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Cosmetic

Efficacy, Safety, and Longevity of Hyaluronic Acid Filler Injection in Treating Temple Hollowness by Sonographic Identifying 17 Soft Tissue Layers

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Background: Successful aesthetic interventions in upper-face aging require a profound understanding of the intricate anatomy of temporal. This study aimed to comprehensively evaluate the effect of hyaluronic acid (HA) injection in temple areas by combining quantitative analysis with detailed anatomical insights.

Methods: Twenty-five women received HA injections for temple hollowness. The injections targeted the interfacial layer between superficial and deep temporal fascia. Three-dimensional scanning, hollowness examination, and sonographic measurements were conducted 3 and 6 months postprocedure.

Results: Sonography identified 17 soft tissue layers in the temple, each with distinct characteristics. The notable layers include the epidermis, dermis, superficial and deep temporal fasciae, innominate fasciae, and superficial and deep temporal fat compartments. Three-dimensional volume was 0.86 mL at 3 months and 0.72 mL at 6 months. The average thickness of HA was 3.82 mm (immediately), 3.00 mm (3 mo), and 2.51 mm (6 mo). The depression on the temple was 4.33 mm (preprocedure), 0.71 mm (3 mo), and 1.62 mm (6 mo). The grade improved by 2.41 and 1.74 levels at 3 and 6 months.

Conclusions: Identifying detailed superficial and deep layers of the deep temporal fascia challenged traditional descriptions, with detailed dividing of superficial and deep temporal fascia in sonography. Innominate fascia was also distinguished. This study provided a comprehensive evaluation of the effects of HA injections in temple areas. Precise anatomical insights and quantitative assessments contribute to a deeper understanding of the structural changes induced by this procedure. Sonography is valuable for delineating distinct layers and guiding aesthetic interventions in the temporal region. *(Plast Reconstr Surg Glob Open 2024; 12:e6154; doi: 10.1097/GOX.0000000000006154; Published online 12 September 2024.)*

INTRODUCTION

Understanding the intricate anatomy of the temporal region is essential for successful aesthetic interventions.[1] Seventeen soft tissue layers with distinct characteristics were identified on the temple using sonography by the author. Notable layers included the epidermis, dermis, superficial fatty layer, superficial temporal (temporoparietal) fascia (STF), innominate fascia, superficial (sDTF) and deep layers of the deep temporal fascia (dDTF), superficial (ST-Fat) and deep temporal fat compartments (DT-Fat), temporalis muscle (Tm), and the periosteum. Arteries such as the superficial, middle, and deep temporal arteries (STA, MTA, and DTA, respectively) contribute to the vascular supply. Furthermore, venous drainage is facilitated by the middle temporal vein (MTV) leading to the sentinel vein.[1] The frontal branch of the facial nerve traverses between the STF and DTF.[2] This study aimed to comprehensively evaluate the effects of hyaluronic acid (HA) injection in temple areas by combining quantitative analysis with anatomical insights.

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Table 1. RTVGS Measurement

Grade	Depression Amounts	Degree
Grade 0	Convex	
Grade 1	0 mm	Almost flat
Grade 2	Concavity 0–2mm	Minimal concavity
Grade 3	Concavity 2–4mm	Mild concavity
Grade 4	Concavity 4–6mm	Moderate concavity
Grade 5	Concavity > 6mm	Extreme concavity

Patients with grade 0 or 1 temple volume loss were excluded from this study.

Takeaways

Question: What is the efficacy, safety, and longevity of hyaluronic acid filler injections for treating temple hollowness?

Findings: This study identified 17 soft tissue layers in the temple. Assessments, including 3D scanning, ultrasound, and grading scale, showed maintained volume over 6 months with significant aesthetic improvement.

Meaning: Hyaluronic acid filler injections, guided by detailed sonographic mapping of temple soft tissue layers, offer a safe, effective, and long-lasting solution for treating temple hollowness with significant aesthetic benefits.

METHODS

Participants

Twenty-five women visited the author's clinic to treat temple hollowness. Quantitative assessments involved 3D scanning analysis system,[3] hollowness examination using a specific ruler, and ultrasound measurements of the thickness of the temple soft tissue, and the injected filler at 3 and 6 months postprocedure. Patients with grade 0 or 1 temple volume loss (RTVGS) (Table 1), skin disease on the face, or history of any filler treatment on the temples in the past 2 years were excluded. They were administered temple injections following routine clinical procedures after the subsequent procedures, such as 3D imaging, ultrasound examinations, and questionnaire filling, were explained to them.

Injection Methods

Before the procedure, the temple layers were examined using 18 MHz-5cm sonography (RS85 Samsung Medison, Seoul, South Korea).[4] One milliliter of HA-filler (YVOIRE Volume plus, LG-Chem, Seoul, South Korea) was injected into each side of the temple using a sono-guide, and the target layer was the interfacial layer between the STF and DTF. For the injection, entry points were made 5mm medial to the temporal fusion line and 10mm below the hairline. Entry points were made using a 23G needle, and 2mL of the tumescent solution was injected between STF and DTF using a 23G cannula. During the test-injection process,[5] the depth was checked using ultrasound. The cannula was maintained, and the syringe used for the tumescent solution was replaced with a syringe for the HA filler. [**See Video 1 (online),** which shows inter-fascial injection technique for a 54-year-old woman using sonography.]

Measuring the Thickness of the Soft Tissue and HA

The ultrasound probe was placed between the eyebrow and the orbital rim and parallel to the hairline. The thickness of the soft tissue and HA were measured.

3D Scanner Volume Analysis

Quantitative assessments included 3D scanning using a 3D camera (3D LifeViz mini: Quantificare, France) to measure volume changes.[3]

RTVGS

An additional innovative author's technique using a 10cm round acrylic plate facilitated the accurate measurement of temple depressions. A hole was made to penetrate the ruler, which measured the amount of temple depression based on the following grades: grade 0, convex; grade 1, 0mm (almost flat); grade 2, concavity 0–2mm (minimal concavity); grade 3, concavity 2–4mm (mild concavity); grade 4, concavity 4–6mm (moderate concavity); and grade 5, concavity greater than 6mm (extreme concavity; Table 1).

Global Aesthetic Improvement Scale

Patient satisfaction at 3 and 6 months was assessed using the Global Aesthetic Improvement Scale (GAIS) survey.

RESULTS

Soft Tissue Layers on the Temple Observed Using Sonography

Seventeen layers were identified using sonography (Fig. 1).

Layer 1 (Epidermis)

The epidermis was identified as the thinnest layer, and the hyperechoic line in the outermost layer consisted mainly of epithelial cells[6] (Fig. 1, no. 1).

Layer 2 (Dermis)

The dermis was identified with a hypoechoic line. The upper dermis showed homogeneous hypo-echogenicity, and the lower dermis showed homogeneous iso-echogenicity using sonography (Fig. 1, no. 2).

Layer 3 (Subdermal Fatty Layer)

Notably, many fine septate fibers from the STF to the dermis were found in this layer. Abundant dense fibrous septa (honeycomb fascia) separated subdermal fat tissues, which look like cuboidal fat. In other body areas, superficial fat appeared solid with much denser fibrous septae than deep fat [Fig. 1, no. 3 (yellow)].

Layer 4 (the Upper Lamina of STF)

The upper lamina of the STF showed greater hyperechogenicity than the main lamina (Fig. 1, no. 4 [red]). The upper lamina of the STF is connected to the fibrous septa from the STF to the dermis. It has more fascia-like tissue, consisting of fibrous tissue that provides compartmentalization and structural support to the dermis. The main lamina of the STF was observed as more

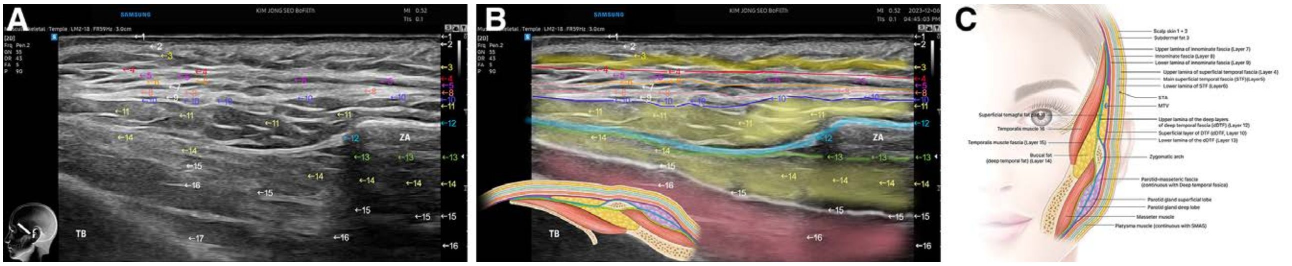

Fig. 1. Sonography of the identified 17 soft tissue layers on the temple region. Seventeen soft tissue layers of the temple were identified using sonography. A, These include the epidermis (layer 1), dermis (layer 2), superficial fatty layer (layer 3), upper lamina of STF (layer 4), main STF (layer 5), lower lamina of STF (layer 6), loose areolar tissue above innominate fascia (layer 7), innominate fascia (layer 8), loose areolar tissue below innominate fascia (layer 9), superficial layer of deep temporal fascia (layer 10), superficial temporal fat compartment (layer 11), upper lamina of deep temporal fascia (layer 12), lower lamina of deep temporal fascia (layer 13), deep fat layer of the temple (layer 14), temporalis muscle fascia (layer 15), temporalis muscle (layer 16), periosteum (layer 17), and temporal bone. B, Enhanced sonographic image with color-coded overlay highlighting the different soft tissue layers of the temple region. This illustration provides a clearer differentiation between each layer, aiding in visualizing the anatomical complexity. The color-coded layers correspond to the same 17 soft tissue layers identified in Figure 1A, enhancing the understanding of their spatial relationships. C, Diagrammatic representation of the soft tissue layers of the temple. This illustration aligns with the sonographic images (A–B) and provides a detailed, labeled cross-section of the temple region. Each layer is annotated, demonstrating the intricate anatomy from the epidermis to the temporal bone, and includes relevant structures such as arteries, veins, and fascia.

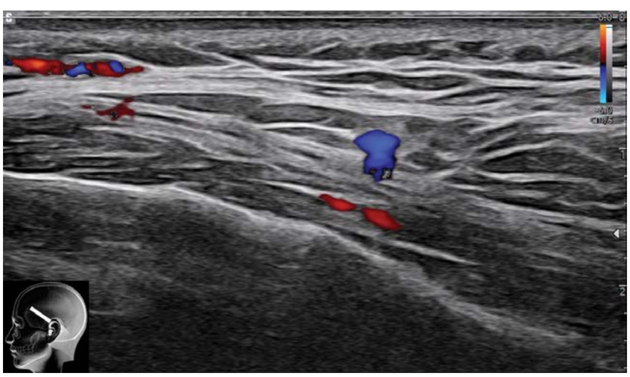

Fig. 2. Sonography of the STA, MTA, and DTA before injection in a 54-year-old woman. The STA runs between the upper (layer 4) and main (layer 5) lamina of the superficial temporal fasciae. The MTA was found between the deep layer of the deep temporal fascia and the fat pad. The DTA was detected in the temporalis muscle. The MTV, with the largest diameter, was in the superficial temporal fat pad.

muscular using sonography. The STA is located between the upper and main lamina of the STF (Fig. 2). [**See Video 1 (online)**].

Layer 5 (Main STF)

The main STF was identified as a definite thick fascial layer of connective tissue located between two fascia-like sheath structures, the upper and lower lamina of the STF [Fig. 1, no. 5 (pink)]. STF contains a multilayered fascia system and consists of multiple layers, including layers 4, 5, 6. The main STF was observed as the muscular-fascial system, which moved when the mouth was opened and closed. [**See Video 2 (online),** which shows movement of the STF and SMAS.] The main STF is more mobile than the upper and lower laminae. In this study, the main STF continued with the superficial muscular-aponeurotic system (SMAS) below the zygomatic arch and the platysma in the neck, as observed using sonography. The STF is connected anteriorly to the orbicularis oculi and frontalis muscles. Regarding surgical considerations, thread insertion, and filler injection, surgeons must identify the STF. [**See Video 2 (online)**].

Layer 6 (Lower Lamina of STF)

The lower lamina of the STF also showed greater hyperechogenicity than the main lamina, such as the upper lamina. The upper and lower laminae of the STF resemble its enveloping fascial tissue and show different movements when the mouth is open [Fig. 1, no. 6 (orange)]. [**See Video 1 (online)**].

Layer 7 (Loose Areolar Tissue above the Innominate Fascia)

Sonography revealed a clear, distinct layer of hypoechogenicity between the STF and the innominate fascia. This loose areolar tissue may provide a sliding function and act as a passageway through which nerves pass around the innominate fascia (Fig. 1, no. 7). The soft tissues should provide extra stretching space for nerves to pass through the face; loose areolar tissue may provide this function.

Layer 8 (Innominate Fascia)

Innominate fascia was identified and distinguishable using sonography and was more hypoechoic than the STF. The thickness was also observed as a thick fascial layer, using sonography. The innominate fascia contains the frontal branch of the facial nerve and is a meaningful and visible fascial layer observed using sonography. The facial nerve is located deeper in the caudal part. Definite loose areolar tissues were observed as hypoechoic lines above and below the innominate fascia. As sonography shows, the innominate fascia is a distinct layer between the STF and dDTF [Fig. 1, no. 8 (Indian pink)].

Layer 9 (Loose Areolar Tissue below Innominate Fascia)

Loose areolar tissues (hypo-echogenicity between the innominate fascia and the DTF) may provide a passageway for the facial nerves around the innominate fascia (Fig. 1, nos. 7, 9).

Layer 10 (sDTF)

The sDTF and dDTF are closely located in the cephalic area. The DTF is divided into deep and superficial layers in the ST-Fat layer. The sDTF passed above the ST-Fat, covering the ST-Fat; the sDTF passed above the superior aspect of the zygomatic arch. Bohr et al reported that "the deep temporal fascia splits into deep and superficial layers before it inserts into the superior aspect of the zygomatic arch." The author's sonography results were completely different from those of many other studies, such as the results of Bohr et al. The sDTF did not attach to the zygoma arch and passed above the zygoma[7–9] [Fig. 1, no. 10 (blue)].

Layer 11 (ST-Fat Compartment)

The ST-Fat pad is located between the sDTF and the dDTF, dividing the DTF into the sDTF and dDTF.[10–12] The MTV, the largest vessel, was found in ST-Fat in all cases, and its diameter was the largest among all the temple vessels (Fig. 2). [**See Video 1 (online)**]. The MTV ran anteriorly, pierced the dDTF, and continued with the sentinel vein, as observed using sonography. In addition, a small arterial perforator was located near the orbital rim and the zygomatic arch. Notably, some MTA and MTV perforators pierced the STF near the orbital rim. The MTA originated from the STA at the superior-posterior portion of the zygomatic arch. Then, the MTA traveled anteriorly to the orbital rim, piercing the sDTF or the dDTF. The MTA diameter was smaller than those of other arteries. In all cases, the MTV was located on the ST-Fat pad. The ST-Fat pad was more hypoechogenic (darker) than the DT-Fat. [**See Video 1 (online)**].

There were many septae inside the ST-Fat, similar to the subdermal fat. Nakajima et al reported that the superficial fat pad contains many honeycomb fasciae and may have a protective function.[13] Similarly, there were more fasciae in the ST-Fat layer than in the DT-Fat layer. ST-Fat and DT-Fat layers were divided using the sDTF. Surek et al reported that the intermediate temporal fat pad (ST-Fat) is a consistent anatomical structure in the anterior-inferior trough of the temporal fossa.[10] Ultrasound technology can be used to identify and inject the fat pad.

Further clinical evaluation will determine the role of this fat pad as a potential intermediate injection target for temple volumization procedures."[10–12] However, in this study, ST-Fat injection was inefficient for volumizing the temple because the ST-Fat was only near the zygomatic arch area. Therefore, the injection into ST-Fat volumized only the lower part of the temple's hollowness (Fig. 1, no. 11).

Layer 12 (Upper-lamina dDTF)

The main dDTF was a moderately thick fascia with a hyperechoic thin line between the ST-Fat and DT-Fat. The main dDTF was divided into the upper and lower-lamina dDTFs near the zygomatic body and arch. Then the upper-lamina DTF passed above the arch (Fig. 1, no. 12 [sky blue]); therefore, the caudal superficial portion of the ST-Fat pad passed and herniated over the zygoma-arch at approximately 3–5 mm. The lower-lamina dDTF passed below the zygoma and the arch [Fig. 1, no. 13 (green)]. Notably, many articles have reported that the dDTF passed under the zygoma arch[7–9]; however, in this study, the dDTF separated into upper- and lower-lamina dDTFs, then only the upper-lamina dDTF passed over the zygomatic arch in all cases. We nominated this portion as the upper-lamina dDTF. The upper lamina of the dDTF did not attach to the zygoma; instead, it passed above it and continued with the masseteric-parotid fascia. The upper-lamina dDTF is the lower boundary of the ST-Fat, whereas the lower-lamina dDTF is the upper boundary of the DT-Fat.

Layer 13 (Lower Lamina of dDTF)

The lower-lamina dDTF was a hyperechoic thinner line than the upper-lamina dDTF covering the upper portion of the DT-Fat. It passed under the zygoma and its periosteum. Notably, many articles have described that the dDTF passed under the zygoma arch[7–9]; however, only the lower-lamina portion of the dDTF passed under the zygoma in this study. For the first time, the author identified the dDTF as the upper- and lower-lamina dDTF.

Layer 14 (Buccal Fat or DT-Fat)

The upper boundary of the DT-Fat was the lower-lamina dDTF, and the lower boundary was the Tm fascia. DT-Fat showed greater hyperechogenicity(brighter) than ST-Fat. DT-Fat passes under the zygoma and continues with the buccal fat pad. The anterior part of DT-Fat (near the zygoma body) was thicker than the posterior part (near the zygoma arch). DT-Fat showed movement when the mouth was opened and closed, acting as a sliding layer [Fig. 1, no. 14 (yellow)].[14,15]

Layer 15 [Temporalis Muscle Fascia]

The Tm Fascia was clearly distinguished from the temporal fascia (STF and DTF), with a thin line observed using sonography. Tm fascia was divided into DT-Fat and Tm. It was the thinnest layer but was visible on sonography. (Fig. 1, no. 15).

Layer 16 (Temporalis Muscle)

The Tm is responsible for jaw movement. The muscle fibers of the anterior portion run vertically and move when the mouth is closed.[16] The muscle fibers of the posterior portion showed a horizontal direction, and contraction was observed during mandibular retrusion. The DTA was identified [Fig. 2 and **Video 1 (online)**], and the anterior part near the orbital rim anterior DTA was found. Furthermore, the posterior DTA was observed near the hairline. The DTA was located in a deeper portion of the Tm and showed a deeper pathway in the cephalic area near the upper portion of the orbital rim. [**See Video 1 (online)**]. When doctors use the "gunshot" technique for temple volumization, the Asher swift gunshot technique may have more risk of damage to the anterior branch of DTA.[17] The DTA was located deeper near the periosteum than in the thickest part of the Tm (Fig. 1, no. 16).

Fig. 3. Sonography showing the thickness of the injected HA after 6 months in a 42-year-old woman. The HA was injected under the STF and over the superficial layer of deep temporal fascia. The thickness was 3.12 mm after 6 months.

Layer 17 (Periosteum)

The periosteum was observed on the bone (Fig. 1, no. 17).

Measurement of Thickness of HA-filler

The thickest area of the injected HA filler was measured on the temple using sonography. The average HA thickness was 3.82 mm ± 1.00 immediately after treatment, 3.00mm ± 0.74 at 3 months, and 2.51 mm ± 0.64 at 6 months (Figs. 3 and 4). [**See Video 3 (online),** which shows the pathway of the MTV in a 42-year-old woman 6 months after injection.] The thickness of the injected HA was 2.51 mm even after 6 months.

3D Scanner Volume Analysis

The mean measured volume using the 3D scanner was 0.86 mL ± 0.098 at 3 months and 0.72 mL ± 0.101 at 6 months (Figs. 5 and 6). [**See Video 4 (online),** which shows before and 3 months after injection in a 53-year-old woman.] The volume of injected HA was maintained at 72% even after 6 months.

RTVGS Measurement after the Injection

The average temple depression was 4.33mm ± 1.07 before the procedure, 0.71mm ± 0.68 at 3 months, and 1.62 mm ± 0.70 at 6 months (Fig. 7). The actual temple depression was maintained at an improvement of 2.71 mm from 4.33 mm before injection to 1.62 mm 6 months later.

The RTVGS was 3.84 before treatment, 1.43 at 3 months, and 2.1 at 6 months, respectively. The grade improved by 2.41 at 3 months and 1.74 at 6 months.

GAIS

GAIS score was 4.93 ± 0.24 immediately after treatment, 4.52 ± 0.50 at 3 months, and 4.02 ± 0.57 at 6 months. The GAIS score was maintained at more than much improvement (4) at all follow-up periods.

DISCUSSION

The temporal region is supported by a bony foundation that comprises the parietal, frontal, sphenoid, and temporal bones. The overlying soft tissue comprises 17 layers, each with unique sonographic characteristics. Notable soft tissue layers on the temple observed using sonography include the epidermis (layer 1), dermis (layer 2), superficial or subdermal fatty layer (layer 3), upper lamina of the STF (layer 4), main STF (layer 5), lower lamina of the STF (layer 6), loose areolar tissue above the innominate fascia (layer 7), innominate fascia (layer 8), loose areolar tissue below the innominate

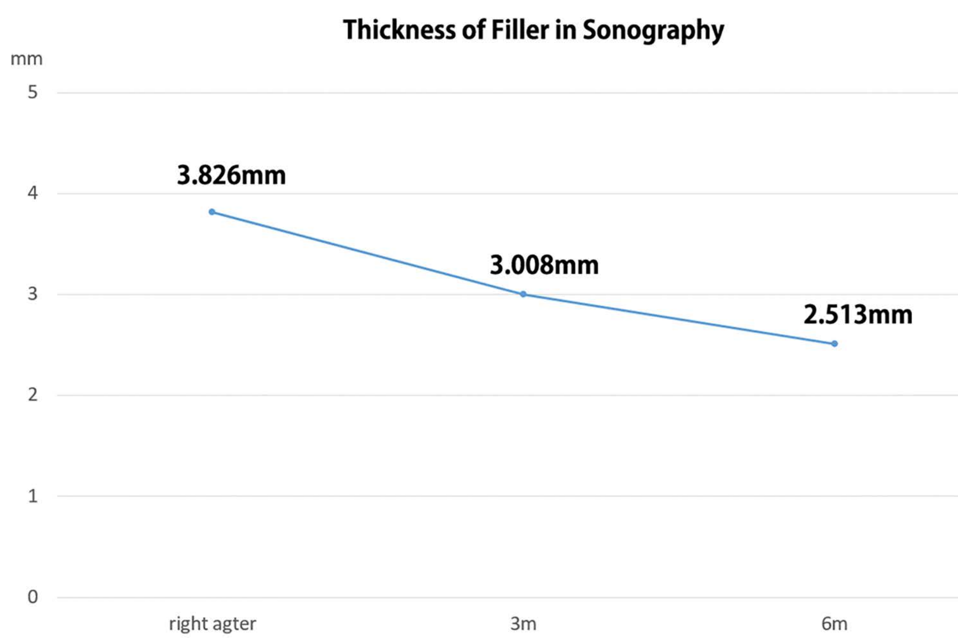

Fig. 4. A graph showing the thickness of the injected HA on both sides of the temple. The thickness was 3.82 mm immediately after injection, 3.00 mm at 3 months, and 2.51 mm at 6 months.

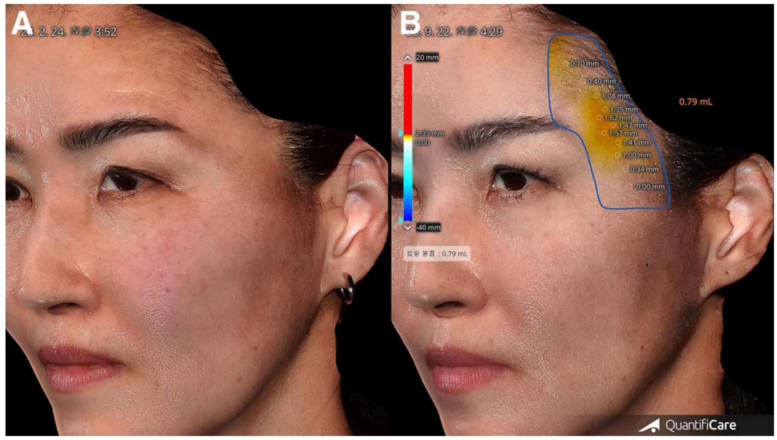

Fig. 5. Before and after injection in a 52-year-old woman. A, Before treatment. B, Six months after 1 mL of HA filler was injected on each side between the superficial and deep temporal fascia using a 23G cannula. The initial volume was 1 mL, and after 6 months, the volume was 0.779 mL as measured by a 3D scanner. The treated depth was approximately 1.6 mm. The thickness on the left side was 2.32 mm at 6 months.

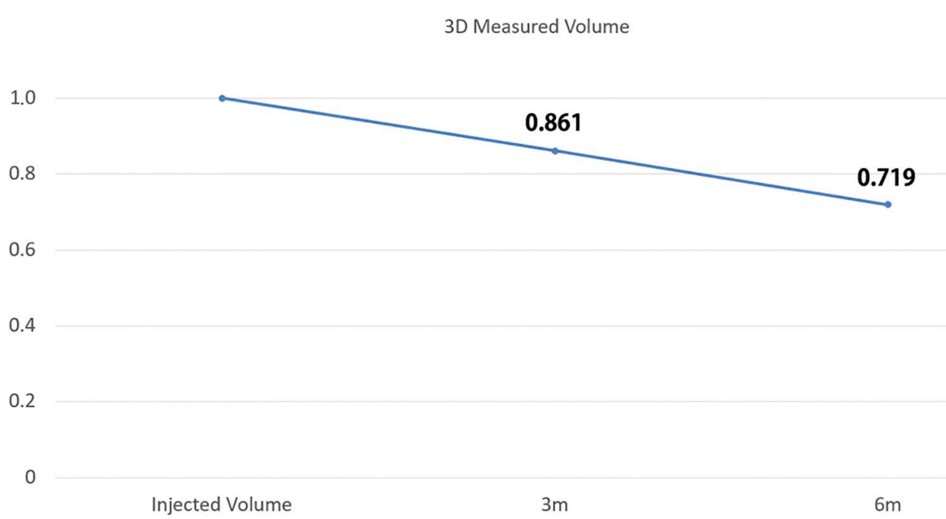

Fig. 6. A graph showing the measured volume changes using three-dimensional (3D) analysis. The volume was 0.86 mL at 3 months and 0.72 mL at 6 months, indicating significant retention of HA.

fascia (layer 9), superficial layer of the DTF (layer 10), superficial temporal fat compartment (layer 11), upper lamina of the dDTF (layer 12), lower lamina of the dDTF (layer 13), deep fat layer of the temple (layer 14), Tm fascia (layer 15), Tm (layer 16), periosteum (layer 17), and the temporal bone.

The intricate network of arteries within these layers, including the superficial, middle, and DTAs, contributes to the vascular supply to the region. [**See Video 1 (online)**]. The STA, which supplies most of the blood to the scalp in the temple area, passes between layers 4 and 5. The DTA runs through the deeper area of the Tm (layer 16). Among the temporal arteries, the MTA with the smallest diameter passes through the superficial fat pad in layer 11. In layer 11, the MTV is mainly responsible for venous drainage. The MTV leads to the sentinel vein as it moves forward (anteriorly). [**See Video 3 (online)**.] The frontal branch of the facial nerve passes through layers 8, 9, and 11, showing deeper caudal locations.

Therefore, it is necessary to determine the suitable layer for filler injection. Previous methods involved injecting fillers into the subcutaneous fat layer (layer 3) or using needles to puncture the skin and injecting near the periosteum between layers 11 and 12. However, injecting into the subcutaneous fat layer poses a risk of vascular damage, as the STA passes just above the STF. In addition, a deep injection into the periosteum can be unsafe, potentially injuring the anterior branch of the DTA. Notably, the gunshot technique only tries to avoid the STA and not the DTA. When injecting near the periosteum, it is impossible to inject into the periosteum directly if the needle pierces

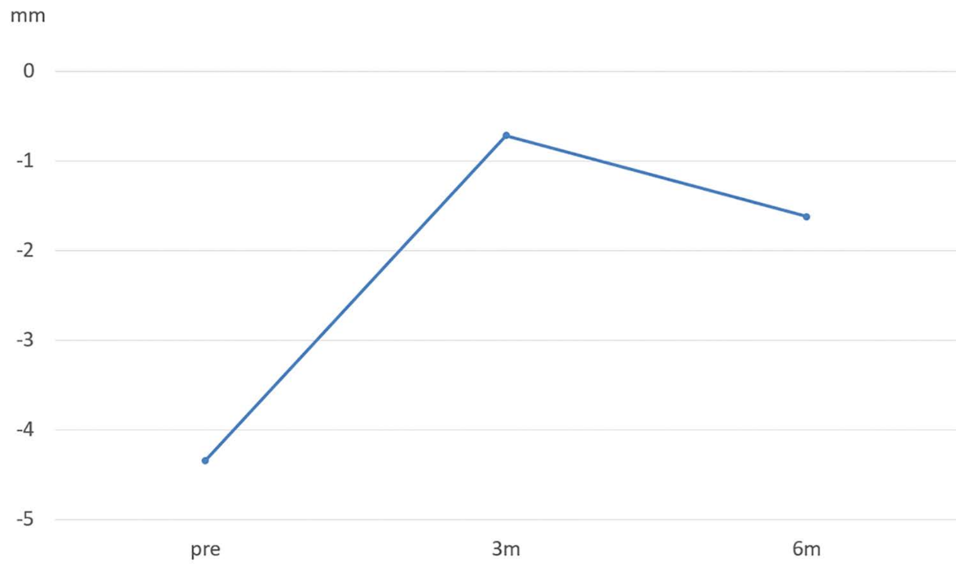

Fig. 7. A graph showing the depression amounts using the author's specific ruler. The average temple depression was 4.33 mm before the procedure, 0.71 mm at 3 months, and 1.62 mm at 6 months.

perpendicularly. This is because the hole in the needle was approximately 1 mm from the needle tip. Therefore, perpendicular injection using the gunshot technique causes the filler to enter the temporalis muscle, inducing dull pain in the patient. This pain worsens when the patient chews food and can cause temporal tension headaches. The needle should be inserted at an angle of approximately 30 degrees to inject close to the periosteum, aligning its surface parallel to the periosteum, with the beveled side facing downward in the author's modified gunshot technique.

The frontal branch innervates the muscles responsible for facial expressions in the forehead and eyebrow regions. The frontal branch exits the main trunk of the facial nerve within the parotid gland between the superficial and deep lobes, travels superiorly and anteriorly, and branches into smaller nerves that innervate the forehead and scalp muscles. It passes through layer 5 of the temple's soft tissues between the STF or temporoparietal fascia (layer 4) and the superficial layer of the DTF (layer 6). It typically runs just above the STA. The transition from the upper to lower temporal compartment, facilitated by the inferior temporal septum, requires a careful sharp dissection to protect the temporofrontal branch of the facial nerve.

Ultrasound imaging can help achieve more accurate and aesthetically pleasing results during facial rejuvenation procedures. This study divided the STF and deep layers of the DTF into detailed categories. The author divided the STF into upper, main, and lower laminae. The upper and lower laminae showed fascia-like structures. However, the main STF had a musculofascial structure and was more movable than the upper and lower STF laminae. The author showed that the movement of the main STF continued with the SMAS. [**See Video 4 (online)**.] In addition, dDTFs were, for the first time, divided into upper- and lower-lamina dDTFs. The upper-lamina dDTF passed above the zygomatic body and arch, whereas the lower-lamina dDTF passed below the zygoma and arch. Injected HA fillers maintained more than 6 months in inter-fascial plane of the temple without any side effects such as swelling, itching, redness, infection, pain, migration or transformation of shape.

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CONCLUSIONS

The thickness of the injected HA was 2.51 mm even after 6 months. The actual measured temple depression using a ruler maintained an improvement of 2.71 mm from 4.33 mm before injection to 1.62 mm 6 months later, and was according to the thickness of the injected HA on ultrasound. The volume of injected HA was maintained at 72% even after 6 months safely without any side effect such as itching, redness, infection, delayed swelling, or delayed immune response.

DISCLOSURE

The author has no financial interest to declare in relation to the content of this article.

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