A

justable sutures in strabismus surgery may be difficult or impossible in poorly co-

operative patients. An adjunct suture technique that allows a 1-step, all-or-nothing,

preprogrammed adjustment in patients not considered good candidates for standard

postoperative adjustable sutures is described. Twelve patients underwent adjustable

strabismus surgery using the ripcord technique. Six patients had unacceptable alignment after sur-
gery. In 5 of these, alignment was successfully adjusted. The ripcord adjustable suture technique
is effective and is well tolerated by patients.

Postoperative adjustable sutures offer stra-
bismus surgeons the opportunity to alter
ocular alignment in the immediate post-
operative period. Active patient partici-
pation is typically required during the
adjustment process, and, therefore, post-
operative adjustable sutures are useful only
for cooperative patients. Methods to mini-
mize the amount of postoperative manipu-
lation required with adjustable sutures have been reported. Saunders and O’Neil1

described a technique that requires
minimal manipulation of the sutures if ad-
justment is not needed. With their techi-
nique, the sutures attached to the extra-
ocular muscle can be cut without tying the
suture ends together. Preplaced knots
along each suture prevent the muscle from
slipping posteriorly through the suture
tract. In cases where adjustment is needed,
however, good patient cooperation is still
required. Intraoperative adjustable tech-
niques have also been described, but have
the disadvantage of prolonging operative
time and have inaccuracies associated with
using corneal light reflection tests to es-
timate ocular alignment.

The purpose of this article is to de-
scribe a technique I have used in selected
patients in whom the potential for post-
operative adjustment was deemed use-
ful, but the patients were not considered
good candidates for the postoperative
manipulation required during standard ad-
justable strabismus surgery. The proce-
dure allows a one-time, single-stage ad-
justment of a recessed or resected muscle
in a predetermined, all-or-nothing step
facilitated by releasing an adjunct suture.
I refer to the technique as the “ripcord
adjustable suture technique” because of
its all-or-nothing effect, a feature similar
to that of pulling the ripcord to deploy a
parachute.

I reviewed the medical records of all pa-
tients who had undergone placement of a
ripcord suture at the time of strabismus
surgery between October 1999 and Octo-
ber 2000. Data analyzed included patient
age, diagnosis, alignment before and af-
ter release of the ripcord suture, and com-
plications. The technique for placement of
a ripcord suture for rectus muscle reces-
sion and resection are outlined as fol-

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a standard technique. A double-arm 6-0 synthetic absorbable suture is used to secure the muscle to the sclera in the desired recession position. The suture ends are then secured into a knot, but only after suspending the muscle to 1.5 to 2 mm posterior to the desired final position of the muscle (Figure 1). A second suture, which I refer to as the ripcord suture, is placed anteriorly in a position that will be readily accessible postoperatively, if adjustment is needed. After passing the ripcord suture through the sclera, the needle is then loaded backward in the needle driver and is passed under the previously tied muscle suture knot. The posterior end of the needle is advanced first to prevent damage to the underlying sclera. The ripcord suture ends are then tied either in a square knot (my preferred method) or in a small bow-knot. As the ripcord suture is tied, tension is exerted on the muscle suture, advancing the muscle to the new scleral insertion.

The ripcord suture must be placed in a manner that allows the muscle suture to be easily distinguished from the ripcord suture to prevent cutting of the wrong suture postoperatively. Although not essential, this can be facilitated by using undyed suture to secure the muscle to the sclera, and using a dyed ripcord suture. The conjunctiva does not need to be recessed if a limbal incision is used. The ripcord suture must, however, be placed in close proximity to the conjunctival incision to facilitate access to the suture postoperatively. Tenon fascia should be dissected from the area around the ripcord suture to facilitate access to the suture postoperatively. Tenon fascia should be cleared from the area. The needle is then loaded backward in the needle driver and is passed with its blunt end forward between the muscle suture knot and sclera, so that it loops around the muscle suture knot. The ripcord suture ends are then tied together with enough tension to pull the knot anteriorly, thus advancing the muscle to the new scleral insertion. Caution should be used to ensure that the ripcord suture can be easily distinguished from the muscle suture postoperatively. If adjustment is needed, the ripcord suture can be cut with blunt-tipped scissors and removed postoperatively. This maneuver, like pulling a ripcord, facilitates a preprogrammed all-or-nothing response, increasing the effect of the recession procedure. Alternatively, the loose end of a bowknot ripcord suture can be pulled to release and remove the suture, although this is not my preferred technique.

**RESECTION TECHNIQUE**

A rectus muscle resection is performed through a limbal or fornix incision using a standard technique. Before securing the suture, the muscle is allowed to recess 1.5 to 2.0 mm posterior to the original insertion (Figure 2). The ripcord suture is placed and the conjunctiva closed in exactly the same manner, as described for the recession technique. When the ripcord suture is tied, the muscle is advanced to the insertion. If an undercorrection is noted postoperatively, the ripcord suture can be removed, resulting in a reduction of surgical effect.
RESULTS

I have used the ripcord technique on 12 patients who I did not believe were good candidates for standard postoperative adjustment, but in whom I thought having the ability to adjust postoperatively might be beneficial. The mean age at the time of surgery was 32 years (range, 10-60 years), with 4 patients younger than 16 years. Only 1 child, a 15-year-old, required adjustment. A ripcord suture was used with 8 rectus muscles that underwent recession; 6 had ripcord adjustment for undercorrection. A ripcord suture was used on 8 rectus muscles that underwent resection or advancement; 2 had ripcord adjustment for overcorrection (Table).

The ripcord suture was released within 3 hours after surgery in 5 patients and at 24 hours in 1 patient, each resulting in improved ocular alignment. A ripcord suture placed on both medial rectus muscles was released at 48 hours in patient 2. The muscles did not appear to retract upon removal of the ripcord sutures and there was no resulting change in alignment after adjustment or at follow-up 2 months later. This adjustment failure most likely occurred because the muscle had already become too firmly reattached to the sclera to allow adjustment with this technique. The patient did not tolerate additional attempts to manipulation of the globe and muscle. The ripcord suture was released without the use of a lid speculum in 4 patients and with a lid speculum in 2 patients, and was well tolerated with minimal discomfort by all patients. No sedation or anesthesia, other than topical anesthesia, was required. None of the patients experienced significant ocular discomfort, nausea, or other systemic problems. In 6 patients who did not require adjustment, the ripcord suture was left intact and was well tolerated. None of the patients complained of pain or had consequences beyond those associated with the standard postoperative course, including those in which the ripcord suture was left intact.

COMMENT

Postoperative adjustable sutures have been used in strabismus surgery for decades because strabismus surgeons believe that they enhance ability to secure accurate postoperative alignment in selected patients. Patients who are unlikely to tolerate adjustable sutures can usually be identified preoperatively. Unsuitable adjustment candidates typically cannot easily tolerate manipulation of the globe for forced traction testing or for other preoperative testing procedures, such as tonometry. I devised the ripcord adjustable suture technique described herein to allow an opportunity to alter ocular alignment postoperatively in this patient subset. I desired a postoperative adjustment phase that would require minimal manipulation of the globe and limited patient cooperation and that could be done without the use of a lid speculum.

I dubbed the adjunct suture a “ripcord suture” because releasing it produces an all-or-nothing effect, similar to that of pulling the ripcord on a parachute. The technique is potentially more useful in patients who are undergoing a recession/resec-
tion of the agonist/antagonist pair in one eye, because placement of a ripcord suture on both muscles allows for adjustment in 2 directions. I have also found it useful, however, for patients undergoing surgery on only one muscle in an eye. Although I have released the ripcord suture only on horizontal rectus muscles, I see no reason why releasing a vertical ripcord suture would not also be effective.

The technique has several obvious disadvantages. First, it has an all-or-nothing effect that allows the surgeon to choose between 2 eye positions with no intermediate adjustment possible. One patient with a large residual postoperative deviation due to restrictive strabismus achieved a 19–prism diopter improvement following release of a ripcord suture placed on each medial rectus muscle, allowing prism correction of his remaining deviation. Despite this patient’s experience, the technique is typically only useful when a small undercorrection or overcorrection is present. In my experience, small undercorrections or overcorrections are the most common indications for adjustable suture manipulation and large undercorrections and overcorrections are infrequent. Bacal et al\(^6\) reported a similar experience. They reported that small adjustments of 3 mm or less were the most commonly required size adjustment. They further reported less accuracy with adjustments larger than 3 mm and suggested that larger adjustments should be avoided, if possible. Despite its limitations, the ripcord adjustable suture technique offers the potential for postoperative adjustment that would not otherwise be possible in selected patients. The adjustment allowed is within the typical range of adjustment needed for most patients.

In summary, a ripcord adjustable suture technique that allows a 1-step preprogrammed adjustment of postoperative alignment in patients with small undercorrections or overcorrections after strabismus surgery has been found to be useful in selected patients. The intraoperative technique is relatively simple. Minimal postoperative manipulation and limited patient cooperation are required if adjustment is necessary, and no postoperative manipulation is needed if ocular alignment is satisfactory. The technique may be useful in selected patients when standard adjustable sutures are deemed inappropriate, but the potential to achieve a well aligned and fusing with prism 2 months after surgery.

Reference: