THE OUTCOME OF STRABISMUS SURGERY IN CHILDHOOD ESOTROPIA

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SUMMARY

The results of squint surgery in 118 children with non-paralytic childhood esotropia are analysed. A 'favourable outcome', defined as a final alignment within ±10 dioptres of straight, or within ±20 dioptres of straight if there was evidence of binocular single vision, was achieved in 86 (72.9%) children. The factors affecting the final outcome are discussed, including age of onset, age at the time of surgery, pre-operative and post-operative amblyopia, refractive error, anisometropia, the surgical procedures used, and post-operative ocular alignment.

Esotropia in childhood may be congenital or acquired. Congenital esotropia is a well-defined entity with an onset prior to 6 months of age, characterised by a large stable angle and a limited potential for binocular single vision.[1] Acquired childhood esotropia may be paralytic or non-paralytic.

Non-paralytic or concomitant childhood esotropia, which is neither congenital nor secondary to ocular pathology, can be divided into three main groups:

1. Accommodative esotropia, which may be fully accommodative, partially accommodative, or accommodative with convergence excess.
2. Non-accommodative esotropia.
3. Esotropia associated with neurological dysfunction, in particular cerebral palsy, hydrocephalus and developmental delay.

We reviewed children in these three categories who underwent strabismus surgery at the Birmingham Children's Hospital, in order to determine the results achieved, to identify the factors associated with favourable and less favourable outcomes, and to consider this information in the planning of future surgery for these conditions.

PATIENTS AND METHODS

The case notes of consecutive patients undergoing surgery for childhood esotropia at the Children's Hospital, Birmingham, in the 5-year period between January 1982 and December 1986 were reviewed. Any patient with congenital or paralytic esotropia, ocular pathology or a post-operative follow-up period of less than 24 months was excluded. Information was obtained from the pre-operative examination, and from examinations at 2 weeks, at 3–6 months, and at yearly intervals thereafter until discharge.

Fully accommodative esotropia was defined as an esotropia which was controlled for distance and near, and partially accommodative esotropia as a reduction in the angle of esotropia of 10 dioptres or more for distance or near, using the full hypermetropic correction. Accommodative esotropia with convergence excess was defined as occurring when the near angle exceeded the distance angle by 15 dioptres or more when fixating an accommodative target, using the full hypermetropic correction where appropriate.

Amblyopia was defined as a difference of two lines or more between the monocular visual acuities. Anisometropia was defined as a spherical or cylindrical difference of greater than 1.0 dioptre between the two eyes.[2] All refractions were undertaken under cycloplegia using either cyclopentolate or atropine.

A 'favourable outcome' was defined as a final alignment within ±10 dioptres of straight, with or without evidence of binocular single vision, or within ±20 dioptres of straight if there was evidence of binocular single vision.

Statistical analysis was performed using medians and the non-parametric Mann–Whitney test for comparing continuous variables, and the chi-squared test with Yates' correction or Fisher's exact test for categorical data.

RESULTS

The inclusion criteria were fulfilled by 118 patients, comprising 24 (20.3%) with accommodative esotropia with convergence excess, 17 (14.4%) with partially accommodative esotropia, 62 (52.5%) with non-accommodative esotropia and 15 (12.7%) with esotropia associated with neurological dysfunction. No patient underwent surgery

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for fully accommodative esotropia. The results are presented for each of the categories described above.

Accommodative Esotropia

Fully Accommodative Esotropia. These children are controlled for near and distance when wearing their full hypermetropic correction. Following the guidelines of Parks and Wheeler, it has not been the policy of the authors to operate on children in this category.[3]

Accommodative Esotropia with Convergence Excess. There was evidence of pre-operative binocular single vision in 17 of the 24 children with accommodative esotropia with convergence excess. The median age of onset was 36 months, and the median age at surgery 64 months. Amblyopia treatment was required for 10 children (41.7%), of whom 2 remained amblyopic at the time of surgery. The median hypermetropic correction was +2.0 dioptres. Anisometropia was present in 3, and inferior oblique overaction was present in 8 children.

Bimedial rectus recessions appropriate to the angle for near were performed for 22 children (91.7%), and a unilateral recession/resection procedure for 2 (8.3%); simultaneous inferior oblique surgery was combined in 6 of these children. Further surgery was required for 8 children: 4 for residual esotropia and 4 for consecutive divergence. Post-operative amblyopia treatment was required in 6 children, of whom 5 were amblyopic at final outcome. The median follow-up was 46 months, and a favourable outcome was achieved for the total group.

Partially Accommodative Esotropia. Only 2 of 17 children in this group showed evidence of pre-operative binocular single vision. The median age of onset was 30 months, and the median age at surgery 57 months. Amblyopia treatment was required for 13 children (76.5%), of whom 3 remained amblyopic at the time of surgery. The median hypermetropic refractive error was +4.0 dioptres. Anisometropia was present in 3, and inferior oblique overaction was present in 6 children.

Bimedial rectus recessions appropriate to the distance angle with spectacles were performed for 12 children (70.6%), a unilateral recession/resection procedure for 4 children (23.5%) and a unilateral medial rectus recession for 1 child (5.9%); simultaneous inferior oblique surgery was combined in 4 children. Further surgery was required in 1 child for a residual esotropia. Post-operative amblyopia treatment was required in 6 children, of whom 5 were amblyopic at final outcome. The median follow-up was 40 months, and a favourable outcome was achieved in 15 of the 17 children in this group.

Non-accommodative Esotropia

There was evidence of pre-operative binocular single vision in 5 children with non-accommodative esotropia. The median age of onset was 26 months, and the median age at surgery 56 months. Amblyopia treatment was required for 51 children (82.3%), of whom 17 remained amblyopic at the time of surgery. The median hypermetropic refractive error was +2.25 dioptres. Anisometropia was present in 5, and inferior oblique overaction was present in 17 children.

Bimedial rectus recessions were performed for 39 children (62.9%), a unilateral recession/resection procedure for 20 children (32.3%), a bimedial rectus recession with unilateral rectus resection in 2 children (3.2%) and a unilateral medial rectus recession in 1 child (1.6%); simultaneous inferior oblique surgery was combined in 12 of these children. Further surgery was required for 17 children: 13 for residual esotropia and 4 for consecutive divergence. Post-operative amblyopia treatment was required in 35 children, of whom 26 were amblyopic at final outcome. The median follow-up was 42 months, and a favourable outcome was achieved in 40 of the 62 children in this group.

Esotropia Associated with Neurological Disorders

The 15 children in the group of esotropia associated with neurological disorders consisted of 5 with cerebral palsy, 5 with hydrocephalus and 5 with non-specific developmental delay. There was no evidence of pre-operative binocular single vision in any of these children. The onset of strabismus occurred in 12 children prior to 6 months of age. The median age at surgery was 35 months. Amblyopia treatment was required for 6 children (40.0%), of whom 2 remained amblyopic at the time of surgery. The median hypermetropic refractive error was +3.25 dioptres. Anisometropia was present in 1 child, and inferior oblique overaction was present in 4 children.

Bimedial rectus recessions were performed for 11 children (73.3%), a unilateral recession/resection procedure for 3 children (20.0%), and a unilateral medial rectus recession in 1 child (6.6%); simultaneous inferior oblique surgery was combined in 3 children. Further surgery was required for 3 children: 1 for residual esotropia and 2 for consecutive divergence. Post-operative amblyopia treatment was required in 3 children, of whom 1 was amblyopic at final outcome. The median follow-up was 49 months, and a favourable outcome was achieved in 7 of the 15 children in this group.

A summary of the results is presented in Table I. Each group was then analysed to determine the indicators of a favourable or non-favourable outcome.

ANALYSIS

The pre-operative factors examined for each group were the age of onset, amblyopia treatment, amblyopia persisting at the time of surgery, refractive error, anisometropia, presence of oblique muscle dysfunction, strabismus angle, age at surgery, and the presence of binocular single vision. The operative factors which were examined were the type and amount of surgery undertaken, and the post-operative factors considered were the immediate and long-term alignment, evidence of binocular single vision, the presence of amblyopia and any further surgery performed.

Accommodative Esotropia

Accommodative Esotropia with Convergence Excess. All

Table I. Clinical characteristics of the individual groups of childhood esotropia

	Accommodative esotropia with convergence excess	Partially accommodative esotropia	Non-accommodative esotropia	Associated esotropia
Pre-operative BSV	17 (70.8%)	2 (11.8%)	5 (8.1%)	0 (0%)
Pre-operative amblyopia treatment	10 (41.7%)	13 (76.5%)	51 (82.3%)	6 (40.0%)
Anisometropia	3 (12.5%)	3 (17.6%)	5 (8.1%)	1 (6.7%)
Re-operation	7 (29.2%)	1 (5.9%)	17 (27.4%)	3 (20.0%)
Follow-up (months)	46	40	42	63
Favourable outcome	24 (100.0%)	15 (88.2%)	40 (64.5%)	7 (46.7%)
Total	24 (100.0%)	17 (100.0%)	62 (100.0%)	15 (100.0%)

BSV, binocular single vision.

children with accommodative esotropia with convergence excess had a favourable outcome. However, this group may be subdivided into 15 children who were straight or had an esotropia of 10 dioptres or less for distance, some only with their hypermetropic correction, and 9 children who had a manifest esotropia for distance of greater than 10 dioptres (Table II). The group who were straight for distance showed a significantly higher incidence of pre-operative binocular single vision, significantly better grades of post-operative binocular single vision and significantly better post-operative alignment.

Alignment within ±10 dioptres of straight at the 3–6 month post-operative visit was present in 22 children (91.7%) for distance. The presence of inferior oblique overaction, pre-operative or post-operative amblyopia, anisometropia, and the age of onset or surgery, could not be shown to influence the final outcome significantly.

Partially Accommodative Esotropia. For the children with partially accommodative esotropia, only 2 of 17 did not achieve a favourable outcome, and it was therefore not possible to make a meaningful statistical comparison between the favourable and non-favourable outcome groups. However, examination of the parameters for the 2 children not achieving a favourable outcome show that both had comparatively large pre-operative squint angles of +50 and +55 dioptres respectively, compared with a median pre-operative squint angle of +45 dioptres for the favourable outcome group. The post-operative squint angle at 3–6 months in these 2 children was +16 dioptres and +40 dioptres respectively, whereas 11 of the 15 children with a favourable outcome had a squint angle within ±10 dioptres at that time (Table III).

Table II. Accommodative esotropia with convergence excess

	Straight for distance	Esotropia for distance
Total	15	9
Pre-operative BSV		
Motor fusion	4 (26.7%)	2 (22.2%)
Stereopsis	11 (73.3%)	0
Total	15 (100.0%)	2 (22.2%)
Final squint angle (median in dioptres)	0	+6
Final BSV		
Motor fusion	2 (13.3%)	7 (22.2%)
Stereopsis	12 (80.0%)	2 (22.2%)
Total	14 (93.3%)	9 (100.0%)
Favourable outcome	15 (100.0%)	9 (100.0%)

Binocular single vision was present in 12 of the 17 children with a favourable outcome; 6 had motor fusion and 6 achieved grades of stereopsis. The presence of inferior oblique overaction, pre-operative amblyopia, anisometropia, and the age of onset or surgery, could not be shown to influence the final outcome significantly. Amblyopia was present at final outcome in 5 children, of whom 2 had a non-favourable outcome, 2 had a favourable outcome with no evidence of binocular single vision and 1 had a favourable outcome with motor fusion.

Non-accommodative Esotropia

For non-accommodative esotropia, the 40 children with a favourable outcome were compared with the 22 children with a non-favourable outcome. No significant difference could be found in any of the pre-operative parameters. A comparable amount of surgery was performed in both groups for equal pre-operative squint angles. Comparison of the median post-operative squint angles for distance at the 2 week visit (9.0 vs. 18.0 dioptres), and the 3–6 month visit (6.5 vs. 15.5 dioptres) in the favourable and non-favourable outcome groups respectively, showed consistently better early alignment in the favourable group.

In order to analyse this further, the data were examined in three groups: 35 children in the favourable outcome group and 10 children in the non-favourable outcome

Table III. Post-operative alignment in partially accommodative esotropia

	Favourable outcome	Non-favourable outcome
Total	15	2
Pre-operative angle	+45	+50/+55
Post-operative angle at 3–6/12	11 within ±10 D	+16/+40 D

D, dioptres.

Table IV. Post-operative alignment following strabismus surgery for non-accommodative esotropia

	Favourable outcome (one operation)	Non-favourable outcome (one operation)	Further surgery
Number	35	10	17
Two weeks post-operative			
Median angle (dioptres)	8	15.5	14
No. within ±10 dioptres of straight	21 (60.0%)	3 (30.0%)	6 (35.3%)
Three to 6 months post-operative			
Median angle (dioptres)	7	14.5	15
No. within ±10 dioptres of straight	25 (71.4%)	1 (10.0%)	7 (41.2%)

group who underwent only a single operation, and a third group consisting of 17 children from both the favourable and non-favourable outcome groups who underwent more than one operation (Table IV). The results demonstrate that the best correlation with a favourable outcome without further surgery is alignment within ±10 dioptres of straight at 3–6 months post-operatively ($P = 0.002$).

The post-operative alignment at 2 weeks provides the best estimation of the mechanical outcome of the strabismus surgery performed, and this is subsequently modified by other factors. Of 30 children with a post-operative alignment within ±10 dioptres at 2 weeks, 21 maintained this alignment at the 3–6 month examination.

We therefore examined the results to determine the success of achieving alignment within ±10 dioptres of straight at the first post-operative visit. This was present in 14 of 19 children (73.7%) with a pre-operative angle from +20 to +40 dioptres. For a pre-operative squint angle equal to or greater than +45 dioptres, only 16 of 43 children (37.2%) achieved this result. The most frequently performed operation for both groups was bimedial rectus recession to a maximum of 6 mm for squint angles of 45 dioptres or greater.

Binocular single vision was present in 28 of the 40 children with a favourable outcome; 13 had motor fusion and 15 achieved grades of stereopsis. Amblyopia was present at final outcome in 26 children; 13 had a non-favourable outcome and 13 had a favourable outcome of whom 6 showed no evidence of binocular single vision. The presence of amblyopia at final outcome was associated with a significantly lower percentage of children achieving final binocular single vision.

Esotropia Associated with Neurological Disorders

Statistical analysis of this group was difficult due to the small numbers. Alignment within ±10 dioptres at the 3–6 month examination was present in 4 of the 7 children (57.1%) with a favourable outcome, and in only 2 of the 8 children (25.0%) with a non-favourable outcome.

Binocular single vision was present in 4 of the 7 children with a favourable outcome, all of whom had motor fusion. The presence of inferior oblique overaction, pre-operative or post-operative amblyopia, anisometropia, and the age of onset or surgery, could not be shown to influence the final outcome.

DISCUSSION

Childhood esotropia is one of the commonest forms of strabismus. Detailed analysis of large groups of patients with extensive follow-up allows a better understanding of the likely outcome of treatment in terms of both stable alignment and binocular single vision. It also allows the formulation of treatment plans to best achieve a favourable outcome.

For accommodative esotropia with convergence excess, a favourable outcome with evidence of binocular single vision is the expected result in the majority of children, particularly in those who pre-operatively are straight for distance. The use of bifocal spectacles[4] or pharmacological manipulation of accommodation[5] may be used pre-operatively to determine whether good-quality binocular function is established when the deviation is fully corrected. Gradual withdrawal of treatment may occasionally effect a cure, but these treatment modalities are most useful for their ability to demonstrate the potential for binocular single vision in a particular patient.

In partially accommodative esotropia, a favourable outcome with evidence of binocular single vision is the expected outcome in the majority of children, although this is not as certain as in the previous group. The surgical strategy should aim for an immediate post-operative alignment within ±10 dioptres of straight, as this was associated with a favourable outcome in the majority of patients. Continuing optical correction may be necessary post-operatively.[6]

In non-accommodative esotropia, almost two thirds of children may be expected to obtain a favourable outcome, with less than half developing evidence of binocular single vision. This result might be improved by obtaining better immediate post-operative alignment, and we therefore intend to increase the amount of surgery currently used. Conjunctival recessions,[7] bimedial recessions of 7 mm[8] and three-muscle surgery[9] may give better immediate post-operative alignment, and should be considered for pre-operative squint angles of 45 dioptres or larger. Post-operative amblyopia treatment is also important, as persistence of amblyopia at final outcome was associated with less favourable results. It will be important to ensure that this more aggressive approach does not lead to a higher incidence of consecutive divergence, and this will be the subject of a later report.

In esotropia associated with neurological dysfunction, the expectations of achieving a favourable outcome are less than in the other categories of childhood esotropia,[10] and delaying surgery to allow stability of the deviation is

justifiable. A favourable outcome can, however, be expected in nearly half of these children, and evidence of binocular function in one quarter. Early post-operative alignment within ±10 dioptres of straight should again be the aim.

The pre-operative use of prisms may improve the assessment of the amount of surgery required, and provide for a better post-operative alignment.[11] Discriminant analysis has previously been performed for acquired esotropia surgery, and has shown that the post-operative deviation at 6 weeks is an important prognostic factor for both the maintenance of ocular alignment and the status of stereopsis.[12] The post-operative alignment at 3–6 months was not specifically examined in that study. The management of post-operative amblyopia includes refraction, as the refractive error in some children may be altered following strabismus surgery.[13]

In summary, we have analysed the results achieved in children undergoing strabismus surgery for childhood esotropia. We have identified post-operative alignment within ±10 dioptres of straight at 3–6 months as a significant indicator of a favourable outcome, and we suggest that further surgery should be considered for children not achieving this alignment. Post-operative amblyopia was associated with a less favourable outcome, and requires early detection and treatment. This information is useful in helping to develop a management strategy for obtaining the optimum results from strabismus surgery in childhood esotropia.

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Key words: Alignment, Amblyopia, Binocular single vision, Esotropia, Strabismus.

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