One stage vertical rectus muscle recession using adjustable sutures under local anaesthesia

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Abstract

Aims—To assess the results of visual axis alignment following one stage adjustable suture surgery to correct vertical diplopia.

Method—Eight patients with a mean age of 44.9 years (range 16–80 years) complaining of vertical diplopia underwent rectus muscle recession under local anaesthesia with intraoperative adjustment of sutures. Diplopia was secondary to superior oblique paresis in four patients, dysthyroid eye disease in two patients, superior rectus paresis in one patient, and one developed a consecutive deviation after previous squint surgery. The surgery consisted of seven single muscle recessions (six inferior recti and one superior rectus) and one two muscle recession (inferior and lateral recti). The surgery was performed under topical anaesthesia supplemented with a subconjunctival injection of local anaesthetic over the muscle insertions.

Results—The patients remained comfortable throughout their surgery. All had a reduction in their vertical deviation. Six were asymptomatic and were eventually discharged. One had residual diplopia which was well tolerated without further intervention. One had persistent troublesome diplopia which was corrected by temporary Fresnel prisms. He became asymptomatic after further surgery of a 1 mm inferior rectus advancement.

Conclusion—One stage adjustable suture surgery is recommended in all cases of strabismus surgery when postoperative results would otherwise be unpredictable.

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Precisely aligning the visual axes with conventional extraocular muscle surgery can be very difficult and time consuming, often requiring a second procedure to obtain binocular single vision. Horizontal fusional reserves may compensate for slight inaccuracies following medial and lateral recti surgery but most patients with vertical strabismus do not have good vertical fusion ranges, especially if acute, and are less likely to control vertical discrepancies, resulting in postoperative diplopia.

One way of combating this problem is to perform the surgery with adjustable sutures. This necessitates two stages: recessing the muscle under general anaesthesia and adjustment under topical anaesthesia in the immediate postoperative period. The main disadvan-

tages of this technique are that two stages are necessary and there is a time lapse between the end of surgery and commencing adjustment, usually performed some hours later. In this period, the muscle begins to adhere to the surrounding tissues and may no longer be freely mobile.

Surgery under local anaesthesia overcomes this problem, by allowing immediate on the table adjustment, and has the additional advantage of being a single procedure which may then be performed on a day case basis.

We review the results of eight patients who underwent this type of surgery.

Method

Eight patients with a mean age of 44.9 years (range 16–80 years) complaining of either intermittent or constant recent onset vertical diplopia in the primary position were reviewed. Four had superior oblique pareses, one superior rectus pareses, two dysthyroid eye disease, and one had previous strabismus surgery. Their stable preoperative measurements are detailed in Table 1.

Premedication was not given and the surgery was performed by the same surgeon (JG). The patients were monitored with continuous electrocardiography and pulse oximetry. The local anaesthetic consisted of 0.4% oxybuprocaine eyedrops followed by approximately 0.25 ml 2% lignocaine with adrenaline (1:200 000) injected subconjunctivally over the muscle insertions. The aim was to produce adequate anaesthesia without compromising ocular motility.

A lid speculum was inserted and a limbal incision with a fornix based conjunctival flap was fashioned to expose the muscle insertion. The muscle was isolated and secured using either a double ended 6/0 Vicryl suture technique, method A (Fig 1) or two single ended 6/0 Vicryl sutures technique, method B (Fig 2). The muscle was over-recessed initially (as advancement during adjustment is technically easier to perform than recession) and tied with a single throw and half knot bow.

A hole was cut in the disposable drape over the unoperated eye to allow the patient to see binocularly. The lid speculum was removed and the operating lights were switched off. A period of time was allowed to elapse allowing the patient to accommodate to the ambient light. Cover and alternate cover tests were performed by the surgeon using a horizontally aligned linear near target. For presbyopic patients a transverse beam on the theatre

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Table 1 Patient symptoms and preoperative measures

Case	Age/sex	Diagnosis	Symptoms	Preoperative measurements				
				Abnormal head posture			Primary position (prism dioptres)	
				Face turn	Head tilt	Chin position	Vertical deviation	Horizontal deviation
1	16 M	R.SO paresis	Vertical diplopia	Left			R/L 10	+2
2	45 F	R.SO paresis	Vertical diplopia		Left	Depressed	R/L 9	+2
3	16 F	L.SO paresis	Vertical diplopia	None noted			L/R 3	+2
4	60 M	L.SR paresis	Vertical diplopia		Left	Elevated	R/L 23	+1
5	80 M	L.SO paresis	Horizontal diplopia + vertical element	None noted			L/R 5	-3
6	41 M	Thyroid eye disease	Vertical diplopia on dextroversion	Right		Elevated	L/R 14	0
7	26 M	Consecutive to previous squint surgery	Oblique diplopia	None noted			L/R 8	-18
8	70 M	Thyroid eye disease	Vertical diplopia when reading	None noted			R/L 18	+2

Vertical deviation (prism cover test): right hyperdeviation = R/L, left hyperdeviation = L/R.
Horizontal deviation (prism cover test): esodeviation = + values, exodeviation = - values.
R = right, L = left, SO = superior oblique, SR = superior rectus.

ceiling was used as a target. The muscle position was advanced objectively to align the visual axes and then further adjusted until the subject reported binocular single vision. Finally the suture was tied securely and the conjunctival incision closed with 8/0 Vicryl. All patients were given a single dose of chloramphenicol eyedrops and were discharged home on the same day on betamethasone and neomycin eyedrops three times a day which was tailed off over the next few weeks.

Postoperative measurements at 1 week, 3 months, and the final outcome are documented in Table 2 and Figure 3.

Figure 1 Method A. Double ended 6/0 Vicryl suture. (A) Two needles enter the muscle belly and exit at the borders. (B) A single half hitch is tied at each border to secure the muscle. (C) The muscle is disinserted. The two needles are passed through the scleral muscle insertion horizontally, exiting centrally. (D) The needles are again passed through the centre of the muscle and secured with a single throw and half knot bow. This knot may now be manipulated for adjustment.

Figure 2 Method B. Two single ended 6/0 Vicryl sutures. (A) Two needles enter the muscle border separately and are secured with a single half hitch. The muscle is disinserted and the two needles are then passed through the muscle insertion horizontally exiting peripherally. (B) Each single ended Vicryl suture is secured with a single throw and half knot bow which is subsequently manipulated when the muscle is adjusted.

Results

All patients remained comfortable throughout their surgery and showed a reduction in their vertical deviation as shown in Figure 3.

In three patients (Nos 3, 4, and 5) the visual axes were initially aligned vertically, three (Nos 2, 6, and 8) were undercorrected, and two (Nos 1 and 7) were overcorrected. Over the next few months, six (Nos 1, 2, 3, 4, 7, and 8) became asymptomatic and were discharged. Of those whose axes were initially aligned vertically, one (No 5) developed an overcorrection (right hyperdeviation of 2 prism dioptres (R/L 2Δ), and complained of minimal residual

Table 2 Surgery and postoperative results

Surgery		Measurements after surgery				Abnormal head posture	Outcome
		1 week		3 months			
		Primary position (prism dioptres)					
Case	Muscle/recession (mm)/method	Vert deviation	Horiz deviation	Vert deviation	Horiz deviation		
1	L.IR 4.5 B	L/R 2	-3	L/R 1		None	Asymptomatic: discharged
2	L.IR 4 B	R/L 6	0	0	+2	None	Asymptomatic: discharged
3	R.IR 2 B	0	+2	0	0	None	Asymptomatic: discharged
4	L.IR 4 A	0	0	0	0	None	Asymptomatic: discharged
5	R.IR 2 B	0		R/L 2		None	Minimal residual diplopia well tolerated: discharged
6	R.IR 6 A	L/R 2	0	R/L 2	0	None	Residual diplopia corrected by Fresnel prism. Further surgery required (see text)
7	R.IR 2/R.LR 6 A	R/L 3	0	L/R 3		None	Asymptomatic: discharged
8	R.SR 4.5 A	R/L 1	0	0	+2	None	Asymptomatic: discharged

IR=inferior rectus, SR=superior rectus. A or B=methods used (see text).

diplopia. This was well tolerated and required no further intervention. Of those who were initially undercorrected, one (No 6) subsequently developed an overcorrection (R/L 2Δ). This continued to give troublesome diplopia which was eliminated by incorporating a temporary Fresnel prism into his spectacles. Further surgery of a 1 mm inferior rectus muscle advancement was performed under local anaesthesia attaining a R/L 1Δ with good recovery and improvement of his symptoms.

One patient (No 7) had undergone previous left squint surgery as a child and presented with an oblique diplopia measuring a left hyperdeviation of 8Δ (L/R 8Δ) and an exotropia of 18Δ. The inferior rectus was recessed and adjusted together with the lateral rectus. Though initially he was vertically overcorrected (R/L 3Δ, 0Δ horizontally) he subsequently developed an undercorrection measuring L/R 3Δ, exotropia 8Δ. Despite this he remained asymptomatic and was discharged.

Discussion

The results of this review show that one stage adjustable suture surgery gives accurate alignment of the visual axes. Only one case required further surgical intervention. These results are comparable with previous studies.¹⁻⁴

Postoperative adjustment of rectus muscles is well described⁵⁻⁸ and widely used, while

intraoperative adjustment under local anaesthesia is less commonly practised. According to Fells,² selection of patients for local anaesthesia is classified into three categories: (1) those whose general health contraindicates general anaesthesia, (2) those who have had previous complications from general anaesthesia, and (3) those who are fit and are able to choose either a local or a general anaesthetic. A fourth option is one that utilises peroperative extraocular muscle function, making it the treatment of choice in certain cases of strabismus surgery.

For one stage adjustable suture surgery to be successful, patient comfort and uncompromised ocular motility are essential. Peribulbar and retrobulbar techniques are rendered inappropriate. Fells *et al*⁷ and Chow *et al*¹ use only topical anaesthesia. This type of anaesthetic is known to poorly penetrate mucosal membranes like the conjunctiva,¹⁰ failing to alleviate discomfort from handling the subconjunctival tissues. It is thought that the unencapsulated freely branching endings of both sensory and motor fibres which are found throughout skeletal muscle transmit wrong information.¹¹ These fibres are particularly dense in the region of the muscle tendons.¹¹ Thus, manipulation and disinsertion of extraocular muscles during surgery are likely to cause pain despite topical anaesthesia. Ruben *et al*⁸ supplement their topical anaesthetic of amethocaine with a subconjunctival infiltration of lignocaine with adrenaline over the muscle insertion. This is the technique used in this study substituting oxybuprocaine for amethocaine as it is less irritant to the conjunctiva and the corneal epithelium.¹⁰ The presence of adrenaline within the lignocaine supplement, doubles the duration of the infiltration and reduces the systemic adverse effects by vasoconstriction, as well as diminishing bleeding.¹⁰ This also reduces possible diffusion posteriorly to the nerve endings supplying the muscle, minimising the risk of compromised ocular motility which may jeopardise the success of the surgery. Though no formal assessment was made regarding the patients' perception of pain during and after surgery, all the patients remained comfortable throughout and none complained of significant

Figure 3 Change in vertical deviation in the primary position 3 months after surgery.

Table 3 Comparison of stability of adjustment from the immediate postoperative period to at least 3 months of follow up

	Rosenbaum <i>et al</i> ⁷		Hamming and Kunisch-Verslype ¹⁵	Chow ¹	Present study
	Two stage adjustable		Two stage adjustable	One stage adjustable	One stage adjustable
Deviation	Vertical	Horizontal	Horizontal	Horizontal	Vertical
Mean change (prism dioptres)	5.5	3	8.82	8.04	1.25
% ≥ 10 prism dioptre change	18.2 (2/11)	8.8 (4/45)	26.5 (9/34)	26.7 (12/45)	0 (0/8)
Follow up period	1-39 months	1-39 months	6 weeks	3 months	3 months
Reoperation rate (%)	18.2 (2/11)	2.2 (1/45)	Unknown	Unknown	12.5 (1/8)

postoperative pain requiring any analgesia. The use of analogue scales to quantify pain perceived during the procedure may be the subject of a future study. The need to convert to general anaesthesia or to abandon the procedure did not arise.⁹

In addition to causing pain, excessive manipulation of the extraocular muscles increases the risk of stimulating the oculocardiac reflex. This occurs when stimulation of the extraocular muscles results in a reflex increase in vagal tone, releasing acetylcholine into the atrioventricular node, generating a bradycardia or atrioventricular block.¹² The incidence of intraoperative oculocardiac reflex during traditional extraocular muscle surgery has been reported to be as high as 68%.¹³ Sprague *et al*,¹⁴ in their study of vagal responses to muscle adjustment when carried out as a secondary procedure, found that 13 of their 20 patients showed an oculocardiac reflex of whom only one was symptomatic. All our subjects had continuous cardiac monitoring and none demonstrated any cardiac arrhythmias.

The surgery was confined to one eye in accordance with Fells's criteria.² Seven had single muscle recessions (six inferior recti and one superior rectus) and one had two muscle recessions (lateral rectus followed by inferior rectus). Fells also recommended that the eye movements should still be under voluntary control to allow access to the muscle. The cover test, however, is of paramount importance for the success of this procedure and voluntary control is essential for this rather than for muscle exposure. Other preferred criteria suggested² are that the patient must have good fusional potential and must be able to lie flat for up to 1 hour. The surgery should also be restricted to a maximum of two muscles and the muscles should not have undergone previous surgery as the postoperative results become erratic. This last factor has been disputed³ as it is considered to be an *indication* for performing one stage adjustable suture surgery rather than a *contraindication*. This review has only one case (No 7) of a consecutive strabismus who was asymptomatic following surgery and who was discharged.

The accuracy of cover testing may also be compromised by diminished visual acuity, which is essential for target fixation. This has been attributed⁴ to corneal drying, abrasions, haemorrhage, pupillary dilatation secondary to the adrenaline, and bleaching of the macular pigments by the theatre operating lights. All of these factors can be minimised. The cover and alternate cover tests were performed both

objectively then subjectively by the surgeon using a horizontally aligned linear target with the patient in the supine position, and the position of the muscle insertion was adjusted accordingly. It was not deemed necessary to perform the prism cover test with the patient in the sitting position preoperatively.

The stability of strabismus surgery following intraoperative adjustment of horizontal recti¹ has been shown to be comparable to two stage surgery. A comparison of stability found with this study and previous studies using one or two stage adjustable sutures is shown in Table 3. The incidence of repeat surgery is also tabulated: 18.2% of vertical recti recessed using a two stage procedure in Rosenbaum *et al*'s series of patients had a change in deviation of 10 Δ or more from the immediate postoperative period to the latest follow up. These individuals required further surgery. In our study there were no patients in this category. There was one patient, however, whose deviation changed 6 Δ postoperatively; this change was in fact a *reduction* in deviation. The results of this review show that of the eight patients, only two experienced diplopia from overcorrection (both by 2 Δ). Of the two, only one (No 6) experienced troublesome diplopia which was alleviated by incorporating temporary Fresnel prisms into his spectacles. Subsequently, further surgery of a 1 mm advancement resulted in a net overcorrection of 1 Δ with the patient being virtually asymptomatic. The other patient (No 5) had minimal residual diplopia which was well tolerated and did not require further surgery. All the remaining patients were asymptomatic.

Seven of the muscles recessed were inferior recti. It has been suggested that there is a tendency for overcorrection following inferior rectus recession⁸ especially if adjustable sutures are used. In a series of 67 patients 21%¹⁴ developed progressive overcorrection after inferior rectus recession (POAIRR) of whom 13 had two stage adjustable suture surgery. Nine of these had thyroid related ophthalmopathy, two superior oblique palsies, and one post cataract surgery. The authors state that the act of adjustment was probably not a predisposing factor, concluding that the bilaterality and pathophysiology of Graves' disease must account for the increased incidence of POAIRR, as well as the unique anatomical relation of the inferior rectus to the inferior oblique and inferior retractors. An additional factor may be the timing of adjustment, which was carried out on the afternoon of surgery or the following morning rather than preoperatively. This time lapse may have allowed the muscle to adhere to

the surrounding tissues thus reducing the accuracy of the adjustment. This may explain the discrepancy experienced. None of our patients showed POAIRR, though only one had thyroid eye disease.

A recent study looking at optimum timing of postoperative adjustment in a rabbit model¹⁶ compared the peak force necessary for adjustment at various postoperative times. The eyes were randomised to adjustment at 15 minutes and at 6, 24, and 48 hours postoperatively. The peak force required to advance the muscle 3 mm was measured using a strain gauge. The authors noted that the peak force required was for initial disinsertion of the muscle from the sclera. They showed there was a significant relation between the time of adjustment and the peak force required for adjustment. The force required at 48 hours was greater than at 24 hours ($p=0.04$), at 6 hours ($p=0.003$), and at 15 minutes ($p=0.0002$). The force required at 24 hours and beyond was greater than the maximal force generated by an extraocular muscle. They concluded that postoperative adjustment should be performed by 24 hours as the ease of adjustment decreased with the lapse of time during the first 24 hours, but especially after 24 hours. The problems of tissue adherence, delayed muscle adjustment, and postoperative tissue scarring following strabismus surgery have been realised in several studies. Attempts to either modify the healing response or lubricate the extraocular tissues by use of intraoperative mitomycin C,¹⁷ sodium hyaluronate,^{18,19} triamcinolone,¹⁹ and silicone sheets²⁰ have been shown to have variable success.

The two stage procedure may be performed as day case surgery²¹ allowing the muscle to be adjusted within the first 24 hours dispelling the need for intraoperative adjuvants to facilitate adjustment. Difficulties with the adverse effects of general anaesthesia have been encountered—namely, vomiting and drowsiness.²² The patients' level of consciousness and compliance are essential for adjustment. Up to 7.9% of intended day cases have been reported to require overnight admission and the most common cause for this is nausea (38%).²³ It would therefore be advisable to perform the surgery in a morning list to minimise the risk of overnight admission.

Recently, intravenous propofol has been used to induce and maintain general anaesthesia.²¹ This has the advantage of being short acting with minimal nausea allowing early postoperative adjustment. Such general anaesthetics introduce a new concept, that of performing suture adjustment in the operating theatre immediately after completion of surgery.²⁴ This would be an attractive alternative with respect to patient oculocardiac reflex monitoring, sterility, comfort and, most importantly, timing. Ward *et al*²⁴ used a combination of propofol and mivacurium. Immediately after extubation patients were awakened, assisted to sit upright, and asked to fixate on a 20/400 Snellen E target on the operating room wall. Prism and alternate measurements facilitated suture adjustment. The stability of adjustment

was assessed by repeating the measurements on the first postoperative day (18–24 hours after surgery). The horizontal and vertical measurements were all within 12Δ, with a mean variation of 4Δ horizontally and 2Δ vertically. They concluded that the total intravenous general anaesthetic technique may provide an opportunity for accurate suture adjustment in the operating room, immediately after completing surgery. The one stage adjustable suture technique allows adjustment to be performed in a sterile and controlled environment. There are no restraints on the timing of surgery which could be performed on a morning or afternoon list allowing efficient use of both the day case theatre and the surgeon's time. As general anaesthetics are not used, the risks of unplanned admission due to adverse effects are reduced. The results suggest that the long term stability appears to be comparable if not better than a two stage procedure.

In conclusion, though the numbers in this review are small, the results obtained are encouraging. Seven out of eight patients who underwent superior or inferior rectus muscle recessions performed under local anaesthesia, with peroperative suture adjustment for vertical diplopia in the primary position, obtained satisfactory results. The eighth required further surgical intervention. The suture techniques demonstrated are simple, relatively easy to master and the surgeon (JG) has used them for a number of years with success. We would recommend this technique of strabismus surgery in all cases where postoperative results would otherwise be unpredictable.

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