



Adjustable sutures: an update

J. Mark Engel^{a,b}

Purpose of review

This review discusses outcomes and recent advances in the use of adjustable sutures in strabismus surgery for children and adults.

Recent findings

Several large studies have compared the success rates of strabismus surgery with adjustable sutures versus nonadjustable sutures by the same surgeon or group of surgeons, and demonstrate a significant increase in the short-term alignment for both children and adults with the use of adjustable sutures. Modifications of adjustable sutures technique that make adjustable sutures a more attractive option, especially for children.

Summary

Recent studies have shown better short-term success rates when using adjustable sutures versus conventional sutures in strabismus surgery. Improved outcomes combined with increased options in surgical technique may lead more surgeons to use adjustable sutures in both children and adults.

Keywords

adjustable sutures, children, strabismus, surgical techniques

INTRODUCTION

Adjustable sutures have been used for many years in strabismus surgery in adults, and increasingly in children. The concept of being able to correct over-corrections and undercorrections in the immediate postoperative period appeals to many surgeons, although many strabismus surgeons continue to be reluctant to use adjustable sutures. Reasons cited for not using adjustable sutures include concerns that they have not been shown to increase success rates, they are associated with increased patient discomfort, and they increase the risk of postsurgical inflammation. The use of adjustable sutures is even less accepted in children, with many surgeons believing that children are too difficult to assess immediately postoperatively, and that the risk of using a second anesthetic – which in many cases is necessary in children undergoing adjustable sutures procedures – is not worth a perceived negligible improvement in the overall success rate.

Adjustable sutures are particularly well suited for more difficult strabismus cases in which the surgical outcome with nonadjustable sutures is less predictable, such as reoperations. Muscle transposition procedures for paralytic or incomitant strabismus are particularly difficult to judge. Phamonvaechavan *et al.* [1^{*}] innovative technique for adjustable sutures in transposition procedures will be described.

DO ADJUSTABLE SUTURES INCREASE THE SUCCESS RATE?

Most studies on adjustable sutures in strabismus surgery have compared success rates only to historical controls. Recently, several studies have compared the success rate of surgery using adjustable sutures versus nonadjustable sutures performed at the same institution and among the same surgeon or group of surgeons [2^{**},3,4]. Conceptually, the ability to have a ‘second chance’ to change the position of the eye after the initial surgery should lead to an increase in the overall success rate of strabismus surgery. Many surgeons have argued that the combination of the difficulty of obtaining accurate postoperative measurements on a patient, particularly a child in the early postoperative period, along with the variability of the postoperative drift, negates any advantage realized by being able to adjust the muscle. Given that using adjustable sutures requires extra operating time, increased time in the recovery

^aDivision of Pediatric Ophthalmology, Robert Wood Johnson Medical School, New Brunswick, New Jersey and ^bWills Eye Hospital, Philadelphia, Pennsylvania, USA

Correspondence to J. Mark Engel, MD, University Children's Eye Center, 4 Cornwall Court, East Brunswick, NJ 08816, USA. Tel: +1 732 613 9191; e-mail: engel@uceyecenter.com

Curr Opin Ophthalmol 2012, 23:373–376

DOI:10.1097/ICU.0b013e3283567321

KEY POINTS

- Recent studies have shown a significant increase in success rates using adjustable sutures versus nonadjustable sutures.
- Adjustable suture techniques continue to be modified for use in children.
- Adjustable sutures significantly increase success in complicated strabismus and primary surgery.

room, additional anesthesia or sedation, and presents a significant learning curve for the surgeon, it is understandable that a skeptical surgeon would want evidence-based data showing that adjustable sutures do increase success rates.

Unfortunately, there are no ‘gold standard’ prospective, double-masked studies comparing adjustable versus nonadjustable sutures in strabismus surgery. Perhaps the most unbiased comparison of the two techniques is the study by Awadein *et al.* [2[■]], which compared the results of one experienced surgeon using adjustable versus nonadjustable sutures in children younger than 10 years of age. To reduce bias between the two techniques as much as possible, the authors compared groups of consecutive patients who had horizontal muscle surgery and who met the criteria of the study, regardless of the complexity of the strabismus surgery. The first group of 98 patients had surgery without adjustable sutures between 1990 and 1993 as compared with 298 patients operated on between 1994 and 2005, almost exclusively using adjustable sutures. The success rate [defined as being within 8 Prism dioptres (PD) of orthophoria] at 3 months after surgery was 79% for the adjustable sutures group versus 64.5% for the nonadjustable sutures group ($P < 0.01$). Although the authors correctly note other confounding factors that could help explain the better results of the adjustable group, including that patients in the adjustable group were operated on at a later date, and thus benefited from the skills of a more experienced surgeon, it is hard to ignore a 15% difference in outcomes by the primary surgeon who by 1990 already had more than a decade of experience.

A large study from Emory University showed a similar benefit for adults who underwent adjustable sutures [3]. This retrospective review of 305 patients who had adjustable sutures versus 186 who had nonadjustable sutures was performed by three surgeons at the same institution. When adjustable sutures were used, 65.7% of the outcomes were within 10 PD of orthophoria, compared with only 42.4% when nonadjustable sutures were used

($P = 0.0016$). The subgroup that benefited most from adjustable sutures was of adults who had undergone previous strabismus surgery (42.4% nonadjustable versus 65.7% adjustable; $P = 0.0268$). The only subgroup that did not appear to benefit from adjustable sutures was the group with thyroid eye disease (76.7% nonadjustable versus 74.1% adjustable; $P = 0.8204$).

A study of 404 adults and children older than 12 found a trend toward increased success with those patients undergoing strabismus surgery with adjustable sutures (77.1% success in the adjustable group versus 69.1% in the nonadjustable group), although this did not reach significance ($P = 0.059$) [4]. The surgery was conducted by one surgeon. Interestingly, the subgroup with exotropia had the most apparent benefit from adjustable sutures (80.8% success rate for adjustable versus 65.9% for nonadjustable sutures; $P = 0.011$). This was the opposite of what Awadein *et al.* found wherein children with esotropia had better outcomes [2[■]]. The improvement in success rates in the Toronto study with adjustable sutures was also greatest in those undergoing primary surgery – contrary to the commonly held belief that adjustable sutures are most useful for more complicated surgery such as reoperations. Awadein *et al.* [2[■]] also found that the advantage of using adjustable sutures was as large in primary surgery as in those undergoing reoperations.

MODIFICATION OF ADJUSTABLE SUTURE TECHNIQUES SPECIFICALLY FOR CHILDREN

Robbins *et al.* [5], along with Engel and Rousta [6[■]], were among the earliest to suggest that the conjunctiva could be closed over the extra suture needed in adjustable sutures so that if an adjustment was not needed at postoperative assessment, the patient could go home without further manipulation. Since our 2004 publication [6[■]] on the use of adjustable sutures in children, my technique has undergone several modifications, including burying the sutures on either side of the muscle with short scleral passes (Fig. 1) [7] and a technique (Fig. 2) for the lateral rectus that does not require a noose to reduce the amount of exposed vicryl suture that needs to be reabsorbed [8].

Nihalani *et al.* [7] and Nihalani and Hunter [9[■]] modified Robbins’ method of tucking the extra suture beneath the conjunctiva with a ‘short tag noose technique.’ In this method, which is particularly useful in children, a fornix incision is used. The two ends of the extra suture that are used if an adjustment is needed are tied 2–3 mm from the noose to form a loop. The extra loop of suture is tucked underneath the conjunctiva (Fig. 1). If no

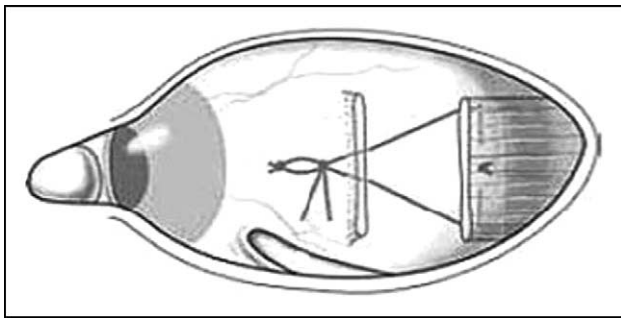


FIGURE 1. Short tag noose technique [7]. A noose is placed around the pole sutures that are left 2–3 mm long. The noose and the pole sutures are buried underneath the conjunctiva.

adjustment is made, the extra loop of suture will prevent the muscle from being lost if the noose slips. If an adjustment is needed, the suture is exposed, and the adjustment takes place under general anesthesia or sedation in children or under local anesthesia in adults. If no further adjustment is needed, the child can go home without additional anesthesia.

Success rates of over 80% are comparable amongst the three techniques discussed here [5,6^{*},7]. One of the main concerns with each is that the extra buried suture, which is needed for an adjustment, could increase the risk of developing suture granulomas. Nihalani *et al.* [7] minimize this risk by keeping the loop of suture, which can be used for adjustment at 2–3 mm. This method has the disadvantage of not allowing the surgeon to perform a larger adjustment. These authors do leave the suture length longer if the possibility of a larger adjustment is anticipated. They report a 1.9% rate for granulomas with his method, which is equivalent to what most surgeons' experiences, and a visible

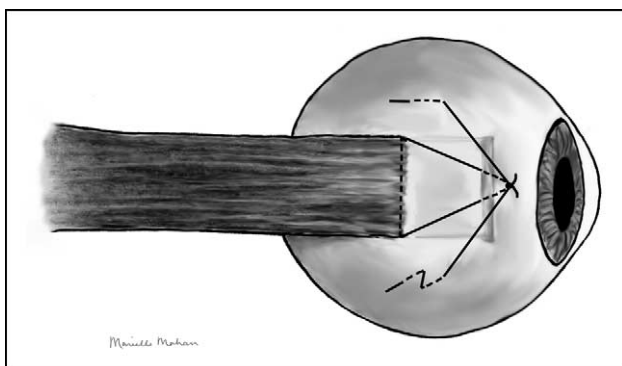


FIGURE 2. Adjustable suture technique. A noose is placed around the two pole sutures, which are buried in the conjunctiva with short scleral passes. Two short scleral passes are made for one of the pole sutures, which prevent the muscle from slipping if the noose is too loose. The fornix incision is closed over the noose and pole sutures.

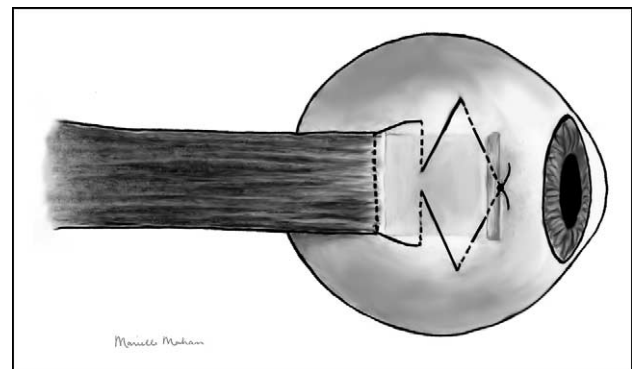


FIGURE 3. Adjustable hemihang-back technique for lateral rectus. This technique has the advantage that no noose is necessary. Additional scleral passes are made and buried underneath the conjunctiva. If an adjustment is necessary, the additional vicryl suture is unburied to either advance or recess the muscle.

increased conjunctival reaction 2 months post-operatively, which can persist for up to 3–6 months after surgery [7]. Engel and Roustia minimize the risk of suture granulomas by burying the suture in the conjunctiva with short scleral passes [6^{*}] (Fig. 2). This allows for larger adjustments if needed, and allows the suture to be tied if an adjustment is performed. They prevent slippage of the muscle by adding an extra scleral pass to one end of the suture if the noose is felt to be loose. Although they reported no granulomas and no visible difference to the eye between muscles placed on adjustable versus nonadjustable sutures, subsequently several patients who had the lateral rectus muscle placed on an adjustable suture using this technique developed a suture granuloma. I have modified my technique to eliminate the noose for the lateral rectus entirely [8] (Fig. 3).

Guyton [8], who has developed and refined many of the techniques used in adjustable sutures, does not bury the extra suture that may be necessary for adjustment underneath the conjunctiva [2^{**}]. Instead, with both children and adults, he leaves the extra suture external to the conjunctiva, tucked in the cul de sac. He then ties and trims the knot of the extra suture whether an adjustment is needed or not. This technique has the advantage of minimizing the amount of suture that needs to reabsorb. The disadvantage in children is that frequently the child needs to be placed under general anesthesia or intravenous sedation, even if an adjustment is not needed.

ADJUSTABLE SUTURE TECHNIQUE FOR TRANSPOSED MUSCLES

Guyton has developed an innovative technique for transposition of the vertical muscles in sixth nerve palsy that reduces the need for the ipsilateral medial rectus to be recessed and also eliminates the need for

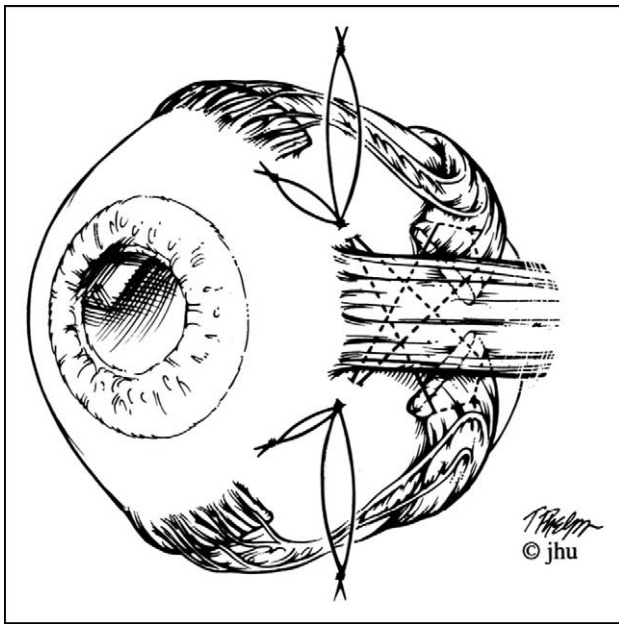


FIGURE 4. Adjustable technique for transposed muscles [1[■]]. The two transposed vertical muscles are placed on an adjustable suture with a noose. The superior rectus can be adjusted with the noose located inferior to the lateral rectus, and the inferior rectus can be adjusted with the noose located superior to the lateral rectus.

a Foster suture [1[■]]. In this technique, a vessel-sparing full tendon-length transposition of the vertical rectus muscles is performed. The adjustable suture for the superior rectus is passed behind the lateral rectus and then placed inferior to the insertion of the lateral rectus, and the adjustable suture for the inferior rectus is passed behind the lateral rectus muscle and then placed superior to the insertion of the lateral rectus (Fig. 4) [1[■]]. This technique allows for further tightening of the vertical muscles by allowing them to cross underneath the lateral rectus muscle, thus, increasing abduction. Using this technique, the medial rectus muscle needed to be weakened in only 37% of cases versus 83% of cases in the conventional vertical transposition procedure [8]. The technique also allows for the adjustment of postoperative vertical misalignment, which is technically not possible with the Foster augmentation. Only one patient of the 19 developed a significant vertical deviation using this technique [1[■]].

CONCLUSION

Conceptually, the ability to adjust the position of the eye postoperatively should decrease the variability of the postoperative response to the primary surgery and lead to better results, yet adjustable sutures have not been embraced by a majority of surgeons, particularly in children, due to the

perceived difficulties in both examining and judging the postoperative drift. Recently, three large studies have compared the results of patients undergoing strabismus surgery performed by the same surgeons using adjustable sutures versus nonadjustable sutures, which demonstrate improved outcomes. Modifications of the adjustable sutures technique in which the adjustable suture is buried underneath the conjunctiva allow the child to be discharged without further manipulation if no adjustment is needed, and provide easier access if adjustment is needed. These developments may lead more surgeons to use adjustable sutures at least on those children with complex strabismus, such as reoperations, in which surgical outcomes with nonadjustable sutures are less predictable.

Acknowledgements

I would like to acknowledge the editorial assistance of Jackie Syrop, and Marielle Mahan for her medical illustrations of my technique.

Conflicts of interest

The author has no financial interest or support in this article, and there are no other conflicts of interest.

REFERENCES AND RECOMMENDED READING

Papers of particular interest, published within the annual period of review, have been highlighted as:

- of special interest
- of outstanding interest

Additional references related to this topic can also be found in the Current World Literature section in this issue (pp. 452–453).

1. Phamonvaechavan P, Anwar D, Guyton DL. Adjustable suture technique for enhanced transposition surgery for extraocular muscles. *J AAPOS* 2010; 14:399–405.

This study describes an innovative technique using adjustable sutures for transposition procedures that reduces the need for additional muscles to be operated.

2. Awadein A, Sharma M, Bazemore MG, *et al*. Adjustable suture strabismus surgery in infants and children. *J AAPOS* 2008; 12:585–590.

This study compared the results of consecutive children undergoing adjustable versus nonadjustable sutures strabismus surgery. It may be the most unbiased study comparing adjustable versus nonadjustable sutures.

3. Zhang MS, Hutchinson AK, Drack AV, *et al*. Improved ocular alignment with adjustable sutures in adults undergoing strabismus surgery. *Ophthalmology* 2012; 119:396–402.

4. Mireskandari K, Cotesta M, Schofield J, Kraft SP. Utility of adjustable sutures in primary strabismus surgery and reoperations. *Ophthalmology* 2012; 119:629–633.

5. Robbins SL, Granet DB, Burns C, *et al*. Delayed adjustable sutures: a multicentred clinical review. *Br J Ophthalmol* 2010; 94:1169–1173.

6. Engel JM, Rousta ST. Adjustable sutures in children using a modified technique. *J AAPOS* 2004; 8:243–248.

This article describes a technique in which the adjustable sutures are buried underneath the conjunctiva with short scleral passes to prevent a conjunctival reaction, allowing the child to go home if no adjustment is needed.

7. Nihalani BR, Whitman MC, Salgado CM, *et al*. Short tag noose technique for optional and late suture adjustment in strabismus surgery. *Arch Ophthalmol* 2009; 127:1584–1590.

8. Engel, JM, Guyton DL, Hunter DG. Adjustable sutures in children. In: *Proceedings of the AAPOS 38th Annual Meeting*; 26 March 2012; San Antonio, Texas; 2012.

9. Nihalani BR, Hunter DG. Adjustable suture strabismus surgery. *Eye (London)* 2011; 25:1262–1276.

An excellent review of the different techniques available for adjustable sutures, along with recommendations on when and how much to adjust. Highly recommended for surgeons considering the use of adjustable sutures.