

ONLINE FIRST

Forehead and Scalp Sensation After Brow-lift

A Comparison Between Open and Endoscopic Techniques

Jason M. Guillot, MD; Daniel E. Rousso, MD; William Repogle, PhD

Objective: To compare postoperative forehead and scalp sensation for the “open” brow-lift (OBL) (coronal and trichophytic) with that of the endoscopic brow-lift (EBL).

Methods: A controlled outcome evaluation study was designed to objectively (mechanceptive and thermoceptive) and subjectively (visual analog scale) test forehead and scalp sensation in a group of patients having undergone or scheduled to undergo either OBL or EBL in a single, private facial plastic surgery clinic. Prospectively enrolled participants were tested at defined intervals (A, preoperation; B, 1-2 weeks after; C, 4-6 weeks after; D, 12-14 weeks after; and E, 24-26 weeks after). To provide extended follow-up data (≥ 6 months), patients returning for scheduled follow-up examination who had already undergone either OBL or EBL were subjected to the same test battery. For statistical analysis of the extended follow-up data, the participants were divided into 2 groups (F, 6-18 months; and G, > 18 months). The null hypothesis was that there would be no measurable difference between the OBL and the EBL groups related to postoperative forehead and scalp sensation.

Results: Twenty-one individuals (EBL, $n=11$; OBL, $n=10$) were enrolled prospectively. All showed normal objective and subjective values preoperatively. While both groups objectively and subjectively demonstrated de-

creased sensation over follow-up, the OBL group showed statistically significant decrement in objective scalp sensitivity at times B, C, and D vs the EBL group. Subjectively, the OBL group felt less sensitive than the EBL group at times C and D. Those relationships disappeared at time E. Fifty-eight individuals were retrospectively enrolled. At time F (EBL, $n=16$; OBL, $n=10$), an objective and subjective difference was again observed with the OBL group demonstrating less scalp sensitivity vs the EBL group. At time G (EBL, $n=20$; OBL, $n=12$), this difference was no longer observed.

Conclusions: We reject the null hypothesis and state that there is a measurable, statistically significant difference between the studied groups related to postoperative forehead and scalp sensation and that those observed differences are objective and subjective in nature as well as time dependent. However, almost no patients (57 of 58), irrespective of the technique used for their brow-lift, viewed their experienced forehead and/or scalp numbness to have been significant enough to deter them from undergoing the surgery again.

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Author Affiliations: Rousso Facial Plastic Surgery Clinic, Birmingham, Alabama (Drs Guillot and Rousso); and Department of Family Medicine, University of Mississippi Medical Center, Jackson (Dr Repogle).

REJUVENATION OF THE UPPER face and periorbital tissues is often directed at the ptotic brow. To address this brow ptosis, differing brow-lift procedures are prescribed. There are many proven techniques for performing brow-lifts that have differing risk-benefit profiles. More specifically, “open” (eg, trichophytic and coronal) brow-lift (OBL) techniques, by nature of their longer incision lines, are theorized to cause greater degree, incidence, and duration of anesthesia and/or dysesthesia vs the endoscopic brow-lift (EBL) technique.¹ To date, there has been no rigorously designed scientific study that has endeavored to formally evaluate the degree and duration of forehead and/or scalp anesthesia after brow-lift. Furthermore, to

our knowledge, there are no studies comparing and contrasting those findings in the context of the different brow-lift techniques performed.

We sought to formally test forehead and scalp sensation in a group of patients undergoing and/or having undergone brow-lift procedures by an “open” or endoscopic method. The null hypothesis was that there would be no measurable difference between the study groups related to postoperative forehead and scalp sensation.

METHODS

PROSPECTIVE

A prospective controlled outcomes evaluation study was designed to objectively and sub-

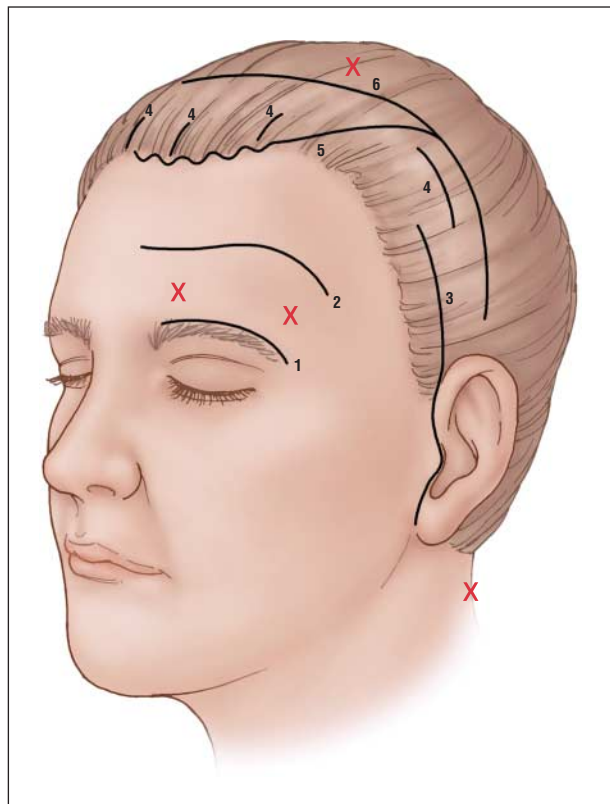


Figure 1. Brow-lifting incisions. 1, Direct; 2, midforehead; 3, temporal/cheek; 4, endoscopic; 5, trichophytic; and 6, coronal. The red X indicates locations of objective sensory testing.

jectively test forehead and scalp sensation in a group of participants scheduled to undergo OBL or EBL as prescribed for upper facial rejuvenation. Participants were not randomized to their respective brow-lift procedure but rather selected to undergo a particular brow-lift technique according to author-surgeon aesthetic judgment and criteria (eg, location of hairline, degree and location of brow ptosis). A group of age-similar participants who had never undergone any brow-lift procedures and/or any significant scalp procedures were enrolled to serve as a control population and undergo the same sensory testing protocol.

RETROSPECTIVE

Extended follow-up data (≥ 6 months) were provided by individuals who visited the clinic as scheduled and had previously undergone either OBL or EBL procedures. These participants also underwent the same sensory testing protocol as the prospectively enrolled participants.

INCLUSION AND EXCLUSION CRITERIA

All participants must have been part of the patient population of a single, private facial plastic surgery clinic (Rouso Facial Plastic Surgery Clinic, Birmingham, Alabama), where all brow-lift procedures were or were to be performed. All procedures were performed by the senior author and fellowship director (D.E.R.) or one of his fellows. More specifically, all techniques for either OBL or EBL were to be consistent (see “Surgical Techniques” subsection) between surgeons. Neither sex was excluded. All potential participants were submitted to an informed consent process, and only those individuals stating their consent to participate were enrolled in the study. Partici-

pants must have been 18 years or older to freely consent to participate. Those with physical illnesses (eg, diabetes, peripheral neuropathy) that might affect their sensation were excluded. Brow-lift procedures performed by methods (eg, midforehead, direct, transblepharoplasty) other than those previously stated were also excluded from statistical analysis.

SURGICAL TECHNIQUES

Open brow-lifts were defined as coronal or trichophytic and performed via the incisions depicted as 5 and 6 in **Figure 1**. All of these procedures were performed in a subgaleal (SG), also known as suprapariosteal, plane under direct visualization. Both the coronal and trichophytic methods exposed and addressed the corrugator supercilii musculature but not the procerus; the frontalis muscle was not myotomized or otherwise manipulated. The coronal and trichophytic incisions were closed in a single-layer fashion with staples. All OBL methods required the excision of redundant skin at their respective incisions prior to closure.

All EBLs were performed in a subperiosteal (SP) plane and via the 5 incisions (2 temporal, 2 paramedian, and 1 midline) (depicted as 4 in **Figure 1**). Surgical visualization was initially via “blind” dissection using periosteal elevators to the level of the midforehead. The dissection of the conjoint tendon, arcus marginalis, and corrugator supercilii muscles were all performed under endoscopic visualization. As in the OBL procedures, only the corrugator muscles were resected and not the procerus muscle. Again, the frontalis muscle was not myotomized or otherwise manipulated. The supraorbital and supra-trochlear neurovascular bundles were identified and preserved in all cases. The brows were suspended via the left and right paramedian incisions using a 0-Vicryl suture to the periosteum posterior to those incisions. All incisions were closed in a single-layer fashion with staples. Only redundant skin located at the temporal incision (lateral to the temporal line) was excised; no skin excision was done at the 3 medial incisions.

OBJECTIVE SENSORY TESTING

Prospective participants underwent preoperative and postoperative (time A, preoperative; time B, 1-2 weeks; time C, 4-6 weeks; time D, 12-14 weeks; and time E, 24-26 weeks postoperative) forehead and scalp sensation testing. Retrospective participants underwent a single-testing protocol when they presented for scheduled follow-up examination. Objective sensation testing was directed at both mechanoreceptive and thermoceptive capabilities. Each forehead was divided into separate hemiforeheads. Each hemiforehead underwent mechanoreceptive and thermoceptive testing at 3 subsites—2 forehead subsites (medial and lateral to the supraorbital notch; the lateral site was, however, medial to the temporal line) and 1 frontoparietal scalp subsite. The 2 forehead subsites were anterior to the respective incision and the 1 frontoparietal scalp subsite was directly posterior to the incisions. The patient’s posterior neck was tested on each side to serve as a control. The sensory testing subsites are depicted in **Figure 1**.

Mechanoreceptive sensation evaluation was performed by testing static light touch with Semmes-Weinstein monofilaments (North Coast Medical Inc, Morgan Hill, California; <http://www.ncmedical.com>; **Figure 2**). Semmes-Weinstein testing was performed as demonstrated in **Figure 3** and as directed by the accompanying package insert. Specifically, 4 monofilaments were used, representing an increasing degree of mechanoreceptive insensitivity. These were the 3.6 monofilament (representing 0.4 g of pressure), the 4.3 monofilament (2.0 g), the 4.6 monofilament (4.0 g), and the 6.7 monofilament (300 g). If the patient could not localize the 6.7 monofilament, they were deemed to have no mechanoreceptive sensation at that subsite.



Figure 2. Semmes-Weinstein monofilaments (North Coast Medical Inc, Morgan Hill, California).

Thermoceptive sensation evaluation was performed by testing temperature discrimination (“hot” vs “cold”) of the same subsites on each hemiforehead. To convey “hotness” or “coldness” to each respective subsite, a stainless steel probe was used (Figure 2). Only the circular tip of the stainless steel probe (6 mm in diameter with a surface area of $3^2\pi$ or 28.26 mm²) was used to contact the patient’s skin at each respective site. Only 2 probes were used for each test. Each probe was heated or cooled with hot or cold liquid for approximately 1-minute duration prior to each test. A concerted effort was made to provide a consistent amount of mechanoreceptive pressure at every subsite tested and between participants during application of this probe to the participant’s skin.

All tests were performed by one of the authors (J.M.G.). The sequence of objective testing followed a uniform method in every patient, every time. Specifically, the posterior neck was tested first to serve as a control for subsequent forehead and frontoparietal scalp testing. During the control mechanoreceptive test, the participant was instructed that they were to give only 3 responses (forced choices), either “left,” “right,” or “nothing.” Forehead and frontoparietal scalp testing would then proceed at the aforementioned subsites with the patient’s eyes closed and neck extended. During the control thermoceptive test, the participant was instructed that they were to again localize and state “right,” “left,” or “nothing”; however, they were to add the designation of “hot” or “cold” to their respective “right” or “left” responses. For the thermoceptive score, only answers that were correct in both sidedness and temperature sensation were counted as correct responses.

SUBJECTIVE SENSORY TESTING

A 5-point visual analog scale (VAS) was used to elucidate the participant’s perceived degree of forehead and scalp anesthesia. More specifically, each participant was asked the question, “On a scale of 1 to 5, with a score of 5 signifying complete numbness and 1 signifying normal sensation, what score would you give your forehead today?” This same question was repeated while substituting the words “scalp just behind your incisions” in place of the word “forehead.” Lastly, the patient was asked, “Would your forehead or scalp numbness keep you from having this type of surgery again?” The last question was not asked during the preoperative testing of the prospective participants or the control population. Only these 3 questions were asked. No effort was made to have the patient compare the right and left sides of his or her head.



Figure 3. Demonstration of mechanoreceptive testing using Semmes-Weinstein monofilament.

SCORING AND DATA COLLECTION

The scoring and data collection sheet is provided in the eFigure (<http://www.archfacial.com>). Objective mechanoreceptive scoring for each forehead and scalp subsite was performed on a 5-point scale with the most mechanoreceptive sensitive response (3.6) receiving a score of 5 and the least mechanoreceptive response (no sensation) receiving a score of 1. Each hemiforehead subsite score was then added to its respective hemiforehead subsite score (eg, right midforehead + left midforehead) to give a total head subsite score (eg, total midforehead) of a possible 10. Thus, the most mechanoreceptive sensitive score for a particular hemiforehead subsite was 10, and the most mechanoreceptive insensitive score was 2. Objective thermoceptive scoring was performed in a similar fashion; however, each subsite received only a score of 1 for a correct response and of 0 for an incorrect response. Once added to its respective hemiforehead subsite, the most thermoceptive sensitive score was 2, and the most thermoceptive insensitive score was 0. The subjective VAS scoring was performed on a 5-point scale similar to the objective mechanoreceptive scoring. Lastly, the participant’s response to the question regarding undergoing their respective brow-lift procedure in the future was duly noted.

STATISTICAL ANALYSIS

As the raw data were nonparametric in distribution, all between-group comparisons were made using the Mann-Whitney test, and data were reported as median values with minimum and maximum ranges. $P \leq .05$ was considered statistically significant.

RESULTS

PROSPECTIVE

A total of 21 participants were enrolled at time A and underwent preoperative testing (EBL, $n=11$; OBL, $n=10$). Of these 21 enrolled participants, all 21 completed testing at time B; 16 (EBL, $n=9$; OBL, $n=7$) completed testing at time C; 16 (EBL, $n=10$; OBL, $n=6$) completed testing at time D; and 9 (EBL, $n=4$; OBL, $n=5$) completed the testing at time E. There was no statistically significant difference in sex (100% female for EBL and 90% female for OBL) or age (mean of 57.6 years for EBL and 53.8 years for OBL) distribution between the study groups. Three age-similar and sex-identical (mean of 51.6 years; 100% female) controls completed and underwent the same testing protocols as the study participants. The control group’s respective test results remained completely nor-

Table 1. Prospective Forehead and Scalp Sensation Data^a

Time Group	A (n=21)			B (n=21)			C (n=16)			D (n=16)			E (n=9)			
	Brow Group	EBL (n=11)	OBL (n=10)	P Value	EBL (n=11)	OBL (n=10)	P Value	EBL (n=9)	OBL (n=7)	P Value	EBL (n=10)	OBL (n=6)	P Value	EBL (n=4)	OBL (n=5)	P Value
Objective																
Mechanoceptive																
Mid-FH	10 (10)	10 (10)	>.99	9 (3-10)	8 (4-10)	.80	9 (7-10)	10 (8-10)	.26	10 (10)	10 (9-10)	.20	10 (10)	10 (10)	>.99	
Lat-FH	10 (10)	10 (10)	>.99	9 (6-10)	10 (6-10)	.14	10 (9-10)	10 (9-10)	.70	10 (10)	10 (10)	>.99	10 (10)	10 (10)	>.99	
Scalp	10 (10)	10 (10)	>.99	7 (2-10)	2 (2-8)	.01 ^b	9 (2-10)	4 (2-9)	.02 ^b	10 (9-10)	8.5 (2-10)	.01 ^b	10 (10)	10 (9-10)	.37	
Thermoceptive																
Mid-FH	2 (2)	2 (2)	>.99	2 (0-2)	1.5 (0-2)	.70	2 (1-2)	2 (1-2)	.40	2 (2)	2 (1-2)	.20	2 (2)	2 (2)	>.99	
Lat-FH	2 (2)	2 (2)	>.99	2 (1-2)	2 (1-2)	.54	2 (1-2)	2 (1-2)	.38	2 (2)	2 (2)	>.99	2 (2)	2 (2)	>.99	
Scalp	2 (2)	2 (2)	>.99	1 (0-2)	0 (0)	.01 ^b	2 (0-2)	0 (0-2)	.01 ^b	2 (2)	1 (0-2)	.01 ^b	2 (2)	2 (1-2)	.18	
Subjective																
FH	1 (1)	1 (1)	>.99	3 (2-5)	3 (1-5)	.97	2 (1-4)	3 (1-4)	.70	2 (1-4)	3 (2-4)	.10	1 (1-3)	2 (1-3)	.50	
Scalp	1 (1)	1 (1)	>.99	3 (2-5)	4 (2-5)	.14	3 (2-5)	4 (3-5)	.04 ^b	3 (1-4)	4.5 (2-5)	.05 ^b	2 (1-2)	2 (1-4)	.56	
"Yes" to re-op, %	NA	NA	NA	91	90	.97	100	100	>.99	100	100	>.99	100	100	>.99	

Abbreviations: A, preoperative; B, 1 to 2 weeks; C, 4 to 6 weeks; D, 12 to 14 weeks; E, 24 to 26 weeks; EBL, endoscopic brow-lift; FH, forehead; Lat, lateral; NA, not applicable; OBL, open brow-lift; "Yes" to re-op, reply is "yes" to undergoing brow-lift again.

^aRaw data are listed as median value (minimum and maximum range [single values represent that all patients scored the same]) unless otherwise specified.

^bP values of $\leq .05$ were considered to show statistically significant differences between groups.

mal and consistent throughout the entire testing period (data not shown).

Objective testing data and analysis are presented in **Table 1**. Objective testing at time A revealed no statistically significant difference between study groups, with all participants testing out as completely normal prior to undergoing their respective surgical procedures. At time B, there existed statistically significant differences between the EBL and OBL groups at both the mechanoceptive (EBL, n=7, vs OBL, n=2; $P=.01$) and thermoceptive (EBL, n=1, vs OBL, n=0; $P=.01$) scalp subsites, with the OBL group demonstrating less sensitivity vs the EBL group. No differences were noted between the groups at the 2 forehead subsites. This same trend continued through time points C and D. At time E, the same trend was observed but did not reach statistical significance. All participants' control site objective testing (eg, posterior neck) remained normal throughout the study.

Subjective testing data and analysis are also presented in Table 1. Again, at time A, all participants rated their scalp and forehead sensation as normal¹ on the 5-point VAS scale. While all participants felt numb on both their foreheads (EBL, n=3, vs OBL, n=3; $P=.97$) and scalps (EBL, n=3, vs OBL, n=4; $P=.14$) at time B, statistical analysis did not reveal a significant difference between groups. However, at times C and D, the participants did note a difference in subjective scalp sensation between the groups that reached statistical significance (EBL, n=3, vs OBL, n=4, at time B [$P=.04$]; and EBL, n=2, vs OBL, n=3, at time D [$P=.05$]). At time E, this relationship disappeared with both groups reporting similar levels of sensation for both the forehead (EBL, n=1, vs OBL, n=2; $P=.50$) and scalp (EBL, n=2, vs OBL, n=2; $P=.56$). Regarding the question of undergoing the same procedure again in the context of now having experienced postoperative forehead and scalp sensation changes, no difference was noted between the groups at any data collection point. Almost all participants stated that their

experienced forehead and/or scalp numbness would not keep them from undergoing the procedure again. More specifically, only 1 EBL and 1 OBL participant stated that their experienced numbness would have kept them from undergoing the procedure at time B. These very same patients stated that they experienced numbness would not keep them from doing the procedure again at times C, D, and/or E.

RETROSPECTIVE

A total of 58 participants were enrolled. There was no statistically significant difference in the sex (EBL, 100% female, vs OBL, 91% female) or age (EBL, 59.4 years, vs OBL, 59.3 years) distribution between the study groups. They were then divided into 2 time groups according to the amount of time since undergoing their respective procedures, yielding 26 (EBL, n=16; OBL, n=10) participants in time group F (6-18 months) and 32 (EBL, n=20; OBL, n=12) in time group G (>18 months).

Objective data are given in **Table 2**. When comparing EBL vs OBL at time F, the forehead showed a return to the median values of "normal" sensation for both OBLs and EBLs (mechanoceptive, n=10; thermoceptive, n=2). However, statistical significance was present at both the mechanoceptive (EBL, n=10, vs OBL, n=7; $P<.001$) and thermoceptive (EBL, n=2, vs OBL, n=0; $P=.01$) sensation for the scalp, with the scalp of the OBLs demonstrating less objective sensitivity. This difference disappeared at time G, with groups demonstrating not only no statistical difference in scalp sensation but with both groups having returned to the median values of normal sensation at the forehead and scalp. Again, all retrospective participants' control site testing (eg, posterior neck) tested out as objectively intact and normal.

Subjective data are given in Table 2. At time F, there was a perceptible difference in forehead and scalp sen-

Table 2. Retrospective Forehead and Scalp Sensation Data^a

Time Group	F (n=26)			G (n=32)		
	Brow Group	EBL (n=16)	OBL (n=10)	P Value	EBL (n=20)	OBL (n=12)
Objective						
Mechanoceptive						
Mid-FH, median (range)	10 (10)	10 (10)	>.99	10 (10)	10 (10)	>.99
Lat-FH	10 (10)	10 (10)	>.99	10 (10)	10 (10)	>.99
Scalp	10 (7-10)	7 (2-10)	<.001 ^b	10 (9-10)	10 (6-10)	.25
Thermoceptive						
Mid-FH	2 (2)	2 (2)	>.99	2 (2)	2 (2)	>.99
Lat-FH	2 (2)	2 (2)	>.99	2 (2)	2 (2)	>.99
Scalp	2 (0-2)	1 (0-2)	.01 ^b	2 (0-2)	2 (1-2)	.32
Subjective						
FH	2 (1-3)	1 (1-3)	.02 ^b	1 (1-3)	1 (1-3)	.75
Scalp	2 (1-4)	3 (1-5)	.05 ^b	1 (1-5)	1 (1-4)	.73
"Yes" to re-op, %	100	100	>.99	95	100	.44

Abbreviations: EBL, endoscopic brow-lift; F, 6-18 mo; FH, forehead; G, >18 mo; lat, lateral; OBL, open brow-lift; "Yes" to re-op, reply is "yes" to undergoing brow-lift again.

^aRaw data are listed as median value (minimum and maximum range [single values represent that all patients scored the same]) unless otherwise specified.

^bP values of $\leq .05$ were considered to show statistically significant differences between groups.

sation between the study groups. While the subjective scalp sensation scores continued to show the same trend of the OBLs feeling less sensate than the EBLs (EBL, n=2, vs OBL, n=3; $P = .05$), this pattern reversed regarding the perception of forehead numbness. The EBL patients perceived their foreheads as more numb vs the OBL patients (EBL, n=2, vs OBL, n=1; $P = .02$). At time G, no statistical difference was noted at either the forehead or the scalp, with both groups feeling as though their forehead and scalp sensation had returned to a median value of 1 ("normal"). Finally, almost all individuals regarded that the numbness felt within the context of their respective brow-lift procedure was not significant enough to have kept them from doing the surgery again; in fact, only 1 participant (an EBL patient in time group G) of the 58 retrospectively tested stated that the experienced numbness would have kept her from undergoing the brow-lift again.

COMMENT

An often theorized and anecdotally observed "advantage" of EBL over OBL is that the duration and degree of forehead/scalp discomfort and/or numbness is of a lesser magnitude and duration. This study sought to verify that theory and observation by formalized sensory testing in a group of patients having undergone that procedure by a single surgical clinic unbiased toward either types of brow-lift techniques.

To put our study and/or studies like ours in perspective, the methods chosen for sensory testing must be valid. Endorsed methods of objective and subjective sensory testing were reviewed in the literature. In a recent review article by Poort et al.,² the preferred methods of sensory testing were outlined in specific relation to the testing and reporting of inferior alveolar nerve function after mandibular procedures. The authors divide objective sen-

sory testing into 2 categories—mechanoceptive (2-point discrimination and static light touch) and nociceptive (pain/pin prick sensation and thermal discrimination). The preferred method of mechanceptive testing was Semmes-Weinstein monofilament application for discerning static light-touch sensory abilities; this was the mechanceptive method chosen and used for our study. No nociceptive testing method was endorsed over another by these authors. For our study, we choose the simplicity of thermal discrimination testing with a limited-choice set (eg, "hot"/"cold"). Finally, the most validated method for testing subjective sensation was to use a VAS to question the participant; again, the VAS method was used for subjective testing in our study. This study's chosen objective and subjective methods were easily administered by the examiner and understood by the participants, yielding an unambiguous data set.

Knize³ performed a detailed study of supraorbital nerve (SON) anatomy via cadaveric anatomic dissection and selective nerve blocks in living subjects; he did not specifically study the supratrochlear nerve anatomy. This study revealed 2 consistent findings, regarding the anatomy of this nerve beyond the orbital rim. The superficial-medial division (SMD) of the nerve quickly penetrated the lower frontalis muscle and passed over (superficial to) that muscle for much of its course. This division provided sensation to the forehead and only to the anterior hairline (range, 1.0-3.5 cm) of the scalp in 90% of subjects; in 10% of the subjects, this division was able to provide sensation to the more cephalad and posterior frontoparietal scalp. The deep-lateral division (DLD) of the nerve ran cephalad across the lateral forehead between the galea aponeurotica and the pericranium, providing sensation to the frontoparietal scalp. This division's course and location was consistent in 100% of the subjects studied. Because of these anatomic findings, Knize³ surmised that it was injury to the DLD-SON that

yields most of the scalp numbness and discomfort experienced by patients after undergoing a brow-lift procedure. In a follow-up article, he then made further recommendations for placement of scalp incisions (endoscopic) and dissection plane (SP) during EBL that would place these nerves at less risk.^{4,5} In the context of this study, we also used those incisions recommended by Knize during our EBL for the benefit of preserving the DLD-SON and thereby frontoparietal scalp sensation (Figure 1).

Wolfe and Baird⁶ reviewed their limited experience (27 female patients) with their OBL technique (coronal and trichophytic incisions), which they performed in subcutaneous plane. They performed directed excision of the frontalis, procerus, and/or corrugator muscles as indicated and found that all patients had sensation in their frontoparietal scalp in the immediate postoperative period. While most patients experienced forehead numbness, sensation had returned by 2 to 4 months. In the initial publication, these authors touted this procedure as better for preserving forehead and scalp sensation but later detracted that statement in a later publication by the senior author.⁷ There are also authors who perform their respective EBLs in a SG plane.^{8,9} Though not formally tested, they claim that the nerves are more easily identified and preserved. They also claim that they have experienced no cases of permanent postoperative anesthesia or paresthesia.

Yet another anatomic point was addressed by Janis et al.¹⁰ In this study, 25 cadaver foreheads were dissected for the purpose of delineating the relationship between the SON the corrugator superciliar muscle. They discovered several different patterns, classifying these patterns as I to IV, of nerve-muscle associations. In 78% of specimens, the SON and its branching pattern were intimately associated with the muscle and at risk during corrugator manipulation and/or resection; furthermore, 74% DLD-SONs were associated with the muscle. In 22%, they found that DLD and/or SMD branching occurred cephalad to the muscle, decreasing the risk to the nerve on dissection of the corrugators. The authors, again, did not address the supratrochlear nerve and its relationship to the brow musculature. Nonetheless, it is well established that the supratrochlear nerve is often intimately associated with the medial aspect of the corrugators, as well as the portions of the procerus and orbicularis oculi muscles; this nerve also traverses a very similar course to the SMD-SON, penetrating the frontalis and moving cephalad in a subcutaneous plain. Thus, the authors deduced that the sensation of the forehead and scalp was at increased risk of harm during brow-lift procedures that divided and/or manipulated the corrugator musculature. In our study, in all OBLs and EBLs efforts were made to partially resect the corrugator musculature while preserving all branches of the SON and supratrochlear nerves.

In an effort to discern outside surgeon opinions on brow-lift techniques, Elkwood et al¹¹ surveyed 3800 plastic surgeons (15% response rate) regarding their use of EBL vs OBL. Approximately 50% of the brow-lifts performed were OBLs and approximately 50% were EBLs. Participants were asked to estimate the amount of per-

manent sensory loss to the forehead and scalp seen within their patient populations with respect to EBL vs OBL. Surprisingly, the EBL group had a slightly higher estimated incidence of permanent sensory loss (0.57%) compared with that of the OBL group (0.07%) among those returning surveys. Thus, this observation is in contrast to the proposed benefit of EBL. It should be stated that the estimated satisfaction rate among patients remained very high (>98%) for both procedures.

Cilento and Johnson¹² retrospectively reviewed the clinical records of 1004 OBLs (628 coronal; 376 trichophytic) performed by the senior author (no EBLs performed by the senior author); surgical dissection plane was SG. They then sent questionnaires to those individuals regarding the procedure, attaining a 64.0% (416 of 650) adjusted-response rate. A portion of the aforementioned questionnaire addressed the perceived duration of forehead sensation. Those questioned were asked to complete the statement, "I had all of the feeling back in my forehead in [blank]." Choice options ranged from 2 months to 8 months (at 2-month intervals); participants were given a "never" choice option as well. The most common response was 4 months (47.4%); 6 months was next (29.4%), yielding 76.8% of participants with subjective normal forehead sensation somewhere between 4 and 6 months after surgery. Even so, 3.1% either answered ">8 months" or "never." Importantly, participant outcome satisfaction rate was 99.5% with their respective OBL. An additional and enlightening aspect of this study focused on the relationship of a procedure's respective description to the actual choice of procedure made by the individual to whom it was described (description bias). They surveyed approximately 400 semirandomly selected individuals. Half were surveyed using a survey tool biased toward the traditional OBL method and the other half using a survey tool biased toward the EBL method. Of those surveyed, 89% choose the traditional OBL if the survey was biased toward that procedure; whereas, 82% choose the EBL if that survey was biased toward that procedure. It must be stated that no EBL procedures or participants were included in this study's analysis. All sensory testing was retrospective and subjective in nature. Those questioned were not specifically asked to quantify the amount of feeling that had or had not returned nor were asked to differentiate between the forehead and scalp subsites.

Behmand and Guyuron¹³ retrospectively reviewed 100 cases of SP EBL performed in their practice with an average follow-up of 44 months. While they found that the EBL procedure itself demonstrated durability and satisfied the patient, 50% of the patients experienced some degree of postoperative anesthesia and/or paresthesia (41% within the supratrochlear nerve distribution and 9% within the supraorbital nerve distribution). Some patient's scalp or forehead sensation abnormalities lasted longer than 1 year (5%). Like the study by Cilento and Johnson,¹² all sensory testing was retrospective and subjective in nature. Those questioned were not specifically asked to quantify the amount of feeling that had or had not returned nor were asked to differentiate between the forehead and scalp subsites.

Some strengths of this study relate to its unique setting and subsequent rigorous design. All participants underwent their respective brow-lift procedure as prescribed by the study's senior author (D.E.R.) and/or his fellow. This author-surgeon is equally comfortable with each brow-lift method and believes each method owns value in the properly selected patient. The sensory testing protocol was performed by the same examiner (J.M.G.) each and every time; also that examiner was not the operating surgeon in almost all of those tested. Lastly, the objective sensory testing method (Semmes-Weinstein monofilaments and thermal discrimination) and subjective testing method (VAS) were/are a validated and recommended manner of performing said sensory testing.

In light of the studies by Knize,^{3,5} an issue that must be addressed regarding the results of this study and the topic of forehead-scalp sensation after brow-lift is the surgical dissection plane used for each procedure. In this study and as previously alluded to, all OBL methods were in a SG plane medial to the temporal line. All EBLs were in a SP plane medial to the temporal line. Both were in the same subtemporoparietal facial (sub-TPF) plane lateral to the temporal line. Thus, the temporal dissections for all of the procedures performed in this study were in the same plane (between the TPF and the deep layer of temporalis fascia), while the medial dissection was performed in different planes (either SP or SG). Despite this difference and in light of the anatomic dissection performed by Knize,^{4,5} the surgical plane that would put the DLD-SON at most risk would be the SG dissection plane, with the SP plane being most likely to preserve that branch of the nerve. Therefore, the OBL (with its longer incisions) and the SG plane (with the DLD-SON coursing in this surgical plane) would put the nerve at most risk of injury. A similar study performed by those practitioners who perform their EBL procedures in a SG plane or who perform their OBL procedures in a SP plane would be interesting and provide further information about whether it is the incision(s) or the plane of dissection that is more important in preserving sensation to the forehead and frontoparietal scalp.

Some may view our lack of focused testing of the supratrochlear nerve sensation vs the SON sensation as a weakness. We submit that this would be technically difficult to do reliably, and even so, it would have provided limited practical information. In light of the both the supraorbital and supratrochlear nerves intimate relationship with the corrugators muscles, an interesting area of further study may be to compare individuals who have corrugator manipulation and those who do not as part of their planned brow-lift. Also to be mentioned, most participants in our study were female (96.2%); nonetheless, it is deemed reasonable to extrapolate these results to an age-similar male patient population.

CONCLUSIONS

We observed that 1 to 2 weeks after OBL or EBL, all individuals will experience significant subjective and objective numbness of both their forehead and scalp. Even

so, the scalps of those undergoing OBL are objectively more insensate than of those undergoing EBL. Despite this objective difference, those undergoing OBL did not necessarily feel more forehead or scalp numbness than those in the EBL group.

At both 4 to 6 weeks and 12 to 14 weeks (approximately 3 months) after brow-lift, the same observations were made in both groups. While the objective and subjective forehead sensation values were returning to near preoperative values, the scalps of the OBL group were substantially more insensate in both the objective and subjective sense vs the scalps of the EBL group.

In those prospectively enrolled at 24 to 26 weeks (approximately 6 months), no objective or subjective differences between the forehead and/or scalp were observed. However, this time group had a significant attrition rate, with only 4 of the initial EBLs (4 of 11; 54.5% dropout) and only 5 of the initial OBLs (5 of 10; 50% dropout) completing testing.

In those retrospectively enrolled at 6 to 18 months, an objective and subjective difference was observed, with the scalps of the OBLs demonstrating less sensitivity vs those of the EBLs. Interestingly, the EBL group subjectively felt that their foreheads were more insensate at this time interval vs those of the OBLs group who had test results that returned to a normal median value. The reason for the increased (subjective) forehead numbness in the EBL group may reflect a more aggressive method of corrugator resection performed as part of the EBL technique.

In the groups retrospectively enrolled and tested at more than 18 months after surgery, no statistically significant differences were observed between groups and sensory subsites, with both groups having returned to normal median values in all objective and subjective categories. Nonetheless, there were several practical and clinically significant observations in this group. It was interesting to note that there were several individuals whose objective scalp testing result had not returned to completely normal at more than 18 months after surgery (EBL, 5% vs OBL, 25%); yet, 100% of foreheads tested had returned to a normal median value. Furthermore, there were some individuals in both the EBL (35%) and OBL (33.3%) groups who did not subjectively feel as though their forehead and/or their scalp sensation had returned to normal at more than 18 months after brow-lift.

We therefore reject the null hypothesis and state that there is a measurable, statistically significant difference between the EBL and OBL techniques regarding postoperative forehead and scalp sensation and that those observed differences are objective and subjective in nature as well as time dependent. Even so, almost no patients, irrespective of the technique used for their brow-lift, viewed their experienced forehead and/or scalp numbness to have been significant enough to deter them from undergoing the surgery again. Lastly, these conclusions must be viewed within the context of the surgical techniques performed (EBL in a SP plane vs OBL in the SG plane), the population studied (predominately women in their sixth decade of life), and the testing method used (eg, Semmes-Weinstein monofilaments).

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Correspondence: Jason M. Guillot, MD, South Louisiana ENT, Facial Plastic & Hair Restoration, 7043 Hwy 190, Ste C, Covington, LA 70433 (jasonmguillot@hotmail.com).

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