Three-Dimensional Perioral Assessment Following Subnasal Lip Lift

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Abstract

Background: The subnasal lip lift is a surgical technique that elevates the "lip line" (interface between vertical maxillary incisor height and upper lip) to achieve a more youthful aesthetic.

Objectives: The authors sought to offer the first ever definition, to their knowledge, of 3-dimensional (3D) changes to the upper lip due to subnasal lip lift.

Methods: A lip lift procedure was performed (on cadaveric samples) in a sequential manner from 2.5- to 5.0-mm intervals (n = 13). 3D photographs were taken with the VECTRA H1 system (Canfield Scientific, Fairfield, NJ), and 3D analysis was performed including vermillion height and width, philtral height, sagittal lip projection, vermillion surface area, and incisor show. A subset of samples (n = 9) underwent a modification of the technique by undermining the upper lip subcutaneous tissue off the underlying muscular fascia.

Results: Vermillion surface area (baseline range, 1.45-5.52 cm^2) increased by an average of 20.5% and 43.1% with 2.5-mm and 5.0-mm lip lift, respectively. Anterior projection of the vermillion increased in all cases by an average of 2.13 and 4.07 mm at 2.5 and 5.0 mm, respectively. Philtral height decreased in all cases by an average of 3.37 and 7.23 mm at 2.5 and 5.0 mm, whereas incisal show increased on average of 1.9 and 4.09 mm, respectively.

Conclusions: This study is the first to our knowledge to define the 3D morphometric changes to the upper lip following subnasal lip lift. Quantifying these changes aids the surgeon in preoperative planning and guiding patient expectations.

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The upper lip and its relationship to the perioral region play an important role in facial aesthetics. Changes to the upper lip due to aging include soft-tissue descent and deflation, which leads to an elongated and thin upper lip with decreased maxillary incisor show.[1] A youthful perioral region consists of a relatively shorter upper lip with soft-tissue projection and appropriate incisor show.[2,3] The aesthetic upper lip demonstrates sufficient vermillion height on anterior view (7-8 mm) and slight sagittal projection in reference to the lower lip and allows for incisor show (approximately 3-4 mm in women and 2 mm in men).

The lip lift technique is a surgical approach to the aging upper lip, originally described by Cardosa and Sperli 1971, followed by many modifications in technique.[4-9] In general, the approach involves excision of a portion of the upper lip

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Figure 1. Bullhorn-style excision pattern at sequential 2.5-mm and 5-mm excision intervals in this 66-year-old male cadaver.

with the goal of shortening the cutaneous upper lip height and increasing maxillary incisor show. The excision pattern is typically a "bullhorn"-shaped wedge resection with the scar hidden in the nasal crease. To better understand the potential impact of this technique on perioral aesthetics, this study aims to use 3-dimensional (3D) technology to characterize changes to this region following lip lift.

METHODS

Lip Lift Technique

A lip lift procedure was performed at interval excision intervals on fresh frozen cadaveric specimens (n = 13; 8 male and 5 female; average age of 64.5 ± 3.02 years, range, 62-68 years). The excision pattern was in the previously described bullhorn-style pattern at 2.5 mm and 5.0 mm sequential heights (Figure 1).

Modified Lip Lift Technique

A subset of cadaveric specimens (n = 9) underwent lip lift with a modified approach. This involved direct excision as above, with the addition of undermining to separate the subcutaneous upper lip from the orbicularis oris muscle to the level of the upper vermillion border. The lateral extent of the subcutaneous undermining was determined by a line from the alar base to the lateral commissure on either side, parallel but shy of the nasolabial fold. A layer of deep dermal sutures was placed, and direct closure was then performed at the subnasal crease (Figure 2).

3D Photography and Analysis

3D photographs were taken at baseline and following each stage utilizing a VECTRA H1 camera (Canfield Scientific, Fairfield, NJ). Photographs of the 3D perioral surfaces following each resection were overlaid and registered onto baseline images utilizing Canfield VECTRA Analysis Module software. Overlays were created by manually selecting facial regions unchanged by resection (forehead, pupils, chin), followed by computer recognition and alignment of the selected identical surfaces. Landmarks were manually placed on significant anatomical landmarks to ascertain distances and on the vermillion border to quantify vermillion surface area.

Statistical Analysis

Mean values and standard errors were calculated for each measurement parameter being studied. Two-tailed paired samples *t* tests analyzing baseline and procedural mean measurements were employed to determine statistical significance. $P < 0.05$ was considered statistically significant. Microsoft Excel (Microsoft Corp., Redmond, WA) and SPSS (IBM, Armonk, NY) were utilized to calculate averages, percentage changes, standard deviations, and *P* values.

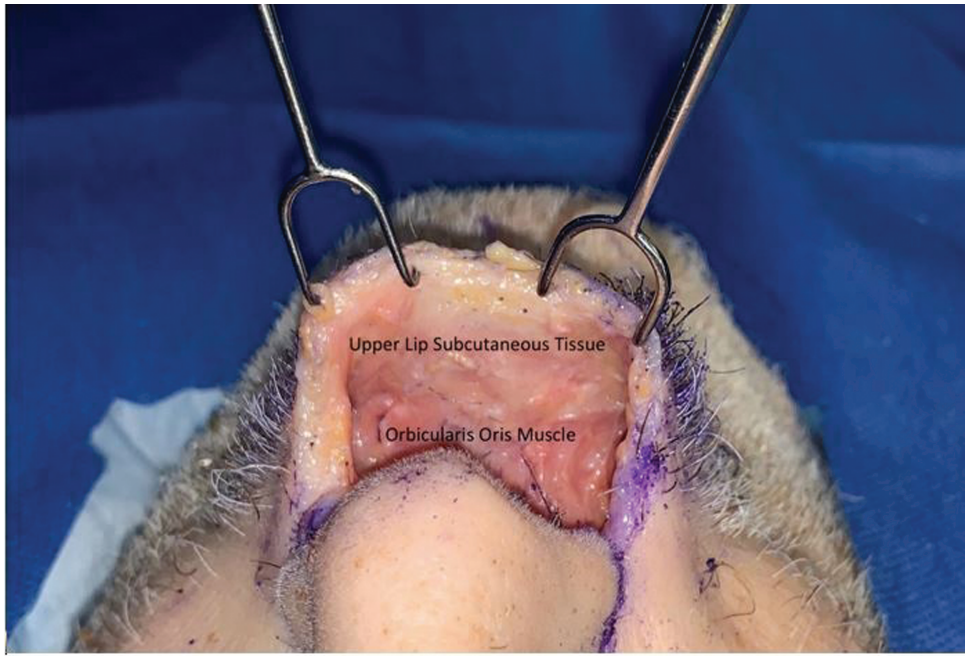

Figure 2. Cadaveric dissection demonstrating variation of the lip lift where the upper lip skin and subcutaneous tissue are elevated off the underlying orbicular oris muscle to the level of the upper lip vermillion in this 66-year-old male cadaver.

RESULTS

Baseline Characteristics

The sample group had an average philtral height of 19.34 mm (±3.2) and vermillion heights of 5.69 mm (±1.57) at baseline. The average philtral to vermillion ratio was 3.72 (±1.36). Nasal base width relative to total lip length (commissure to commissure) averaged 0.61 (±0.09).

Vermillion Surface Area and Height

Vermillion surface area at baseline averaged 3.57 cm^2 (±1.43) and increased by an average of 20.5% (±20%, $P = 0.002$) and 43.1% (±28.2%, $P = 0.003$) for 2.5- and 5-mm lifts, respectively. Increased surface area corresponded to increased eversion of the vermillion as noted by the increases in upper vermillion heights of 0.75 mm (±0.65, $P = 0.001$) and 1.98 mm (±1.08, $P < 0.001$) in the 2.5- and 5-mm lifts, respectively. These represented increases in vermillion height of 14.1% and 37.4%, respectively.

Sagittal Projection

Sagittal projection increased in all cases by an average of 2.13 mm (±1.03, $P < 0.001$) for 2.5-mm lifts and 4.07 mm (±1.18, $P < 0.001$) for 5-mm lifts. All upper lips following lip lifts had a sagittal projection of ≥2.0 mm past the static lower lip and chin (Figure 3).

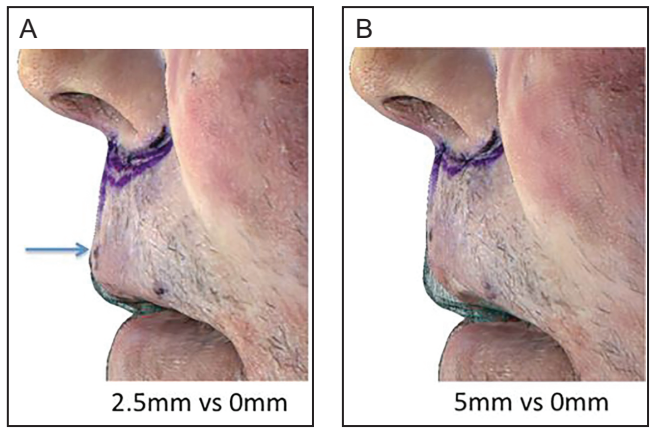

Figure 3. A 3-dimensional overlay demonstrating increased sagittal projection of the upper lip following lip lift in this 65-year-old male cadaver. The mesh represents 0 mm baseline: (A) 2.5-mm resection and (B) 5-mm resection.

Incisor Show

The average baseline incisor show was 1.81 mm (±2.1). Two samples were edentulous. Lip lifts resulted in a gain of incisor show on average of 3.72 mm (±2.87, $P = 0.003$) and 5.91 mm (±3.1, $P < 0.001$) with 2.5- and 5-mm lifts, respectively. This represented average percent increases from baseline of 105% and 226%, respectively (Figure 4).

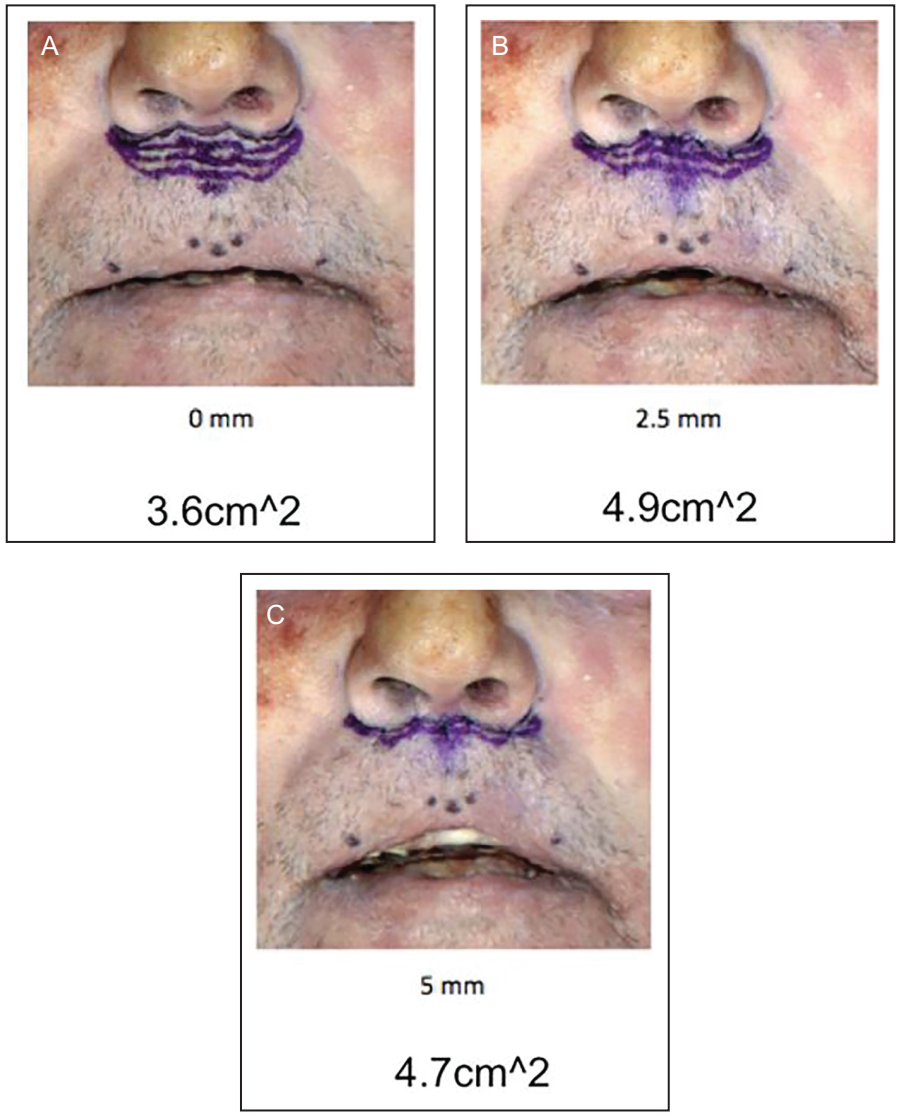

Figure 4. A 3-dimensional analysis demonstrating increased surface area with lip lift in this 66-year-old cadaver patient. (A) Preoperative image, (B) 2.5-mm excision, and (C) 5-mm excision.

Philtral Length and Philtral to Vermillion Ratio

Philtral length decreased in all cases of the lip lift procedure, with an average decrease of 3.34 mm (±1.5 $P < 0.001$) for 2.5-mm lifts and 7.24 mm (±2.26, $P < 0.001$) for 5-mm lifts. The changes in length corresponded to an improvement in philtral to vermillion height ratios. After a lip lift, all samples approached a more ideal philtral to vermillion ratio within the ideal range of 1.2 to 2.3. After a 2.5-mm lift, the average ratio was approaching ideal at 2.65 (±0.7). After a 5-mm lift, 10 out of the 13 samples had values within the ideal range with a cumulative average of 1.68 (±0.61) (Figure 5).

Nasal Base Width and Lip Width

Nasal base width, defined as the horizontal distance from alar-facial groove to alar-facial groove, had an average value of 29.92 mm (±4.46). Lip width, defined as the horizontal distance from commissure to commissure, had an average baseline value of 49.08 mm (±6.44). Lip width following 2.5- and 5-mm lifts did not significantly change from 48.37 (±6.04, $P = 0.06$) and 48.25 mm (±6.18, $P = 0.12$), respectively. For all samples, the average nasal base width to lip width ratio was 0.61 (±0.09). No individual samples had a nasal base width to lip width ratio <0.50. The most superior border of the excision is the crease formed by the interface of the alar base and upper lip; the alar base itself is not modified.

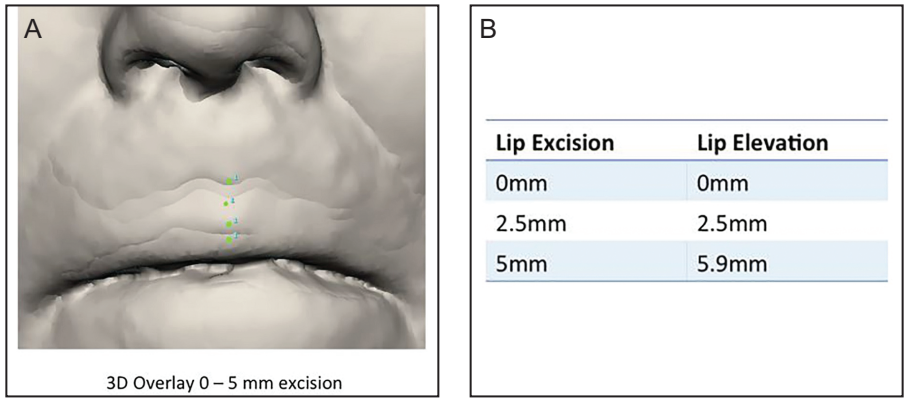

Figure 5. (A) A 3-dimensional demonstration of increased lip elevation with subnasal lip lift procedure in this 66-year-old male cadaver. (B) Increased lip elevation based on excision intervals.

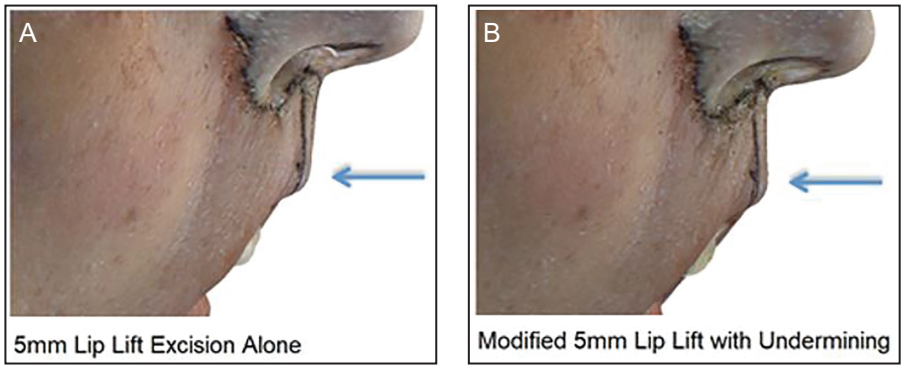

Figure 6. (A) A 5-mm lip lift with resection only in this 66-year-old female cadaver. (B) A modified 5-mm lip lift with subcutaneous undermining off the orbicularis oris.

Modified Lip Lift With Subcutaneous Undermining

Modification of the 5-mm lip lift with subcutaneous undermining (Figure 6) off the orbicularis oris led to a significant increase in average incisor show and decrease in philtral height compared with the 5-mm lip lift alone. Incisors show increased on average by 5.11 mm (±2.82, $P = 0.03$) for the 5-mm lip lift with undermining and 4.09 mm (±2.26, $P = 0.006$) for the 5-mm lip lift alone. Philtral height decreased on average by 7.6 mm (±1.9, $P < 0.001$) for the 5-mm lip lift with undermining and 7.24 mm (±2.26, $P < 0.001$) for the 5-mm lip lift alone. Average philtral height for all samples was 0.72 mm (±0.73) shorter for the 5-mm lip lift with undermining compared with the 5-mm lip lift alone.

This shows that the amount of lift achieved is greater than direct excision alone. The upper vermillion height increased on average by 0.45 mm ($P = 0.05$) for all samples. Average changes in sagittal projection, philtral to vermillion height ratio, and lip width did not reach the level of significance.

DISCUSSION

The perioral region is essential to facial aesthetics. The components of the perioral aesthetic include both soft-tissue and skeletal elements such as the dimensions of the philtrum and upper lip skin, the vermillion, and perioral fat compartments as well as dentition and cephalometric relationships. Changes to the upper lip due to aging are characterized by an elongated upper lip with deflation of soft-tissue volume and decreased vermillion surface area.[10] Early studies by Bisson found fashion models to have nearly twice the vermillion surface area compared with that of non-models.[11] Popenko et al further quantified this aesthetic goal by reporting that lips that had been digitally modified to increase vermillion surface area were ranked as most attractive.[12] With aging, however, these attractive features are lost as the upper lip elongates with flattening of the philtrum and cupids bow and decreased vermillion surface area and incisor show.[13]

In an effort to restore a youthful upper lip, several surgical and nonsurgical methods have been proposed.

Surgical lip lift procedures are a permanent solution to an aging upper lip by increasing vermillion surface area and incisor show. In addition, only surgical lip lift procedures can shorten elongated upper lips seen with aging. Nonsurgical methods are largely limited to restoring volume and require frequent retreatment. Blondeel et al demonstrated a systematic approach to lip rejuvenation utilizing both techniques.[3] This study builds on this approach by objectively defining the morphometric changes to the upper lip and relationship to the dentition following surgical lip lift.[3] The purpose of this study was to provide quantifiable changes with the "bullhorn" lip lift technique in an effort to generate reproducible and consistent results. Based on our findings, 5 aspects of the perioral appearance were improved according to aesthetic standards of upper lip aesthetics: vermillion surface area, sagittal projection, incisor show, philtral length, and overall upper vermillion height. With a 5-mm lip lift, the vermillion surface area increased on average by 41%, with an increase in upper vermillion height by an average of 34.8%. The average vermillion height with a 5-mm lip lift was noted to be 7.55 mm (±1.59), which is within reported ideals of upper lip height of 7 to 8 mm.[5] In addition, all upper lips had a sagittal projection of ≥2.0 mm past the static lower lip and chin, which is indicative of a youthful appearance (Figure 3).[14] The combination of these findings demonstrates that the effect of the lip lift is to evert the aged lips and ultimately result in a fuller and more "pouty" appearance. This study also demonstrated that this technique resulted in an average incisor show of 3.72 mm and 5.91 mm in 2.5- and 5-mm lifts, respectively. This represented a 105% and 226% increase in incisor show, respectively, on average from baseline. These findings may help guide plastic surgeons in determining how much lip to resect to achieve a desirable result.

A notable finding of this study was that the average decrease in philtral length exceeded the amount of tissue resected. So, a 2.5-mm resection led to an average 3.37-mm decrease in philtral length, and a 5-mm resection resulted in an average 7.25-mm decrease in philtral length. This nonlinear relationship may be explained by additional tension and shortening of philtral length provided by suture closure. There are 2 possible reasons for a greater than one-to-one response after the subnasal lip lift. One is surgeon error given the surgeon is cutting in 2.5-mm increments, and this margin of error could be additive after serial excisions. The other is that when we put in deep dermal sutures during closure, the tissue is everted, and the lift may be greater than the amount of tissue excised. This could account for differences on a submillimeter level of lift when evaluating the changes to the upper lip after excision and closure.

The addition of a subcutaneous undermining to the lip lift has been proposed to further evert the upper lip and create greater vermillion show. The results of this study support this conclusion with an average increase of 0.45 mm (± 0.39) in vermillion height. The data are drawn from a limited sample (n = 13), and changes in vermillion must be considered in the context of global perioral soft-tissue changes. Additionally, resulting dynamic changes in the lip created a significant decrease in philtral length and a corresponding significant increase in incisor show. Thus, the effect of the subcutaneous undermining was to provide greater lip eversion with more incisors show and a shorter lip.

Understanding the dynamic nature of the perioral region in response to subcutaneous undermining is critical to preoperative planning and understanding the eventual outcome. If the goal is to increase vermillion show while increasing incisor display and shortening the upper lip, the subcutaneous undermining would be most effective to accomplish this when paired with a larger subnasal full-thickness resection. This approach would achieve a fuller and more youthful-appearing upper lip and contribute to the knowledge base of the lip lift procedure by providing objective and reproducible results.

Limitations of this cadaveric study include sample size, inability to study long-term outcomes in clinical patients, and differences in tissue response between fresh frozen cadavers and clinical patients. A small sample size of 13 cadaveric heads poses a limitation and indicates the need for a future study with more samples. Our experience, and that reported in the literature, suggests that some degree of reversion occurs in the initial weeks to months following the lip lift.[15] This partial return to baseline has not been well described or quantified and will require future studies on living patients. For the purposes of this study, our group utilized fresh frozen cadavers to analyze the effects of different lip lift techniques. Although this study would ideally be on living tissue, fresh frozen cadavers most closely simulate living tissue. The utilization of cadavers allowed us to conduct sequential lip lifts at standard intervals across study subjects including 2 methodologies without the impact of edema on our results. That would not be possible in live patients.

Additionally, cadaveric skin has different tensile properties from that of a living person, and therefore the findings of this study may not accurately reflect changes seen with this technique. It is important to consider the muscle dynamics of a cadaver may not be comparable with a live patient because there are no active muscle movements to analyze. Furthermore, the lack of muscle tone in cadavers may influence the reported results and may limit the reliability of the results in live patients. In addition, postural changes did not affect our results, which may differ in live

patients with greater tissue elasticity. Future studies with similar 3D assessments in live patients are ongoing and will help clarify potential discrepancies.

Our study investigated the overall change in surface area of the central lip; however, employing 3D technology in future studies, we can further delineate the changes to different areas of the lip and consider the utility of the subnasal lift when addressing the asymmetric lip. This is a preliminary evaluation of the overall change in the local characteristics of lip lift; the observations of this study will lead to further evaluations of the central and lateral changes to the lip in addition to addressing different techniques in live patients, including indirect lip lift, which would affect the vermillion.

CONCLUSIONS

The lip lift is a popular and minor procedure that can significantly enhance facial aesthetics and provide dramatic improvement in the aged lip. With the aid of 3D imaging, soft-tissue changes following the lip lift were quantified to improve preoperative planning and manage patient expectations. This study demonstrated aesthetically desirable changes to the upper lip due to the subnasal lip lift, including an increase in incisor show, increase in vermillion projection and surface area, and a decrease in philtrum height. These results are based on a small sample of cadavers, so it is important to utilize clinical judgement when performing the subnasal lip lift in live patients. Additional studies in clinical settings with similar 3D assessments of live patients are ongoing and will provide supplementary data for this technique.

Supplemental Material

This article contains supplemental material located online at www.aestheticsurgeryjournal.com.

Disclosures

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