Mitek Anchor–Augmented Static Facial Suspension

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Objective: To evaluate the efficacy of the Mitek minianchor suture system as an adjunctive procedure for static facial suspension and assess its ability to improve functional and aesthetic outcomes in patients with complete facial paralyses.

Methods: A retrospective review of 5 patients who underwent adjunctive static facial suspension with the Mitek GII minianchor suture system at a tertiary care academic center. A bone anchor in the maxilla connected to 2 suture arms was used. One suture arm elevated the oral commissure on the paralyzed side. The second suture arm adjusted for upper lip segment asymmetry and Cupid’s bow deviation, or lateralized the external nasal valve. Outcome was evaluated by photodocumentation and clinical examination.

Results: There was an average of 76.9% improvement in vertical symmetry of the oral commissure (range, 43%-100%), an average of 65.0% improvement in horizontal deviation of the Cupid’s bow (range, 50%-100%), and an average of 85.3% improvement in symmetry of upper lip segments (range, 67%-100%). All patients experienced improvement in oral-nasal competency.

Conclusions: The Mitek minianchor suture system is a safe and effective adjunctive method to improve facial symmetry and oral-nasal competency in patients with facial paralyses. Its multivector design approximates the ideal positions of key anatomical points of the midface during static facial suspension surgery.

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Facial nerve paralysis as a consequence of trauma, surgery, or infection results in a flaccid hemiface that is aesthetically disfiguring. Neural rehabilitation procedures for dynamic facial reanimation, such as cross-facial grafting and hypoglossal-facial nerve transpositions, can be used for patients with complete facial paralyses. However, these procedures are reserved for patients with intact distal nerve integrity, viable facial muscles, and less than 18 months of paralysis. The musculofacial sling procedure, which includes harvesting of autogenous temporalis or masseter muscle, results in restricted dynamic mobility of the mid and lower face but is limited by donor site deformity and inherent limitations in range of movement. Static facial suspension procedures for those with long-standing paralysis can establish facial symmetry at rest when no viable re-innervation potential exists. It can also be integrated with dynamic procedures such as facial nerve grafting to provide instantaneous restoration of facial symmetry during the postoperative recovery period.

Static facial suspension procedures traditionally involve suspension of the mid and lower face with a sling consisting of harvested fascia, acellular dermal graft (AlloDerm; LifeCell Corp, Branchburg, New Jersey), or alloplastic material such as polytetrafluoroethylene (GORE-TEX; W. L. Gore Associates Inc, Flagstaff, Arizona). This is usually performed in conjunction with a traditional unilateral face-lift on the paralyzed side for further elevation. GORE-TEX soft-tissue patches have been shown to provide adequate elevation of midfacial and perioral soft tissues. They can function as a sling attached from the deep temporalis fascia to the oral commissure without the need for sacrifice of autogenous muscle.1 Although static suspension slings can recreate definition at the nasolabial fold,2 they do little to evert the upper lip or to lateralize a collapsed ala to its original pre paralyzed position. This is because elevation can be provided only in a flat, 2-dimensional plane. In addition, asymmetry in the length of the upper lip segments is inevitable owing to stretching of the upper lip segment on the paralyzed side by the superior-lateral pull by the static suspension sling.

Mitek suture anchors (Depuy Mitek, Raynham, Massachusetts) have recently been commercially developed to facili-
tate stable attachment of soft tissues to bone. Although their use is well characterized in orthopedic literature, they have also recently been described in plastic surgery for fixation of pedicled muscle flaps to exposed bone for reconstruction of soft-tissue defects, especially in cases in which adequate periosteum or soft tissue is not available for standard suture techniques. Various other uses for the Mitek anchor suture system have now been described in the specialty of otolaryngology, including a role in canthoplasty, reconstructive flap fixation with repositioning. Mitek anchor sutures have been used to fasten fasciocutaneous or musculocutaneous free flaps to underlying bone in the region of the midface to achieve functional outcomes, and pertinent information such as age, sex, preoperative diagnosis, operative technique, and presence of complications were noted. Preoperative and postoperative photodocumentation, which remains a routine part of our surgical evaluation, was also evaluated. Objective evaluation of aesthetic results was performed with respect to (1) restoration of vertical symmetry of the oral commissures, (2) medialization of the Cupid’s bow, and (3) symmetry in length of upper lip segments. Subjective evaluation of aesthetic results was performed with respect to (1) definition at the nasolabial fold and (2) lateralization ofalar soft tissues. Evaluation of aesthetic outcome was achieved by performing facial analyses of preoperative and postoperative photographs, using both subjective comparison and objective criteria, whenever photodocumentation was available. Postoperative assessment routinely took place 6 months or longer after surgery to ensure that long-term results were assessed. Evaluation of functional outcome was achieved by patient history.

Several objective measurements were made before and after Mitek minianchor suture placement (hereinafter “pre-Mitek” and “post-Mitek”) to determine the amount of (1) vertical elevation of the oral commissure (on the paralyzed side), (2) correction of horizontal philtrum deviation (to the nonparalyzed side), and (3) correction of previous asymmetry of upper lip segments created by excessive lateralization of the oral commissure (on the paralyzed side) from previous facial static suspension sling. All measurements were made and calculated by 2 independent physicians.

Vertical measurements of the oral commissure were made from a straight line drawn between the medial canthi, and were measured for the nonparalyzed “ideal” side (y1), the paralyzed pre-Mitek side (y2), and the paralyzed post-Mitek side (y3). The “ideal” amount of vertical elevation needed would be the difference between y1 and y2, and the “actual” amount of vertical elevation obtained would be the difference between y1 and y3 (Figure 1A). The lengths of the upper lip segments, defined as the distance from the oral commissure to the Cupid’s bow, were measured on the paralyzed side (x), and on the nonparalyzed side (x’). All measurements made before Mitek placement were denoted with a subscript of 1, and all measurements made after Mitek anchor placement were denoted with a subscript of 2 (Figure 1, Figure 2, and Figure 3). The difference between the lip segment length on the nonparalyzed and the paralyzed side were measured in the preoperative photographs as x1 − x1’ and designated as X1. This was also measured in the postoperative photographs as x2 − x2’ and designated X2. The percentage improvement in lip segment asymmetry was measured by subtracting the postoperative change in lip segment length (X2) from the preoperative change in lip segment length (X1) and dividing it by the preoperative change in lip segment length, or (X1 − X2)/X1.

For analysis of horizontal deviation of the philtrum, we first determined the midline of the face. This was performed by drawing a straight line from the trichion to the menton that passed through at least 2 main midpoints between reliably symmetric facial markers: (1) the midpoint between medial canthi and (2) the midsubnasale. Because patient 1 was smiling with controlled effort while photographs were taken and her teeth were visible, another point between the central incisors was used to further verify the midpoint. Because the hairline of patient 4 was not fully visible, another midpoint along a straight line drawn between 2 points in the midtemporal region was used in this patient to further verify midpoint. For patient 5, in whom the medial canthus was not attached at its proper position owing to acquired deformity, the midpoint of both the columnella and subnasale was used as a more accurate midline landmark. To determine the distance of philtrum deviation (B), we measured the distance from where the midline crosses the upper lip segment to the philtrum deviation point (Figure 3).
lip to the region of the Cupid’s bow. To measure the angle of philtrum deviation (b), we measured the angle between the midline and a line drawn from the trichion intersecting the Cupid’s bow (Figure 1B).

An oral commissure angle of asymmetry was also measured before ($\alpha_1$) and after ($\alpha_2$) Mitek minianchor placement by finding the angle created between (1) a line from the oral commissure on the paralyzed side to the oral commissure on the nonparalyzed side; and (2) a straight line through the oral commissure on the nonparalyzed side (Figure 1C). The absolute vertical difference in height between the oral commissures was designated as $A_1$ in the preoperative photographs and $A_2$ in the postoperative photographs.

To ensure that facial proportions were not distorted in relation to the post-Mitek photographs, both horizontal and vertical designated standard distances were measured and verified to be equivalent in pre-Mitek and post-Mitek photographs. The standard horizontal distance was the intercanthal distance, and the standard vertical distance was the distance from the medial canthus to the nonparalyzed oral commissure ($y_1$). Also of note, none of the patients underwent concurrent surgery to alter the position of the medial canthus. However, some patients exhibited asymmetry at the level of the medial canthi.
which was noted to be present and stable both before and after Mitek anchor placement.

SURGICAL TECHNIQUE

We started with a circumferential alar-facial incision that extended from the alar crease downward toward the nasolabial crease. Through this incision, the midfacial soft tissues were elevated off the maxilla in the subperiosteal plane. A Mitek 1.8- or 2.0-mm drill bit was used to make a drill hole in the maxilla at the level of the piriform aperture. The Mitek minianchor was then inserted into the maxillary bone by properly seating the inserter in the predrilled hole and turning the inserter in a clockwise fashion until fastened. Release of the suture anchor was automatic. The second anchor suture could then be passed horizontally toward the midpoint near the anatomical Cupid’s bow from superficial to deep if correction of philtrum deviation or upper lip segment asymmetry was desired. Another option for use of the second anchor suture in patients with issues of nasal valve incompetency was to pass this suture through the nasolabial soft tissues at the level of the alar groove. In some cases, the second anchor suture did not need to be used at all.

RESULTS

All facial paralyses were unilateral and complete. Three occurred on the right side of the face, and 2 occurred on the left side. All patients had previously undergone a static facial suspension sling, which provided lift and lateralization to the mid-lower face. Patients then underwent additional adjunctive static reanimation with the Mitek minianchor suture system. The duration of postoperative follow-up ranged from 6 to 16 months. No complications occurred in our series of patients. There was an average of 76.9% improvement in the vertical symmetry of the oral commissure (range, 43%-100%), an average of 65.0% improvement in the horizontal deviation of the Cupid’s bow (range, 50%-100%), and an average of 85.3% improvement in the symmetry of upper lip segments (range, 67%-100%) (Table 1 and Table 2). The percentage of improvement in the angle of philtrum deviation averaged 60.8% (range, 38%-100%), and the percentage of improvement in the angle of oral commissure asymmetry averaged 71.4% (range, 47%-100%).

CASE 1

A 66-year-old woman had permanent complete right facial paralysis after resection of an aggressive glomus tumor (Figure 1). She initially underwent surgery consisting of a right-sided facial suspension sling in conjunction with unilateral blepharoplasty, rhytidectomy, brow suspension, tarsal strip shortening of the lower eyelid, and lip augmentation. However, over the next year, the patient developed progressive blunting of the nasolabial fold, ptosis of the oral commissure, and problems with oral incompetence. The patient underwent a second surgery...
using the Mitek minianchor system with placement of 1 suture arm at the midpoint of the upper lip segment to elevate the right oral commissure and evert the upper lip. At this time, patient was more than 18 months past resection of a glomus tumor that had caused facial paralysis and therefore was not eligible for nerve transfer.

CASE 2

A 67-year-old woman had complete right facial paralysis following resection of a cavernous hemangioma (Figure 2). Her initial surgery involved a right-sided facial suspension sling, rhytidectomy, brow suspension, tarsal strip shortening of the lower eyelid, and lip augmentation. Over the next year she experienced persistent asymmetry of the right oral commissure, philtrum deviation toward the nonparalyzed side, and severe upper lip segment asymmetry. She also experienced external valve incompetence from collapse and ptosis of the right alar base. The patient elected to undergo additional surgery with an ansa hypoglossi to facial nerve transfer. The Mitek minianchor suture system was used to provide interim improvement in symmetry of her upper lip segments, elevation of the right oral commissure, and lateralization and lift of the external nasal valve.

Table 1. All Facial Measurements

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<th>x2</th>
<th>x2'</th>
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*For an explanation of the symbols used for measurements, see the “Study Procedures” subsection of the “Methods” section.

Table 2. Calculated Changes and Percentages in Facial Measurements

<table>
<thead>
<tr>
<th>Patient No.</th>
<th>Ideal Vertical Δ in Dist From MC to OC (y1-y1)b</th>
<th>Actual Vertical Δ in Dist From MC to OC (y1-y2)b</th>
<th>IVE Obtained at OC (y1-y1)/%</th>
<th>Δ in LS Length Preop (x1-x1)b=ΔX1</th>
<th>Δ in LS Length Postop (x2-x2)b=ΔX2</th>
<th>Improvement in LS Symmetry (ΔX1/ΔX2)%</th>
<th>Δ Distance of PD Preop/Postop (b1-b2)b</th>
<th>IHMP Obtained (b1-b2)b/ΔX1, %</th>
<th>Improvement in APD (b1-b2)b/ΔX1, %</th>
<th>Improvement in AOCA (b1-b2)b/ΔX1, %</th>
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<td>1.0</td>
<td>100</td>
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Abbreviations: AOCA, angle of oral commissure asymmetry; APD, angle of philtrum deviation; dist, distance; IHMP, ideal horizontal medialization of philtrum; IVE, ideal vertical elevation; LS, lip segment; MC, medial canthus; OC, oral commissure; PD, philtrum deviation; postop, postoperatively; preop, preoperatively.

*For an explanation of the symbols used for measurements, see the “Study Procedure” subsection of the “Methods” section.

b Data are given in millimeters.

A 67-year-old woman had complete right facial paralysis following resection of a cavernous hemangioma (Figure 2). Her initial surgery involved a right-sided facial suspension sling, rhytidectomy, brow suspension, tarsal strip shortening of the lower eyelid, and lip augmentation. Over the next year she experienced persistent asymmetry of the right oral commissure, philtrum deviation toward the nonparalyzed side, and severe upper lip segment asymmetry. She also experienced external valve incompetence from collapse and ptosis of the right alar base. The patient elected to undergo additional surgery with an ansa hypoglossi to facial nerve transfer. The Mitek minianchor suture system was used to provide interim improvement in symmetry of her upper lip segments, elevation of the right oral commissure, and lateralization and lift the right alar base. The first anchor suture was passed into the right nasolabial area suspending the oral commissure in a superior lateral direction, and the second anchor suture was passed through the right alar base for lateralization and lift of the external nasal valve.
CASE 3

A 33-year-old woman had complete right facial paralysis following resection of an acoustic neuroma (Figure 3). She initially underwent a right-sided facial suspension sling, a cross facial interpositional graft, brow suspension, lower eyelid lift with implant, and right eye gold weight. However, some oral commissure asymmetry and philtrum deviation persisted, and despite nerve grafting she did not have any movement of the right side of her face. She then decided to undergo a second procedure using the Mitek minianchor system, with 1 anchor suture through the nasolabial region suspending the right oral commissure in a superior lateral direction. The second suture was used for lateralization and elevation of the right alar base.

COMMENT

The Mitek minianchor suture system allows for operator-dependent control and multivector utility in the secure fixation of soft tissue for static facial suspension. This system allows approximation of the ideal position of key anatomical points in a more precise manner. Our previous experience with the GORE-TEX sling in patients with complete facial paralysis revealed that asymmetry of the oral commissure and upper lip as well as oral-nasal incompetence may persist because it provides only unilateral elevation in a 2-dimensional plane. Achieving more complete facial balance requires upper lip eversion, improved symmetry of the oral commissure and upper lip segments, and lateralization of alar soft tissues. This requires a 3-dimensional approach that cannot be attained using a unilateral sling. In addition, movement in isolated vertical vectors is difficult using the GORE-TEX sling, which provides mainly a superior-lateral pull owing to its distal attachment at the temporalis fascia.

With the Mitek minianchor suture system, elevation and correction of lower facial deviation can occur in multiple dimensions depending on placement of each of the 2 suture limbs. This multivector flexibility is key to attaining the customized lift that is crucial for optimal aesthetic and functional correction in patients with facial paralysis. The Mitek minianchor suture system, which is securely fastened to bone at the piriform aperture, can better provide the vertical lift and lateralization that is difficult to achieve with the use of a more distantly placed static suspension sling.

The Mitek minianchor suture system also has excellent operator-dependent versatility to achieve both fine adjustments as small as 0.5 mm to larger distances as needed, with demonstrated accuracy and stability over time. In our case series, we were able to achieve vertical elevation of the oral commissure in a range of 0.5 mm to 4 mm, with a mean accuracy of 76.9%. Precise medialization of the philtrum was more difficult to achieve, with a mean accuracy of 65.0%. This could be due to the location of placement of the Mitek anchor in the region of the piriform aperture, which optimizes the vertical pull of the oral commissure immediately inferior to the anchor, but makes horizontal vectors of pull for medialization of the philtrum more difficult.

When used to perform static facial reanimation, the Mitek minianchor suture system provides several advantages: (1) it can be performed through a relatively small incision that is easily concealed in the alar-facial and nasolabial crease, (2) it involves minimal amounts of soft-tissue manipulation and requires only limited medial dissection, (3) it requires little amount of foreign material implantation, and (4) its low-profile design allows for complete implantation of the device within bone with minimal risk of accidental anchor overpenetration. It allows for precise and secure soft-tissue fixation that reliably counters the effects of gravity and scar contracture postoperatively.

In cases of facial paresis, in which the facial nerve is intact but weak, the Mitek minianchor suture system can also be used to achieve symmetry of the oral commissure by localized elevation and eversion of the upper lip. It is also advantageous in cases of paretic weakness in that the dissection necessary for implantation of the Mitek anchor is limited and medial, and this decreases any further risk of injury to the weakened but functioning facial nerve as it is repairing itself.

Furthermore, previous studies have suggested that static suspension procedures, in addition to providing static symmetry, also enhance facial movement on the affected side in patients with partial paresis by keeping facial muscles at the length required for optimal contraction. As contractions of facial muscles on the non paralyzed side are less opposed by absent or reduced force of muscle contraction on the paralyzed side, the face may appear to shift toward the nonparalyzed side over time. All patients in this study had preoperative evidence of facial landmark shifting (ie, deviation of the philtrum to the nonparalyzed side as well as medialization and ptosis of their oral commissure), which can lengthen the facial muscles on the paralyzed side, and provide a functional disadvantage for initiating muscle contraction and producing facial movement.

These landmarks were shifted closer to their normal positions following placement of the Mitek minianchor, hence reversing some of the functional disadvantage for initiating muscle contraction.

We are still refining the technique of static facial reanimation through use of a GORE-TEX sling in conjunction with strategically placed Mitek minianchors sutures. It is a multistaged process in evolution that often requires several operations for tightening of the GORE-TEX sling, excision of lax skin, and repositioning of the Mitek minianchor sutures. A study of complications of static facial suspensions with expanded GORE-TEX has shown that despite prestretching prior to implantation, the GORE-TEX suspension sling has failed owing to progressive stretching after implantation.

This progressive stretching of the GORE-TEX sling is complicated further by tissue healing and scar contracture. We aim for overcorrection of approximately 30% on average in anticipation of subsequent scar contracture and drop from gravity, which may vary slightly owing to individual scarring and laxity of skin.

Although at this point we cannot be certain of the permanency of these results, initial postoperative follow-up of these patients for a minimum of 6 months has
demonstrated persistence of oral commissure elevation and medialization of the Cupid’s bow. Owing to the minimal amount of soft-tissue incision and dissection, it would be relatively simple to readjust or tighten the suture arms should final positioning change secondary to gravity or scar contracture.

The favorable aesthetic and functional results obtained by use of the Mitek mini-anchor suture system, as well as its operator-dependent placement of anchor sutures, demonstrate its effectiveness and versatility as an adjunctive procedure. It can be used to elevate the lateral oral commissure complex with eversion of the upper lip and to recreate lip symmetry by repositioning the Cupid’s bow at midline. In addition, it can be used to enhance definition of key areas of the midface, such as the nasolabial fold, or to attain lateralization and lift of the alar soft tissues to mitigate external valve collapse. Use of a bone anchor to securely reposition and fix midfacial soft tissues to the facial skeleton is an innovative and safe adjunctive method for static facial suspension in patients with facial paralysis.

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Author Contributions: Dr Costantino had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. Study concept and design: Yu and Costantino. Acquisition of data: Yu and Tadros. Analysis and interpretation of data: Yu and Kim. Drafting of the manuscript: Yu and Kim. Critical revision of the manuscript for important intellectual content: Yu, Kim, Tadros, and Costantino. Statistical analysis: Yu and Kim. Study supervision: Yu, Tadros, and Costantino.

Financial Disclosure: Dr Costantino is a consultant for Stryker Leibinger.

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REFERENCES