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Clinical Evaluation, Imaging, and Anesthetic Considerations in Facial Implant Procedures: An Interdisciplinary Approach for Dentistry, Radiology, and Anesthesia

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Abstract

Background: Facial implants are increasingly used across cosmetic and reconstructive dentistry and maxillofacial surgery to restore projection, symmetry, and contour—most commonly at the chin, malar eminence, and mandibular angle. Contemporary data show overall complication rates of ~4%–11% and highlight the need for rigorous anatomic, imaging, and anesthetic integration to optimize safety and outcomes.

Aim: To synthesize an interdisciplinary, practice-oriented framework that unifies clinical evaluation, imaging workflows, and anesthetic decision-making for facial implant procedures, with emphasis on anatomy-driven risk mitigation and team-based care.

Methods: Narrative, interdisciplinary review and consolidation of current operative anatomy (trigeminal and facial nerve danger zones; infraorbital/mental neurovascular bundles; muscular attachments), imaging modalities (2D cephalometry, CBCT, stereophotogrammetry, digital planning), materials science (HDPE, silicone, titanium, and patient-specific implants), perioperative anesthesia, and complication profiles.

Results: High-value risk zones include the supraorbital/supratrochlear, infraorbital, zygomaticofacial/zygomaticotemporal, and mental foramina, and the temporal, zygomatic–buccal, and marginal mandibular branches of CN VII. 3D imaging (CBCT + surface scanning) refines diagnosis, fit, and fixation, while cephalometric metrics and AI-assisted planning guide implant choice and position. Intraoral approaches with subperiosteal dissection, secure fixation (screws/sutures), and layered closure limit migration and soft-tissue ptosis. Reported infections occur in ~2%–5%, displacement in ~1%–3%, mental nerve injury near ~2.4%, and porous polyethylene shows less bony resorption than solid silicone. Tailored anesthesia (IV sedation or general), antibiotic prophylaxis, and postoperative compression further reduce morbidity.

Conclusion: A standardized, anatomy- and imaging-led pathway—coupled with vigilant anesthetic planning and interprofessional execution—improves safety, predictability, and aesthetics in facial implant surgery. Future multicenter studies and registries should refine risk stratification, material selection, and patient-reported outcomes.

Keywords: Facial implants; CBCT; stereophotogrammetry; malar augmentation; chin implant; trigeminal nerve; facial nerve; HDPE; silicone; titanium; anesthesia; complications; patient-specific implants.

Introduction

Facial implants are widely utilized in both cosmetic and reconstructive dentistry and maxillofacial surgery to enhance facial aesthetics, correct congenital or developmental deficiencies, and restore symmetry after trauma. Common augmentation sites include the chin, zygomatic arches, and mandibular angles, which are critical for defining facial contours and proportions. According to a 2020 survey conducted by the American Society of Plastic Surgeons, malar implants were the most frequently performed facial implant procedures and ranked as the third most common cosmetic surgical procedure overall. Since 2000, the use of malar implants has increased dramatically by 938%, while chin implant procedures have grown by 63% over the

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same period. Although less common, implants are also placed in regions such as the nasal dorsum, glabella, and temporal regions, highlighting the diversity of anatomical applications and the growing demand for facial augmentation [1]. Recent systematic reviews published in 2024 and 2025 report pooled complication rates for facial implant surgeries ranging from 4% to 11%. Complication rates are lowest for malar and chin implants and higher in paranasal and temporal regions, reflecting the complexity of anatomical variations and soft tissue support in these areas [2]. The choice of implant material is critical, with ideal implants being chemically inert, biocompatible, and easily sculpted to fit patient-specific anatomical requirements. While facial implants may be organic or synthetic, the predominant materials in contemporary practice include high-density polyethylene (HDPE), medical-grade silicone, and titanium. Autologous grafts, once frequently employed for facial augmentation, have declined in popularity due to their long-term variability, unpredictable resorption, and donor site morbidity [3].

Complications associated with facial implants vary in severity. Poor cosmetic outcomes, often resulting from asymmetry or improper placement, are the most common complications and may necessitate revision procedures. More serious complications include infection, soft tissue irritation, extrusion, and bone erosion. Implant removal can be particularly challenging in porous materials, such as HDPE, which permit soft tissue ingrowth, in contrast to solid implants surrounded by a fibrous capsule, which are easier to explant [4][5]. Advancements in imaging technology have significantly improved the evaluation and planning of facial implant procedures. Three-dimensional (3D) imaging, including cone-beam computed tomography (CBCT) and stereophotogrammetry, allows precise mapping of skeletal deficiencies and soft tissue contours, facilitating personalized surgical planning. Traditional two-dimensional (2D) imaging, including lateral cephalograms, remains valuable for evaluating specific relationships, such as chin position and mandibular symmetry, but its limitations in midface and complex zygomatic assessments necessitate complementary 3D approaches. Objective criteria for implant selection, including skeletal measurements, facial proportions, and soft tissue thickness, have been developed to standardize surgical planning. However, aesthetic goals must also incorporate patient preferences and societal trends, as perceptions of beauty are dynamic and culturally influenced. Achieving optimal outcomes requires a combination of precise diagnosis, comprehensive facial analysis, judicious implant selection, and meticulous surgical technique, supported by interdisciplinary collaboration among dental surgeons, radiologists, and anesthesiologists to ensure both functional and aesthetic success.

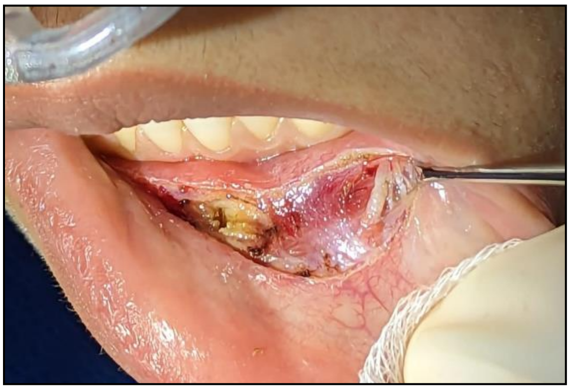

Fig. 1: Mental Nerve terminal branches.

Anatomy and Physiology

Facial implant surgery demands meticulous appreciation of regional anatomy to avoid iatrogenic injury to sensory and motor nerves, to preserve arterial and venous integrity, and to respect the functional architecture of the facial and masticatory musculature. In practice, the most consequential hazards arise where neurovascular structures emerge from bony foramina to enter the superficial soft tissues or traverse corridors that coincide with common dissection planes. Accordingly, safe placement hinges on anticipating the course and depth of key branches of the trigeminal and facial nerves, on recognizing the proximity of named vessels that accompany sensory nerves at points of egress, and on understanding how the insertions and vectors of facial and jaw muscles intersect with customary implant pockets. The following overview synthesizes these anatomic priorities in a manner oriented to operative decision-making and risk reduction during chin (genial) and malar (zygomatic) augmentation as well as other facial implant procedures. The trigeminal nerve (cranial nerve V) provides the principal sensory innervation of the face and, via its mandibular division, motor innervation to the muscles of mastication. It is conventionally described in three divisions—ophthalmic (V1), maxillary (V2), and mandibular (V3)—each of which exits the cranial cavity through a discrete foramen and then arborizes into terminal branches that pierce the soft tissues of the viscerocranium to reach their cutaneous or mucosal targets [6]. From a surgical standpoint, injury risk is not uniformly distributed; rather, it concentrates at or near bony exits where nerves become more superficial and are less protected by overlying muscle or fascia. The ophthalmic division (V1), which traverses the superior orbital fissure, divides into frontal, lacrimal, and nasociliary branches before emerging to supply the upper face and anterior scalp. The frontal branch is the dominant sensory conduit in this territory; as it passes through the orbit and exits superiorly, it bifurcates to form the supraorbital and supratrochlear nerves. These nerves fan across the forehead and anterior scalp to provide sensation to the upper eyelid, conjunctiva, and scalp, and they are particularly vulnerable where the supraorbital nerve crosses the orbital rim, especially in procedures that involve subperiosteal dissection of the superior orbital margin or supraorbital rim contouring [6]. The lacrimal nerve, the smallest of the V1 branches, participates in innervating the lateral upper eyelid and conjunctiva and communicates with the zygomatic nerve, contributing to lacrimal gland innervation. Although this branch is less commonly injured during implant surgery, its proximity to the lateral orbit and zygomaticofrontal suture line means that malar dissection must be disciplined and limited to the intended subperiosteal plane. The nasociliary nerve, dividing within the orbit, generates the infratrochlear and external nasal branches, which provide sensation to the medial upper eyelid, the root, and the dorsum of the nose; surgeons should be alert to these when extending dissection medially along the superior nasal bones during combined aesthetic procedures.

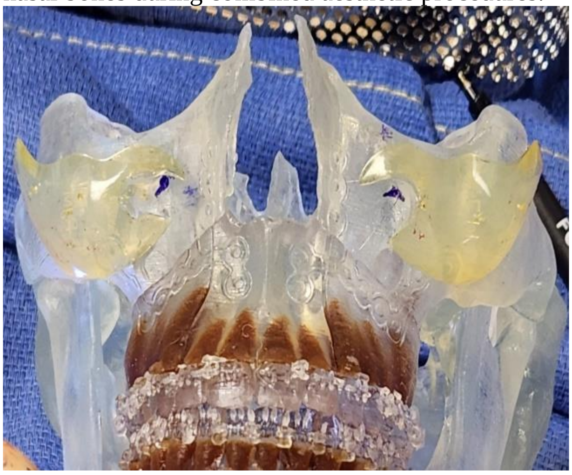

Fig. 2: Silicone Malar Implants. Silicone malar implants positioned on a 3D-printed stereolithographic model.

The maxillary division (V2) exits the cranial vault via the foramen rotundum and gives rise to two branches of paramount importance in facial implant surgery: the infraorbital and the zygomatic nerves. The infraorbital nerve progresses within the infraorbital canal and emerges through the infraorbital foramen on the anterior maxilla, where it divides to innervate the lower eyelid, lateral nose, upper lip, and cheek. Because malar implants often require subperiosteal pocket creation extending from the zygomatic eminence toward the infraorbital rim, the infraorbital neurovascular bundle is at elevated risk at its point of emergence. Accurate localization of the infraorbital foramen preoperatively and intraoperatively, maintenance of a subperiosteal plane while skirting the foramen, and avoidance of retractor compression at the exit point are indispensable to preserving sensation in the midface. The zygomatic nerve travels laterally along the orbital wall before dividing into zygomaticotemporal and zygomaticofacial branches, each exiting through small foramina to supply sensation to the temple and the malar eminence. These branches occupy a corridor that aligns with subperiosteal dissection for zygomatic augmentation, and thus careful instrument handling and precise elevation are required to avert traction, crush, or transection injuries to the small fascicles that confer sensation in the target implant area. Collectively, the infraorbital, zygomaticofacial, and zygomaticotemporal nerves illustrate how the interface of bony exits and implant pocket edges creates a predictable locus of vulnerability during midfacial augmentation. The mandibular division (V3), leaving the skull through the foramen ovale, is more complex, containing both sensory and motor fibers. It emits numerous branches—including pterygoid, masseteric, deep temporal, buccal, auriculotemporal, lingual, and inferior alveolar nerves—reflecting its dual role in sensation and mastication. Although the motor fibers of V3 innervate the muscles of mastication, these fibers penetrate their target muscles beyond the typical subperiosteal planes used for facial implants. As a result, the motor components of V3 are generally less susceptible to direct injury during malar or chin augmentation, provided the dissection remains on bone and avoids deep intramuscular violation. Sensory branches, by contrast, can be jeopardized when they emerge from bone or course superficially along the intended path of dissection. The inferior alveolar nerve, which enters the mandibular foramen on the medial ramus, courses within the mandibular canal, and exits as the mental nerve through the mental foramen, exemplifies this risk. The mental foramen is usually located apical to the first and second premolars and sits approximately 1.5 cm superior to the inferior border of the mandible, a landmark of cardinal importance during subperiosteal preparation for chin implants [7]. Because the mental nerve emerges and immediately subdivides into branches that pass deep to the depressor anguli oris muscle to innervate the lower lip, chin, and gingiva associated with the mandibular incisors, careless undermining or aggressive retractor placement at this site can produce postoperative hypoesthesia, paresthesia, or dysesthesia. For surgeons performing genioplasty, the mental nerve is a frequent and unavoidable encounter; safe technique therefore relies on precise incision placement, subperiosteal elevation that identifies and protects the foramen, and gentle handling of the distal branches as the implant pocket is extended laterally beneath the mentalis and depressor anguli oris [8]. When the implant is broader than the symphyseal region, its lateral wings must be shaped and positioned to avoid compressing the mental nerve branches or impinging on their glide paths during facial movements.

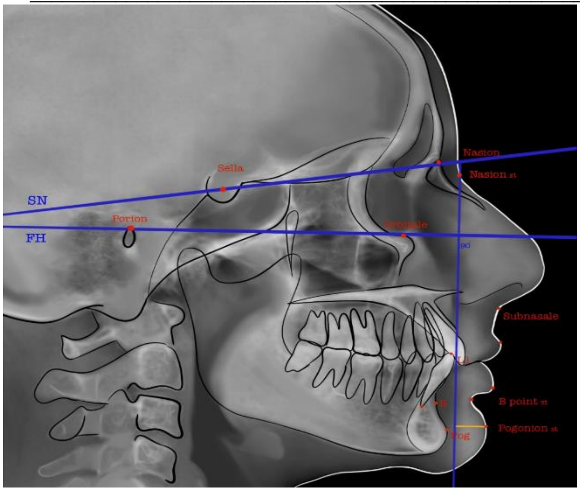

Fig. 3: Zero-Degree Meridian. Lateral cephalometric view demonstrates the 0° meridian line.

Motor innervation to the muscles of facial expression is supplied by the facial nerve (cranial nerve VII). Although the main trunks and larger branches of CN VII typically course deep to the superficial musculoaponeurotic system (SMAS) and are not directly exposed in subperiosteal facial implant dissections, these branches remain susceptible to neuropraxia from stretch or compression, particularly during vigorous retraction, prolonged instrument pressure, or hematoma formation. After exiting the stylomastoid foramen, the facial nerve enters the parotid gland and divides into five principal branches—temporal, zygomatic, buccal, marginal mandibular, and cervical—which proceed in a complex plexus deep to the SMAS. The temporal branch ascends over the zygomatic arch to innervate the frontalis and the superior fibers of the orbicularis oculi. Given its superficial course over the arch, aggressive superior retraction or dissection in the sub-SMAS plane near the lateral brow can endanger this branch, with clinical sequelae such as brow ptosis or decreased forehead wrinkling. The zygomatic and buccal branches travel deep to the masseteric fascia and run relatively near subperiosteal dissection planes during malar augmentation; these branches innervate the inferior orbicularis oculi, nasal musculature, and a constellation of upper lip and cheek muscles. Excessive lateral dissection or forceful subperiosteal elevation along the lateral zygoma thus carries a higher risk of traction neuropathy in this region. The marginal mandibular branch emerges from the inferior pole of the parotid and runs along, or just below, the inferior border of the mandible; it innervates the depressor anguli oris and mentalis muscles, among others. Compression or injury to this branch, particularly during submandibular access or retraction along the mandibular border for chin implants, can lead to asymmetry of lower lip depression and an altered smile. The cervical branch continues inferiorly to supply the platysma, and while it is seldom encountered in midfacial augmentation, neck retraction during combined procedures can still affect its function [9]. In sum, while facial implant surgery rarely transects facial nerve branches outright when planes are respected, vigilance against compression and stretch injuries is essential to preserve facial animation.

The facial vasculature largely derives from branches of the external carotid artery, with the facial artery and its anastomoses providing perfusion to much of the midface and lower face. Major vessels are most at risk at the time of incision and early soft-tissue dissection, when they are superficial relative to later subperiosteal planes. Particular attention is warranted where vessels accompany nerves through bony exits: the infraorbital artery and vein course with the infraorbital nerve, and the mental artery and vein accompany the mental nerve. At these foraminal exits, a triangular convergence of artery, vein, and nerve creates a compact neurovascular pedicle vulnerable to laceration or avulsion. Preoperative mapping—using palpation, anatomical landmarks, and, where indicated, adjunctive imaging—combined with judicious intraoperative hemostasis and subperiosteal elevation that avoids foramen entry, minimizes bleeding and preserves tissue perfusion. Furthermore, maintaining the integrity of periosteal attachments around the foramen helps protect the pedicle and reduces the risk of delayed hematoma or neuropathy from postoperative swelling. Muscles of facial expression, embedded within the superficial fascial layers and inserting into the dermis or fibromuscular hubs such as the modiolus, are integral not only to aesthetics but also to implant stability and postoperative function. Their superficial location means that, although subperiosteal dissection often passes deep to these muscles, changes in contour and vector forces induced by an implant can alter their resting tone and excursion. The occipitofrontalis muscle exemplifies this dynamic. Its frontal belly originates from the epicranial aponeurosis and inserts into the skin of the eyebrow and forehead; contraction elevates the brows, wrinkles the forehead, and protracts the scalp in expressions of surprise. The occipital belly originates from the lateral two-thirds of the superior nuchal line of the occipital bone and inserts into the epicranial aponeurosis, retracting the scalp and assisting the frontal belly. Implants that engage the superior orbital rim or frontal process of the zygoma can subtly modify the tension distribution across the frontal belly, with downstream effects on brow position.

Around the eye, the orbicularis oculi arises from the medial orbital margin, medial palpebral ligament, and lacrimal bone and inserts circumferentially into the skin around the orbital margin and into the tarsal plates. Its palpebral portion closes the eyelids gently, while the orbital portion closes them tightly. Although subperiosteal malar dissection typically spares the eyelid portions of orbicularis, lower eyelid and midface implants can alter lower lid support and the muscular balance that governs blinking and tear film dynamics. The corrugator supercilii originates on the medial superciliary arch and inserts into skin superior to the supraorbital region, pulling the brows inferomedially in a worried expression. Deeper to it, the procerus and the transverse (compressor) portion of the nasalis originate from the facial aponeurosis over the nasal bones and lateral nasal cartilage; they insert into the skin of the lower forehead and glabella, lowering the medial brow and wrinkling the nasal bridge in expressions of disgust or disdain. The alar portion of nasalis, together with the levator labii superioris alaeque nasi, arises from the frontal process of the maxilla and inserts into the major alar cartilage, flaring the nostrils and widening the anterior nasal aperture. Though these nasal muscles are not directly affected by malar or chin implants, augmentation that changes nasal base support or the projection of the malar eminence may subtly influence midfacial expressions through changes in soft-tissue drape.

Perioral function depends heavily on the orbicularis oris, which encircles the mouth, originating from the medial maxilla and mandible and from the angle of the mouth in the deep perioral skin, and inserting into the mucous membrane of the lips. It closes the oral fissure, protrudes the lips for kissing, and compresses the lips for blowing. Adjacent elevators and dilators modulate smile dynamics and nasolabial contour: the levator labii superioris originates from the infraorbital maxilla and inserts into the upper lip, elevating and everting it while accentuating the nasolabial sulcus in sadness; the zygomaticus minor, arising from the anterior zygomatic bone, also inserts in the upper lip and participates in its elevation and eversion. The zygomaticus major originates from the lateral zygomatic bone and inserts into the modiolus, drawing the labial commissure superolaterally to produce a smile bilaterally or an expression of disdain unilaterally. The levator anguli oris arises from the infraorbital maxilla and inserts into the modiolus as well, elevating the commissure and widening the oral fissure to produce a grin or grimace. By contrast, the risorius originates within the parotid fascia and buccal skin and inserts into the modiolus to draw the commissure laterally in frowning or sadness. Inferior perioral depressors include the depressor anguli oris, arising from the anterolateral mandibular body and inserting into the modiolus to lower the commissure, and the depressor labii inferioris, which arises from the platysma and anterolateral mandible to insert into the lower lip, depressing and everting it in pouting or sadness. The mentalis, arising from the mandibular body and inserting into the skin of the chin, raises and protrudes the lower lip and bunches the chin skin in a doubtful expression. The platysma, originating from the subcutaneous tissue of the infraclavicular and supraclavicular regions and inserting along the mandibular base, cheek and lower lip skin, modiolus, and orbicularis oris, depresses the mandible against resistance and tightens the skin of the lower face and neck in a tense expression. For implant surgeons, the interplay of these muscles with the modiolus and mentalis is especially salient: overextended or malpositioned chin implants can tether or distort the mentalis, producing chin ptosis, lip incompetence, or contour irregularity; similarly, malar implant placement that fails to respect zygomaticus origins can blunt a natural smile or create asymmetrical dimpling.

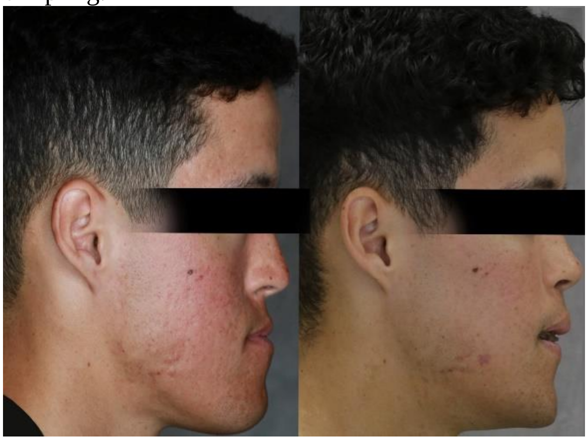

Fig. 4: Zygomatic Submalar Implant. Preoperative and postoperative views of zygomatic submalar implant placement.

Chewing and speech depend on the four principal muscles of mastication—temporalis, masseter, lateral pterygoid, and medial pterygoid—all of which receive motor innervation from the anterior trunk of V3. Chin and malar implants are positioned near the origins or insertions of these muscles; an implant that impinges on a tendon, restricts muscle excursion, or alters joint mechanics can engender pain, malocclusion, or temporomandibular joint (TMJ) symptoms. The temporalis originates from the floor of the temporal fossa and the deep temporal fascia and inserts onto the coronoid process and anterior aspect of the mandibular ramus; its vertical fibers elevate the mandible, closing the jaw, while its posterior fibers retrude the mandible after protrusion. Overly aggressive subperiosteal elevation along the temporal crest or implant designs that encroach on the coronoid process may provoke trismus or tenderness during mastication. The masseter, arising from the zygomatic arch and the inferior and medial aspects of the zygomatic bone, inserts broadly along the lateral surface of the mandibular ramus and angle; it elevates and contributes modestly to protruding the mandible, with deeper fibers stabilizing the TMJ. Lateral extension of a malar implant beneath the zygomatic arch must therefore be contoured to avoid impingement on masseteric fascia and to respect the sliding zone between the arch and muscle during jaw opening. The lateral pterygoid has two heads—a superior head from the greater wing of the sphenoid and an inferior head from the lateral surface of the lateral pterygoid plate; these insert respectively into the TMJ capsule and articular disc and into the pterygoid fovea on the neck of the mandibular condyle. Bilaterally, the lateral pterygoids protrude the mandible and help lower the chin; unilaterally, they effect side-to-side movements essential for grinding. While not directly encountered in subperiosteal midface dissection, perizygomatic manipulation and implant contouring should avoid distal encroachment that could alter condylar mechanics or disc tension. The medial pterygoid mirrors the masseter on the deep side of the ramus; its deep head arises from the lateral pterygoid plate, and its superficial head from the maxillary tuberosity; it inserts on the medial mandibular ramus just inferior to the mandibular foramen. Acting bilaterally, it elevates and protrudes the mandible; unilaterally, alternating contractions generate lateral grinding. Broad chin implants with posterior wings that extend toward the antegonial notch must be sculpted to prevent subperiosteal contact with the medial pterygoid's insertion, which could otherwise cause pain with mandibular excursion.

In the aggregate, these relationships yield several practical principles for implant surgery. First, subperiosteal dissection should be performed with constant awareness of foraminal locations—supraorbital and supratrochlear at the superior orbital rim; infraorbital on the anterior maxilla; zygomaticofacial and zygomaticotemporal on the malar surface and temporal fossa; and mental along the mandibular body—because each marks a transition from protected intrabony course to a more exposed superficial path [6][7][8]. Respecting these exits by maintaining a true subperiosteal plane, avoiding instrument tips directed into foramina, and minimizing retractor pressure across neurovascular bundles mitigates sensory complications. Second, implant pocket design must accommodate the dynamic motion of perioral and masticatory muscles. For the chin, this often means tunneling beneath the mentalis but re-suspending it securely to the periosteum upon closure to prevent chin ptosis and lower lip incompetence. For the malar region, implant edges should be feathered near the origins of zygomaticus major and minor to preserve natural smile mechanics and prevent palpable ridges. Third, dissection and retraction should honor the course of facial nerve branches, especially the temporal branch over the zygomatic arch, the zygomatic and buccal branches deep to the masseteric fascia, and the marginal mandibular branch along the mandibular border, so that postoperative animation remains symmetric and expressive [9]. Fourth, vascular planning—including the anticipation of accompanying arteries and veins at nerve exits—reduces bleeding, facilitates clear visualization, and shortens operative time, all of which support lower complication rates. Finally, effective surgical practice integrates anatomical vigilance with functional testing. Intraoperative palpation and visual confirmation of foramina, gentle neurostimulation when doubt arises about the identity of a motor branch, and judicious adjustments in implant contour and position to accommodate a patient's unique bony and soft-tissue architecture can preempt many of the complications associated with facial augmentation. Postoperatively, transient neurapraxia from traction or edema may occur even in meticulously executed cases, but by preserving the integrity of the infratrochlear, supraorbital, supratrochlear, infraorbital, zygomatic, buccal, marginal mandibular, and mental pathways—and by avoiding violating or compressing the deep motor fibers of V3—surgeons can expect most sensory and motor functions to be maintained, with any temporary deficits resolving as swelling subsides. Mastery of this anatomy and physiology, pursued with an operative plan that foregrounds the nerve exits, muscular attachments, and vascular companions most likely to be encountered, is the cornerstone of safe and aesthetically satisfying facial implant placement [6][7][8][9].

Indications

Facial implants are indicated for both functional and aesthetic purposes, addressing deficiencies in soft tissue support, loss of facial volume, asymmetry due to growth discrepancies, congenital syndromes, and age-related bony resorption. Midfacial volume loss typically becomes apparent in the third and fourth decades of life, when uneven skeletal resorption accentuates the signs of aging. Commonly affected areas include the infraorbital region and the pyriform maxilla, which contribute to flattening of the midface and periorbital hollowing. Osseocutaneous ligaments, such as the zygomatic and mandibular ligaments, connect the periosteum of the underlying bone to the overlying skin. The masseteric ligaments extend from the muscle to the dermis. Progressive weakening and decreased elasticity of these ligamentous structures contribute to soft tissue ptosis, exacerbated by gravitational forces over time [10]. Facial fat pads are distributed in multiple compartments separated by fascial septa and undergo progressive atrophy with aging. The malar region, for instance, contains both superficial and deep fat pads divided by the superficial musculoaponeurotic system (SMAS). Jowl formation occurs due to the bilateral descent of subcutaneous fat along the inferior mandibular borders and is influenced by volume loss, soft tissue and muscular ptosis, and diminished skeletal support. Isolated genioplasty is insufficient to correct the prejowl sulcus and may even deepen it if an osteotomy is performed. Consequently, implant augmentation of the prejowl region, chin, or both provides the preferred method for correcting these contour deficiencies [11]. Skeletal asymmetries are common in congenital deformities and result from deviations in normal craniofacial growth patterns, which occur along transverse, sagittal, and vertical axes. Maxillary growth occurs anteriorly, inferiorly, and laterally, while mandibular condyles grow superoposteriorly, displacing the mandible anteroinferiorly. The chin completes growth earlier than the remainder of the mandible, which continues to expand transversely and vertically [12]. Deviations from these patterns may produce a dolichocephalic profile, characterized by a long, retrognathic, and vertical orientation, or a brachycephalic profile, which is short, prognathic, and horizontally oriented. While orthodontic therapy can address dental malocclusion associated with hypoplastic mandibles, residual skeletal deficiencies often necessitate orthognathic surgery, implant augmentation, or combined interventions for optimal functional and aesthetic correction [13][14].

Congenital syndromes affecting the first and second branchial arches result in a spectrum of craniofacial anomalies. Craniofacial microsomia, the second most common congenital craniofacial disorder after cleft lip and palate, frequently involves the maxilla, mandible, and orbital structures. Clinical severity is variable, and multiple classification systems exist to guide management. Implant augmentation is particularly suitable for patients with mild manifestations or for those who have previously undergone surgical correction, including orthognathic procedures [15]. Cleft lip and palate patients often present with midfacial deficiency, particularly malar hypoplasia. While Le Fort I osteotomies may correct certain midface deficits, including lip and nasolabial contour, their efficacy in addressing malar deficiencies is limited. In such cases, facial implants provide a predictable method for augmenting deficient regions and improving facial symmetry, either as a primary intervention or as a secondary adjunct following orthognathic surgery [16]. Facial implants, therefore, serve as a versatile tool for addressing age-related changes, congenital asymmetries, post-traumatic deformities, and residual skeletal deficiencies, with indications guided by detailed facial analysis, skeletal and soft tissue evaluation, and individualized patient goals.

Contraindications

Facial implant surgery has few absolute contraindications, but careful patient selection is critical. The procedure is generally avoided in individuals with incomplete craniofacial growth, as ongoing skeletal development may alter outcomes and lead to asymmetry. Growth cessation is assessed using serial cephalometric imaging, with linear measurements from consecutive radiographs used to determine growth rates. Female individuals typically complete craniofacial growth earlier than male individuals, usually between ages 14–16 in females and 16–18 in males [17][18]. Patients with large skeletal or soft tissue deficiencies that exceed implant correction capacity are better served with alternative procedures, such as orthognathic surgery, especially when extensive osteotomies are required. Active infection or inadequate bony and soft tissue support also contraindicates implant placement due to the increased risk of complications, including poor implant stabilization, exposure, or infection. Thin, soft tissue coverage limits maximal implant size because of increased visibility and palpability, necessitating cautious augmentation planning.

Equipment

Standard facial implants include alloplastic materials such as titanium, high-density polyethylene (HDPE), and silicone. Titanium implants are rigid, chemically inert, and permit tissue ingrowth via fenestrated mesh, making them suitable for mandibular angle augmentation [19]. HDPE implants are thermoplastic with variable pore sizes, supporting either bone or fibrous tissue ingrowth; pore sizes between 100–250 µm are ideal for bony integration, requiring secure fixation to prevent disruption [20][21][22]. Silicone implants are nonporous, encapsulated, and rely on fixation via sutures or screws to prevent migration, bony resorption, and seroma formation [23][24]. Autogenous bone grafts are less common due to unpredictable resorption, donor site morbidity, and operative complexity [25][26]. Patient-specific implants, produced using 3D imaging and printing, allow precise conformity to skeletal anatomy, reducing intraoperative modification and complication risk [27]. Anesthesia is delivered via intravenous sedation or general anesthesia, supplemented with local infiltration (lidocaine ± bupivacaine). Surgical instruments include scalpels, electrocautery, periosteal elevators, retractors, suture sets, and fixation hardware. The surgical team typically consists of a primary surgeon with an assistant, while an anesthesia provider and operating room nurses manage sedation, monitoring, and intraoperative support. Subperiosteal dissection permits safe reflection of tissues without routine nerve monitoring, though mental and infraorbital nerves are identified and protected.

Preparation

Preoperative planning integrates 2D photography, cephalometry, and 3D imaging, including cone-beam CT and digital surface scanning, to assess bone and soft tissue. Artificial intelligence-assisted surgical planning allows simulation of implant positioning and postoperative outcomes. Standardized photographs in frontal, 45°, and profile views provide volumetric assessment. Cephalometric parameters—Holdaway ratio, 0° meridian line, true vertical line, and labiomental angle—guide implant selection and placement [28][29][30]. Midfacial deficiencies are categorized into types 1–3: skeletal hypoplasia (type 1), submalar soft tissue loss (type 2), and combined defects (type

3). These classifications inform implant design, pocket creation, and surgical approach [31][32].

Technique or Treatment

Surgical site preparation includes antiseptic cleansing, local anesthetic administration, and prophylactic antibiotics. Intraoral approaches are standard for malar and chin implants, while mandibular angles may require intraoral or extraoral access. Blunt subperiosteal dissection minimizes nerve injury, and implant sizers confirm pocket adequacy. Fixation is achieved via nonresorbable sutures or titanium screws. Layered closure of muscle and mucosa reduces functional deficits and ptosis, with postoperative compressive dressings supporting soft tissue and reducing swelling [33][36].

Complications

Complications are classified as early (weeks) or late (months to years). Early issues include hematoma, seroma, wound dehiscence, and infection. Late complications involve implant displacement, bone resorption, poor cosmesis, nerve injury, and functional deficits. Infection rates for alloplastic implants are 2–5%, with displacement in 1–3% of cases. Porous polyethylene exhibits lower bone resorption than solid silicone due to tissue ingrowth [38]. Intraoral approaches reduce visible scarring but may marginally increase infection risk. Mental nerve injury occurs in ~2.4% of cases, often linked to alveolar resorption. Surgical correction or implant removal may be necessary in persistent cases.

Clinical Significance

Facial implant surgery is minimally invasive compared with osteotomies, providing safe, efficient enhancement of facial projection, contour, and symmetry. Chin, malar, and mandibular angle implants improve aesthetics, restore skeletal support, and may assist in posttraumatic reconstruction or gender-affirming procedures [39][40]. Proper technique and patient selection optimize outcomes, minimize complications, and support interprofessional collaboration among surgeons, anesthesiologists, and nursing staff.

Enhancing Healthcare Team Outcomes

A multidisciplinary team ensures procedural safety and success. Surgeons, anesthesiologists, and nurses collaborate throughout preoperative planning, intraoperative execution, and postoperative care. Patient participation in planning and informed consent is critical. The FDA regulates implantable devices, requiring patient awareness of material-specific risks, such as silicone-associated bone resorption [40]. This integrated model promotes patient safety, satisfaction, and high-quality care.

Conclusion:

Facial implant procedures deliver impactful, durable improvements in facial projection, contour, and symmetry with substantially less morbidity than osteotomies when embedded in a disciplined, interdisciplinary pathway. Optimal outcomes begin with careful patient selection that respects growth status, soft-tissue coverage, and the magnitude of skeletal deficiency, followed by imaging-rich planning that integrates cephalometry with CBCT and surface scanning to select the correct implant geometry, position, and fixation strategy. Intraoperatively, strict subperiosteal technique that honors the “no-fly zones” around the infraorbital and mental foramina and the temporal, zygomatic–buccal, and marginal mandibular facial nerve trajectories is essential to preserving sensation and animation. Materials should be matched to goals and biology—silicone for smooth removal and contouring, porous polyethylene for tissue stability with lower resorption, titanium mesh for rigid, form-stable augmentation—and patient-specific implants can translate virtual planning into precise, efficient execution. Tailored anesthesia (IV sedation or general), antibiotic prophylaxis, hemostasis, and layered closure with resuspension of the mentalis or SMAS where relevant reduce infection, seroma, displacement, and soft-tissue ptosis. Finally, postoperative compression, early complication surveillance, and longitudinal follow-up support stable results and patient satisfaction. Advancing the field will require prospective, multicenter data on materials, fixation, AI-enabled planning, and patient-reported outcomes, coupled with consistent interprofessional collaboration across dentistry, radiology, anesthesia, and nursing.

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