A Review of 13 Years of Experience With Endoscopic Forehead-lift

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Objective: To conduct objective quantitative and qualitative evaluations of the long-term result in endoscopic forehead-lift.

Methods: Medical charts of 143 patients who underwent endoscopic forehead-lift between 1994 and 2007 were reviewed for postoperative complications and the duration of complaints. Patients received a questionnaire to evaluate satisfaction and social restriction after surgery. Objective photographic preoperative and postoperative eyebrow-to-eye distances in a relaxed position and during muscle contractions were obtained.

Results: A total of 98 patients (69% response; mean follow-up, 38 months) showed high satisfaction (score, 7.1 of 10). In a relaxed position, mean midpupil-to-eyebrow elevation was 5.6 mm after surgery, with significant eyebrow symmetry between the left and right eyes ($P<.05$), and showed significant influence of time ($P=.005$) on persisting eyebrow elevation, with a decrease of almost 1 mm per year. Measurements during muscle contraction showed no relevant differences.

Conclusion: Endoscopic forehead-lift enables long-lasting results with highly satisfied patients.

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IN 1992, THE ENDOSCOPIC FOREHEAD-lift was introduced by Isse1 as an alternative procedure to the commonly performed coronal forehead-lift and gained widespread popularity in facial rejuvenation.2,3 Clinical indications, advantages, and limitations of both approaches are well known,2,4,5 but recent reports suggest that results of endoscopic forehead-lifts are superior to coronal lifts.6-14 Most studies present the surgeons’ personal experience by reviewing their series and complications.1,14-19 Only a few authors quantify their long-term results by comparing ratios8 of the coronal approach with those of the endoscopic lift as well as specific singular measurements from the brow to the eye.3,6,7,12,20 Currently, only limited data are available regarding the statistically significant influence of time on eyebrow elevation as well as long-term follow-up studies after endoscopic forehead-lift.6,7

Since 1994, the endoscopic forehead-lift has been performed by our department. We review 13 years of experience with endoscopic forehead-lift and propose a quantitative and qualitative assessment of long-term results with clinical and photographic examination as well as a patient questionnaire evaluation.

Methods

The examination was designed as a retrospective study at the Department of Plastic Surgery and Hand Surgery, University Hospital rechts der Isar, Munich Technical University, Munich, Germany, by reviewing the medical records of 143 patients who underwent endoscopic forehead-lift between 1994 and 2007 without any concomitant procedure. All medical charts were reviewed for postoperative complications and the duration of complaints (eg, hematoma, swelling, pain, alopecia, itching). Patients’ satisfaction with the long-term results was evaluated through questionnaires. Patients were requested in written form to participate in our study, and the questionnaires were mailed to them. In addition, all patients were asked to undergo a photographic examination after surgery. Patients received a number to guarantee that survey responses were anonymous and to differentiate responders from nonresponders. Nonresponders were contacted twice by telephone and received a second identical copy of the questionnaires to maximize the response rate. All patients gave their written informed consent to participate in the study in accordance with the guidelines of the Munich Technical University.
SURGICAL TECHNIQUE

Surgical access is obtained through 4 to 6 incisions of 1 cm in length, placed 2 cm behind the hairline, with the patient under general anesthesia. Two incisions are placed in a parmedian plane, and 2 further incisions are made in the parietotemporal region. If necessary, 2 further incisions are made in the temporal region to obtain additional surgical access. Through the incisions, the subperiosteal plane of dissection is reached, and a blind dissection with periosteal release is performed. Under direct visualization, the subperiosteal dissection down to the supraorbital rim is carried out with the dissector using a standard Karl Storz 4-mm endoscope with a 30° angle (Karl Storz GmbH & Co KG). After identification of the supraorbital and the supratrochlear nerves, the corrugator and the procerus muscles are removed carefully with forceps or scissors. The dissected scalp is then carefully and symmetrically repositioned. The new positioned forehead is then anchored to the outer table of the cranium with a 16-mm Leibinger endoscopic brow-lift screw (Stryker Leibinger Corp). All incision sites are closed with staples. At the end of the procedure, compression with bandages is applied. Usually, no coagulation or drainages are needed. All screws and staples are removed after 7 days.

PATIENT QUESTIONNAIRE

The questionnaire consisted of 18 questions concerning epidemiologic data, patient’s postoperative social behavior/restriction and satisfaction. A score system from 0 to 10 was used to assess patient’s satisfaction after surgery, with 10 expressing excellent and 0 poor results.

PHOTOGRAPHIC EVALUATION

Three frontal pictures were taken preoperatively and postoperatively for each patient (Figure 1), 1 in a relaxed position and 2 during facial muscle contraction (one picture was taken while elevating the eyebrows and a second one while frowning) using a Sony Digital Handycam DCR-VX2000E (Sony Corporation). For the evaluation of persisting eyebrow elevation, the following perpendicular eyebrow-to-eye distances in millimeters were recorded from each picture (Figure 2, lines 1-7):

- From the top of the eyebrow to the medial canthus (lines 3 and 4),
- From the midpupils (lines 2 and 5), and
- From the lateral canthus (lines 1 and 6).

In addition, the horizontal distance between the eyebrows was measured (line 7). The distance between the eyebrows was measured (line 7). Distances on the photographs were measured with Jasc Paint Shop Pro 7 (Jasc Software Inc). To convert measured data into real metric values (millimeters) and to avoid different scales of preoperative and postoperative photographs, 3 conversion steps were taken. First, all postoperative photographs were digitally zoomed to the size of the previously scanned preoperative photographs to obtain the same scale. Second, every patient was photographed postoperatively with a ruler positioned beside the lateral eyebrow. And third, the distance between the pupils was measured on the patient. Through converting ratios, reliable data in millimeters were obtained for each individual patient. Finally, the differences between postoperative and preoperative measurements of each distance were calculated. To obtain long-term results, only measurements from patients after a follow-up period of at least 24 months were included.

STATISTICAL ANALYSIS

Mean values and standard deviations were calculated for all eyebrow-to-eye distance measurements. Least-squares linear regression was applied to evaluate persisting eyebrow elevation and eyebrow distance between the eyes. The time after the surgical procedure was considered as an influence variable. The Wald test was used for testing the time effect. The symmetry of the left and right side was assessed by the Wilcoxon test. All tests were 2-sided, with a global significance level of $P < .05$. Analyses were performed with SPSS version 11.5 (SPSS Inc) statistical software.

RESULTS

CLINICAL AND QUESTIONNAIRE EVALUATION

Of 143 patients, 98 (response rate, 69%) returned a completed questionnaire and were included in the study. Ninety-four patients (96%) were female (mean [range] age, 60 [31-79] years) and 4 (4%) were male (mean [range] age, 65 [62-68] years), with a mean follow-up time of 38 months (range, 9-108 months).

Within the first 4 postoperative weeks, most of the patients complained of pain, hematoma, or swelling. These concerns were mostly transient, and full recovery was generally obtained within 5 to 8 weeks (Table 1). Other concerns like numbness were less common, but if present, these complaints were present longer (Table 1 and...
Table 1. Overview of Early Complications 1 to 4 Weeks and 5 to 8 Weeks After Surgery in 98 Included Study Patients

<table>
<thead>
<tr>
<th>Complication</th>
<th>Early Complications, No. (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1-4 wk After Surgery</td>
</tr>
<tr>
<td>Pain</td>
<td>74 (76)</td>
</tr>
<tr>
<td>Hematoma</td>
<td>73 (75)</td>
</tr>
<tr>
<td>Swelling</td>
<td>81 (83)</td>
</tr>
<tr>
<td>Forehead paralysis</td>
<td>36 (37)</td>
</tr>
<tr>
<td>Numbness, scar</td>
<td>68 (69)</td>
</tr>
<tr>
<td>Numbness, forehead</td>
<td>44 (45)</td>
</tr>
</tbody>
</table>

Table 2. Overview of Late Complication 3 to 6 Months and More Than 6 Months After Surgery of 98 Included Study Patients

<table>
<thead>
<tr>
<th>Complication</th>
<th>Late Complications, No. (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3-6 mo After Surgery</td>
</tr>
<tr>
<td>Alopecia, scar</td>
<td>48 (49)</td>
</tr>
<tr>
<td>Pruritus</td>
<td>50 (51)</td>
</tr>
<tr>
<td>Numbness, scar</td>
<td>68 (69)</td>
</tr>
<tr>
<td>Numbness, forehead</td>
<td>44 (45)</td>
</tr>
<tr>
<td>Eyebrow overlifting</td>
<td>14 (14)</td>
</tr>
<tr>
<td>Unaesthetic scar</td>
<td>30 (31)</td>
</tr>
</tbody>
</table>

Table 2). After 2 months, the most frequently reported complaints were alopecia, numbness, and itching (Table 2). If patients were concerned about eyebrow overcorrection or unaesthetic scars, almost no recovery in the first half year was reported (Table 2). Furthermore, the patients reported occasionally about insufficient eyebrow-lifting (2%), new hair partings due to scars (3%), no symmetrical eyebrow positioning (6%), and postoperative migraine (1%). One examined patient with damage of the supraorbital and supratrochlear nerves complained of serious disturbed sensibility.

Patient satisfaction was generally high, and on a score from 0 to 10, the endoscopic forehead-lift obtained an average score of 7.1. Of the patients, 63% are likely or certain to undergo the same procedure again and 67% are likely or certain to recommend the procedure to others (Table 3); 4% to 6% of the patients would never undergo the same procedure again or would not recommend it to others. Seventy-eight percent of the patients specified a private social restriction in the first 4 weeks, and 22% did not feel socially comfortable even after 4 weeks (Table 4). Similar results were observed for social restriction at work (Table 4 and Table 5). Surgical correction was performed only in 1 case with a blepharoplasty of the upper eyelid.

PHOTOGRAPHIC EVALUATION

Of 143 patients, 52 (36%) had complete preoperative photographic documentation and agreed to undergo an objective photographic examination at least 24 months postoperatively for evaluating long-term results. All 52 patients were female (mean [range] age, 63 [48-71] years), with a mean follow-up time of 66 months (range, 24-108 months). Results are divided into the following 3 groups: (1) eyebrow elevation in a relaxed position; (2) eyebrow elevation during muscle contraction; and (3) symmetry of eyebrow elevation (Figure 3).

The mean (SD) eyebrow elevation in a relaxed position was 5.6 (1.8) mm (range, 8.7 mm after 24 months to 2.8 mm after 108 months) for the midpupil-to-eyebrow distance (lines 2 and 5); 5.3 (1.3) mm from the medial canthus to the eyebrow (lines 3 and 4); and 5.0 (1.5) mm from the lateral canthus to the eyebrow (lines 1 and 6) (Figure 3).

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The mean (SD) eyebrow elevation during muscle contraction (elevating) was 6.4 (1.6) mm for the midpupil-to-eyebrow distance; 6.2 (0.9) mm from the medial canthus to the eyebrow; and 6.1 (1.4) mm from the lateral canthus to the eyebrow (Figure 3). The mean (SD) eyebrow elevation during muscle contraction (frowning) was 5.1 (1.1) mm for the midpupil-to-eyebrow distance; 4.9 (1.8) mm from the medial canthus to the eyebrow; and 5.0 (1.9) mm from the lateral canthus to the eyebrow (Figure 3).

Symmetry of eyebrow elevation showed statistically significant (P < .05) symmetry of eyebrow positioning between the left and the right eye (comparing lines 1 and 6, 2 and 5, and 3 and 4) in a relaxed position as well as during muscle contractions (Figure 3 and Table 6). During eyebrow elevation, the most cranial part of the eyebrow is the central part above pupil level (lines 2 and 5) followed by the medial parts (lines 3 and 4). The lateral eyebrow parts (lines 1 and 6) are less involved in these forehead movements. While frowning, the medial parts (lines 3 and 4) are lowered the most, followed by the central part (lines 2 and 5). The lateral eyebrow parts (lines 1 and 6) showed no involved in these forehead movements (Figure 1).

In addition, eyebrow elevation in a relaxed position showed a significant influence of time (P = .005) on persisting eyebrow elevation for patients with a follow-up period of at least 24 months (Table 7). According to linear regression, persisting eyebrow elevation decreased almost 1 mm (0.984 mm) per year, on average (Figure 4). In the eyebrow elevation during muscle contraction group, no significant influence of time on eyebrow elevation was observed during forehead and facial muscle contraction (while elevating the eyebrows and while frowning) after a follow-up period of 24 months (Table 7). In addition, no statistically significant influence of time on the distance between the eyebrows, neither in relaxed position nor during muscle contraction, was observed (Table 7).

COMMENT

Owing to the minimally invasive nature of the endoscopic forehead-lift, the recovery after surgery is expected to be fast and comfortable, and patients’ acceptance rate of this procedure is high. Nevertheless, our postoperative evaluation revealed that social restriction for 22% of the patients lasted more than 4 weeks after surgery (Table 4), and pain, hematoma, and swelling lasted at least 4 weeks in 75% to 83% of the patients after surgery (Table 1). For this rea-
son, patients must be given reliable, detailed information prior to surgery to reduce immoderate expectations to this minimally invasive procedure.

Most reported complications are minor, transient, and well tolerated by patients, with the most frequently reported issue of alopecia coinciding with our results. Alopecia is reported to be significantly less present when using internal fixation methods compared with external fixations. Results regarding eyebrow asymmetry have been reported to be approximately 5%, corresponding with our data (6%).

Various scalp fixation methods have been described. Although a gold standard has not yet been defined, a classification in endogenous (eg, bony tunnels, fibrin glue) and exogenous methods (eg, screws, resorbable skin anchors, clips, wires) is well established. Fixation with fibrin glue is preferred by some surgeons because of its easy application, its hemostatic effect, and the potential obliteration of dead spaces. Furthermore, fixation with fibrin glue is reported to provide additional transverse spreading, especially in the glabellar area where wrinkles usually do not completely disappear (Figure 1). Alopecia rate and the appearance of new hair partings in scar regions are reported to be higher when using screws. Although we are aware of alternative fixation methods, in our experience screws provides easy, sufficient, safe, and symmetrical adjustment without excessive brow elevation and complications. In the future, long-term results regarding new alternative fixation methods like resorbable skin anchors should be performed and objectively compared with existing methods.

Table 3. Patients’ Satisfaction After Surgery With a Mean Follow-up Time of 38 Months

<table>
<thead>
<tr>
<th>Patient Satisfaction, No. (%)</th>
<th>Never</th>
<th>Unlikely</th>
<th>Maybe</th>
<th>Likely</th>
<th>Yes</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Same procedure again?</td>
<td>6 (6)</td>
<td>12 (12)</td>
<td>18 (18)</td>
<td>18 (18)</td>
<td>44  (45)</td>
<td>98 (100)</td>
</tr>
<tr>
<td>Recommendation to others?</td>
<td>4 (4)</td>
<td>12 (12)</td>
<td>16 (16)</td>
<td>14 (14)</td>
<td>52  (53)</td>
<td>98 (100)</td>
</tr>
</tbody>
</table>

Table 4. Duration of Social Restriction (Private vs Work) After Surgery

<table>
<thead>
<tr>
<th>Duration of Social Restriction, No. (%)</th>
<th>0-1 wk</th>
<th>1-2 wk</th>
<th>2-3 wk</th>
<th>3-4 wk</th>
<th>≥4 wk</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Private</td>
<td>2 (2)</td>
<td>26 (27)</td>
<td>12 (12)</td>
<td>36 (37)</td>
<td>22 (22)</td>
<td>98 (100)</td>
</tr>
<tr>
<td>Work</td>
<td>3 (10)</td>
<td>6 (20)</td>
<td>3 (12)</td>
<td>12 (43)</td>
<td>4 (14)</td>
<td>28 (100)</td>
</tr>
</tbody>
</table>

Table 5. Intensity of Social Restriction (Private vs Work) After Surgery

<table>
<thead>
<tr>
<th>Intensity of Social Restriction, No. (%)</th>
<th>No</th>
<th>Few</th>
<th>Moderate</th>
<th>Much</th>
<th>Very</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Private</td>
<td>22 (22)</td>
<td>16 (16)</td>
<td>22 (22)</td>
<td>18 (18)</td>
<td>20 (20)</td>
<td>98 (100)</td>
</tr>
<tr>
<td>Work</td>
<td>8 (29)</td>
<td>5 (18)</td>
<td>6 (21)</td>
<td>3 (11)</td>
<td>6 (21)</td>
<td>28 (100)</td>
</tr>
</tbody>
</table>

*Not all patients worked.

Figure 3. Mean eyebrow elevation (lines 1-6) and symmetry evaluation of eyebrow positioning (comparing lines 1 and 6, 2 and 5, 3 and 4) in a relaxed position, while elevating the eyebrows, and while frowning.

Figure 3. Mean eyebrow elevation (lines 1-6) and symmetry evaluation of eyebrow positioning (comparing lines 1 and 6, 2 and 5, 3 and 4) in a relaxed position, while elevating the eyebrows, and while frowning.
McKinney and Sweis\textsuperscript{12} presented an average value of 4.13 mm of brow elevation in 24 patients during an average follow-up period of 9 months. Brow elevation assessment was measured from the eyebrow to the pupil in straight-gaze sitting position. In this study, intraoperative pupil-to-brow elevation was 6 to 7 mm. It is certainly important to document intraoperative eyebrow decrease immediately after surgery. However, under the influence of anesthesia and in a horizontal position, muscle forces and gravity act in a different way than in a standing position. Therefore, these measurements might be better done postoperatively, while standing and after disappearance of swelling. In fact, these authors reported a significant decrease of eyebrow elevation in the early postoperative period.

Jones and Grover\textsuperscript{3} presented an investigation with a mean follow-up time of 9.4 months (range, 3-60 months). Two different fixation methods (fibrin glue [189 patients] and polydioxanone sutures tied through bone tunnels [8349 patients]) were compared and 1 midpupil to eyebrow distance was measured preoperatively and postoperatively. After comparing measurements more than 3 months postoperatively, they concluded that tunnel fixation (mean pupil brow height change, 6.16 mm) produces a significantly more stable result than fibrin glue fixation (mean pupil brow height change, 3.79 mm). No statistical influence of time on eyebrow elevation was determined, and only 99 patients (38 fibrin fixation and 61 tunnel fixation) had endoscopic forehead-lift solely without any other concomitant surgical procedure.

Troilius\textsuperscript{6} reported on 30 endoscopic subperiosteal brow-lifts, with a mean follow-up time of 12 months (range, 12-14 months) and measured a mean midpupil to eyebrow elevation of 6.7 mm, a mean lateral canthus to eyebrow elevation of 5.6 mm, and a mean medial canthus to eyebrow elevation of 6.3 mm in a relaxed position. We observed similar ratios in a relaxed position (Figure 3), demonstrating the central part above pupil level (lines 2 and 5) to be higher than the medial part (lines 3 and 4), followed by the lateral eyebrow parts (lines 1 and 6).

In our opinion, measurement of eyebrow positioning is a good method for evaluating and comparing surgical forehead procedures. To obtain representative data, more than 1 eyebrow-to-pupil distance should be taken into account for evaluation. Furthermore, as facial muscles are removed during this procedure, we think that eyebrow positioning should be assessed not only in a relaxed position but also during muscle contraction (Figure 1 and Figure 3). Therefore, we propose the evaluation of endoscopic brow-lift with quantitative assessment of eyebrow positioning in a relaxed position as well as during muscle contraction.

In our study, we tried to evaluate the influence of time on persisting eyebrow elevation in a relaxed position, for the first time to our knowledge. Eyebrow elevation decreases almost 1 mm per year, on average. In addition, eyebrow positioning was demonstrated to be significantly sym-
metrical. No statistically significant influence of time on eyebrow elevation could be demonstrated for measurements during muscle contraction and for the horizontal distance between the 2 eyebrows. There are 2 reasons for this phenomenon. First, because measurements are made in millimeters, high reproducibility of eyebrow movements has to be ensured and greatly depends on the patients’ cooperation during muscle contraction. Second, hair depilation between the eyebrows makes it almost impossible to identify clear medial borders and to obtain representative data. However, this study is limited because of its retrospective character. It will be necessary to design a prospective study under predetermined evaluation conditions to ensure regular assessment of eyebrow-to-eye distances at specific time points to demonstrate the influence of time on eyebrow elevation.

In conclusion, the majority of the patients undergoing endoscopic forehead-lift are highly satisfied and long lasting results are achieved with a mean midpupil-to-eyebrow elevation of 5.6 mm in a relaxed position after 5.5 years. However, further additional prospective studies for evaluation of long-term results on a larger number of patients, as well as long-term evaluations of different fixation techniques and in comparison with the coronal approach, are needed.

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REFERENCES