CLINICAL STUDY

Measurements for horizontal extraocular muscle surgery from the suture site: outcome and influencing factors

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Abstract

Background **Measurement of recession in strabismus surgery is performed either from the limbus or from the muscle insertion. These measurement methods may result in inaccuracies that may influence the outcome of the procedure. We prospectively evaluated the outcome of recessions measured from the extraocular muscle suture site to its insertion in an incidence cohort.**

Methods **Thirty-six consecutive surgical procedures for infantile esotropia and 23 for constant exotropia were performed in which measurements were performed from the suture site. A successful surgery for esotropia was defined as an orthophoria of up to +10 prism dioptres of deviation for non-accommodative targets at a distance of 20 feet, measured by cover and prism test. A successful surgery for exotropia was defined as a residual deviation between −10 and +10 prism dioptres. The statistical significance of the outcome influencing factors was assessed by chi-square test.**

Results **Six weeks following surgery, 28 procedures (78%) for infantile and non-accommodative esotropia and 19 procedures (83%) for exotropia were successful. At the end of the follow-up period (mean 13.7 months ± 9.4 for esotropia and 11.6 months ± 12.8 for exotropia), the success rate was 77% for esotropia and 75% for exotropia. Prematurity and mental retardation in esotropia, exotropia with pre-operative deviations larger than –45 prism dioptres and amblyopia in exotropia were related to unfavourable outcome ($p < 0.05$).**

Conclusions **Measurement for muscle recession can be performed from the suture site. The outcome is comparable to the outcome when measurements are performed from the limbus or the insertion, probably due to the incidence cohort. Refinement of the technique and defining other factors influencing the outcome of strabismus surgery may improve the outcome.**

Key words Constant exotropia, Deviation measurement, Infantile esotropia, Rectus muscle, Strabismus surgery, Suture site

Accurate measurement of the angle of deviation in esotropia and exotropia is one of the prerequisites for success of strabismus surgery. The amount of recession and resection of the extraocular muscles is determined according to the pre-operative measurements.

The amount of recession may be measured from the limbus or from the muscle insertion.[1–7] The success rate for a heterogeneous esotropia group that underwent surgery with measurement from the limbus was found to be 72–82%,[1,2] and for a heterogeneous esotropia group that underwent surgery with measurement from the insertion, 63%.[3] The fair outcome may be since distance of the insertion from the limbus is variable and placement of the suture may vary. We were interested to know whether measurement from the suture site would improve the outcome of horizontal strabismus surgery compared with the previous techniques.

We prospectively examined the hypothesis that direct measurement of recession from the suture site may improve the outcome of strabismus surgery. We had two purposes when designing the study. The first was to include all consecutive patients in order to evaluate the outcome of measurement from the suture site in surgery for esotropia and exotropia in a cohort study group. The second purpose was to divide the patients into subgroups and to disclose the factors that may be involved in poorer outcome. We evaluated the influence of the type of procedure, presence of amblyopia, primary angle of deviation, refractive errors, and pathological systemic conditions including premature delivery, mental and developmental retardation, and angle delta (the difference between the pre- and post-operative angles of deviation).

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Patients and methods

Patients

Fifty-nine patients underwent 59 strabismus surgical procedures for infantile and non-accommodative esotropia and exotropia between January 1990 and June 1995. Patients with accommodative esotropia were excluded due to the influence of their accommodation on the outcome. The surgery was performed on 30 males between the ages of 1 and 25 years (mean 10.6 ± 6.8 years) and 29 females between 2 and 38 years of age (mean 11.3 ± 9 years). Thirty-six consecutive procedures (61%) were performed for infantile esotropia and 23 consecutive procedures (39%) for exotropia. Informed consent was obtained for all the patients.

All 59 patients were re-evaluated 6 weeks following surgery. Thirty-six esotropic patients were followed up for a period ranging between 3 and 40 months (mean 13.7 ± 9.4 months). Twenty-three patients with exotropia were followed up for between 4 and 61 months (mean 11.6 ± 12.8 months). Nine patients failed to follow up (6 with esotropia and 3 with exotropia).

Successful outcome in esotropia surgery was defined as orthophoria or residual deviation of up to +10 prism dioptres for non-accommodative targets at a distance of 20 feet. The success of exotropia operation was defined as an angle between –10 and +10 prism dioptres, measured for non-accommodative targets at a distance of 20 feet. The deviation measurements before and after surgery were performed with the optimal optical correction after full cycloplegic refraction. The patients continued using their refractive aids immediately after surgery and spectacles were changed according to changes in refraction.

The influence of several parameters on the surgical outcome was evaluated. These included the type of procedure, presence of amblyopia, primary angle of deviation, refractive errors, pathological systemic conditions (premature delivery, mental or developmental retardation) and angle delta (the difference between the pre- and post-operative angles of deviation). The statistical significance of the influencing factors was assessed by chi-square test.

Surgical procedure

The measurements and the surgical procedures were performed by two authors (Z.S., S.R.). Either bilateral recession or unilateral recession and resection was performed. The procedure of choice was bilateral medial rectus recession for esotropia, and bilateral lateral rectus recession for exotropia. Patients with amblyopia underwent a unilateral recess-resect procedure.

The surgery was performed under loop magnification. A fornix-base conjunctival flap of approximately 100° was raised and 7-0 polyglicolic (Vicryl) sutures were pre-placed at the corners of the flap. The recession measurement was obtained from the suture site (Fig. 1). For recession, a double-armed 6-0 Vicryl suture was placed 1.0 mm from the muscle insertion, measured with calipers. The distance for recession was measured from the suture site and scleral marks were performed with low-temperature disposable monopolar cautery. Resection was measured from the muscle insertion to the intended suture placement site. Marking was performed on each side and adjacent to the muscle. Two muscle hooks were then placed below the muscle adjacent to the insertion and the muscle severed between the insertion site and the suture. The hooks were removed and the muscle allowed to slide back, while the sutures were tight to the sclera. The double-armed suture was passed through partial-thickness sclera corresponding to the cautery marks. The arms were tight together in order to tighten the muscle into the new position. The conjunctival flap was approximated with the pre-placed sutures. At the completion of the surgery chloramphenicol and dexamethasone ointment were applied. The patients were treated post-operatively with topical corticosteroids, which were tapered gradually over 2 weeks.

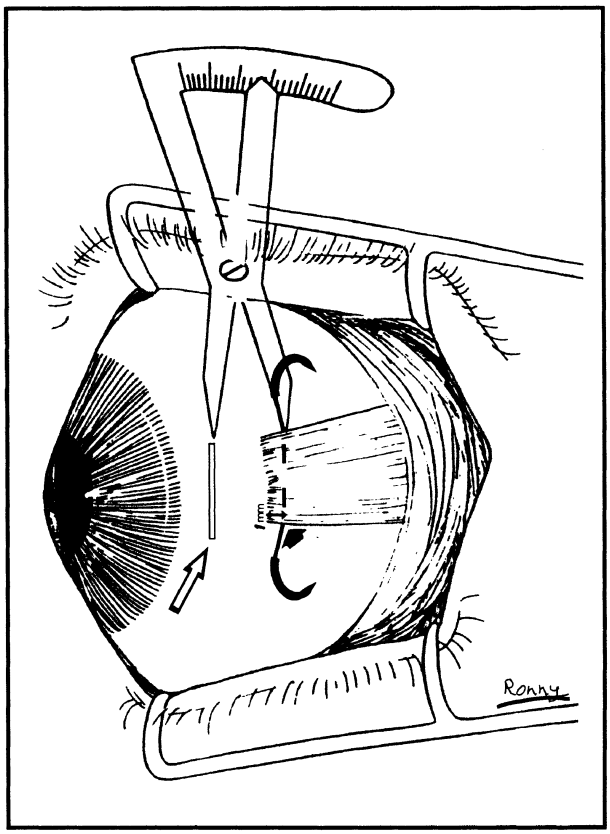

Fig. 1. *Recession measurement performed from the suture site. The suture is secured to the muscle 1.0 mm from the insertion (small double arrow). The recession is measured from the suture (black arrow) to the insertion site (hollow arrow) without manipulations of the muscle.*

Results

Outcome of surgical procedure for esotropia

Twenty-nine bilateral medial rectus recessions (80%), and 7 medial rectus recessions and lateral rectus resections were performed. The pre-operative deviation was between +25 and +70 prism dioptres. Six weeks

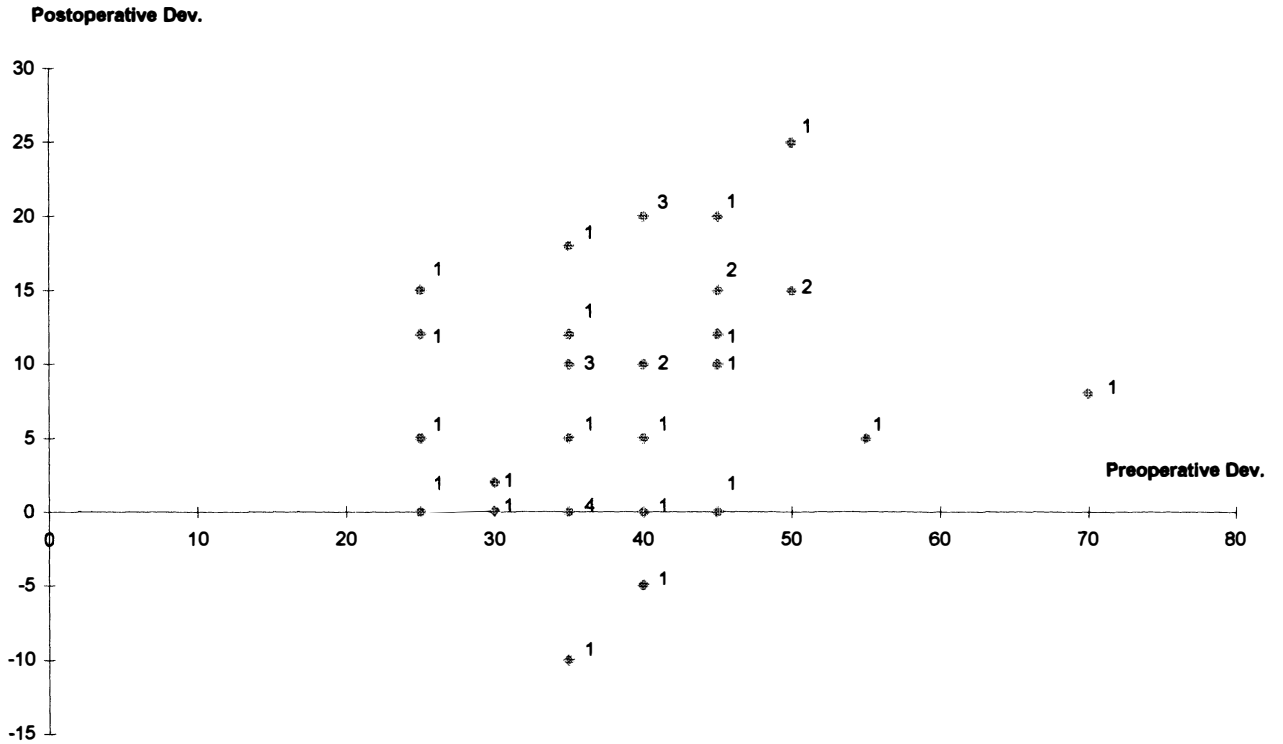

Fig. 2. *The range of the pre- and post-operative (6 weeks) deviation for patients with esotropia in prism dioptres. The number of patients appears near each spot.*

post-operatively 28 operations (78%) were successful, while 8 (22%) were unsuccessful. Within the successful group, 3 patients were overcorrected and 5 were undercorrected – quite a balanced outcome (Fig. 2). At the end of the follow-up period, there were 23 patients (77%) in the successful group. Unfavourable outcome was found in 7 patients (23%).

Influencing factors on the outcome for esotropia

Bilateral medial rectus recession yielded a higher success rate (83%) than a recess-resect procedure (57%) ($p < 0.05$). The pre-operative deviation in the successful group ranged between +25 and +70 prism dioptres (mean +38.3 ± 9.9), while the pre-operative range in the unsuccessful group was +30 to +50 prism dioptres (mean +40.0 ± 5.3). The success rate after excluding the patients with myopic refractive errors was 80%, which was similar to the overall success rate ($p > 0.05$). A pre-operative deviation of +45 prism dioptres or more had no influence on the success rate (71%).

In the unsuccessful group, there was 1 mentally retarded child and 1 premature infant and 2 had high myopia; there were no such patients in the successful group ($p < 0.05$). In both groups, there were 2 amblyopic patients.

No significant difference in angle delta was found between the successful group (mean 30.6 ± 7 prism dioptres) and the unsuccessful group (mean 27.3 ± 16 prism dioptres) ($p > 0.05$).

Outcome of surgical procedure for exotropia

Seventeen bilateral lateral rectus recessions and 6 lateral rectus recessions with medial rectus resections were performed. The pre-operative deviation ranged between –20 and –65 prism dioptres. Six weeks following surgery, 19 patients (83%) had successful results. Four patients (17%) had unsuccessful results, of whom 3 had a small undercorrection and 1 had an overcorrection (additional ± 5 prism dioptres) (Fig. 3).

In the successful group, 14 procedures were bilateral lateral rectus recessions, with a success rate of 74%. Five patients in this group underwent a unilateral recess-resect procedure. In the unsuccessful group, 3 patients underwent a bilateral lateral rectus recession and 1 patient underwent a recess-resect procedure.

At the end of the follow-up period, 15 patients (75%) had a successful outcome. Five patients had an unsuccessful result. Three patients failed long-term follow-up.

Influencing factors on the outcome for exotropia

The pre-operative deviation in the successful group was –30 to –65 prism dioptres (mean –36.6 ± 11.5), and –25 to –60 prism dioptres (mean –40.0 ± 13.7) in the unsuccessful group. When the divergence was –45 prism dioptres or less, the success rate increased to 84% ($p < 0.05$).

At the end of the follow-up period, patients with a pre-operative deviation of –45 prism dioptres or less had a success rate of 93% ($p < 0.05$). Three patients (16%) in the successful group had a pre-operative deviation of

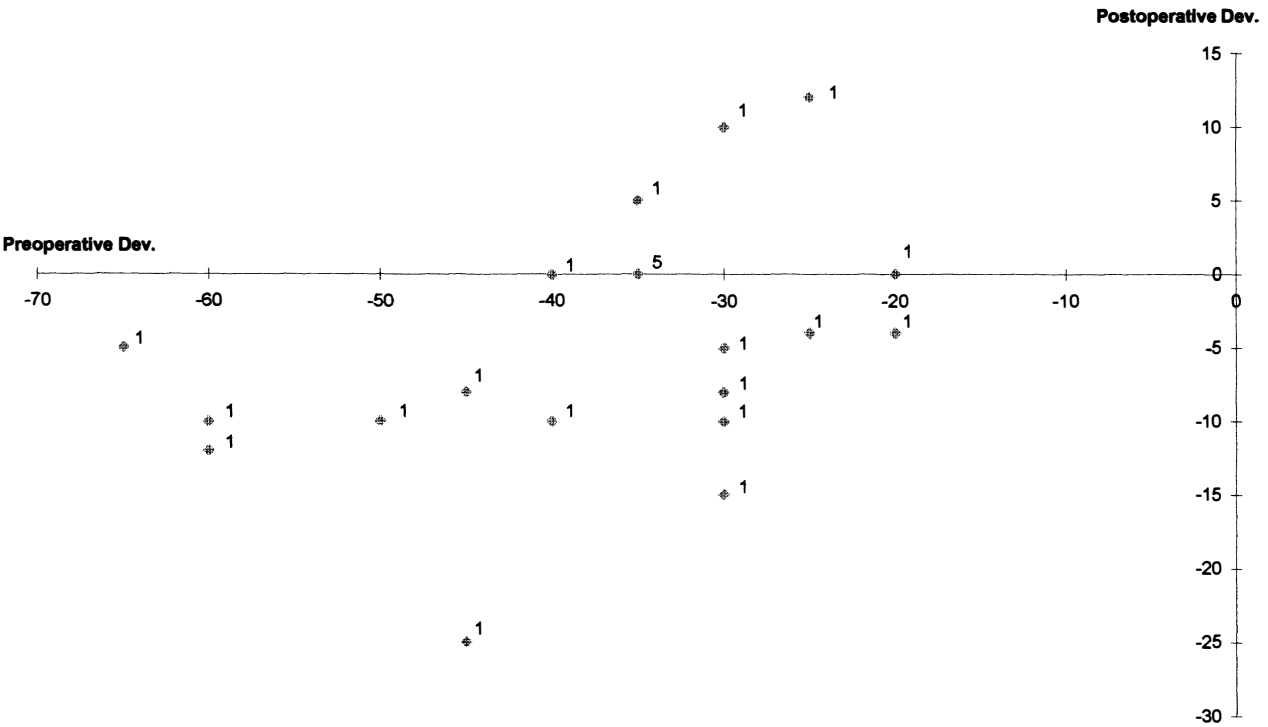

Fig. 3. *The range of the pre- and post-operative (6 weeks) deviation for patients with exotropia in prism dioptres. The number of patients appears near each spot.*

more than 45 prism dioptres. Only 1 patient (25%) in the unsuccessful group had a pre-operative deviation of more than 45 dioptres. The success rate of bilateral lateral rectus recession was 87%.

In the successful group, there was only 1 patient with amblyopia (7%), whereas the unsuccessful group had 2 amblyopic patients (40%). The patients with amblyopia in the latter group had high post-operative divergence angles between –16 and –35 prism dioptres. The success rate increased to 93% when the amblyopic patients were excluded ($p < 0.05$).

The angle delta was 29.93 ± 12.29 prism dioptres in the successful group and 22.00 ± 11.66 prism dioptres in the unsuccessful group. No patients with myopia, developmental or mental retardation and prematurity were found in either the successful and unsuccessful groups. Excluding the influencing factors of large pre-operative deviations and amblyopia, the overall success rate in exotropia was about 85% ($p < 0.05$). Figs. 2 and 3 present the pre- and post-operative deviations in the esotropia and exotropia patients respectively.

Discussion

The two common ways to measure the amount of recession in strabismus surgery are from the limbus or from the muscle insertion. The success rate initially reported 6 weeks after graded bimedial rectus recession, measured from the limbus, for infantile esotropia was 72%.[1] Later, a success rate of 82% was reported for an extended follow-up for a larger series.[2] The success rate after graded recession measured from the insertion was 63%,[3] but when the amount of recession was increased, the success rate also increased.[4–7] These results are comparable and controversy still exists regarding the best method for measurement in strabismus surgery.

Measurement from the limbus may be inaccurate because of individual variations in the distance between the insertion and the corneoscleral limbus.[3] The medial rectus was found to be inserted 3.5–5.5 mm from the limbus. This distance does not correlate with the mean pre-operative deviation. The power of the rectus muscles is determined by the position of the globe in relation to the visual axis. It is related to the insertion site and not to the limbus. The power decreases as the distance from the insertion increases. Therefore, the limbus may not be the best reference point for recess-resect measurement.

Measurement from the insertion may be also inaccurate since the effective recession depends upon the location of the suture along the muscle.[8] The suture is usually placed 0.5–1.0 mm from the insertion. Since the new insertion is located at the suture site and not at the muscle's stump edge an 'advancement' effect may occur. This results in undercorrection due to shortening of the muscle by 0.5–1.0 mm. This artefact can be avoided by placement of the suture before measurement. Furthermore, the muscle insertion site also has a finite thickness of about 1 mm and the posterior border of the insertion may represent a more reproducible landmark.[9] When the measurement is performed from the anterior edge of the insertion, the reattachment site to the sclera should be measured from the anterior edge of the stump. Interpersonal and intrapersonal variations in suture placement may be crucial for successful outcome of strabismus surgery.

Another artefact may be caused by the use of forceps to fixate the severed muscle.[10] This may cause muscle lengthening of about 1 mm. When suture placement and measurement are performed prior to manipulation with forceps such lengthening can be avoided. 'V'-shaped deformity of the stump may be caused by crushing the muscle with a forceps. These artefacts are avoided by our approach and we tried to evaluate whether avoiding muscle manipulation improves the surgical outcome.

Our technique may also provide other advantages. Measurement from the suture may allow suture placement and severing the muscle up to the planned recess-resect amount. Subtracting the distance between the insertion and the suture site from the intended amount of recession or resection may reflect the true amount of recession or resection. Therefore, a larger stump can be left attached to the sclera that may serve for traction and globe manipulations. Severing the muscle at some distance from its insertion and measurement from the suture site may be beneficial after trauma, previous muscle surgery or in congenital disorders when the insertion site is distorted, attenuated or scarred. It may also allow adjustment of the new insertion site to areas of normal sclera in cases of local scleral thinning (e.g. scleromalacia perforance, blue sclera).

We have found that the success rates of our method were 80% for esotropia and 85% for exotropia, 6 weeks following surgery, when we excluded the poor prognostic factors discussed below. Our results are slightly better than those in previous reports measuring from the limbus or from the muscle insertion,[1–7,11–13] suggesting that the success rate is probably not determined by measurements alone. However, it is difficult to compare our data with the other reports due to probable differences in the patient populations. Further refinement of the techniques may improve the surgical outcome and this should be further evaluated.

Influencing factors on the outcome

Bimedial rectus recession had a better outcome than a resect-recess procedure for esotropia. Exotropia of –45 prism dioptres or less and absence of amblyopia were associated with better outcome. Other studies debated whether the presence of amblyopia might influence the outcome of esotropia surgery.[11,12] In addition, others have found that the outcome for patients with exotropia was favourable in true and intermittent distance exotropia and if a small overcorrection was achieved immediately post-operatively.[13]

Our postulation that accuracy in recession measurement for strabismus surgery by measuring from the suture site should improve the surgical outcome is probably incomplete. The success rate of strabismus surgery is probably multifactorial. Identifying these factors may improve the surgical outcome and define the group with long-term stable alignment. Large series with extended follow-up is warranted. Patients with exotropia and amblyopia may need larger recessions. In ametropic eyes, the globe circumference can be calculated.[14] In microphthalmic eyes, lesser recession may be preferred, whereas in buphthalmic eyes, larger recessions may be preferred.

Conclusions

Accurate measurement of the angle of deviation is a prerequisite for strabismus surgery success, but probably it is not the only factor for success. Whether measurements are performed from the limbus, insertion or suture, the surgeon should adopt the best outcome approach according to his or her own experience. Repeating the same surgical technique that the surgeon is comfortable with and refining it may improve the surgical outcome.

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