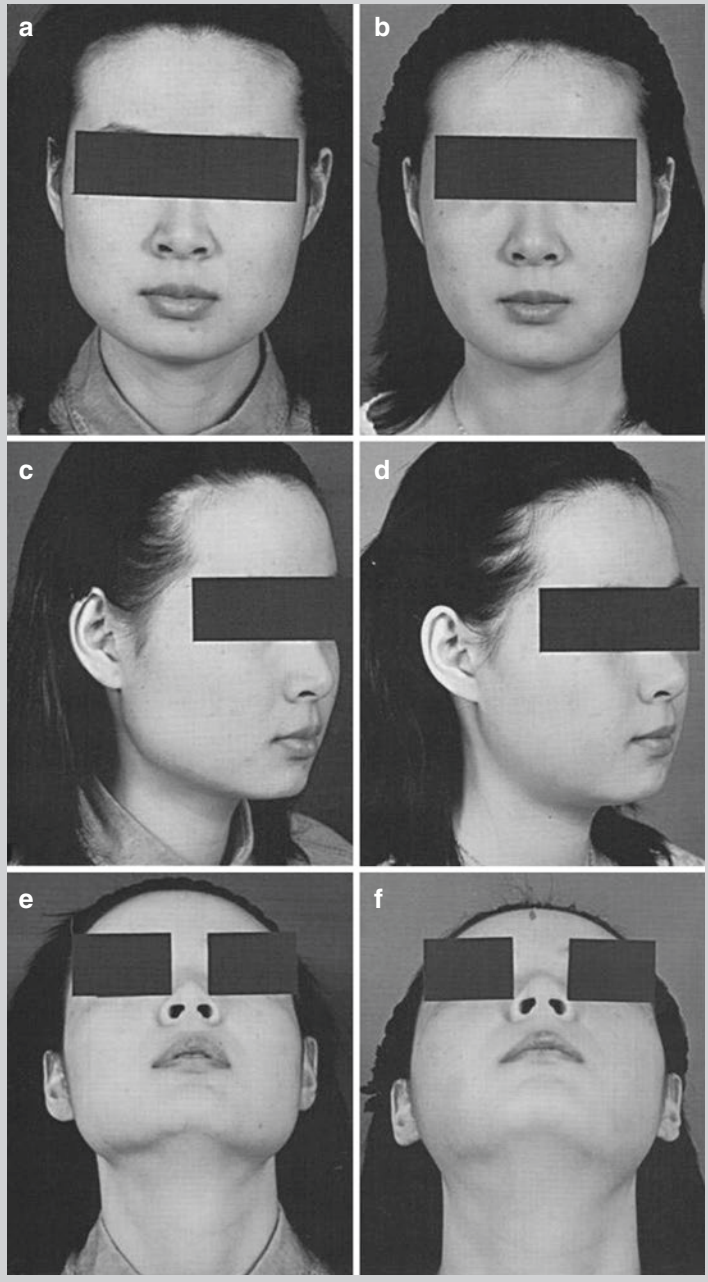

Fig. 17.3 Preoperative view (*left*). Postoperative view at 1 year after malar reduction with concomitant mandibular angle reduction (*right*)

Complications and Management

Possible complications are asymmetry, undercorrection, wide scalp scar, hematoma, infection, and facial nerve injury, all of which can be avoided by thorough surgical planning and strict adherence to surgical principles and techniques [3].

With the coronal approach, serious complications that might occur are frontal branch of facial nerve injury and temporal hollowing. Temporal hollowing can result from dissection through the temporal fat pad under the superficial layer of the temporalis fascia to avoid injury to the facial nerve. To prevent both temporal hollowing and frontal branch injury, the temporal area is dissected just under the superficial temporal fascia without entering the superficial temporal fat pad. This way, the frontal branch, which travels on the undersurface of the temporoparietal fascia, is protected. Once reaching the zygomatic arch, the periosteum is incised on the posterosuperior surface of the arch to expose the lateral facial skeleton (Fig. 17.4).

Malunion and cheek ptosis are common complications of reduction malarplasty, although they are rare with the coronal approach. A major risk factor for nonunion is insufficient rigid fixation at the superior portion of the malar complex. Nonunion or malunion can lead to inferior displacement of the malar complex and subsequent cheek ptosis. To prevent malunion and subsequent cheek ptosis, adequate bone-to-bone contact and rigid fixation at the superior part of the malar complex, rather than the zygomaticomaxillary buttress as in the intraoral approach, is necessary. Two-point fixation is preferred over one-point fixation. In cases where malunion or nonunion has occurred, the revision should be performed through a coronal approach. The soft tissue in the bone gap should be completely removed. The malar complex is repositioned superomedially and secured rigidly at two sites. The bony gap at the zygomatic arch can be treated with a bone graft (Fig. 17.5).

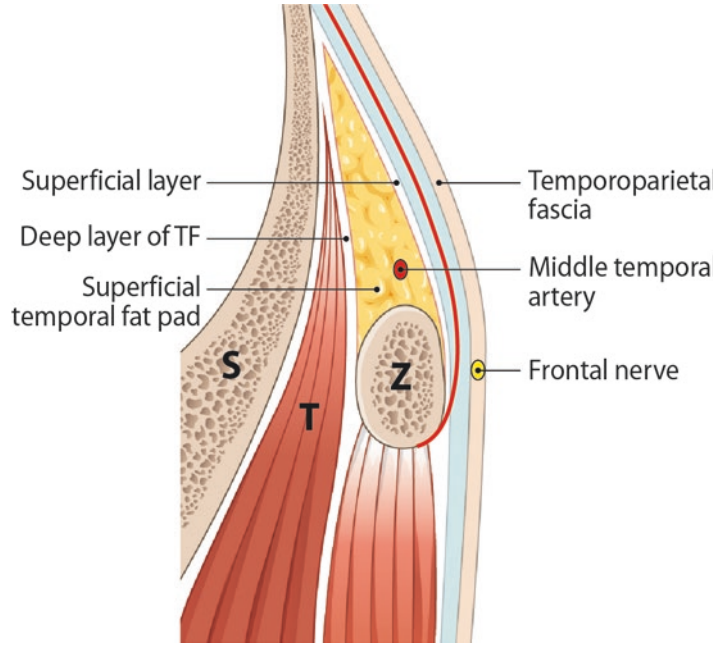

Fig. 17.4 Schematic cross-sectional diagram of the recommended dissection path to avoid facial nerve injury and temporal hollowing (**a**, *red line*). The integrity of superficial temporal fat pad is not violated and the periosteum is incised once reaching the zygomatic arch (**b**). *S* indicates skull; *T* temporalis muscle; *Z* zygomatic arch; *TF* superficial layer of TF

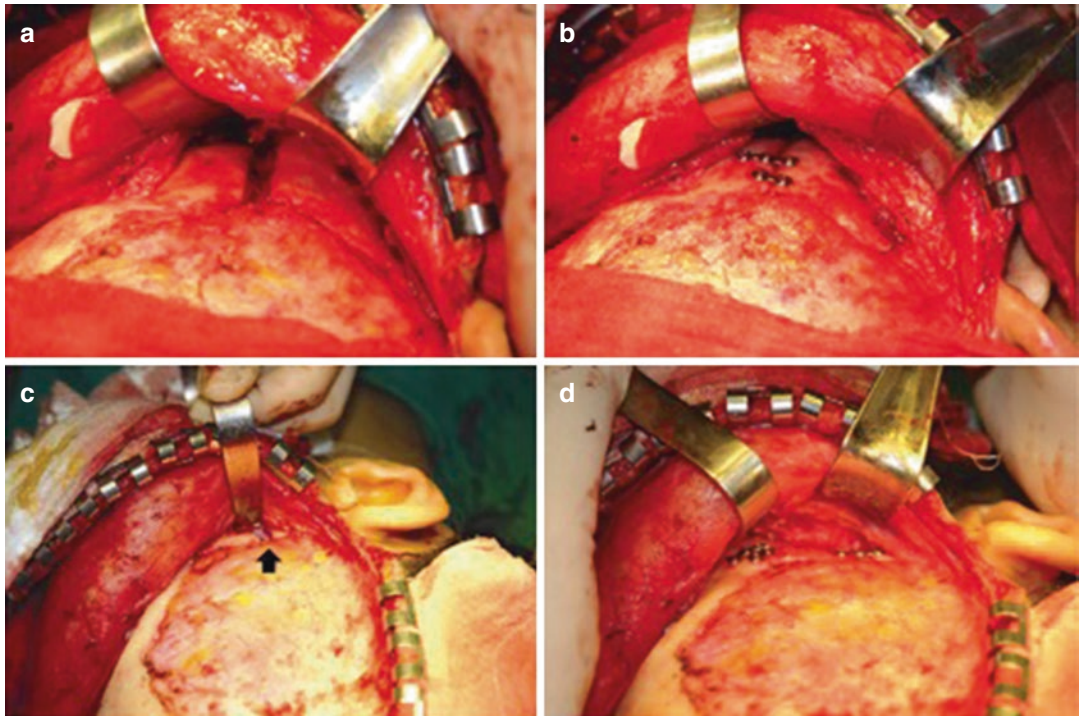

Fig. 17.5 A case showing nonunion after reduction malarplasty. After dissection, there is a bony gap at the zygomatic body (**a**). The malar complex is repositioned superomedially and secured with plate and screws (**b**). Superomedial repositioning leaves a bony gap (*black arrow*) at the posterior zygomatic arch (**c**). This gap is filled with an interpositional calvarian bone graft, which is secured in place (**d**)

Discussion

When performing malar reduction surgery, the surgeon should keep in mind that the malar complex must be integrated and be in balance with the rest of the facial features. Proper management begins with appropriate patient selection. For example, in a patient with both prominent malar bones and mandibular angles, malar reduction alone may accentuate and attract attention to the mandibular angles. Such a patient will benefit from malar reduction combined with angle resection (Fig. 17.3). Sometimes augmentation genioplasty using the resected bone from the mandibular angle may further aesthetically improve the patient's face by lengthening a short, square face. It is important to realize that changing the prominence of the malar bone often produces changes in the nose and eyes also [4].

The malar bone can be manipulated through three different incisions: intraoral, coronal, or preauricular incision. A major complication of the intraoral approach is cheek droop, which is mostly likely due to detachment of bony origins of the perioral musculature during intraoral dissection. A consequence of cheek droop is an older appearance to the face after surgery. Therefore, the intraoral approach is recommended for patients with mostly anteromedial prominence and those with sparse hair in whom a coronal incision would leave a noticeable scar.

The advantages of our technique are that accurate osteotomies and resection of the exact amount of bone are possible because everything can be done under direct vision. Symmetry and sufficient reduction can be easily achieved. This procedure does not alter the natural curvature or contour of one's malar bone but simply moves the entire

complex to a location that will result in a more attractive appearance. It is easy to accomplish symmetric reposition of the mobilized zygomatic complex and to give rigid and stable fixation under coronal approach. Additionally, there is no cheek droop after surgery owing to complete redraping of the facial soft tissue. For patients who may benefit from forehead or subperiosteal face lift, the procedures can be performed concomitantly with malar reduction through the coronal approach.

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18 The Orbito-Malar Complex Reduction with Extended Approach

Jaehyun Kwon and Sanghoon Park

Pearls

1. There are some patients seeking additional improvement after reduction malarplasty. Major reasons are as follows: One is suboptimal reduction of zygomatic body, and another is prominence being located at or close to the orbital rim that cannot be improved by conventional reduction malarplasty.
2. Conventional reduction malarplasty focuses mainly on reduction of the anterolateral zygomatic body and zygomatic arch and offers limited improvement at the orbital rim.
3. In selected patients with malar prominence located close to the orbital rim, reduction malarplasty with a modified tripod osteotomy and burring of the orbital rim provides aesthetically satisfying and reliable results.
4. Both burring of the orbital rim and modified tripod osteotomy can be done through subciliary or transconjunctival approach, not through bicoronal approach.
5. The orbito-malar complex is osteotomized at the zygomatic arch, zygomaticomaxillary suture, and inferior to the usual zygomaticofrontal suture by a reciprocating saw and osteotome. The movable bony segment is repositioned and fixed at the lateral orbital rim, inferior orbital rim, and zygomatic arch. For minimizing bony step around the osteotome line and additional reduction of partial bony protrusion, burring also can be applied.
6. Care should be taken to protect the orbital tissue during the burring and tripod osteotomy by adequated retractors and good knowledge of three-dimensional anatomy.

Introduction

Most Asians have a relatively short and wide face, as a result of the prominence of the zygomatic body and arch [1–5]. In contrast to the Western perception wherein prominent cheekbones are considered attractive, Asians generally consider a slender face, with a less prominent zygoma, as aesthetic and desirable [6–9]. Against this cultural background, there is an increasing demand for facial contouring procedures, with reduction malarplasty becoming a favorite facial bone contouring surgery, especially in East Asian countries. Various surgical techniques with refinement in approaches, osteotomies, and fixation techniques have been developed and tailored to the patients' anatomy and individualized needs [6, 10–16]. Hence, the current overall outcomes with facial contouring procedures are reasonably satisfying.

However, some patients seeking additional improvement owing to undercorrection of the prominent zygomatic body and orbital rim with a

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S. Park (ed.), *Facial Bone Contouring Surgery*, DOI 10.1007/978-981-10-2726-0_18

resultant aggressive and masculine facial profile visit our center (Fig. 18.1). The major reasons for this could be either owing to suboptimal reduction of the zygomatic body or due to the prominence being located at or close to the orbital rim, rendering adequate osteotomy difficult. Conventional reduction malarplasty focuses mainly on reduction of the anterolateral zygomatic body and zygomatic arch and offers limited improvement at the orbital rim. Even if osteotomy is attempted as close as possible to the orbital rim, the results are only partially successful. Moreover, application of conventional techniques to these patients may result in an overcorrected zygomatic body, which highlights the orbital rim protuberance further and results in a hollow appearance of the midface. In all these cases, it is important to screen for, and diagnose, hypertrophy of the inferolateral orbital rim during initial consultation. Once diagnosed, a more targeted and effective reduction than the conventional reduction malarplasty is required. Herein, the authors present a technique of tripod osteotomy and burring method, modified and applied to the orbito-malar complex to achieve orbito-malar reduction as an attempt to effectively and reliably solve the problem of inadequate osteotomy in these patients.

Patient Assessment and Consultation

Patients who had previous conventional reduction malarplasty but were dissatisfied with the results seek secondary operation for further

Fig. 18.1 Preoperative (*left*) and postoperative (*right*) views after conventional reduction malarplasty. Note the lack of reduction at the anterolateral malar protrusion, especially at the inferolateral orbital rim area after conventional reduction malarplasty procedure

improvement as the zygomatic body and the inferolateral orbital rim continued to appear prominent. Some patients who complain of prominent cheekbones, which were assessed as difficult to be reduced by using conventional methods, are also proper candidates of orbito-malar complex reduction surgeries. All patients are analyzed by physical examination, along with clinical photographs and radiographic studies. Zygomatic arch view and three-dimensional computed tomography images are used for radiographic inspection to assess the extent of change before and after surgery. All patients have a detailed consultation with the surgeon to discuss their requirements and to understand the practical goals of the procedure before surgery.

Surgical Techniques

All patients are given general anesthesia. Orotracheal intubation is preferred at ID hospital, but nasotracheal intubation can be used. Intraoral, preauricular and subciliary, or transconjunctival approaches were universally applied. Intraoral and preauricular incisions are equal to those of conventional reduction malarplasty described at the previous chapter. Through these incisions, the soft tissues are elevated superiorly and laterally at the subperiosteal plane to expose the anteroinferior portion of the maxilla, zygomatic body, infraorbital foramen, and zygomatic arch with care taken to prevent infraorbital nerve injury. In contrast with conventional reduction malarplasty, dissection aims at exposing the zygomaticomaxillary suture as the osteotomy is performed along this suture line. For the subciliary approach, a skin incision is made inferior to the lower eyelashes, almost along the full length of the eyelid. To reach the orbital rim, a skin-muscle flap is elevated inferior to the lower eyelid. Preseptal transconjunctival approach is also useful especially in patients favoring invisible scars as possible. Lateral canthotomy can be considered to minimize the risk of periorbital tissue injuries and secure lateral orbital rim exposure. After the periosteum is incised, subperiosteal dissection

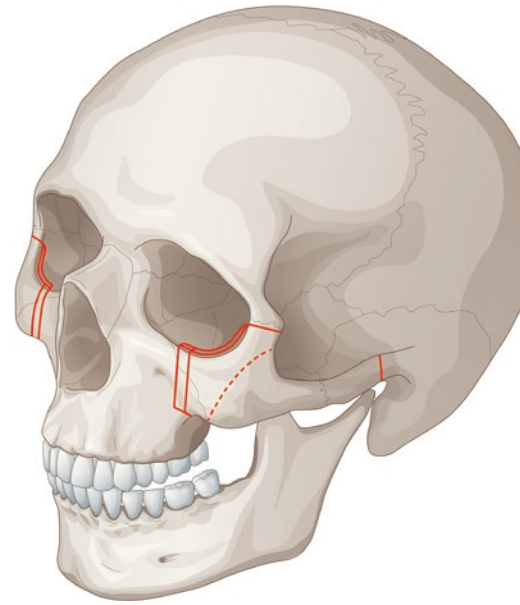

Fig. 18.2 Osteotomy lines of orbito-zygomatic reduction

was performed to expose the lateral and inferior aspect of the orbital rim. The extent of dissection of the lateral orbital rim is narrower than in conventional tripod osteotomy surgery, and the usual exposure of the zygomaticofrontal suture is not mandatory as the level of osteotomy and burring is inferior to the location of the suture.

Tripod Osteotomy

In patients with moderate to severe orbital rim protrusion, tripod osteotomy is a more effective strategy. The orbito-malar complex is osteotomized at the zygomatic arch, zygomaticomaxillary suture, and about 5 mm inferior to the usual zygomatico frontal suture by a reciprocating saw and osteotome (Fig. 18.2). The walls of the lateral and inferolateral portion of orbit are osteotomized at about 5 mm from the margin of the orbital rim, on the inner aspect of the orbital walls. Osteotomy lines are designed as shown in Fig. 18.3. The application of the osteotome around the orbital rim requires gentle osteotomy and manipulation to avoid the risk of

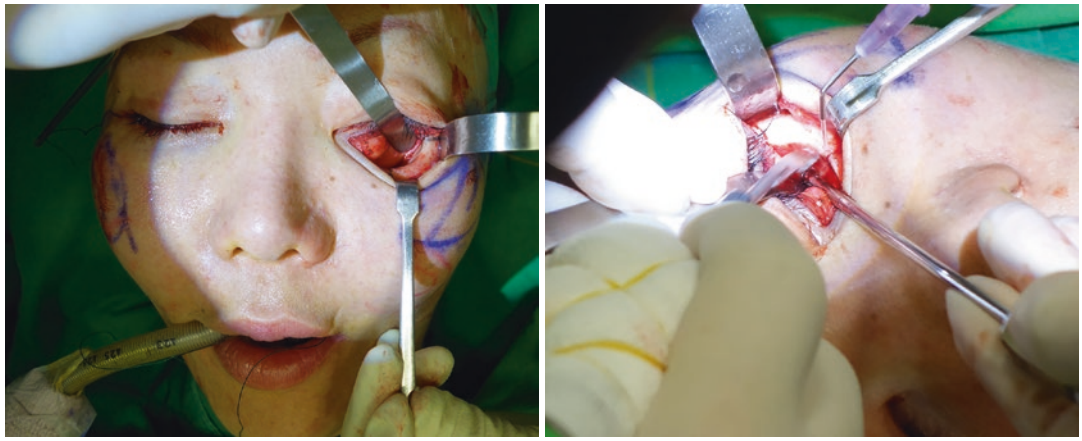

Fig. 18.3 Intraoperative photos. Osteotomy design of the orbital rim (*left*) and osteotomy using reciprocating saw and osteotome (*right*)

eyeball injuries, enophthalmos, and alteration in orbital volume. After the osteotomies are completed along the designed lines, the intervening bony segment is removed, shaved, and repositioned posteromedially as planned. The repositioning of the bony segment involved fixing with microplates and screws at the lateral orbital rim, inferior orbital rim, and zygomatic arch. Sophisticated burring is applied to palpable bony steps, if any, to obtain a smoother and more natural contour. Wound closure was performed after confirming bilateral symmetry.

Orbital Rim Shaving

In patients with mild orbital rim protrusion or localized protrusion, the orbital rim can be shaved off by burring method. After completion of osteotomy, the channel retractor is inserted to protect the soft tissue around the orbit and burring the rim ends leaving enough the cortical bone to fix the plate with resected zygomatic body. Irrigation of areas leaving no bony dust is critical and let the soft tissue re-drape naturally around the region. Quite extensive burring of the orbital rim is possible and proves to be a very effective and versatile method for orbitozygomatic prominence.

Key Technical Points

Conventionally, there are two surgical methods described for improving the prominent inferolateral orbital rim: one, shaving the orbital rim with a burr and, the other, mobilizing the orbital rim by tripod osteotomy. The shaving method is less invasive, but the rasping and burring of the orbital rim may be traumatic to the periorbital soft tissue, and the degree of improvement achieved may be inadequate. The tripod osteotomy, though more invasive, is considered to be more effective and reliable in achieving the desired improvement. Surgeons should make a decision which method is effective and efficient.

Case Study

Case 1

A 34-year-old woman complained of prominent zygoma and wide midface (Fig. 18.4, left). We recommended orbito-zygomatic reduction for this patient as she had concurrent protrusion of her orbital rim and zygomatic body and arch. Osteotomy was performed to achieve a 5-mm reduction of each zygoma in order to reduce the protrusion of her zygoma. The posterior part of the zygomatic arch was divided by performing a complete osteotomy. The osteotomized orbito-malar complex was shifted medially (by 5 mm) and posteriorly (by 3 mm) and fixed by using microplates and screws. The prominence of orbital rim and zygoma markedly improved as seen at 6 months postoperatively (Fig. 18.4, right).

Fig. 18.4 Preoperative view of a 34-year-old woman who underwent the orbito-zygomatic reduction surgery (*left*) and postoperative view at 6 months after the surgery (*right*). The protrusion of the inferolateral orbital rim is efficiently improved resulting in a smooth contour of the midface

Case 2

A 37-year-old woman had history of zygoma reduction surgery at another hospital 6 years prior to her consultation with us. She complained of prominence of the malar area, especially at the inferolateral aspect of the orbital rim (Fig. 18.5, left). Osteotomy was performed to achieve a 3-mm reduction of each zygoma in order to reduce the protrusion of her zygoma. The osteotomized orbitomalar complex was shifted medially (by 3 mm) and posteriorly (by 3 mm) and fixed by using mini-plates and screws. The prominence of the orbital rim and zygoma markedly improved as seen at 6 months postoperatively (Fig. 18.5, right).

Fig. 18.5 Preoperative view of a 37-year-old woman who underwent the orbito-zygomatic reduction surgery (*left*) and postoperative view at 6 months after the surgery (*right*). The protrusion of the inferolateral orbital rim is efficiently improved resulting in a smooth contour of the midface

Complications and Management

Complications include postoperative swelling, mild bruising, edema of sclera, and conjunctival congestion or irritation. Hematoma requiring surgical intervention, wound-related problems, unexpected fractures, diplopia, surgical site infection, permanent neurosensory deficit, facial paralysis, or facial asymmetry can occur [8, 11, 17]. Above all, avoiding injury to the eyeball and periorbital tissue is most important. If inadvertent injury to the orbital tissue occurs such as lacrimal duct system injury and retrobulbar hematoma that is known as ophthalmologic emergency, delicate ophthalmologic examination should be considered.

Discussion

Most of available studies related to reduction malarplasty focus on attempts to improve protrusion of the anterolateral zygomatic body and/or arch. There is limited information regarding management of specific cases of inferolateral orbital rim protrusion with or without zygomatic prominence. In these specific cases, even if osteotomy is performed as close to the orbital rim as possible, the degree of improvement is limited resulting in a dissatisfied patient, often seeking further consultations and operative corrections. Occasionally, surgery may result in the orbital rim being highlighted against the reduced zygomatic body, resulting in a facial appearance similar to that of patients with Treacher Collins syndrome. The orbito-zygomatic reduction is an effective technique aiding in the management of these specific cases.

Reduction malarplasty performed by using the tripod osteotomy technique was first described by Satoh and colleagues in 1993 [18]. They exposed the malar bone at the subperiosteal plane through a conventional coronal incision and fully detached the lateral canthal ligament to expose the lateral orbital rim. Tripod osteotomy was then performed, with osteotomy anteriorly at the frontozygomatic suture, laterally along the maxillozygomatic suture, and posteriorly at the temporozygomatic suture. After repositioning the osteotomized zygoma, interosseous wiring was performed at the frontozygomatic suture and the temporozygomatic suture. Even though this technique resulted in remarkable surgical results, this method did not gain popularity owing to its invasiveness and the associated morbidity.

With the development of the intraoral approach along with an increase in our expertise with the procedure, we were able to demonstrate comparable results with our procedure, at least in terms of reduction of the zygoma. In our procedure, since the lateral canthal osteotomy is below the zygomaticofrontal suture, lateral canthal ligament is preserved leading to a lesser risk of change in the shape and appearance of the eye. Intraoral orbito-zygomatic reduction also had additional advantages of smaller scars, shorter operation time, less bleeding, and lower risk of facial nerve injury.

Correction of malar protrusion using tripod osteotomy might seem excessive from the Western aesthetic point of view. However, East Asians favor a smooth facial profile with minimal malar protrusion and were satisfied with the results of orbito-zygomatic reduction achieved by us.

The ideal candidates for this surgery are patients with protrusion of upper one third of the zygomatic body and/or protrusion of the inferolateral orbital rim. In cases selected with precision, we propose orbito-zygomatic reduction as an effective alternative method for the correction of prominent zygoma accompanying inferolateral orbital rim protrusion.

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The Mini-Zygoma Reduction Surgery

19

Tae Sung Lee

Pearls

1. In the fields of facial bone contouring surgery, there is an increase in demand on improving mild or borderline problems in a minimally invasive manner.
2. Conventional full-scale reduction malarplasty procedure requires general anesthesia, while previously introduced minimally invasive reduction malarplasty lacks surgical stability and reliability.
3. The "mini-zygoma reduction surgery" introduced here is indicated for patients who seek for both minimal invasiveness and reliability, especially for patients with a chief complaint of wide midface width having isolated zygomatic arch protrusion without severe zygomatic body prominence.
4. Under local anesthesia, through both a temporal and sideburn incision, complete osteotomy is performed on the zygomatic body and the arch. After an inward reposition of the osteotomized zygoma segment, rigid fixation is done on the zygomatic arch with metal fixtures.
5. The surgery resulted in the patient's fast recovery and minimal postoperative swelling and the segments can be remained stable without any displacement of the bony segment.
6. The "mini-zygoma reduction surgery" can be the proper surgical option for patients showing a minimal zygomatic arch prominence and are seeking for a surgery that is minimally invasive, while predictability and reliability are assured with rigid fixation.

Introduction

The reduction malarplasty is popular especially among the Asian population which is widely performed for patients with prominent cheekbones resulting into a wide facial contour [1–5]. A wide-looking face is caused either by the lateral protrusion of the zygomatic body or a lateral projection of the zygoma arch. Conventional reduction malarplasty mostly focuses on managing the zygomatic body protrusion with less concern on the change of the zygomatic arch [6–11]. Therefore, for patients who have a wide facial appearance resulting from the lateral protrusion of the zygomatic arch even without any excessive zygomatic body prominence, a conventional reduction malarplasty may be improper and overly invasive.

The majority of reduction malarplasty surgical techniques include an intraoral approach [1, 3, 7, 8, 12, 13]. The intraoral approach has benefits compared such as concealed scars and

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S. Park (ed.), *Facial Bone Contouring Surgery*, DOI 10.1007/978-981-10-2726-0_19

the availability of direct visual access to surgical fields. However, it must be performed under general anesthesia in order to secure the airway during surgery. Meanwhile, more people are asking to improve the outlines of their facial contour by a simpler and easier way nowadays. To meet these needs, previous studies reported about the reduction malarplasty through either a Gillies' temporal approach or a small preauricular incision without intraoral incisions. However, the lack of rigid fixation resulting into an unpredictable and unreliable surgical outcome and possible bony nonunion are the major weak points of these "minimally invasive" approaches. The "mini-zygoma reduction surgery" can be an effecting surgical procedure in reducing the lateral prominence of the zygoma arch with a more simplified and reliable method while minimizing the disadvantages of other reduction malarplasty techniques [1].

Patient Assessment

Patients must thoroughly analyzed by physical examination together with imaging studies including clinical photographs, cephalometric and panoramic radiographs, and three-dimensional computed tomography. Preoperative status of any degree of facial nerve weakness or abnormality of the temporomandibular joint should also be identified preoperatively. Inpatients with isolated zygomatic arch protrusion without any over-prominence in the zygomatic body region are the proper indications for the mini-zygoma reduction surgery.

Surgical Technique

Operations were performed under local anesthesia along with intravenous sedation. After infiltration of a solution containing 1% lidocaine and 1:100,000 epinephrine to the proposed incision lines, first, an incision is made on the sideburn area for access to the posterior portion of the zygomatic arch. At this point, the incision should be deepened carefully as the incision site is adjacent to the frontal branch of the facial nerve. As the incision is reached to the periosteal layer of the zygomatic arch, a sharp incision is made on the periosteum. Subperiosteal dissection is continued for exposure of the osteotomy and fixation site. Using a reciprocating saw, complete osteotomy is performed just in front of the anterior tubercle of the zygomatic arch [1].

Another incision is additionally made on the temporal area with a length of about 2 cm, which is located approximately 2 cm posterior to the temporal hairline and 5 cm above the helical root of the ear. The incision is deepened down until the temporalis muscle is exposed. Through the surgical plane between the deep layer of deep temporal fascia and the temporalis muscle, blunt dissection is carried out downward until it reaches to the posterior margin of temporal process of zygomatic body. The posterior side of the periosteum on the temporal process of the zygomatic body is elevated with a periosteal elevator, and complete osteotomy is performed with a J-shaped reciprocating saw, guided under careful palpation of the nondominant hand. Anterior side of the periosteum on the zygomatic body is left intact even after the complete osteotomy (Figs. 19.1 and 19.2) [1].

After the osteotomy is completed on the zygomatic body, movability of zygomatic arch is visible through the sideburn approach. After all osteotomy procedures are completed, the arch is repositioned inwardly into the proposed position according to the preoperative surgical plan. Bone shaving by a surgical bur on the edge of the osteotomy margin may be performed to avoid palpability of the bony steps. After blunting the sharp osteotomy margins, the zygomatic arch is rigidly fixed using a prebent three-hole linear titanium plate and screws [3]. This allows the osteotomized arch segment to resist against a downward and rotational force which is mainly caused by the attached musculature (Fig. 19.3) [1].

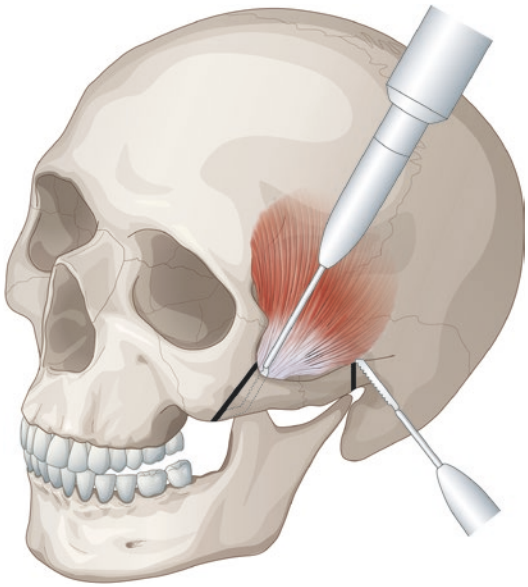

Fig. 19.1 Illustration of the mini-zygoma reduction surgery. First, osteotomy of the zygomatic arch is performed through a sideburn incision using a reciprocating saw. Then, osteotomy on the zygomatic body is done through a temporal incision with a J-shaped reciprocating saw

Fig. 19.2 Intraoperative photographs of the mini-zygoma reduction surgery. The zygomatic arch is completely osteotomized through a sideburn incision (*above*). The zygomatic body is osteotomized through a temporal incision, while the anterior side of the periosteum of the zygomatic body is left intact to avoid bone displacement (*below*). After all osteotomies are completed, the zygomatic arch is rigidly fixed with metal fixtures via the sideburn incision

Key Technical Points

1. During the approach through the sideburn incision, blunt dissection for the subcutaneous fatty layer is recommended rather than the use of electrocautery or sharp scissors to avoid injury on the frontal branch of the facial nerve.
2. Although the osteotomy is completed on the zygomatic body, it is important to confirm the mobility of the zygomatic arch before removing the saw from the zygomatic body osteotomy site because it is difficult for the surgeon to place the saw exactly on the previous osteotomy site if an additional sawing is required [1].
3. In cases which the zygomatic arch protrusion starts behind the anterior tubercle of the zygomatic arch, additional burring on the posterior portion of the osteotomy site on the arch will be helpful in achieving a more favorable result [14].
4. Patients may be discharged on the same day of surgery and informed to have soft diet for 2 weeks postoperatively. Trauma or direct pressure on the surgical site should be avoided for about a 6-week period after the surgery.

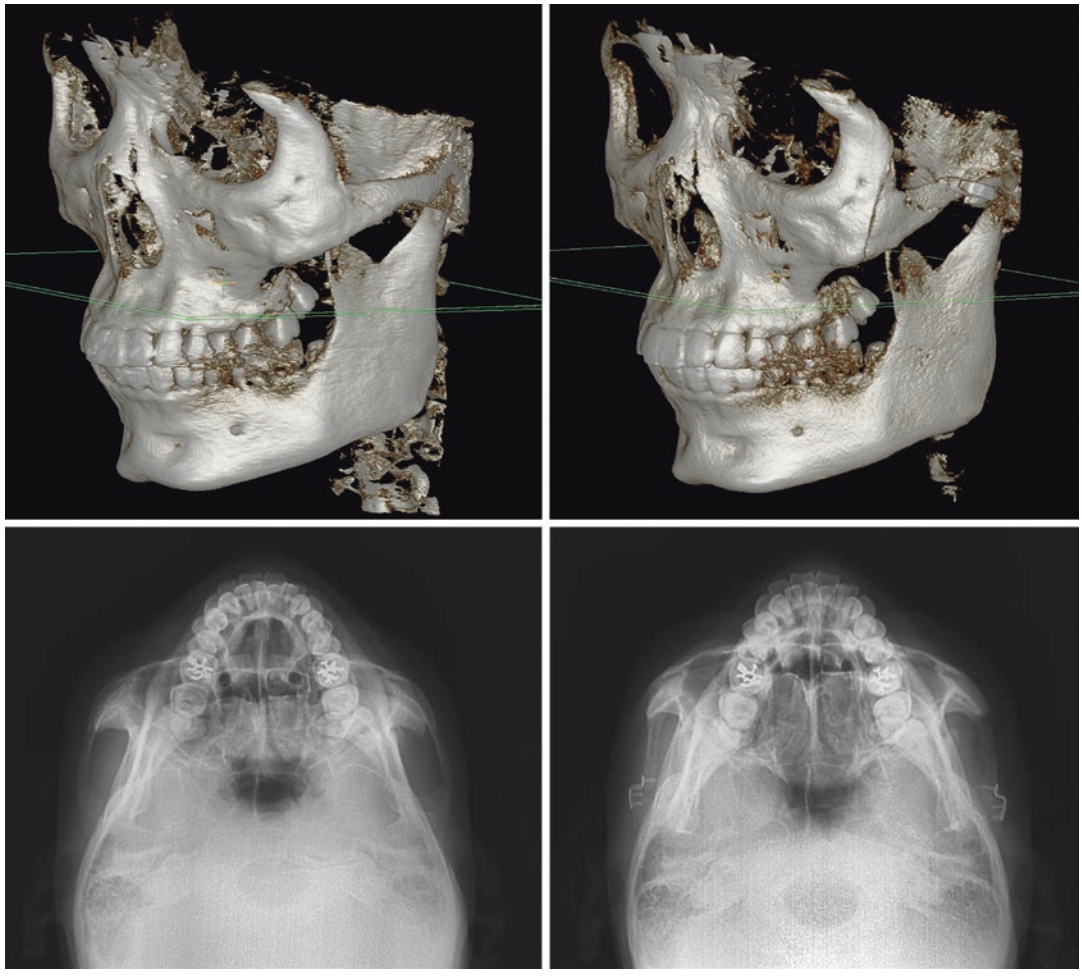

Fig. 19.3 Comparison on preoperative and postoperative imaging studies. Preoperative and postoperative three-dimensional computed tomographic images (*above*). Preoperative and postoperative zygomatic arch view radiographs (*below*)

Case Study

Case 1

A 28-year-old man with an outward protrusion of the zygomatic arch underwent the mini-zygoma reduction surgery. A concomitant mandibular angloplasty was performed. The protrusion of the zygomatic bone is efficiently improved resulting in a reduction of the midface width and a smooth facial contour (Fig. 19.4).

Fig. 19.4 Preoperative view of a 28-year-old man who underwent the mini-zygoma reduction surgery (*left*) and postoperative view at 4 months after the surgery (*right*)

Case 2

A 21-year-old woman with lateral prominence in her midface region was planned for the mini-zygoma reduction surgery. Botulinum toxin injection was done together to treat her masseteric hypertrophy. The outwardly protruding portion of the zygomatic bone was reduced to result in a slender and smooth facial contour and to a more feminine appearance (Fig. 19.5).

Fig. 19.5 Preoperative view of a 21-year-old woman who underwent the mini-zygoma reduction surgery (*left*) and postoperative view at 3 months after the surgery (*right*)

Complications and Management

According to a previous study reported from the authors' institution, the mini-zygoma reduction surgery was all performed under outpatient basis without any notable immediate complications such as unexpected bleeding or any degree of nerve injuries [1]. None of the patients required hospitalization for postoperative management. Other complications such as facial nerve paralysis, hematoma, infection, nonunion, or malunion of the bone segments were not reported throughout the same study.

Meanwhile, about 10.6% of the patients who underwent the mini-zygoma reduction surgery were not satisfied with the surgical results based on self-reports of patients [1]. They mainly complained about the remaining prominence in the zygomatic body. However, most of these patients with dissatisfactory results were those who previously refused a full-range zygoma reduction surgery under general anesthesia that was recommended by the surgeon. All of the patients with subjective dissatisfactory surgical outcomes later underwent a conventional zygoma reduction surgery to achieve a gratifying result [1]. In a few patients, the prominence of the zygomatic body was noticed postoperatively as the zygomatic arch was reduced; the body portion got relatively spotlighted. Strict inclusion criteria should be applied to the mini-zygoma reduction surgery by the surgeon to avoid additional surgery and increase patient satisfaction.

Discussion

Protrusion of the zygoma can be distinguished either by the protrusion of the zygomatic body or the protrusion of the zygomatic arch or sometimes even both [1, 3, 13, 15]. Conventional malar reduction techniques usually focus both on the zygomatic body and arch and surgically reduce both regions [6–11]. However, not all patients who have a wide midface show the sign of zygomatic body over-prominence. The proportion of patients who have isolated protrusion of the zygomatic arch region was roughly about 10% in a retrospective review on records of patients that visited the authors' institute.

Majority of the conventional malar reduction methods usually have a dual surgical approach that includes an intraoral incision accompanied with an additional percutaneous incision. However, the intraoral approach basically requires general anesthesia in order to secure the patient's airway during surgery, because certain amounts of bleeding or saline used for surgical site irrigation can go down through the airway and may lead to fatal respiratory difficulty [1, 16]. Also, soft tissue sagging or cheek drooping which is one of the major concerns after a zygoma reduction surgery is related with the wide dissection area during an intraoral approach. During the postoperative recovery period, cautions on dietary intakes should be taken to patients with intraoral incisions because of the possibilities of wound contamination.

In patients with isolated zygomatic arch protrusion without any over-prominence in the zygomatic body region, an intraoral approach is unnecessary to improve the aesthetics of the facial contour. A simpler surgical method without the need of general anesthesia can be performed in such selected cases and the aforementioned possible complications related with intraoral approaches can be avoided. Meanwhile, all previously introduced "minimally invasive" zygoma reduction techniques without an intraoral approach lack the usage of rigid fixtures [16, 17]. Downward displacement of the osteotomized zygomatic bone segment is one of the unpredictable complications after a zygoma reduction surgery which may lead to malunion or nonunion of the bony segment. For such reasons, the mini-zygoma reduction surgery introduces rigid fixation on the zygomatic arch through the sideburn incision [1]. The rigid fixations make the osteotomized segment to resist against the downward, rotational force that is mainly caused by the masseter muscle action, and provides long-term stability. Also by using a prebent titanium plate, the surgeon may equally reposition the zygomatic arch and also easily correct asymmetry by differentially repositioning the arch by using different sized plates [1, 2].

In conclusion, managing patients with a wide facial appearance needs to be categorized carefully whether the patient needs a reduction in the zygomatic body region or not. In carefully selected cases of isolated zygomatic arch protrusion, the mini-zygoma reduction technique provides a simpler way of improving the midface aesthetics while providing reliable and predictable results and can easily be adopted in outpatient basis.

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Alloplastic Augmentation of the Midface

20

Jongwoo Lim

Pearls

1. Augmentation in midface can give more volume and balance to a face in Asians.
2. The most frequently performed procedures are paranasal augmentation and suborbital augmentation.
3. In Asian countries, augmentation of the midface is frequently performed in paranasal area, but rarely performed in malar eminence because of the cultural backgrounds.
4. Alloplastic materials include implants such as silicone or porous polyethylene. Autogenous fat graft can replace the alloplastic materials, but it has limited amount of augmentation and unpredictability due to cell survival.
5. Autogenous bone graft is rarely used because of resorption.
6. Screw fixation of the implant not only prevents implant movement but also prevents gaps between the implant and the skeleton.

Introduction

In comparison with reduction malarplasty, augmentation of the midface is less often performed in Asian countries. Reduction malarplasty mainly focuses on the reduction of the width of face. In contrast, augmentation of midface focuses on augmentation of anterior-posterior dimension of face. It makes more volumetric and convex face. Most frequently augmented areas of midface are paranasal area and suborbital area. The alloplastic materials used are implants such as silicone and porous polyethylene. Autogenous fat graft or soft tissue filler are alternatives to implants, but it has limitation of unpredictability of the result and donor site morbidities. As to midface skeletal augmentation, alloplastic implants such as silicone and porous polyethylene (Medpor®) can give more long-lasting effect and predictability than fat graft does. But, implants have also shortcomings such as inflammation, migration, and discomfort of foreign body sensation.

The use of alloplastic implants to restore or improve contour of the facial skeleton was employed in the 1960s and 1970s when surgeons used alloplastic materials such as Silastic sponges and solid polyethylene to reconstruct posttraumatic, post-ablative, and congenital defects. In the 1970s and 1980s, Ed Terino, Bob Flowers, and Linton Whitaker saw the potential of skeletal augmentation with alloplastic materials as an important element of aesthetic facial enhancement. Using remote incisions to place biocompatible materials under well-vascularized soft tissues, they developed techniques to alter the contours of the facial skeleton reliably [1].

The materials used for skeletal augmentation of midface are mainly silicone and porous

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S. Park (ed.), *Facial Bone Contouring Surgery*, DOI 10.1007/978-981-10-2726-0_20

polyethylene. These two materials have different characteristics, so surgeon should understand the features and choose proper material.

Silicone implants have the following advantages: they are easily sterilized by steam or irradiation; they can be carved with either scissors or scalpel; and they can be stabilized with a screw or suture. There are no known clinical or allergic reactions to silicone implants. Because they have a smooth surface, there is no soft tissue ingrowth, allowing them to be easily removed. Disadvantages to silicone implants include the tendency to cause resorption of underlying bone, the potential to migrate if not fixed to the underlying skeleton, and the likelihood of its fibrous capsule to be visible when placed under a thin soft tissue envelope.

Polyethylene is a simple carbon chain of ethylene monomer. Polyethylene used for facial implants is porous with intramaterial porosity between 125 and 250 μm. The porosity allows fibrous tissue growth into the surface of the implant. The porosity of this implant has both advantages and disadvantages. Soft tissue growth into the implant lessens the tendency to migrate and to erode underlying bone. Porosity also allows some flexibility and adaptability of the implant. However, its porosity causes its soft tissue to adhere to it, making placement more difficult and requiring a larger pocket to be made than with smoother implants. The soft tissue ingrowth also makes implant removal more difficult.

In our institute, we prefer silicone implant to porous polyethylene for augmentation of paranasal area and suborbital area because silicone is easy to handle, fix, and remove. It is also cheap and easily available.

Patient Assessment and Consultation

Physical examination is the most important element of preoperative assessment and planning. Reviewing photographs with the patient can be helpful when discussing aesthetic concerns and goals. Most aesthetic augmentation procedures do not need any preoperative radiologic evaluations. In general, the size and position of the implant are determined according to surgeon's aesthetic judgements. But, in specific cases such as surgically altered or traumatically deformed skeleton, cephalometric X-rays and computed tomographic (CT) scans are required to review the skeleton in different planes and in three dimensions.

Most midface augmentation is done to enhance facial appearance in patients whose skeletal relationships are within normal range. Midface hypoplasia is a common facial skeletal variant. Occlusion of the patient with midface hypoplasia is usually within normal limit. They want more volume to flat or depressed area and desire more balanced facial appearance. Depressed paranasal area makes the nasolabial fold even deeper and consequently gives older impressions [2]. Flat suborbital area is frequently accompanied with prominent malar eminence and can also give old impressions. So, surgeon should carefully inspect the volumetric status of these two areas while consulting patient initially. Because facial bone contouring surgery can alter the facial dimension dramatically, adjuvant augmentation is effective for more balanced and harmonious profile.

Profile analysis can reveal deficiency or excess of suborbital area and paranasal areas. Because a concave face in profile view tend to give older looks, volumetric augmentation on midface are often required to make a convex midface giving youthful appearance. Alloplastic implant insertion in the paranasal area can simulate the effect of LeFort I advancement visually. Pyriform aperture augmentation increases the projection of the nasal base and opens the nasolabial angle. It also tends to lessen the depth of the nasolabial fold by effacing it from below.

Surgical Techniques

1. Alloplastic augmentation of the midface can be performed under either local anesthesia with sedation or general anesthesia. When implants are placed through intraoral approaches, general anesthesia with endotracheal intubation assures protection of

the airway and possible antiseptic preparation of the oral cavity.

2. Intraoral sulcus incisions are used likewise other facial bone contouring surgery. These incisions should be made with a sufficient labial cuff to allow watertight mucosal repair. Because the implant is a foreign body, watertight closure is important to prevent possible contamination and inflammation around the implant.
3. Paranasal augmentation is performed through an intraoral incision made about 1 cm above the upper gingivolabial sulcus. The medial extent of the incision is made just lateral to the pyriform aperture not to place incisions directly over the implant. Suborbital augmentation is done through an intraoral incision from the canine to the second premolar about 1 cm above the upper gingivolabial sulcus (Fig. 20.1).
4. Subperiosteal dissection exposes the area to be augmented. The infraorbital nerve should be identified and preserved. The extent of dissection is important because too wide dissection can cause large dead space resulting in seroma collection and resultant infection, while too narrow dissection can cause distortion of implant (Fig. 20.2).
5. The choice of appropriate size of implant is the most important factor for successful augmentation. It is helpful to place candidate implants over the skin surface to check the size and contour.
6. After choosing certain implants, the implants are carved with scalpel or scissors to adjust the size and surface fit to the area to be augmented. Then, the implants are washed with betadine solution and inserted through the intraoral incision.
7. Proper placement of implant is another important factor. In paranasal augmentation, if the medial border of implant is too far from the pyriform aperture, the effect of augmentation won't be sufficient and can cause unnatural demarcation. In contrast, if the implant is positioned over the pyriform aper-

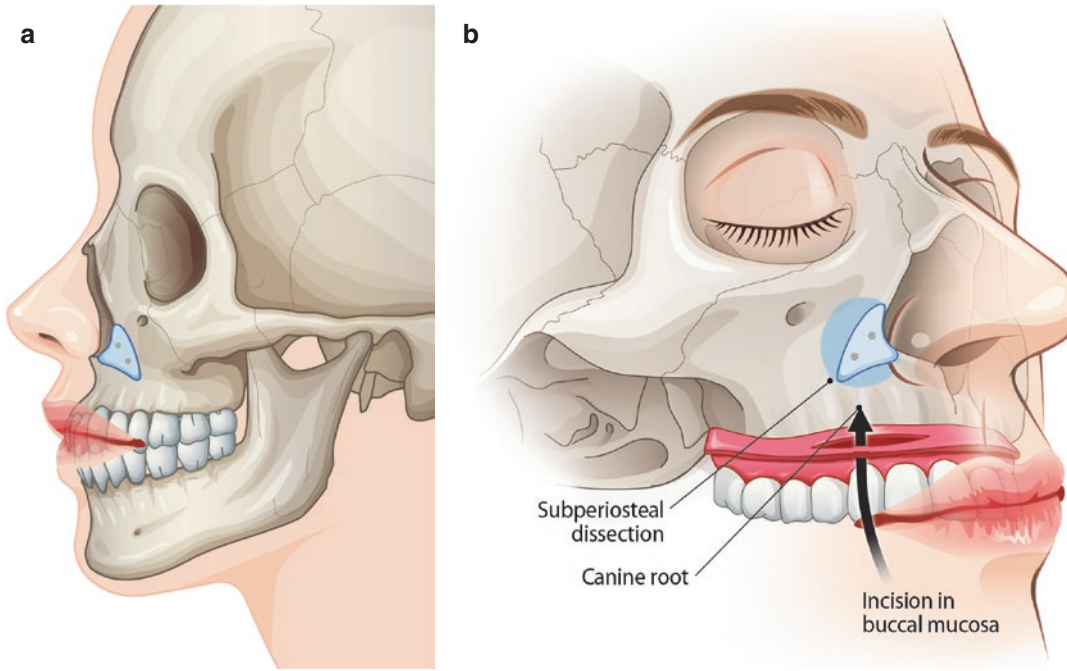


Fig. 20.1 Paranasal augmentation. Note that intraoral incision is made about 1 cm above the upper gingivolabial sulcus. Subperiosteal dissection exposes the area to be augmented. The infraorbital nerve should be preserved. Two points fixation with screws are recommended to prevent rotation of implant. The root of the canine should be avoided when the implant is immobilized with screws

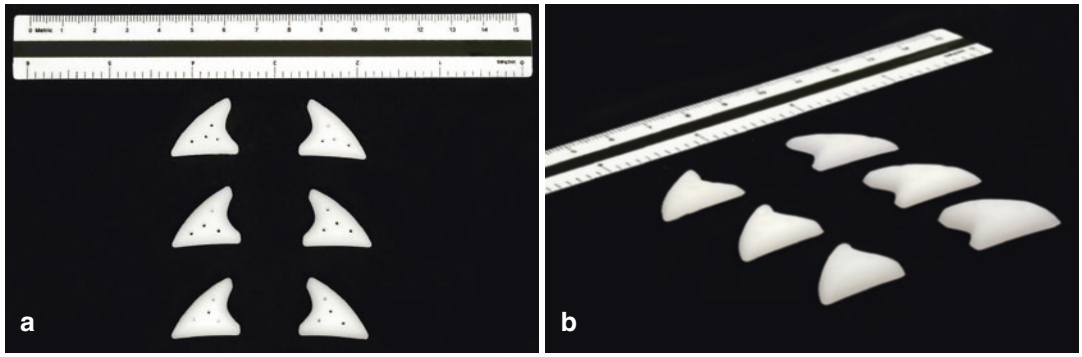


Fig. 20.2 Implants for paranasal augmentation. The implants used in ID hospital are shown. It is made of silicon, triangular shape with concave medial side to fit to pyriform aperture. The thickness of implants ranges from 2 to 6 mm usually

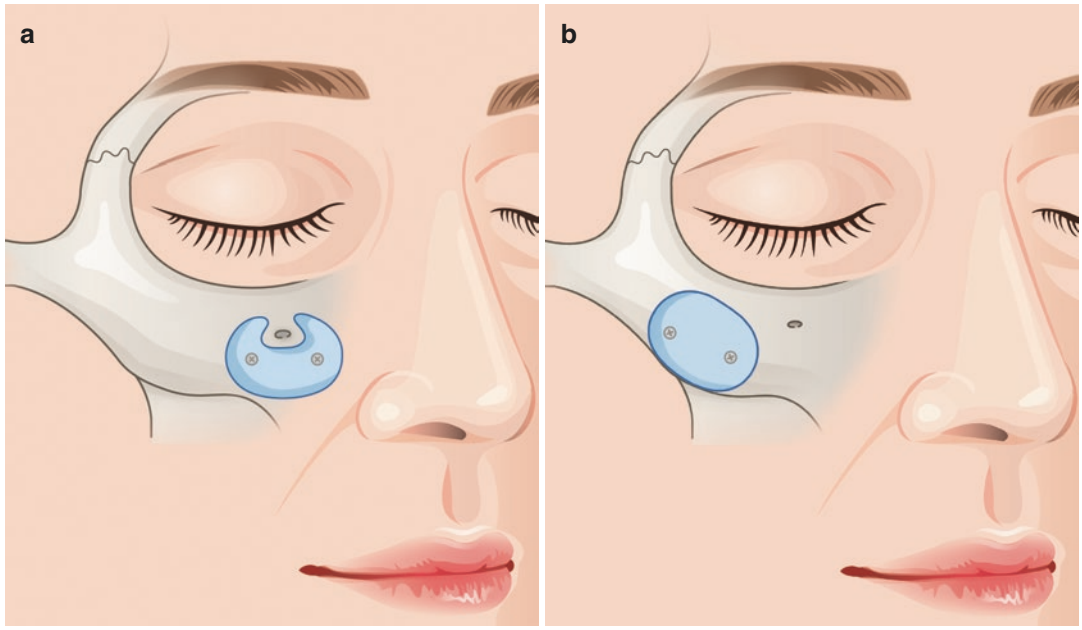
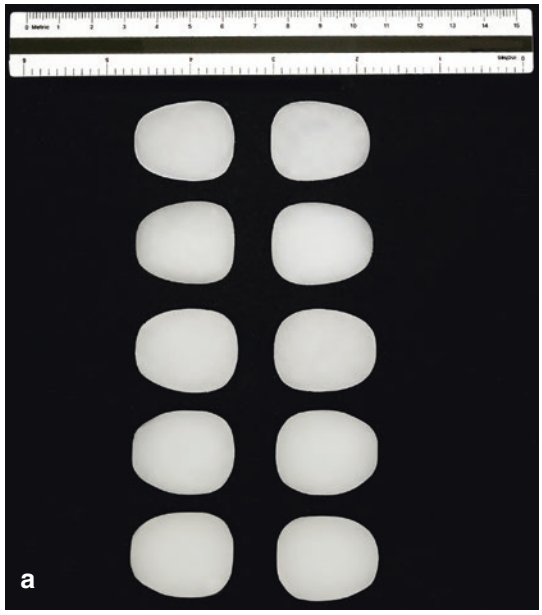


Fig. 20.3 Suborbital augmentation. (**a**) Note that the infraorbital nerve should be identified and preserved during the subperiosteal dissection. To avoid irritation or compression to the infraorbital nerve, the superior border of the implant should be trimmed. The posterior surface of implant should be carved to obliterate the dead space above the anterior surface of the zygoma. Implants are fixed with titanium screws in two points for immobilization. (**b**) Implants may be positioned on zygomatic body to augment the maximum malar projection

ture, it may compromise the nasal airway and distort the nostril shapes.

8. In suborbital augmentation, implant should be placed up enough to assure the proper augmentation. However, it should be away from the infraorbital nerve to keep the sensation in midface (Fig. 20.3).
9. Before immobilization with screws, it is better to check the augmentation effect and symmetry by view and manual palpation from the surface.
10. In general, at least two-point fixation with screws is recommended to prevent rotation of implant and to assure predictable



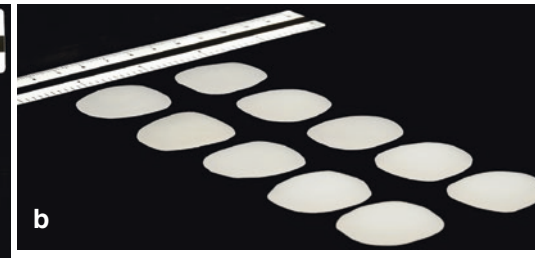


Fig. 20.4 Implants for suborbital augmentation. The implants used in ID hospital are shown. It is also made of silicon like paranasal implants. Unlike the paranasal implants, the shape is ovoid to rectangular with round border. The thickness of implants ranges from 2 to 6 mm

outcomes. The root of the canine should be avoided when the implant is immobilized with screws.

11. After massive irrigation with betadine mixed normal saline, meticulous hemostasis should be performed because even small amount of hematoma can cause infection around the implants (Fig. 20.4).
12. Finally, the wound is closed with 4–0 Vicryl in water-tight manner.

Key Technical Points

1. Proper selection of implant and placement are cornerstones in success.
2. Dissection should be minimized but not too small to distort the implants.
3. Immobilization with two points screws fixation give stable positioning of the implants.
4. Clean operative field and bleeding control are important to prevent infection.

Case Study

Case 1

A 25-year-old man was planned for the malar reduction and V line surgery. But, he had depressed paranasal area because of recessed pyriform aperture. Thus, paranasal augmentation is performed using silicon implants of 5 mm simultaneously with the malar reduction and V line surgery. At 2 month follow-up after surgery, the result was satisfactory for paranasal area to give more convex appearance to midface (Fig. 20.5).

Fig. 20.5 *Case 1*. A 25-year-old man was performed paranasal augmentation using silicon implants of 5 mm simultaneously with the malar reduction and V line surgery. At 2 month follow-up after surgery, the result was satisfactory for paranasal area to give more convex appearance to midface

Case 2

A 26-year-old woman was planned for the suborbital area augmentation simultaneously with the malar reduction surgery. The profile was flat to concave on midface, thus looked older than her ages. The thickness of silicon implant used was 4 mm. At 2 month follow-up after surgery, the profile view was improved flat to convex and she was satisfied with the result (Fig. 20.6).

Fig. 20.6 *Case 2*. A 26-year-old woman was planned for the suborbital area augmentation simultaneously with the malar reduction surgery. The thickness of silicon implant used was 4 mm. At 2 month follow-up after surgery, the profile view was improved flat to convex and she was satisfied with the result

Complications and Management

Infection

The presence of a foreign body decreases the minimal infecting dose of *Staphylococcus aureus* in an animal model due to impaired bacterial clearance. If microorganisms are not eliminated rapidly from an implant surface, they will adhere to the implant initially by nonspecific physical forces and then by the formation of biofilms characterized by clustering together in an extracellular matrix attached to the implant. Biofilms protect bacteria from host defenses and antibiotics. Since antibiotic treatment alone is usually not successful, facial implant-related infections are usually treated by implant removal, antibiotics, and appropriate wound care.

Sensory Disturbance

Sensory disturbance after alloplastic midface augmentation is usually caused by compression of infraorbital nerve by the inserted implant. Visualization of the infraorbital nerve before and after implant placement avoids problems with nerve compression. Secure fixation with screws is also important because migration of implant can cause compression or irritation.

Migration of Implant

If surgeons apply two-point fixation on the implant, migration of implant is a very rare complication. But it may happen if the screws are loosened and the fixation does not work. Another risk for implant migration is wide dissection without proper fixation. In case fixation is not used, dissection should just fit the implant to prevent migration.

Asymmetry

Asymmetric contour is not a complication, but rather a dissatisfactory result. However, this is the most common cause of implant removal or repositioning surgeries. So the surgeon should take great effort to place the implants symmetrically. For this, direct vision and palpation from the surface are recommended before final immobilization with screws.

Discussion

Skeletal Versus Soft Tissue Augmentation

Midfacial augmentation may be necessary due to either soft tissue problems or the skeletal problems. Therefore soft tissue or skeletal augmentation should be applied according to the respective causes of the problems. Sometimes, however, problems can be camouflaged with easier method.

Autogenous fat grafting and various soft tissue filler injection are effective for soft tissue volume loss due to senile atrophy or sagging. They show limited effects on an increase in skeletal projection. Fat injection has limited effect on focal soft tissue deficiencies such as paranasal hypoplasia.

In contrast to soft tissue augmentation, skeletal augmentation with alloplastic implant can give predictable projection to the hypoplastic midface skeleton. Bony resorption under implant may occur; however, the amount is usually negligible in midface comparing chin area where high pressure causes great resorption of underlying bone.

Implant Materials

Implant materials used for skeletal augmentation of midface should be biocompatible. There is an acceptable reaction between the material and the host. The host has little or no enzymatic ability to degrade alloplastic implants, so the implant can maintain its volume and shape. Autogenous bone graft will be remodeled to various degrees and changed in volume and shape after revascularized. So, its final shape and volume is highly unpredictable.

The host forms a fibrous capsule around the implant, isolating the implant from the host. The most critical features of implant that determines this encapsulation nature is the surface characteristics. Smooth implants result in smooth-walled capsule, whereas porous implants cause various degrees of soft tissue ingrowth that result in a less dense and less defined capsule. The most commonly used, commercially available materials today for facial skeletal augmentation are solid silicone, which has a smooth surface, and porous polyethylene.

Immobilization

Facial implants should be immobilized. Many surgeons stabilize the position of the implant by suturing it to surrounding soft tissues or by using temporary transcutaneous pullout sutures. Screw fixation of the implant to the skeleton is highly recommended in case of midface augmentation. Screw fixation prevents any movement of the implant and also assures adaptation of the implant to the surface of the bone. Screw fixation of implants not only prevents implant movement but also obliterates gaps between the implant and the native skeleton. Gaps result in unanticipated increase in augmentation and are potential spaces for hematoma and seroma formation.

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Secondary and Revisional Zygoma Reduction

21

Jihyuck Lee

Pearls

1. The etiology of unfavorable results after reduction malarplasty is classified into five categories: undercorrection of zygoma arch, undercorrection of zygoma body, undercorrection of zygoma arch and body, zygoma asymmetry, and zygoma malposition.
2. Sufficient medial displacement of the zygoma complex is necessary for adequate reduction of midfacial width. Appropriate posterior repositioning of the zygoma complex is necessary to reduce the malar protrusion in oblique view. Assessment of undercorrection or necessity of reoperation should be evaluated in terms of facial width and malar projection.
3. In most cases, intraoral approach can be used for secondary operation. However, coronal approach may be required when there are fractured segments, stiff soft tissue envelope.
4. Although greenstick fracture of arch and no fixation is easy and convenient, the result is difficult to control accurately and the position of arch is unstable. Instability of arch may induce asymmetry and relapse.
5. Inappropriate fixation of zygoma complex in reduction malarplasty can lead to zygoma malposition and cheek ptosis. Rigid fixation with sufficient and healthy bony contact is critical in secondary operation.

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Introduction

Reduction malarplasty is a popular aesthetic surgery for contouring wide midface and prominent malar area [1–9]. Some patients complain the postoperative results and want to revise the malar contour. The case of secondary reduction malarplasty grows up in Far East Asia. We analyzed the etiology of unfavorable results and performed secondary reduction malarplasty for correcting the problems of the previous surgery. The major complaint after a primary reduction malarplasty is classified into five categories: undercorrection of zygoma arch, undercorrection of zygoma body, undercorrection of zygoma arch and body, zygoma asymmetry, and zygoma malposition [10–14].

Although greenstick fracture of arch with no fixation is easy and convenient, the result is difficult to control accurately and the position of arch is unstable. Instability of arch may induce asymmetry and relapse. Recently, minimally invasive zygomatic reduction without fixation is one of the major sources of instability and relapse [11, 12, 14].

Inadequate osteotomy of the body is the most frequent source of undercorrection. If placed too low, the remaining body and orbital rim may

S. Park (ed.), *Facial Bone Contouring Surgery*, DOI 10.1007/978-981-10-2726-0_21

cause zygomatic prominence. Improper position after osteotomy is the second frequent source of undercorrection. Thus, during the operation, check the final position of zygomatic body before fixation and make sure that reduction is sufficient. Unsecure fixation may result drifting of body laterally and inferiorly due to muscle pull. Insufficient resection of zygomatic body is quite common when surgeon only use the osteotomy instead of ostectomy. In patient assessment, amount of bony resection in zygomatic body is critical and usually necessary in Asian patients [2, 3, 8, 12–14].

Patient Assessment

The midfacial and malar morphology of the patient is evaluated with clinical examination and radiologic images. The shape and position of zygoma is analyzed using simple radiography and three-dimensional computed tomography. The morphologic evaluation includes the degree of zygomatic prominence, the amount midfacial width, and the position of zygoma complex. According to the prominent degree and portion, the surgical plan was set up. The surgical plan consists of the amount of body resection, the amount of arch impaction, and the direction of repositioning [2, 12, 13, 14].

Surgical Technique

The authors approached the body of zygoma through an intraoral incision and the arch through a 1-cm-long vertical incision within the sideburns. The periosteum on the zygoma was dissected and the scar tissue was trimmed. Also we removed the wires, plates, and screws which used in previous surgery. The scar tissue interposed between the previous osteotomy and shaving site was removed. An inverted L-shaped osteotomy and a vertical linear osteotomy were applied to zygomatic body and arch, respectively. The previous osteotomy line was trimmed and the secure bone-to-bone contact was made. The osteotomized zygomatic complex then was brought into the desired position based on the surgical plan desired from preoperative analysis. With the zygoma in the desired position, it is stabilized with plates and screws at the body and arch of zygoma. The junction between the anterior and posterior parts of the separated zygomatic arch is fixed with a midplate and screws. Bending midplate was prefabricated for relaxing the residual strength. On the anterior side of the maxilla, the fixation was performed with double-bridged plate for enhancing the stiffness. With the double-bridged midplate and the prebending midplate, we can achieve the enhanced connection strength and improve the stability of the repositioned zygoma.

Cases

(A) Undercorrection of Zygoma Arch: Insufficient Midfacial Width Reduction

A 27-year-old female who previously underwent reduction malarplasty in other clinic visited our hospital. The patient complained that the facial width was not reduced. After a new body osteotomy was performed on medial side of the previous osteotomy, the arch was cut through sideburns incision. The osteotomized zygoma was impacted medially and fixed with plates and screws (Figs. 21.1 and 21.2).

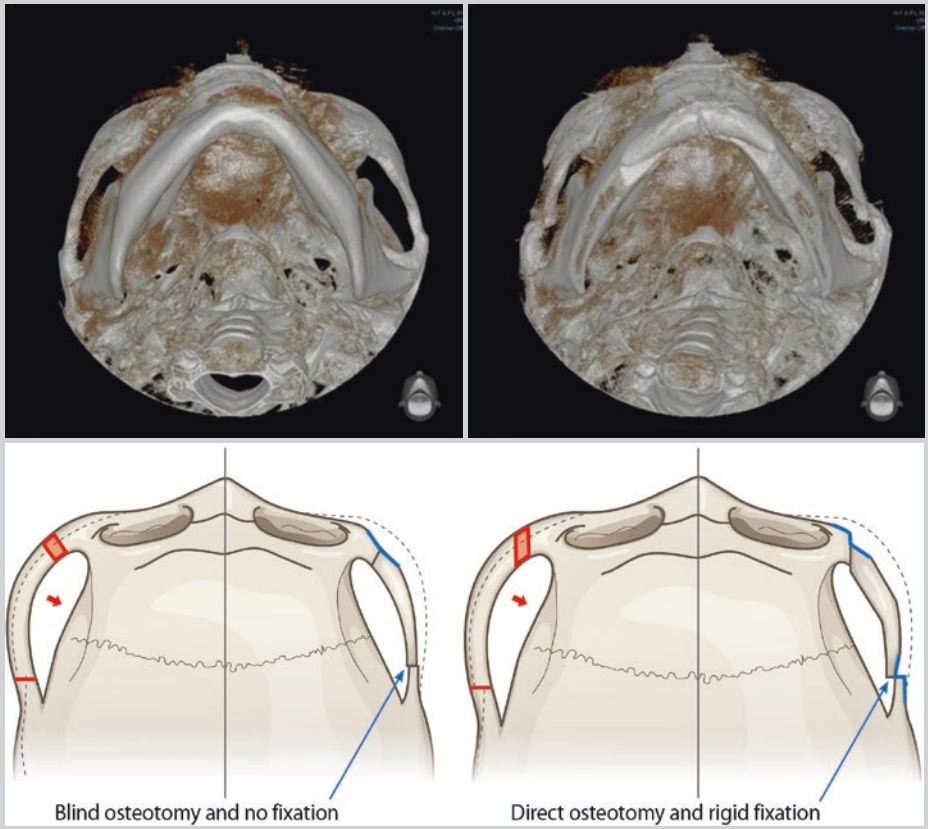

Fig. 21.1 (*Left*) Blind osteotomy and no fixation of zygoma arch. (*Right*) Direct osteotomy and rigid fixation of zygoma arch

Fig. 21.2 (*Left*) Preoperative frontal view. (*Right*) Postoperative frontal view

(B) Undercorrection of Zygoma Body: Malar Protrusion in Oblique View

A 26-year-old female who underwent reduction malarplasty through infracture technique. The patient complained that the body was still prominent. We reduced the body size and impacted zygoma medially with using medial impaction technique.

In infracture technique, greenstick fracture of body cannot effectively reduce the excess protruding body. Postoperative facial depression in the preauricular area was a common problem because only the posterior portion of arch was impacted medially.

In our technique, complete L-type osteotomy of body can effectively reduce the excess protruding body. And, balanced malar contours are achieved because we can freely control the degree of body impaction as well as arch impaction (Figs. 21.3 and 21.4).

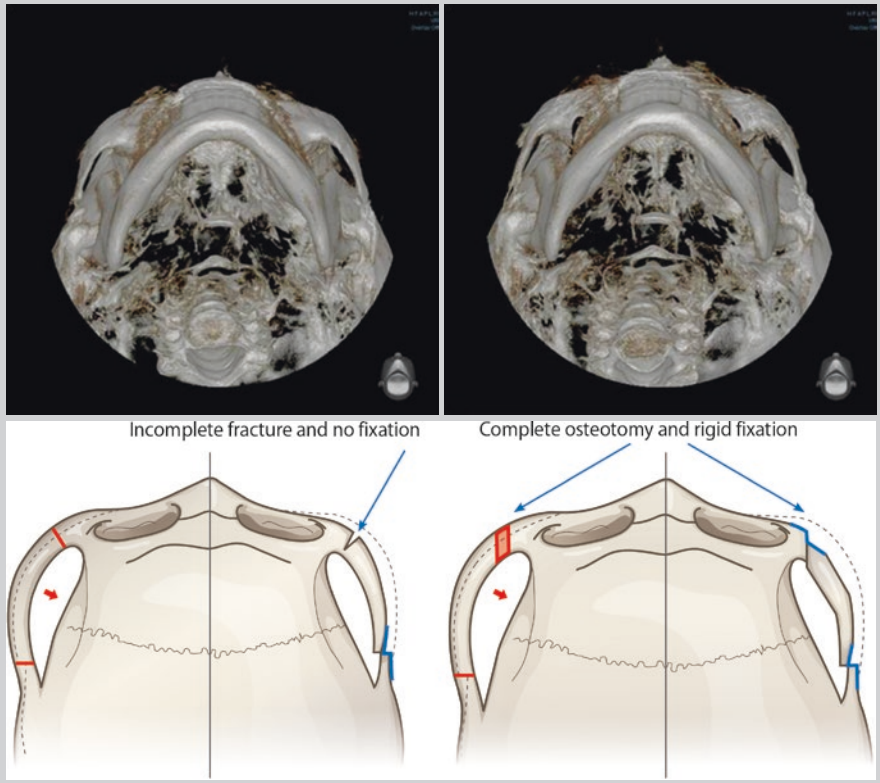

Fig. 21.3 (*Left*) Incomplete fracture and no fixation of zygoma body. (*Right*) Complete osteotomy and rigid fixation of zygoma body

Fig. 21.4 (*Left*) Preoperative frontal view. (*Right*) Postoperative frontal view

(C) Undercorrection of Zygoma Body and Arch: Total

A 25-year-old female who previously underwent reduction malarplasty complained that the zygoma was still protruded and the midfacial width was not reduced. The patient wanted secondary zygoma reduction for aesthetic reasons. After a new body osteotomy was performed on medial side of the previous osteotomy, the arch was cut through sideburn incision. The osteotomized zygoma was impacted medially and fixed with plates and screws (Fig. 21.5).

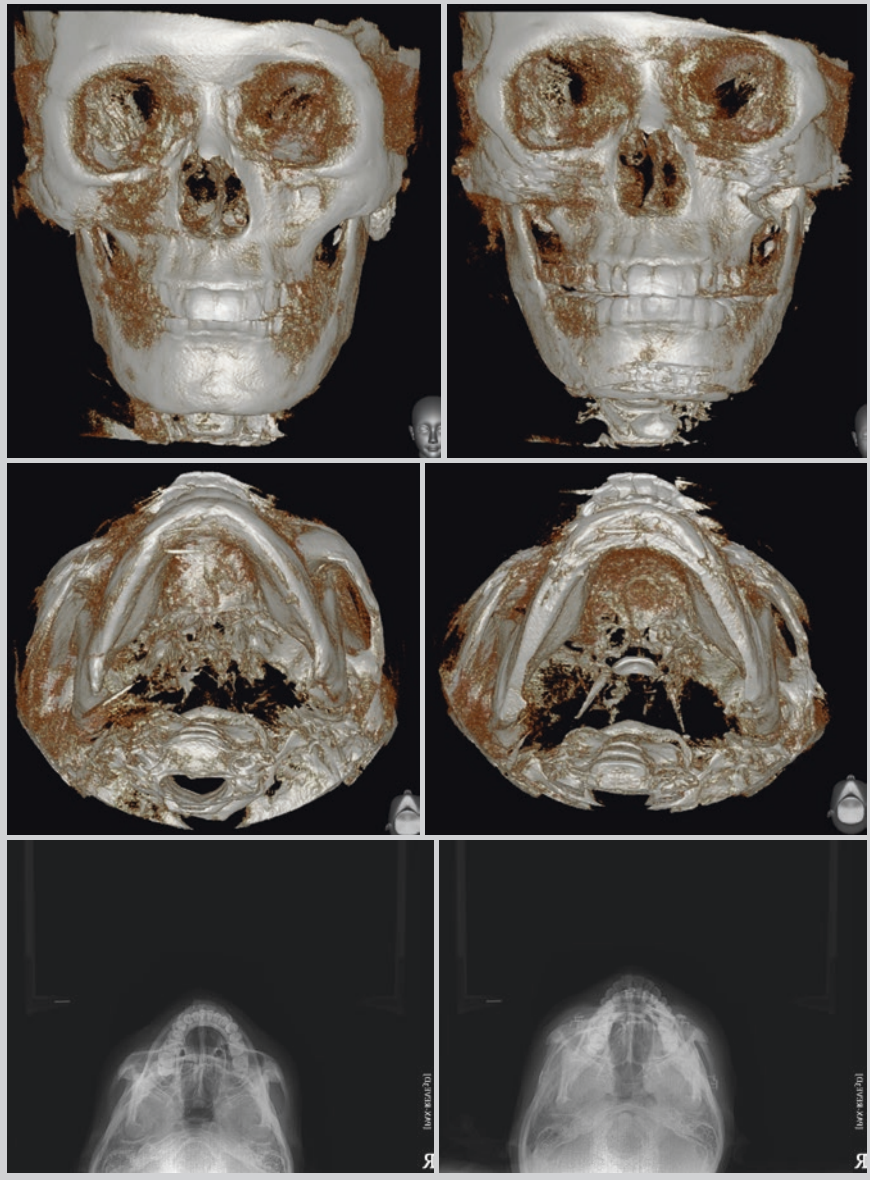

Fig. 21.5 (*Above and center, left*) Preoperative three-dimensional CT scan. (*Above and center, right*) Postoperative three-dimensional CT scan. (*Below, left*) Preoperative basal skull radiograph. (*Below, right*) Postoperative basal skull radiograph

(D) Asymmetry: Zygoma Malposition

A 29-year-old female patient visited our hospital for malar asymmetry and cheek drooping after primary reduction malarplasty. Right malar complex was displaced inferiorly by malunion and left zygoma arch was more protruded, resulting cheek drooping and malar asymmetry. After re-osteotomy and trimming at the previous osteotomy site, the right malar complex was shifted superiorly and medially. Two-point rigid fixation was performed with using plates and screws. More reduction of zygoma body and medial impaction of arch was made in the left (Fig. 21.6).

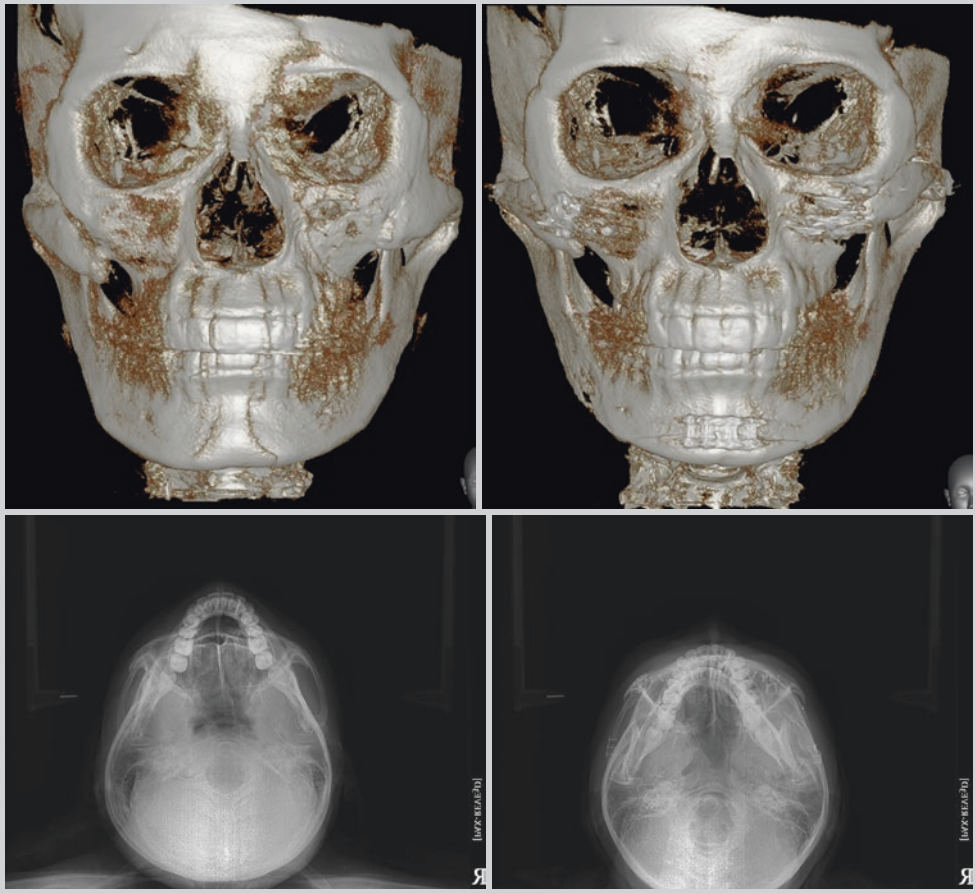

Fig. 21.6 (*Above, left*) Preoperative three-dimensional CT scan. (*Above, right*) Postoperative three-dimensional CT scan. (*Below, left*) Preoperative basal skull radiograph. (*Below, right*) Postoperative basal skull radiograph

Complications and Management

Most common complication in secondary reduction malarplasty was numbness of the upper lip and pain of the temple area. The numbness of the upper lip disappeared in 2–3 months. Zygomaticofacial nerve injury may cause the pain of lateral orbit and temple area. And temporalis muscle swelling and damage influenced on the temporary temple pain. Rarely few patients complained this kind of pain more than 1 year after reduction malarplasty. Anterior wall of maxillary sinus has to be opened and sinus mucosa was necessarily damaged for effective

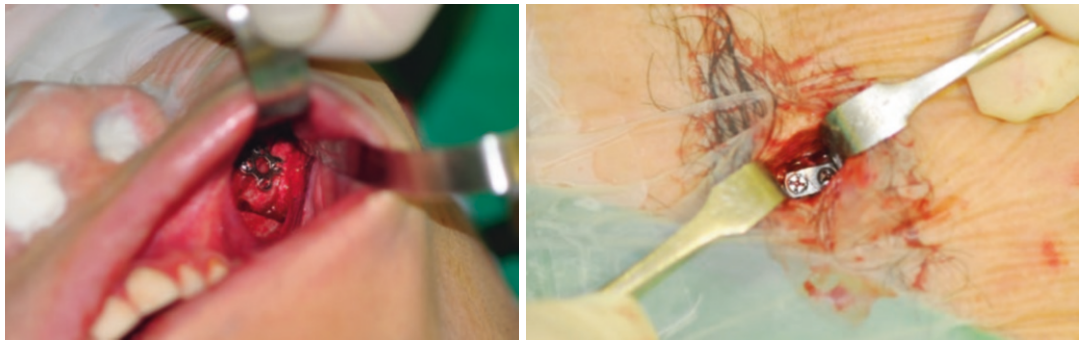

Fig. 21.7 Adequate bone contact and rigid fixation. (*Left*) Applying a double-bridged midplate to zygoma body. (*Right*) Applying a prebending midplate to zygoma arch

reduction of zygoma body. The anterior wall of the maxillary sinus was carefully managed during the osteotomy and should be kept as intact as possible during fixation for avoiding sinusitis. Amoxycillin-clavulanate was the first choice antibiotics for preventing and treating sinusitis.

Discussion

Surgical techniques for reduction malarplasty can be classified by three factors: approach, osteotomy, and fixation. Bicoronal approach was adopted in secondary cases because it provided definite manipulation under direct vision. But young patients do not prefer coronal approaches because of long scars [2]. In authors' experience intraoral approach can expose enough space even in most of secondary cases (Fig. 21.7). Absolute indication for coronal approach is multiple-segmented zygoma which cannot be controlled. In case of delayed nonunion or malunion, strong muscle pull and stiff soft tissue make the reposition of the zygoma impossible. In these cases, wide exposure and release of all the attaching soft tissue may be necessary via coronal approach [12, 14].

Nonunion of the osteotomy site may result in clicking sound, pain, and relapse. Major source of nonunion is insecure fixation; however, inadequate immobilization by mastication and trauma may be the sources as well. Vague, dull, sustaining pain around the maxilla and eye is a source of suspicion. However, accurate diagnosis is not easy. Diagnostic and imperative surgical intervention may be necessary in case of clinical impression. Complete resection of scar tissue between osteotomy, exposing fresh bony margin is critical. If there should be bony gap, proper bone graft is necessary. So preparation of bony donor site and discussion with patient on the necessity of bone graft is important.

Soft tissue depression along the osteotomy site is rare but happens in patient with thin skin. Bony gap or bony step may be reconstructed with either bone graft or alloplastic materials such as medpor. In most cases with mild depression, an easier way is fat injection or filler injection as a camouflage.

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Ancillary Soft Tissue Procedures of Zygoma Reduction

22

Seungil Chung

Pearls

1. While performing malar contouring procedure in Asians, plastic surgeons should pay special attention to ethnic characteristics of Asians whose prominent high cheekbone is usually accompanied by up-slanted eyes as well as abundant and thick soft tissues.
2. The up-slanted eyes leave a wide margin below the eyes and emphasize their high cheekbones, especially when smiling. Also abundant soft tissues and thick skin frequently cause cheek drooping and exaggeration of the nasolabial fold after zygomatic reduction. If worse comes to worst, descent of midcheek fat and skin causes jowls to develop.
3. To attain a more satisfactory midfacial contour, complementary procedures, when well-thought-out and implemented optimally, can in some cases have as much or more effect on the final result than the zygomatic reduction alone. The most representative "big two" procedures of those complementary procedures include lateral canthoplasty and midface lifting procedures.
4. There are several advantages of combining these operations in one sitting. One is the added periorbital approach enables us to reduce the remaining protruding inferolateral orbital rim, which will help refine the contour of the periorbital region including the upper zygomatic body. Another advantage is that reversion of mongoloid slant reduces the wide margin below the eyes and makes their high cheekbones less conspicuous, especially when smiling. In addition, soft tissue sagging is minimized by superomedial repositioning of the osteotomized malar complex and midface lifting procedure.
5. Surgical method of lowering lateral canthoplasty combined with zygoma reduction consists of two parts. One is a standard reduction malarplasty using L- or High L-shaped osteotomy via intraoral and preauricular approach. The other is a lowering lateral canthoplasty combined with protruding inferolateral orbital rim reduction, if necessary.
6. Midface lifting procedure using elastic thread is a preferred method for relatively young Asian patients who undergo facial bone contouring surgery.

Introduction

As surgeons, we see a patient requesting a reduction malarplasty. Then we perform a reduction malarplasty using our best skills and technique and (hopefully) get an esthetically pleasing result. One possible source of these problems is the soft

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S. Park (ed.), *Facial Bone Contouring Surgery*, DOI 10.1007/978-981-10-2726-0_22

tissue structure in the midface. However, we sometimes cannot obtain the satisfactory result for both surgeons and patients. Although zygomatic reductions are effective for midface contouring, some soft tissue procedures, when well-thought-out and implemented optimally, can have as much or more effect on the final result than the zygomatic reduction alone. Recently, we see more demands for the malarplasty patients with features such as single-eyelid, small palpebral fissure and high cheekbones. Their soft tissues over the malar area tend to be abundant, and even thick. Particular attention should be paid to the mongoloid slant of the palpebral fissure as well as cheek soft tissues for successful midface contouring. For example, some Asian patients with slanted eyes or thick soft tissues are not fully satisfied with the outcomes by simply reducing zygomatic prominence, even though surgical and technical issues are absent. They even request further surgery (Fig. 22.1).

Fig. 22.1 An example of unfavorable results after standard reduction malarplasty using L-shaped osteotomy. This patient with prominent cheekbones and up-slanted eyes underwent reduction malarplasty using standard L-shaped osteotomy. Although malar prominence was effectively reduced from the three-quarter oblique view, she complained that she still had a wide margin below the eyes from the front view. Thus, she wanted to have a further surgery, a lowering lateral canthoplasty, to attain a softer image as a separate procedure

There are two main reasons. One is because much attention on the contouring procedure has focused on the position of the zygomatic body and arch. As a result, periorbital appearance including mongoloid slant of palpebral fissure and the protrusion of the orbital rim as well as cheek soft tissues are often overlooked or ignored. Therefore, remaining up-slanted eyes leaves a wide margin below the eyes and become obvious among their high cheekbones, especially when smiling. Although prominent high cheek bones with the superolateral orientation of the brow and the mongoloid slant of the palpebral fissure are regarded as attractive and youthful by Western standards of beauty, they are not by Asians as it gives a strong and aggressive impression. Thus, recently, to attain a more attractive and smooth midfacial contour, lowering lateral canthoplasty are widely performed with reduction malarplasty as well among Asians.

However, the author believes that there are several advantages of combining the two operations in one sitting. One is the periorbital approach for canthoplasty enables us to reduce the remaining protruding inferolateral orbital rim, which will help refine the contour of the periorbital region including the upper zygomatic body. Another advantage is that reversion of mongoloid slant reduces the wide margin below the eyes and makes their high cheekbones less conspicuous (Fig. 22.2).

Abundant soft tissue and thick skin frequently causes cheek drooping and exaggeration of the nasolabial fold. Descent of midcheek fat and skin causes jowls to develop [1–3]. Many procedures from the least invasive laser rejuvenation to the most invasive conventional face lift surgery are available to correct soft tissue sagging. However, patients who undergo reduction malarplasty are usually young [4–6]. Thus, we prefer thread lift using elastic thread (Elasticum®, Korpo SRL, Genova, Italy) despite of its limitations.

Patient Consultation and Assessment

Preoperative Evaluation

Patient's photographic documentation and radiologic examination that includes zygomatic arch view and three-dimensional computed tomographic image are routinely obtained. A comprehensive evaluation of the entire midface including malar prominence, infraorbital rim protrusion, globe-orbital rim relationships, lateral canthal angle, and overlying soft tissues is essential to determine the combination of the procedures needed.

Preoperatively, the patient's periorbital appearance including lateral canthal slant and inferolateral orbital rim projection is thoroughly examined and discussed in sitting position and

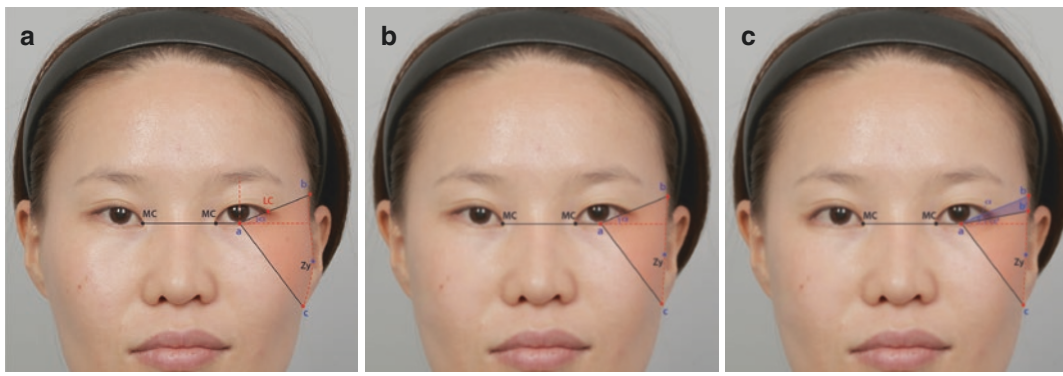

Fig. 22.2 Simulating the lowering lateral canthoplasty after reduction malarplasty. This simulation can demonstrate how vertical lowering and horizontal expanding of the lateral canthus make the high cheek bone less conspicuous by reducing the surface below eyes. 9.2% of malar surface area (a-b′-c) is decreased more than that of reduction malarplasty alone (a-b-c). Through virtual plastic surgery, we can verify the effectiveness of the combination of zyR and LLC. Also it shows the patients the potential changes that might occur

in order to determine how much lower the lateral canthus vertically and lengthen the palpebral fissure horizontally. The degree and location of external orbital rim prominence should be evaluated through three-quarter oblique view of the 3D CT to determine how much reduction of the rim by shaving method. Especially, in case of enophthalmic eyes with well-developed orbital rim, it should be reduced more than expected.

The lower lid itself should also be examined for laxity. A preoperative snap-back test and measuring intraoperative lid distraction are useful indicators of lower lid tone. This information can then be used to determine if a canthopexy vs. canthoplasty would be beneficial in restoring lower lid support and preventing postoperative complications related to lid malposition. Similarly, the degree of eye proptosis should also be noted prior to surgery, as this can influence optimal placement of the canthal anchoring suture. In particular, patients with slightly protruding eyes, lateral canthal suture should be placed superiorly to prevent for scleral show.

Patient Selection

Lowering Lateral Canthoplasty (LLC)

The main inclusion criteria were the presence of zygomatic prominence with up-slanted eyes. The exclusion criteria were acute or chronic sinus infection and lack of permeability of the osteomeatal complex. Also, the cases with a small eyeball surrounded by a prominent lateral orbital rim (enophthalmic eyes with well-developed orbital rim) were excluded as the lowering lateral canthopexy (LLC) may be less effective and may keep the lower lid away from the eyeball. In particular, patients with very protruding eyes ought to be excluded for fear of scleral show.

Simultaneous reduction of inferolateral orbital rim may be indicated in selected patients.

Cheek Lifting Procedure

After assessment of the patients' age, volume of fat and skin elasticity in an upright sitting position, the high-risk groups for skin and soft tissue sagging are selected as follows: (1) age over 40, (2) abundant cheek fat, and (3) thin skin and skin laxity. This is evaluated before the surgery because once the patient lies on a bed, soft tissue distribution is changed. Then, fat removal area, soft tissue sagging area, and lifting design are marked on the patient's face.

Surgical Technique

Lowering Lateral Canthoplasty Combined with Zygomatic Reduction

This LLC-Zy contouring procedure involves two, and sometimes three, basic maneuvers, which includes bone sculpturing along with high L-shaped osteotomy, inferolateral orbital rim shaving, if necessary, and, finally, repositioning of lateral canthus (Figs. 22.3 and 22.4). Under general anesthesia, with the patient in neck-extended supine position, the patient's zygomatic contour was designed. Two possible periorbital approaches are used depending on (1) whether the redundant skin of the lower eyelid needs to be excised or (2) the tendency of entropion. When excision of the lower eyelid skin is required or when ectropion is anticipated after LLC, the subciliary incision is useful. The transconjunctival approach allows for better scar camouflage. A continuous oblique canthotomy incision starting is made from the lateral canthus and extending laterally and inferiorly according to the slope between the lateral part of the upper eyelid and the lateral canthus. The length of the incision is usually 3–4 mm. Then dissection is carried out through preseptal space toward infraorbital rim. It is important to identify the infraorbital nerve and the zygomaticofacial nerve. Of these, the infraorbital nerve should be protected. However, the zygomaticofacial nerve might be

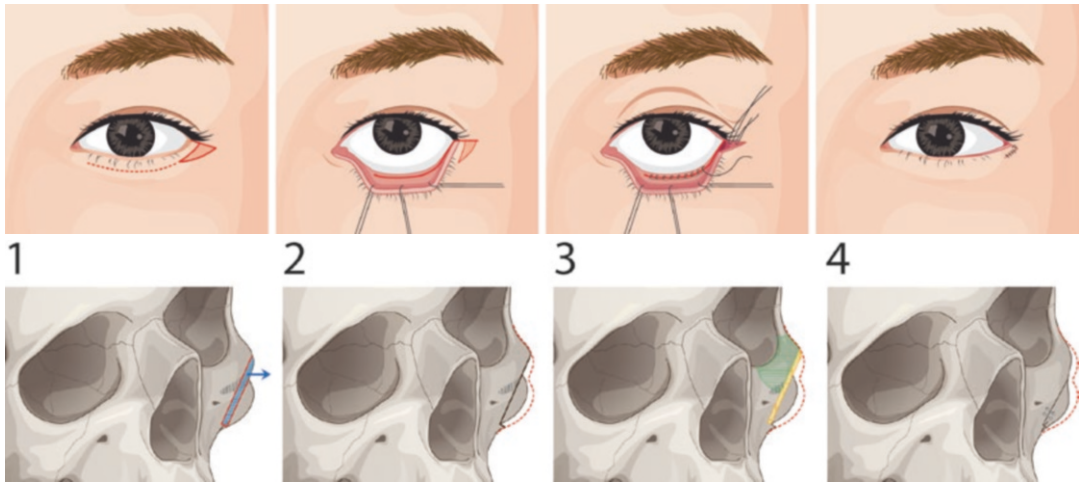

Fig. 22.3 Overview of complimentary procedure 1: lowering lateral canthoplasty combined with zygomatic reduction. (*Upper row*) once all of the contouring is finished, the detached lateral end of lower lid tarsus is secured toward inferolateral direction onto the periosteum of the lateral orbital rim (a lowering lateral canthoplasty). Canthopexy with section of the canthal ligament and low neo-canthal positioning alter the tilt of the eyelids. (*Lower row*) after the reduction and setback of the zygomatic body, protruding external orbital rim is reduced

Fig. 22.4 Clinical photographs show a step-by-step description of the LLC-Zy contouring technique. The process of lowering lateral canthopexy is divided up into these stages after the completion of the inferolateral orbital rim reduction through lower lid. A Senn retractor and a malleable retractor are used to retract the lower lid and the orbital contents

sacrificed inevitably to allow the medial oblique osteotomy to be placed close to external orbital rim. When combined with LLC procedures, this high-L osteotomy is a preferred method. The main difference of this technique with conventional L-shaped osteotomy is in the oblique part of the osteotomy line; the oblique line is moved more toward the external orbital rims in comparison with the L-shaped osteotomy, in which medial oblique osteotomy is placed lateral to the zygomaticofacial nerve foramen to avoid the injury. Reduction malarplasty is done in the same way. The lower lid and midface soft tissues are freed by subperiosteal dissection (area of dissection shown in green). It is important to eliminate any possible interference and inspect the transition zones, paying special attention to avoid any periorbital soft tissue injury.

Once all of the contouring is finished, the detached lateral end of lower lid tarsus is secured toward inferolateral direction (usually at lower pupil margin level) using nonabsorbable 5-0 nylon suture onto the periosteum of the lateral orbital rim. It is important to ensure that a new lateral canthal angle is formed as desired and that the proper contact between the eyeball and palpebral conjunctiva is maintained by preventing ectropion of the lower eyelid. Then pull the end of conjunctival flap and suture it to the skin of the lateral corner. The wound is closed while removing the dog-ear skin surrounding the lateral canthus by making the minimal incision following the cilia on the lower eyelid.

Elasticum Midface Lifting Combined with Zygomatic Reduction

The most important thing in our elastic lift is the exit point and thread returning point. Firstly, draw around the soft tissue bulge in the cheek; secondly, mark the point of maximal bulging. Thirdly, mark the exit point distal to the maximal bulge, keeping in mind the depth of subcutaneous needle penetration and direction of pull.

The elastic lifting procedure is performed under intravenous sedation in isolated cases and under general anesthesia in simultaneous cases with facial bone contouring surgeries. The incision sites at both scalp were infiltrated with 2% lidocaine and 1:100,000 epinephrine. Two vertical stab incisions are made with no.15 blade at the level of the highest point of ear helix. Then a sharp mosquito was used to dissect down deep to the temporal fascia. An Owl was used to anchor an elastic thread at the deep temporal fascia. The free end of the elastic thread was pinched with a mosquito to prevent it from pulling inside. Then the Jano needle®was inserted through the incision site opposite to the free end. The needle was passed through the deep subcutaneous tissue plane and extracted at the target point. It is important not to extract the needle entirely. There are five depth marks on the needle at each interval of 5 mm. So, the surgeon can adjust the distance from the needle exit site to the tissue which was actually to be lifted. The needle was extracted until the last one or two depth marks was shown, and the elastic thread was pulled through the needle exit site as much as possible. Then the needle was rotated toward the incision site bearing the free end. The needle was passed through deep subcutaneous layer with the posterior tip now becoming anterior and extracted fully at the incision site of the free end. Now, surgeon should evaluate that lifting layer was appropriate and lifting didn't cause any dimpling, depression, or soft tissue bunching by pulling the elastic thread with adequate power. The elastic thread was knotted under tension and placed deeply not to be exposed. The same procedure was carried from the opposite incision site with opposite direction use of Owl. The two stab incisions were sutured with no.4-0 nylon (Fig. 22.5).

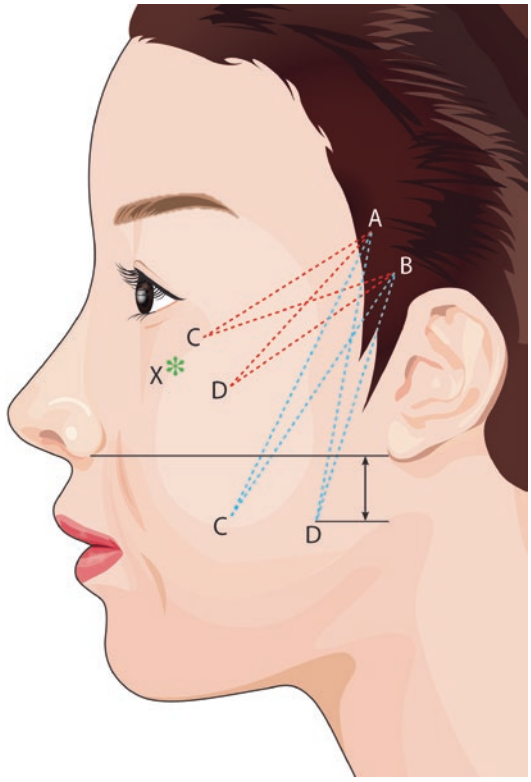

Fig. 22.5 Overview of complimentary procedure 2: elasticum-midface lifting combined with zygomatic reduction. Points A and B were drawn at the lower temporal region within the hairline. The line that connects the lateral margin of the alar base and the root of ear lobe was drawn. We drew points C and D, the malar fat pad region (located 1.0 cm proximal to the point "x"; 2 cm below the lateral canthus)

Cases

Case 1

Preoperative views of a 22-year-old female patient presented with a prominence cheek bone and up-slanted eyes. In anterior view, she showed a facial asymmetry and small lateral scleral triangle because of steep mongoloid slant. From the oblique view, a severely projected 45° zygomatic body and abundant soft tissues over malar area were noted. After reduction malarplasty using high L-shaped osteotomy (body resection 5/6 mm, setback 3/4, arch medialization 4/5, posterior arch shaving on both sides), mongoloid slant lowering was completed with downward movement of 2 mm and lateral extension of 3 mm on both sides. Five months postoperatively, the protruding cheek bone was reduced, mongoloid slant became less steep, and the lateral scleral triangle was enlarged (Fig. 22.6).

Fig. 22.6 Preoperative views of a 22-year-old female patient in Case 1 (*Left column*). Postoperative views after zygoma reduction combined with lowering lateral canthoplasty (*Right column*). Six months postoperative views showed that the contour of midfacial margin was smooth. And the slope of palpebral fissure became less steep. The lateral canthus was extended laterally and inferiorly exposing more sclera which gives a softer image, especially, while smiling

Fig. 22.6 (continued)

Case 2

A 52-year-old female patient with moderate skin sagging and wrinkle sought for minimally invasive facial rejuvenation with a low risk of complications and rapid recovery time. She underwent elastic midface lift and showed excellent results (Fig. 22.7).

Fig. 22.7 Preoperative views of a 52-year-old female patient in Case 2 (*Left column*). Postoperative views after elastic midface lift (*Right column*). Postoperative views showed that the contour of midfacial margin was smooth, which gives a softer image

Discussion

Reversion of mongoloid slant reduces the wide margin below the eyes and makes their high cheekbones less conspicuous, especially when smiling. Good candidates are patients with (1) exophthalmic eyes, (2) a distance of 4 mm or more between the lateral canthus and lateral orbital rim, and (3) a lateral fornix deeper than 3 mm [7]. It should be considered that the average value of the slant of palpebral fissure was 8.5 +/− 2.0 degrees for males and 8.8 +/− 2.5 degrees for females. When lateral canthoplasty is to be performed on an Asian patient, it would be better to apply 8.5 degrees as the standard for male patients and 8.8 degrees as the standard for female patients [8].

There is no single technique that can address the full spectrum of small palpebral fissure, and the surgeon must rely on a set of techniques that are applicable to specific types of small palpebral fissure. Of the appropriate techniques, the surgeons can use the most comfortable technique with themselves.

The two most frequent complications were under-correction and asymmetry. Under-correction usually is caused by relapse or inappropriate placement of the canthal anchoring suture. Under-corrected lateral canthus can be revised within the first few week of the initial operation. Beyond this period, however, revisions should not be attempted until after 6 months, or until the hypertrophic response has subsided. Frequently, revisions are required due to asymmetry in the lateral canthal angle and horizontal length. To prevent unnecessary revision, patients should be provided with sufficient explanations about how two lateral canthi have different horizontal length and vertical direction. The surgeon should inform patients about the possibility of developing minimal difference between the left and right, the possibility of additional operations, and the limits of these operations before surgery. Disadvantages of our method are exposure of red conjunctiva when the conjunctiva is pulled too much and a visible scar at the lateral part of the lower eyelid.

Patients with a significant amount of soft tissue would get minimal changes by facial bone contouring surgery alone, because the fatty layer and hypertrophic muscle conceal the effect of facial contouring surgery. Also it may cause cheek drooping [1–3]. To overcome these problems, soft tissue lifting procedures are required. Among the various methods, the author prefer to use less invasive elastic thread lifting ((Elasticum®, Korpo SRL, Genova, Italy). Elastic lift has four advantages over barbed thread lift. First, it can give more long-term elevation effect than absorbable barbed threads [9]. Second, elastic thread has elasticity that gives more natural lifting effect in resting and dynamic stage. Third, the elastic thread is impalpable because it has the same consistency with soft tissue and it has no barb. Fourth, when removal of the elastic thread is required, elastic thread can be easily removed because the core of nonabsorbable thread is silicon that does not cause adhesion with surrounding connective tissues. But it has also some limitations. First, many patients fear the placement of nonabsorbable materials in their faces. Second, it takes time for surgeon to learn about the insertion layers, traction force control, etc. Third, it has less data about the long-term effect and complication than barbed thread lift.

To accomplish the most natural, harmonious midface contouring, especially in cases of East Asians with unique anatomical characteristics as well as specified requests and goals, the surgeon should master not only the zygomatic reduction techniques but also the synergistic procedures (lowering lateral canthoplasty and midface lifting). When these procedures are applied optimally, they produce true synergy.

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