Endoscopic Brow Lift: Objective Results After 1 Year

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Background: The endoscopic brow lift procedure is gaining acceptance as an effective aesthetic procedure. Although several authors have described their techniques, none have objectively quantified their result at 1-year follow-up.
Objective: The purpose of this study was to objectively evaluate the outcome after an endoscopic brow lift with a minimum of 1 year follow-up.
Methods: The amount of brow elevation at three points along the brow, the outcome of corrugator ablation, changes in corrugator and frontalis furrows, sensory changes, temporal branch function, and patient satisfaction in 20 consecutive patients were evaluated. The average time at follow-up was 15 months, with a range of 12 to 23 months.
Results: The brow at the lateral canthus was elevated 2.1 ± 2.8 mm ($P < .001$*), 1.9 ± 2.5 mm (*$P < .001$*) at the lateral limbus, and 2.4 ± 3.0 mm (*$P < .001$*) at the medial canthus. The frontalis furrows improved significantly (*$P = .002$*). Eighty-five percent of the patients had normal sensation, and 15% had abnormal sensation. Seventy-five percent had no alopecia or scarring, and 25% had small areas of spot alopecia and scarring. No patients had a temporal branch nerve injury.*
Conclusions: This study confirms that the endoscopic brow lift procedure is effective and that the results can be objectively quantified at 1-year postoperative follow-up. The procedure had complications including spot alopecia and some sensory changes persistent at 1 year. A high (95%) patient satisfaction rate was noted in our study.

The endoscopic brow lift is gaining acceptance as a method of elevating the brow without the morbidity of a bicoronal incision.[1] The coronal brow lift has been criticized for the length of the incision, neurosensory changes, scarring, and alopecia. By limiting the incision length, scarring and sensory changes are minimized with the endoscopic approach.[2] Although several authors[3-5] have described their techniques, none have objectively quantified their result at 1-year follow-up.

Our primary goal was to determine how much eyebrow lift along three areas—lateral canthus, lateral limbus, and the medial canthus—could be objectively documented at 1 year after an endoscopic brow lift. Additionally we wanted to determine the outcome of corrugator ablation, corrugator and frontalis furrows, sensory changes, temporal branch function, and patient satisfaction at 1-year follow-up.

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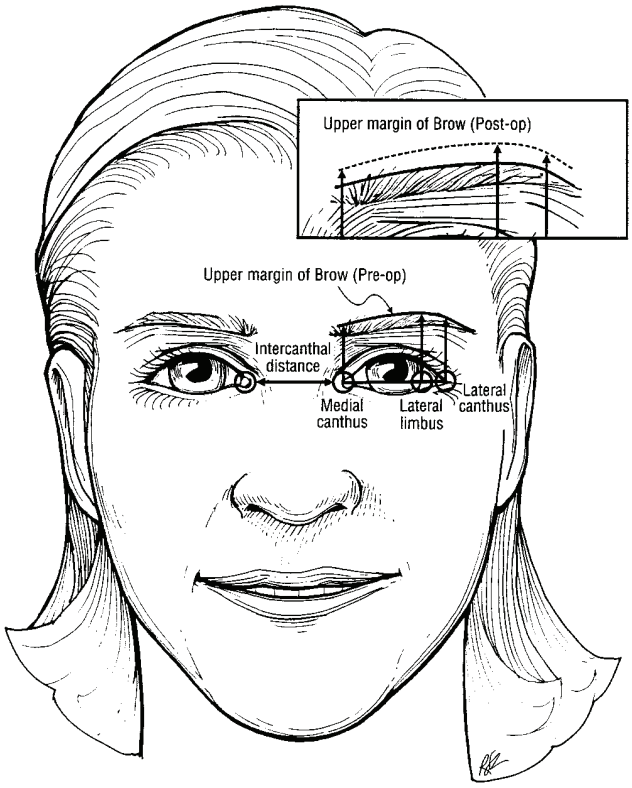

Figure. *Diagram of brow height measurements. Illustration by Richard S. LaRocco.*

Material and Methods

Physicians

The endoscopic procedures were performed during a 12-month period between October 1994 and September 1995. To be included in the endoscopic brow lift study, the surgeon must have performed at least 10 endoscopic brow lift procedures before operating on the study patient, be board eligible in plastic surgery, have taken an endoscopic brow lift course, have used the same operative plane of dissection and fixation technique, and have agreed to an independent postoperative evaluation. Five surgeons were included in the study. One surgeon performed 12 of the 20 procedures, and 4 surgeons performed the remaining 8 procedures.

Patients

Twenty patients were drawn from consecutive operations during the study time period from October 1994 to September 1995. The criteria for patient inclusion were the following: availability for at least 1 year follow-up, having had no prior brow lift surgery, living within a 30-mile radius of New York City, having had no lateral canthoplasty, and agreeing to be included in the study. The average follow-up was 15.9 months, and the range was 12 to 23 months.

Table 1. Concomitant procedures in 20 patients undergoing endoscopic brow lift

10 face lifts
7 face lifts and blepharoplasty
1 lower blepharoplasty
2 endoscopic brow lift procedure only

The average patient age was 54 (range 30 to 73 years, Table 1). There were 20 patients: 19 women and 1 man. Ten patients underwent concomitant face lifts, and 7 underwent face lift with blepharoplasty. One patient underwent concomitant lower blepharoplasty and 2 underwent only the endoscopic brow lift. All surgery was performed at Manhattan Eye, Ear and Throat Hospital, New York, NY. The endoscopic equipment used was manufactured by Snowden Pencer (Tucker, Ga).

Surgical Technique

During the study period, all surgical procedures in this outcome study were performed the same way. A 2-cm transverse midline incision was made 1.5 cm posterior to the hairline. The lateral incisions were sagittal and 2 cm in length, at 4 cm and 7.5 cm from the midline. The plane of dissection was subgaleal down to the corrugator muscles. Resection of all visible corrugator muscles was performed with preservation of the supratrochlear and supraorbital nerves. A subperiosteal dissection was performed laterally to release the temporal fusion line. The brow was then elevated. Fixation was achieved at the 4-cm and 7-cm sagittal incision site using 2-mm cortical titanium miniscrews and staples posterior to the screws. The screws were removed at 10 to 14 days after surgery.

Follow-up Examination

The follow-up examination was conducted at the Manhattan Eye, Ear and Throat Hospital by a plastic surgeon who had not participated in the surgical procedures. Corrugator and frontalis function were graded as minimal, moderate, or hyperactive when evaluated with maximum contraction. Corrugator and frontalis furrows were graded as minimal, moderate, or severe when evaluated in repose.

Sensation was tested in the distribution of the supratrochlear and supraorbital nerves, as well as in the scalp

Table 2. Preoperative and postoperative changes in brow height (n = 40 brows)

Brow location	Lateral canthus	Lateral limbus	Medial canthus
Elevation ± SD	2.1 ± 2.8 mm	1.9 ± 2.5 mm	2.4 ± 3.0 mm
Preoperative mean ± SD	22.3 ± 4.0	23.7 ± 3.4	19.6 ± 2.8
Postoperative mean ± SD	24.4 ± 3.6	25.6 ± 2.9	22.0 ± 2.8
P value	<.001	<.001	<.001
t test	4.7	4.9	5.2

SD, Standard deviation.

Table 3. Comparison of endobrow patients with upper blepharoplasty versus all others in study

Brow location	Lateral canthus	Lateral limbus	Medial canthus
Upper blepharoplasty subgroup (*n* = 10 brows)	1.7 ± 3.4 mm	1.4 ± 3.3 mm	1.8 ± 3.3 mm
All other endobrow patients (*n* = 30 brows)	2.2 ± 2.1 mm	2.1 ± 1.9 mm	2.6 ± 2.7 mm
Average difference between upper blepharoplasty and all other endobrow patients	0.5 mm	0.7 mm	0.8 mm
P value	.97	.8	.7

(the deep division of the supraorbital nerve). The patient was asked to describe the sensation of moving, light touch as normal or abnormal. If the sensation was reported as abnormal, evidence of neuroma formation was tested by use of Tinel's sign or point tenderness.

The incision sites were examined for scar hypertrophy, widening, and alopecia. Patients were asked to describe their results as excellent, good, fair, or poor.

Photographic Analysis

The same photographic studio took all of the preoperative and postoperative photographs. All measurement analyses were performed on one-to-one, life-size photographs. Brow height, brow shape, corrugator and frontalis furrows, asymmetry, and postoperative aesthetic improvement were measured. After all measurements were completed in a randomized method by the evaluator, the evaluator was asked to compare the patients' aesthetic appearance.

Brow height was evaluated by measuring the vertical distance to the top of the eyebrow at the lateral canthus, lateral limbus, and medial canthus, along a line connecting the medial and lateral canthi (Figure). The medial and lateral canthal insertions are fixed points, not changed by brow or eyelid procedures. The change in preoperative and postoperative brow height was calculated at these 3 points for both the right and left brows (n = 40). Five patients who did not undergo a brow procedure were evaluated with preoperative and postoperative photographs and were used as a control against measurement error, photographic error, and evaluator error.

The analysis was completed by randomizing the preoperative and postoperative photographs of all 25 patients—20 study patients (n = 40 brows), and 5 control subjects (n = 10 control brows). The intercanthal distance was measured as a control for preoperative and postoperative photographic measurement error. Statistical significance for each of the comparisons made in Table 2 was determined by use of the paired *t* test (preoperative versus postoperative) analysis. The alpha level was set at a conservative level of 0.005 throughout to adjust for multiple comparisons. The actual *P* values are given. Rather than using a *P* value for "change in controls vs change in surgery patients," a *P* value for "change in surgery patients vs 0 [zero]" was used; this decision was made because in some instances the change in controls was zero with no standard deviation. Control subjects were used to monitor for certain measurement errors, such as adjustment over time. No statistically significant change was seen in any of the control measurements. Statistical analysis for the comparisons made in Table 3 between the upper blepharoplasty subgroup and all other patients

undergoing endoscopic brow lift in the study was determined by use of the nonparametric Mann-Whitney test, because the standard deviations were so large. The nonparametric comparisons, forehead and eyebrow furrows, brow shape, and brow asymmetry were analyzed by use of the Wilcoxon paired rank test.

Results

A total of 50 brows (20 study patients and 5 control subjects) were evaluated. At the postprocedure evaluation, an overall increase in brow height was found when the position on the brow at the lateral canthus, lateral limbus, and medial canthus was compared in the preoperative and postoperative photographs (Table 2). The brow at the lateral canthus was elevated 2.1 ± 2.8 mm ($P < .001$), and the lateral limbus was elevated 1.9 ± 2.5 mm ($P < .001$). The brow at the medial canthus was elevated the most at 2.4 ± 3.0 mm ($P < .001$). No significant change was found in the intercanthal distance when the preoperative and postoperative photographs were compared by use of the paired *t* test analysis ($P < .04$). Thus the intercanthal distance functioned as a control for the preoperative and postoperative photographic measurements.

A comparison was made between the 5 patients in the upper blepharoplasty subgroup and the other 15 patients in the endobrow study. The patients in the upper blepharoplasty subgroup had less brow height elevation. The greatest difference in brow height elevation occurred at the medial canthus at 0.8 mm and the lateral limbus at 0.7 mm. The differences, however, were not statistically different, given that the blepharoplasty subgroup had only 5 patients.

The frontalis furrows improved significantly ($P = .002$) when the preoperative and postoperative photographs were analyzed. Six patients with obvious furrows on preoperative photographs had some (n = 4) or minimal (n = 2) furrows on the postoperative photographs. Five patients with "some" visible furrows in repose on preoperative photographs improved after endoscopic brow lift. Eight patients with either some or minimal furrows on preoperative photographs were unchanged when compared with their postoperative photographs. Only 1 patient with minimal furrows before surgery was found to have "some" furrows on postoperative photographs at 22 months follow-up.

The changes in corrugator furrows, brow shape, and brow asymmetry were not found to be statistically significant when the preoperative and postoperative photographs were compared with control subjects ($P = .009$, $P = .2$, and $P = .6$, respectively). Examination of the patients after surgery revealed that 13 (65%) had moderate corrugator function and seven (35%) had minimal corrugator function. No patients had hyperactive or severe function of the corrugators.

The frontalis function remained intact, with 18 (90%) of the patients having moderate function when asked to wrinkle the brow. Two (10%) patients had minimal function. After surgery the study patients' foreheads were inspected for furrows while in repose. Nineteen (95%) patients were found to have minimal corrugator furrows, and only one (5%) patient had moderate furrows. Examination for frontalis furrows revealed that 18 (90%) of the patients had minimal furrows and 2 (10%) had moderate furrows.

With respect to forehead and scalp sensation, 17 (85%) of the 20 patients studied reported normal sensation at least 1 year after surgery. Three patients (15%) reported abnormal sensation. One patient reported that the top of her head was numb at 15 months follow-up. Another patient reported a decrease in sensation in the right supraorbital nerve distribution at 17 months follow-up. The third patient reported abnormal forehead sensation with a decreased sensation in the supraorbital nerve distribution bilaterally. No patient reported hypersensitivity or neuroma in either the supraorbital or supratrochlear nerve distributions.

Examination of the patients' scalps revealed that 15 (75%) had no alopecia or scarring, although 5 (25%) of the study patients had small areas of alopecia or scarring. Five patients had alopecia at the screw fixation or scalp incision sites that ranged between 5 × 5 mm and 8 × 6 mm. One patient had a 5 × 5-mm area of alopecia at the right screw fixation site. Another patient had bilateral 5 × 5-mm areas of alopecia at the screw fixation sites. A third patient had a 7 × 7-mm area of alopecia at the right paramedian incision site, whereas a fourth patient had an 8 × 6-mm area of alopecia at the right paramedian incision site. The fifth patient had 3 areas of alopecia measuring 5 × 5 mm at the right paramedian incision, as well as the screw fixation sites. None of the 5 patients reported a change in hairstyle as a result of these areas of alopecia.

At 23 months follow-up, 1 patient had no alopecia and no widened scar. Although she did have a palpable titanium miniscrew over which the scalp grew, she reported

that it did not bother her and declined to have it removed. No patient had a temporal branch nerve injury.

A high (95%) rate of patient satisfaction was noted in our study. Thirteen patients (65%) reported their level of satisfaction with the endoscopic brow lift as excellent. Six patients (30%) reported their level of satisfaction as good. Only 1 patient (5%) reported a fair result, and no patient reported a poor result.

Discussion

Since the advent of the endoscopic brow lift procedure, the question "Does it really work?" has been posed. Answering this question was our goal. We found that the endoscopic brow lift procedure does measurably and reliably lift the brow. Data from objective photographic analysis and objective physical examinations were analyzed. The mean elevations at the lateral canthus, lateral limbus, and medial canthus were 2.1 mm, 1.9 mm, and 2.4 mm, respectively. All of the patients and their photographs were analyzed at follow-up 1 year or more after the procedure. A high (95%) patient satisfaction rate was found for this minimally invasive procedure.

Hamas and Rohrich[6] reported their endoscopic brow lift experience using direct suture fixation with an average follow-up of 9 months. They found that eyebrow elevation at the midpupil ranged from 3 to 6 mm only in their later study patients, when they had begun to quantify the preoperative and postoperative eyebrow positions. Daniel[7] found that the medial brow was elevated 2 mm after corrugator-procerus muscle resection as a result of the unopposed frontalis muscle.

In our study, no patients had the "surprised" look that has been cited as an unfavorable aesthetic result of the coronal brow lift. The postoperative shape of the brow was not found to be statistically different from the preoperative shape. Nevertheless, the medial brow was elevated the most, followed by the lateral brow. The least elevated area was the lateral limbus. This type of elevation tended to flatten the brow, which may not be the most aesthetically desirable shape. Freund and Nolan[8] found in their study of brow shapes that both cosmetic surgeons and cosmetologists preferred the medial brow at the orbital rim to have an apex lateral slant. Brow lift surgery does not usually produce this result. The authors found that the eyebrows are frequently placed too high relative to the preferences of cosmetic surgeons and cosmetologists. The shape is frequently changed from an apex lateral slant to the less desirable flat or apex medial slant. The endoscopic technique lifted the brow; however, the brow shape does not always become the aesthetically ideal shape. The finding in this study, that the medial brow is elevated more than the lateral brow, has led us to attempt new methods of lateral brow elevation and fixation (discussed below).

There were no injuries to the frontal branch of the facial nerves in our study series. The endoscopic brow lift with microscrew fixation is not without its own minor complications, as our series demonstrates. Alopecia occurred in 25% of our patients, but the areas were small (5 to 8 mm) and were usually at the screw fixation sites. Daniel and Tirkanits[3] reported a 15% transitory alopecia around the screws, which they believed to be avoidable by not using a fine tip cautery to complete the incisions. It seemed more likely, in our analysis, that the alopecia is caused by pressure necrosis of the hair follicles during the endoscopic procedure or by the screw and staple fixation. Since the time of this study, the authors have changed their method of galeal fixation. The screw-and-staple method has been abandoned. The brow is now elevated by use of nonabsorbable suture fixation of the galea to tunnels drilled into the outer table of the calvarium. Based on my observations since adopting this technique, the brow elevation and longevity have increased and the incidence of spot alopecia has decreased. As with face lift procedures, there is some relapse with the endoscopic brow lift. Because the greatest relapse in the endoscopic brow lift is at the lateral brow, the senior author recommends pulling the lateral brow maximally before fixation and resecting the corrugator and procerus muscles. Additionally, widely releasing the scalp posterolaterally and over the temporalis muscle contributes to brow elevation. The surgeon must judge the brow contour and symmetry when adjusting the position of the medial brow.

When planning an endoscopic brow lift concomitant with an upper blepharoplasty, elevate the eyebrow in the correct position first and then mark the excess upper eyelid skin to be resected. The upper blepharoplasty is performed first because it is difficult to judge the amount of upper eyelid skin to resect once the forehead becomes edematous. Patients in the study who had both endoscopic brow lift and upper blepharoplasty had less brow elevation laterally, which is most likely due to eyelid skin excision.

Three of the patients in the study reported sensory changes after surgery. One complained of numbness at the top of the head. This may have been caused by injury

to the deep division of the supraorbital nerve that runs across the lateral forehead between the galea aponeurotica and the pericranium as the sensory nerve to the frontoparietal scalp.[9] Perhaps the sensation to the deep division of the supraorbital nerve can be preserved in the endobrow technique following Knize's[9] suggestions. The temporal fusion and superior temporal lines can be marked before surgery, as well as the approximate course of the deep division on the forehead skin. Lateral dissection could be performed in the subperiosteal plane to preserve the deep division, which runs between the galea and the pericranium.[9]

Lorenc et al[2] reported neurosensory preservation in 10 consecutive patients who underwent endoscopic brow lift. The patients had preserved 4- to 5-mm static two-point discrimination. Isse[4] reported postoperative numbness lasting 1 month in 2 of the 61 patients in his subperiosteal endoscopic brow lift series. Connell et al[10] reported their experience with scalp sensory changes after coronal forehead lifts. They reported that unusual scalp sensations and intense itching occur about 3 to 6 months after surgery but are usually gone after 6 to 9 months. Occasionally there may be a feeling of forehead tightness that persists as long as 12 to 18 months, which Connell et al[10] attribute to regenerating sensory nerves.

In spite of magnification and illumination with the endoscope, subtotal resection of the corrugator muscles resulted in incomplete ablation. This finding, however, is consistent with the experience of Daniel and Tirkanits:[3] "A careful review of muscle function following subperiosteal origin resection demonstrated greater retained movement than with the classic coronal approach done by experts." Hamas[11] reports his experience with endoscopic brow lifts and improvement of glabellar furrows (ie, corrugator furrows) with 35 patients. He found in his series that even with aggressive resection of the corrugator muscle, 20% of subconscious frowning expressions remained. One would expect less of this if the corrugators were only released or divided. Conscious frowning when using maximal effort was reduced to about 50% (range 20% to 100%). These numbers were determined by having patients look into the mirror and compare their postoperative results to their preoperative photographs.

Comparing preoperative and postoperative photographs, it was noted that the frontalis furrows improved significantly, but the corrugator furrows did not. This can be attributed, perhaps, to the fact that the corrugator muscle function remained after surgery and continued to produce the furrows. With brow elevation there may be less of a tendency to either consciously or unconsciously raise the eyebrows, whereas squinting and other activity that contracts the corrugators is not influenced by the change in brow position.

Conclusions

Surgical procedures undergo a process of evolution over time. This study was a retrospective analysis of the outcome of a particular surgical technique used approximately 1 year after the endoscopic brow lift technique was first introduced at our institution. The analysis has helped us to objectively evaluate the strengths and shortcomings of our surgical technique. We have used this information to improve on a technique that was proven to be effective with a high rate of patient satisfaction. ■

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