A randomised comparison of bilateral recession vs. unilateral recession-resection as surgery for infantile esotropia

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Abstract

Objective: Infantile esotropia, a common form of strabismus, is treated either by bilateral recession (BR) or unilateral recession-resection (RR). Differences in degree of alignment achieved by these two procedures have never been examined in a randomised controlled trial.

Design: Controlled, randomised multicenter trial.

Setting: 12 University clinics

Participants and Intervention: We randomly assigned 124 patients to either BR or RR. Standardised protocol prescribed that the total relocation of the muscles, in millimetres was calculated by dividing the preoperative latent angle of strabismus at distance, in degrees, by 1.6.

Main outcome measure: Alignment assessed as the variation of the postoperative angle of strabismus during alternating cover.

Results: The mean preoperative latent angle of strabismus at distance fixation was $+17.2^\circ$ (SD $\pm 4.4^\circ$) for BR and $+17.5^\circ$ (SD $\pm 4.0^\circ$) for RR. The mean postoperative angle of strabismus at distance was $+2.3^\circ$ (SD ± 5.1) for BR and $+2.9^\circ$ (SD ± 3.5) for RR ($P=0.46$ for reduction of the angle and $P=0.22$ for the within-group variation). The mean reduction of the angle of strabismus was 1.41 degree per millimetre of muscle relocation (SD ± 0.45) for RR and 1.47 (SD ± 0.50) for BR ($P=0.50$ for reduction of the angle).

Alignment was associated with postoperative binocular vision ($P=0.001$) in both groups.

Conclusions: We did not find a statistically significant difference between BR and RR as surgery for infantile esotropia.

Trial registration: Clinical trials NCT 00304577.

INTRODUCTION

Infantile esotropia (prevalence 0.2 – 0.35 %)¹ is usually corrected by posterior relocation of the insertion of the medial rectus of both eyes (bilateral recession, BR) or unilateral recession of the medial rectus muscle combined with a resection of part of the tendon of the lateral rectus muscle (recession-resection, RR).^{2 3} A good surgical result is a slight esotropia, because overcorrection into exotropia may lead to double vision.³⁻⁶ Complete restoration of binocular vision or stereopsis is rare.³⁻⁷ To date, there have been no randomised controlled trials to compare BR with RR.⁸⁻⁹ In a recent Cochrane review on interventions for infantile esotropia it was concluded that the preference of BR or RR is subject of discussion and further research was necessary.²

The reduction of the angle of strabismus achieved by surgery depends primarily on the distance of relocation of the medial or lateral rectus muscle.¹⁰⁻¹⁸ The degree of alignment is subject to a large variation.¹⁹ Factors contributing to this variation are variation of the preoperative angle of strabismus, variations of measurements of the angle of strabismus, the variation of the actual relocation of the muscle insertion during surgery, the variation in anatomy, mechanical properties of eye muscles, and other unknown parameters.^{3 6 13 16 19}

We examined whether the reduction of the angle of strabismus was more predictable with either surgical technique, assuming that alignment can be more easily achieved when a particular surgical technique gives a more predictable result. Primary outcome was alignment assessed as the variation of the angle of strabismus after surgery, a large variation indicating an unreliable surgical technique.

METHODS

DESIGN AND PATIENTS

We performed a controlled, randomised, multicenter trial and recruited patients from 12 university clinics in Germany and the Netherlands. Approval was obtained from the Medical Ethics Committee at the Erasmus MC and confirmed by the local ethics committees of the participating clinics. Written informed consent was obtained from both parents of the children, and one parent in case of single parenthood. Inclusion of study subjects occurred over a period of 48 months. Eligible were all children aged three to eight years with a normal psychophysical development and onset of esotropia before age one, who visited one of the clinics during the study period. The decision to not include children under the age of three was made because the angle of strabismus could not be accurately examined in very young children. Exclusion criteria were: previous strabismus surgery, an angle of strabismus larger than 24° or smaller than 10° , any binocular vision, more than 1 line Logmar acuity difference between the two eyes, hypermetropia $> +6$ diopters or myopia > -3 diopters, up- or downshoot in (25°) adduction $> 8^\circ$, V-pattern (esotropia measured in 25° up- and downgaze) $> 8^\circ$, A-pattern $> 5^\circ$ and manifest vertical strabismus $> 4^\circ$. Cases with significant convergence excess with an angle of strabismus at near more than 1.5 times as large as the angle at distance were excluded.

STUDY PROCEDURES

Procedures for orthoptic examination and surgery were protocolised. Each participating centre was visited by the research orthoptists who gave instruction on the procedures

before and twice during the study. The preoperative orthoptic examination consisted of the following procedures: Refractive error was determined by retinoscopy and fully corrected (under- correcting hypermetropia by no more than half a dioptre) before the angle of strabismus was determined. If present, amblyopia was treated before entry in the study. The measurement of the manifest and latent angle of strabismus was performed by prism cover- un-cover test and alternating prism cover test at near with a fixation object, and at distance with a fixation light. A prism-adaptation test was allowed for a maximum of four hours, with a maximum of three prisms in increasing strength. After the final preoperative examination the child was randomly assignment by permuted block randomisation to either BR or RR.

Postoperatively, two orthoptic examinations were performed: Immediately after the bandage was taken off on the day after surgery, the angle of strabismus was estimated by observing the corneal light reflex at one meter distance. At three months, an extensive orthoptic examination was performed, used for final analysis. The angles of strabismus at near and distance fixation were measured. The angle of strabismus at distance fixation was also measured in 25° right and left gaze, to detect incomitance of the angle of strabismus. Binocular vision was examined at near and distance fixation by means of Bagolini striated glasses. Retinoscopy was repeated and, if the spherical equivalent differed more than 0.75 diopters, new glasses were prescribed and orthoptic examination was performed six weeks later.

SURGICAL TECHNIQUES

The consensus surgical protocol contained regulations for the surgical plan and for the surgical technique. It prescribed that the total relocation of the two muscles, in

millimetres; either BR or RR was calculated by dividing the preoperative latent angle of strabismus at distance, in degrees, by 1.6. The preoperative latent angle of strabismus measured the day before surgery at distance fixation was the basis for the distance of relocation of the operated muscles. The study committee, consisting of the participating paediatric ophthalmologists, determined this procedure, including the fixed ratio of 1.6 millimetres per degree of angle of strabismus and the use of the angle measured the day before surgery. The relocation of the muscles by recession or resection was divided equally over the two muscles in either BR or RR. All ophthalmologists had a minimum of five years experience with both recessions and resections. To evaluate the inter-operator differences and its accuracy, photos were taken in approximately every tenth patient during two stages of the operation in either recession or resection: (1) after fitting the sutures through the muscle and (2) before closing the conjunctiva. A millimeter ruler next to the muscle was photographed with the eye.

MAIN OUTCOME MEASURES

The primary parameter to assess whether the reduction of the latent angle of strabismus at distance fixation was more predictable with either technique was the variation of the latent angle at distance fixation, three months postoperatively. Secondary outcome was the variation of the mean reduction of the angle of strabismus, divided by the distance of muscle relocation. Another secondary outcome was the presence of binocular vision after surgery. Note that having demonstrable binocular vision prior to surgery was one of the exclusion criteria.

STATISTICAL ANALYSIS

For the main analysis - the assessment of a difference between the variance of the postoperative angles after BR and that after RR - the F-test was used. For detection of a difference between the mean reduction of the angles of strabismus of surgery after BR and after RR, also the F- test was used. The Student t-test was used to assess differences between the RR and BR group with respect to the mean values of quantitative parameters of interest such as angles of strabismus, and the chi-square test was used for differences in qualitative parameters such as the presence or absence of postoperative binocular vision. Using retrospective data, we could establish a relationship between post-operative angle of strabismus and the chance of a reoperation. Assuming normal distributions of postoperative angles, a clinically relevant reduction in reoperations of 30% would correspond with a reduction in standard deviation (SD) of 1.8 degrees. The resulting F statistic would be 1.93 (assuming an SD of 5 degrees in both groups on average). Inclusion of 120 patients would give the study 80% power at $\alpha = 0.05$ to detect such an F ratio.

RESULTS

During a period of 36 months, 124 consecutive children (average age 5.8) who met the eligibility criteria were recruited by the twelve participating clinics. (Figure 1 and 2) The parents of three children refused to participate. In one child the randomisation procedure failed. In one patient the angle of strabismus increased preoperatively and the surgeon retracted the patient for this reason from the study. One patient, who was assigned to BR, did not show up at the final orthoptic examination. The remaining 118 patients were treated according to permuted block randomisation assignment. 58 patients underwent RR, and 60 patients underwent BR. The base-line characteristics of the two groups are summarized in Table 1. There were no statistically significant differences in demographic or orthoptic characteristics between the two groups.

Table 1. Baseline Characteristics of Randomized Children who Completed the Final Orthoptic Examination			
Characteristics	BR (n = 62)	RR (n = 59)	P Value
N	62	59	
Age (years)	5.9 (1.3)	5.6 (1.1)	0.71
Male	32	28	0.73
Spherical equivalent	+2.6 (1.4)	+2.6 (1.3)	0.82
Additional recession inferior oblique	7	5	
Preoperative latent angle at near fix.	+ 20.3° (4.1)	+ 19.8° (5.3)	0.17
Preoperative latent angle at distance fix.	+ 17.2° (4.4)	+ 17.5° (4.0)	0.49
Preoperative manifest angle at near fix.	+ 17.9° (4.6)	+ 18.3° (5.5)	0.54
Preoperative manifest angle at distance fix.	+ 15.1° (5.1)	+ 16.2° (4.5)	0.21

The mean total recession in the BR group was 10.2 mm (S.D. = 2.0, range 6-15 mm), and the mean total amount of millimetres resected and recessed in the RR group was 10.4 (S.D. = 2.1, range 6-15 mm). In twelve patients the inferior oblique muscles were recessed bilaterally as well, seven in the BR group and five in the RR group. The mean interval between surgery and the last postoperative visit was 98 days in the BR group (range: 46 - 201) and 103 days (range: 43 - 435) in the RR group ($P=0.58$). Dissociated vertical deviation (DVD) was reported in 10 cases. Latent nystagmus (LN) was reported in 26 cases. A combination of DVD and LN was reported in 19 cases.

OUTCOME

Analysis of the BR and RR groups with inferior oblique muscles surgery showed no differences in postoperative horizontal angle. Therefore, the patients with additional oblique surgery were analysed together with those who underwent a standard BR or RR. The mean latent angle of strabismus at near and distance were similar in both groups, three months postoperatively (Figure 3). The mean latent angle at distance was $+2.3^\circ$ (S.D. ± 5.1) for BR, and $+2.9^\circ$ (S.D. ± 3.5) for RR ($P=0.46$). The mean latent angle at near was $+5.0^\circ$ (S.D. ± 4.8) for BR, and $+4.8^\circ$ (S.D. ± 4.1) for RR ($P=0.79$).

To determine the postoperative variation of the angle of strabismus, the within-group variations of the BR and of the RR were compared. For manifest and latent angles, there were no statistically significant differences for the within-group variation tested with the F-test (latent at near $P=0.83$, and latent at distance $P=0.22$). The mean ratio between the reduction of the latent angle of strabismus at distance fixation divided by the distance of muscle relocation, was 1.41° per millimetre (S.D. 0.45) for RR and

1.47° per millimetre (S.D. 0.50) for BR. No statistically significant difference in this ratio was found between the BR and RR ($P=0.50$, t-test).

Eight patients treated with RR and nine patients with BR had an exotropia three months postoperatively. The presence of binocular postoperatively vision was found with the Bagolini striated glasses in 41.1% of BR, and in 35.7% of RR ($P=0.35$). The variation of the manifest postoperative angle at distance (SD) was 2.0° in patients with binocular vision as compared to 4.5° in patients without binocular vision ($P=0.001$) (Figure 4). We did not find a difference in incomitance between the BR and RR. Traction and scarring of the conjunctiva overlying the resected lateral rectus muscle was not reported as a complaint.

As a quality measure we analysed the adherence to the protocol. The guideline of dividing the angle of strabismus measured in degrees the day before surgery by 1.6° to obtain the distance of muscle relocation per millimetre was not strictly implemented in 33% of the cases. Reasons for deviating from the guideline were collected by means of a questionnaire among the participating paediatric ophthalmologists and was categorised as follows: (1) Measurements of the angle of strabismus preceding the day before surgery had been considerably larger or smaller (in hindsight it would have been better to take the average of most or all preoperative measured angles of strabismus), (2) the angle at near fixation or the manifest angle at distance fixation had been considerably larger or smaller, or (3) there was a significant hypermetropia.

We verified the results of the primary outcome measure by determining, as a secondary outcome measure, the variation of the reduction of the angle per millimetre of muscle relocation. We determined its coefficient of variation (CV). CV is a measure of dispersion of a probability distribution; it is defined as the ratio of the standard deviation

to the mean. In those who had adhered fully to the protocol, the CV of the reduction of the angle of strabismus was 32% in RR and 34% in BR for ophthalmologists who adhered to the protocol. It was 36% in RR and 35% in BR for those who did not fully adhere to the protocol. Similarly; the CV of the ratio between the reduction of the angle of strabismus and the relocation of the muscle was 32% in RR and 34% in BR. In those who had not fully adhered to the protocol the CV the ratio was 36% in RR and 34% in BR. In summary, if paediatric ophthalmologists had not fully adhered to the protocol, (preoperative angle of strabismus divided by 1.6° per millimetre to obtain the distance of BR or RR) the CV of the postoperative angle and the CV of the mean reduction of the angle of strabismus were not better than in cases where the paediatric ophthalmologists had operated in full accordance with the protocol.

DISCUSSION

In this controlled prospective randomised trial in children with infantile esotropia, we could not demonstrate differences between BR and RR. Primary outcome was alignment assessed as the variation of the angle of strabismus after surgery, a large variation indicating an unreliable surgical technique in both cases. We could not demonstrate that either technique gave a more predictable result, i.e. no differences were found between BR and RR for variation of the postoperative angle of strabismus. As a secondary measure, the variation of the ratio between reduction of the angle of strabismus and the millimetres of muscle relocation for BR and RR was determined. No differences were found.

We had set in this trial rigorous inclusion criteria to guarantee the enrollment of a homogeneous group of infantile esotropes. This enabled us to study the effect of surgery in a more precise manner, but made recruitment difficult. Age of at least three years was a criterion in our study to allow for accurate orthoptic measurements. It is questionable that differences between BR and RR could be demonstrated for children under three.

For both BR and RR, 38.4% of subjects had some degree of binocular vision, postoperatively assessed with Bagolini striated glasses test. These children had significantly better ocular alignment, which may have been either a cause or a consequence of the gain of binocular vision.

Contributors:

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Operated children per clinic