Facial Plastic and Reconstructive Surgery
second edition

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Chapter 25

Aesthetic Facial Implants

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Over the past decade, the marked improvement in biomaterial and the design of facial implants have expanded their use in aesthetic surgery and offered ready-made solutions for replacement needs, avoiding donor morbidity and reducing operative complexity. Facial implants are currently used to augment skeletal dimension, to restore facial contour by expanding areas where facial volume loss occurs, or to work in combination with rhinofac-
tomy or other procedures as part of the more current mult-
immobility approach to facial reconstruction surgery. Common implant procedures include cheek augmentation to balance the effects of malar hypoplasia; mandibular augmentation to create a stronger mandibular profile and better nose-chin relationship; mandibular body and angle implants to create a stronger lateral dimension to the mandible; submalar and midfacial implantation to fill out the hollowed areas and aug-
ment the fullness that occurs to the midface during the norm-
mal process of aging; nasal implantation in the form of dorsal or dorsal-columnella shapes; or premalar (peripryorhin) implantation to augment a retrusive midface. Computer-
assisted custom-designed implants now provide solutions for more complex facial defects due to trauma, congenital causes, or acquired immunodeficiency diseases. Long-term HIV-
positive patients become victims to an accelerated form of lipodystrophy, with complete loss of facial fat brought about by antiretroviral therapy and other factors related to the HIV virus itself that are not completely understood.1

Critical to the successful use of facial implants is the accurate assessment of facial anatomy. Distinguishing rela-
tionships between different bony prominences and deter-
miming the volume and thickness of surrounding soft tissue and skin will play into the subtleties of choosing implant sizes, type of material, and ultimate placement to attain both the patient’s and the surgeon’s vision of the end result.

CONCEPT OF FACIAL CONTOURING

The individual configuration of nose, malar-midface area, and mandible-jawline determines the fundamental architec-
tural proportions and contour of the face. Balance between these structures and the even distribution of the overlying soft tissue structures determines facial beauty and harmony. Modern hallmarks of beauty are distinguished by bold facial contours that are accentuated by youthful malar-midface config-
uration and a sharp, well-defined jawline. Any of these

prominences being too small or too large affects the aesthetic importance of the others. For example, reducing the nasal prominence causes both the malar-midface and the mandibular-
jawline volume and projection to appear more distinct, whereas accentuating the malar-midface or enhancing the
mandibular or malar-midface volume makes the nose appear smaller and less prominent.

The concept of facial contouring implies an change in the shape of the face. Only by judiciously altering mass and vol-
ume in different anatomic regions and redistributing the overlying soft tissues can the surgeon produce substantive contour changes. Typically, when augmentation is the desired goal, it is accomplished through selection of implants with the proper shape and size, and controlling their posi-
tion over the facial skeleton.

IMPLANTS AND BIOMATERIALS

Deciding which biomaterial to use for implantation requires an understanding of the histopathology of the individual im-
plant material-tissue interface and the host response. All implant materials induce the formation of fibroconnective tis-

IE to encapsulate, which creates a barrier between the host and the implant.10 Adverse reactions are a consequence of unresolv ed inflammatory response to implant materials. This behavior is also a function of configuration characteristics of the site of implantation, such as thickness of overlying skin, scar, and the tissue bed, and underlining bone architecture that would tend to create a condition for implant instability. For example, implants that are more deeply placed with thicker overlying soft tissue rarely become exposed or extrude. Other important factors, such as pre-
vention of hematomas, seromas, and infection both during surgery and in the postoperative stage, contribute to the pre-
vention of host-implant interaction and to increasing implant survivability.

The Ideal Implant

The ideal implant material should be inert, non-toxic, nonallergic, noncarcinogenic, biocompatible, and resistant to infection. It should be inert, easily removed, easily con-
formable, easily inseparable, and capable of permanently main-
taining its original form. The implant should be easy to mold and customize to the needs of the recipient area during the surgical procedure without compromising the integrity of the
Implant and should be easy to learn to handle without degradation of the implant.

The presence of favorable surface characteristics is important for implant placement and stabilization; paradoxically, it is just as important to facilitate easy removal and exchangeability without causing injury to surrounding tissues. Implant immobilization implies that the implant will be fixed in place for the lifetime of the patient. Implant materials such as silicone elastomer induce the formation of a surrounding capsule that maintains implant position, whereas expanded polytetrafluoroethylene (ePTFE), which encapsulates to a lesser degree, provides fixation with minimal tissue ingrowth. Each type of material-host interaction provides certain advantages in different clinical settings. Materials that cause significant tissue ingrowth and permanent fixation are often undesirable, particularly if the patient desires to change augmentation characteristics in later years. The natural encapsulation process of silicone and the minimal surface ingrowth into ePTFE products ensures immobility yet provides exchangeability without damage to surrounding soft tissue.

The ideal implant design should include tapered margins that blend with the adjacent bony surface to create a nonpalpable, imperceptible transition to the surrounding recipient area. An implant that is malleable and conforms readily to the underlying structures further reduces mobility, while the anterior surface shape should emulate the desired natural anatomic configuration. The new silicone implant Conform (Implantech Associates, Inc., Ventura, CA) is currently being engineered for enhanced conformability to the underlying bony surface. For example, implants with a new type of grid backing reduce the memory of the silicone elastomer and improve flexibility. Greater adaptability to irregular bony surfaces reduces the chance of movement and prevents posterior dead space from occurring between the implant and underlying bone (Fig. 25-1). Renewed interest in research and development in biomaterial engineering has led to development of a composite implant (using both silicone and ePTFE) that promises to combine the advantages of two biomaterials for future use in facial implants (Personal Communication, Implantech Associates, Inc. and W.H. Gore, Inc., January, 1999).

![Figure 25-1](image)

**Implant Biomaterials**

**Polymeric Materials/Solid Polymers**

**Silicone Polymers**

Beginning in the 1950s, silicone has had a long history of widespread clinical use with a continued, excellent safety-efficiency profile. The chemical name for silicone is polydimethylsiloxane. Currently, only silicone elastomer can be customized by the use of three-dimensional computer imaging and CAD/CAM technology. Differences in manufacture have significance in the purity and stability of the product. For example, the harder the implant the more stable it is. An implant that has a hardness (durometer) of less than 10 will approach the characteristics of a gel and see time potentially “leach” or leak some of its internal molecular substances. However, the most recent studies on breast implant gel silicone have shown no objective cause and effect for silicone in producing scleroderma, systemic lupus erythematosus, collagen vascular disease, or other autoimmune diseases.24 Solid silicone elastomer has a high degree of chemical inertness, is hydrophobic, and is extremely stable, with no toxicity or allergic reactions.27 Tissue reaction to solid silicone implants is characterized by a fibrous tissue capsule without tissue ingrowth. When unstable or placed without adequate soft tissue coverage, the implants are subject to moderate ongoing inflammation and possible seromas formation. Capsular contracture and implant deformity rarely occur unless the implant is placed too superficially or migrates to the overlying skin.

**Polyethersulfone**

Polyethylene can be produced in a variety of consistencies, with the current most popular form being porous. Porous polyethylene, also known as Medpor (W. J. Gore, Flagstaff, Arizona), suggests stability with minimal inflammatory cell reaction. However, the material is hard and difficult to sculpt. The possibility of polyethylene remains extensive tissue ingrowth, which provides an advantage for endosseous implant stability. However, it is extremely difficult to remove secondarily, creating a condition for potential damage to surrounding soft tissue, particularly if placed in areas of thin soft tissue covering.

**Polytetrafluoroethylene**

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

Expanded Polytetrafluoroethylene (ePTFE) (Gore-Tex, W. L. Gore, Inc.)

This material was originally produced for cardiovascular applications. Animal studies showed the material to elicit limited fibrous tissue ingrowth without capsule formation and minimal inflammatory cell reaction. The reaction seen over time compared favorably with many of the materials in use for facial augmentation. The material has found acceptable results in subcutaneous tissue augmentation and for use in preformed implants. Due to lack of significant tissue ingrowth, ePTFE offers advantages in subcutaneous tissue augmentation because it can be modified secondarily and removed in the event of infection.

Mesh Polyurethane

The mesh polyurethanes, which include Marlex (Dowvul Corp., Providence, RI), Dacron (Dow Corning, Midland, MI), and Nercelene (Dow Corning, Midland, MI), have similar advantages of being easily folded, sutured, and shaped; however, they also promote fibrous tissue ingrowth, causing difficulty with secondary removal. Polyamide mesh (Supramid) is a derivative ofylon that is hydrophobic and unstable in vivo. It elicits a solid foreign body reaction with multinucleated giant cells and over time causes implant degradation and resorption.  

Metals

Metals consist essentially of stainless steel, vitallium, gold, and titanium. Except for use in gold in some applications, such as upper eyelid springs or in dentistry, titanium has become the metal of choice for long-term implantation. Reasons include high biocompatibility, high corrosion resistance, strength, and minimal x-ray attenuation during computer tomographic scanning or magnetic imaging.

Calcium Phosphate

Calcium phosphate or hydroxyapatite materials are not osteoconductive but do provide a substrate into which bone from adjacent areas can be deposited.  

The granule form of hydroxyapatite crystals is used in oral and maxillofacial surgery for augmenting alveolar ridges. The block form has been used as an interpositional graft material in osteotomies. However, it has been shown to be of less value as an augmentation or onlay material due to its brittleness, difficulty in shaping or contouring, and inability to adapt to bone surface irregularities and mobility.

Autografts, Homografts, and Xenografts

Autografts, available as autogenous bone, cartilage, and fat, are limited by donor site morbidity and limitation of available donor material. Processed homograft cartilage has been used in nasal reconstruction but eventually succumbs to resorption and fibrosis. Other forms of materials and injectables are commercially available (Table 25-1).

Tissue Engineering and Formation of Biocompatible Implants

During the past several years, tissue engineering has emerged as an inter-disciplinary field. Properties of synthetic compounds are manipulated to enable delivery of an aggregate of dissociated cells into a host by a method that results in the formation of functional new tissue. The field of tissue engineering has evolved by combining scientific advances in multiple fields including material science, tissue culture, and transplantation. These techniques facilitate the seeding of cells into a suspension that provides a three-dimensional environment that promotes matrix formation. This structure anchors cells and permits nutrition and gas exchange with the ultimate formation of new tissue in the shape of a gelatinous material. A number of tissue-engineered cartilage implants have previously been generated based on these new principles. This includes joint articular cartilage, tracheal rings, and auricular constructs. For in vivo cartilage formation, allograft has been successfully employed with the injection by syringe for the treatment of vascularuretal reflux. This results in the formation of irregularly shaped beads of cartilage, which are capable of obstructing the obstructing the urinary flow found in urethral incompetence. Tissue engineering offers the potential to grow cartilage in a precisely preformed shape and presently is in the developmental stage of generating various types of contoured facial implants consisting of immunocompatible cells and matrix. Once employed on a commercial basis, these techniques would require minimal donor site morbidity and, like alloplastic implants, reduce operative time.

PATHOPHYSIOLOGIC FACTORS IN AGING

It is generally acknowledged that patients endowed with strong, well-balanced skeletal features will best endure the ravages of age. Analysis of the faces of teens reveals an abundance of soft tissue that provides the underlying framework for the harmonious composite of youthful facial form.
Full cheeks and smooth, symmetrical contours free of sharp, irregular projections, indentations or skin wrinkling, or dyschromia commonly characterize these youthful faces. Facial structures, like the rest of the body, are in a state of constant flux and are influenced by many factors, such as sun exposure, weight loss, trauma, or disease. Even excessive exercise contributes to the development of certain consistent and identifiable facial contour defects. The development of lines and wrinkles is a result of genetic factors, sun exposure and other environmental exposures, smoking, underlying diseases, gravity, and the effects of muscular action. Depending on the underlying skeletal structure, resolution of the soft tissue changes associated with the aging process bring about different but definable configurations of the face that appear progressively more obvious and pronounced with time. Recognition of these various defects and configurations caused by aging is an integral part of the successful use of facial contouring procedures. These include the development of a generalized thinning of the face, thinning of the vermilion border of the lips, formation of jowls, areas of deep cavities, depressions of the cheek, the formation of deep folds of the skin and thighs. Other specific soft tissue configurations include the prominence of the nasolabial folds, flattening of the soft tissue below the chin, and formation of the prejowl sulcus. Among many techniques evolving in facial rejuvenation surgery, the missing link still remains the ability to permanently replace soft tissue volume in sufficient quantity and with lasting effect. The recent popularity of fat transplantations has rekindled tissue replacement as a key component of the rejuvenation process. However, if autogenous fat is not available in the presence of an atrophic soft tissue component of the face that will not benefit from reposioning, then the options are limited to simulating its replacement with the use of alloplastic implants. Alloplastic augmentation techniques now volumetrically address these problems by softening sharp angles and depressions, normalizing the underlying surface to smooth out wrinkles as well as enhance attractive skeletal structure.

Surgical Considerations in Nasal Augmentation

The relatively thin skin covering the nasal dorsum often fails to provide adequate camouflage for poorly contoured replacement tissue. Nasal augmentation has been performed using many different materials. Currently, the most commonly used implants consist of silicone, polyethylene, and polyethylene. Silicone eventually produces some overlying skin atrophy and must be anchored to prevent movement. Both polyethylene and silicone have the potential to cause infection but are easily removed and replaced. Polyethylene (Medpor) implants, as with any other implant that promotes significant tissue ingrowth, invoke the potential for major soft tissue damage to the overlying skin if removal becomes necessary. Homognat cartilage has a high percentage of resorption and autogenous bone has an additional problem of the grafting, because human cartilage has a limited capacity to regenerate effective long-term dorsal nasal reconstruction has remained problematic despite extensive efforts in use a wide variety of autografts, allografts, and alloplastic materials. A suitable replacement implant intended to reconstruct the original nasal profile must possess a number of unique characteristics. It must be of adequate length and have consistent curves, thickness, and tapered edges so as to fit well over the nasal bridge and blend with the surrounding soft tissues and bone. In addition, it must possess a high degree of malleability, flexibility, and compliance so as to endure despite long-term stresses and trauma.

The use of autogenous tissue avoids the problem of biocompatibility but sometimes fails to provide necessary volume to provide the size and shape. A more ideal substitute to replace deficient skeletal structure, particularly over the nasal dorsum, would be a reconstructive cartilage reproduced from one's own cells that closely mimics the original skeletal contour. This cartilage implant has been synthesized through tissue engineering. The concept involves use of donor septal cartilaginous tissue that is harvested and broken down to its cellular components. The cells are cultured in vitro, thus permitting them to multiply. A synthetic alginic scaffold is created in the shape of a dorsal nasal implant through a molding process. The cells are impregnated into the gelatin scaffold, which is placed subcutaneously into mice and permitted to evolve, in vivo, into a final shape. It is during this phase that the alginic scaffold slowly dissolves and is replaced by viable hyaline cartilage. The cartilage is then
Surgical Considerations
in Midfacial Enhancement

Refinements in aesthetic contouring and lifting of the midface have increased patient expectations. Our ability to rejuvenate the midface and correct midface volume problems has improved dramatically. Rhinectomy has become just one component of facial rejuvenation options. Now, browlift, midfacial augmentation procedures, cheeklift, midface lift, and revascularizing techniques all must be considered when customizing a surgical plan for a patient. If possible, the ultimate goal for midfacial enhancement is to combine the two key components of rejuvenation and augmentation. If, however, either surgical option by itself is insufficient to relocate platysmal soft tissue or augment volume loss, then the alternative solution must individually be combined with other procedures to provide the maximum multimodality approach to remedy the problem.

Specific criteria are available for determining regions of aesthetic deficits and their corresponding alloplastic solutions. In addition, other distinguishing considerations in midfacial aging and imbrication must also be identified. They are periocular aging, midfacial descent and volumization, and facial bone maldevelopment with accompanying soft tissue imbalances, ptosis, and asymmetry.

Periorbital aging. With age, there is a weakening of the orbital septum and herniation of the peribulbar fat, causing infraorbital hollowness. The orbicularis muscle becomes ptotic, especially on its most inferior aspect. Use of conventional blepharoplasty tends to exacerbate laxity of the lower eyelid, which contributes to the formation of the “tarsal trough” dermopathy or, in severe cases, a “saccharo cephalopexy.” Attend with aging is subcutaneous tissue atrophy, which has more damaging affects on the thin infraorbital skin accounting for the hollows of the eyes with advanced aging.

Skeletal insufficiency and imbalances are usually caused primarily by the hypoplastic development and inherent bony imbalances of the facial skeleton, which are exacerbated by the aging process.

Midfacial descent and volume loss. Midfacial descent involves ptosis of the infraorbital subcutaneous tissues, the malar fat pad, the suborbicularis oculi fat (SOOF), and the subcutaneous muscle. As the cheek falls and colobates on the upper nasolabial fold, the thicker tissues of the malar fat pad descend and leave the infraorbital region exposed to thin soft tissue covering. Thus, the nasolabial “tarsal” trough region becomes prominent, the lower eyes appear hollow, and the infraorbital rim becomes more prominent. The loss of subcutaneous fat occurs everywhere in the body but affects midfacial tissues more severely, including the buccal fat pad, the malar fat pad, and the SOOF. As these tissues continue to lose volume and descend, different patterns of midfacial aging develop in the infraorbital and cheek regions.

In the midface, most soft tissue deficiencies are found within the region described as the “suborbicular Triangle.” This inverted triangle area of midfacial depression is bordered above by the prominence of the zygoma, medially by the nasolabial fold, and laterally by the body of the masseter muscle (Fig. 25-3). In patients, in whom severe degenerative changes of the skin and the loss of underlying soft tissue and fat associated with deficient underlying bone structure are combined, the gravitational effects of aging will be exaggerated and cause further deepening of depressions, folds, and wrinkles. In other individuals who have exceptionally prominent cheek bone structure combined with thin skin lacking in subcutaneous or deep supporting fat, facial depressions will be further emphasized. This type of pattern causes a gaunt or haggard appearance in an otherwise healthy person. The severe form of this midfacial pattern can be seen in anorexia nervosa, starvation, or in a newly identified group of HIV-positive patients who have been on protease inhibitors for

**Figure 25-7** The inverted suborbicular 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.
prolonged periods. In combination with the primary disease process, the protease inhibitors and other newer generation HIV therapies have a predisposition for erosion of the midfacial fat and the buccal fat pad. These conditions of volume loss that are also associated with the aging process often preclude use of rhytidectomy alone for complete facial rejuvenation and are currently being successfully treated with the use of computer-assisted custom-designed facial implants.

Figure 25-4 (A, C) This preoperative photograph represents a patient who has been treated with protease inhibition for a prolonged period. Many patients eventually develop complete erosion of the midfacial fat and the buccal fat pad leaving a particularly deep cavity depression in the midface. (B, D) At 1 year post surgery, the condition was successfully treated with computer-assisted custom-designed midfacial implants.
Midfacial Procedures:
(A Multimodality, "Multilevel" Approach)

For successful rejuvenation of the midface, this descent and vol-
ume loss must be camouflaged, corrected, or replaced. This now entails a multilevel as well as a multimodality approach to the pathophysiology of aging. Camouflage techniques, such as zygomatic bone grafting, cause blunting of the nasojugal groove/furrow trough region by securing the infram-
bital fat pad to the masseter of the mandible. \(^5\) Midfacial excision tech-
niques reverse midfacial descent by lifting the midfacial tissues and anchoring them to more superior lateral structures. \(^6\) Allo-
plastic or autogenous augmentation techniques reverse the effects of midfacial descent by replacing midfacial volume and providing soft tissue support at the deepest plane. Because there are many elements of structural deficiency and phenom-
ena of aging, along with chondroderma, bone resurfacing, and many other structural techniques, facial implants are used col-
lectively as a necessity part of the framework to restore and exten.

PREOPERATIVE ANALYSIS FOR FACIAL CONTOURING

Considering the infinite variations of facial form that exist, most analytical measurements used in determination of aesthetic guidelines have been unreliable. Recent studies and angle guidelines have been helpful as a first step in dictating contour. However, facial augmentation is a three-dimensional procedure and geometrically increases the variables of structural diagnosis and ultimate treatment. Having a good understanding of skeletal anatomy and being able to identify specific types of topographic patterns guides the surgeon in making the final determination for optimal implant selection and placement.

Augmentation of the facial skeleton with alloplastic implants changes the deepest skeletal plane of the face with a threedimensional modality. Evaluation of the face for contouring procedures starts with an understanding of specific zones of skeletal anatomy and identification of distinctive and recognizable configurations of facial deficiency. Correlating these elements of structural and topographic variations is essential for choosing the optimal implant shape, size, and position to obtain the best results in facial contouring.

Evaluation of Mandibular
Contour Defects

Delineation of zonal principles of anatomy within the pre-
mandibular space allows the surgeon to create specific chin and
jaw line contours. \(^7\) Traditionally, chin implants were placed over the area between the mental foramina. This familiar
location constitutes only one segment or zone of the mandible that can be successfully altered. Implants placed in the central segment alone and without lateral tension often produce abnormal round proptromines that are unwanted. A midfacial zone within the promandibular space can be defined as the region extending from the mental foramen posteriorly to the oblique line of the horizontal body of the mandible. When this zone is augmented in addition to the central segment a widening of the anterior jaw line contour results. This is the basis for the development of the extended anatomical and pre-
jow chin implant. \(^7\) The posterior lateral zone is the third zone of the promandibular space, which encompasses the posterior half of the horizontal body including the angle of the mandible and the first 2 to 4 cm of the ascending ramus. This zone can be modified with a mandibular angle implant that will widen or elongate the posterior mandibular angle to produce a stronger posterior jaw line contour.

Zonal principles of skeletal anatomy are useful for concep-
tualizing the malar and midfacial region into distinct anatom-
ical zones (Fig. 28-5). Zone 1, the largest zone, includes the major portion of the malar bone and the first third of the zygomatic arch. Augmentation within this zone maximizes the projection of the malar eminence. It produces a high, sharp angular appearance. Zone 2 overlies the middle third of the zygomatic arch. Enhancement of this zone along with zone 1 accentuates the cheek bone laterally, producing a

\(\text{Figure 28-5 Allploastic facial contouring by zonal principles of skeletal anatomy. The zones of malar bone augmentation: central pyriform (CM), central mandible (PL), and posterior lateral (PL) on the malar and maxillary ridge. Face Plast Surg Clin North Am 1992; 266-283. With permission.)}\)
broader dimension to the upper third of the face. Zone 3, the prenasal area, lies midway between the infraorbital fossa and the nasal bone. A vertical line drawn from the infraorbital fossa marks the lateral border of zone 3, which is the medial extent of the dissection usually done for malar augmentation. Augmentation of zone 3 gives medial fullness to the infraorbital region. Zone 4 overlaps the posterior third of the zygomatic arch. Augmentation in this area produces an unnatural appearance and in most cases is not indicated. The tissues overlying this zone are adherent to the bone, and dissection must be performed cautiously because the zygomaticofrontal division of the facial nerve passes superficially within the temporoparietal fascia over the zygomatic arch and would be prone to injury. Zone 5 is the submalar triangle.

Midfacial Contour Defects

A typographic classification of midfacial contour deficiencies has proven to be extremely useful as a basic reference guideline to correlate distinctive anatomic patterns of deformity to specific implants.28 (Table 25–2; Fig. 25–7) Type I deformity occurs in a patient who has good midfacial fullness, but insufficient malar skeletal development. In this case, a malar shell implant to augment the zygoma and create a higher arch to the cheekline would be desirable. The larger surface area of the implant imparts greater stability and helps reduce rotation or displacement. Inferior extension into the submalar space establishes a more natural transition from the localized area of maximal augmentation to contiguous areas of relative recession (Fig 25–8). Type II deformity occurs in a patient who has atrophy or ptosis of the midfacial soft tissues in the submalar area with adequate malar development. In this case, submalar implants are used to augment or fill these depressions or provide anterior projection (Figs. 25–9). Type II deficiency is the most common, found most in the aging patient where the submalar implant is used effectively as an adjunct to the facelift surgery (Fig. 25–10). Type III deformity occurs in a patient who has thin skin and exceptionally prominent malar eminences. These characteristics combine to cause an abrupt transition from the cheek bone superioity to an extreme area of hollowness found within the submalar region, producing an exceptionally gaunt or skeletonized facial appearance. In this group of patients, a second-generation submalar transition implant is used to fill the abrupt midfacial hollow. Type IV deformity is the result of malar hypoplasia and submalar soft tissue deficiency, which is described as the "volume-deficient" face. In this situation, a single combined malar-submalar implant most serve two purposes: it must proportionately augment a deficient skeletal structure over the malar area and fill the void created by absent midfacial soft tissue within the submalar area. Because this condition is also associated with premature aging of the skin in terms of excessive midfacial wrinkling and deep folds, these patients are often classified as suboptimal candidates for rhinoplasty. As seen in Fig. 25–11, total midfacial restoration and lateral mandibular augmentation, using a combined malar-submalar implant and prejowl implant, provide the structural basis for this patient to derive greater benefit from the concurrently performed rhinodectomy procedure and successfully eliminate the deep folds that were present in
TABLE 25-2 Patterns of Midfacial Deformities Correlated with Type of Implant

<table>
<thead>
<tr>
<th>Deformity type</th>
<th>Midfacial deformity</th>
<th>Type of augmentation required</th>
<th>Type of implant (predominantly used)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Primary malar hypoplasia; adequate submalar soft-tissue development</td>
<td>Requires projection over the malar eminence</td>
<td>Malar implant: &quot;shell-type&quot; implant extends inferiorly into submalar space for more natural result</td>
</tr>
<tr>
<td>II</td>
<td>Submalar deficiency; adequate malar development</td>
<td>Requires anterior projection; implant placed over face of maxilla and/or masseter tendon in submalar space. Also provides for midfacial fill</td>
<td>Submalar implant (New Conform type or Conception I submalar implant)</td>
</tr>
<tr>
<td>III</td>
<td>Extreme malar-zygomatic prominence; thin skin; with abrupt transition to a severe submalar recess</td>
<td>Requires normal anatomic transition between malar and submalar regions; plus mid-toe augmentation around inferior aspect of zygoma</td>
<td>Submalar implant (Generation II-III) cliped to fit w/in submalar space and around inferior border of prominent zygoma</td>
</tr>
<tr>
<td>IV</td>
<td>Both malar hypoplasia and submalar deficiency</td>
<td>Requires anterior and lateral projection; &quot;volume replacement implant&quot; for entire midface recontouring</td>
<td>&quot;Combined&quot; submalar-shell implant; lateral (malar) and anterior (submalar) projection. Fills large midfacial void</td>
</tr>
<tr>
<td>V</td>
<td>Tear trough deformity (Infratrochlear rim depression or recede)</td>
<td>Requires site-specific augmentation along infratrochlear rim</td>
<td>&quot;Tear trough implant&quot;; to fit site-specific submalar groove</td>
</tr>
</tbody>
</table>

the medial middle third of the face. The tear trough (type V) deformity is specifically limited to a deep groove that commonly occurs at the junction of the thin eyelid and thicker cheek skin. In this deformity, a pronounced fold extends downward and laterally from the inner canthus of the eye across the infraorbital rim and the suborbital component of the malar bone. A tear trough-silicone dermoker implant, ePTFE, and fat have been used in attempts to correct this deformity.323

Of specific approach to the hollow infraorbital and nasojugal region is an infraorbital/midfacial elevation technique, the superficial cheeklift.32 This addresses the vector component of midfacial aging. The superficial cheeklift enables an elevation in the thicker cheekskin and subcaneous tissue to cover the inferior orbital rim. This also reduces herniations of the upper medulloidal fold (Fig. 25-12). The lateral and midpupillary region are most effectively treated. For a more severe tear trough deformity medically, a concomitant access marginosis use of infraorbital fat or tear trough implant can also be used concurrently if additional augmentation is necessary. The superficial dissection plane offers advantages in ease of performance, direct access to the pliable cheekskin, and lower complication rates over subperiosteal dissection techniques. Caution and experience in midfacial anatomy are still necessary before any midface elevation procedure can be undertaken. If excessive midfacial elevation (or overcorrection of seemingly loose infraorbital skin) is attempted, downward traction from the mouth can result in traction on the lower eyelid. Cheeklift techniques are now and are still undergoing modification as their role in midfacial rejuvenation increases.

**PROCEDURE**

An implant of a particular shape or size that is used for a wide face may need to have its overall dimension or thickness reduced for a narrow face, or in the presence of thin skin. At all faces are different, it should be the rule that implants require modifications. Therefore, the surgeon must...
Figure 25-7  Frontal and lateral drawings illustrate the anatomical areas of the midface and five distinctive topographic patterns of midfacial deformity. Specific implants that are directly correlated with and used to correct these specific patterns of midfacial deformity are selected (see Table 25-2).
Figure 25-8  (left) Preoperative example of malar hypoplasia (type I deficiency). (right) Eight months after malarplasty using a Malar-Shell implant. Augmentation of a greater surface area and extension inferiorly into the submalar space produces a more natural high cheekbone effect.

Figure 25-9  (A) Preoperatively, this patient has a relatively good malar bone structure but was complaining of early flatness to the midface (type II deformity) in addition to a mandibular paraphyseal depression caused by an earlier performed genioplasty. (B) Submalar augmentation restored the anterior projection to the middle third of the face, providing a more youthful expression as well as reducing the depth of the nasolabial folds. A custom implant was used to fill in the paraphyseal depression.
be prepared to have all anticipated designs, shapes, or materials available and be prepared to modify the implant on an impromptu basis. Failure to have the right implant for a particular patient can only yield a suboptimal result.

On the day prior to surgery, the patient is started on a broad-spectrum antibiotic regimen that will continue for 5 days after surgery. Intravenous antibiotics and sedatives are also administered preoperatively. 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 optimize their mutual goals (Fig. 25-13).

General Surgical Technique for Facial Implantation

The basic principles for augmenting the malar, midfacial, premandibular spaces or nasal augmentation are identical. Controlling the shape, size, and positioning of the implant will determine the overall final facial contour.

Surgical Technique for Mandibular Augmentation

Anterior Mandibular Implants

Access to the premandibular space can be accomplished by either an introral or an external route. The external route utilizes a 1 to 1.5-cm incision in the submental crease.
Figure 25-11  (A) frontal; (B) oblique; (continued on next page)
Figure 25-11 (cont.) (C) head down; (D) lateral. Left 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. Right 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 facelift procedure to provide meaningful, long-term improvement. (From Binder WJ. A comprehensive approach for aesthetic contouring of the midface in rhytidectomy. Fac Plast Surg Clin North Am 1992; 1:231–255. With permission.)
Advantages of the external route are that it does not involve intraoral bacterial contamination; it has direct access to the inferior mandibular border where cortical bone is present; it does not require significant retraction of the mental nerves; and it allows the implant to be secured to the periosteum along the inferior mandibular border with simple suture fixation. This helps to prevent side-to-side or vertical slippage. The intervalional route provides the obvious advantage of leaving no external scars. The entry wound for the intervalional route is a transverse incision made through the mucosa. The mental muscle is divided vertically in the midline right to avoid transection of the muscle belly or detachment from the bony origins. This midline incision provides adequate access indirectly to the bone of the central mentum and eliminates the potential muscle weakness that may occur if transection takes place. Lateral dissection requires identification and retraction of the mental nerves.

Basic technical rules for safe and adequate mandibular augmentation should be followed. (1) 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. Strong adherence of periosteum along the anterior inferior border of the mandible comprises the origins of the anterior mandibular ligament, which defines the pre-
jowl sulkus at the inferior aspect of the aging marionette cause. It is often necessary to incise these ligamentous attachments to allow dissection to continue along the inferior segment of the mandible. (2) Dissection of this space must be adequately expanded to accommodate the prosthesis comfortably. A sharp dissecting instrument may be used carefully, 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, which 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 prevention of postoperative hematomata or seroma.

A Joseph or 4-mm periosteal elevator is used to perform the dissection along the inferior mandibular border. When the pockets are large enough, one side of the implant is inserted into the lateral portion of the pocket on one side and then folded on itself whereby the contralateral portion of the implant is inserted into the other side of the pocket. The implant is then adjusted into position. If the implant material does not allow flexibility, then either the incision must be made larger or the procedure must be performed.
Figure 25-12  (cont.) (b) A 52-year-old woman, preoperative, with hollow infraorbital and nasojugal region. (c) Six months postoperative superficial cheeklift. (From Moellerken B, et al: The superficial subciliary cheeklift: a technique for rejuvenating the infraorbital region and nasojugal groove—clinical series of 71 patients. *Plast Reconstr Surg* 1999;104(6). With permission.)

Figure 25-13  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 rhinoplasty. *Fac Plast Surg Clin North Am* 1993;1: 231–255. With permission.)
through an introral incision. Implants expanding into the midfacial or parasympathetic zone accomplish anterior widening of the lower third of the facial segment. The necessary average central projection is 6 to 9 mm for men and 4 to 7 mm for women. Occasionally, in a patient with severe microgenia, implants measuring 10 to 12 mm in projection or greater may be necessary to create a normal profile and a broader jawline.

**Mandibular Angle Implants**

Access to the angle of the mandible is achieved through a 2 to 3-mm mucosal incision at the retromolar trigone. This gives direct access to the angle of the mandible. Dissection is performed on bone and beneath the masseter muscle to elevate the periosseous uptoward 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 rami of the mandible. This permits accurate placement of angle implants that are specifically designed to fit the posterior bony border of the ascending ramus and enhance angle definition. These implants are secured with a titanium screw.

**Surgical Techniques for Malar and Midfacial Contouring**

The primary route for entering the malar-midfacial areas is the introral approach. Other approaches include the buccal (via lower blepharoplasty), transconjunctival, rhinoplasty, zygomaticotemporal, and transoral routes.

**Introral Route**

The introral route is the most common and the preferred route for most maxilfacial implantations with the exception of the tear trough implantation. 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 (Fig. 25-14). Because the mucosa will stretch and allow complete visual inspection of the midfacial structures, a long incision through adjacent submuosal or muscular layers is not necessary and is discouraged. The incision should be made high enough to leave a minimum of 1 cm of gingival mucosal cuff. If the patient wears dentures, this incision must be placed above the dentures’ superior border. Dentures can be left in place after the procedure, which in our experience does not cause extrusion or increase the incidence of complications. A broad Tenenier-type elevator (approximately 10 mm wide) is directed through the incision onto the bone in the same orientation as the incision. A broad elevator helps facilitate the dissection safely and with relative ease within the subperiosteal plane (Fig. 25-14B). While keeping the elevator directly on bone, the soft tissues are elevated obliquely upward off the maxillary sinuses and the malar eminence. The elevator is kept on the bone margin along the inferior border of the malar eminence and the zygomatic arch. The external or free hand is used to help guide the elevator over the designated areas.

For routine malar-submalar augmentation procedures, no attempt is made to visualize or dissect within the vicinity of the infraorbital nerve unless an implant is intended for this area. If necessary, the infraorbital nerve is easily visualized in a more medial location. The submalar space is created by elevating the soft tissues inferiorly over the masseter muscle below the zygomas (Fig. 25-14C). One can discern the correct plane of dissection by the glinting white fibers of the masseter tendons by direct vision. It is important to note that these masticatory attachments are not cut and are left completely intact to provide a supporting framework on which the implant may rest. As the dissection moves posteriorly along the zygomatic arch, the space becomes tighter and is not as easily manipulated as the medial segment. However, part of this space can be opened by gently advancing and elevating the tissues with a heavy, blunt periosteal elevator. It is of utmost importance that the dissection be extended sufficiently so that the implant fits passively within the pocket. A pocket that is too small will force the implant toward the opposite direction, causing implant displacement or extrusion. Under normal conditions, the pocket is estimated to collapse and obliterate most of the space around the implant within 24 to 48 hours following surgery. Implant selection is aided by observing the actual topographic changes produced by placement of the different implant “sizers” into the pocket (Fig. 25-14D).

Final implant placement must correspond to the external topographic defects outlined on the face preoperatively (Fig. 25-14E). In submalar augmentation, the implant may reside below the zygoma and zygomatic arch, over the masseter bender, or it may overlap both bone and tendons. The larger shell-type malar implants reside primarily on bone in a more superior lateral position and may extend partially into the submalar space. The combined implant will occupy both areas. Any implant placed in areas with noticeable facial asymmetry, thin skin, or an extremely prominent bone structure may require modification to reduce the thickness or length and avoid abnormal projections. Among the advantages of silicone elastomer midfacial implants is flexibility enabling large implants to be compressed through small incisions, which are the key to longevity. A pocket is created beyond the incision. This avoids having to make the larger incisions required for more rigid implants and allows for ease of implant insertion and removal during the selection process.

**Facial Asymmetry**

The most difficult task in achieving successful results in facial contouring is the management of facial asymmetry. During the preoperative consultation, a thorough discussion regarding this problem is essential because most patients are usually unaware of the qualitative or quantitative presence of their own facial asymmetry.25 Meticulous attention to detail is required to visualize, perceptually integrate, and then make procedural adjustments to accommodate existing three-dimensional discrepancies. It is not unusual to find adequate malar development and a well-sustained soft tissue pad with good external contour on one side of the face, and a hypoplastic malar eminence along with relative atrophy of the soft tissues and greater wrinkling of the skin on
Figure 23-16  (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 to 1.5 cm) and is placed over the lateral aspect of the canine fossa and lateral bursae at least 1 cm above the bicoronal suture line. (B) The 9- and 10-ram curved and straight periosteal elevators used for dissection. (C) Demonstrates the general extent of dissection required for most midfacial implants. The dissection must be sufficiently extended pomerolaterally over the zygomatic arch, and/or expanded inferiorty into the subperiosteal space over the breadth of insertion of the temporalis muscle so that the implant can be accommodated passively within the pocket. (D) Direct visual inspection of midfacial structures can be obtained through the incision. (E) By retracting the overlying tissues. Using sizers or different implants helps to determine optimum size, shape, and position of the final implant selected. (The stippled area represents a bone that has been placed within the window.) (F) Left: The external drawings made on the skin delineate the maxilla bone and subperiosteal space below. Right: The shape and size of the 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 subperiosteal space. (From Rinder P.) A comprehensive approach for aesthetic contouring of the midface in this manner. J. Plast. Surg. Clin. North Am. 1991;1:241-255. With permission.)
the other side. In these cases, it is essential to have an ade-
quiate selection of implants available and to anticipate carv-
ing or altering the implants to adjust to the differences in con-
trast and projection between the two sides. Unilateral asymmetry may
also require use of different implants for each side or shap-
ning that can be carved from a silicone block that are natural to
the patient's own structure of the implant to increase the projec-
tion of a particular segment.

Implant Fixation
Once position has been established, it is usually necessary to
secure the implant. This can be accomplished by a num-
ber of different methods. Internal suture fixation relies on
the presence of an adjacent stable segment of periosteum or
bony structure on which to anchor the implant. Stainless steel or titanium screws can also be used. There are
two methods of external fixation used to stabilize mid-
facial implants. The indirect lateral suspension technique
uses 2.0 suture needles wedged on large Keith needles and
placed through the implant tunnel. These needles are then
inserted through the pocket, directed superiorly and poste-
riorly to exit percutaneously posterior to the temporal hairline.
The sutures are then tied over a bolster exerting traction on
the tail of the implant. This technique is more suitable for
malar implants. The direct method of external fixation is
often used in patients with gross asymmetry or when sub-
malar or combined implants are used. In these situations,
the direct external method of fixation prevents slippage in
the immediate postoperative period. With this method, the
implants are positioned to correspond directly with marks
on the skin that coincide with the two most medial fenes-
trations of the implant. Symmetrical placement of both
implants is assisted by measuring the distance from the
malar line to both right and left medial markings (Fig. 25-15A).
Then the implants are removed and placed on
the skin by lining up the medial fenestration over the cor-
responding mark. The position of the lateral portion of the
implant is then decided by placing a second mark corre-
sponding to the adjacent implant fenestration. A double-
sutured suture with 1-in, straight needles is then passed
through the two medial fenes
trations of the implant from a
posterior to anterior direction. The needles are advanced
through the pocket, passed perpendicularly through the
skin, and allowed to exit at the respective external marks-
ings (Fig. 25-15B). The implant, following the needles, is
guided into the pocket. The implant is then secured in place
by tying the sutures over bolsters composed of two cotton
rolls (Fig. 25-15C).

Subcutaneous (Lower Blepharoplasty) Approach
It is more difficult to introduce a large implant through a sub-
cutaneous approach. However, this is the preferred approach for
the insertion of the lower midfacial implant. In lower augmenta-
tion only, when zone 1 or 2 requires a smaller malar implant to
achieve high volume cheek bones, the blepharoplasty ap-
proach may be adequate. The advantages of the subcutaneous
approach are the lack of oral contamination and the soft tissue
support inferiorly, which reduces the chances for implant
descent. However, this technique can also precipitate an
ectropion in the presence of a weak tarsus.

Transconjunctival Approach
The transconjunctival approach has been used for insertion
of midfacial implants but may also require dissection of the
lateral canthal tendons. This necessitates secondary compensation
canthoplasty with the attendant risk of lower eyelid asymmetry.

Rhytidectomy Approach
The malar space may be safely entered through zone 1 of the
malar region. Penetration of the subcutaneous musculo-
areolar system (SMAS) is made medial to the zygomatic emergence and then bluntly carried down to bone. There are no
significant facial nerves branches in this area. The malar pocket is then created primarily by retrograde dissection. However,
insertion of an implant by this approach can introduce tech-
nical difficulties during SMAS resection and elevation and pro-
vides limited access for extended implant positioning.

Zygomatic/Temporal and
Cervical Approaches
The cranial facial techniques for subperiosteal facelifts pro-
vide ready access to the malar zygomatic region. However, endoscopic approaches for the most part provide reduced
exposure or the required visualization necessary for regional augmentation with larger implants.

COMPLICATIONS
Complications of implantation in facial augmentation include
bleeding, hematoma, infection, exposure, extrusion, malposition,
displacement or slippage, fistulae, seroma, persistent edema, abnormal prominence, persistent inflammatory
action, pain, and nerve damage. However, in most of the
complications listed, very few are due solely to the implant
material itself. It is extremely difficult to separate the surgical
techniques from the surrounding circumstances of the indi-
vidual operation as well as from individual patient risk fac-
tors not associated with the implant.

Examination should not occur if the technical rules have been
followed. The extended surface area of the larger or extended
implants that fit along the malar and mandibular contours
maintain position and rotation. Adequate dissection of
the subperiosteal space to a large enough degree to create
midfacial and postorbital tunnels in the mandible and the
desired pockets in the malar will maintain 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 midfacial zone. It is important not to
traumatize the tissues that overlay this area. The course of the
mental nerve is anatomically directed superiority into the lower
lip, which also helps to protect it from dissection trauma. Temporary hyposthesia 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 0.05% of a statistically large numbers of cases. If enlargement of the nerve by the implant is detected due to displacement or malposition, then repositioning of the implant below the nerve should be done as early as possible.

The temporal branch of the facial nerve passes posterior to the musculature of the zygomatic arch, and care must also be provided when dissecting in this area. Injection of the pocket at the end of the procedure with either normal saline or with heparin, 50,000 units per liter of sterile saline. Seeking the porous implants in antibiotic solution is 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 considerably reduces the risk of hematomas, seromas, swelling, and, consequently, the postoperative complications related to fluid accumulation within the pocket (Fig. 25-11). Bone resorption is more commonly found in mandibular augmentation than in other alloplastic implant procedures. Findings of bone erosion following chin implantation were reported in 1968. However, since these early reports, there have been no clinical reports of significance after surveying large populations of implants. 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 prior cosmetic enhancement.
DISCUSSION
Understanding the principals of zonal anatomy, observing the types of external facial forces, and paying careful attention to basic techniques result in greater predictability in facial contouring. Critical analysis of the patient's face and precise and focused communication between surgeon and patient lead to optimal patient satisfaction. Many different types of facial implants are available with which the surgeon can create a variety of contours to fulfill most needs. Reconstructing more complex contour defects can be accomplished by using three-dimensional computer imaging and CAD/CAM technology to manufacture custom implants. A recent increase in the number of HIV-positive patients seeking prostheses has necessitated the use of this technique to effectively treat this cosmetically disabling condition.

CONCLUSION
Facial implant procedures provide the patient with significant change in his or her facial appearance, and the rewards to the patient in terms of producing increased harmony and proportion to the face are unlimited. Although challenging, few procedures can provide the major rewards that facial contouring procedures can offer.

REFERENCES