Improving Surgery on the Aging Neck With an Adjustable Expanded Polytetrafluoroethylene Cervical Sling

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Objectives: To evaluate the ability of the expanded polytetrafluoroethylene (ePTFE) cervical sling to improve results of surgery on the aging neck in the short term as well as its ability to achieve long-term cosmesis through its secondary adjustability.

Design: A retrospective analysis.

Setting: A private facial plastic surgery practice.

Patients: The first 100 consecutive patients who underwent placement of the ePTFE cervical sling with a minimum follow-up of 36 months.

Intervention: Placement of a preplatysmal, mastoid-to-mastoid, ePTFE cervical sling sutured to the fascia overlying the insertion of the sternocleidomastoid bilaterally in conjunction with a graded surgical approach appropriate for each patient. This included lipoplasty, midline platysmal plication, and rhytidectomy.

Outcome Measures: Aesthetic appearance of the neck was evaluated by comparison of preoperative and postoperative photographs at 1 year. Appraisal of secondary adjustability was similarly assessed 1 month after sling tightening. Patient satisfaction was recorded via self-assessment of both procedures for cosmesis and comfort. Complications specific to sling placement and tightening were reviewed.

Results: One year after initial surgery, 85 patients had significant or marked improvement. More than 90% of patients felt that the procedure met or exceeded their cosmetic expectations, while 99 patients felt no residual discomfort. Secondary to rebound tissue relaxation, 9 of 100 patients required sling tightening a mean interval of 14 months after primary surgery. All 9 of these had either a significant or marked improvement, with similarly high patient satisfaction in cosmesis (n=9; 100%) and comfort (n=8; 89%). Two patients had postauricular infections necessitating sling removal. There were no complications with sling tightening.

Conclusions: Placement of the ePTFE cervical sling is a safe and effective procedure to aesthetically improve short-term surgical results on the aging neck. By virtue of its secondary adjustability, it offers a safe, long-term solution to rebound tissue relaxation and associated submental laxity.

Arch Facial Plast Surg. 2003;5:491-501

The aging process causes gradual and predictable changes in the soft tissue layers of the lower face and neck, the anatomic basis of which has been well documented.1-6 Loss of elasticity and fragmentation of collagen results in rhytid formation and skin redundancy. Subcutaneous fat thickens and becomes more noticeable. Stretching of the fascia and musculature results in a loss of the supporting “sling” of the submentum, often resulting in submandibular gland ptosis. Further loss of tone and muscular atrophy results in banding of the medial platysmal borders, blunting of the cervicomental angle, and loss of lateral mandibular definition.

The failure of the classic rhytidectomy to adequately address the consequences of aging in the neck has prompted the development of a number of modifications and adjunctive procedures. These include skin excisions,7-9 various lipoplasty techniques10-13, anteriorly or posteriorly based platysmal transection, resection, or plication procedures; superficial musculaponeurotic system platysma flaps14-28, and even suture suspension techniques.29-32 However, these modifications have their limitations. Problems with

For editorial comment see page 502

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bowstring contractures and scarring have resulted in the near abandonment of midline skin excision with subsequent Z-, W-, or T-plasty. Liposuction or direct lipocountouring plays an important role in the aging neck, but fat modification by itself cannot address platysmal banding and often causes an increase in its prominence. Posterior platysmal modification (transsection, resection, or plication) is limited by blunting of the lateral mandibular angle and accentuation of anterior irregularities such as skin dimpling. It may also decrease soft tissue support in the submentum. Anteriorly based procedures, whether limited to the upper neck or done in corset fashion bolsters soft tissue support and improves the cervicomental angle. However, it too fails to improve definition of the lateral mandibular angle. Suspension suture techniques allow for excellent lateral definition but are hampered by suture rupture and skin rippling. Lateral suture suspension also does not allow for subsequent modification.

Perhaps most importantly, current techniques are limited by their inability to combat rebound relaxation inherent to the nature of soft tissues. This inevitably results in the recurrence of banding and submental ptosis requiring in many cases a major revisional procedure. The results in the recurrence of banding and submental ptosis inherent to the nature of soft tissues. This inevitably limited by their inability to combat rebound relaxation subsequent modification.

Patient satisfaction with the procedure was evaluated in the categories of cosmesis and comfort also at 12 months. Each patient was asked to fill out a questionnaire in which they critiqued their own results by choosing whether the procedure met, exceeded, or failed to meet their preoperative expectations for cosmetic improvement. In regard to comfort, the patients were asked to take into consideration the sling sensation as well as subcutaneous palpability (in the postauricular region) and to comment on whether the ePTFE sling was comfortable, uncomfortable but tolerable, or intolerable. Finally, each patient was asked to stipulate if they would recommend the procedure to a friend or relative.

**METHODS**

A retrospective chart analysis was undertaken of the first 100 consecutive patients seeking elective aesthetic improvement of the aging neck who underwent ePTFE cervical sling placement along with individually appropriate aging neck surgery. Inclusion in the study required at least 36 months of postoperative follow-up.

All patients were preoperatively evaluated for the presence or absence of fat accumulation, platysmal weakness or banding, submandibular gland ptosis, cervicomental angle, lateral mandibular angle definition, and hyoid position. In this manner, patients were stratified along the Dedo classification of cervical abnormalities. Each patient also underwent extensive preoperative counseling in regard to the risks, benefits, and alternatives to the procedure and use of a foreign body. Expectations in terms of a “sling sensation” and subcutaneous palpability were carefully reviewed.

A graded surgical approach then dictated the procedure chosen for each patient. Lipoplasty was carried out for excess fat accumulation. Midline platysmal plication with or without lipoplasty was undertaken for those patients with platysmal banding or weakness. If rhytidectomy was indicated, it was done in conjunction with midline platysmal plication and posterior superficial musculoaponeurotic system flap imbrication in all cases, with lipoplasty when necessary.

Outcome was judged by a comparison of standardized preoperative and postoperative photodocumentation at 12 months. Taken into consideration was the acuity of the cervicomental angle, presence of blunting of the angle of the mandible, persistence or recurrence of platysmal banding, submental skin laxity, and submandibular gland prominence. This included but was not limited to the visual criteria for successful restoration of the youthful neck, as described by Ellenbogen and Karlin. A grade was then jointly assigned by both of us according to the following scale for each patient: poor (minimal to no change), fair (moderate improvement), good (significant improvement), or superior (marked improvement).

Patient satisfaction with the procedure was evaluated in the categories of cosmesis and comfort also at 12 months. Each patient was asked to fill out a questionnaire in which they critiqued their own results by choosing whether the procedure met, exceeded, or failed to meet their preoperative expectations for cosmetic improvement. In regard to comfort, the patients were asked to take into consideration the sling sensation as well as subcutaneous palpability (in the postauricular region) and to comment on whether the ePTFE sling was comfortable, uncomfortable but tolerable, or intolerable. Finally, each patient was asked to stipulate if they would recommend the procedure to a friend or relative.

For those patients whose slings were tightened secondarily, surgical outcome comparison as well as patient self-assessment was based on the patient’s “pretightening” state, regardless of whether 12 months had fully elapsed. The reason for sling tightening and the interval to tightening from time of primary surgery were noted. At 1 month following sling modification, patients were graded jointly by both of us according to the method detailed above. Patient satisfaction was again similarly assessed.

All charts were carefully reviewed for sling-related complications through 36 months after surgery. These included infection, extrusion, seroma formation, induration, sling visibility, sling rupture, sling suture rupture, venous congestion in the neck, and persistent dysphagia or odynophagia. Any and all complications were then recorded. This included any requests for removal of the sling.

**SURGICAL TECHNIQUE: PRIMARY SLING PLACEMENT**

For this procedure, the patient is seated upright, and an a suitable horizontal submental crease marked in the midline. If platysmal bands are present, they are demarcated. Three-centimeter postlobular incisions are also drawn bilaterally. (If a rhytidectomy is planned, standard rhytidectomy incisions obviate the need for these incisions.) The patient is then placed supine on the operating table, and intravenous anesthesia is administered, with noninvasive monitoring secured. The submental region is then infiltrated with a total of 20 mL of 1% lidocaine with 1:100,000 epinephrine dilution in the subcutaneous plane.

After appropriate preparation and drapage, a 3.5-cm incision is made horizontally in the midline submental crease. Subcutaneous tunneling is then undertaken with the aid of a liposuction cannula. In the event of excess fat, liposuction is
then commenced. This is followed by wide subcutaneous scissors dissection between the mandibular borders down to the thyroid prominence in the preplatysmal plane. Great care is taken to retain a layer of fat on the skin flap to avoid dermal exposure. Platysmal bands are further defined by removal of fat between the medial edges. Midline plication of the platysma is then completed with a series of interrupted, buried, 2-0 Surgidac sutures (United States Surgical Corporation, Norwalk, Conn) from the thyroid cartilage to mentum. If rhytidectomy is planned, it can now be completed. If not, attention is turned to the postlobular creases where 3-cm-long incisions are made bilaterally. A region of 3 cm is then undermined anteroinferiorly superficial to the sternocleidomastoid fascia. Further dissection is then undertaken at the angle of the mandible to connect the postauricular dissection to the submandibular triangle.

An 8-mm-wide, 1-mm-thick strip of prestretched ePTFE soaked in gentamicin solution is then introduced into the left postauricular incision and withdrawn from the submental incision using a long Takahashi forceps. Prestretching from 8 mm to 15 mm decreases the modulus of elasticity of the ePTFE, thus reducing its tendency to stretch postoperatively. The edge of the ePTFE is folded on itself, and this double layer is then sutured with 2-0 Surgidac suture to the underlying premastoid fascia just behind the ear lobule with 3 interrupted vertical mattress sutures. The opposite end of the ePTFE is then passed from the submental incision to the contralateral postauricular incision, again with Takahashi forceps. With adequate lateral traction exerted with a Kelly clamp, the ePTFE can then be secured to the underlying fascia just behind the ear lobule with an interrupted, vertical mattress 2-0 Surgidac suture after making sure that the strip is snug and in correct position in the midline. The strip naturally falls into the apex of the cervicomental angle at the level of the hyoid bone (Figure 1 and Figure 2).

After the excess ePTFE is sharply removed and the distal edge is folded on itself, 3 more interrupted 2-0 Surgidac sutures are placed, further securing the strip. After careful hemostasis is achieved, a suction drain is placed into the neck through a separate stab incision superiorly in the postauricular sulcus. Submental and postauricular incisions are then closed in layers including interrupted 5-0 Vicryl sutures (Ethicon Inc, Somerville, NJ) subcutaneously, and a running, interlocking, 5-0 fast-absorbing gut suture for the skin. All patients are treated with oral cephalaxin or ciprofloxacin for 7 days postoperatively. The drain should be removed after 48 hours unless drainage exceeds 50 mL/d.

SURGICAL TECHNIQUE: SECONDARY SLING TIGHTENING

The awake patient is seated upright while the 2 edges of the ePTFE are palpated postauricularly. The more prominent edge is arbitrarily chosen, marked, and the area infiltrated with 2 to 3 mL of 1% lidocaine with 1:100,000 epinephrine dilution. The patient is then laid supine and prepared and draped in the usual sterile fashion.

A 3-cm incision is then made in the inferior portion of the postauricular crease along the previous suture line. Dissection is undertaken subcutaneously until the edge of ePTFE is visualized. The Surgidac sutures are carefully lysed and the ePTFE edge grasped with a Kelly clamp. Lateral traction is then exerted, lysing any small proximal adhesions surrounding the ePTFE and facilitating its excursion through the subcutaneous tissues. This is continued until submental laxity is adequately resolved and desired tightening achieved. A 2-0 Surgidac suture is then placed in vertical mattress fashion securing the ePTFE to the underlying fascia. After excision of the excess ePTFE (usually about 2 cm), the new edge is folded on itself and further secured with 2 more 2-0 Surgidac sutures.

After careful hemostasis, the incision is closed in 2 layers, including interrupted 5-0 Vicryl sutures subcutaneously.
Table 1. Stratification of Patients by Dedo\textsuperscript{39} Classification

<table>
<thead>
<tr>
<th>Preoperative Dedo Classification</th>
<th>No. of Patients</th>
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<tbody>
<tr>
<td>Class 1 (normal)</td>
<td>0</td>
</tr>
<tr>
<td>Class 2 (skin laxity only)</td>
<td>13</td>
</tr>
<tr>
<td>Class 3 (+ fat accumulation)</td>
<td>15</td>
</tr>
<tr>
<td>Class 4 (+ platysmal banding)</td>
<td>68</td>
</tr>
<tr>
<td>Class 5 (+ congenital microgenia)</td>
<td>0</td>
</tr>
<tr>
<td>Class 6 (low hyoid position)</td>
<td>4</td>
</tr>
</tbody>
</table>

Table 2. Surgical Procedures With Sling

<table>
<thead>
<tr>
<th>Surgical Procedure</th>
<th>No. of Patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sling + lipoplasty</td>
<td>6</td>
</tr>
<tr>
<td>Sling with midline platysmal plication &amp; lipoplasty</td>
<td>35</td>
</tr>
<tr>
<td>Sling with rhytidectomy (midline and posterior</td>
<td>59</td>
</tr>
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</table>

RESULTS

Of the 100 consecutive patients who underwent elective neck rejuvenation surgery with incorporation of an ePTFE cervical sling between October 1996 and December 1998, 88 were women; mean age was 54.7 years; and mean follow-up was 40 months, with a range of 36 to 54 months. A total of 28 patients had undergone previous neck rejuvenation procedures without ePTFE slings.

Preoperative stratification done jointly by both of us according to the Dedo\textsuperscript{39} neck classification (Table 1) revealed that 83% of our cases fell into either class 3 or class 4. Of the 13 patients classified in the second Dedo group, 10 had undergone previous neck rejuvenation surgery.

Six patients underwent ePTFE sling placement with lipoplasty alone (Table 2), while 35 patients underwent sling placement in combination with midline platysmal plication as well as lipoplasty when necessary. Most patients (n=59) underwent sling placement as an adjunct to rhytidectomy, which included midline platysmal plication and posterior platysmal imbrication with lipoplasty being done when indicated. Undermining in the submental region by pretunneling was carried out with the help of a liposuction cannula in all patients regardless of the presence or absence of fat to ease subsequent scissors dissection and skin redraping.

Of the 100 patients who underwent sling placement with at least 36 months of follow-up, 99 were eligible for photographic comparison at 12 months (see Figures 3, 4, 5, and 6). Eighty-four patients had either a significant or marked improvement over preoperative standardized photographs (good or superior result; Table 3).

Subjective assessment of the sling procedure by 99 of the 100 patients at 12 months after initial placement revealed a satisfaction rate in appearance (met or exceeded expectations) of greater than 90%. Eight patients felt that the procedure did not meet expectations (Table 4). A total of 99 patients (100%) assessed felt no discomfort with the sling procedure at 12 months (Table 5). There were no requests for sling removal, and 86 patients claimed that they would recommend the procedure to a friend or relative.

Chart review for sling-related complications at 36 months revealed only 2 cases of infection. Wound cultures were positive for Staphylococcus in both cases. Lack of response to prolonged antibiotic therapy resulted ultimately in sling removal in both of these cases within 8 weeks. Sequelae from sling removal included persistent induration for an additional 6 weeks in one patient and submental pleating in the other. The latter patient subsequently underwent revision submentoplasty with replacement of the ePTFE sling, and the pleating resolved without untoward effects. The other patient refused revision sling placement and was therefore ineligible for outcome comparison or satisfaction survey at 12 months. Sling-related complications are listed in Table 6.

The most common sequelae related to sling placement was seroma formation in the submentum. All cases resolved with serial aspiration, although 2 cases required between 3 and 4 weeks of therapy. Induration along the soft tissues overlying the sling was found in 2 patients. This resolved in both cases with weekly injections of 2 mg/mL of triamcinolone. Of note, the first 2 patients who underwent sling placement were noted to have postauricular suture rupture within 2 weeks. Clear Prolene 4-0 suture (Ethicon Inc) had been used in these cases, and the slings were refastened bilaterally with 2-0 Surgidac suture. All subsequent patients underwent sling placement with 2-0 Surgidac suture without incidence of suture rupture. Slings were repositioned postauricularly in 3 patients, 1 for persistent pain probably secondary to accidental suturing of the greater auricular nerve, and the other 2 for sling visibility near the postauricular incision. There were no cases of sling extrusion, venous engorgement, or persistent dysphagia or odynophagia lasting longer than 1 week following surgery.

Of the 100 patients who underwent sling placement, 9 required secondary sling tightening. The mean interval to sling tightening was 14 months. The reason for tightening was recurrence of submental ptosis secondary to rebound tissue relaxation in all cases. Joint photographic comparison by the authors 1 month after sling tightening (Figure 7) revealed that each of the cases showed either significant improvement (4 patients) or marked improvement (5 patients). All patients undergoing sling tightening felt that the procedure either met preoperative cosmetic expectations (3 patients) or exceeded them (6 patients). Eight patients felt that the sling was uncomfortable but tolerable. There were no complications associated with sling tightening.

COMMENT

Although Julien Bourget first noted the importance of platysmal manipulation in aesthetic neck surgery in 1928,\textsuperscript{14} the difficulty of achieving long-lasting results in the neck
continues to challenge surgeons more than a half century later. Over the past 3 decades, notable improvements have been made to the classic cervicofacial skin-plasty. Surgeons such as Skoog, Jost and Lamouche, Rees, Rees and Aston, Connel, Connell and Gaon, Baker, Millard et al, Guerrerosantos, Aston, and more recently Webster et al, Feldman, Kamer and Lefkoff, and Hamra have brought to the forefront the importance of modifying the deeper tissue layers of the neck. Liposuction and direct lipocontouring have resulted in the accurate removal of unsightly fat accumulation. Superficial musculoaponeurotic system and platysma modifications (transection, wedge resection, plication, or rotational flaps) have resulted in the correction of banding, an improved mandibular line, and better support for the deeper structures of the neck. These techniques have thus become integral to the modern multilayered neck-lift.

Lipoplasty and platysmal modifications, however, are still inherently limited. Posterior platysmal transection can cause blunting of the lateral mandibular angle and contour irregularities toward the medial platysmal borders. Posterior plication decreases the cervicomental angle (sometimes acutely) but often leads to decreased support of submental soft tissues and submandibular gland prominence. Midline platysmal plication improves the cervicomental angle to a great extent but does not improve lateral mandibular definition. Combining midline and posterior platysmal modification offers perhaps the best surgical outcome. However, this necessitates wide exposure for often short-lived results. In the event of low hyoid position, even combination an-

Figure 3. Preoperative (A and C) and 12-month postoperative (B and D) photographs of a patient who underwent placement of an expanded polytetrafluoroethylene cervical sling along with liposuction.
terior and posterior platysmaplasty fails to create an optimal cervicomental angle (105°-110°). In addition, aggressive suprahyoid release procedures (transection of the anterior bellies of the digastric, geniohyoid, and mylohyoid to allow movement of the hyoid posteriorly and superiorly secondary to unopposed contraction of the stylohyoid muscles) have resulted in only moderate enhancement.

Suture suspension techniques, pioneered by Guarnerosantos, Giampapa and Di Bernardo, and Webster et al, and later modified by Ramirez, achieve better definition of the cervicomental angle and lateral mandibular line but are hampered by suture rupture. Skin rippling over the lateral margins of the neck is an additional problem. Also, suture suspension of the platysma does not allow for future tightening. Therefore, revision requires repeat suture suspension.

Figure 4. Preoperative (A and C) and 12-month postoperative (B and D) photographs of a patient who underwent placement of an expanded polytetrafluoroethylene cervical sling along with midline platysmal plication and liposuction.

The chief limitation of current techniques, therefore, is their lack of ability to address rebound tissue relaxation. Platysmal modification decreases the amount of recurrent ptosis seen with cervicofacial skinplasty alone. However, forces inherent to the skin that cause rebound relaxation can also be found in muscle and fascia and inevitably result in a recurrence of the submental laxity. Current procedures thus primarily provide only short-term improvement. They do not allow for simple secondary modification, and patients often require revision submentoplasty or secondary rhytidectomy.

Numerous authors, including Kamer, Kamer and Lefkoff, Kamer and Frankel, and Perkins and Gibson, have described in detail the need for revision surgery in the neck with standard procedures. In a recent study by Perkins and Gibson, rebound relaxation of tissues was the main anatomic factor leading to revision submentoplasty.
Use of the ePTFE cervical sling is an extension of the technique of lateral suture suspension. It is also a modification in the sense that one preplatysmal strip extends from mastoid to mastoid falling at the apex of the cervicomental angle. The vector in the midline is therefore posterior and superior, duplicating the pull of the stylohyoid muscles. This is in direct contrast to a ePTFE cervical suspension described by Conrad et al in 7 patients in whom a “membrane” was placed submentally, anterior to the cervicomental angle, and anchored to the submental periosteum between the angles of the mandible. Although additional support of the submentum was achieved, re-creation of the cervicomental angle was poor, and risk to the marginal mandibular nerve increased. The ePTFE mastoid-to-mastoid sling, however, results in a more ideal cervicomental angle, avoids lateral blunting, and improves the lateral mandibular line. In those patients with low hyoids, it gives the illusion of more normal hyoid position and obviates more complicated procedures such as suprathyroid muscular release. By virtue of its course across the submandibular triangles, ptotic submandibular glands are also supported.

In the present study, 84 patients had either a good or superior result when considering these factors. Likewise, patient satisfaction was very high. Over 90% of patients felt that surgery with sling placement met or exceeded their cosmetic expectations, while all felt that the sling was comfortable at 12 months. A total of 86 patients were willing to recommend the procedure to a friend or relative. Although a case-controlled study would be a more accurate means to compare results with and without the addition of the ePTFE sling, it was clear to us that there was significant improvement over standard techniques in the short term.

Figure 5. Preoperative (A and C) and 12-month postoperative (B and D) photographs of a patient who underwent placement of an expanded polytetrafluoroethylene cervical sling along with midline platysmal plication and liposuction.
In contradistinction to standard suture suspension or even ePTFE suture suspension, the placement of an 8-mm-wide strip of ePTFE in the form of a sling allows for simple revision or tightening under local anesthesia. Tightening counters the rebound tissue elasticity by distributing the recurrent submental laxity laterally. Cosmesis of longer duration can thus be achieved. Nine of our 100 patients undergoing a graded surgical approach to the aging neck with addition of a ePTFE sling had rebound ptosis within an average of 14 months. Subsequent sling tightening resulted in successful reduction (significant or marked improvement) of submental laxity in all 9 patients. In addition, 6 of the 9 patients felt that the tightening procedure exceeded their expectations. Most importantly, there was no evidence of secondary lateral pleating.

The physiologic nature of the soft tissue–ePTFE interaction that allows for sling tightening without formation of lateral pleating is particularly interesting. Histologically, the ePTFE facial implant, owing to its pore size

<table>
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<tr>
<th>Surgeons' Combined Evaluation</th>
<th>No. of Patients</th>
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<tbody>
<tr>
<td>Poor (no improvement)</td>
<td>3</td>
</tr>
<tr>
<td>Fair (moderate improvement)</td>
<td>12</td>
</tr>
<tr>
<td>Good (significant improvement)</td>
<td>37</td>
</tr>
<tr>
<td>Superior (marked improvement)</td>
<td>47</td>
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</table>

*Postoperative photographs taken 12 months after primary sling surgery.

In contradistinction to standard suture suspension or even ePTFE suture suspension, the placement of an 8-mm-wide strip of ePTFE in the form of a sling allows for simple revision or tightening under local anesthesia.
(22 µm), allows for limited tissue ingrowth. Therefore, tissue ingrowth occurs only when the alloplast is stationary in relation to the surrounding soft tissue envelope. By virtue of normal, horizontal, rotational neck movement after the primary surgery, the lateral (fixed) portion of the ePTFE allows for sufficient tissue ingrowth. In contrast, the more medial portion (mid-neck), which is in constant motion in relation to the overlying soft tissue, incites formation of a fibrocollagenous capsule without tissue ingrowth into the sling.

This allows for movement of the ePTFE in relation to the overlying soft tissue without tethering or pleating. Since the soft tissue layers (dermis, fat, and platysma) essentially fuse after primary surgery, lateral excursion of the ePTFE, lying in the middle of this soft tissue “envelope,” results in tightening of all 3 layers. The ability of the ePTFE to be easily tightened or revised can be used to advantage in other areas. Recently, Konior, who noted rebound tissue relaxation in patients undergoing facial reanimation with ePTFE soft tissue patches, was able to advance the implant superiorly and achieve better suspension and correction of the recurrent ptosis. Facial reanimation of longer duration can thus be achieved.

The decision to surgically use an alloplast in an elective situation may initially require a difficult jump in personal philosophy. However, its safe record in multiple areas of surgery has made its inclusion easier. Expanded PTFE is highly biocompatible and elicits little tissue reaction. It is noncarcinogenic and easily removable. There is no donor site morbidity, and it is available in an unlimited quantity. It is autoclavable, easy to cut and shape, and although used in the 1-mm thickness in this procedure, its edges are easily beveled. Today, ePTFE is used by most surgical disciplines, including general surgery, vascular surgery, obstetrics and gynecology, orthopedics, ophthalmology, and urology. In the head and neck, ePTFE has US Food and Drug Administration approval for use in facial reconstruction and augmentation, including rhinoplasty, mentoplasty, maxilloplasty, malarplasty, forehead defects, auriculoplasty, orbital repair, facial animation, nasolabial folds, and glabellar creases. It is contraindicated for cosmetic lip augmentation, temporal, poromandibular joint reconstruction, cardiovascular defects, and dermal placement.

In the present study, the most common complication encountered possibly related to sling placement was seroma formation found in 10% of the patients. This was amenable to aspiration in all cases, although 2 patients required serial aspiration for more than 2 weeks. This incidence was slightly higher than that found in our cases without ePTFE placement (5%). There are, however, no animal studies or clinical reports that have documented seroma formation secondary to ePTFE placement. In addition, cultures of all aspirates removed from these patients were negative.

Two patients required sling removal secondary to infection, which was diagnosed from the presence of unilateral, postauricular cellulitis. This subsequently resulted in drainage from the wound in both patients, and cultures were positive for Staphylococcus aureus. This was thought to be related to transcutaneous suture exposure in at least one of the patients secondary to the proximity of the sling to the postauricular suture line. There was no extension of the cellulitis from the postauricular region in either patient. There was also no evidence of infection tracking along the sling. The condition failed to improve in both patients with subsequent antistaphylococcal therapy, and ultimately the slings were removed. One patient underwent repeat sling placement at 6 months and had no further problems over the ensuing 36 months. The other patient had resolution of the infection without untoward sequelae. An additional 2 patients had persistent induration along the lateral margin of the sling that responded eventually to local triamcinolone injections. This induration was probably due to overzealous liposuction and contact of the ePTFE with the dermis in those areas.

Shoenrock and Reppucci and Cisneros and Singh have documented that direct contact of ePTFE with dermal elements incites a strong inflammatory reaction of erythema and edema at the skin site. It is therefore advisable to leave a layer of fat on the skin flap. Another option would be to bury the sling into the fascia covering the sternocleidomastoid muscle. Of note, there was no incidence of ePTFE rupture or extrusion. There were also no complications encountered with sling tightening.

| Table 4. Patient Self-assessment of Cosmetic Improvement 12 Months After Primary Sling Surgery |
|-----------------------------------------------|-----------------------------------------------|
| Self-assessment                              | No. of Patients                              |
| Failed to meet expectations                  | 8                                             |
| Met expectations                             | 43                                            |
| Exceeded expectations                        | 48                                            |

| Table 5. Patient Self-assessment of Comfort 12 Months After Primary Sling Surgery |
|-----------------------------------------------|-----------------------------------------------|
| Self-assessment                              | No. of Patients                              |
| Comfortable                                  | 99                                            |
| Uncomfortable                                | 0                                             |
| Intolerable                                  | 0                                             |

| Table 6. Sling-Related Complications Through 36 Months After Primary Sling Surgery |
|-----------------------------------------------|-----------------------------------------------|
| Complication                                | No. of Patients                              |
| Infection                                    | 2                                             |
| Extrusion                                    | 0                                             |
| Seroma                                       | 10                                            |
| Persistent seroma (>1 wk)                    | 2                                             |
| Induration                                   | 2                                             |
| Sling visibility                             | 1                                             |
| Sling rupture                                | 0                                             |
| Suture rupture                               | 2                                             |
| Venous engorgement (neck)                    | 0                                             |
| Persistent pain (>2 wk)                      | 1                                             |
| Dysphagia/odynophagia (>2 wk)                | 0                                             |
CONCLUSIONS

The failure of the classic cervicofacial skinplasty to treat the aging neck has resulted in the evolution of a number of important modifications and adjunctive techniques that address the deeper layers of the neck. However, these procedures are still limited in the early postoperative period and in the long term by rebound relaxation of elastic neck tissue. In this study, 100 patients underwent placement of a preplatysmal ePTFE cervical sling from mastoid to mastoid along the apex of the cervicomental angle in conjunction with a graded surgical approach to the aging neck. Results supported the hypothesis of improved short-term cosmesis by the creation of a more ideal cervicomental angle, improvement in lateral mandibular definition, and better support of submandibular soft tissues. The lack of any significant morbidity demonstrated the safe and effective nature of this procedure. Perhaps more importantly, the unique ability of the ePTFE sling to combat rebound tissue relaxation by successfully allowing long-term secondary adjustability was clearly evidenced.

Accurate rejuvenation of the aging neck depends not only on proper preoperative analysis of the deformities involved in each patient but also on the proper choice of techniques to adequately address each of the contributing anatomic factors. Regardless of a personal choice among the many surgical procedures, the ePTFE cervical sling with its built-in adjustability is a powerful addition to the surgical armamentarium in treating the aging neck.

Accepted for publication June 9, 2003.

This article was presented at the Seventh International Symposium of the American Academy of Facial

Figure 7. Preoperative (A and C) and 12-month postoperative (B and D) photographs of a patient who underwent tightening of the expanded polytetrafluoroethylene cervical sling.
REFERENCES


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