Cosmesis of the Mouth, Face and Jaws

Edited by Steven A. Guttenberg

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Chapter 8 Aesthetic Facial Implants

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Introduction

The last four decades have seen an increase in the use of facial implants in aesthetic surgery. Alloplastic materials offer a long-term solution to augment skeletal deficiencies, restore facial contour irregularities, and rejuvenate the face. Implants are used throughout the face with commonly augmented areas including as follows: the cheeks to balance the effects of malar hypoplasia; submalar and midfacial implants to augment the hollowness found with aging; nasal implants for dorsal augmentation; mandibular augmentation to create a stronger jaw profile and better nose–chin relationship; mandibular prejowl and angle implants to augment traditional cervicofacial rhytidectomy; and premaxillary implants to augment a retrusive midface. The marked improvement in biomaterials, in addition to the development of computer-assisted custom-designed implants, now provide solutions for more complex facial defects due to trauma, congenital deformities, or lipoatrophy.[1,2]

The concept of facial contouring includes changing the shape of the face. Modern hallmarks of youth and beauty are distinguished by bold facial contours emphasized by convex malar-midface configurations and a distinct, well-defined jawline. Any of these promontories that are too small or too large influence the aesthetic importance of the others. For example, reducing the nasal prominence results in increased definition of volume and projection of both the malar-midface and the mandibular-jawline. Similarly, enhancement of the mandibular or malar-midface volumes makes the nose appear smaller and less imposing. Substantive contour modifications may be surgically produced by judiciously altering mass and volume in various anatomical regions and redistributing the overlying soft tissue.

A thorough understanding and analysis of the face, including proportions, anatomy, and the aging process, is critical to the success of using facial implants. The appropriate implant will depend on the relationship between the bony promontories and the surrounding soft tissue. The individual arrangement of the malar-midface area, nose, and mandible-jawline determine the fundamental architectural proportions and contour of the face. Balance between these structures and the distribution of the overlying soft tissue determines facial beauty and harmony. Augmentation is typically accomplished through selecting implants with the proper shape and design while controlling their position over the facial skeleton and under the soft tissue. As a result, alloplastic facial contouring can be utilized to augment both bony and/or soft tissue anomalies.

Implants and biomaterials

All implants induce the creation of fibroconnective tissue encapsulation, creating a barrier between the host and the implant.[3,4] Adverse reactions are primarily a consequence of unresolved inflammatory response to implant materials. Characteristics of the site of implantation also influence the resultant reaction,

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including the thickness of overlying skin, scarring of the tissue bed, and underlying osseous architecture that may create a condition for implant instability. For example, implants that are deeply placed with thick overlying soft tissue rarely become exposed or extrude. Other important factors such as prevention of perioperative hematoma, seroma, and infection can significantly reduce interaction between the host and implant, and thereby improve implant survivability.

The ideal implant

The ideal implant material should be nontoxic, nonantigenic, noncarcinogenic, resistant to infection, and cost-effective. The implant itself should be easily shaped, conformable, simple to insert, static, and able to permanently maintain its form. Additionally, tailoring the implant to the needs of the recipient area during the surgical procedure should not be time-consuming, should not compromise the integrity of the implant, and it must be easy to autoclave without degradation.

Favorable surface characteristics are important for implant placement and stabilization, and paradoxically equally important to facilitate easy removal and exchange without causing injury to surrounding tissues. Implant immobilization is dependent on their capability to be permanently fixed in place for the lifetime of the patient. The characteristics of the implant material also heavily determine immobilization. For example, silicone elastomer induces the formation of a surrounding capsule that maintains implant position, while expanded polytetrafluoroethylene (ePTFE), which encapsulates to a lesser degree, provides fixation with minimal tissue ingrowth. The various material–host interactions provide certain advantages in different clinical settings. Materials that cause significant tissue ingrowth and permanent fixation are often undesirable, particularly if the patient wishes to revise augmentation characteristics in later years. The natural encapsulation process of silicone and the minimal surface ingrowth in ePTFE products insure immobility yet provide easy exchangeability without damage to surrounding soft tissue.

The ideal implant design should have tapered edges that blend on to the adjacent bony surface to create a nonpalpable and smooth transition to the surrounding recipient area. An implant that is malleable and readily conforms to the underlying structures further reduces mobility, while the anterior surface shape should duplicate the natural anatomical configuration. Newer silicone implants are currently being engineered for enhanced adaptability to the underlying bony surface and surrounding soft tissue. For example, Conform™ implants (Implantech Associates Inc., Ventura, CA) have a new type of grid backing that reduces the stiffness of the silicone elastomer and improves flexibility. Increased malleability to irregular bony surfaces reduces the potential for movement and prevents posterior dead space from occurring between the implant and underlying bone (Figure 8.1). Recent advances in research and development in biomaterial engineering have developed a composite implant (using both silicone and ePTFE) that promises to combine the advantages of both biomaterials for future use in facial implants.[5]

Conform mandibular

Malar shell implant

Figure 8.1 The Conform™ type of implant is made from a softer silicone material and has a grid design on the posterior surface of the implant that reduces its memory to more easily adapt to the underlying bone surface. The grid feature also reduces the chances of implant slippage and prevents displacement.

Implant biomaterials

Polymeric materials

Silicone polymers

Various forms of silicone have been used in clinical settings since the 1950s with excellent safety and efficacy profiles. Silicone is polymerized dimethylsiloxane that can take the form of a solid, gel, or liquid, depending on its polymerization and cross-linking. The gel form of silicone can potentially leak some of its internal molecular substances over time. Recent studies, however, examining the safety of silicone gel as breast implants have shown no objective cause and effect for silicone in producing scleroderma, lupus, collagen vascular, or other autoimmune diseases.[6,7]

Solid silicone products tend to be more stable as implants, as solid silicone elastomer has a high degree of chemical inertness.

It is hydrophobic and extremely stable without any evidence of toxicity or allergic reactions.[8] Tissue response to solid silicone implants is characterized by a fibrous tissue capsule without ingrowth. When unstable or placed without adequate soft tissue coverage, implants may produce ongoing moderate inflammation and possible seroma formation. Capsular contracture and implant deformity rarely occur unless the implant is placed too superficially or if it migrates to the overlying skin.

Polymethacrylate (acrylic) polymers

Polymethacrylate is supplied as a powdered mixture and is catalyzed to produce a very hard material. The rigidity and hardness of acrylic implants cause difficulty in many of the procedures utilizing large implants inserted through small openings. Furthermore, difficulties may exist in adapting the acrylic form to the underlying bony contour when using preformed implants.

Polyethylene

Polyethylene can be produced in a variety of consistencies and is now most commonly used in a porous form. Porous polyethylene, also known as Medpor® (Porex Surgical, Newnan, GA), causes minimal inflammatory cell reaction. The material is hard, and as such, difficult to sculpt. Additionally, the porosity of polyethylene permits extensive fibrous tissue ingrowth that provides an advantage for enhanced implant stability but makes it extremely difficult to remove.

Polytetrafluoroethylene

Polytetrafluoroethylene is composed of a group of materials that has had a defined history of clinical application. The known brand name was Proplast, which is no longer available in the United States because of the related complications of its use in temporomandibular joints. Under excessive mechanical stress, this implant material was subject to breakdown, intense inflammation, thick capsule formation, infection, and ultimately, extrusion or explantation. It is mentioned here because of its historical significance.

ePTFE

ePTFE was originally produced medically for cardiovascular applications.[9,10] Animal studies showed the material to elicit limited fibrous tissue ingrowth without capsule formation and minimum inflammatory cell response. The reaction seen over time compared favorably with many of the materials already in use for facial augmentation. The material has shown acceptable results in subcutaneous tissue augmentation and for use as preformed implants. Due to lack of significant tissue ingrowth, ePTFE offers advantages in subcutaneous tissue augmentation since it can be modified secondarily and relatively easily removed in the event of infection.

Mesh polymers

The mesh polymers, which include Marlex® (crystalline polypropylene), Dacron® (polyethylene terephthalate), and Mersilene® (polyethylene terephthalate), have similar advantages in their ability to be folded, sutured, and shaped with relative ease, but the materials also promote fibrous tissue ingrowth causing difficulty with secondary removal.

Supramid® (Resorba Wundversorgung, Nürnberg, Germany) is a polyamide mesh derivative of nylon that is unstable in vivo. It elicits a mild foreign body reaction with multinucleated giant cells, and over time causes implant degradation and resorption.[11]

Metals

Metal implants consist essentially of stainless steel, vitallium, gold, and titanium. Except for use of gold in eyelid reanimation and in dentistry, titanium has become the metal of choice for long-term implantation. The advantages of titanium include high biocompatibility, corrosion resistance, strength, and minimal X-ray attenuation during computed tomographic scanning or magnetic resonance imaging. Titanium is primarily used in craniofacial and dental implant reconstruction and does not lend itself for use in facial augmentation.

Calcium phosphate

Calcium phosphate or hydroxyapatite materials are not osteoconductive, but do provide a substrate into which bone from adjacent areas can be deposited.[12] The granular form of hydroxyapatite crystals are regularly used in oral and maxillofacial surgery for augmenting the alveolar ridge. The block form has been used as interpositional grafts during osteotomies.[13] These materials, however, have been shown to be of less value as an augmentation or onlay material due to their brittleness, difficulty in contouring, and inability to adapt to bone surface irregularities and mobility.

Autografts and homografts

Autografts, available as autogenous bone, cartilage, and/or fat, are limited by donor site morbidity and the amount of available donor material. Processed homograft cartilage has been used in nasal reconstruction, but eventually succumbs to resorption and fibrosis.

Tissue-engineered biocompatible implants

Tissue engineering of implant materials has evolved into a multidisciplinary field in the past few years. Characteristics and properties of synthetic compounds are now manipulated to facilitate delivery of an aggregate composed of dissociated cells into a host in order to recreate new functional tissue. This has evolved by combining scientific advances in multiple fields including materials science, tissue culture, and transplantation.

The protocol consists of seeding cells into a suspension that provides a three-dimensional structure to promote matrix formation. This structure anchors the cells and permits nutrition and gas exchange with the ultimate formation of new tissue in the shape of a gelatinous material.[14] A number of tissue-engineered cartilage implants have previously been generated based on these new principles, including joint articular cartilage, tracheal rings, and auricular constructs.

Tissue engineering offers the potential to grow cartilage in a precisely predetermined shape, and presently is in the developmental stage of generating various types of contoured facial implants consisting of immunocompatible cells and matrix.[15] Once employed on a commercial basis, these techniques would require minimal donor site morbidity and, like alloplastic implants, reduce operative time.

Surgical considerations for alloplastic implants

General

Patients with prominent, well-balanced, and strong skeletal features will better withstand the negative effects of aging.[16] An analysis of the adolescent face reveals an abundance of soft tissue that provides the harmonious composite of youthful facial form. Full cheeks with smooth, symmetrical contours free of sharp, irregular projections, indentations, rhytides, or dyschromias commonly embody these youthful qualities.[17] Facial aging is influenced by genetic factors, sun exposure, smoking, underlying diseases, gravity, and the effects of muscular action, which produce hyperfunctional lines of aging.[18]

Depending on the underlying skeletal structure, involutional soft tissue changes associated with the aging process result in transformations of the face that appear progressively more pronounced, and thus obvious, with time.

Recognizing structural and soft tissue defects and altered anatomy is an integral part of assessing whether a patient is a candidate for facial contouring procedures. Involutional facial changes include flattening of the midface, thinning and/or inversion of the vermillion border of the lips, development of deep cavitary depressions in the cheek, and formation of deep skin folds and rhytides.[19] Specific to soft tissue, alterations due to aging also include increased prominence of the nasolabial folds, flattening of the soft tissue button of the chin, and formation of the prejowl sulcus[20,21] (Figure 8.2).

One of the most elusive aspects of facial rejuvenation is the replacement of soft tissue volume in sufficient quantity that will remain for the life of the patient. The recent popularity of facial fat grafting has reemphasized tissue replacement as a key component of the rejuvenation process. Alloplastic augmentation techniques aim to address reductions in volume by softening sharp angles or depressions, reexpanding the underlying surface to reduce rhytides as well as enhance inadequate skeletal structure.[22–24]

Augmentation of the midface

Rhytidectomy has become just one of many components of facial rejuvenation. Midfacial augmentation, face-lifts, and resurfacing techniques must all be considered when customizing a surgical plan for the patient. The pathophysiology of the aging process is a key factor in determining the correct surgical treatment. It is now well recognized that the aging process not only results in the descent of midfacial structures but also produces atrophy of the soft tissue in multiple facial planes. Although midfacial rejuvenation is often achieved through suspension techniques alone, the surgeon must also evaluate whether augmentation of the soft tissue and/or skeletal foundation is needed.

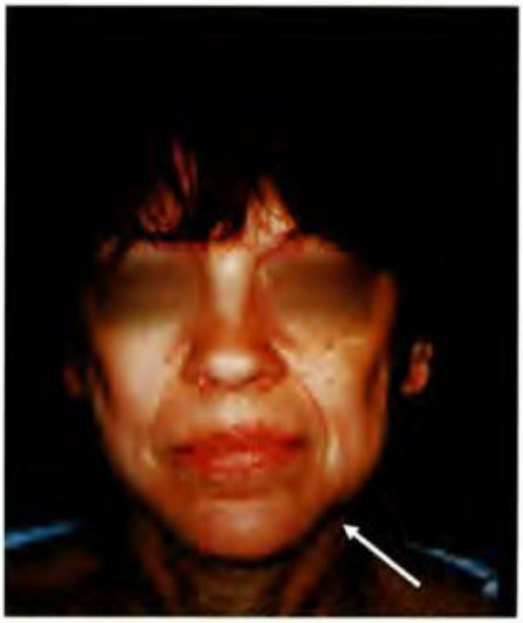


Figure 8.2 Resorption of bone within the anterior mandibular groove, coupled with relaxation of the soft tissue causing progressive encroachment of the jowl, creates the prejowl sulcus (arrow) and contributes to the development of marionette lines. In these conditions, a prejowl implant is used to augment and help correct the deficiency and assist the rhytidectomy to achieve the desired straight mandibular line and prevent recurrence of the jowl. (From Binder WJ. A comprehensive approach for aesthetic contouring of the midface in rhytidectomy. Facial Plast Surg Clin N Am 1993;1:231–55.)

Alloplastic augmentation of the midface is an effective way to rejuvenate the whole face in appropriate candidates. Midfacial implants are readily reversible and can be combined with standard rhytidectomy procedures, although some patients may require only augmentation via implants for facial rejuvenation. The procedure is a straightforward, long-lasting, and relatively low-risk surgical option that consistently and predictably improves facial aesthetics while producing changes on more than one level. It replaces soft tissue volume that was lost, which consequently increases the anterolateral projection of the cheeks and cheekbones, thereby improving laxity and decreasing the depth of the nasolabial folds. The net effect is a softening of the sharp angles and depressions of the aged face, resulting in a more natural, "unoperated" look.

Midface augmentation can also enhance rhytidectomy in several ways. The skin and soft tissue can be draped over a broader, more convex midface region after implant placement. There is also minimal traction on the perioral tissues and lateral labial commissures if the implants are placed prior to the rhytidectomy, which can help to avoid an "overpulled" appearance. Many patients who present for revision rhytidectomy who additionally require volume restoration can also be improved by

expanding the midface region while decreasing downward vertical traction forces on the lower eyelid.

Specific criteria are available for determining regions of structural and/or soft tissue deficits and their corresponding alloplastic solutions.[25,26] In addition, other regions that contribute to the overall appearance of the midface must be considered during evaluation of the patient. In the periorbital region, the aging process results in the weakening of the orbital septum and herniation of the periorbital fat, causing infraorbital bulges.

The orbicularis oculi muscle becomes ptotic, especially in its most inferior aspect. The use of conventional blepharoplasty will tend to aggravate laxity of the lower canthal ligament, which can contribute to the formation of the "tear trough" deformity and malposition of the lower lid.[27,28] These signs of aging are exaggerated in patients who have a negative vector to the infraorbital rim and malar bone or a retrusive maxilla.

The hollowness of the eyes found with advanced age is a result of subcutaneous tissue atrophy that has more damaging affects on the very thin infraorbital skin. Skeletal insufficiency and imbalances are usually caused primarily by the hypoplastic development and inherent bony imbalances of the facial skeleton that are exacerbated by the aging process. Midfacial descent involves ptosis of the infraorbital subcutaneous tissues, malar fat pad, the suborbicularis oculi fat (SOOF) and orbicularis muscle. The SOOF is the transition tissue between the orbital septum and the malar fat pad and is a thin layer of granular fat present under the lower orbicularis fibers. It is *not* connected with the periorbital fat, which remains separated from the SOOF by the orbital septum and its insertion onto the inferior orbital rim at the arcus marginalis.

As the cheek falls and the thicker tissues of the malar fat pad descend, it leaves the infraorbital region exposed to the covering of thin soft tissue. Thus, the tear trough and nasojugal groove areas become defined, the lower eyes appear hollow, and the infraorbital rim becomes more prominent. The mound of tissue on the superior border of the nasolabial fold becomes more defined. Although subcutaneous tissue loss occurs throughout the body, midfacial tissues that include the buccal fat pad, the malar fat pad, and the SOOF are more visibly affected than other areas of the face. As these tissues continue to lose volume and descend, the patterns of midfacial aging developing in the infraorbital and cheek regions become more apparent.

The majority of soft tissue deficiencies in the midface are found within the recess described as the "submalar triangle."[29] This inverted triangular area of midfacial depression is bordered superiorly by the prominence of the zygoma, medially by the nasolabial fold, and laterally by the body of the masseter muscle (Figure 8.3). The combination of significant soft tissue involutional changes associated with deficient underlying bone structure exaggerates the effects of the aging process. Individuals with thin skin lacking subcutaneous or deep supporting fat but have prominent cheekbones may also exhibit depressions in the cheek area. This type of pattern causes a gaunt appearance in an otherwise healthy person, although the severe form of this pattern can be seen in anorexia nervosa, starvation, or HIV-associated lipoatrophy. In combination with the primary disease process,

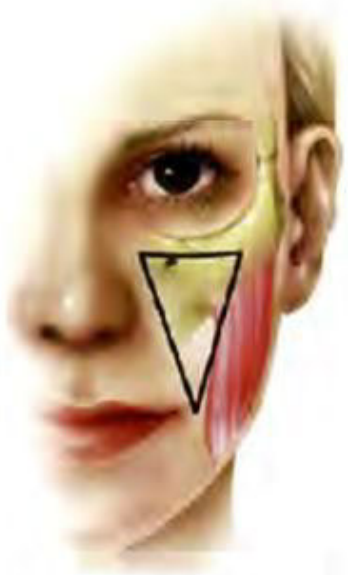


Figure 8.3 The inverted submalar triangle is an area of midfacial depression bordered medially by the nasolabial fold, superiorly by the malar eminence, and laterally by the main body of the masseter muscle.

protease inhibitors and other newer generation HIV therapies have a predilection for erosion of the midfacial fat and the buccal fat pad[1,2] (Figure 8.4). These conditions of volume loss, in addition to the aging process, often preclude rhytidectomy or fillers alone to completely rejuvenate the face, but can be successfully and permanently treated with the use of computer-assisted custom-designed facial implants.[30]

A three-dimensional approach must be utilized for successful rejuvenation of the midface. The descent and volume loss of the midface must be corrected, replaced, or camouflaged. The surgeon must therefore approach facial rejuvenation using a multimodality paradigm. Camouflage techniques such as lower blepharoplasty with fat repositioning can result in the blunting of the nasojugal groove/tear trough recession by securing the infraorbital fat past the arcus marginalis.[31] Cheek lifting techniques counteract midfacial descent by lifting the tissues and anchoring them in a more superior-lateral direction.[32] Alloplastic or autogenous augmentation techniques reduce the effects of midfacial descent by replacing volume and providing soft tissue support at the deepest plane. Acknowledging the many elements of structural deficiency and phenomena of aging, multimodality treatments at different levels of soft tissue and bone are thus necessary to restore the face to a more youthful appearance.

Nasal augmentation

The relatively thin skin overlying the nasal dorsum often fails to provide adequate camouflage for poorly contoured replacement tissue. Effective long-term dorsal nasal reconstruction has continued to remain problematic despite extensive use of a wide variety of equipment, including autografts, allografts, and

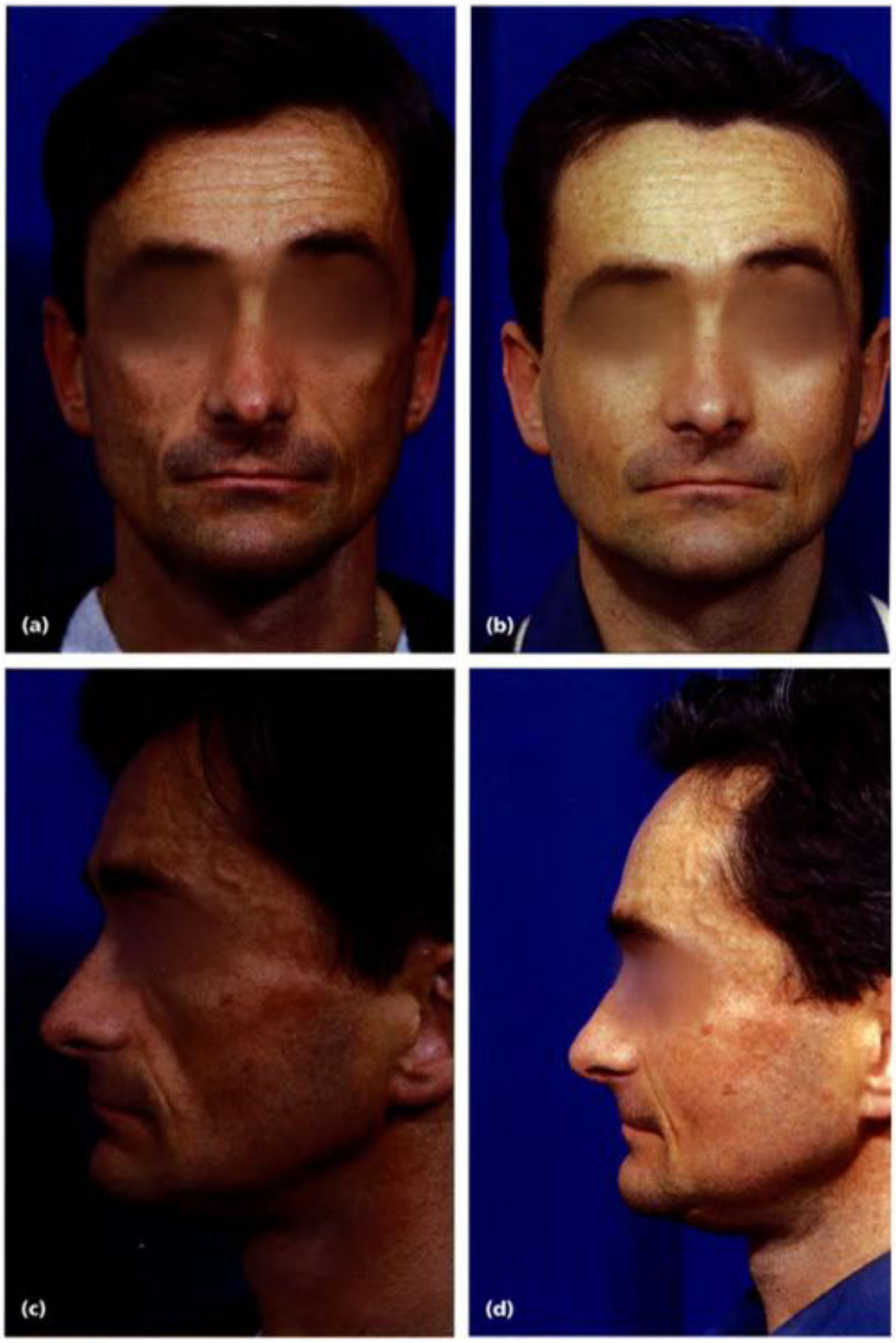


Figure 8.4 (a and c) Preoperative photographs of an HIV patient who has been treated with protease inhibitors for a prolonged period of time. Many patients eventually develop complete erosion of the midfacial fat and the buccal fat pad, leaving a particularly deep cavitary depression in the midface. (b and d) One year postsurgery, the condition was successfully treated with computer-assisted custom-designed midfacial implants.

alloplastic materials. An appropriate replacement implant to reconstruct the original nasal profile must possess a number of unique characteristics. Its shape must be of adequate length, consistent curves, thickness, and tapered edges so that it can fit well over the nasal bridge and blend in with the surrounding soft tissues and bone. It must also possess a high degree of malleability, flexibility, and compliance so that the implant can endure long-term stress and trauma.

Autogenous tissues such as calvarial bone grafts, as well as septal, conchal, and costal cartilages, are always preferred. Septal

and conchal cartilages, however, often do not provide adequate volume. Costal cartilage and calvarial bone grafts have a high rate of donor site morbidity, and costal cartilage has the potential to warp. Homograft cartilage has previously been utilized for nasal reconstruction, but has a high percentage of resorption. Currently, the most commonly used alloplastic implants for nasal augmentation consist of silicone, ePTFE, and polyethylene (Medpor). Silicone can eventually produce overlying skin atrophy and must be anchored to prevent movement. Silicone and ePTFE have the potential for infection, but are easily removed and replaced. Polyethylene implants, as with any other implant that promotes significant tissue ingrowth, has the potential for extensive soft tissue damage to the overlying skin if removal becomes necessary. Currently, silicone is the most commonly used alloplastic implant in Asian rhinoplasty.

Mandibular augmentation

Mandibular augmentation is perhaps the simplest and most powerful aesthetic procedure available to the surgeon. The key to mandibular augmentation is in the restoration of anterior projection and/or expansion of lateral contour. Mandibular enhancement can create a stronger profile and improve the presentation of the nose by making it appear smaller and less imposing. Additionally, augmentation of the prejowl sulcus and the mandibular angle can help enhance the effects of rhytidectomy by creating a sharper cervicofacial angle. The primary indications for mandibular augmentation include as follows: as a stand-alone procedure for mandibular augmentation; as an adjunctive procedure to rhinoplasty with an emphasis on profileplasty; and as an adjunctive procedure to rhytidectomy, which is often necessary for obtaining a long-lasting jaw-neck line in patients with mandibular deficiency.

The mandible can be divided into three zones for the purposes of augmentation[33] (Figure 8.5). Zone 1 consists of the central chin area, which extends from the mentum to mental foramen. Zone 2 is midlateral, defined by a line extending from the mental foramen posteriorly to the oblique line of the horizontal body of the mandible. Zone 3 of the premandibular space encompasses the posterior half of the horizontal body, including the angle of the mandible and the first 2–4 cm of the ascending ramus.

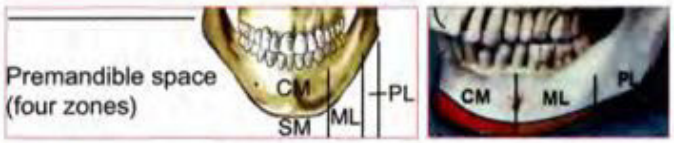


Figure 8.5 Zones of the mandible. Zone 1 consists of the central chin area, which extends from the mentum to mental foramen. Zone 2 is midlateral, defined by a line extending from the mental formen posteriorly to the oblique line of the horizontal body of the mandible. Zone 3 encompasses the posterior half of the horizontal body, including the angle of the mandible and the first 2–4 cm of the ascending ramus. CM: chin midline; SM: submental; ML: mandibular lateral; PL: posterior lateral.

The central chin area (Zone 1) is one of the most important aspects of profileplasty while performing rhinoplasty, as the projection of the chin directly affects the illusory projection of the nose in an inverse relationship. The traditional chin implants, placed only within Zone 1 without lateral extension into the midlateral zones, often created suboptimal results. These early implants, unidimensionally designed with a single vector, were often bulky, not anatomically correct, and often gave the appearance of an abnormal and unattractive round chin protuberance. Moreover, a centrally placed, smaller implant has a greater tendency to shift or rotate than a larger, more extended implant. Most of these early problems have been corrected with the design of the extended mandibular implants that occupy Zones 1 and 2. Placement of an implant that extends into at least two zones (central chin and midlateral) also results in a natural widening of the anterior jawline in addition to increasing the vertical dimension of the lower third of the face (Figure 8.6). Augmentation of the posterior-lateral zone widens the jaw to produce a stronger posterior jawline contour. This can be achieved using a mandibular angle implant to augment the posterior lateral zone of the mandible (Zone 3).

The atrophy and descent of soft tissue, volume loss, and skin laxity in the lower face manifest themselves as a loss of a straight jawline, the development of a prejowl sulcus, jowling, and/or marionette lines. Evaluating the lower face shows that the prejowl sulcus exhibits a marked drop-off in soft tissue volume and bony mandibular projection with aging. The sulcus or depression can occur from several factors such as a deficiency of bone, congenitally narrow mandible, or aggregation of soft tissue around the mandibular ligament that contributes to the jowl. The skin overlying the prejowl sulcus is also significantly thinner than the skin lateral or medial to this location. The anterior mandible may form a deepening of the prejowl sulcus due to flattening of the soft tissue button of the chin. Additionally, the anterior mandibular groove deepens, which further accentuates the jowls.

Reestablishment of a smooth mandibular line and treatment of the jowl primarily requires rhytidectomy, which repositions and tightens the soft tissue along the lower third of the face. Rhytidectomy alone, however, may not completely address the prejowl sulcus and in that case, a prejowl implant is required. Prejowl and chin implants have been developed for use in conjunction with face-lift surgery and submental liposuction to enhance the ability of these procedures to create a smooth, well-defined straight jawline (Figure 8.7).

Preoperative analysis for facial contouring

General

Facial augmentation is a three-dimensional procedure that exponentially increases the variability of structural diagnosis and treatment. A thorough understanding of skeletal anatomy and the ability to identify specific types of topographical patterns is necessary to guide the surgeon in making the final decision for optimal implant selection and placement. Evaluation of the

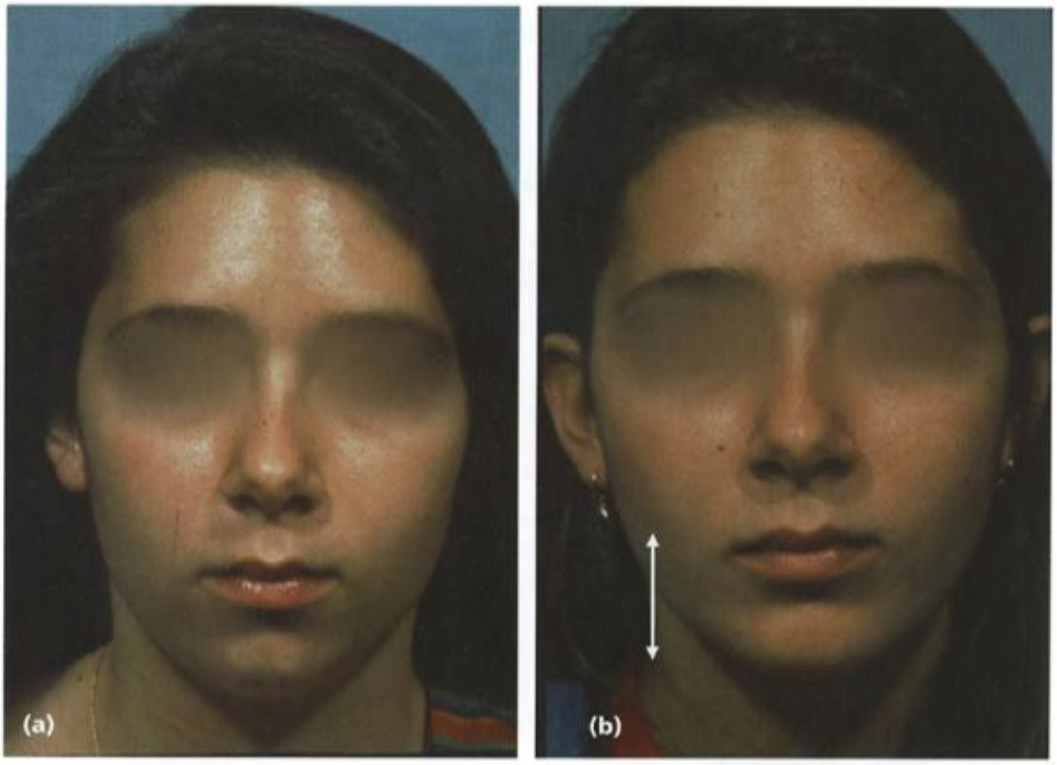


Figure 8.6 Preoperative (a) and postoperative (b) photographs of a patient who underwent placement of an implant that extends across two zones (central chin and midlateral). Note the natural widening of the anterior jawline, as well as the increase in the vertical dimension of the lower third of the face.

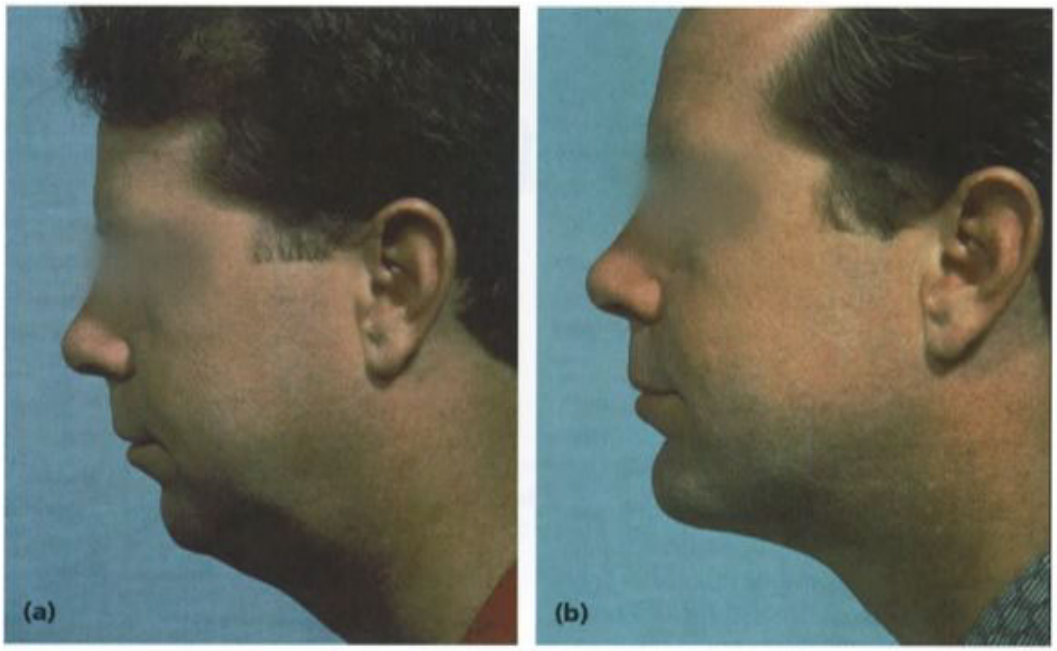


Figure 8.7 Preoperative (a) and postoperative (b) photographs of a patient who underwent an extended mandibular implant combined with submental liposuction.

Table 8.1 Patterns of midfacial deformity

Deformity type	Description of midfacial deformity	Type of augmentation required	Type of implant predominantly used
Type I	Primary malar hypoplasia; adequate submalar soft tissue development	Requires projection over the malar eminence	Malar implant; "shell-type" implant extends inferiorly into submalar space for more natural result
Type II	Submalar deficiency; adequate malar development	Requires anterior projection; implant placed over face of maxilla and/or masseter tendon in submalar space; also provides for midfacial fill	Submalar implant (new Conform™ type or generation I submalar implant)
Type III	Malar hypoplasia and submalar deficiency	Requires anterior and lateral projection; "volume replacement implant" for entire midface restructuring	"Combined" submalar shell implant; lateral (malar) and anterior (submalar) projection; fills large midfacial void

face for contouring procedures starts with an understanding of specific zones of skeletal anatomy, as well as identification of distinctive and recognizable configurations of skeletal and soft tissue deficiency. Correlating these elements of structural and topographical variations is essential for choosing the optimal implant shape, size, and position to obtain the best results in facial contouring. Thus, the goal of augmentation via implants is to reconstruct contour deformities or deficiencies of the face with normal skeletal contour utilizing a high degree of predictability.

Midfacial contour defects

The classification of midface deformities has been modified in order to simplify the analysis of the area during the consultation (Table 8.1 and Figure 8.8). A separate evaluation of both the bony malar region and the soft tissue submalar area should be conducted to best determine the appropriate surgical procedure.

Patients with Type I deformity have primary malar hypoplasia with adequate submalar soft tissue. This defect is best addressed with malar shell implants that cover the bony midface and project the cheek in a lateral direction (Figure 8.9).

Type II deformity consists of submalar soft tissue deficiency with normal malar skeleton. Type II is the most common deficiency found in the aging population. Inferior descent and atrophy of the submalar soft tissue result in a flat and hollowed appearance to the midface. Type II deficiency is best treated surgically with submalar implants to restore midface convexity and provide greater anterior projection to the flattened face (Figure 8.10). Submalar implants can be used alone or in combination with rhytidectomy for facial rejuvenation (Figure 8.11).

Type III deformity occurs when there is a combined bony malar hypoplasia and soft tissue paucity. These patients often exhibit exaggerated effects of aging because ptotic soft tissues have little bony support and readily descend, gathering along the nasolabial folds and oral commissures. Rhytidectomy alone would provide suboptimal results in these patients since they have limited underlying skeletal support to provide a scaffold on which to resuspend the skin and soft tissue. A combination of malar and submalar implants can significantly improve the overall appearance of Type III patients (Figure 8.12).

Mandibular contour defects

Projection of the chin is often a subtle feature, but is one of the most important characteristics of the face. An appropriate shape and projection of the chin balances the rest of the face and provides an anatomical component for facial rejuvenation and in profileplasty in conjunction with rhinoplasty. Deficiencies of the chin and mandible can expose or exaggerate other facial features, such as the perceived versus actual shape and size of the nose.

Traditionally, chin implants were placed over the area between the mental foramina. This familiar location constitutes only Zone 1, or one segment of the mandible that can be successfully altered. Augmentation of Zone 2 in addition to Zone 1 results in a widening of the anterior jawline contour. This is the basis for the development of the extended anatomical and prejowl chin implants (Figure 8.13). Zone 3, the posterior lateral zone, can be modified with a mandibular angle implant that will either widen and/or elongate the posterior mandibular angle to produce a stronger posterior jawline contour.

In general, profileplasty has always emphasized an end point whereby the chin should project to the level of the vermillion border based on the Gonzalez-Ulloa meridian, perpendicular from the Frankfort horizontal (Figure 8.14). It is extremely important, however, to differentiate between males and females when trying to define goals and end points of implant size. Females generally require less projection anteriorly than do male patients.

It is also important to assess the entire mandible including the need for lateral augmentation, particularly within the prejowl area. Augmentation of the chin with implants such as a small anterior button-type implant can have the unwanted effect of actually increasing the jowl by accentuating the prejowl sulcus.

The location of the mental foramen must be determined. The area of the mental nerve marks the point of maximal resorption

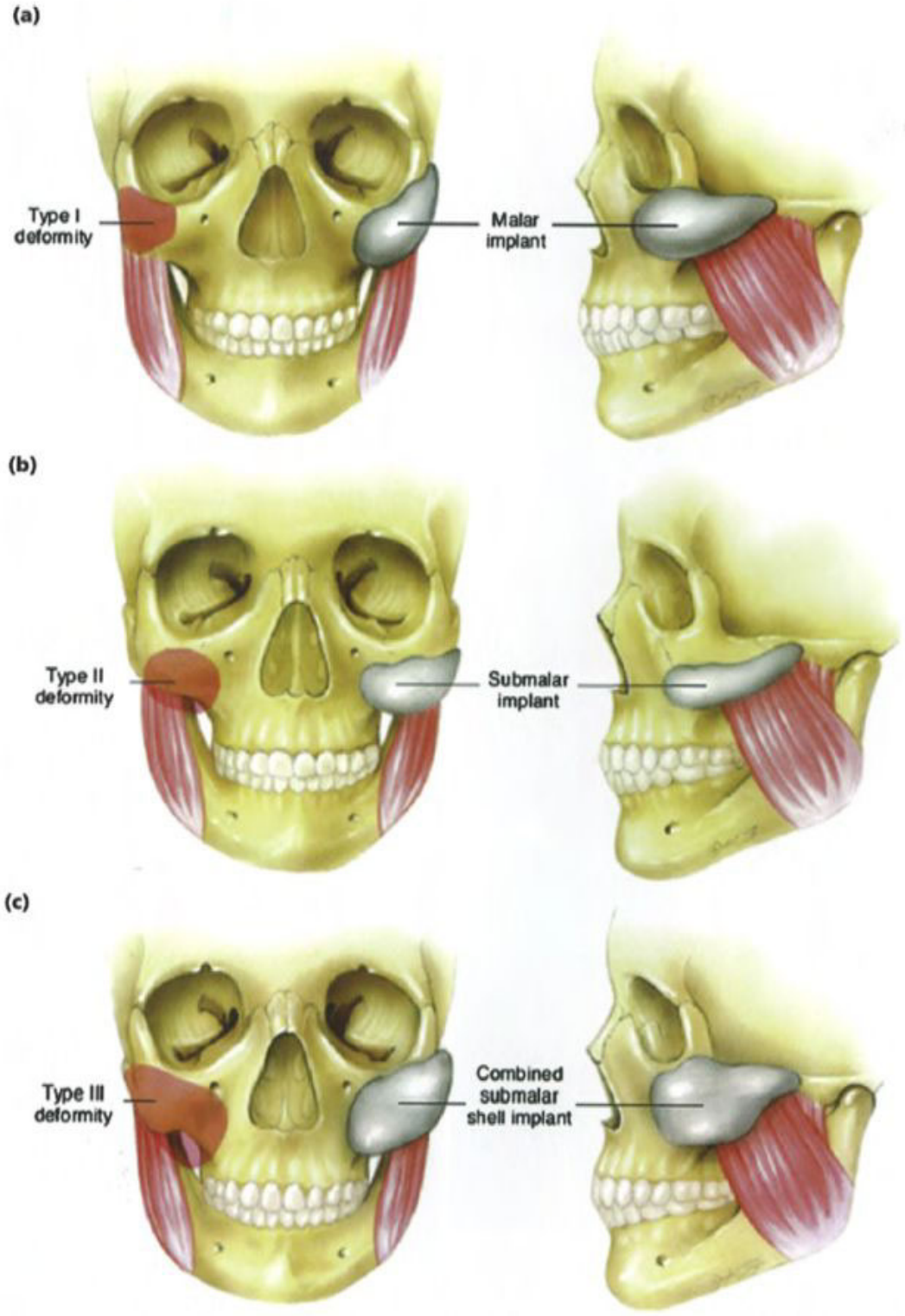


Figure 8.8 Frontal and lateral drawings illustrate the anatomical areas of the midface and three distinctive topographical patterns of midfacial deformity. Specific implants that are directly correlated with and used to correct these specific patterns of midfacial deformity are selected.

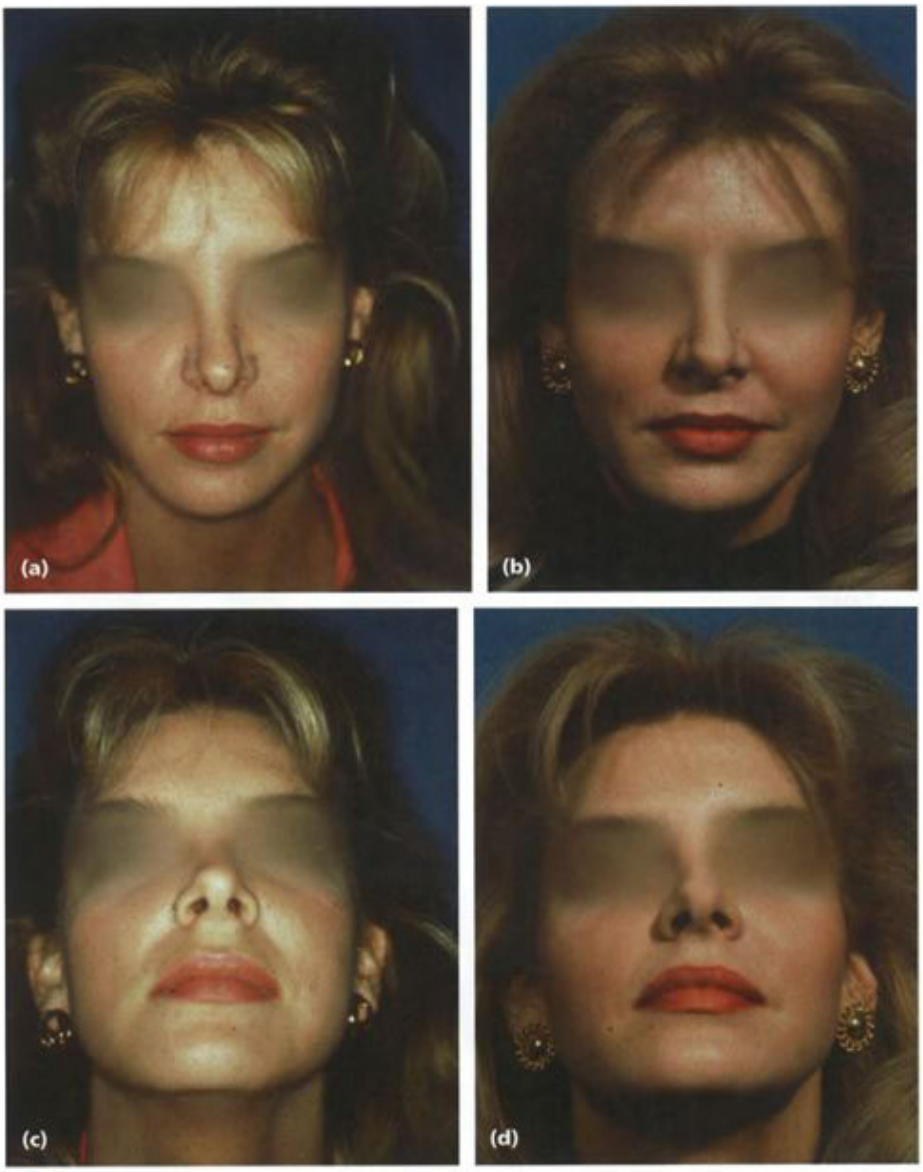


Figure 8.9 (a and c) Preoperatively—example of malar hypoplasia (Type I deficiency). (b and d) Eight months after malarplasty using a Malar-Shell™ (Implantech Associates) implant. Augmentation of a greater surface area and extension inferiorly into the submalar space produces a more natural high cheekbone effect.

of the alveolar process, and in the edentulous jaw, for example, there is excessive thinning of the bone. Resorption of the jaw, however, particularly associated with edentulous patients, occurs primarily from the superior alveolar ridge downward, as the area of bone below the mental nerve remains relatively stable in dimension. This enables the safe placement of extended implants even in conditions of relative bone atrophy and in the edentulous mandible. It should also be noted whether the patient has had previous dental implants, posts, or plates that may influence the positioning of the implants, as well as a history of fractures or other mandibular trauma.

Surgical procedures

General guidelines for facial implants

The basic principles for augmenting the malar, midfacial, nasal area, or premandibular spaces are identical. Controlling the shape, size, and positioning of the implant will determine the overall final facial contour. The surgeon must be prepared to have all anticipated designs, shapes, and/or materials available and be prepared to modify the implant intraoperatively. It should be the rule, rather than the exception, that implants require

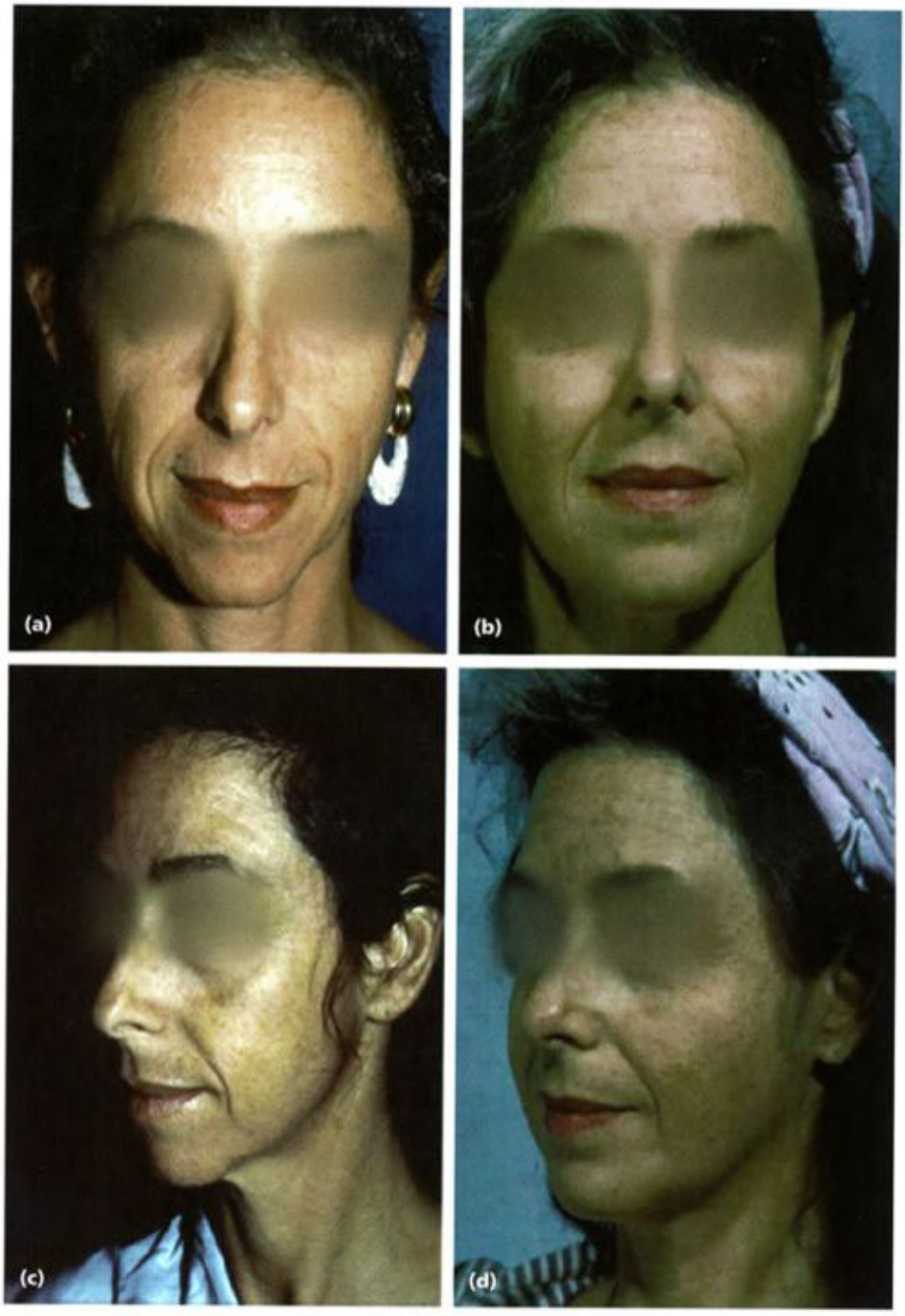


Figure 8.10 Type II midface deformity. (a and c) Preoperative photographs of a patient with Type II submalar deficiency. The patient had adequate facial skeletal structure but had deficiency of the submalar soft tissues. (b and d) Seven-year postoperative photographs after placement of submalar and chin implants, demonstrating the long-term enhancement of facial rejuvenation.

modification due to individual variation. Failure to have the right implant for a particular patient can only yield a suboptimal result.

The day prior to surgery, patients are started on broad-spectrum antibiotics, to be continued for 5 days postsurgery. Intravenous antibiotics and dexamethasone are also administered perioperatively. Before starting anesthesia, the patient must be in an upright position while the precise area to be augmented is outlined with a marking pen. This initial outline that is drawn on the skin is then explained to the patient so that a cooperative effort is made to finalize both the surgeon's and patient's perception of implant shape, size, and position to address their mutual goals (Figure 8.15).

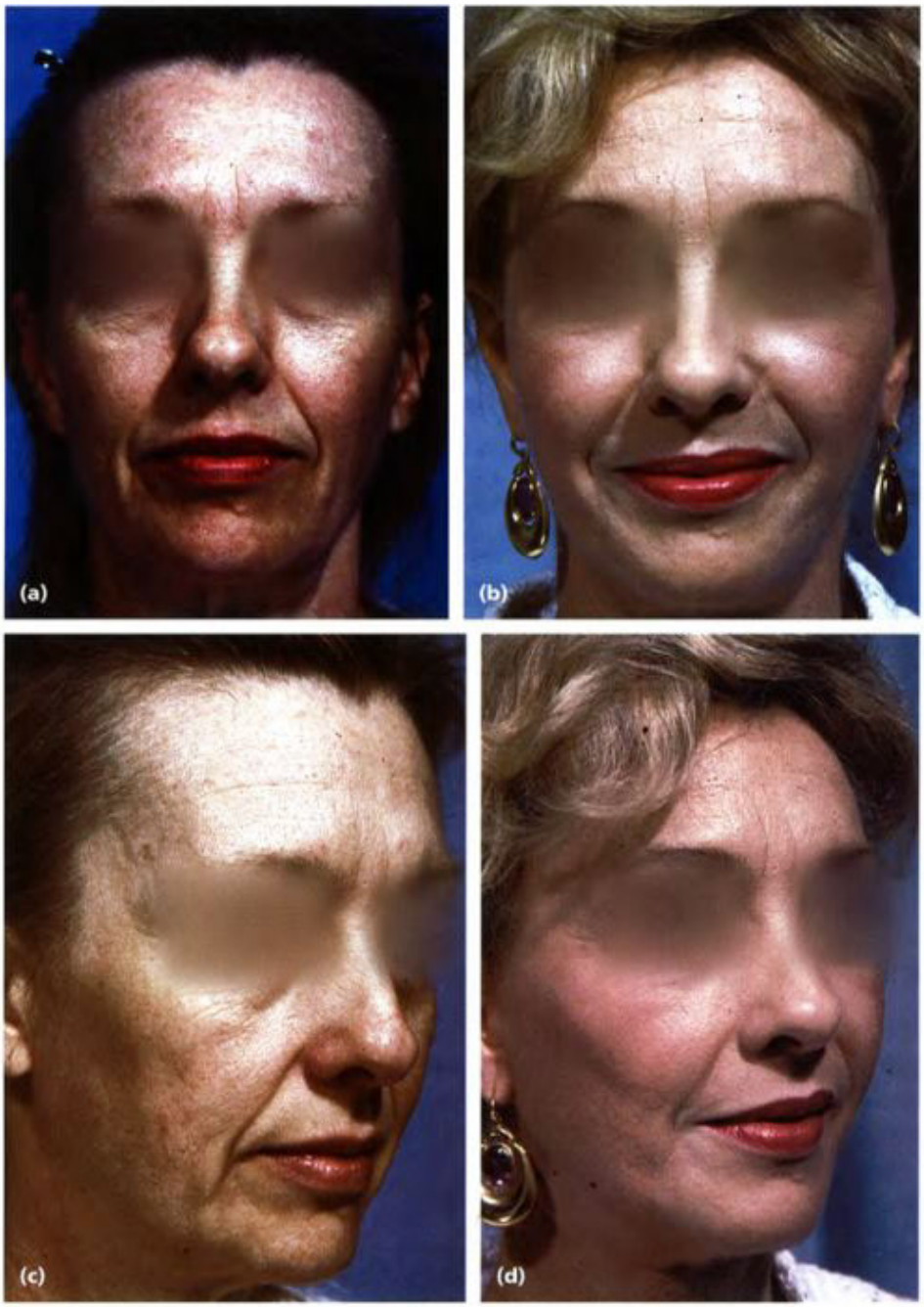


Figure 8.11 (a and c) Preoperative. (b and d) Six months postoperative. In conjunction with rhytidectomy and upper and lower blepharoplasty, a Conform™ submalar implant was used adjunctively to help restore volume and structure and establish the basis for a greater longevity to the face-lift operation.

Surgical techniques for malar and midface contouring

The primary path for entering the malar-midfacial areas is via the mouth. Other approaches include the subciliary (via lower blepharoplasty), transconjunctival, rhytidectomy, zygomaticotemporal, and transcoronal routes. The intraoral route is the most common and the preferred route for most midfacial implants.

After infiltration of the anesthetic solution, a 1-cm incision is made through the mucosa and carried directly down to bone in a vertical oblique direction above the buccal-gingival line and over the lateral buttress (Figure 8.16a). Since the mucosa will stretch and allow complete visual inspection of the midfacial structures, a long incision through adjacent submucosal or muscular layers is not necessary and is discouraged. The incision should be made high enough to leave a minimum of 1 cm of

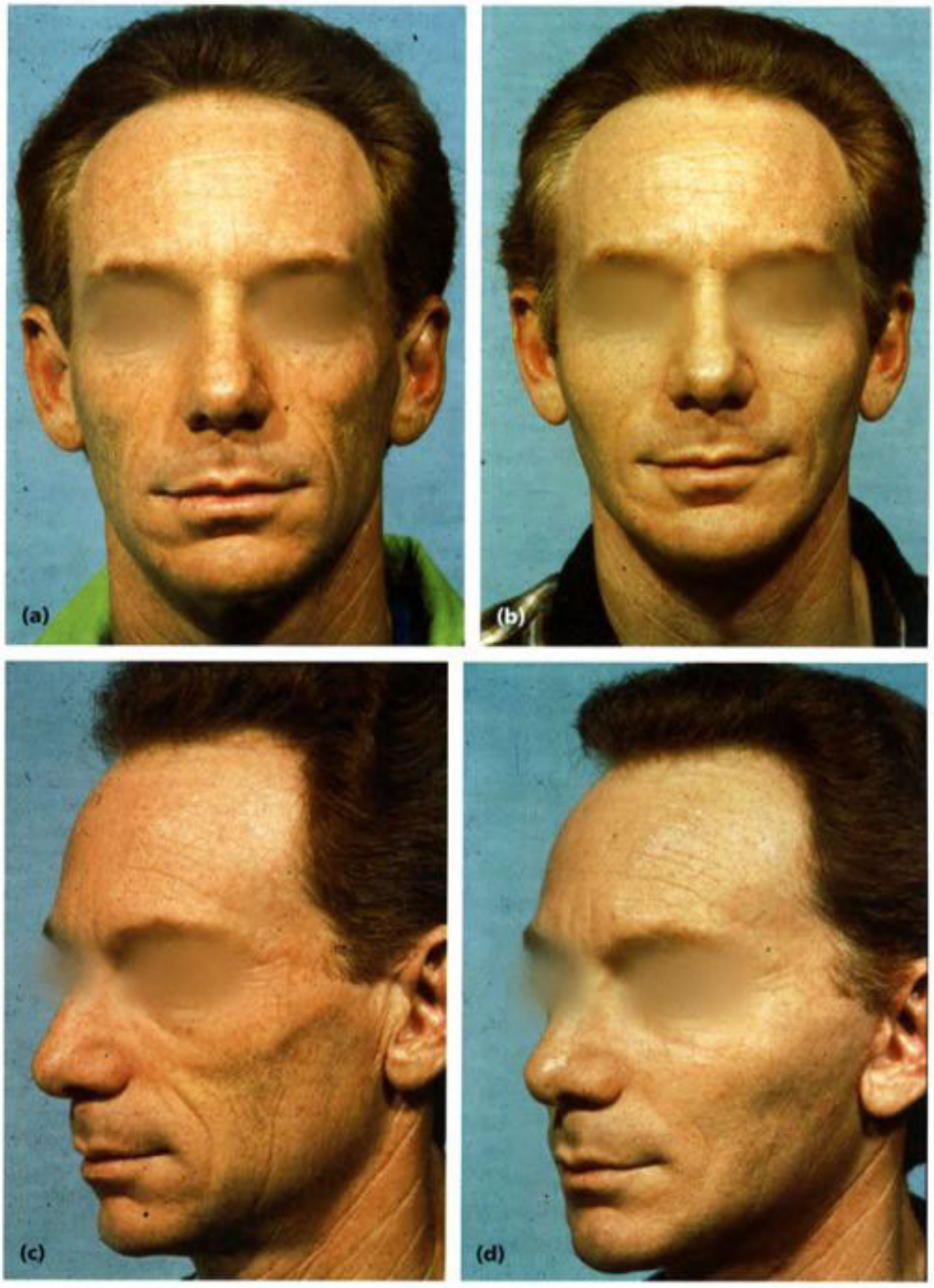


Figure 8.12 (a and c) Preoperative analysis of the facial configuration in this 40-year-old patient reveals the presence of severe deficiency in both skeletal structure and soft tissue volume, contributing primarily to the excessive wrinkling of the skin in the area of the midface. (b and d) Seven months postoperative. Performed concurrently with rhytidectomy, the combined submalar shell implants were used to restructure the entire midface, and a prejowl implant was used to add width to the mandible. In this patient, these augmentation procedures were essential for the structural and volumetric enhancement required for the face-lift procedure to provide a meaningful, long-term improvement. (From Binder WJ. A comprehensive approach for aesthetic contouring of the midface in rhytidectomy. Facial Plast Surg Clin N Am 1993;1:231–55.)

gingival mucosal cuff. If the patient wears dentures, this incision must be place above the denture's superior border. Dentures can be left in place after the procedure, and in our experience has not been found to cause extrusion or increase the incidence of complications. A broad Tessier-type elevator (10 mm wide) is directed through the incision onto the bone in the same orientation as the incision. A broad rather than narrow elevator helps to facilitate the dissection safely and with relative ease within the subperiosteal plane (Figure 8.16b). While keeping the elevator directly on bone, the soft tissues are elevated obliquely upward

and conchal cartilages, however, often do not provide adequate volume. Costal cartilage and calvarial bone grafts have a high rate of donor site morbidity, and costal cartilage has the potential to warp. Homograft cartilage has previously been utilized for nasal reconstruction, but has a high percentage of resorption. Currently, the most commonly used alloplastic implants for nasal augmentation consist of silicone, ePTFE, and polyethylene (Medpor). Silicone can eventually produce overlying skin atrophy and must be anchored to prevent movement. Silicone and ePTFE have the potential for infection, but are easily removed and replaced. Polyethylene implants, as with any other implant that promotes significant tissue ingrowth, has the potential for extensive soft tissue damage to the overlying skin if removal becomes necessary. Currently, silicone is the most commonly used alloplastic implant in Asian rhinoplasty.

Mandibular augmentation

Mandibular augmentation is perhaps the simplest and most powerful aesthetic procedure available to the surgeon. The key to mandibular augmentation is in the restoration of anterior projection and/or expansion of lateral contour. Mandibular enhancement can create a stronger profile and improve the presentation of the nose by making it appear smaller and less imposing. Additionally, augmentation of the prejowl sulcus and the mandibular angle can help enhance the effects of rhytidectomy by creating a sharper cervicofacial angle. The primary indications for mandibular augmentation include as follows: as a stand-alone procedure for mandibular augmentation; as an adjunctive procedure to rhinoplasty with an emphasis on profileplasty; and as an adjunctive procedure to rhytidectomy, which is often necessary for obtaining a long-lasting jaw-neck line in patients with mandibular deficiency.

The mandible can be divided into three zones for the purposes of augmentation[33] (Figure 8.5). Zone 1 consists of the central chin area, which extends from the mentum to mental foramen. Zone 2 is midlateral, defined by a line extending from the mental foramen posteriorly to the oblique line of the horizontal body of the mandible. Zone 3 of the premandibular space encompasses the posterior half of the horizontal body, including the angle of the mandible and the first 2–4 cm of the ascending ramus.

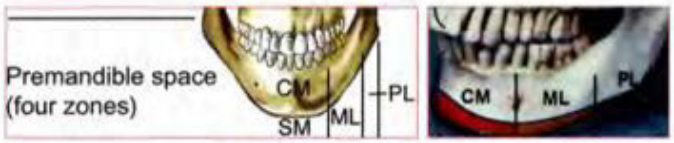


Figure 8.5 Zones of the mandible. Zone 1 consists of the central chin area, which extends from the mentum to mental foramen. Zone 2 is midlateral, defined by a line extending from the mental formen posteriorly to the oblique line of the horizontal body of the mandible. Zone 3 encompasses the posterior half of the horizontal body, including the angle of the mandible and the first 2–4 cm of the ascending ramus. CM: chin midline; SM: submental; ML: mandibular lateral; PL: posterior lateral.

The central chin area (Zone 1) is one of the most important aspects of profileplasty while performing rhinoplasty, as the projection of the chin directly affects the illusory projection of the nose in an inverse relationship. The traditional chin implants, placed only within Zone 1 without lateral extension into the midlateral zones, often created suboptimal results. These early implants, unidimensionally designed with a single vector, were often bulky, not anatomically correct, and often gave the appearance of an abnormal and unattractive round chin protuberance. Moreover, a centrally placed, smaller implant has a greater tendency to shift or rotate than a larger, more extended implant. Most of these early problems have been corrected with the design of the extended mandibular implants that occupy Zones 1 and 2. Placement of an implant that extends into at least two zones (central chin and midlateral) also results in a natural widening of the anterior jawline in addition to increasing the vertical dimension of the lower third of the face (Figure 8.6). Augmentation of the posterior-lateral zone widens the jaw to produce a stronger posterior jawline contour. This can be achieved using a mandibular angle implant to augment the posterior lateral zone of the mandible (Zone 3).

The atrophy and descent of soft tissue, volume loss, and skin laxity in the lower face manifest themselves as a loss of a straight jawline, the development of a prejowl sulcus, jowling, and/or marionette lines. Evaluating the lower face shows that the prejowl sulcus exhibits a marked drop-off in soft tissue volume and bony mandibular projection with aging. The sulcus or depression can occur from several factors such as a deficiency of bone, congenitally narrow mandible, or aggregation of soft tissue around the mandibular ligament that contributes to the jowl. The skin overlying the prejowl sulcus is also significantly thinner than the skin lateral or medial to this location. The anterior mandible may form a deepening of the prejowl sulcus due to flattening of the soft tissue button of the chin. Additionally, the anterior mandibular groove deepens, which further accentuates the jowls.

Reestablishment of a smooth mandibular line and treatment of the jowl primarily requires rhytidectomy, which repositions and tightens the soft tissue along the lower third of the face. Rhytidectomy alone, however, may not completely address the prejowl sulcus and in that case, a prejowl implant is required. Prejowl and chin implants have been developed for use in conjunction with face-lift surgery and submental liposuction to enhance the ability of these procedures to create a smooth, well-defined straight jawline (Figure 8.7).

Preoperative analysis for facial contouring

General

Facial augmentation is a three-dimensional procedure that exponentially increases the variability of structural diagnosis and treatment. A thorough understanding of skeletal anatomy and the ability to identify specific types of topographical patterns is necessary to guide the surgeon in making the final decision for optimal implant selection and placement. Evaluation of the

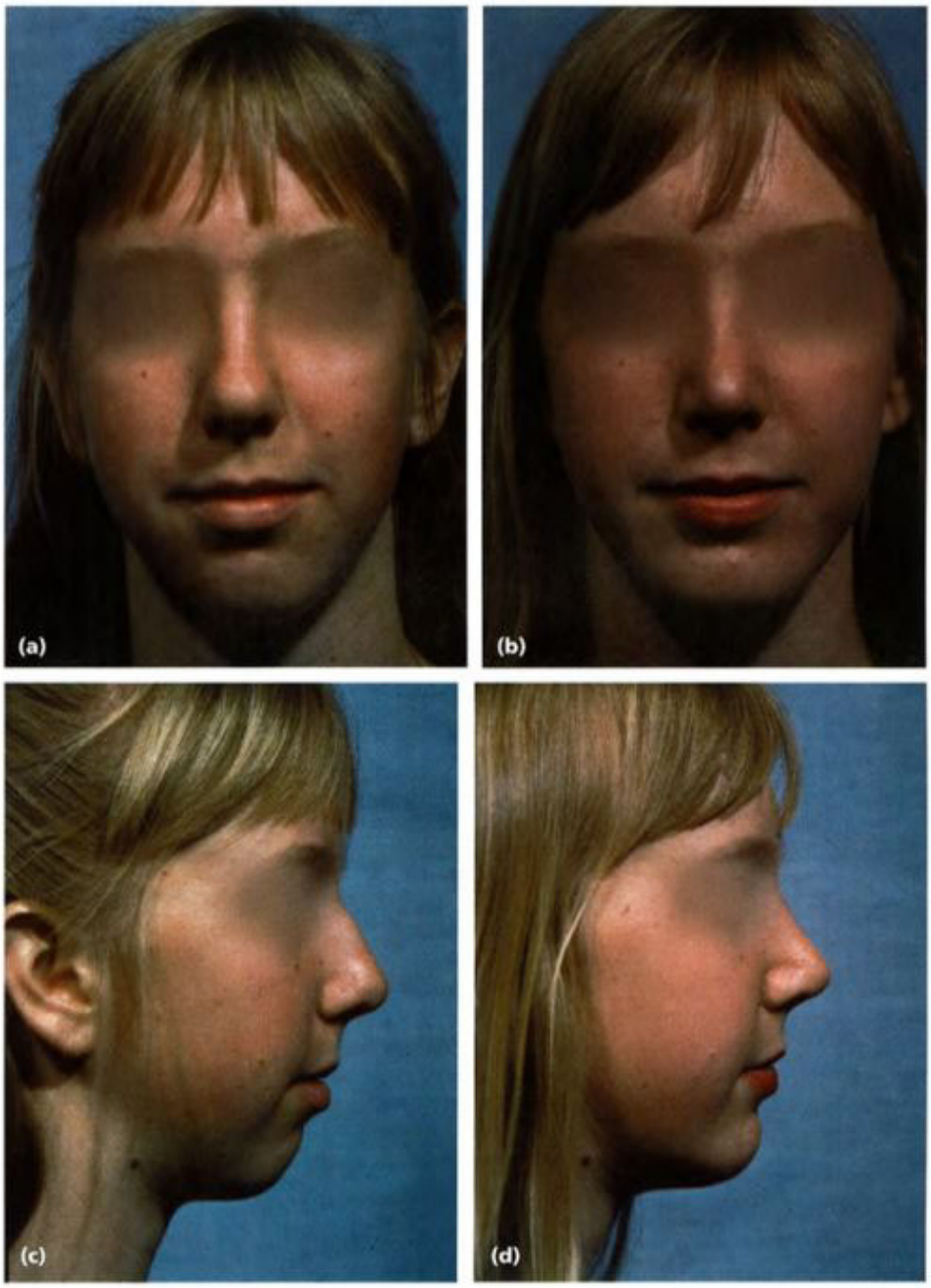
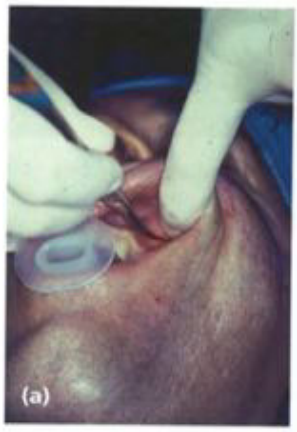
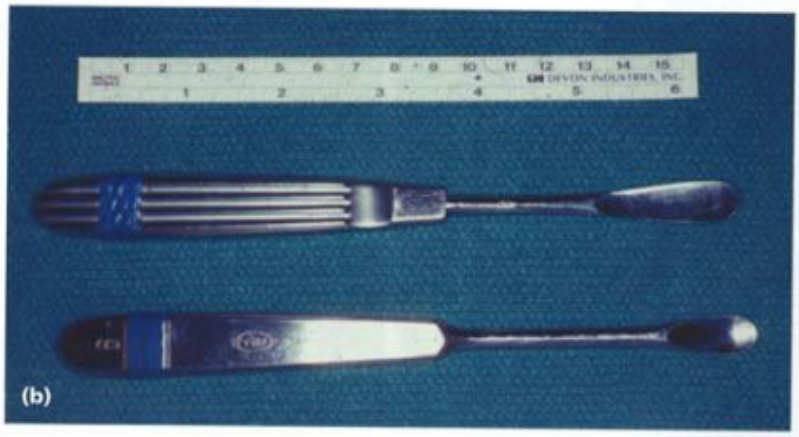


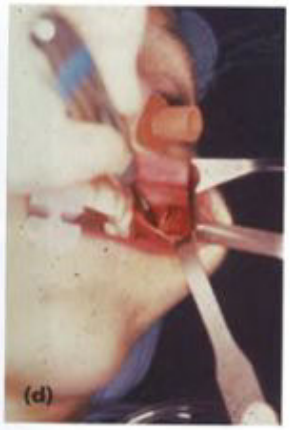
Figure 8.14 Preoperative (a and c) and postoperative (b and d) extended mandibular implant. It should be emphasized that in female patients, it is not always prudent to extend the chin to the Gonzalez-Ulloa meridian.

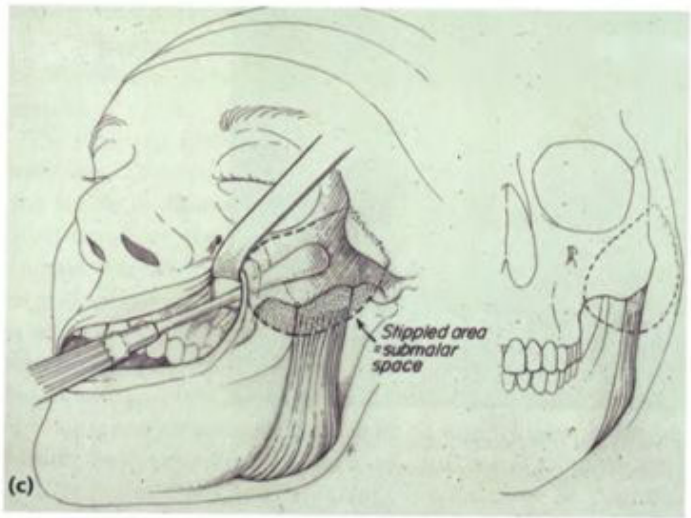
The position of the medial fenestration should be marked on the external skin while the implant is inside the subperiosteal pocket. Locating these holes can be achieved with a right-angle clamp that pushes the implant upward, underneath the fenestration, causing an external protuberance that can be marked on the external skin. Measuring the distance from the midline to both right and left medial markings ensures symmetric placement of the implants (Figure 8.17a). The implants are then removed and placed on the skin by lining up the medial fenestration over its corresponding mark. The position of the lateral portion of the implant is then decided by placing a second mark corresponding to the adjacent implant fenestration. A double-armed 3-0 silk suture is then passed through the two medial fenestrations of the implant from a posterior to anterior direction. The needles are advanced through the pocket, passed perpendicularly through the skin, and exited at the respective external markings (Figure 8.17b). The implant, following the needles, is guided into the pocket and is secured in place by tying the sutures over bolsters composed of two dental cotton rolls (Figure 8.17c). The bolsters are removed on the first postoperative day.

Figure 8.15 Prior to infiltration of local anesthetic, the areas requiring augmentation are specifically outlined with the patient sitting in the upright position. In the majority of cases, the medial border of submalar or malar implants is placed lateral to the infraorbital foramen corresponding approximately to the midpupillary line. (From Binder WJ. A comprehensive approach for aesthetic contouring of the midface in rhytidectomy. Facial Plast Surg Clin N Am 1993;1:231–55.)









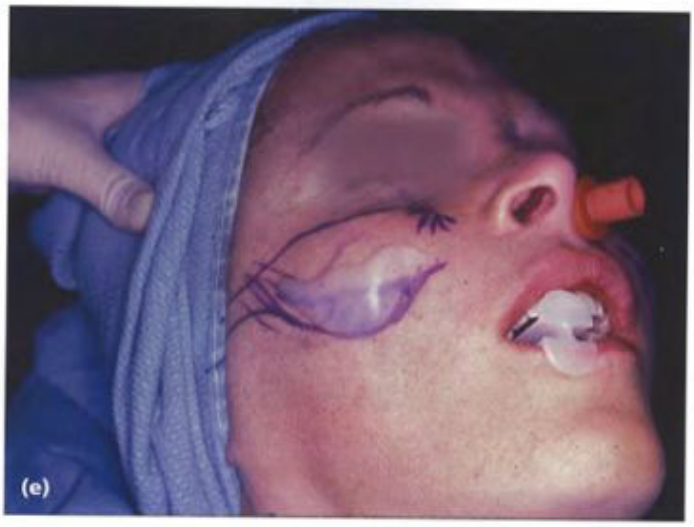
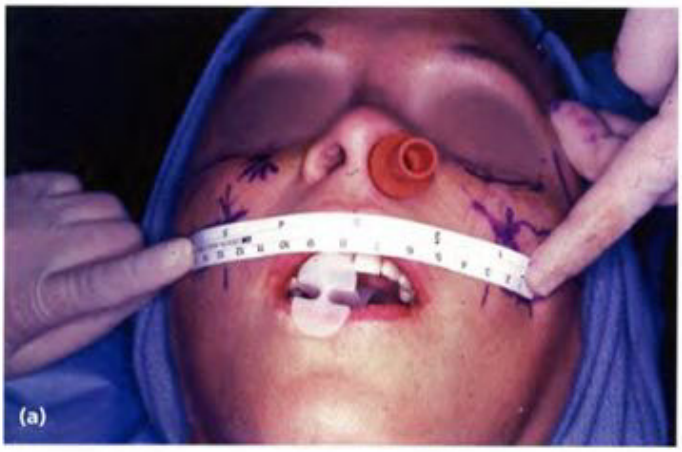
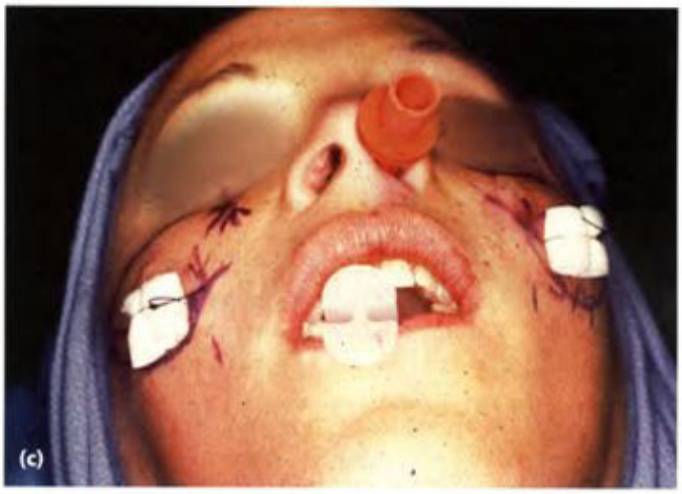


Figure 8.16 (a) After injection with local anesthetic, the mucosa is compressed and a single incision is carried through mucosa and periosteum directly onto bone. The incision is small (1–1.5 cm) and is placed over the lateral aspect of the canine fossa and lateral buttress at least 1 cm above the buccal-gingival line. (b) The 9- and 10-mm curved and straight periosteal elevators used for dissection. (c) This illustration demonstrates the general extent of dissection required for most midfacial implants. The dissection must be sufficiently extended posterolaterally over the zygomatic arch, and/or expanded inferiorly into the submalar space over the tendinous insertions of the masseter muscle so that the implant can be accommodated passively within the pocket. (d) Direct visual inspection of midfacial structure can be obtained through the intraoral route by retracting the overlying tissues. Using sizers or different implants help to determine the optimum size, shape, and position of the final implant selected. (The stippled area represents a sizer that has been placed within the pocket.) (e) Left: The external drawings made on the skin delineate the malar bone and submalar space below. Right: The shape and size of the superimposed implant should roughly coincide with the external topographical defect demarcated prior to surgery. In this case, the inferior aspect of the implant extends downward to occupy the submalar space. (From Binder WJ. A comprehensive approach for aesthetic contouring of the midface in rhytidectomy. Facial Plast Surg Clin N Am 1993;1:231–55.)





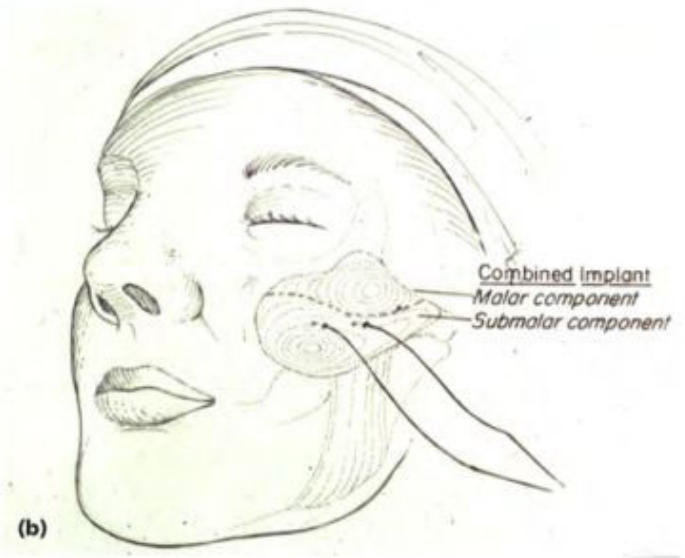


Figure 8.17 (a) Symmetrical placement is assisted by measuring the distance from the midline to both the right and left marks. A second mark is then placed on the skin, which corresponds to the second, adjacent fenestration that determines the superior-inferior orientation of the lateral portion of the implant. (b) A double-armed 2-0 silk suture is passed around the posterior surface of the implant and through the fenestration. From inside the pocket, the needles are passed directly perpendicular to the skin, exiting at the respective external markings, thus providing two-point fixation. (This figure illustrates the two components [malar and submalar] that form the combined implant.) (c) The implant is stabilized by tying the suture directly over an external bolster (composed of two cotton rolls). The suture and bolster are removed by the third postoperative day. (From Binder WJ. A comprehensive approach for aesthetic contouring of the midface in rhytidectomy. Facial Plast Surg Clin N Am 1993;1:231–55.)

Surgical technique for mandibular augmentation

Anterior mandibular implants

Either an intraoral or external route can provide access to the premandibular space. The intraoral route affords the obvious advantage of leaving no external scars. The entry wound for the intraoral route is a transverse incision made through the mucosa. The mentalis muscle is divided vertically in the midline raphe to avoid transection of the muscle belly or detachment from the bony origins. This midline incision provides adequate access inferiorly to the bone of the central mentum and eliminates potential muscle weakness that may occur if the muscle is cut transversely. Lateral dissection requires identification and retraction of the mental nerves.

The external route utilizes a 1–1.5-cm incision in the submental crease. The advantages of the external route include avoidance of intraoral bacterial contamination, direct access to the inferior mandibular border where cortical bone is present, limited retraction of the mental nerve, and easy fixation of the implant to the inferior mandibular periosteum. Fixation of the implant prevents side-to-side or vertical slippage of the implant.

Basic technical rules should be followed for safe and accurate mandibular augmentation:

1 The dissection should stay on bone. Placement of implants in the subperiosteal plane creates a firm and secure attachment of the implant to the bony skeleton. One often finds a condensation of fibrous attachments just to the midline of the mentum. It is often necessary to incise these tendinous

attachments to allow dissection to continue along the inferior segment of the mandible.

2 The dissection must be adequately expanded to accommodate the prosthesis comfortably. A sharp dissecting instrument may be used centrally, but only blunt instruments are used around the nerves and adjacent to soft tissues.

3 The mental nerve should be avoided. This is accomplished by compressing the tissues around the mental foramen with the opposite hand that helps to direct the elevator away from the nerve and along the inferior border of the mandible. A dry operative field is essential for accurate visualization, precise dissection, proper implant placement, and the prevention of postoperative hematoma or seroma.

A Joseph's or 4-mm periosteal elevator is used to perform the dissection along the inferior mandibular border. Once the pockets are large enough, half of the implant is inserted into the lateral portion of the pocket on one side and then folded upon itself, whereby the contralateral portion of the implant is inserted into the other side of the pocket. The flexibility inherent in silicone enables the implant to be placed through a small incision. The implant is then adjusted into position. If the implant material does not allow flexibility, either the incision must be made larger or the procedure must be performed through an intraoral incision.

Implants that expand into the midlateral or parasymphyseal region result in anterior widening of the lower third of the facial segment. The central projection necessary averages between 6 and 9 mm for men and 4 and 7 mm for women. Occasionally, implants measuring 10–12 mm in projection or greater may be necessary to create a normal profile and a broader jawline in patients with severe microgenia.

Mandibular angle implants

Access to the angle of the mandible is achieved through a 2–3-cm mucosal incision at the retromolar trigone, which gives direct access to the angle of the mandible. Dissection is performed on bone and beneath the masseter muscle to elevate the periosteum upward along the ramus and then anteriorly along the body of the mandible. A curved (90-degree) dissector is used to elevate the periosteum around the posterior angle and ramus of the mandible. This permits accurate placement of the angle implants that are specifically designed to fit the posterior bony border of the ascending ramus and enhance angle definition. These implants may be secured with a titanium screw. Implants that are custom-designed for this area, for example, 3D Accuscan® (Implantech Associates Inc.) and those made of high-density polyethylene (Medpor), usually do not require fixation.

Complications

Complications of implants include bleeding, hematoma, infection, exposure, extrusion, malposition, displacement or slippage, fistula, seroma, persistent edema, abnormal prominence, persistent inflammatory action, pain, and nerve damage.[36] Very few of the complications listed, however, are due solely to the implant material itself. It is extremely difficult to differentiate the surgical technique, the surrounding circumstances of the individual operation, as well as the individual patient risk factors that are not associated with the implant.

Extrusion should not occur if the technical rules outlined have been followed. The extended surface area of the larger or extended implants that fit along the midface and mandibular contours minimizes malposition and malrotation. Adequate dissection of the subperiosteal space large enough to create midlateral and posterolateral tunnels in the mandible and the desired pockets in the midface will keep the implant in proper position. In mandibular augmentation, the mandibular branch of the facial nerve passes just anterior to the midportion of the mandible in the midlateral zone. It is important not to traumatize the tissues that overly this area. Avoidance of facial nerve injury is assured as long as the dissection is in the subperiosteal plane. The course of the mental nerve is anatomically directed superiorly into the lower lip, which also helps to protect it from dissection trauma. Temporary hypoesthesia of the mental nerve can occur for several days to several weeks after surgery. Permanent nerve damage is extremely rare and in one study represented less than 0.5% of a statistically large numbers of cases.[37] If encroachment on the nerve by the implant is detected due to misplacement or malrotation, then repositioning of the implant below the nerve should be performed as early as possible. The frontal branch of the facial nerve passes posterior to the midaspect of the zygomatic arch and care must be taken when dissecting in this area.

Infection can be minimized by irrigation of the pocket at the end of the procedure with either normal saline or with bacitracin, 50,000 units per liter of sterile saline. Soaking porous implants in antibiotic solution is also advised. Drainage techniques are not ordinarily necessary in mandibular augmentation but may be used in midfacial augmentation if there is more than the normal amount of bleeding. We have found that immediate application of pressure over the entire midface by using a full-face compression garment for the first 24 hours postoperatively considerably reduces the risk of hematoma, seroma, swelling, and consequently, the postoperative complications related to fluid accumulation within the pocket (Figure 8.18).

Bone resorption is more commonly found in mandibular augmentation than in other alloplastic implant procedures. Findings of bone erosion following chin implants were reported in 1960. Since these early reports, however, there have not been reports of clinical significance after surveying large populations of surgeons.[37,38] As long as the implant is in the correct position over cortical bone, the condition appears to stabilize without the loss of any substantial projection or exhibiting any reduction in the long-term aesthetic enhancement.

Conclusion

Facial contouring is extremely predictable when the surgeon understands the principals of facial topography and anatomy and adheres to basic principles of surgical technique. Critical facial analysis with appropriate communication between the

Figure 8.18 The immediate application of some pressure over the entire midface by using a full-face compression garment has been found to considerably reduce the risk of hematoma, seroma, and swelling.

surgeon and patient will lead to optimal patient satisfaction. Many different types of facial implants are available for the surgeon to create a variety of contours to fulfill most needs. Reconstruction of more complex contour defects can be accomplished by using three-dimensional computer imaging and computer-aided design/computer-aided manufacturing (CAD/CAM) technology to manufacture custom implants.[27]

Facial implant procedures provide excellent long-term solutions for the facial cosmetic surgeon. Midface implants can be used to correct underlying skeletal abnormalities as well as restore the youthful appearance of volume. Chin augmentation with alloplastic implants provide a safe alternative to correct microgenia. Mandibular implants can be also used with excellent results in facial rejuvenation for patients with prominent prejowl sulcus. Overall, there are very few procedures that offer the simplicity and provide the major rewards that facial contouring procedures can offer.

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