
MINI REVIEW

Adjustable sutures in squint surgery

Despite widespread attention in the ophthalmic literature the use of adjustable sutures in squint surgery remains limited in the United Kingdom. This review examines the advantages of adjustable sutures, surgical indications, and operative techniques.

The concept of adjustable suture surgery was originally developed more than 50 years ago,¹ but it was not until the mid 1970s that the technique was popularised by Jampolsky² following work on squint surgery under topical anaesthesia with on table adjustment.³ A one stage procedure with adjustment under general anaesthesia has been described,⁴ but ocular alignment depends solely on examination of the corneal light reflexes. Furthermore, the resting position of the eyes is affected by general anaesthesia,⁵ although attempts have been made to estimate the 'true' position and predict optimal postoperative alignment.^{6,7} The majority of surgeons now opt for a two stage procedure; initial surgery being carried out under general anaesthesia, with post-operative adjustment under topical anaesthesia.

Indications

Adjustable sutures are intended primarily to facilitate more accurate ocular alignment and decrease the need for reoperation. In patients with fusion an optimal position within the fusional range can be selected, minimising postoperative diplopia and maximising the functional field of binocular single vision. In cosmetic procedures the most appropriate ocular alignment is more easily attained.

Indications for the use of adjustable sutures vary widely – 'a horizontal or vertical deviation requiring a weakening or strengthening procedure on a rectus muscle in a cooperative patient' being proposed by the more enthusiastic.⁸ The advantages of an adjustable technique are most apparent when the results of conventional surgery are unpredictable, particularly as a result of tethering, scarring, or contracture of extraocular muscles. Specific indications include reoperations, large angle squints, thyroid eye disease, blow-out fractures, diplopia following retinal detachment surgery, paralytic squints, and combined horizontal and vertical muscle procedures. A possible limitation of the technique is that it is difficult to perform vertical transposition in conjunction with horizontal muscle surgery^{9,10} although this is not universally accepted.¹¹

Preoperative assessment

A full explanation of the procedure, including details of the adjustment, is mandatory. To gauge the suitability of a patient for adjustment, topical anaesthesia is applied and a cotton bud used to manipulate the bulbar conjunctiva.¹² Patients tolerating the 'cotton bud test' are likely to cooperate with adjustable surgery. In our experience this includes most adults and some children as young as 8 years.

The two stage approach

The anaesthetist should be aware that an adjustable procedure is planned so that the patient is as alert and cooperative as possible in the early postoperative period. Day case surgery

is ideal, the operation being performed in the morning and adjustment carried out later the same day. Adjustment is possible with recession or resection, on horizontal or vertical muscles, on two muscles of the same eye and on both eyes in a bilateral procedure. Adjustment may be performed as soon as the patient is sufficiently alert to cooperate, usually within 6 hours of surgery. Waiting until the following morning is an acceptable alternative, but difficulty may be encountered as some muscles adhere firmly to the globe within 24 hours.

Limbal, Swan, and fornix incisions are practised. We prefer the limbal approach which has the advantage of good exposure, allows conjunctiva to be recessed in cases of restriction and is generally favoured in re-operations. Difficulty may be encountered when contact lenses are worn and required at the time of adjustment; in such cases a Swan or fornix incision is preferred.^{12,13}

Two principal techniques of muscle reattachment have been described, the 'bow tie'² and the 'sliding knot'.¹¹ In the bow-tie technique the arms of the suture are passed through scleral tunnels starting near each end of the insertion and emerging 1.5 mm apart, advancing nearer to the limbus to facilitate adjustment.¹¹ A double throw is placed, with the muscle correctly positioned and secured with a loop. Fells passes both arms of the suture through the insertion twice, each time from posterior to anterior to form two 'Z' configurations.¹² The position is maintained by friction alone and only a loose bow need be tied. When a sliding knot is to be employed, the two arms of the suture are brought out parallel and close together at the insertion, and lassoed with a second piece of 6/0 vicryl. This is tied tightly around the muscle suture and snugged down to the insertion. If the muscle is then pulled anteriorly as far as the insertion, the distance between sliding knot and insertion can be measured, and will be equal to the amount of recession performed. This technique allows accurate estimation of the final muscle position following adjustment, but tends to leave a larger knot. In a final variation, Campos leaves the two ends of the vicryl suture completely untied allowing the muscle to hang back freely, thereby committing himself to adjustment.¹⁴ Subsequent adjustment in all cases is eased by the ability to fix the globe, which is best done with the aid of a 'bucket handle' suture, such as 6/0 vicryl (Polyglactin 910), placed in the sclera at or anterior to the insertion.

A key factor in the success of adjustable sutures has been the use of the double armed 6/0 vicryl suture on spatulate needles. Despite its gauge, 6/0 vicryl has remarkable tensile strength and little tendency to snag. Identification at the time of adjustment is eased by using a dyed suture and the handling characteristics may be improved by coating with bone wax. A tendency for 'tissue drag' to occur between conjunctiva, Tenon's capsule, and muscle can be reduced by lubrication with Healon,¹⁵ although this is rarely necessary.

Some surgeons deliberately over-recess at operation as it is easier to advance rather than recess a muscle at the time of adjustment. Such a strategy inevitably increases the number of cases requiring adjustment, and it is our policy to recess the exact amount required. When resecting a muscle, it is usual to resect slightly more than the estimated amount, and then leave the muscle recessed to allow adjustments either way. Excess resection, however, would increase both the risk

of restriction and the documented incidence of muscle slippage,^{8,16} making adjustable resection in general a far less popular option.

Several strategies have been proposed for dealing with the conjunctival flap following a limbal incision. In the 1970s, problems were encountered with irritation from the non-absorbable sutures used at that time¹⁷ but this is much less apparent with vicryl. It should be remembered that some squint operations are cosmetic, and that the handling and repair of conjunctiva is an important part of the operation. Jampolsky originally advocated leaving the knot exposed on bare sclera, and excising it 2 to 3 weeks postoperatively.¹¹ We routinely close conjunctiva, with a loosely recessed flap allowing access to the bow. Alternatively, sutures may be placed through the corners of the flap and corresponding limbal conjunctiva in the first stage of the procedure, with either one¹⁸ or both¹⁹ corners being left mobile on loosely tied loops to allow access for adjustment. Finally, conjunctiva may be closed as an entirely secondary procedure at the time of adjustment.⁴ When conjunctiva is closed, it is important to ensure that no restriction of ocular movement is induced.

After the first stage the suture ends are tucked into the conjunctival fornix or taped to the skin. Antibiotic drops are instilled and the eye padded. The pad is removed at least 30 minutes before adjustment (as occlusion is known to alter ocular muscle balance²⁰) and topical anaesthetic drops instilled. The correct refraction must be worn by the patient during assessment, the surgeon having ensured that no prismatic correction has been incorporated. Adjustment is a 'semi-sterile' procedure performed at the bedside or in the clinic, the requirements being adequate lighting and a distant fixation target. Correcting any underaction is straightforward as an over-recessed muscle is easily advanced. An overacting muscle is further recessed by slackening off the suture, and then fixing the globe by means of the bucket handle while the patient attempts to look in the direction of action of the muscle. Several adjustments may be necessary to achieve the correct alignment, at which time the bow tie is converted to a knot, or the limbs of the sliding knot and muscle sutures cut short.

Long term success requires an understanding of the optimal postoperative alignment. Early drift of several dioptres is known to occur⁹ and may be predicted. A tendency has been noted for initial over-correction of a horizontal deviation to reverse, prompting some authors to adjust only those patients with significant under-correction.²¹ Rosen *et al*, studying post adjustment drift in the first 12 months, observed a swing towards under-correction of horizontal deviations and over-correction of vertical deviations, the former occurring more rapidly in cosmetic than in functional groups.²² Wright has observed a greater final under-correction of the angle of squint following bilateral recessions, compared with unilateral recess-resect procedures, for esotropia.²³

Complications

Complications are rare. Nausea may be induced by adjustment, but careful handling of the globe minimises both this and the risk of bradycardia. Breakage of the suture is very uncommon, as is the inability to achieve a satisfactory alignment. Parks has questioned the use of any form of 'hang loose' suture, stressing both the tendency for the muscle width to collapse and the potential uncertainty of the final position of attachment of muscle to sclera.⁹ Inferior rectus is prone to slip postoperatively as a consequence of its attachments to Lockwood's ligament and inferior oblique: Kushner has advocated the use of a non-absorbable adjustable suture in this situation.¹⁰

Results

The recognition of any new surgical technique as successful is best made with reference to prospective studies comparing the newly proposed procedure with a previously accepted technique. Such information is not available, but results have been published and should be considered carefully. The absolute criterion for failure in squint surgery is the need to reoperate. Two retrospective studies have shown a decrease in the reoperation rate comparing adjustable sutures with conventional surgery.^{24,25} Other authors have examined their reoperation rates following adjustable techniques, quoting figures of 5–8%,^{17,18,26} Alternatively, considering 'success' to be a final deviation of less than 10 prism dioptres horizontally or 5 prism dioptres vertically, Kraft and Jacobson typify published results with a success rate of 85% for primary procedures and 78% for reoperations.¹⁸ Their 'adjustment rate' of 40% is similar to that of other studies.^{17,24–26}

Conclusion

Success in ocular motility surgery depends on many factors. The adjustable suture technique is designed to minimise variability in one of these factors, namely the idiosyncratic response of an individual patient to a stereotyped surgical procedure. Adjustable sutures have been employed across the whole spectrum of squint surgery, from the cosmetic correction of a divergent blind eye to the functionally complex Harada-Ito procedure.^{27,28} Each surgeon must base his practice on his own results, the particular needs of the individual patient and the time and resources available. The techniques outlined above are simple to perform and take up no more theatre time than conventional squint surgery. Although adjustable suture surgery is not at present regarded as routine, the simple objective of avoiding large post-operative ocular misalignment in unpredictable cases should endorse this procedure to all squint surgeons.

ROBERT J MORRIS
ANDREW J LUFF

Southampton Eye Hospital,
Wilton Avenue,
Southampton SO9 4XW

- O'Connor R. The cinch shortening loop in surgery of the extraocular muscles. *West J Surg* 1931; **39**: 670–6.
- Jampolsky A. Strabismus reoperation techniques. *Trans Am Acad Ophthalmol Otolaryngol* 1975; **79**: 704–17.
- Thorson JC, Jampolsky AJ, Scott AB. Topical anesthesia for strabismus surgery. *Trans Am Acad Ophthalmol Otolaryngol* 1966; **70**: 968–72.
- Richards R. *A text and atlas of strabismus surgery*. London: Chapman and Hall, 1991: 173–9.
- Apt L, Isenberg S. Eye position of strabismus patients under general anaesthesia. *Am J Ophthalmol* 1977; **84**: 574–9.
- Romano P, Gabriel L. Intraoperative adjustment of eye muscle surgery: correction based on eye position during general anaesthesia. *Arch Ophthalmol* 1985; **103**: 351–3.
- Romano PE. Results of stage III intraoperative adjustment of eye muscle surgery (under general anaesthesia) for neuroparalytic and mechanical strabismus. In: Campos EC, ed. *Strabismus and ocular motility disorders*. Proceedings of the sixth meeting of the international strabismological association. London: MacMillan, 1990: 67.
- Flynn JT. The adjustable suture: a clinician's experience. *Pediatric ophthalmology and strabismus: transactions of the New Orleans Academy of Ophthalmology*, New York: Raven Press, 1986: 245–6.
- Crawford JS. Discussion of Parks MM. Adjustable sutures in strabismus. *Pediatric ophthalmology and strabismus: transactions of the New Orleans Academy of Ophthalmology*. New York: Raven Press, 1986: 501–16.
- Kushner BJ. Pearls and pointers in adjustable sutures for strabismus surgery. *Transactions of symposium on oculoplastic surgery, strabismus and pediatric ophthalmology*. New Orleans Academy of Ophthalmology. Thorofare, NJ: Slack, 1990: 215–25.
- Jampolsky A. Current techniques of adjustable strabismus surgery. *Am J Ophthalmol* 1979; **88**: 406–18.
- Fells P. Adjustable sutures. *Eye* 1988; **2**: 33–5.
- Nelson LB, Calhoun JH, Harley RD, Freeley DA. Cul-de-sac approach to adjustable strabismus surgery. *Arch Ophthalmol* 1982; **100**: 1305–7.
- Campos EC, Chiesi C, Gulli R, Schiavi C. Personal approach for adjustable sutures technique. In: Campos EC, ed. *Strabismus and ocular motility disorders*. Proceedings of the sixth meeting of the international strabismological association. London: Macmillan, 1990: 457–62.
- Clorfeine GS, Perker WT. Use of Healon in eye muscle surgery with adjustable sutures. *Ann Ophthalmol* 1987; **19**: 215–7.
- MacEwan CJ, Lee JP, Fells P. Aetiology and management of the 'detached' rectus muscle. *Br J Ophthalmol* 1992; **76**: 131–6.

- 17 Rosenbaum AL, Metz HS, Carlson M, Jampolsky AJ. Adjustable rectus muscle recession surgery. *Arch Ophthalmol* 1977; 95: 817-20.
- 18 Kraft SP, Jacobson ME. Techniques of adjustable suture strabismus surgery. *Ophthalmic Surg* 1990; 21: 633-40.
- 19 Shwartz RL, Choy AE, Cooper CA. Delayed conjunctival closure in adjustable strabismus surgery. *Ophthalmology* 1984; 91: 954-5.
- 20 Morton GV, Kushner BJ. The use of diagnostic occlusion in strabismus management. *J Ocular Ther Surg* 1983; 2: 194-200.
- 21 Olivier P, N'Guyen D. Ocular alignment variations after strabismus surgery. In: Ravault PR, ed. *Transactions of the Fifth International Orthoptic Congress*. Lyon: LIPS, 1983: 523-8.
- 22 Rosen P, Morris R, McCarry B, Fells P, Lee J. Variability following adjustable suture strabismus surgery. In: Tillson G, ed. *Advances in amblyopia and strabismus*. Transactions of the seventh international orthoptic congress. Germany: Fahner Verlag, 1991: 89-93.
- 23 Wright KW. *Color atlas of ophthalmic surgery. Strabismus*. Philadelphia: JB Lippincott, 1991: 87-124.
- 24 Wisnicki HJ, Repka MX, Guyton DL. Reoperation rate in adjustable strabismus surgery. *J Pediatr Ophthalmol Strabismus* 1988; 25: 112-4.
- 25 Metz HS, Hartman DK. Motor alignment following traditional surgery versus adjustable suture strabismus surgery. In: Lenk-Schafer M, ed. *Orthoptic horizons: Transactions of the sixth international orthoptic congress*. London: British Orthoptic Society, 1988: 454-9.
- 26 Keech RV, Scott WE, Christensen LE. Adjustable suture strabismus surgery. *J Pediatr Ophthalmol Strabismus* 1987; 24: 97-102.
- 27 Metz HS, Lerner H. The adjustable Harada-Ito procedure. *Arch Ophthalmol* 1981; 99: 624-6.
- 28 Elsas FJ. Vertical effect of the adjustable Harada-Ito procedure. *J Pediatr Ophthalmol Strabismus* 1988; 25: 164-6.