Surgical management of small angle strabismus

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Small angle deviation refers to deviations <15 prism diopters (PD). Standard rectus muscle recession–resection is designed to correct moderate to large angle strabismus >10 PD. Small angle eso-deviations and vertical deviations cause asthenopic symptoms and diplopia which may be frustrating for the patient and surgeons alike. This can be true for primary deviations and unfortunately even in postoperative patients. Several nonsurgical management options to overcome the diplopia include prisms, botulinum injections, Bangarters filters and the last resort of self-guided coping mechanism. If these fail or any of these are non-desirable, then the alternative solution would be the surgical intervention. Unfortunately, small angle strabismus surgery is prone for over correction when using standard recession–resection procedure. The reason leading to a list of alternative surgical approaches which include

2. Graded partial tenotomy of vertical rectus for hypertropia Mini-tenotomy.
5. Adjustable fadens/combined recession and resection of a rectus muscle.

Partial thickness myotomy
This common procedure today is marginal myotomy, often performed as ‘Z’ plasty across one-third to ½ the tendon width. It is used to weaken the already dramatically recessed muscle, when recession is not prudent. It is also indicated in patients with thin sclera or to weaken a rectus muscle that has at or near its insertion an implant, exoplant or encircling element used in retinal detachment or for glaucoma filtration.

Partial tenotomy/graded tenotomy
In 2000, Alan Scott described a rectus muscle tenotomy procedure called graded rectus muscle tenotomy which he performed under local anesthesia to treat small degrees of vertical strabismus. Biglan and co-workers did the same in 2004 on vertical muscles only. Partial tenotomy can be done as a primary procedure or in reoperations for small angle strabismus to improve diplopia. The procedure was done under sub conjunctival injection of lignocaine, conjunctival incision was made to expose the tendon and making successive small cuts in the rectus muscle at the insertion until the desired effect is achieved. Over half the tendon was removed starting at one pole, leaving one tendon pole attached to sclera, resulting in the cut tendon slanting back at an angle of 45°. A 60–70% tenotomy, or removing 6–7 mm of tendon, corrects ∼4Δ of strabismus.

The slanted tenotomy works by effectively moving the insertion, thus changing the vector of muscle force and potentially inducing incomitance. A vertical deviation could be induced if an upper tenotomy of one medial rectus muscle was performed along with a lower tenotomy on the contralateral medial rectus muscle. Likewise, an A pattern could theoretically be induced, or a V pattern treated, if the upper poles of both medial rectus muscles were removed, effectively moving the insertions down. This induced incomitance caused by the slanted pole tenotomy was substantiated by van der Muelen-Schot et al.

The advantages of this procedure include the ease of the procedure, adjustments can be made intraoperatively, less bleeding, sutureless and the temporal incision reduces the risk of infection. Graded partial tenotomy of vertical rectus muscle may have applications beyond that has been described.

Mini tenotomy
This is usually considered for the treatment of vertical deviation of ≤6 PD, and horizontal deviations <16 PD. Kenneth W described mini-tenotomy, a central tenotomy of 3–mm of tendon insertion, producing a correcting effect of ∼2–3Δ of strabismus. A correction of up to 4–5Δ can be obtained if binocular surgery was performed. For example, a right hypertropia of 4Δ could be corrected by a right superior rectus tenotomy and left inferior rectus tenotomy. An esotropia of 4–6Δ can be treated with bilateral medial rectus tenotomies. This mini-tenotomy could be adjusted by remeasuring the deviation after operating on one muscle and determine if additional surgery is needed. The size of the tenotomy can be enlarged by resnipping additional tendon fibers for residual deviation.

Surgical technique
Under topical anesthesia following steps can be performed (Figure 1)

(a) Grasp tendon of the rectus muscle centrally with Wright 0.75-tooth tenotomy forceps through the intact conjunctiva.
(b) Cut the central tendon between the forceps and sclera with blunt Westcott scissors.

(c) final outcome shows intact two muscle poles at the extremes of the insertion. These ends maintain the stability and a central approach avoids the ciliary vessels.

In patients in whom the mini-tenotomy fails to alleviate the diplopia standard surgery can be safely done without difficulty.

Mini-plication

The mini-plication described by Kenneth et al. was conceived for deviations of 8Δ to 10Δ, which are too small angles for standard surgery. The approximate dose-response of the procedure was about 5Δ to 7Δ correction in patients without previous surgery resection and those with a recession of the antagonist had a correction of 8Δ to 10Δ per muscle. The response can be tailored by placing the securing suture farther back from the muscle insertion.

Surgical technique (Figure 2)

(a) A swan conjunctival incision is made over the muscle insertion, dissection is done and muscle is grasped centrally ~5 mm from insertion.

(b) A double-armed 6-0 polyglactin 910 suture is placed underneath the forceps the suture is tied in a square knot.

(c) The sclera suture is placed anterior to the insertion and tied in place to plicate the central portion of the muscle.

(d) The final outcome showing plication.

The mini-plication has many advantages over standard strabismus surgery that requires hooking and removing the muscle. It is less invasive and preserves the integrity of the muscle insertion and presumably the anterior ciliary vessels, though this was only studied in the full plication procedure. Vicryl suture is used in this procedure as well as in the full plication procedure, because a permanent suture placed anterior to the muscle insertion will erode through the conjunctiva. It can be done under topical anesthesia and can be reversed.

One muscle strabismus surgery

The role of unilateral rectus muscle surgery has been controversial due to the significant number of under correction and or ocular incomittance. Recent studies have shown that unilateral rectus recession or resection is a safe, effective and predictable treatment for small to moderate angle horizontal deviation including exo-deviation between 15 and 20 PD, exo-deviation between 15 and 40 PD, in patients with under-corrections or recurrent strabismus and in patients with convergence or divergence insufficiency. Single muscle surgeries are often resurgeries. Residual esotropia or exotropias of ~15–20 PD respond well with single muscle recessions or resections. Studies show ~60–90% success rate. The advantage of this is that it limits the surgery to one eye.

Combined recession and resection of rectus muscle/adjustable faden procedure

Scott suggested a procedure that was based on modification of the faden principle for improving incomitance in gaze away from the primary position. The faden procedure in itself does not affect primary position alignment and is difficult technically and is ineffective on the lateral rectus due to large arc of contact. He performed a large resection of a rectus muscle and then recessed the muscle, using a standard hang-back/adjustable technique, in a position where the recession amount exceeded the resection amount. The reattachment of the muscle to sclera at a posterior insertion point produced the mechanical effect of
faden operation. The combined recession–resection procedure has a useful role in the management of symptomatic incomitant strabismus. The procedure is particularly valuable when dealing with incomitance on lateral gaze due to limitation of adduction, when the overacting muscle is the contralateral lateral rectus muscle. It seems to be an effective procedure in expanding the field of single binocular vision.

Conclusion
The various causes of small angle strabismus include microtropia, residual deviations after optical and surgical corrections, intermittent squints, sensory micro-strabismus and paretic strabismus. Normal divergence and vertical fusion amplitudes are small, with divergence measuring 4–6 PD (Δ) and vertical vergence <2 D. Because of this, even small eso-deviations and vertical deviations can cause significant asthenopic symptoms and diplopia, especially when the deviation is acquired in adulthood. Historically, these small-angle deviations have been treated with prism glasses. Prism spectacles are an excellent option if the patient is wearing spectacles for a refractive error. Prisms do not correct incomitance and for many patients prism spectacles are undesirable.

Management of patients with small to moderate angle horizontal and vertical deviation continues to be challenging for the strabismus surgeon. These lesser invasive strabismus surgery provides a valuable option to our strabismus patients with small deviations. The various surgical techniques described can be used to treat diplopia in patients with small angle strabismus who are not ideal candidates for conservative management. These procedures can be done in the office under topical or local anesthesia and provide an alternative to prisms and the standard strabismus surgery. The key to success is careful patient selection, analyzing the critical factors like the angle type-vertical/horizontal, angle size, angle character—phoria/tropia. Most of the surgeries described are muscle weakening procedure although the weakening effect is limited. The procedures described can be useful addition to a strabismus surgeons repertoire.

References

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