Function of transected or avulsed rectus muscles following recovery using an anterior orbitotomy approach

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PURPOSE To assess the function of muscles retrieved from a retrobulbar location using an anterior orbitotomy approach and to identify the prognostic factors favoring a good outcome.

METHODS The records of all patients undergoing anterior orbitotomy for the retrieval of a transected or avulsed muscle in a retrobulbar location were reviewed. Ocular motility, before and after retrieval (with ductions scaled from −4 to +4), was evaluated.

RESULTS Record review identified 11 patients who had suffered trauma to 12 muscles (5 inferior, 6 medial, and 1 lateral rectus muscle). Ductions improved from -4 ± 0.4 preoperatively to -2.7 ± 0.9 postoperatively ($P = 0.002$); mean primary position deviation improved from $34^\Delta \pm 14^\Delta$-$15^\Delta \pm 9^\Delta$ ($P < 0.001$), and mean deviation in the field of action improved from $47^\Delta \pm 20^\Delta$-$20^\Delta \pm 22^\Delta$ ($P = 0.02$). Ductions improved by at least two units in three patients, all of whom had medial rectus trauma. Single binocular vision in primary gaze was achieved in 6 patients. Patients with medial rectus muscle injury and patients injured by sinus surgery had the lowest likelihood of recovering single binocular vision.

CONCLUSIONS Our results are similar to historical series in which muscles were not retrieved and transpositions performed; however, muscle retrieval avoids risks associated with transposition surgeries such as anterior segment ischemia. Muscle recovery via the anterior orbitotomy approach may be reasonable to consider in those cases with a reasonable possibility of having active force generation postoperatively. (J AAPOS 2012;16:336-341)

Extraocular muscle transection or avulsion is a grave complication of surgery or trauma. Various techniques for retrieval and repair of traumatized muscles have been described.[1,2] In published series of rectus muscle disinsertion or transection, retrieval rates ranged from 50% to 100%.[1-5] Muscles that are transected posteriorly are the most difficult to retrieve and are often impossible to retrieve from a standard anterior approach.[1-5] In the largest study of traumatic muscle disinsertion, the retrieval rate was 53%, whereas the remaining 47% of cases were converted to adjacent rectus muscle transpositions or to maximal recessions of the antagonist muscle.[4] Our group has used an anterior orbitotomy approach for retrieving transected rectus muscles, with a recovery rate of 100%[1,6]; however, because function of the retrieved muscle stump has not been systematically assessed, the utility of extensive surgical procedures remains questionable. The purpose of this study was to evaluate muscle function after retrobulbar recovery of severely traumatized rectus muscles via anterior orbitotomy.

Methods

This study was approved by the University of California, Los Angeles, Institutional Review Board and conformed to the requirements of the United States Health Insurance Portability and Accountability Act. Clinical records of all patients who underwent anterior orbitotomy combined with strabismus surgery between 1998 and 2010 were reviewed. Patients who sustained an extraocular muscle transection or insertional avulsion were included. Patients who suffered a ruptured globe or had undergone prior strabismus surgery were excluded. In general, patients underwent anterior orbitotomy and attempted retrieval in cases of severely traumatized rectus muscles whose anterior terminal portions were recognized to be in a retrobulbar location on magnetic resonance imaging (MRI) or computed tomography (Figure 1A

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and 1B) and displayed some evidence of contractile function on multipositional MRI performed at our center. In cases where multipositional MRI was not obtained, the mechanism and location of injury also became important in decision making: for example, in cases with very anterior avulsions. In general, if patients had a multipositional MRI that revealed a complete lack of contractility, we did not attempt to retrieve the rectus muscle after the acute phase of injury (<3 months). Our technique for visualizing extraocular muscle location and contractility using high-resolution surface-coil MRI to assess muscle thickening during contraction by imaging in different positions of gaze is described elsewhere.[7-9]

The following pre- and postoperative characteristics were assessed: time from injury to surgery, best-corrected visual acuity, preoperative motor alignment at distance in the cardinal positions of gaze, degrees of torticollis, and ocular ductions. Surgical data included the results of intraoperative forced duction testing and all subsequent surgical procedures. Forced duction testing of the antagonist muscle was typically scored on a four-point scale: no restriction, "mild" restriction (felt at approximately 10° of rotation), "moderate" restriction (felt at approximately 20° of rotation), and "severe" restriction (felt at approximately 30° of rotation).

In general, ocular alignment in most cases was measured using Krimsky light reflex testing due to poor motility; however, if motility improved postoperatively, alignment was occasionally assessed using cover-uncover and alternate prism cover testing at distance (20 feet) in the cardinal gaze positions. Motor alignment at near was assessed at 14 inches. All motor evaluations were done using spectacle correction. Torticollis was estimated in the patient's habitual head position in degrees by the same clinician pre- and postoperatively, but no goniometer or other quantitative device was utilized. Ocular ductions were measured using a standard nine-point scale (−4 to 4).[10] If the patient was unable to reach the midline, the ocular duction was recorded as "off-scale" and designated −5. All pre- and postoperative evaluations were done by the same strabismus surgeon (Arthur L. Rosenbaum), who was not masked to the procedure or history. Our procedure for recovering extraocular muscles using an anterior orbitotomy approach has been published.[1] In brief, the periosteum is accessed via a transconjunctival approach, and dissection proceeds posteriorly toward the orbital apex. Because the muscle belly is situated immediately adjacent to the periosteum in the posterior orbit, it is located easily and then advanced as far as possible with the globe rotated into a −1 contralateral rotation while minimizing restriction of globe rotation (evaluated by intraoperative forced duction testing).

Surgical outcome was analyzed in two ways. Objective success based on ductions was defined as at least two units of improvement in duction (eg, −4 improvement to −2). Subjective success was characterized by elimination of diplopia in the primary position.

Statistical analyses were performed using the statistical software STATA version 10.0 (StataCorp, College Station, TX). To assess parametric differences between pre- and postoperative measurements, paired *t* test was used. To assess associations of continuous variables with success or failure status, a Mann-Whitney-Wilcoxon test was performed. The association of various preoperative factors and a successful outcome was determined using the Fisher exact test. A χ^2 test was used to compare groups for ordinal values (eg, results of forced duction testing). A *P* value of ≤0.05 was deemed statistically significant for all comparisons.

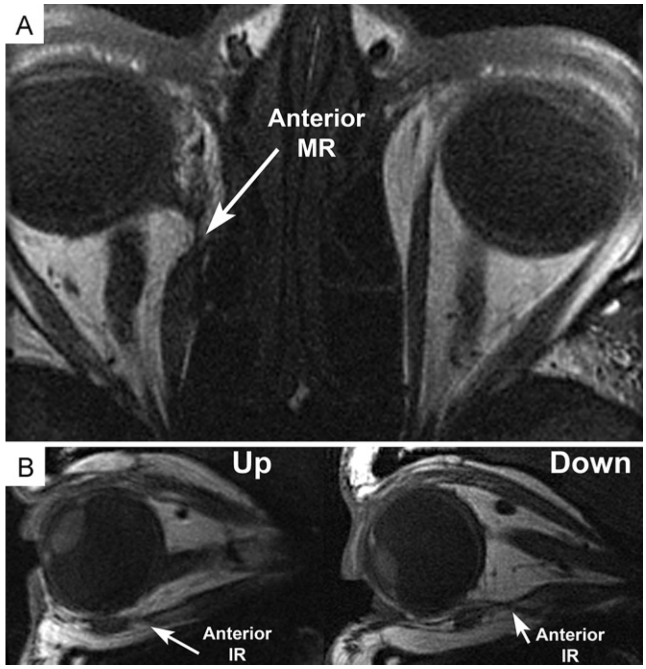

FIG 1. T1-weighted MRI scans of patients with muscle transections. A, Axial image of a patient with a medial rectus muscle (MR) transection deep in the orbit after endoscopic sinus surgery (arrow pointing to anterior portion of the transected muscle stump). B, Sagittal image of a patient with a traumatic inferior rectus (IR) muscle transection of the left eye (arrow pointing to anterior portion of the transected muscle stump). Residual contractility is revealed by contraction of the IR on downgaze (right panel) compared to relaxation on upgaze (left panel).

Results

A total of 11 patients were included, with the following underlying etiologies: two orbital fractures (both inferior rectus); three inadvertent entries into the orbit, with resultant muscle transection during endoscopic sinus surgery (all medial rectus); three cases of extraocular muscle "pulled in two syndrome" during extraocular surgery [scleral buckle in two patients (one medial rectus/inferior rectus, one lateral rectus), laser blepharoplasty in one patient (inferior rectus)]; and two other traumas [fish hook to eye in one patient (medial rectus), shattered glass to eye in one patient (inferior rectus)]. A representative patient is depicted in Figure 2. Both patients with orbital fracture and one who had endosopic sinus surgery underwent orbital fracture repair, and four patients had undergone attempted muscle recovery prior to successful retrieval at our institution. One patient with muscle injury during scleral buckle surgery had "pulled in two syndrome" of both the medial and the inferior rectus muscles (Figure 2). Of the 11 patients, 9 underwent multipositional MRI scans at our institution, of which 7 were available for review. All of these