A Quantitative Analysis of Lateral Canthal Position Following Endoscopic Forehead-Midface-Lift Surgery

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IMPORTANCE The value of this study is to evaluate outcomes of endoscopic forehead-midface-lift surgery. Many surgeons are reluctant to offer this procedure for fear of change in the shape and appearance of the eyelid.

OBJECTIVE To objectively evaluate the change in lateral canthal position following endoscopic forehead-midface-lift surgery.

DESIGN A retrospective review of consecutive patients undergoing endoscopic forehead-midface-lift and lower blepharoplasty procedures for cosmetic midface rejuvenation.

SETTING A private facial plastic surgery practice.

PARTICIPANTS Photometric data were obtained from before-and-after surgery images from 40 patients.

MAIN OUTCOMES AND MEASURES All photographs were analyzed to determine the horizontal width, vertical height, palpebral fissure width, or angle between the medial and lateral canthi. The right and left eyes were evaluated independently, with the results analyzed using a 2-tailed paired t test with a confidence interval of 0.05 or less (required for statistical significance).

RESULTS The results indicated no statistically significant change in the horizontal width (right, \( P = .25 \); left, \( P = .07 \)), vertical height (right, \( P = .99 \); left, \( P = .72 \)), palpebral fissure width (right, \( P = .28 \); left, \( P = .48 \)), and angle of the lateral canthus (right, \( P = .99 \); left, \( P = .30 \)) before and after surgery.

CONCLUSIONS AND RELEVANCE The endoscopic forehead-midface-lift is a reliable method of addressing midface descent. This study objectively identified no significant differences in the position of the lateral canthus before and after surgery.

LEVEL OF EVIDENCE 4.
The endoscopic forehead-midface-lift is uniquely designed to address aging in the upper two-thirds of the face. This surgery combines brow-lift, midface-lift, and lower blepharoplasty procedures to resuspend ptotic tissues in a more youthful position. With advancing age, there is descent of the malar fat pad and suborbicularis oculi fat, as well as pseudohermiation of orbital fat.\(^3,4\) The combination of these events produces the characteristic double convexity and tear trough deformity of the lower eyelid and prominence of the nasolabial fold. The primary goal of a midface-lift is to reposition the suborbicularis oculi fat and malar fat pad in a superior and lateral position relative to the facial skeleton. This leads to a reduction in infraorbital hollowing, pads the infraorbital rim, and helps to correct a double-contour deformity.\(^3,4\) It also improves midface ptosis, the depth of the nasolabial fold, and lower facial jowling.\(^5\)

When the midface is approached through a temporal incision, a subperiosteal dissection elevates tissue from the posterior root of the zygoma laterally to the pyriform aperture medially, with the orbital rim and lower maxilla representing the superior and inferior limits.\(^6\) After being completely released, the ptotic midface tissue is elevated to a more youthful position and secured to the deep temporal fascia. The suspended suborbicularis oculi fat and malar fat pad lead to bunching of the skin in the lower eyelid and lateral canthal areas, requiring lower blepharoplasty and brow-lift procedures to be completed in conjunction with midface-lifts. The superolateral vector of pull created by using the deep temporal fascia as the point of fixation has led to prominent lateral canthal displacement.\(^7-9\) Most literature citing lateral canthal distortion relies on anecdotal experience and potential risks of midface surgery. To our knowledge, only 1 published study\(^10\) has objectively evaluated the change in lateral canthal position after midface surgery.

Comparing photographs before and after surgery, Williams et al\(^10\) evaluated the change in lateral canthal position following brow-midface procedures. This well-designed study, which included 50 patients, evaluated the change in the horizontal distance and angle of inclination of the lateral canthus. The change in horizontal distance is more appropriately termed the palpebral fissure width because it comprises both horizontal and vertical components. The authors’ results indicated virtually no difference in the position of the lateral canthus following midface-lift surgery. The palpebral fissure width increased 0.09% in the left eye and 0.006% in the right eye, with neither change being statistically significant. The authors also identified a nonsignificant upward deflection of 0.77° in the left eye and a significant upward deflection of 0.86° in the right eye. They commented that no patient had objectionable canthal distortion at the end of follow-up. The relative lack of change in canthal position reported in this study would seem contrary to previously cited anecdotal evidence regarding lateral canthal distortion after midface-lifts.\(^7-9\)

A review of the statistical methods might explain this disparity. Williams et al\(^10\) analyzed the mean displacement, which may not entirely explain the true amount of lateral canthal distortion. For example, using a formula of (\(-25%\) + 25%/2, the mean displacement of a 25% reduction and a 25% gain is 0%.

A more descriptive method would be to evaluate the absolute mean displacement, which does not average lengthenings and shortening but rather evaluates for overall change in position. Using the previous example, the absolute value mean displacement of a 25% reduction and a 25% gain is (|–25%| + |25%|)/2 = 25% change in position.

A second limitation of the previous study\(^10\) was that the authors did not evaluate changes in the vertical axis of the lateral canthus. Instead, they used the canthal angle to describe upward and downward deflections of the lateral canthus.

The present study was designed to objectively evaluate the change in lateral canthal position following endoscopic forehead-midface-lift surgery. The position of the lateral canthus before and after surgery was evaluated in terms of change in horizontal width, vertical height, palpebral fissure width, or lateral canthal angle.

Methods

This retrospective review evaluated consecutive male and female patients undergoing endoscopic forehead-midface-lift and lower blepharoplasty procedures from 2006 through 2010 (Figure 1), all performed by the senior author (V.C.Q.). Patients were excluded if they were undergoing revision surgery, had less than 10 months of follow-up, and did not have adequate medical record documentation or photometric data.

Surgical Techniques

Endoscopic Forehead-Midface-Lift

The senior author’s endoscopic forehead-midface-lift technique, which has been described previously, will be summarized herein.\(^3,5,11\) Preoperatively, the Pitanguy line, representing the path of the frontal branch of the facial nerve, and the temporal line were marked bilaterally. The forehead and midface were injected with an equal mixture of 0.5% lidocaine with 1:200 000 epinephrine and 0.25% bupivacaine with 1:200 000 epinephrine. We made 3-cm incisions in the bilateral temples and 2 stab incisions medially. An endoscopic brow-lift periosteal elevator (Ramirez EndoForehead “I” Dissector No. 4; Snowden-Pencer; Cardinal Health) was used to elevate the superficial temporal fascia and overlying tissue off the deep temporal fascia to the temporal line. The forehead and scalp tissues were then elevated in a subperiosteal plane through the lateral incision. Under endoscopic visualization, the arcus marginalis was completely released, as was the periosteum over the glabella and nasal radix. Using the endoscope, the supratrochlear and supratrochlear neurovascular bundles were dissected under visualization. If significant glabellar rhytids were present, the corrugator and procerus muscles were horizontally sectioned and cauterized.

Dissection proceeded with the endoscopic brow-lift periosteal elevator toward the zygomatic arch. The periosteum over the entire superior aspect of the arch was exposed and incised at the anterior aspect of the arch. Subperiosteal dissection then proceeded over the entire arch with the endoscopic brow-lift periosteal elevator (Ramirez EndoForehead Arcus Marginalis Dissector No. 6; Snowden-Pencer; Cardinal Health).

\(^{3,5,11}\)
Dissection continued on the anterior face of the maxilla toward the pyriform aperture medially and along the infraorbital rim. An important 2-cm area of periosteum around the lateral canthus was left undisturbed.

The infraorbital nerve was protected by manual pressure. Laterally, a portion of the tendinous attachments of the masseter to the zygoma was lysed. The medial and lateral subperiosteal pockets were then joined by finger dissection. The dissection was completed when there was mobility of all midface tissues, including the malar fat pad and suborbicularis oculi fat. The brow was resuspended and secured using 4-mm screws placed at the medial incisions. Before suspending the midface, a lower blepharoplasty was performed.

A total of 1 mL of 2% lidocaine with 1:100 000, mixed in equal parts with 0.25% bupivacaine hydrochloride with 1:200 000 epinephrine, was injected into the lower eyelid externally. Cotton-tipped applicators applied 4% cocaine to the conjunctiva. An additional 0.5 mL of the local anesthetic mixture was injected into the conjunctival incision and fornix.

An insulated Desmarres eyelid retractor (Bausch & Lomb) and a plastic Jaeger plate (Padgett Instruments, Integra LifeSciences) were used to protect the globe and cornea. A Colorado tip (45° angled and insulated) bovie was used to make an incision through the conjunctiva approximately 4 mm from the fornix. The incision was carried down through the lower eyelid retractors and capsulopalpebral fascia. The preseptal plane was developed by blunt dissection with cotton swabs to the infraorbital rim. Small incisions were made in the preseptal fascia with scissors and protruding fat compartments (medial, middle, and/or lateral) either excised after bipolar cau-
tery or cauterized to ablation. Following transconjunctival removal of orbital fat, the midface was suspended. A polyglactin 910 suture (Vicryl; Ethicon) on a UR6 needle was passed through the periosteum lateral to the zygomatico-facial foramen and tacked to the deep temporal fascia using a superolateral vector of pull. A second midfacial suspension suture was placed lateral to the Pitanguy line and secured to the deep temporal fascia. Three more suspension sutures were placed through the superficial temporal fascia just inferior to the incision and suspended higher to the deep temporal fascia to elevate the temporal tissue and prevent skin bunching from midfacial elevation.

Attention was then drawn externally, where the excess infraorbital skin was crimped using Brown-Adson forceps just below the ciliary margin, extending from 1 mm lateral to the medial canthus to beyond the lateral canthus (in a crow’s foot) by approximately 1 cm. The excess skin was pinched such that the dermatochalasis was eliminated without tension or evidence of scleral show. The pinched skin was then excised using scissors. The subcilliary incision was reapproximated using 7-0 silk suture in a running locked fashion medially and vertical mattress 6-0 nylon sutures laterally.

**Photographic Measurements**

Photometric data were obtained from the patients’ digital images before and after surgery. Postoperative photographs required a minimum of 10 months from the date of the procedure to be evaluated. All photographs were analyzed using Adobe Photoshop’s Measure Tool (Adobe Photoshop 6.0) to determine the horizontal width, vertical height, diameter (palpebral fissure width), and angle between the medial and lateral canthi (Figure 2).

**Table. Lateral Canthal Position Changes**

<table>
<thead>
<tr>
<th>Lateral Canthal Position</th>
<th>Mean</th>
<th>Median</th>
<th>ABV Mean</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right eye (n = 40)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Width</td>
<td>−0.38</td>
<td>−0.39</td>
<td>1.83</td>
<td>.25</td>
</tr>
<tr>
<td>Height</td>
<td></td>
<td></td>
<td>0.64</td>
<td>.99</td>
</tr>
<tr>
<td>PFW</td>
<td>−0.42</td>
<td>−0.04</td>
<td>1.94</td>
<td>.28</td>
</tr>
<tr>
<td>Angle, deg</td>
<td>−0.01</td>
<td>−0.20</td>
<td>2.23</td>
<td>.99</td>
</tr>
<tr>
<td>Left eye (n = 40)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Width</td>
<td>0.80</td>
<td>0.62</td>
<td>2.30</td>
<td>.07</td>
</tr>
<tr>
<td>Height</td>
<td></td>
<td></td>
<td>1.10</td>
<td>.72</td>
</tr>
<tr>
<td>PFW</td>
<td>0.42</td>
<td>0.82</td>
<td>2.55</td>
<td>.48</td>
</tr>
<tr>
<td>Angle, deg</td>
<td>−0.71</td>
<td>−0.50</td>
<td>2.45</td>
<td>.30</td>
</tr>
</tbody>
</table>

Abbreviations: ABV, absolute value; PFW, palpebral fissure width.

* Values are presented as percentages unless otherwise indicated.

**Statistical Analysis**

Of primary importance was eliminating any difference in camera-to-subject distance in the preoperative and postoperative photographs. Using methods devised in the Williams et al10 study, we divided the measurements between the medial and lateral canthi by a known fixed distance. The horizontal visible iris diameter (HVID) was presumed not to change between surgical procedures, using the right iris for analysis of the right eye measurements and the left iris for analysis of the left eye measurements. By converting the distance into a ratio, the change in lateral canthal position could be calculated accurately. The right and left eyes were evaluated independently, with the results analyzed using a 2-tailed paired t test with a confidence interval of 0.05 or less (required for statistical significance).

The percentage of change in the horizontal axis and palpebral fissure width was calculated by subtracting the preoperative distance (A) from the postoperative distance (B) and dividing the total by the preoperative distance. The following formula summarizes this mathematical calculation: 

\[
\frac{(B/HVID_{\text{post}}) - (A/HVID_{\text{pre}})}{(A/HVID_{\text{pre}})}
\]

This equation, however, could not be used to calculate the percentage of vertical change. When the medial and lateral canthi lay at the same vertical axis, the difference in height was 0. The change in vertical height could not be calculated with a denominator of 0. Instead, the absolute value mean change in vertical height was calculated from the absolute value mean changes in horizontal and palpebral fissure widths. Using the Pythagorean theorem, with the formula \(Y = \sqrt{(H^2 - X^2)}\), the percentage change in vertical height (Y) could be calculated by using the change in palpebral fissure distance as the hypotenuse (H) and the change in width (X).

The internal validity of the Adobe Photoshop’s Measure Tool and statistical analysis was verified by comparing the
change in the left iris before and after surgery. Using the here-
tofore mentioned methods, we calculated a change of 1% or
less (mean, 0.16%) in the diameter of the left iris before and
after surgery for all eyes. The average horizontal visible iris di-
ameter has been reported as 11.8 mm,12 with a corresponding
1% change of 0.118 mm. The medial canthus should not be af-
ected by surgery, and all results were presumed to reflect
changes in the lateral canthal position.

Results

A total of 35 women and 5 men met inclusion and exclusion
criteria for this study. Forty right eyes and 40 left eyes were
evaluated independently. The mean duration between sur-
gery and the postoperative photographs was 13 months (range,
10-19 months). The results of the statistical analysis are pre-
sented in the Table.

Horizontal Axis
The mean change in the horizontal width of the right eye was
-0.38%, corresponding to a shortening of the horizontal axis. The
absolute value mean change was 1.83%, reflecting only the over-
all change without taking into account increases or decreases of
distances. The mean change in horizontal distance of the left eye
was 0.8%, with an absolute value mean change of 2.3%. There
were no statistically significant changes in the horizontal axis of
the right ($P = .25$) or left ($P = .07$) lateral canthi.

Vertical Axis
The absolute value mean change in vertical height was 0.64%
in the right eye and 1.1% in the left eye. There were no statis-
tically significant changes in the vertical axis of the right
($P = .99$) or left ($P = .72$) lateral canthi.

Lateral Canthal Angle
The mean change in the lateral canthal angle of the right eye was
-0.01°, corresponding to a downward deflection of the lateral
canthus. The absolute value mean change was 2.23°, which re-
fers only the overall change without taking into account up-
ward or downward deflections. The mean change in the lateral
canthal angle of the left eye was -0.71°, with an absolute value
mean change of 2.45°. There were no statistically significant
changes in the lateral canthal angles of the right ($P = .99$) or left
($P = .30$) eyes.

Palpebral Fissure Width
The mean change in the palpebral fissure width of the right and
left eyes was -0.42% and 0.42%, with an absolute value mean
change of 1.94% and 2.55%, respectively. There were no sta-
tistically significant changes in the palpebral fissure width of
the right ($P = .28$) or left ($P = .48$) eyes.

Discussion

Rejuvenation of the lower eyelid, nasojugal groove, and mid-
face continues to inspire passionate debate. Many surgeons ad-
dress prominent tear trough deformities through a lower eye-
lid approach with transposition of orbital and suborbicularis
oculi fat, orbicularis oculi muscle plication, or other ex-
tended blepharoplasty techniques.13-15 Proponents favoring
blepharoplasty alone cite the risks of midface surgery, includ-
ing lateral canthal distortion, as reasons for not pursuing a more
extensive surgery.

The amount of lateral canthal displacement continues to
be one of the most controversial components of midface
procedures.7-9 The present study was designed to objectively
evaluate the change in lateral canthal position following en-
doscopic forehead-midface–lift surgery.

The results indicated no statistically significant change in
the palpebral fissure width, horizontal width, vertical height,
and angle of the lateral canthus following endoscopic forehead-
midface–lifts. These results reflect the final position of the lat-
eral canthus at least 10 months after surgery and do not ac-
count for transient postoperative canthal distortion. Patients are
typically counseled that they can expect a temporary pull of the
lateral canthus lasting 2 weeks before settling into a more natu-
ral position. Although no change was significant, a closer look
at the statistical analysis reveals several important findings.

As expected, the absolute value mean displacement tended
to be greater than the mean displacement. The absolute value
mean displacement does not consider lengthening or short-
ening but reflects overall change in position. The absolute value
Analysis of Lateral Canthal Position

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REFERENCES

mean change in palpebral fissure widths was 1.94% and 2.55% for the right and left eyes, respectively. A change in palpebral fissure width of 2% to 3% may be perceptible to patients. The mean displacement averages the cumulative lengthenings and shortening of the palpebral fissure width along a single continuum. When averaging the net positive and negative changes in distance, the mean displacements were -0.42% and 0.42% for the right and left eyes, respectively. It is unlikely that changes of less than 0.5% in the palpebral fissure width would be perceptible to an observer.

The most important factor in limiting postoperative canthal distortion is conservative subperiosteal elevation over the lateral orbit and zygomaticomaxillary complex. A minimum of 2 cm² of periosteum in the region of the lateral canthus should remain undisturbed (Figure 3). If this periosteum is completely released, the patient will be at risk for prolonged canthal tethering and superolateral displacement. By limiting the dissection around the lateral canthus, most patients can expect a temporary pull on the lateral canthus postoperatively. One week after surgery, we use massage and other conservative techniques to assist movement of the canthus to its preoperative anatomic position.

In addition to being retrospective and nonrandomized, this study had other limitations. Most notable was using ratios to evaluate the percentage of change rather than using the actual distance. A prospective study could have used a ruler or marker of known distance to be included in all before-and-after photographs. By using a known distance, the amount of canthal displacement could have been directly measured, helping to identify the amount of change in position in millimeters in addition to percentage. The preoperative and postoperative photographs ranged from 10 to 19 months after surgery. Ideally, all images would have been taken exactly at 12 months postoperatively. And finally, although the vertical position of the lateral canthus was measured directly, the absolute value mean change was not. Instead, this value was calculated using the absolute value mean changes in the horizontal axis and palpebral fissure width.

In conclusion, the endoscopic forehead-midface-lift is a reliable method of addressing midface descent. This study objectively identified no significant differences in the horizontal width, vertical height, palpebral fissure width, or angle of the lateral canthus before and after surgery.