Factors Influencing Sensory Outcome Following Surgical Correction of Infantile Esotropia

Anna R. O’Connor, Ph.D.*
Sherry I. Fawcett, Ph.D.*,#
David R. Stager, M.D.#
Eileen E. Birch, Ph.D.*,#

ABSTRACT

Introduction: The aims of this study are to compare the binocular function following 7mm vs. standard (3.5 to 6.5mm) bilateral medial rectus recessions, and to determine whether timing of surgery or duration of misalignment prior to surgery impact on binocular function.

Methods: Participants were 85 children with infantile esotropia: all had deviations of 50° or more and were followed for a minimum of four years. At a mean age of 7 years binocular function was assessed with the Randot® Preschool stereo test, the Titmus® fly, and the Worth 4 dot test.

Results: There were 37 children in the 7mm recession group and 48 in the standard recession group. There was no difference in binocular sensory outcome for either stereopsis (P = 0.3) or fusion between the two types of surgery. For all children the duration of misalignment prior to initial surgery (P < 0.01) and age at alignment (P = 0.04) were associated with stereopsis. Duration of alignment following first surgery, however, was not associated with stereopsis (P = 0.5).

Discussion: In this study 7mm bilateral medial rectus recessions did not result in improved binocular sensory outcome compared to standard recessions. The most important factor associated with good binocular sensory outcome was a short duration of misalignment prior to surgery.
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INTRODUCTION

Although surgical treatment of infantile esotropia can achieve excellent alignment, it typically does not result in normal stereoacuity. Nonetheless, it is possible to develop some degree of binocular function following surgical correction. There is no consensus, however, on the best type or the amount of surgery to perform to promote the development of binocular vision. A common surgical approach to correct infantile esotropia is bilateral medial rectus recessions, but there is controversy regarding how far the medial rectus can be safely recessed. One approach is to maximally recess the muscle by 7mm in all patients; alternatively, the amount of recession is tailored to the size of deviation. In a study of 36 children with infantile esotropia, Weakley et al. had a high success rate (75%) for alignment with large recessions of 7mm.\(^1\) One disadvantage to this approach is an increased risk of delayed consecutive exotropia.\(^2\) A second disadvantage is a possible limitation in adduction following surgery;\(^3\) however, more recent evidence does not support this.\(^4,5\) Proponents of the 7mm recession approach suggest the benefit of early alignment outweighs the risk of consecutive exotropia because early alignment is necessary for the development of binocular function.\(^3\) Long-term investigation is necessary to determine whether improved binocular function occurs.

Another debate concerning the treatment of infantile esotropia centers around the timing of surgery. Numerous studies have shown that surgical intervention before 24 months is associated with a higher prevalence of fusion and stereopsis than surgery after 24 months.\(^6\) Currently, there is a trend toward increasingly earlier surgery, as early as 4 months, as this may result in a higher likelihood of maintaining good alignment due to the early opportunity for development of fusion.\(^7\)–\(^10\) although again there is no uniform approach to treatment.

The main aims of this study are to determine if there is any sensory benefit, in terms of fusion and stereoacuity, to performing 7mm bilateral medial rectus recessions compared to standard recessions in the treatment of infantile esotropia. In addition, we aim to determine which risk factors are more likely to result in poor sensory outcome: a long duration of misalignment, age at alignment, or a short duration of alignment following surgery.

SUBJECTS AND METHODS

Subjects

Participants were 85 healthy children enrolled in a prospective study of visual development in infantile esotropia. All patients had constant esotropia, which remained after hyperopic correction, if indicated. The deviation was at least 50 ∆ as measured at near by the prism and cover test or with the modified Krimsky method and the deviation was present on at least two visits prior to surgery. All patients underwent bilateral medial rectus recessions performed by one of three doctors with the degree of recession ranging from 3.5 to 7mm. The minimum period of follow-up was four years. None of the patients had known neurological defects or other coexisting diseases.

Methods

The age at onset was calculated to the nearest month according to an average of the parents’ reported estimated date of onset and the date of the ophthalmologist’s first visit. As in earlier studies\(^11\) when the parental report of age at onset was within the first two months of life, an onset age of two months was assigned as
the literature suggests that infantile esotropia does not occur before this age. The age at alignment is defined as the age, in months, at which they were first aligned within $8^\circ$ of orthotropia and alignment maintained for at least three months. Duration of misalignment is calculated as the age, in months, at surgery minus the age at onset. Duration of alignment is the length of time after the initial surgery that the eyes remained with $8^\circ$ of orthotropia.

At the most recent visit, aged four years or above, binocular sensory outcome was evaluated. Sensory fusion was assessed using the Worth 4 Dot test at 33cm (peripheral fusion) and 3 meters (foveal fusion). Stereopsis was measured using the Titmus® fly for coarse stereopsis and the Randot® Preschool Stereoacuity Test for stereacuity.

**RESULTS**

Of the 85 patients, 37 had 7mm bilateral medial rectus recessions and 48 had smaller amounts of recession ranging from 3.5 to 6.5mm. These two groups were very similar with no significant differences in the age at diagnosis (means 3.4 and 3.5 months, respectively), age at surgery (means 7.8 months and 8.5 months), and age at follow up (mean 7.4 years in both groups), in all cases $P > 0.1$ by t-test. The median angle prior to surgery in the 7mm group was slightly but significantly larger ($70^\circ$ and $60^\circ$, Mann-Whitney, $P < 0.001$). However, this sample is biased by the nine children in the 7mm group with deviations greater than $80^\circ$ (including three deviations of $120^\circ$).

To compare the stereacuity results from the Titmus® and Randot® Preschool Stereoacuity Tests they were grouped into three categories, $\leq 500^\circ$, 550–3000$^\circ$ and no measurable stereacuity. There were two children in the 7mm group and one child in the standard group that had no record of stereacuity test results but did have Worth 4 Dot results, so they are omitted from this analysis. There was no significant difference between the two groups when comparing all three stereacuity categories (Figure 1, $\chi^2 = 2.46$, $P = 0.3$) However, Figure 1 shows that the standard recession group had a higher percentage (22.9%) of children in the best outcome group compared to the 7mm group (10.8%). To determine if the large numbers of children with no stereacuity were biasing the results, the analysis was repeated omitting this category. The difference between the two groups remained statistically insignificant ($\chi^2 = 2.46$, $P = 0.1$). As stated in the methods, there was a significant difference in the angle of the 7mm group; therefore, the analysis was repeated omitting any child with an angle

![Figure 1: Levels of final stereacuity in the two surgical groups.](image-url)
SENSORY OUTCOME IN ESOTROPIA

### TABLE 1
THE EFFECT OF DURATION OF MISALIGNMENT ON STEREOACUITY DEVELOPMENT (n = 82)

<table>
<thead>
<tr>
<th>Duration of misalignment (months)</th>
<th>Stereoacuity (seconds of arc)</th>
<th>≤500</th>
<th>&gt;500–3000</th>
<th>None</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;3</td>
<td></td>
<td>5</td>
<td>7</td>
<td>2</td>
</tr>
<tr>
<td>3–6</td>
<td></td>
<td>6</td>
<td>13</td>
<td>18</td>
</tr>
<tr>
<td>7–12</td>
<td></td>
<td>2</td>
<td>2</td>
<td>12</td>
</tr>
<tr>
<td>&gt;12</td>
<td></td>
<td>2</td>
<td>3</td>
<td>10</td>
</tr>
</tbody>
</table>

Worth 4 Dot testing was performed on 47 patients at 33 cm and 41 at 3 meters. A higher percentage of the standard recession group (n = 21/25) gave a binocular peripheral fusion response than the 7 mm group (n = 14/22), although this was not significant ($\chi^2 = 2.55, P = 0.1$). When assessing foveal fusion, there was no difference between the groups: in the 7 mm group, one of 19 demonstrated foveal fusion, while in the standard recession group, three out of 22 demonstrated foveal fusion ($\chi^2 = 0.81, P = 0.4$).

### TABLE 2
THE EFFECT OF AGE AT ALIGNMENT ON STEREOACUITY DEVELOPMENT (n = 82)

<table>
<thead>
<tr>
<th>Age at alignment (months)</th>
<th>Stereoacuity (seconds of arc)</th>
<th>≤500</th>
<th>&gt;500–3000</th>
<th>None</th>
</tr>
</thead>
<tbody>
<tr>
<td>3–5</td>
<td></td>
<td>7</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
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<td>3</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
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<td></td>
<td>1</td>
<td>3</td>
<td>9</td>
</tr>
<tr>
<td>12–18</td>
<td></td>
<td>2</td>
<td>3</td>
<td>9</td>
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<tr>
<td>&gt;18</td>
<td></td>
<td>2</td>
<td>2</td>
<td>8</td>
</tr>
</tbody>
</table>

was necessary to combine groups for the purposes of statistical analysis. In all analyses, the two groups with stereoacuity are combined ($\leq 500^\circ$ and $550–3000^\circ$) and compared to those with no stereoacuity. In addition to combining the stereoacuity groups, it was also necessary to combine the results for the risk factors into a comparison of two groups. The tables demonstrate which groups are compared. The division of the groups was based on the previous findings of Birch et al.\textsuperscript{11}

A duration of misalignment of three months or less is significantly associated with the presence of stereoacuity compared to a duration of misalignment greater than three months ($\chi^2 = 9.2, P < 0.01$). The division of the groups was based on the previous findings of Birch et al.\textsuperscript{11}

### TABLE 3
THE EFFECT OF DURATION OF ALIGNMENT ON STEREOACUITY DEVELOPMENT (n = 82)

<table>
<thead>
<tr>
<th>Duration of alignment (months)</th>
<th>Stereoacuity (seconds of arc)</th>
<th>≤500</th>
<th>&gt;500–3000</th>
<th>None</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
<td>3</td>
<td>3</td>
<td>11</td>
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<tr>
<td>&lt;6</td>
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<td>0</td>
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<td>3</td>
</tr>
<tr>
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</tr>
<tr>
<td>&gt;12</td>
<td></td>
<td>10</td>
<td>14</td>
<td>22</td>
</tr>
</tbody>
</table>

A relative risk analysis was performed to determine which factors are associated with an absence of stereoacuity.\textsuperscript{14} Figure 2 shows the relative risk (white line through the black box) and 95% confidence intervals (edges of the box) for each of the factors. If the confidence interval in-
includes 1, it means it is not a significant risk factor. From this analysis, it can be seen that misalignment of greater than three months duration increased the risk for no stereoacuity by four times and alignment after 6 months of age increased the risk by two times.

**DISCUSSION**

In this sample of 85 children, 47% achieved some measurable stereopsis. This finding is similar to previous reports following early surgery for infantile esotropia. Comparison of 7mm bilateral medial rectus recession to standard recessions (3.5 to 6.5mm) did not appear to result in an improved sensory outcome. This finding may suggest that the type of surgery does not affect binocular sensory outcome. However, as Weakley showed less residual esotropia following 7mm surgery, it may mean that there is an improved sensory outcome, but the difference is too subtle to be detected by this sample size or the tests utilized in this study. The comparison of the two groups was repeated for just those who had stereopsis because there may be a subgroup of children with infantile esotropia who have an innate capacity for stereopsis and stereoacuity outcomes may be improved in the 7mm group, but again no difference was found. Ideally, a large randomized controlled trial would be the best way to determine whether the 7mm surgery improves binocular function by removing any possible bias.

**CONCLUSION**

Our results demonstrate that early alignment and particularly a short period of misalignment are important for developing binocular function in children with infantile esotropia. This confirms the findings of earlier studies, which indicate that the best outcome attained is independent of the timing of surgery, but is associated with a short period of misalignment. Birch et al. also found that improved random dot stereoacuity outcomes are associated with a lower rate of consecutive esotropia and exotropia requiring surgery. Therefore, reducing the period of misalignment by early surgical correction may reduce the major disadvantage of the 7mm procedure, decreasing the risk of consecutive exotropia. Further comparison of the 7mm procedure to standard resections may reveal an improvement in binocular function in the 7mm group if all children have a short period of misalignment.
REFERENCES

1. Weakley DR, Stager DR, Everett M: Seven-mil-
limeter bilateral medial rectus recessions in in-
fantile esotropia. J Pediatr Ophthalmol Strab-

2. Stager DR, Weakley DR, Everett M, Birch EE: Del-
ayed consecutive exotropia following 7-mil-
limeter bilateral medial rectus recession for con-
genital esotropia. J Pediatr Ophthalmol Strab-
ismus 1994; 31:147–150.

3. Beisner DH: Reduction of ocular torque by me-
85:13–17.

4. Weakley DR: Seven-millimeter rectus reces-
sions and large-angle esotropia. Arch Ophthal-

5. Prieto-Diaz J: Large bilateral medial rectus re-
cession in early esotropia with bilateral limita-
tion of abduction. J Pediatr Ophthalmol Stra-

6. Ing MR: The timing of surgical alignment for con-
genital (infantile) esotropia. J Pediatr Ophthal-

mol 2000; 84:536–538.

8. Ing MR: Outcome study of surgical alignment be-
fore six months of age for congenital esotro-

9. Shauly Y, Prager TC, Mazow ML: Clinical char-
117:183–189.

DK, Plager DA, Sprunger DT: Results of early align-
ment of congenital esotropia. Ophthalmol-
ogy 1999; 106:1716–1726.

11. Birch EE, Fawcett S, Stager DR: Why does early surgical alignment improve stereoacuity
outcomes in infantile esotropia. J AAPOS 2000;
4:10–14.

12. Archer SM, Sondhi N, Helveston EM: Strabis-

13. Birch EE, Williams C, Hunter J, Lapa MC, and
the ALSPAC “Children in Focus” Study Team: Ran-
dom dot stereoacuity of preschool children. J Pediatr Ophthalmol Strabismus 1997; 34:
217–222.


15. O’Keefe M, Abdulla N, Bowell R, Lanigan B: Bino-

16. Wright KW, Edelman PM, McVey JH, Terry
AP, Lin M: High-grade stereo acuity after early
surgery for congenital esotropia. Arch Ophthal-
mol 1994; 112:913–919.

17. Birch EE, Stager DR, Berry P, Everett M: Pro-
spective assessment of acuity and stereopsis in
amblyopic infantile esotropes following early
surgery. Invest Ophthalmol Vis Sci 1990; 31:
758–765.

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gery, stereoacuity.