

17. Ganguly A, Mittal G, Garg R. Comparison between 3D delta plate and conventional miniplate in treatment of condylar fracture: a randomised clinical trial. *J Craniomaxillofac Surg* 2021;49:1026–1034
18. Meyer C, Martin E, Kahn JL, et al. Development and biomechanical testing of a new osteosynthesis plate (TCP) designed to stabilize mandibular condyle fractures. *J Craniomaxillofac Surg* 2007;35:84e90
19. Liokatis P, Tzortzinis G, Gerasimidis S, et al. Finite element analysis of different titanium plates for internal fixation of fractures of the mandibular condylar neck. *J Oral Maxillofac Surg* 2021;79:665.e1–665.e10
20. Zhou W, Rong Q, An J, et al. Finite element analysis of two- and three-dimensional fixation in treating mandibular symphyseal fracture combined with bilateral condylar intracapsular fractures. *J Craniofac Surg* 2021;32:2557–2561

Anatomy-Based Filler Injection Techniques for the Forehead

Gi-Woong Hong, MD, PhD,* Isaac Kai Jie Wong, MBBS,[†]
Jong Keun Song, MD,[‡] Jesper Thulesen, MD, PhD,[§]
Ka Fai Wong, MBChB,^{||} and Kyu-Ho Yi, MD, PhD[¶]

Abstract: Forehead filler injections have become a popular non-surgical approach to enhance facial aesthetics by correcting volume deficiencies and improving contours. This anatomy-based approach emphasizes the importance of understanding the complex structural components of the forehead, including fat compartments, muscles, and vascular pathways. Proper diagnosis of forehead depressions—categorized as central, bilateral, mixed, or total types—guides targeted treatment strategies using submuscular or subdermal injection planes. Submuscular injections provide structural support, minimizing risks associated with superficial placement, such as uneven distribution and vascular complications. Techniques tailored to specific anatomic features, particularly in East Asian patients who often present with narrower foreheads,

ensure natural and balanced results. Fillers used in this paper are Hyaluronic Acid (Mali, Sinclair) and Polycaprolactone (Ellanse, Sinclair). Combining fillers with botulinum toxin injections can address both dynamic and static wrinkles, achieving comprehensive facial rejuvenation while maintaining natural expressions, which is especially true for Polycaprolactone biostimulator fillers. This integrated approach optimizes aesthetic outcomes and enhances patient satisfaction by delivering smooth, contoured, and youthful forehead appearances.

Level of Evidence: Level V.

Key Words: Anatomy, botulinum toxins, cosmetic techniques, dermal fillers, forehead

Forehead filler injections are increasingly popular for esthetic enhancement due to their ability to correct volume deficiencies and improve facial contours. The forehead region, which extends vertically from the hairline (trichion) to the eyebrows and horizontally between the temporal crests and the superior temporal septum (STS), plays a crucial role in defining facial esthetics.^{1,2} Proper contouring of the forehead contributes to a smooth and gently convex appearance that enhances the overall harmony of the face, achieving a softer and more refined esthetic.^{3,4}

Filler injections in the forehead must be performed with an understanding of the underlying anatomic structures, including the fat compartments, muscle layers, and vascular distribution. The forehead's anatomy is complex, with key structures such as the frontalis muscle, which elevates the eyebrows, and various fat compartments that influence the injection plane. Proper diagnosis of forehead depressions—whether they are central, bilateral, mixed, or total types—allows for targeted treatments that enhance volume and contour. Techniques such as submuscular or subdermal filler placement are tailored to address specific issues, ensuring natural and esthetically pleasing results while minimizing risks associated with vascular complications. Understanding these anatomic nuances is essential for achieving optimal outcomes in forehead filler injections, enhancing facial symmetry, and providing patients with a rejuvenated appearance.

PREPROCEDURE CONSIDERATIONS

The forehead region is anatomically defined by its vertical length from the trichion at the hairline to the eyebrows, and its horizontal width between the temporal crests and the superior temporal septum (STS) on either side.^{5,6} Generally, Western cranial structures tend to be longer front-to-back and narrower in width,⁷ whereas East Asian cranial structures are wider and shorter in depth.⁸ However, despite the wider cranial width in East Asians, the actual horizontal width of the forehead is relatively narrow. In addition, the distance between the eyebrows tends to appear broader due to the shorter width of the eyes, which can make the face appear wider compared with Western faces. When viewed from the side, an appropriately contoured, smooth, and slightly convex forehead contributes to a pleasing S-line in the upper face, creating a soft and gentle appearance.⁹

Western individuals typically have a more rounded forehead shape, necessitating injections superior to the supraciliary arch to achieve optimal contouring. In contrast, East Asian individuals often have a flatter forehead, allowing for a broader injection approach to achieve a smooth and natural augmentation. In addition, East Asians have thicker reticular cutis compared with Caucasians, meaning that using a thicker cannula width facilitates smoother and more efficient filler placement.

From the *Samskin Plastic Surgery Clinic, Seoul, Korea; †The Artisan Clinic, Singapore; ‡Pixelab Plastic Surgery Clinic, Seoul, Korea; §Capitol Eye Clinic/Clinic Aesthetica, Copenhagen, Denmark; ||Gaddiel Medical Group Limited, Tsim Sha Tsui, Hong Kong; and ¶Department of Oral Biology, Division in Anatomy and Developmental Biology, Human Identification Research Institute, BK21 FOUR Project, Yonsei University College of Dentistry, Seoul, Korea.

Received June 26, 2025.

Accepted for publication August 27, 2025.

Address correspondence and reprint requests to Kyu-Ho Yi, MD, PhD, Division in Anatomy and Developmental Biology, Department of Oral Biology, Human Identification Research Institute, BK21 FOUR Project, Yonsei University College of Dentistry, 50-1 Yonsei-ro, Seodaemun-gu, Seoul 03722, Korea; E-mail: kyuh090@daum.net

This study was conducted in compliance with the principles set forth in the Declaration of Helsinki.

The products utilized in this study were donated by the injectors for the purposes of this study.

G.-W.H., J.W., K.-H.Y., J.T.: conceptualization. J.W., K.-H.Y., I.W. K.J., J.K.S., K.F.W.: writing—original draft preparation. G.-W.H.: writing—review and editing. K.-H.Y.: visualization. K.-H.Y.: supervision. All authors have reviewed and approved the article for submission.

The authors report no conflicts of interest.

Copyright © 2025 by Mutaz B. Habal, MD

ISSN: 1536-3732

DOI: 10.1097/SCS.00000000000012003

Furthermore, due to differences in soft tissue thickness and skin elasticity, practitioners may need to adjust the injection depth and product choice. East Asians, who typically have denser connective tissue within the retinacular cutis, may benefit from fillers with higher G-prime values to maintain shape and prevent displacement. Conversely, Western patients with softer, more elastic skin may require fillers with moderate viscosity to blend seamlessly with the surrounding tissue.

From a frontal view, any depressions or uneven areas on the forehead can create a shorter, more constrained appearance, necessitating correction. A moderately convex and 3-dimensional forehead can help make the face appear narrower, which is a desirable effect among East Asians who often prefer a smaller facial appearance. However, caution is required to ensure that the forehead does not protrude more than the supraorbital ridge, where the eyebrows are located, as this can cause the brows and eye area to appear sunken and the nose to look flattened.¹⁰

In cases where the forehead appears sunken, the main depression typically occurs in the lower two-thirds of the forehead, between the frontal eminences—small protrusions on either side of the forehead and the supraorbital ridge, which is the most prominent bony structure of the eyebrows. On the basis of the shape of the depression, it can be classified as central, where the middle area above the glabella is primarily affected; bilateral, where the sides above the eyebrows are more deeply indented in a triangular shape; or mixed, where both the central and lateral areas are sunken.¹¹

For minor depressions affecting the upper one-third of the forehead, the issue often appears as a depression due to the backward angle of the upper part of the frontal bone rather than actual volume loss. In some cases, a total depression may occur, where both the lower two-thirds and the upper one-third of the forehead are sunken, causing the entire forehead to appear hollow.¹²

ANATOMIC CONSIDERATIONS

The layers of tissue in the forehead are skin, subcutaneous tissue, muscles encased by the superficial musculoaponeurotic layer, a loose areolar connective tissue layer, and periosteum of the frontal bone.¹³ When performing filler injections in the forehead area, it is essential to identify the appropriate injection plane by carefully identifying the underlying skin layers and anatomically significant structures. Beneath the skin, there is a subcutaneous fat layer composed of the central forehead compartment and 2 lateral compartments, known as the middle forehead compartments. These compartments are typically separated by a sheltering fibrous sheath that follows the pathway of the supraorbital artery and nerve.^{14,15} The lateral compartments are bordered externally by the superior temporal septum (STS), which separates them from the lateral temporal cheek fat compartment adjacent to the temple area.¹⁵ During filler injection, the filler may sometimes track along the pathway between these compartments, following the fibrous sheaths or septa, which can result in visible linear formations that resemble the trajectory of large veins.¹⁶

This subcutaneous layer, composed of fat, contains large veins, and superficial branches of the major arteries. Medially, the supratrochlear, dorsal nasal, angular arteries, and branches of the supraorbital artery form connections, while laterally, branches of the supraorbital artery, superficial temporal artery, and zygomatico-orbital artery converge. These vessels predominantly run through the central and lower one-third of the forehead.^{17,18} Therefore, when performing injections in this area, care must be taken to avoid injuring these vascular branches, as damage can lead to significant bleeding.

Injecting more rigid fillers with high elasticity to enhance volume can sometimes result in an uneven surface appearance, espe-

cially if the filler encounters the fibrous sheaths or septa between compartments, making it difficult to achieve a smooth molding effect. Therefore, this subcutaneous fat layer is not considered the ideal injection plane for volumizing corrections.¹² Beneath the subcutaneous fat layer lies the frontalis muscle, which plays a key role in elevating the eyebrows and counteracts the downward movement of muscles such as the procerus, corrugator, depressor supercilii, and orbicularis oculi, which are involved in lowering the eyebrows and creating frown lines (Fig. 1).¹⁹ The frontalis muscle extends upward, connecting to the galea aponeurotica, which links posteriorly to the occipital muscle and laterally extends beyond the STS to merge with the superficial temporal fascia (STF) of the temple.²⁰ Lateral to the STS, the frontalis ends and there is no upward vector to counteract the pull of brow depressors and gravity on the lateral brow, which may explain why descent preferentially occurs at the lateral brow.²⁰ Beneath this muscle, a small amount of submuscular fat is present laterally, but as one moves medially, the space between the muscle and the periosteum (the bone covering) contains little to no fat (Fig. 1).^{15,21,22}

The arterial supply of the upper face is supplied by branches of the external and internal carotid arterial systems. The vascular and neural pathways in the forehead and glabellar regions are of significant clinical relevance, particularly during esthetic procedures to avoid the risk of iatrogenic vascular occlusion following soft tissue injections.^{13,23,24}

Laterally, the anterior branch (frontal branch) of the superficial temporal artery (STA) enters the lateral border of the frontalis muscle ~1.5 to 2 cm above the lateral end of the eyebrow. Typically, the main branch of the STA bifurcates into anterior and posterior branches near the horizontal plane of the superior orbital rim. The anterior branch then courses medially at an angle of ~60 degrees. Before this bifurcation, the STA also gives rise to the zygomatico-orbital artery, which extends toward the lateral orbit, running parallel to the zygomatic arch and crossing above the lateral margin of the eyebrow. This artery is present in more than two-thirds of the Korean population.¹⁷ In cases where the zygomatico-orbital artery is absent, the anterior branch of the STA may descend towards the eyebrow, making it essential to consider the possibility of vascular structures passing directly beneath the injection site during procedures near the lateral end of the eyebrow.²⁵

The anterior branch, after being contained beneath the superficial temporal fascia (STF) up to the lateral margin of the frontalis muscle at the outer boundary of the forehead, emerges superficially as it crosses the vertical line drawn from the lateral canthus. From this point, it becomes more superficial, requiring careful attention during procedures to avoid vascular damage. In addition, the temporal or frontal branches of the facial nerve, which are responsible for the movement of the forehead muscles, branch out ~2 cm above the lateral end of the eyebrow, further emphasizing the need for precision in this area (Fig. 2).²⁵

Medially, the supratrochlear artery and nerve originate from the supratrochlear notch or foramen located along the vertical line drawn from the medial canthus. These structures exit the medial orbit and bifurcate into superficial and deep branches. The superficial branch ascends immediately after emerging from the

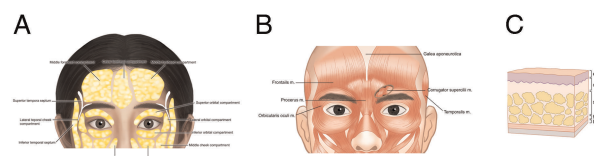


FIGURE 1. The superficial fat compartments of the forehead region are outlined (A). Muscles of the forehead and glabellar regions are depicted (B). The basic layers of the forehead region are illustrated (C).

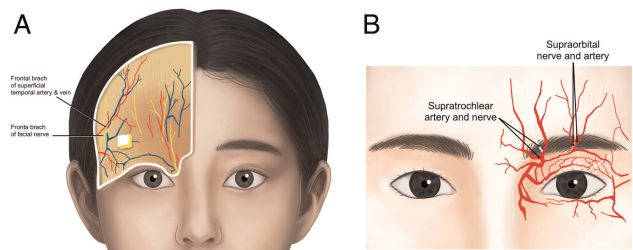


FIGURE 2. The superficial temporal artery and facial nerve within the forehead region are highlighted (A). The pathways of the supratrochlear and supraorbital arteries are shown.

orbit, piercing the corrugator muscle and continuing upwards, eventually passing through the frontalis muscle. Typically, this occurs 1.5 to 2.5 cm above the superior orbital rim, where the branch fully penetrates the frontalis muscle and enters the subcutaneous fat layer. Due to its size, this superficial branch requires particular caution. The deep branch, after exiting the notch, travels along the periosteum before eventually surfacing and, in some cases, extends deeply toward the hairline (Fig. 2).²⁶

The supraorbital artery and nerve also emerge from the supra-orbital notch or foramen, located along the vertical line drawn from the medial limbus of the eye (Fig. 3). Typically, these structures branch into a deep and a superficial branch as they pass between the transverse and oblique heads of the corrugator muscle. The deep branch courses deeply through the corrugator muscle, while the superficial branch travels more superficially. As they traverse the bony orbit and penetrate the corrugator muscle, these branches enter the frontalis muscle and continue to ascend. The superficial branch of the supraorbital artery, similar to the supratrochlear artery, pierces the frontalis muscle and extends into the subcutaneous fat layer.²⁶

Unlike the supratrochlear artery, the deep branch of the supraorbital artery does not continue its deep course all the way to the hairline. Instead, all deep branches initially travel deeply but eventually emerge to a more superficial course as they ascend. These branches typically send offshoots that penetrate the frontalis muscle at 1 to 3 points, ~2 to 4 cm above the orbital rim. Beyond this, at about 4 to 6 cm above the orbital rim, the branches fully enter the subcutaneous fat layer. However, variations do exist, with some branches emerging at lower points, around 1.5 to 2 cm above the orbital rim (Fig. 4). When addressing forehead depressions, it is generally effective to fill the depressed area located above the supraorbital ridge, the most prominent structure of the orbital bone. This area is traversed by blood vessels that emerge from the upper orbital bone and ascend superficially

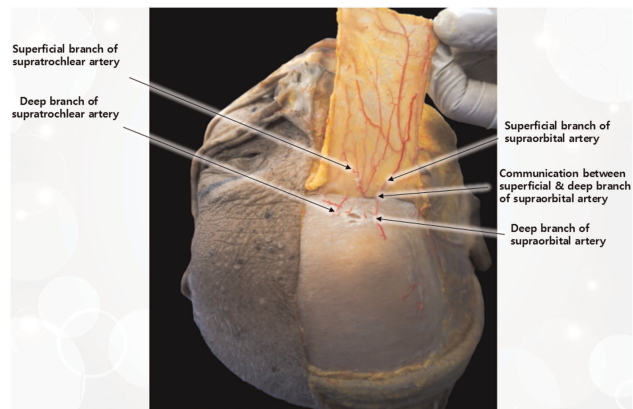


FIGURE 3. Different pathways of the supratrochlear and supraorbital arteries are illustrated.

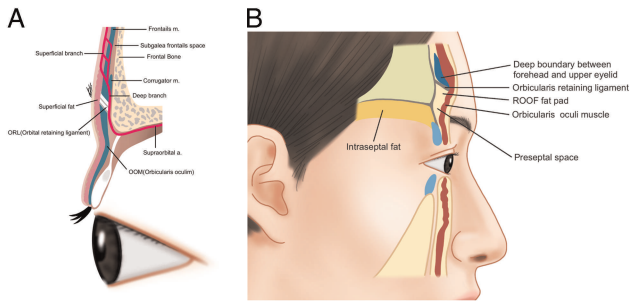


FIGURE 4. The pathway of the supraorbital artery is detailed (A). The orbicularis retaining ligament and ROOF are displayed (B).

through or over the muscles. Therefore, by positioning the injection plane beneath the muscles, the risk of significant vascular or nerve damage during the procedure is minimized.²⁷

However, postprocedural ocular swelling can occur following filler injections in the forehead. This is due to the weakening of the orbital retaining ligament, located 2 to 3 mm above the superior orbital rim, which serves as a barrier between the forehead and the orbit.²⁸ When this ligament is compromised, filler material can migrate into the ocular area, especially if there is an abundance of deep fat in the retro-orbicularis oculi fat (ROOF) space beneath the orbicularis oculi muscle. Gravity can further cause the filler to spread into the orbital area. To minimize this risk, it is advisable to avoid injecting filler too close to the supraorbital ridge.²⁸ When refining the boundary between the lower forehead and the orbital area, it is preferable to use a soft filler injected superficially within the dermis (Fig. 4).¹²

A thorough understanding of the forehead's anatomic layers is critical to ensuring safe and effective filler placement. Beneath the skin, the subcutaneous fat layer is divided into the central forehead compartment and 2 lateral compartments, separated by fibrous septa. These compartments influence filler distribution and may contribute to track formation if not properly considered.

The frontalis muscle, responsible for eyebrow elevation, is a key landmark for injection depth. Beneath this muscle lies a submuscular plane, which is the preferred site for volumization due to its ability to minimize filler migration and reduce the risk of vascular occlusion. Submuscular injections also enhance forehead convexity while maintaining a natural transition between the forehead and surrounding structures.

Vascular structures in the forehead, including the supratrochlear and supraorbital arteries, must be carefully navigated during injections. These vessels become more superficial as they ascend, increasing the risk of vascular injury in the subcutaneous plane. Using a cannula and slow injection technique, along with ultrasound guidance when necessary, helps reduce these risks.

PROCEDURE METHOD

The entry point for cannula insertion, particularly for cases involving bilateral or mildly pronounced central forehead depressions, should be located ~1 cm above the upper margin of the eyebrow, near the boundary between the forehead and the temple at the superior temporal septum. This point is strategically chosen between the anterior branch of the superficial temporal artery, which lies 1.5 to 2 cm above the eyebrow margin, and the zygomatico-orbital artery, allowing the procedure to be performed without damaging these blood vessels.²⁶

After puncturing the skin with a needle, the cannula is inserted inward, penetrating the muscle and advancing beneath it. Upon confirming the correct position against the periosteum, the cannula

is gently advanced through the fibrous subgalea-frontalis space, which facilitates relatively easy access to the target treatment area. Given that the forehead is not a flat surface, the cannula must navigate through curved areas, ensuring that it remains close to the periosteum to avoid damaging blood vessels or nerves. This is achieved by advancing the cannula using a fan-type dissection technique. Once the desired location is reached, the filler is injected beneath the muscle using a retrograde fanning technique as the cannula is gradually withdrawn.²⁶

Recent studies have identified that, similar to the subcutaneous layer, the space beneath the frontalis muscle is divided into 3 compartments: the centrally located deep central forehead compartment and 2 deep lateral forehead compartments on either side. These compartments are delineated by fibrous adhesions along the supraorbital neurovascular structure, similar to those found in the superficial forehead compartment (Fig. 5).¹⁵

When inserting the cannula beneath the frontalis muscle for filler injection, it is crucial to sufficiently release the adhesions in this area. Failure to do so may cause the filler to follow the path of the adhesion, forming a track along the superficial compartment, potentially leading to an uneven distribution and a visible line of filler extending upwards (Figs. 6–8).²⁹

For patients with central-type depression or significant central mixed-type depression, it may be necessary to establish an entry point at the midline of the forehead. This point should be located at the boundary between the glabella and the central forehead depression. Since the central forehead artery, a branch of the dorsal nasal artery, often runs along the central line, it is advisable to choose a puncture site slightly lateral to the midline to avoid puncturing this vessel and causing bleeding.¹⁷ After puncturing, the cannula is advanced beneath the muscle, using retrograde fanning, cross-hatching, and droplet techniques to fill and lift the depressed areas effectively.⁷

In cases where there is a total type depression extending to the upper third of the forehead, and the previously mentioned entry points do not provide adequate volume restoration, an additional entry point can be established at the hairline along the vertical line of the midpupil. This allows for the treatment of upper forehead depressions in a manner similar to that used for bilateral depressions, ensuring sufficient volume enhancement in these areas.¹²

Once a satisfactory volume has been achieved, a soft filler can be used to inject the dermal and subdermal layers, ensuring that any uneven areas or boundaries between treated and untreated zones are smoothly blended. This final step helps to achieve a natural, even appearance across the entire forehead.³⁰

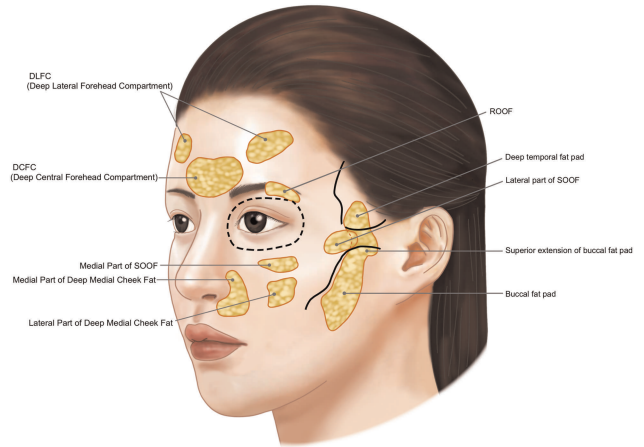


FIGURE 5. Deep fat compartments of the forehead region are illustrated.

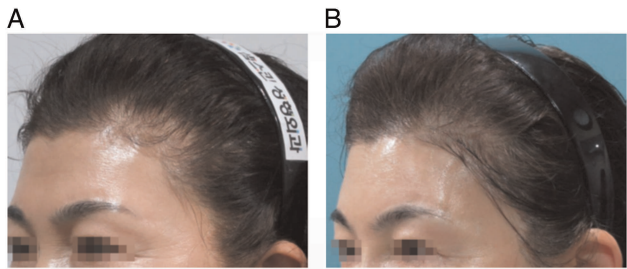


FIGURE 6. The before (A) and after (B) photo of the the patient treated with forehead filler augmentation. Submuscular injection is used for volumization, employing Maili filler [Sinclair Define or Volume (1–2 mL) administered with a 23–25 G cannula]. Subdermal injection is performed to improve depressed wrinkle lines and even out the skin surface, using Maili filler Precise or Define (0.5–1 mL) with a 30 G nanoneedle. Each injection plane targets specific issues, optimizing the treatment outcomes.

When dynamic wrinkles caused by the movement of forehead muscles are prominent, it is advisable to combine filler treatment with toxin injections. Muscle movement can cause the filler to migrate or reduce its longevity, so administering a toxin to temporarily paralyze the muscles can enhance the durability and effectiveness of the filler. If dynamic wrinkles have evolved into static lines that remain visible even without facial expression, these can be further addressed by injecting a soft filler into the dermis using techniques such as the fern leaf or duck walk methods, applied perpendicular or at a 60-degree angle to the horizontal wrinkles. This approach helps to elevate and smooth out the creased areas, restoring a more even and youthful appearance to the skin.³¹

To minimize the risk of vascular occlusion, the preprocedural vascular mapping using ultrasound, particularly in patients with

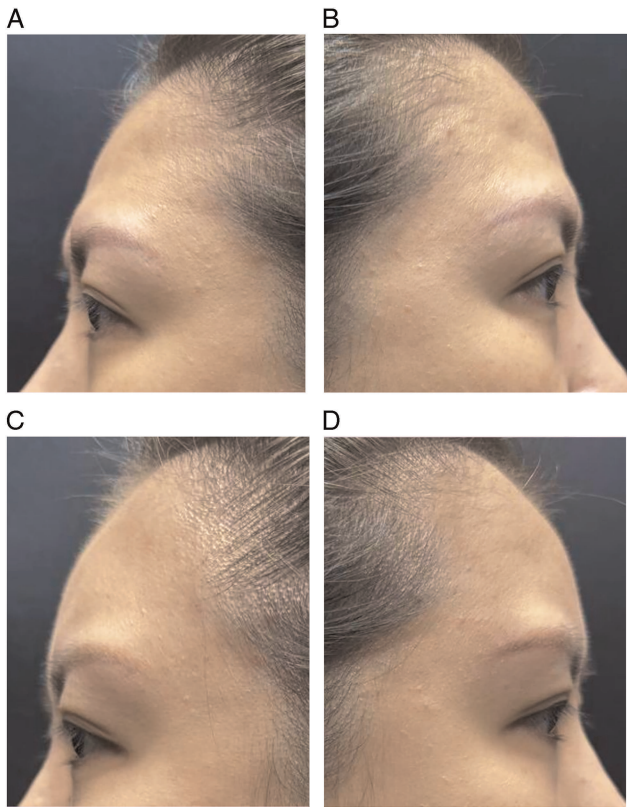


FIGURE 7. A 42 years old East Asian lady who had 4 ml of Maili Define augmentation of the central forehead. Adequate augmentation, forehead projection and creation of the Ogee curve was seen. (A), (B) Before. (C), (D) After 2 weeks.

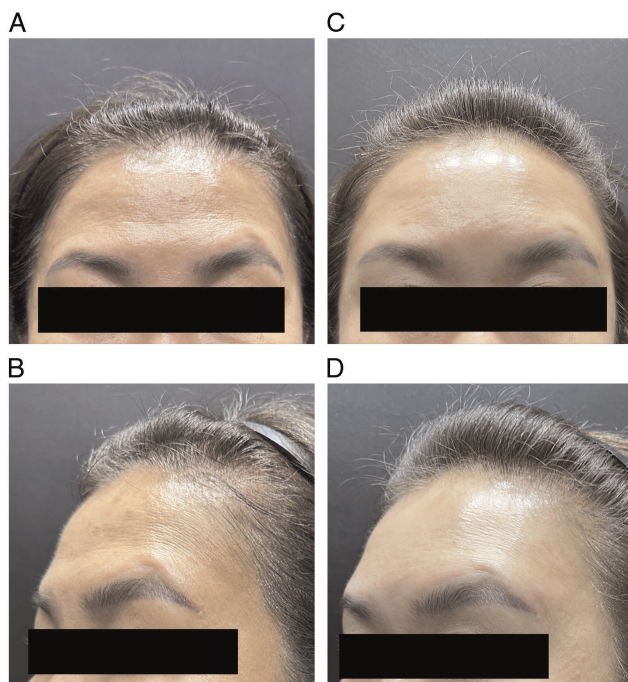


FIGURE 8. A 55 years old East Asian lady who had 4 ml of Ellanse augmentation of the central forehead. (A), (B) Before. (C), (D) After 3 months. Improvement of forehead volume deficiency, reduction of static forehead lines, improvement of skin radiance and skin quality were noted besides an overall more youthful appearance.

atypical anatomic variations is important. In addition, palpating arterial courses, usage of blunt cannulas, slow, low-pressure injections and frequent aspiration checks are recommended to further reduce the likelihood of vascular compromise.³⁸

For cases of filler migration, we recommend using firmer fillers in the submuscular plane to reduce unintended displacement. In patients with high mobility in the forehead region, stabilizing the filler placement with concurrent botulinum toxin administration has been shown to reduce migration risk by limiting excessive muscle movement.

DISCUSSION

In South Korea, a rounded, convex forehead has been associated with youthful and feminine features, influenced by K-beauty trends and celebrity endorsements. However, preferences are evolving, with an increasing number of male patients requesting subtle augmentation to create a structured but natural appearance, with a preference to reduce the appearance of frontalis wrinkles at the same time. In addition, recent trends in China and East Asia reflect a growing preference for a more balanced, 3-dimensional forehead contour rather than extreme convexity, demonstrating the evolving nature of esthetic ideals.

The demand for forehead augmentation in East Asia is also influenced by the concept of facial harmony, which extends beyond individual features to include the overall proportion of the face. While past trends emphasized a highly convex forehead, there is now an increasing preference for subtle volumization that enhances but does not drastically alter the natural shape. This shift is evident in patient requests for a “softer, elegant” forehead rather than a “prominent, doll-like” appearance, reflecting evolving standards influenced by international esthetics.

Cross-linked hyaluronic acid fillers exhibit an average longevity of 12 to 18 months in forehead augmentation, with their degra-

dation influenced by patient-specific factors such as metabolic rate, injection depth, and concurrent treatments. The availability of an immediate reversal agent of hyaluronidase makes hyaluronic acid filler a good choice for injectors less experienced with the forehead anatomy. Mialli filler (Kylane labs, Sinclair) has 373% more projection force, 34.5% more projection height and is able to withstand more than 4 times compression force as compared to Juvederm Voluma.⁴⁰ Microsphere Polycaprolactone fillers (Ellanse, Sinclair Pharma), known for their biostimulatory effects, can last 24 months and longer, and is highly suitable for patients who want longer lasting and natural forehead contouring results. In a Korean study of forehead augmentation with Ellanse, the mean GAIS scores of the subjects were 2.1 at 1 month post-injection, 2.5 at 6 month post-injection and stayed at 2.4 at 24 months post-injection, which is a testament to its longevity.^{32,33} It is recommended to schedule touch-up sessions every 12 to 15 months to maintain optimal results, particularly in patients with high forehead mobility, which can accelerate filler breakdown.³⁴

Furthermore, in patients receiving concurrent botulinum toxin treatments to reduce muscle movement, filler longevity has been observed to extend by ~20% to 30% due to reduced mechanical stress. This strategy allows for longer intervals between touch-up treatments, enhancing cost-effectiveness and patient satisfaction.³⁴

The anatomy-based approach to forehead filler injections provides a framework that prioritizes safety and efficacy by thoroughly understanding the unique structural aspects of the forehead. The forehead is not a uniformly flat surface; it consists of various compartments with distinct fat layers, muscles, and vascular structures, each influencing how filler is placed and behaves post-injection. Proper identification of these compartments allows practitioners to select appropriate injection planes and techniques tailored to individual patient anatomy, which is particularly important given the anatomic differences between Western and East Asian populations. For instance, East Asians often present with narrower foreheads and more pronounced depressions, necessitating techniques that create a balanced and harmonious contour without over-projection that can distort facial features.

The submuscular injection plane is often preferred for volumization because it provides structural support beneath the frontalis muscle, minimizing the risk of uneven filler distribution and track formation commonly seen when fillers are placed in the subcutaneous layer. This placement also reduces the likelihood of vascular injury, particularly in areas where major arteries, such as the supratrochlear and supraorbital arteries, are superficial and prone to damage. Moreover, submuscular injections tend to create a more natural contour that blends seamlessly with the surrounding facial structures, reducing the appearance of sharp transitions that can occur when fillers are placed too superficially. However, care must be taken to adequately release fibrous adhesions between compartments during injection to prevent the filler from forming visible tracks along these pathways. Patient-reported outcomes indicate that submuscular injections are associated with a lower incidence of visible irregularities and prolonged retention times.³⁵ A multicenter study on forehead augmentation found that 87% of patients who received submuscular injections reported higher satisfaction due to the natural blending of filler with the surrounding soft tissues.³⁶ Furthermore, volumetric analysis through MRI studies has confirmed that fillers placed in the submuscular plane maintain their shape more effectively over time compared with subcutaneous placements, which are more prone to gravitational displacement and premature absorption.³⁷

Addressing forehead depressions requires careful consideration of both the esthetic goals and functional anatomy. For example, fillers should not be placed in a way that causes the forehead to protrude excessively beyond the supraorbital ridge, as this can result in an unnatural appearance where the brow area appears sunken and

the eyes look recessed. The choice of filler type also plays a significant role; firmer fillers with high elasticity are suitable for deeper volumization, while softer fillers are preferred for superficial applications to smooth out wrinkles and create an even surface. This approach ensures that the filler integrates well with the natural movement of the forehead muscles, maintaining facial expressions without creating a stiff or overly “frozen” look.^{3,4}

Combining fillers with other treatment modalities, such as botulinum toxin injections, can further enhance outcomes, particularly for patients with dynamic wrinkles caused by muscle activity. While botulinum toxin effectively reduces muscle movement and prevents wrinkle formation, its use alone may not fully correct deep, scar-like depressions that have developed over time. By integrating filler injections to volumize and smooth out these areas, practitioners can achieve a more comprehensive rejuvenation of the forehead. This combined approach addresses both the dynamic and static components of forehead aging, allowing for a balanced restoration of youthful contours without compromising natural facial expressions.

REFERENCES

1. Abramo AC, Do Amaral TP, Lessio BP, et al. Anatomy of forehead, glabellar, nasal and orbital muscles, and their correlation with distinctive patterns of skin lines on the upper third of the face: reviewing concepts. *Aesthetic Plast Surg* 2016;40:962–971
2. Bae B, Lee G, Oh S, et al. Safety and long-term efficacy of forehead contouring with a polycaprolactone-based dermal filler. *Dermatol Surg* 2016;42:1256–1260
3. Yi KH, Lee JH, Seo KK, et al. Anatomical proposal for botulinum neurotoxin injection for horizontal forehead lines. *Plast Reconstr Surg* 2023;153:322
4. Yi KH, Lee JH, Hu HW, et al. Anatomical proposal for botulinum neurotoxin injection for glabellar frown lines. *Toxins (Basel)* 2022; 14:268
5. Lee SH, Lee HI, Kim JN, et al. Anatomical relationship between the inferior temporal septum and the temporal branch of the facial nerve for clinical applications. *Plast Reconstr Surg* 2024;153:812–819
6. Chi D, Kim JH, Kim TK, et al. Cadaveric study of deep temporal fascia for autologous rhinoplasty grafts: dimensions of the temporal compartment in Asians. *Arch Plast Surg* 2020;47:604–612
7. Sykes JM, Cotozana S, Trevidic P, et al. Upper face: clinical anatomy and regional approaches with injectable fillers. *Plast Reconstr Surg* 2015;136:204S–218S
8. Morris DE, Moaveni Z, Lo LJ. Aesthetic facial skeletal contouring in the Asian patient. *Clin Plast Surg* 2007;34:547–556
9. Gu Y, McNamara JA Jr, Sigler LM, et al. Comparison of craniofacial characteristics of typical Chinese and Caucasian young adults. *Eur J Orthod* 2011;33:205–211
10. Erdogmus S, Govsa F. Anatomy of the supraorbital region and the evaluation of it for the reconstruction of facial defects. *J Craniofac Surg* 2007;18:104–112
11. Foissac R, Camuzard O, Piereschi S, et al. High-resolution magnetic resonance imaging of aging upper face fat compartments. *Plast Reconstr Surg* 2017;139:829–837
12. Sykes JM. Applied anatomy of the temporal region and forehead for injectable fillers. *J Drugs Dermatol* 2009;8:s24–s27
13. van Loghem J, Sattler S, Casabona G, et al. Consensus on the Use of Hyaluronic Acid Fillers from the Cohesive Polydensified Matrix Range: Best Practice in Specific Facial Indications. *Clinical, Cosmetic and Investigational Dermatology* 2021;14:1175–1199
14. Skaria AM. The median forehead flap reviewed: a histologic study on vascular anatomy. *Eur Arch Otorhinolaryngol* 2015;272:1231–1237
15. Cotozana S, Mian A, Sykes JM, et al. An update on the anatomy of the forehead compartments. *Plast Reconstr Surg* 2017;139:864e–872e
16. Carruthers J, Carruthers A. Volumizing the glabella and forehead. *Dermatol Surg* 2010;36(suppl 3):1905–1909
17. Kleintjes WG. Forehead anatomy: arterial variations and venous link of the midline forehead flap. *J Plast Reconstr Aesthet Surg* 2007;60:593–606
18. Faris C, van der Eerden P, Vuyk H. The midline central artery forehead flap: a valid alternative to supratrochlear-based forehead flaps. *JAMA Facial Plast Surg* 2015;17:16–22
19. Goldberg RA, Wu JC, Jesmanowicz A, et al. Eyelid anatomy revisited. Dynamic high-resolution magnetic resonance images of Whitnall's ligament and upper eyelid structures with the use of a surface coil. *Arch Ophthalmol* 1992;110:1598–1600
20. Bryan Mendelson, Chin-Ho Wong. *Anatomy of the Aging Face*. Elsevier; 2013:2
21. Costin BR, Plesec TP, Sakolsatayadorn N, et al. Anatomy and histology of the frontalis muscle. *Ophthalmic Plast Reconstr Surg* 2015;31:66–72
22. Carruthers J, Carruthers A. A prospective, randomized, parallel group study analyzing the effect of BTX-A (Botox) and nonanimal sourced hyaluronic acid (NASHA, Restylane) in combination compared with NASHA (Restylane) alone in severe glabellar rhytides in adult female subjects: treatment of severe glabellar rhytides with a hyaluronic acid derivative compared with the derivative and BTX-A. *Dermatol Surg* 2003;29:802–809
23. Garritano F, Quatela V. Surgical Anatomy of the Upper Face and Forehead. *Facial Plastic Surgery* 2018;34:109–113
24. Scheuer JF, Sieber DA, Pezeshk RA, et al. Anatomy of the Facial Danger Zones: Maximizing Safety during Soft-Tissue Filler Injections. *Plastic & Reconstructive Surgery* 2017;139: 50e–58e
25. Reece EM, Schaverien M, Rohrich RJ. The paramedian forehead flap: a dynamic anatomical vascular study verifying safety and clinical implications. *Plast Reconstr Surg* 2008;121:1956–1963
26. Cong LY, Phothong W, Lee SH, et al. Topographic analysis of the supratrochlear artery and the supraorbital artery: implication for improving the safety of forehead augmentation. *Plast Reconstr Surg* 2017;139:620e–627e
27. Cong LY, Lee SH, Tansatit T, et al. Topographic anatomy of the inferior medial palpebral artery and its relevance to the pretarsal roll augmentation. *Plast Reconstr Surg* 2016;138:430e–436e
28. Moss CJ, Mendelson BC, Taylor GI. Surgical anatomy of the ligamentous attachments in the temple and periorbital regions. *Plast Reconstr Surg* 2000;105:1475–1490; discussion 1491–1478
29. Sundaram H, Cassuto D. Biophysical characteristics of hyaluronic acid soft-tissue fillers and their relevance to aesthetic applications. *Plast Reconstr Surg* 2013;132:5s–21s
30. Carruthers A, Carruthers J, Monheit GD, et al. Multicenter, randomized, parallel-group study of the safety and effectiveness of onabotulinumtoxinA and hyaluronic acid dermal fillers (24-mg/ml smooth, cohesive gel) alone and in combination for lower facial rejuvenation. *Dermatol Surg* 2010;36(suppl 4): 2121–2134
31. Coleman S. Avoidance of arterial occlusion from injection of soft tissue fillers. *Aesthetic Surgery Journal* 2002;22:555–557
32. Bae B, Lee G, OH S, et al. Safety and Long-Term Efficacy of Forehead Contouring With a Polycaprolactone-Based Dermal Filler. *Dermatologic Surgery* 2016;42:1256–1260
33. Betemps Jérémie Bon, Marchetti Francesco, Lim Tingsong, et al. Projection capacity assessment of hyaluronic acid fillers. *Plastic and Aesthetic Research* 2018;5:19
34. Küçüker I, Aksakal IA, Polat AV, et al. The effect of chemodenervation by botulinum neurotoxin on the degradation of hyaluronic acid fillers: an experimental study. *Plast Reconstr Surg* 2016;137:109–113
35. van Loghem J, Sattler S, Casabona G, et al. Consensus on the use of hyaluronic acid fillers from the cohesive polydensified matrix range: best practice in specific facial indications. *Clin Cosmet Investig Dermatol* 2021;14:1175–1199
36. Rzepniewski PT, Zatorski T, Nowak A, et al. Longevity of hyaluronic acid dermal fillers—current state of knowledge. *Dermatol Rev Przegl Dermatol* 2024;111:47–51
37. Vandeputte J. Real-world experience with volume augmentation using cohesive polydensified matrix hyaluronic acid gel: a retrospective single-center analysis of 110 consecutive patients with medium- to long-term follow-up. *J Clin Aesthet Dermatol* 2018;11:30–39