

# Dermal Fillers in Oral and Maxillofacial Surgery: A Review

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## ABSTRACT

Minimally invasive facial aesthetic procedures have expanded dramatically over the past two decades, with dermal fillers becoming central tools in contemporary facial rejuvenation and reconstruction.<sup>1-3</sup> Oral and maxillofacial surgeons (OMFS) are uniquely positioned to deliver these therapies safely due to their detailed understanding of craniofacial anatomy, soft-tissue biomechanics, and surgical complication management.<sup>1,4-6</sup> Dermal fillers permit three-dimensional restoration of facial volume, refinement of skeletal-based corrections, camouflage of post-traumatic and post-surgical deformities, and improvement of perioral aesthetics with relatively low morbidity and high patient satisfaction.<sup>3,5,7</sup> This narrative review summarizes the classification and properties of commonly used dermal fillers, relevant facial anatomy and “danger zones,” evidence-based injection techniques, clinical indications in OMFS, complication profiles, and current approaches to prevention and management of adverse events, with emphasis on vascular complications and visual compromise.<sup>2,8-12</sup> Ethical and medicolegal aspects, as well as future developments in bioactive fillers and image-guided, anatomy-based protocols, are also discussed in the context of safe integration of fillers into OMFS practice.<sup>9,11,13</sup>

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## INTRODUCTION

Facial aging is a multidimensional, layer-specific process involving skeletal remodeling, selective deflation and descent of facial fat compartments, attenuation of retaining ligaments, dermal thinning, and compensatory muscle hyperactivity.<sup>1,4,5</sup> Classic work by Rohrich and Pessa and subsequent authors demonstrated that facial fat is organized into discrete superficial and deep compartments separated by fascial septa, shifting the paradigm from a uniform “sagging” model toward compartmentalized deflation and descent.<sup>1,4,5</sup> For OMFS, whose traditional focus has been correction of skeletal disharmonies, trauma, and oncologic defects, contemporary aesthetic facial surgery now requires integrated management of both hard and soft tissues to achieve harmonious, natural-appearing outcomes.<sup>5,7</sup> Dermal fillers provide a minimally invasive, office-based method to restore volume, support soft tissues, modulate contour, and address asymmetry or contour irregularities with limited downtime and high reversibility when hyaluronic acid (HA) products are used.<sup>2,3,14</sup> In addition to purely cosmetic indications, fillers are increasingly used in OMFS to refine orthognathic outcomes, treat post-traumatic or post-surgical contour deformities, and assist in functional rehabilitation such as camouflage in facial nerve palsy.<sup>3,6,11</sup> The expanding scope of filler use underscores the need for OMFS clinicians to understand product characteristics, anatomy-specific techniques, risk zones, and evidence-based complication management protocols.<sup>2,8,9,12</sup>

## CLASSIFICATION AND PROPERTIES OF DERMAL FILLERS

Dermal fillers can be classified according to biodegradability (temporary versus permanent), composition (e.g. HA, calcium hydroxylapatite, poly-L-lactic acid, polymethylmethacrylate), and primary mechanism of action (space-occupying gel versus biostimulatory scaffold).<sup>2,3,14</sup> From a clinical perspective, biodegradable fillers are generally preferred in OMFS due to their safety profile, reversibility in the case of HA, and lower long-term complication rates, whereas permanent fillers are associated with higher risks of delayed granulomas and difficult-to-manage adverse events.<sup>2,14,18</sup>

### Hyaluronic Acid Fillers

HA fillers represent the most widely used injectable materials globally owing to their biocompatibility, hydrophilic nature, and enzymatic degradability with hyaluronidase.<sup>2,14-16</sup> HA is a naturally occurring, non-sulfated

glycosaminoglycan present in the extracellular matrix, synovial fluid, and vitreous humor, where it contributes to tissue hydration and viscoelasticity.<sup>14,15</sup> Commercial HA fillers differ in HA concentration, degree and type of cross-linking, particle size, and rheological parameters such as elastic modulus (G'), cohesivity, and viscosity, which determine their suitability for specific anatomical planes and indications.<sup>14-16</sup> Highly cross-linked, high G' products are typically chosen for structural support in the midface, chin, or jawline, whereas softer, more cohesive gels are indicated for superficial lines or dynamic perioral rejuvenation.<sup>14-16</sup> Key advantages of HA include immediate volumization, reversibility using hyaluronidase in the event of overcorrection or vascular compromise, and a relatively low incidence of true immunogenic reactions when products are manufactured under stringent conditions.<sup>2,14,15</sup>

### Calcium Hydroxylapatite

Calcium hydroxylapatite (CaHA) fillers consist of synthetic CaHA microspheres suspended in a carboxymethylcellulose carrier gel and were originally developed for vocal fold augmentation before adoption for facial volumization.<sup>2,3</sup> CaHA provides immediate structural augmentation and acts as a scaffold for neocollagenesis, leading to longer-lasting effects (approximately 12–18 months) compared with many HA formulations.<sup>2,3</sup> However, CaHA is not reversible with hyaluronidase, is radiopaque, and should not be injected superficially due to the risk of palpable nodularity and visible irregularities, making product selection and injection depth particularly critical in high-visibility areas.<sup>2,14</sup>

### Poly-L-lactic Acid

Poly-L-lactic acid (PLLA) is a biodegradable synthetic polymer classified as a biostimulatory filler that induces a subclinical inflammatory response and subsequent collagen type I deposition over several months.<sup>2,3</sup> Clinical effects are gradual and cumulative across multiple treatment sessions, making PLLA particularly suitable for diffuse volume loss such as HIV-associated lipoatrophy or generalized midface deflation.<sup>2,3</sup> Because PLLA particles can provoke nodule or papule formation if improperly diluted, inadequately massaged, or placed too superficially, adherence to product-specific protocols and careful patient selection are essential.<sup>2,14</sup>

### Non-biodegradable and Permanent Fillers

Polymethylmethacrylate (PMMA) microspheres suspended in bovine collagen constitute one of the principal permanent fillers, offering very long-lasting correction through durable particulate implantation and surrounding collagen deposition.<sup>2,18</sup> Although PMMA can provide stable correction, it has been associated with higher rates of delayed granulomatous reactions, irregularities, and challenging management of complications, limiting its use in contemporary OMFS practice where reversibility and safety are prioritized.<sup>2,14,18</sup> Other permanent agents such as liquid silicone have been largely abandoned due to severe long-term complication profiles, while structural fat grafting is typically considered a separate surgical procedure rather than an office-based dermal filler technique.<sup>3,18</sup>

## FACIAL ANATOMY AND “DANGER ZONES”

Safe and effective filler injection requires detailed understanding of layered facial anatomy, including bone, deep and superficial fat compartments, retaining ligaments, mimetic musculature, and a complex vascular network with variable patterns and anastomoses.<sup>1,4,5,6</sup> The concept of distinct facial fat compartments has major implications for volumetric rejuvenation: age-related deflation of specific superficial compartments (e.g. medial and lateral cheek) and deep compartments (e.g. deep medial cheek fat) contributes to characteristic shadows and folds that can be targeted with precise compartment-specific filler placement.<sup>1,4,5</sup>

### Arterial Anatomy Relevant to Fillers

Several key arteries course in close proximity to commonly injected sites, making inadvertent intravascular injection or external compression a critical concern.<sup>6,8,10,11</sup> The facial artery emerges at the inferior border of the mandible and gives rise to the inferior labial, superior labial, and angular branches, which supply the perioral region, nasolabial fold, and medial canthus.<sup>6,10</sup> The infraorbital artery exits the infraorbital foramen to supply the midface and tear trough region, whereas the supratrochlear and supraorbital arteries, branches of the ophthalmic artery, traverse the glabella and forehead.<sup>6,8,10</sup> Extensive anastomoses between facial, ophthalmic, and internal carotid systems explain the potential for retrograde embolization of filler into the ocular circulation, resulting in retinal artery occlusion and irreversible vision loss.<sup>8,10,11</sup>

### Facial Danger Zones

“Danger zones” are anatomical regions where major vessels run superficially, where there is direct communication with the ophthalmic circulation, or where confined tissue spaces increase the risk of ischemia.<sup>6,8,11</sup> High-risk areas include the glabella (supratrochlear and supraorbital arteries), nasal dorsum and radix (dorsal nasal, lateral nasal, and angular branches), nasolabial fold (facial and superior labial arteries), and tear-trough/infraorbital region (infraorbital artery and branches).<sup>6,8,11</sup> Injectors are advised to use small aliquots, low injection pressure, constant needle or cannula movement, aspiration where feasible, appropriate depth (often supraperiosteal or deep to key vessels), and consideration of blunt cannulas in these zones to reduce the likelihood of intra-arterial injection.<sup>6,8,9,10</sup>

## INJECTION TECHNIQUES

The choice of instrument (needle versus cannula), injection plane, and technique must be individualized according to the filler's rheology, the target anatomical layer, and the desired aesthetic or reconstructive outcome.<sup>2,3,6,15</sup> In OMFS practice, the goal is not only volumetric augmentation but also structural support and controlled vectoring of soft tissues in relation to the underlying skeleton.<sup>5,7</sup>

### Needle Versus Cannula

Sharp needles allow precise bolus placement and are useful for periosteal injections in the midface, chin, and piriform fossa, but carry a higher risk of arterial penetration and embolization if used in high-risk vascular territories.<sup>6,8,10</sup> Blunt-tip microcannulas, typically 22–27 G, may reduce the risk of vascular injury and bruising by gliding along tissue planes rather than transecting vessels and are often favored for nasolabial folds, cheeks, and perioral regions, particularly in “danger zones.”<sup>6,10,14</sup> However, cannulas do not eliminate vascular risk entirely, and their safe use still depends on appropriate plane selection, low-pressure injection, and thorough anatomical knowledge.<sup>6,8,10</sup>

### Depth and Planes of Injection

Plane selection is dictated by both product characteristics and indication.<sup>2,3,6,14</sup>

- Supraperiosteal plane: Used for structural augmentation of the zygomaticomalar region, chin, mandibular angle, and piriform fossa, typically with high G' HA or CaHA to project and support overlying tissues.<sup>4,5,7,15</sup>
- Deep subcutaneous / sub-SMAS plane: Employed in the midface and nasolabial region to efface deep folds and restore midfacial convexity with cohesive, moderately firm HA or CaHA.<sup>4,5,15</sup>
- Superficial/subdermal plane: Reserved for fine lines, perioral rhytides, and skin-texture improvement with low-viscosity HA; superficial placement of high-particulate fillers risks nodules and Tyndall effect.<sup>2,14,16</sup>

### Injection Techniques

Common injection methods include linear threading (anterograde or retrograde), serial puncture, small-volume bolus injections, cross-hatching, and fanning.<sup>2,3,6</sup> Linear threading distributes filler evenly along the length of a fold or contour, whereas small bolus injections at key anchor points allow lifting and projection along specific vectors, such as malar or chin augmentation.<sup>5,7,15</sup> Technique selection should account for tissue quality, skin thickness, scarring, and the need for symmetry, and injections should proceed with constant monitoring for blanching, disproportionate pain, or color change suggestive of vascular compromise.<sup>2,8</sup>

## CLINICAL APPLICATIONS IN ORAL AND MAXILLOFACIAL SURGERY

The integration of dermal fillers in OMFS extends beyond traditional cosmetic practice to encompass aesthetic, functional, and reconstructive indications.<sup>3,6,11</sup> This aligns with an emerging “lift-and-fill” paradigm in which skeletal corrections are complemented by volumetric soft-tissue adjustments for optimal facial harmony.<sup>4,5,7</sup>

### Aesthetic Applications

For perioral and periorificial rejuvenation, HA fillers can enhance lip volume, define the vermilion border, correct perioral rhytides, and support the oral commissures, thereby improving both aesthetics and perceived oral competence.<sup>2,14,15</sup> In the midface, strategic augmentation of the malar eminence, deep medial cheek fat, and zygomatic arch restores youthful convexity, reduces the appearance of the nasolabial fold, and can harmonize outcomes following orthognathic procedures.<sup>4,5,7,15</sup> Chin and jawline augmentation with high G' fillers allows non-surgical correction of mild microgenia, camouflaging of minor skeletal discrepancies, and refinement of mandibular border definition in selected patients.<sup>5,7,13</sup> Tear-trough correction with low-viscosity HA in the preperiosteal plane can reduce infraorbital hollowing, although this region is anatomically demanding and should be approached with conservative volumes and meticulous technique.<sup>2,6,9</sup>

### Functional and Reconstructive Applications

Fillers are increasingly used as adjuncts to skeletal and soft-tissue reconstructions to address contour irregularities, asymmetry, and residual defects after trauma, oncologic resection, or orthognathic surgery.<sup>3,6,11</sup> They can camouflage step deformities, soften scar depressions, and provide interim or long-term enhancement when further surgery is contraindicated or deferred.<sup>3,11</sup> In facial nerve palsy, targeted filler placement can improve symmetry at rest and during expression by augmenting the paralyzed side and supporting oral commissure position, often in combination with botulinum toxin to modulate contralateral hyperactivity.<sup>3,11,13</sup> For OMFS practitioners, fillers provide a flexible tool to fine-tune outcomes postoperatively, often avoiding additional operative procedures while maintaining reversibility and adjustability over time.<sup>6,11,13</sup>

## COMPLICATIONS ASSOCIATED WITH DERMAL FILLERS

Complications are generally categorized as immediate, early, and delayed, with severity ranging from transient edema to catastrophic events such as skin necrosis or blindness.<sup>2,3,8,12,18</sup> While many adverse effects are mild and self-limited,

OMFS clinicians must be prepared to recognize and manage serious complications promptly, particularly those involving vascular compromise.<sup>2, 8, 9, 12</sup>

### **Early Local Complications**

Common early events include pain, erythema, edema, ecchymosis, and transient needle-track papules, which typically resolve spontaneously or with conservative measures.<sup>2, 3, 14, 18</sup> Asymmetry or overcorrection may occur due to uneven product distribution, pre-existing anatomical differences, or early post-injection edema and can often be addressed by gentle massage, small-volume hyaluronidase (for HA), or staged touch-up treatments after inflammation subsides.<sup>2, 14</sup> Injection into or near superficial vessels may produce hematoma or visible telangiectasia, while superficial placement of particulate fillers can cause contour irregularities and Tyndall effect.<sup>2, 14, 18</sup>

### **Vascular Complications and Visual Loss**

Intravascular injection or extrinsic compression of arteries can result in acute ischemia, presenting as disproportionate pain, blanching, livedo reticularis, or delayed dusky discoloration in the affected angiosome.<sup>2, 8, 9, 12</sup> DeLorenzi highlighted that even small volumes injected under high pressure into key arteries (e.g. supratrochlear, angular, dorsal nasal) can retrogradely propagate and then embolize distally, leading to cutaneous necrosis or, if the ophthalmic circulation is involved, central retinal artery occlusion and blindness.<sup>8, 9, 10</sup> Systematic reviews by Beleznyay et al. reported vision loss from various fillers, including HA, autologous fat, and CaHA, and emphasized that visual recovery is rare and no management strategy has consistently reversed established retinal ischemia.<sup>10, 11</sup> Prophylactic strategies include detailed knowledge of vascular anatomy, use of small volume aliquots, slow injection with minimal pressure, frequent aspiration where feasible, preferential use of cannulas in high-risk areas, and avoidance of large bolus injections in the glabella and nasal dorsum.<sup>6, 8-11</sup>

### **Delayed and Chronic Complications**

Delayed complications include persistent nodules, granulomatous reactions, late-onset edema, and biofilm-associated infections, often occurring weeks to months after injection.<sup>2, 3, 14, 18</sup> Lemperle and others have described that permanent fillers and certain biostimulatory products carry a higher risk of foreign-body granulomas, which may manifest as firm, sometimes tender nodules that are difficult to treat and may require intralesional corticosteroids, 5-fluorouracil, or surgical excision.<sup>2, 14, 18</sup> Biofilm-related reactions can present as low-grade, recurrent erythematous nodules and may be triggered by systemic infections, dental procedures, or subsequent facial interventions, necessitating prolonged, culture-directed antibiotic therapy along with possible partial filler removal.<sup>11, 14, 18</sup>

## **MANAGEMENT OF COMPLICATIONS**

Management strategies should be protocolized, and every OMFS clinic performing filler injections must maintain a readily accessible “filler emergency kit” including high-dose hyaluronidase, warm compresses, aspirin or other antiplatelet agents, vasodilators, topical nitroglycerin, and arrangements for prompt ophthalmologic referral when indicated.<sup>8, 9, 11, 13, 19</sup> Early recognition and aggressive treatment are critical to limiting tissue loss and functional sequelae.<sup>8, 9, 11</sup>

### **Immediate Management of Vascular Occlusion**

At the first sign of vascular compromise—sudden severe pain, blanching or mottling, coolness, or livedo reticularis—the injection must be stopped immediately, and the area should be massaged and warmed to enhance perfusion.<sup>8, 9, 12</sup> High-dose, pulsed hyaluronidase administration is recommended for suspected HA-related occlusion, typically using repeated doses infiltrated throughout the ischemic zone and along the suspected path of the artery.<sup>9, 14, 19</sup> Adjunctive measures include oral aspirin, topical nitroglycerin (with caution), and, in selected cases, low-dose low-molecular-weight heparin, although the evidence base for many adjuncts is limited and primarily experiential.<sup>9, 11, 19</sup> For signs of ocular involvement (sudden visual disturbance, scotoma, ocular pain), urgent ophthalmologic consultation is mandatory; emerging techniques such as supratrochlear or supraorbital hyaluronidase injection and retrobulbar hyaluronidase have been described, but outcomes remain inconsistent.<sup>10, 11</sup>

### **Role of Hyaluronidase**

Hyaluronidase is the cornerstone enzyme for both elective reversal of HA fillers and emergency management of HA-associated vascular events and nodules.<sup>14, 15, 19</sup> Hirsch and subsequent authors have detailed protocols for hyaluronidase use across a spectrum of complications, emphasizing allergy screening for ovine- or bovine-derived preparations and advocating generous dosing in occlusive events, since the risk of undertreating ischemia outweighs concerns about aesthetic undercorrection.<sup>14, 15, 19</sup> In addition to vascular compromise, hyaluronidase can be used to treat Tyndall effect, overcorrection, misplaced product, and certain delayed-onset nodules, often in combination with intralesional steroids and antibiotics when biofilm or inflammatory components are suspected.<sup>14, 18, 19</sup>

## **ETHICAL AND MEDICOLEGAL CONSIDERATIONS**

Ethical practice in filler use demands adequate training, adherence to evidence-based guidelines, and clear delineation of scope of practice, particularly as non-surgical aesthetic procedures diffuse across multiple specialties and

non-physician providers.<sup>3,6,9,11</sup> Informed consent must comprehensively address not only common, minor side effects but also rare, severe complications such as skin necrosis, blindness, and stroke, as well as the potential need for urgent interventions, referral, or surgical debridement.<sup>8-11</sup> Meticulous documentation of product type, batch number, injection sites, volumes, technique, and immediate post-treatment findings is critical for medicolegal defensibility and continuity of care.<sup>3,6</sup> From a professional standpoint, OMFS specialists should integrate fillers within a broader framework of facial aesthetic and reconstructive care, avoiding over-treatment, respecting anatomical and cultural norms of beauty, and managing patient expectations with realistic, anatomy-based counseling.<sup>5,7,13</sup>

### FUTURE DIRECTIONS

Future developments in filler science and technique are likely to further expand their role in OMFS.<sup>3,5,13</sup> Novel fillers incorporating bioactive components, tunable rheology, and regenerative properties aim to improve tissue integration and longevity while minimizing adverse immunologic reactions.<sup>2,3,14,18</sup> Advances in imaging—such as high-frequency ultrasound and three-dimensional photography—may enable real-time visualization of filler placement, better assessment of facial fat compartments, and more precise preoperative planning, particularly in complex reconstructive cases.<sup>4,5,7</sup> Additionally, emerging consensus guidelines and anatomy-based injection algorithms, such as the Global Aesthetics Consensus on HA fillers, support standardized, safer practice and facilitate multidisciplinary collaboration between OMFS, dermatology, and plastic surgery.<sup>9-11,13,15</sup>

### CONCLUSION

Dermal fillers have significantly broadened the therapeutic armamentarium of oral and maxillofacial surgeons, enabling nuanced, minimally invasive modulation of facial soft tissues that complements traditional skeletal and soft-tissue surgery.<sup>3,5,6</sup> A sophisticated understanding of filler materials, facial fat-compartment anatomy, vascular “danger zones,” and evidence-based injection and complication-management protocols is essential to harness their benefits while minimizing risk.<sup>1-4,8-12</sup> By integrating ethical principles, rigorous documentation, and ongoing education into practice, OMFS clinicians can deliver safe, predictable, and natural-appearing results for both aesthetic and reconstructive indications using dermal fillers.<sup>3,6,9,13</sup>

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