**Objective:** To evaluate and quantify the increase in lower eyelid tension (stress) after endoscopic forehead/midface-lift in a cohort of patients with normal lower eyelid function preoperatively.

**Methods:** A prospective nonrandomized study was conducted at a private facial plastic surgery practice and ambulatory surgical center on 22 patients who underwent subperiosteal endoscopic forehead/midface-lift from October 2000 to June 2002. Patients were evaluated preoperatively, 4 to 6 months postoperatively, and approximately 12 months postoperatively.

**Results:** Compared with preoperative lower eyelid tension, there was a 4- to 5-fold increase in lower eyelid tension at 3 and 5 mm of distraction immediately after the operation. Four to 6 months after the operation, lower eyelid tension decreased but was still 2 to 3 times that of preoperative values. Twelve-month measurements for the 15 patients who remained in the study (the other 7 patients were lost to follow-up or refused to have measurements taken) showed that lower eyelid tension was 1.7 to 1.9 times preoperative values.

**Conclusions:** Our results show that lower eyelid tension increases following endoscopic forehead/midface-lift and that this increased tension is long lasting and quantifiable 12 months after surgery.

**Arch Facial Plast Surg.** 2005;7:227-230

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The endoscopic forehead/midface-lift is a well-known technique for rejuvenation of the upper half of the face. Its reconstructive role in addressing lower eyelid ectropion and excess lower eyelid laxity, however, has only recently been explored. As a result of the combined effects of dissection and the elevation of the malar fat pad and the orbitozygomaticus complex in the superolateral direction, the endoscopic forehead/midface-lift releases the downward gravitational forces exerted on the lower eyelid by the prolapsed orbital fat, ptotic orbicularis oculi, and sagging malar fat pad, thus repositioning these tissues at a higher level and reinforcing the lower eyelid sling. The role of the endoscopic forehead/midface-lift in supporting the lower eyelid was initially discovered by the senior author (V.C.Q.), who noticed difficulty in retracting the lower eyelid for a transconjunctival blepharoplasty if the endoscopic forehead/midface-lift was initially performed during surgery. He has subsequently used this technique successfully in cases of iatrogenic cicatricial ectropion caused by resection of lower eyelid skin. This study attempts to answer 2 questions: (1) Does addressing the midface region through the endoscopic forehead/midface-lift improve support for the lower eyelid by increasing lower eyelid tension (stress)? (2) If so, does this increase in lower eyelid tension maintain itself over time? This study seeks to answer these questions by objectively quantifying lower eyelid tension in a cohort of patients with healthy lower eyelid function preoperatively and then comparing these values against those measured postoperatively, 4 to 6 months postoperatively, and 12 months postoperatively.
right and left eyes were examined independently in the statistical analysis. Patients were placed supine on the operating table with the hook and strain gauge positioned above the eye to distract the eyelid away from the globe in an axis parallel to the Frankfort plane. This was achieved by using a right-angle ruler to set each patient’s Frankfort plane perpendicular to the operating room floor. To negate the effects of soft tissue variability and swelling in measuring lower eyelid distraction, especially immediately after the endoscopic forehead/midface-lift, an Instratrak headpiece (Visualization Technology Inc, Lawrence, Mass) was placed into the external auditory meatus and on the bony nasal dorsum (Figure 1). Thus, measurements were based on a bony rather than soft tissue landmark.

The force of resistance (in grams) required to distract the lower eyelid 3 mm and 5 mm away from the globe was measured prior to and immediately after surgery, as well as 4, 6, and 12 months thereafter (Figure 2).

An endoscopic forehead/midface-lift, usually in conjunction with other facial rejuvenative procedures, was performed. Dissection was carried out in a subperiosteal plane, pulling the scalp and malar complex in a superolateral direction that supported the lower eyelid. Three suspension sutures were placed in the subcutaneous tissue, pulled in a posterior superolateral direction, and secured to the temporalis fascia and periosteum lateral to the zygomaticofacial foramen. These 3 sutures created a tension band across the lower eyelid supporting the lower eyelid sling. Excess lower eyelid skin that occurs after suspension sutures placement was addressed with a lower eyelid skin pinch.4

We used paired t test variable analysis to determine statistical significance when comparing preoperative stress values with postoperative stress values. We assumed lower eyelid tension would remain neutral in patients who had not undergone surgery.

The Table shows mean preoperative and postoperative stress values of the left and right lower eyelids as well as their respective P values. Compared with preoperative lower eyelid tension, there was a 4- to 5-fold increase in lower eyelid tension at 3 and 5 mm of distraction immediately after surgery. Four to 6 months after the operation, lower eyelid tension decreased but was still 2 to 3 times preoperative values. Twelve-month measurements for the 15 patients who remained in the study showed that lower eyelid tension was 1.7 to 1.9 times preoperative values. The Table lists the P values. Figure 3 shows the stress-strain relationship and upward shift in tension for the lower eyelid at 4 to 6 months after surgery compared with preoperative values.

The etiologies of lower eyelid laxity and retraction are multifactorial but can be considered anatomically. The aging process plays the main role in eyelid laxity, whereas lower eyelid retraction can occur from shortening of any of the 3 lamellas. In the case of the posterior lamella (capsulopalpebral fascia and conjunctiva), capsulopalpebral fascia contracture can occur from a transconjunctival approach. Contracture of the middle lamella (orbital fat and orbital septum) can occur with fat fibrosis from prior blepharoplasty. Abnormalities of the anterior lamella can occur from overresection of skin during lower eyelid blepharoplasty, trauma, or cicatricial skin disease.

**Figure 1.** Method of measuring lower eyelid tension. The Frankfort plane is marked on every patient. The Instratrak headpiece (Visualization Technology Inc, Lawrence, Mass) resting on the nasion provides a bony landmark for measurement. A strain gauge placed directly above the patient is mounted on the Nikon focuser (Tokyo, Japan) allowing for fine (millimeter) and gross (centimeter) amounts of distraction. A small coated hook connected via metal wire to the strain gauge is placed under the patient’s lower eyelid to measure tension.

**Figure 2.** A close-up view of the small coated hook under the patient’s lower eyelid; 3 mm of distraction.
The medial and lateral canthal tendons, which attach the tarsal plate to the bony orbital rim, can lengthen secondary to increased elasticity and to the continued downward force exerted by the weakened orbital septum, prolapsed orbital fat, and periorbital soft tissues such as the midface region.5,7 Often overlooked in the anatomy of the lower eyelid is the downward pull exerted on the lower eyelid by the aging effects of the ptotic midface region. The orbicularis oculi is intimately attached to the midface inferiorly and to the lower eyelid sling superiorly.9 When gravitational forces pull the malar fat pad downward, these same effects exert a downward force on the lower eyelid. The gravitational force of the ptotic malar fat pad translates to the orbicularis oculi, which then transmits this downward force through direct attachments to the lower tarsal plates and canthal tendons. Lower eyelid support is provided in part by the concentric orbicularis oculi muscle, which contracts to help lift the periorbital structures and to help counter their downward gravitational pull on the lower eyelid. As seen in patients with facial paralysis, loss of facial tone and midface descent results in lower eyelid laxity and retraction, also known as paralytic ectropion. Another example of loss of midface support can be seen in patients with so-called hypoplastic midface or maxilla, as the loss of support for the lower eyelid causes lower eyelid retraction or ectropion. Recent studies have directed attention toward repositioning the midface in repairing lower eyelid retraction and laxity.3,6-17 Patipa3 recently reviewed various techniques for correcting lower eyelid retraction following cosmetic blepharoplasty and advocated lifting the malar fat pad in severe cases. The endoscopic forehead/midface-lift has cosmetic advantages over traditional methods for correcting lower eyelid retraction. The lateral rounding of the eyes seen after cantholysis and canthopexy surgical techniques is avoided because lower eyelid length is preserved. Skin graft to the lower eyelid for severe lower eyelid retraction is a cosmetically unacceptable result and may be avoided by using the endoscopic forehead/midface-lift technique, which provides excess skin for the lower eyelid.

To our knowledge, this is the first study to quantify lower eyelid tension after any surgical intervention to correct lower eyelid laxity. We empirically chose distraction distances of 3, 5, and 8 mm. Our decision to measure the eyelid tension with this strain gauge was not based on a previous study. We used 3 mm as the initial measurement because at that length the eyelid was distracted from the globe when the retractor was inserted into the lower eyelid. We chose the other 2 distances because in the unoperated eyelid, we observed that those distances adequately described the linear and nonlinear portions of the lower eyelid stress-strain curve. Eight millimeters was also slightly greater than the standard distance for an eyelid distraction test (6 mm).16 Although the biomechanical properties of the individual components of lower eyelid tissue have been studied and quantified, to date no study has measured the viscoelastic properties of the lower eyelid.

An important limitation of this study is the assumption that lower eyelid tension in the healthy individual does not change appreciably in a year. Thus, our “control group” stress-strain relationship was defined by the preoperative stress-strain relationship curve of the individual patients. Last, caution should be used in applying this control group stress-strain relationship across age groups and sex because of the limited and selective patient population involved in the study, that is, all women in the age range of 45 to 73 years.

With respect to the design study limitations and measurements, we placed importance on obtaining reproducible, standardized measurements rather than on measuring the increase in tension in the vertical axis, defined as the plane perpendicular to the Frankfort plane. Thus, one may conclude correctly that the lower eyelid should have been distracted inferiorly to truly measure the increase in lower eyelid tension in the vertical plane. This was attempted in the pilot study, but difficulties in obtaining reproducible results and measuring distances forced us to abandon distraction in the horizontal plane.

As this study indicates, while postoperative lower eyelid tension was increased 12 months postoperatively from preoperative values, there was a steady decline in tension over the year. This steady decrease most likely represents a continuum of etiologies from early resolving postoperative edema in the first few months postoperatively, such as creep and natural tissue relaxation, which causes the decrease toward the 12-month point. It would be useful to continue measuring these patients past the 12-month point to see if this increase in lower eyelid tension plateaus or continues to decrease to preoperative values.

Nonetheless, our results have shown that lower eyelid tension increases following endoscopic forehead/
midface-lift and that this increase is quantifiable and statistically significant 12 months postoperatively, and it may be longlasting. The findings in this study advocate the role of supporting the midface in selective treatment of lower eyelid laxity and indicate the added benefit of allowing the surgeon to be more aggressive with lower eyelid skin removal in the patients undergoing cosmetic procedures. All patients enjoyed a reduction in infraorbital hollowness, cheek pad ptosis, upper nasolabial fold depth, and improved overall upper midface appearance. No major lower eyelid malpositions were noted in any of the patients except for mild temporary asymmetries (3%-5%), prolonged conjunctival edema (2%-3%), dry eye (1%), and paresthesias (1%). The endoscopic forehead/midface-lift is an adjunct to aesthetic surgery for midface laxity and can serve as a unique reconstructive adjunct to correct lower eyelid malposition.

Accepted for Publication: April 11, 2005.
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