Objective: To evaluate the technique of using an intact autogenous periosteal flap for tethering of the globe in patients with severe paretic strabismus.

Methods: We performed a periosteal flap procedure on 5 patients and followed their postoperative course. The flap was created from the medial, lateral, or superior orbital walls. A description of the harvesting and manipulation of the flap and the initial postoperative findings are presented.

Results: All patients showed marked reduction in their postoperative strabismic deviation compared with preoperative measurements. Greater early postoperative swelling was noted after this procedure than with the standard strabismus surgery. No complications were experienced during or after surgery. Two patients required a second operation for adjustment of the periosteal flap for adequate alignment.

Conclusions: The vascularized periosteal flap technique provides an excellent tether for the globe. Early and late stability has been favorable.


Occasionally, severe paretic and restrictive strabismus problems require globe fixation in the primary position because of the presence of only one active extraocular muscle. In these cases, the one rectus muscle is completely palsied or not functioning, and even supramaximal recession of its antagonist will almost always result in recurrence of the strabismus. Thus, passive globe fixation in the primary position is needed to prevent recurrence. Classic examples of this type of problem are complete third nerve palsy and severe ocular fibrosis syndrome. A variety of techniques are available to accomplish this task, including use of various alloplastic and autogenous materials.1-3

In our evolution of treatment of this problem, we have used permanent suture material and autogenous fascia such as temporalis fascia attached to the remnant muscle. Transposition of the superior oblique muscle with and without removal of the tendon from the trochlea has also been described to achieve medial fixation. Although these materials were sometimes successful in initially tethering the globe, there was a tendency with time for late drift and failure. We were therefore motivated to find a more substantial tissue to use for globe tethering in complex paretic or restrictive strabismus. This led to our use of orbital periosteal flaps. Periosteal flaps are not only autogenous but have the substantial advantage of being vascularized and based ideally at the orbital apex, in the same area as the origin of the extraocular muscle whose function the periosteal flap is designed to replace. Creating the flaps and manipulating them within the orbit uses techniques and takes advantage of anatomical features that should be familiar to the orbital surgeon.

In this article, we describe the surgical technique for harvesting and manipulating periosteal flaps and our initial experience with 5 patients.

We created periosteal flaps from the superior, lateral, and medial orbital walls (Figure 1). The lateral wall, floor, and medial wall can be accessed through conjunctival incisions. The roof is best accessed through an eyelid crease incision.

From the Jules Stein Eye Institute, University of California–Los Angeles School of Medicine. The authors have no proprietary interest in the products described in this article.
The conjunctival incision is performed in the fornix overlying the parietic muscle. To create a lateral periosteal flap, the dissection is carried out through the orbital fat to the lateral rim. To create an inferior periosteal flap, the dissection follows the plane of the lower eyelid retractors down to the floor and orbital rim. To create a medial flap, the incision is located at the lateral edge of the caruncle. In the caruncular conjunctival approach, the dissection must follow the plane of the Horner muscle to the posterior lacrimal crest to avoid injury to the lacrimal sac and canaliculi (Figure 2).

In all patients, once the rim is achieved, the fat is cleared from the periosteum. A periosteal flap is designed approximately 1 cm in width and incised with a sharp-tipped monopolar cautery. The flap should be started anteriorly as close to the rim (or posterior lacrimal crest medially) as possible and can include the arcus marginalis at the anterior rim as its anterior leading edge. It is easy to trim the edge of the flap if it is too long but impossible to lengthen it if it is too short.

Once the periosteum in the desired quadrant is exposed and the flap is designed, the margins of the flap are sharply dissected and the flap is elevated from the underlying bone using a sharp periosteal elevator (Figure 2). The periosteum is often somewhat thin and friable, and careful dissection is required to avoid transecting the flap. The flap should be based as widely as possible at the apex (≥1 cm wide) to minimize the chance of flap transection. The flap does not have to be taken back all the way to the apex. Dissection approximately midway into the orbit is usually sufficient to adequately mobilize the flap. After the flap is created, it is fixated with a double-armed suture through its tip (Figure 3).

The muscle insertion is then exposed by dissecting the Tenon capsule anteriorly. Blunt scissors and then a fine hemostat are pushed through the orbital fat just posterior to the intramuscular septum and visualized in the extraperiosteal plane. Both arms of the preplaced suture can be grasped with the hemostat and pulled back into the sub-Tenon plane. This allows the periosteal flap to travel from the extraconal space into the periconal space (Figure 4).

The periosteal flap can then be attached to the extraocular muscle’s insertion point under appropriate tension to position the globe.
Figure 2. The medial orbital wall is approached through a caruncular incision. The plane of the Horner muscle is followed to the posterior lacrimal crest. A lacrimal rake is used to retract the medial cut edge of conjunctiva, and a thin malleable retractor is used to hold back the orbital fat. Copyright 1998 Regents of the University of California, reprinted with permission.

Figure 3. A permanent suture such as 5-0 Mersilene on a spatulated double-armed needle is passed through the edge of the periosteal flap. Copyright 1998 Regents of the University of California, reprinted with permission.

Figure 4. Axial section. A fine hemostat is passed by blunt dissection from the periconal space to the periosteal space, and the sutures are grasped. Copyright 1998 Regents of the University of California, reprinted with permission.
to approximately 5- to 10-prism diopter (PD) overcorrection (Figure 5), recognizing that undercorrections are more frequent than are overcorrections in these patients. It is necessary to tie the suture “in the hole,” passing one end back into the orbit as the knot is tied, to avoid pulling the suture out of the periosteal flap.

To harvest a periosteal flap in the superior orbit (to tether the globe against an unopposed inferior rectus muscle), the orbital rim is best approached through an eyelid crease incision, working superior to the levator aponeurosis and muscle. An eyelid crease incision provides rapid access to the superior orbital rim. The superior flap is harvested lateral to the supraorbital neurovascular bundle to avoid injury to the frontal nerve (Figure 1, C), but the flap can then be slightly curved medially if desired as it is dissected back to the apex so that the flap actually crosses over the nerve. Working through a separate conjunctival incision over the superior rectus insertion, the flap can then be brought from the extraconal to the periconal space using a hemostat, as described above. The flap is passed around the lateral edge of the levator muscle.

The conjunctiva is closed using interrupted absorbable sutures. To decrease postoperative inflammation and chemosis after this extensive, multiplane orbital dissection, a corticosteroid injection (such as triamcinolone acetate) is given at the end of the procedure.

REPORT OF CASES

Five patients were evaluated and underwent the periosteal flap procedure. Presented are their preoperative and postoperative histories, including strabismic measurements and any previous or subsequent eye muscle operations.

CASE 1

A 9-month-old girl had a left face turn and a dilated right pupil for 4 months before our initial examination. She had 45 PD of exotropia (XT) at distance and near, with limitation of elevation, depression, and adduction of the right eye. The right pupil was 4 mm and the left pupil was 2 mm. Although there was no ptosis, the findings indicated a right third cranial nerve palsy. At another institution 1 month later, she underwent an 8-mm recession of the right lateral rectus muscle and a 6-mm resection of the right medial rectus, both with superior transposition. Examination 2½ years later revealed a 30-PD XT at distance and near (Figure 6, A). At age 3½ years, she underwent an additional 4-mm recession of her right lateral rectus and a right medial periosteal flap procedure to tether the XT eye in the primary position. Although she was orthophoric 3 months after surgery (Figure 6, B), 5 months after surgery she had 5 to 10 PD of XT (Figure 6, B); 14 months after surgery she had 5 to 10 PD of XT with 5 to 10 PD of right hypertropia.

CASE 2

A 4-month-old girl had limited abduction of the right eye for 2 months. On examination, she had 30 PD of esotropia (ET) with minimal abduction in the right eye. She also had
reduction of elevation and depression in the right eye. At age 11 months, shortly before surgery, she had 40 PD of ET with 5 PD of right hypertropia. Passive forced duction testing of the right eye under anesthesia revealed severe restriction in all directions consistent with ocular fibrosis syndrome. She underwent a right lateral periosteal flap procedure and 7-mm recession of the right medial rectus. The right superior rectus was tight and severely nasally displaced and therefore was recessed 7 mm; it was believed that the nasal displacement was contributing to the abduction restriction. Therefore, the right superior rectus was recessed. Six weeks after surgery she had a residual ET of 15 PD. Eight months after surgery there was 15 to 20 PD of ET with a right hypotropia of 15 to 20 PD. Nine months after surgery a revision of the lateral periosteal flap with tightening, an additional 6-mm recession of the right medial rectus muscle, and a 10-mm recession of the right inferior rectus muscle were performed. Six months later, no horizontal deviation occurred and left hypertropia was 20 PD.

CASE 3

A 4-year-old boy with bilateral ocular fibrosis syndrome had no ability to rotate either eye above the midline and severe restriction of adduction bilaterally. Years before our examination he had undergone bilateral large inferior rectus muscle recessions for a large chin-up position because of the inability to elevate either eye. However, both eyes were still “fixed” in downgaze with a compensating chin-up position, and the child could not elevate either eye to the horizontal position. The left inferior rectus muscle was again recessed to a distance of 15 mm posterior to the limbus, accompanied by a superior orbital periosteal flap in an effort to stabilize the left eye in the primary position and prevent recurrence of the left inferior rectus contracture. Six weeks after surgery both eyes were near the horizontal midline with little or no chin-up position. Three months later a left hypotropia and chin-up position had recurred, and a revision of the superior periosteal flap was performed. Eight months after the revision he had a 10° chin-up position with a left hypotropia of 5 PD and an XT of 10 PD.

CASE 4

A 79-year-old woman sustained a cerebrovascular accident 1 year before our evaluation and had a resultant left third cranial nerve palsy. She had a 65-PD XT with a left hypotropia of 10 PD (Figure 7, A). She had marked reduction of elevation, depression, and adduction of the left eye. The patient underwent a medial periosteal flap procedure with an 18-mm recession of her left lateral rectus muscle on an adjustable suture and a 9-mm recession of the left superior rectus muscle. Three months after surgery she was orthophoric at distance and had a 6-PD XT near. Sixteen months after surgery she had an 8-PD XT at distance and near (Figure 7, B).

CASE 5

A 3-year-old girl had congenital cerebral palsy associated with facial diplegia. On our initial evaluation she had a 70-PD XT with poor supraduction, infraduction, and adduction of both eyes. She had undergone bilateral ptosis repair at 2 years of age. Passive forced duction testing under anesthesia revealed marked restriction of the elevation and depression and moderate restriction of adduction of both eyes, consistent with ocular fibrosis.
syndrome. She underwent a right medial periosteal flap and a 9-mm recession of her right lateral rectus muscle. Forced duction testing under anesthesia 4 weeks after surgery demonstrated a slight release of the periosteal flap procedure but continued good tethering effect. Postoperative week 7 measurements showed an XT of 15 PD.

The Table summarizes the characteristics and outcomes of the patients. Four of the 5 patients were children. Three patients had ocular fibrosis syndrome and 2 had third cranial nerve palsies. Preoperative deviations ranged from 6 to 70 PD in the plane of the periosteal flap, with an average deviation of 42 PD. All patients experienced marked reduction of their preoperative deviations at the 6-week postoperative measurements. The average postoperative week 6 measurement was 6 PD of deviation (range, 0-15 PD), with an average reduction of 36 PD (range, 5-65 PD). This translates to an average correction of 88% from orthophoria (range, 63%-100%). Both patients who underwent revision of the periosteal flap had ocular fibrosis syndrome.

**COMMENT**

The management of paralytic and restrictive strabismus is based on the principle of rebalancing unequal forces of antagonist muscles. For instance, the presence of a sixth cranial nerve palsy creates an imbalance between the medial and lateral rectus muscles in one eye, with a resultant ET. The treatment is based on either resecting a paretic lateral rectus to reestablish the equilibrium of forces between the medial and lateral recti or performing some type of muscle transposition procedure of the vertical recti laterally to create a new lateral force to balance the unopposed normal medial rectus force. In restrictive strabismus, the stronger or more restrictive force is usually weakened by recessing a rectus muscle, as in a patient with Graves disease with a hypotropia, with a restriction of upward rotation. In this situation, the inferior rectus muscle is recessed to reestablish a balance of force between the inferior and superior recti.

This treatment strategy works well in situations in which the antagonist is capable of generating sufficient muscle strength or in which transposed muscles can establish an opposing force. However, in some complicated situations, the rebalancing of forces is not possible. For instance, in a patient with a complete third cranial nerve palsy, the normal lateral rectus muscle is essentially unopposed by any meaningful adduction force. Consequently, conventional strabismus surgical procedures are not effective, and XT will usually recur, even with aggressive lateral rectus recession. In this type of situation, it might be desirable to create an effective restriction medially that will result in alignment in the primary position and prevent recurrent XT by creating an opposing mechanical restriction to balance active lateral rectus contraction. Similarly, in ocular fibrosis syndrome, it might be necessary to tether the globe against the unopposed action of an antagonist muscle.

Multiple attempts have been made to create such a tethering effect using various materials. We and other investigators have evaluated alloplastic materials such as silicon bands and permanent sutures. With silicon bands, some authors have tried to regulate the amount of elastic tension provided by the band.
We and other authors have also used autogenous materials as tethering agents, including fascia lata and temporalis fascia.\(^1\)\(^2\) The amount of fascia lata harvested as described by the authors is a 1 × 5-cm strip.\(^2\) However, the limitation of the fascia lata is that a sufficient amount cannot be harvested in very young children.\(^2\)

The periorbital flap has several distinct advantages. The tissue itself is autogenous and therefore eliminates the problems associated with alloplastic materials, such as extrusion, inflammatory reactions, and resorption. The periorbital flap is also well vascularized because it is a tissue flap compared with free grafts harvested from other parts of the body, such as the temporalis fascia and fascia lata. Because the periorbital flap has its base at the orbital apex, it originates from the same area as the extraocular muscles, allowing the flap to follow a course through the orbit similar to that of the rectus muscle it was designed to replace. In addition, the procedure reduces the number of rectus muscles operated on to achieve the desired alignment, thus decreasing the possibility of anterior segment ischemia.

Our initial experience with 5 patients has allowed us to evaluate the creation of the periorbital flap from the medial, lateral, and superior orbital walls. The basic procedure is similar for all, although a transconjunctival approach was used for the lateral and medial wall and an eyelid crease incision was used for the roof of the orbit. The purpose of the periorbital flap, as with other tethering techniques, is to shift the affected globe into an orthotropic position in primary gaze. No active movement generation is expected from the flap, and the patients or their parents were advised of this.

More postoperative edema was noted after the procedure compared with after standard strabismus surgery, which was expected given the greater extent of dissection necessary for the creation of the periorbital flap. It is recommended that a sub-Tenon corticosteroid injection be given at the end of the surgery.

The end point for intraoperative alignment was a small overcorrection (approximately 5-10 PD) based on the eye position in the orbit. The creation of the periorbital flap was performed in conjunction with the recession of the active antagonist muscle to decrease the tension experienced by the flap. Two patients required revision of the flap, as can be expected from the complex nature of their strabismus. The recurrence of the deviation might be caused by the opposing force of the antagonist muscle at the time of flap-scleral adhesion formation. Botulinum toxin injection of the antagonist muscle to temporarily create a palsy of this muscle might be beneficial to reduce the tension at the wound interface, although we have not yet added this modification. Suturing the antagonist muscle insertion might be helpful to prevent it from totally reducing its opposing effect and also decreasing the periorbital-scleral wound interface tension.

To treat difficult paretic strabismus when other options were limited, we used a vascularized periorbital flap based at the apex, tunneled from the periorbital space to the periconal space and attached to the rectus muscle insertion to fixate and tether the globe. The exposure of the periorbita through conjunctival incisions laterally, inferiorly, or medially is difficult, but with good illumination and assistance it is well within the technical capability of a surgeon versed in orbital anatomy and approaches. Superiorly, an eyelid crease approach provides wide visualization of the periorbita. Although we had to adjust the position of the tether in 2 patients, we have been pleased with the early and late stability of the tethering effect. Aside from increased early postoperative swelling compared with standard muscle procedures, we have noted no complications related to the harvesting or fixation of the flap.

In our anecdotal experience, the vascularized periorbital flap provides superior globe tethering compared with alloplastic or autogenous nonvascularized tethers.

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Reprints: Robert A. Goldberg, MD, Jules Stein Eye Institute, University of California—Los Angeles School of Medicine, 100 Stein Plaza, Los Angeles, CA 90095.

REFERENCES


