Early Perioperative Use of Polytef Suspension for the Management of Facial Paralysis After Extirpative Skull Base Surgery

Kevin A. Shumrick, MD; Myles L. Pensak, MD

Background: The satisfactory management of facial paralysis after extirpative skull base surgery has been notoriously difficult. To optimize physical and psychological recovery, early perioperative use of polytef (polytetrafluoroethylene [PTFE]) facial suspension has been used in patients with either profound electrophysiological or anatomical disruption of the facial nerve.

Objective: To review the efficacy of this clinical algorithm.

Study Design: Retrospective medical record review.

Setting: Tertiary care University Hospital Inc, University of Cincinnati College of Medicine, Cincinnati, Ohio.

Patients and Methods: Medical records review of 32 patients who underwent lateral skull base surgery with resultant facial paralysis who had facial rehabilitation using polytef suspension.

Results: All patients who underwent polytef facial suspension reported improvement in both facial function as well as aesthetics. One patient had a late extrusion of the polytef implant.

Conclusion: The early peri-extirpative application of this technique provides psychological and physical support to patients with facial paralysis who are recovering from lateral skull base surgery.

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The safe removal of benign and malignant lesions involving the temporal bone and adjacent skull base represents one of the major achievements of our specialty in the late 20th century. Review of the literature demonstrates an evolutionary process wherein surgeons have attempted to achieve maximal tumor removal while minimizing morbidity. Nevertheless, despite increased survival and decreased morbidity, the loss of vital neural and vascular structures at times remains unavoidable. The loss of facial function often has a profoundly negative effect on individuals with physical and psychological sequelae. Physically, patients with facial paralysis have difficulty with eating, drinking, speaking, decreased visual fields, and breathing through their nose. These disabilities are in addition to the vision-threatening consequences of being unable to protect and lubricate the eye by blinking. Socially, facial paralysis presents a distorted continence that others find disquieting. Affected individuals are avoided and often feel socially isolated. The combination of physical and psychological disabilities often results in a lasting postoperative depression.

Historically, a number of static and dynamic procedures have been advocated to address the liabilities experienced in this select patient population.1-4 Moreover, debate continues as to the optimal timing of intervention in the postoperative period as well as, the reconstructive method to be used.5 Irrespective of the underlying pathologic condition, it is our firm conviction that the sooner a patient is functionally and aesthetically rehabilitated the sooner he or she will resume his or her preoperative lifestyle. We report our current management algorithm using early peri-extirpative polytef (polytetrafluoroethylene [PTFE]; Gore-Tex Inc, Flagstaff, Ariz) facial suspension in patients sustaining complete facial paralysis resultant from the removal of skull base lesions, or in whom a protracted recovery period is anticipated based on electrophysiological criteria.6

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PATIENTS, MATERIALS, AND METHODS

Between 1990 and 1996, 32 patients (21 women and 11 men, aged 26 to 84 years) underwent the removal of skull base lesions that resulted in the complete electrophysiological disruption or sacrifice of the facial nerve. Among the lesions, there were 17 acoustic neuromas, 8 temporal bone malignant neoplasms (squamous cell or basal cell), 3 facial neuromas, 2 glomus tumors, 1 cerebellopontine angle epidermoid tumor, and 1 brainstem cavernous malformation. All patients undergoing polytef facial suspension also had upper eyelid gold-weight implantation to restore eyelid closure. The time from skull base surgery to polytef implantation varied. Early in our experience we waited up to 6 months for polytef implantation. Later, when the technique was shown to be well tolerated, we routinely performed implantation on patients within 2 weeks of skull base surgery. The site of polytef implantation varied with the severity of the patient’s symptoms and expected functional outcome.

In all 8 temporal bone resections the facial nerve was sacrificed and nerve grafting was not believed to be an option. In patients with acoustic neuroma, the nerve was anatomically lost in 3 cases at the root entry zone and they underwent 7th and 12th nerve anastomoses in addition to static polytef facial suspension. Owing to the fact that a prolonged recovery period for facial reinnervation was anticipated after sural nerve grafting in 2 patients and primary anastomosis in 3 patients, these patients had polytef suspension to ameliorate the morbidity of facial paralysis during nerve regeneration (typically 12-18 months). Nine patients with acoustic neuromas underwent polytef facial suspension after maximal neural stimulation at the brainstem produced no electrophysiological response, despite a response with stimulation in the distal (labyrinthine) segment. These patients had an anatomically intact nerve but physiological paralysis with an expected recovery time of at least 12 months. The 2 patients with glomus tumors had cable grafts placed as did the 3 patients with facial neuroma. The patient with the brainstem cavernous malformation and the patient with the cerebellopontine angle epidermoid tumor both had complete denervation without stimulation of the seventh nerve at the conclusion of surgery despite an anatomically preserved facial nerve.

RESULTS

TIMING OF SURGERY

The first 2 patients who underwent polytef facial suspension had the suspension performed at 6 and 4 months after temporal bone resection without nerve grafting. Subsequently, when it was determined that a patient would benefit from polytef facial suspension, we tried to perform the suspension as soon as possible. Most of them were performed within 2 weeks of surgery. Three patients who underwent temporal bone resection had the polytef facial suspension performed at the time of resection. All of the patients with intercranial tumors had their polytef facial suspensions performed as a second surgical procedure.

RESULTS OF FACIAL NERVE REGENERATION

Facial nerve response was categorized in 32 patients after 18 months’ follow-up using House-Brackmann grading: 10 patients with grade VI paralysis, 6 patients with grade V paresis, 9 patients with grade IV paresis, 5 with grade III paresis, and 2 with grade II mimetic function.

SITE OF POLYTEF IMPLANTATION

All patients had the melolabial crease suspended. Four patients had the melolabial crease and nasal alar-facial crease suspended. Three patients had the melolabial crease, nasal alar crease, and eyebrow suspended.

COMPLICATIONS

Despite the return of some facial muscle function in most patients, we have not electively removed their polytef implants. In fact, of those patients with some facial nerve regeneration, it was noted that the implants continued to provide support to the incompletely reanimated face. There was one polytef implant removed in a somewhat debilitated patient living in another state. We were unable to examine her, but it seems as if she developed a late wound infection (20 months).

DURATION OF SUSPENSION

The duration of suspension seems to be long lasting. Two patients with complete paralysis have had a revision of their polytef facial suspension at 36 and 48 months postoperatively.

All 32 patients believed that the facial suspension with polytef provided benefits: improved their ability to handle foods, particularly liquids; improved their speech and production of passive sounds such as /p/; improved their breathing through the ipsilateral nostril; and in those patients undergoing eyebrow suspension, lessened hooing of the ipsilateral eyebrow. No patient reported speech difficulty; all patients agreed that there was a significant cosmetic benefit.

TECHNIQUE OF POLYTEF SUSPENSION FOR THE PARALYZED FACE

The aim of polytef suspension in the management of the paralyzed face is to attempt amelioration of the most troublesome aspects of facial paralysis. For most patients the most bothersome part of a facial paralysis is not loss of volitional or mimetic movement, but loss of baseline facial muscle tone. This loss of muscle tone is responsible for most of the difficulty these patients experience with eating, drinking, speaking, hooing of the upper eyelid, breathing through the ipsilateral nostril, and
the aesthetic sequelae of facial drooping. The middle third of the face and eyebrow are treated separately. In the middle third of the face we focus on repositioning the corner of the mouth, oral commissure, and lateral nostril. The eyebrow is managed with elevation at its middle and lateral thirds.

In this series, all patients undergoing polytetrafluoroethylene (PTFE) suspension had suspension of the ipsilateral oral commissure elevated (Figure 1 and Figure 2). If nasal obstruction was present, due to nasal alar collapse, then an alar suspension was also performed. The oral commissure is elevated by making a 7- to 10-mm incision along the melolabial crease (just above the level of the oral commissure). Dissection is continued anteriorly until the fibers of the orbicularis oris are identified. If the nasal ala is to be suspended, then an incision is made in the alar facial crease and blunt dissection is used to expose the perinasal muscles. A final incision is made over the body of the zygoma (at the transition zone of lower eyelid skin to cheek skin) (Figure 1D and Figure 2C). The cheek incision is oriented to run with the relaxed skin tension lines and, after the skin has been incised, blunt dissection is used to expose a portion of the zygoma. Subcutaneous tunnels between the cheek incision and the perinasal and perioral incisions are created by blunt dissection in a deep subcutaneous plane, superficial to the zygomatic muscles. This plane is superficial to the course of the facial nerve and, therefore, should not interfere with nerve reinnervation. Strips of 1-cm-wide polytetrafluoroethylene are then passed through the tunnels (Figure 1E and Figure 2D-E). A 1-mm-thick polytetrafluoroethylene strip is used for the nasal suspension and a 2-mm-thick polytetrafluoroethylene strip is used for the perioral. The inferior ends of the polytetrafluoroethylene strips are sewn to the perinasal muscles and orbicularis muscles with multiple, interrupted, permanent sutures (at present we are using 5-0 polytetrafluoroethylene sutures). The polytetrafluoroethylene strips are then stretched until the desired amount of suspension has been achieved (usually slight overcorrection is used) and the strips are crossed over one another. A hole is then drilled through both strips into the underlying zygoma and a single screw is used to tack the polytetrafluoroethylene to the bone (we routinely use a 1.5-mm-diameter screw [Synthes, Paoli, Pa] that is 6 mm long) (Figure 1F).

The technique of managing the eyebrow ptosis has been evolving. We are performing the eyebrow elevation in conjunction with an endoscopic eyebrow lift. Vertical incisions are made just at the hairline in the midline and paramedian position. A supraperiosteal plane is established and wide undermining of the ipsilateral forehead performed. The endoscopes are used to release the periosteum from the orbital rims and to protect the supraorbital nerves. The periosteum is then incised to allow greater lift. A horizontal incision is then made 5 mm above the middle third of the eyebrow and a 1-mm-thick and 1-cm-wide polytetrafluoroethylene strip is passed between the paramedian scalp incision and the supra-eyebrow incision (Figure 1G). A 1-mm-thick polytetrafluoroethylene strip is used because it is less noticeable under the thin forehead skin. The inferior end of the polytetrafluoroethylene strip is then sewn to the orbicularis with incorporation of the periosteum, if possible. The polytetrafluoroethylene strip is then used to elevate the eyebrow to the desired position and it is secured to the skull with a 1.5-mm-diameter, 5-mm-long screw (Synthes) (Figure 1H).

The facial and supra-eyebrow incisions are closed with 6-0 polyglycolic acid sutures subcutaneously, and 6-0 fast-absorbing gut in the skin. The scalp is closed with a single layer of staples. The surgery is performed with conscious sedation (usually a propofol drip) anesthesia on an outpatient basis. External dressings are not used.

### Alloplastic Material

Expanded polytetrafluoroethylene (PTFE) or polytetrafluoroethylene is a synthetic polymer based on 2 carbon atoms single-bonded to 4 fluorene molecules. This chemically inert stable compound is noted to be nonadherent, nonallergenic, and quite malleable owing to the electronegative fluorene atoms protecting the carbon chain. The physical characteristics of the expanded PTFE that make it highly desirable as a material conduit for facial suspension for surgical intervention include: (1) porosity (22-30 µm), (2) absent cellular reactivity, (3) long-term structural integrity, (4) consistency, and (5) ease of applicability.

Since Levet and Jost first reported the use of polytetrafluoroethylene for dynamic facial suspension in 1987, there has been a generally favorable response to its employment. In 1992, Konior noted that facial suspension with a fascial lata graft had the undesirable result of both donor-site morbidity and an initial gross overcorrection that was requisite to compensate for postoperative soft tissue relaxation and stretching. In commenting on his series of 11 patients using polytetrafluoroethylene for facial suspension, he noted a low morbidity wherein only 1 patient developed a localized infection, and there were 2 cases of postoperative suture extrusion.

Subsequent reports by Iwahira and Maruyama and Petroff et al further demonstrated the utility and efficacy of polytetrafluoroethylene in facial paralysis rehabilitation. These authors, along with Bradford and most recently Campbell and Shumrick have commented on many biological and physiological functional advantages to the usage of polytetrafluoroethylene. Included among these observations are the fact that: (1) the material is easy to store and can be readily resterilized; (2) the material can be easily tailored to the local anatomical site of usage; (3) the material itself is soft and supple; however, from a functional viewpoint, it is strong and durable; (4) the use in more than 500,000 clinical cases, on a worldwide basis, for a wide variety of clinical usages has demonstrated its outstanding biocompatibility and lack of general cellular reactivity.

Recently, Fisher and Frodel described using acellular human dermal allografts as the suspending material in their series of 10 patients with facial paralysis. They believed that the advantage of acellular human dermis was that potential for host tissue ingrowth and tissue integration. The advantages of tissue integration are, theoretically, more stable and long-lasting results with less chance of long-term complications. We believe that acellular human dermis may well have potential, but in our limited experience we noted a distinctly decreased...
Figure 1. A-C, Patient with intact facial nerve but facial paralysis after acoustic neuroma surgery who is about to undergo polytet suspension of the face and eyebrow as well as tarsal strip of the lower eyelid and gold-weight placement in the upper eyelid. D, Planned incisions for suspension of the oral commissure, nasal ala, and eyebrow. E, Placement of polytet strips for lower face suspension. Note how they have been crossed over one another so that a simple screw (Synthes, Paoli, Pa) can secure them. F, View after placement of the screw. G-H, Placement and screw fixation of polytet eyebrow suspension. I-J, One month postoperative result.
duration of noticeable suspension results with the acellular human dermis when compared with polytef. Perhaps acellular human dermis may be the route to go in patients who are expected to recover facial nerve function.

Concern has been expressed about the use of polytef in patients who have had, or will undergo, radiation therapy. There is little written on this subject, but an article about chest wall reconstruction with polytef and postoperative radiation therapy showed that it was well tolerated. In all 8 of our patients who underwent temporal bone resection we consulted with our radiation oncology service and the site of polytef implantation was determined to be well anterior to the irradiation portals. This does not definitively answer the question of polytef compatibility with radiation therapy and clinicians should always be appropriately cautious.

From a functional viewpoint, polytef facial suspension of the paralyzed face provides significant mollification of drooling and the ability to minimize buccal vestibule distention that results in pooling of food, particulate matter, and liquids. Moreover, focal repositioning of the oral commissure allows for the leveling of the lips thereby improving facial symmetry, and for minimizing the spout-like effect of a drooping lateral oral commissure. Suspension of the nasal ala improves the nasal airway and facial asymmetry. Eyebrow elevation improves eyebrow ptosis, which can be severe in patients with facial paralysis. Note that these improvements are accomplished without the need for a donor site, do not interfere with facial nerve regeneration, and can be undone quickly and easily if the need should arise.

Because of its biocompatibility and stability, polytef is able to provide long-lasting soft tissue suspension. The use of polytef for repositioning the oral and nasal sphincters, in addition to eyebrow suspension, has provided a simple effective means for ameliorating some of the most troublesome aspects of facial paralysis in patients undergoing skull base surgery. When used conjointly with a tarsal strip for tightening of the lower eyelid and an upper eyelid gold weight for ocular protection, patients with facial paralysis may be returned to a relative state of “normalcy” without donor-site morbidity and interference with potential facial nerve regeneration.

Increasingly, we have begun to use polytef for early facial rehabilitation in patients with anatomically intact facial nerves but electrophysiological dissociation secondary to nerve manipulation during tumor removal. In cases wherein the proximal-to-distal stimulus ratio is profound, and a prolonged recovery period is anticipated, polytef facial suspension is used during the recovery phase to ameliorate the severe functional and psychological sequelae of facial paralysis.

We have not found it necessary to remove the polytef implants after facial function returns. In fact, the implants often continue to provide some support for

Figure 2. A-B, Representative preoperative photographs of a patient about to undergo polytef suspension of the lower face (nasal ala and oral commissure) for rehabilitation of a right-sided facial paralysis. Note the unsightly tarsorrhaphy. C, Preoperative skin incision markings. The markings for the lip and nasal incisions are overly long for illustrative purposes. Typically, the incisions are only 7 to 10 mm long. D, The polytef strips have been passed through the subcutaneous tunnels and sewn to the perinasal and perioral musculature. E, Polytef strips have been crossed over one another and placed on tension prior to being secured to the zygoma with a screw (Synthes, Paoli, Pa). F, Six-month postoperative photograph showing improved symmetry of the face. Additionally, the patient is functioning much better with regard to eating, drinking, speaking, as well as breathing through her nose. Note also the improved appearance and position of her eye after release of the tarsorrhaphy and placement of a gold weight.
those individuals with incomplete recovery of facial nerve function.

**CONCLUSIONS**

Because of ease of applicability, minimal morbidity, and near-universal patient satisfaction, we have aggressively used polytef suspension for facial rehabilitation in the early perioperative recovery period of patients undergoing skull base surgery. Furthermore, because the polytef implants do not impede or ultimately diminish facial nerve regeneration, polytef suspension may be used in patients with intact nerves that are temporarily not functioning. Finally, we believe that any procedure that lessens the physical and psychological stress precipitated by the removal of skull base lesions should be pursued to facilitate early facial rehabilitation.

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Corresponding author: Kevin A. Shumrick, MD, Department of Otolaryngology–Head and Neck Surgery, University of Cincinnati, PO Box 670528, Cincinnati, OH 45267-0528.

**REFERENCES**


And William Osler is a fascinating man whom we need nowadays. In this time of cynicism, it is good to know that the earth can be inherited by those who have faith and trust in the improvability if not the perfectibility of humankind; in this time of bioethical conundrums, it is good to know that patience, good will, and personal morality will unite far more intellectual knots than the disarray of rancor, conflict, and special interests; in this time of great medical miracles it is good, and properly humbling too, to know that there have been other periods of miracles, and yet the ancient problems of health and human happiness remain, bringing new challenges to each succeeding generation.

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