Mini-plication to treat small-angle strabismus: A minimally invasive procedure

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BACKGROUND Mini-plication is a new rectus muscle tightening procedure for the correction of small-angle strabismus that can be performed under topical anesthesia. The purpose of this study was to report the outcomes of mini-rectus muscle plication.

METHODS We retrospectively reviewed the medical records of patients who underwent mini-plication. In this procedure, 6-0 polyglactin 910 suture was secured to the central 3 to 4 mm of the muscle belly 5 mm posterior to the insertion and was then passed through the sclera just anterior to the muscle insertion to plicate the central portion of the muscle. This differs from the standard procedure, in which the entire width of the muscle is plicated. Two groups were analyzed: those who underwent mini-plication alone and those who underwent mini-plication after prior antagonist muscle–weakening surgery.

RESULTS Our review identified nine patients aged 5 to 78 years. Topical anesthesia was used for all adults, who experienced no local or systemic complications. Mini-plication reduced vertical and horizontal deviations an average (± SD) of $6.7^{\Delta} \pm 3.5^{\Delta}$. The mini-plication–only group (3 patients) had an average postoperative correction of $5.5^{\Delta} \pm 2.6^{\Delta}$; the prior surgery group (6 patients), an average of $9^{\Delta} \pm 2.7^{\Delta}$. Diplopia was noted in 50% of the adults preoperatively and none postoperatively. All patients experienced a decrease in strabismus, with an average outcome of $<5^{\Delta}$ of postoperative deviation.

CONCLUSIONS Mini-plication, which can be performed under topical anesthesia, corrected small deviations and was especially useful for adult strabismus patients with diplopia. (J AAPOS 2012;16:327-330)

Rectus muscle–tightening procedures such as resection and full plication are used to correct deviations usually $>15^{\Delta}$. These procedures typically require either general anesthesia or local anesthetic block, such as retrobulbar injection. They require hooking the muscle, pulling on the muscle, and an extensive posterior dissection. Muscle resection also requires disinsertion and clamping of the muscle and permanently disrupts anterior ciliary blood supply. Resections also run the risk, albeit small, of a lost muscle.[1] The full plication procedure, first described by the senior author, is less invasive than the resection procedure because it is done without disinserting the rectus muscle. The traditional plication has virtually no risk of a lost muscle, is reversible within 5 days after surgery, and preserves the anterior ciliary blood supply. Iris fluorescein angiograms have documented the vessel-sparing characteristics of the full plication procedure.[2,3] This procedure, however, corrects relatively larger deviations and is difficult to perform under topical anesthesia because it requires pulling on the muscle and posterior dissection.

Although there has been an increasing interest in performing standard procedures under topical anesthesia,[4] the correction of relatively small deviations is still problematic. Minimally invasive muscle-relaxing procedures such as the mini-tenotomy have been shown to be practical under topical anesthesia.[5] Recently, Mojon and coworkers[6-8] advocated minimally invasive strabismus surgical techniques, including recession and plications. These techniques are done under general anesthesia and involve tenotomies or plications of the superior and inferior boarders of the muscle and use less dissection than the standard procedures.

Here we describe a novel, less invasive, technique that tightens the central part of a rectus muscle and the initial study of the outcomes of this procedure.

Methods

The institutional review board of the Cedars Sinai Medical Center Medical Center approved this retrospective, consecutive

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case study of mini-plication. The medical records of all consecutive patients who underwent mini-plication from November 2007 to November 2010 were retrospectively reviewed. Patients with concomitant strabismus surgery at the time of the procedure or less than 1 month of follow-up were excluded. The following data were collected: age, sex, visual acuity, previous eye muscle surgery, presence or absence of diplopia pre- and postoperatively, surgery performed, pre- and postoperative strabismus measurements, and length of follow-up. Indications for performing this procedure were the presence of symptomatic or amblyogenic strabismus, with an angle of deviation too small for treatment by standard placation, or recession procedure and too large for mini-tenotomy (2^{Δ}-4^{Δ}).[5] The mini-plication was offered as an option to patients whose deviation was between 8^{Δ} and 10^{Δ} for unilateral surgery and $<16^{\Delta}$ to 20^{Δ} for bilateral surgery. The target outcome was $<5^{\Delta}$ of deviation and resolution of diplopia, if present.

Patients were divided into two groups. Patients in the mini-plication–only group had no history of previous recession of the antagonist; those in the previous surgery group also underwent only mini-plication at the time of surgery but had a history of previous recession of the antagonist. All procedures were done by the senior author (KWW).

Strabismus measurements were taken for distance and at 1/3 meter using prism and alternate cover testing. The amount of prism diopters corrected was calculated by subtracting the postoperative deviation from the preoperative deviation for both distance and near measurements. This number was then divided by two if bilateral surgery was performed.

Surgical Procedure

The procedure entails plication of the central 3 to 4 mm of the central muscle. If topical anesthesia was used, then two drops of tetracaine were instilled in the eye followed by application of lidocaine gel. Phenylephrine 2.5% and an antibiotic drop were also administered prior to surgery in all patients. A Swan conjunctival incision was placed just over the rectus muscle insertion, with dissection to bare sclera 2 mm anterior to the insertion. The eye was rotated away from the surgical muscle using toothed forceps or a traction suture. Rotating the eye stretches the muscle, which makes it possible to grasp the muscle more posteriorly. A dissection of the conjunctiva off the central muscle was performed 6 mm posterior to the muscle insertion. The conjunctiva was retracted and 0.5 toothed forceps grasped the central 3 to 4 mm of muscle 5 mm posterior to the insertion (Figure 1A). Care was taken to avoid the anterior ciliary vessels. The forceps was elevated off the sclera and a 6-0 polyglactin 910 suture with a double-armed needle was passed under the forceps full thickness to secure the grasped muscle (Figure 1B). The suture was tied tight around the incorporated muscle with a square knot and then secured to the sclera 0.5 mm anterior to the muscle insertion (Figure 1C) and pulled to advance the tied muscle to the sclera, thus plicating the central aspect of the muscle (Figure 1D). The suture was tied and the conjunctiva closed with absorbable suture.

Results

Nine patients aged 5 to 78 years (median, 66 years) were identified, of whom two were children. Of the nine patients, two (22%) had a hypertropia of 4^{Δ} to 10^{Δ}; seven (77%) had a horizontal deviation (esodeviation, six; sensory exotropia, one). Overall, mini-plication reduced vertical and horizontal deviations an average (± SD) of $6.7^{\Delta} \pm 3.5^{\Delta}$. Specifically, the vertical deviations were reduced by $5.75^{\Delta} \pm 2.9^{\Delta}$, the esodeviations by $10.2^{\Delta} \pm 5.3^{\Delta}$, and the exodeviation by $8^{\Delta} \pm 0.7^{\Delta}$. The mini-plication–only group (three patients) had an average preoperative deviation of $7.8^{\Delta} \pm 3.6^{\Delta}$ and a postoperative average deviation of $0.7^{\Delta} \pm 1.0^{\Delta}$ for an average correction of $5.5^{\Delta} \pm 2.6^{\Delta}$. The prior surgery group (six patients) had an average preoperative deviation of $13.1^{\Delta} \pm 7.3^{\Delta}$ and a postoperative average deviation of $2.8^{\Delta} \pm 4.0^{\Delta}$ for an average correction of $9^{\Delta} \pm 2.7^{\Delta}$ (Tables 1 and 2).

The goal of the surgery was twofold: to decrease diplopia, if present, and to reduce deviation to an average of $<5^{\Delta}$. Two patients with vertical deviations and seven of seven with horizontal deviations had improvement of their strabismus and were within the target deviation. In the adult patients, diplopia was noted in 50% preoperatively and none postoperatively. All seven adults underwent topical anesthesia for the procedure and no one experienced local or systemic complications or complained of intraoperative pain. Patients were followed an average of 1 month (range, 1-10 months) without recurrence or need for reoperation during this time. None of the patients in our series was overcorrected or experienced significant complications.

Discussion

Prism glasses are often used to treat small-angle strabismus-causing diplopia.[9] Prisms, however, do not correct incomitance and are not desirable for many patients, such as those who have had successful refractive surgery and want to be spectacle-free. With the advent of refractive surgery and the need for an alternative to prism glasses, the senior author has been developing less invasive strabismus surgical procedures that can be done in a few minutes with topical anesthesia specifically for small-angle strabismus. One of these minimally invasive procedures is the mini-tenotomy, a muscle-weakening procedure. This procedure disinserts the central 3 to 4 mm of the tendon. We have found mini-tenotomy to be particularly effective in correcting diplopia caused by small vertical deviations of 2^{Δ} to 4^{Δ}; however, it has shown limited success for correcting larger deviations.[5]

The mini-plication described here was conceived for deviations of 8^{Δ} to 10^{Δ}, which may yet be too small for standard surgery. The specific dose–response to the procedure requires further study; however, we found that patients without previous surgery had a correction of 5^{Δ} to 7^{Δ} and those with a recession of the antagonist had a correction of 8^{Δ} to 10^{Δ} per muscle. This response can be tailored by placing the securing suture farther back from the muscle insertion. Most of our patients had small esodeviations, which can cause severe diplopia and, in children, amblyopia; the mini-plication procedure seemed to be