Infantile Esotropia: Emergence of Binocular Function years after surgery

I. Reich-d’Almeida¹, C. Costa Lança², F. Reich-d’Almeida³

¹Clinica Oftalmológica Dr. Reich-d’Almeida, Lisbon, Portugal
²Lisbon School of Health Technologies, Lisbon, Portugal
³Centro de Investigação em Saúde Pública, Escola Nacional de Saúde Pública, Universidade Nova de Lisboa, Lisbon, Portugal

ABSTRACT: Purpose. To demonstrate that in surgically treated infantile esotropia (IE) patients, it is possible, after a very long therapy and follow-up period, to achieve functional rehabilitation well above the conventionally accepted age for sensorial recovery. Methods. In a retrospective observational cohort study, 45 IE patients were enrolled. Inclusion criteria comprised previous surgery, follow-up of at least six years, the emergence of binocular function (BF) after nine years of age and maintenance of a mono-fixation syndrome (MS), using prism and optical regular re-evaluation. Results. The time-lag between the first appointment and first signs of binocularity varied between 5-16 years (10.31 ± 2.70) and age of BF appearance from age 9-16 (mean age of 12.31 ± 1.84 years). Follow-up lasted between 6-36 years (mean 16.6± 6.68 years). From 45 patients, stereoscopy was found in 31.1% (n=14), 62.2% (n=28) attained motor and sensory fusion in real space, and simultaneous perception (SP) without fusion was detected in 6.7% (n=3). Near stereocuity ranged from 200-400 arc with a mean of 88.57 ± 55.50 and 22.22% (n=10) presented stereocuity of < 70°. Distance stereocuity values were 400-600° (mean of 176 ± 135.20). Conclusion. Operated IE cases may achieve BF way above the conventional age limit. In this study, BF sometimes arises as much as 16 years later which is epidemiologically relevant in this condition and can be far-reaching in consequences for the patient's social role and integration, thereby for his quality of life. It also reinforces the notion of brain and visual system plasticity at a much later age.

KEYWORDS: Binocular vision; infantile esotropia; late binocularity in squint; neural plasticity; stereocuity.

1 INTRODUCTION

The first goal of any squint treatment is realignment with full sensorial rehabilitation. A crux problem in IE has been, however, recovery of BF. Scholarly attention has been given to the age of surgery, and it is commonly taken as a dogma that functional results depend upon intervention before the age of 6-24 months, preferably six months¹². In recent years, from neuroscience as from the clinical ground, opposing views did quote immediate post-operative binocularity following IE surgery in older age groups³⁴. Though plasticity of the visuomotor process, neuro-adaptation potential and the building up of new neurons, all remain controversial. In this cohort, BF did emerge in teenhood or early adulthood. Most significantly, there was a long span (5-16years) between surgery (1st, 2nd or 3rd operations) and BF appearance.

2 METHODS

Inclusion criteria: Diagnosis of IE, consecutively expressed in its definition⁴. In all cases, a convergent deviation started 1-4 months after birth, with clear photographs taken during that period and further on until the date of the first exam. Cases re-examined in the last two years were
chosen. Also selected because development of binocularity occurred at a later stage (average age of 9 years) and evolved to an MS stable angle (3/40) from orthophoria. Exclusion criteria: Among other excluding unusual cases, patients were also excluded if doubts existed as to the date of the squint first signs. Surgical protocol: either a unilateral RR or a binocular recession. Occasionally MR retro-surgical myectomy was applied. Limited or formix mesions were used. Surgery was performed by the same surgeon (FRA) at a private hospital in Lisbon.

Follow-up routine: A comprehensive ophthalmological orthoptic exam was carried out. (11) For refractive: all were subject to atoropic cycloplegia (atroopic sulphate 1%, 3 x 2 days for 3-5 days). Refraction procedure was periodically rechecked by retinoscopy. Often also by computerized assistance (Sure-Sight AR). (2) Visual acuity (VA) was assessed (near/distance) by the usual tests dependent upon age; (3) Binocularity assessment: For Snellen, Bagolini (near and distance). Maddox wing (near), Maddox rod (for distance) were adopted. For sensory fusion: Bagolini, Worth 4-dot (near/distance; macular/paramacular); For motor fixation: vergences were evaluated with prism bars (near/distance). Quarterly, interquartile ranges, and median values were analyzed. (4) Stereopsis: For near, stereopsis was evaluated using the Randot Preschool Stereocuity Test. TNO, the Stereo Butterfly Test, Lang-Sternotests I and II, and Frisby. For distance, both Randot (3 m) and the Mentor B-Vat II-SG (6 m) were adopted. Stereo tests were administered and scored according to commonly established practice and to the manufacturer’s instructions; (5) Prisms: Horizontal residual deviations (±: 10°, vertical: ± 4-6°) following surgery or in-between operations, were corrected adopting ground-in-prisms (GIP), regularly updated. Within monocular range, GIP were used to maximally collapse the subjective angle.

Follow-up at the decisional stage: Length of follow-up was not a matter of concern. When a binocular response was present, therapy was continued, though this decision was dependent upon the parents/patients choice. Treatment was kept until adulthood.

Data statistical analysis: The SPSS method of descriptive statistics (IBM SPSS Statistics, 22, desktop 64-bit version) was adopted for this work.

3 RESULTS

From a total of 45 patients, 22 were male (48.9%) and 23 female (51.1%). Age of first appointment (AAP) was the date when they were first examined at the clinic. Mean AAP was 30.96 ± 7.76 months with a range of 7-72 months. The mean age for 1st surgery was 45.93 ± 20.71 months with a range of 14.84 months. Visual acuity: Resuming to itching, drug penalization (atroopic sulphate) and optical penalization, single or combined, anhydropia, when present, took between 7-28 months to normalize, with final normal immobility (near/distance).

Motor results: Table 1 discloses the number and relative frequency of operations.

<table>
<thead>
<tr>
<th>Table 1. Results /Surgery: Number, Frequency, and Relative Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of operations</td>
</tr>
<tr>
<td>----------------------</td>
</tr>
<tr>
<td>Total</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>2</td>
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<td>3</td>
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<td>4</td>
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</table>

Sensory results:

Motor and sensory fusion: On the whole, adding the stereopsis (in 114 and hipotinitol, in 25 subjects, a total percentage of 93°, or 21 exhibited fusion (true vergences) in real space. Abnormal visual correspondence (AVC) prevalent.

Anoptos parameters: they are addressed in Table 2.

Emergence of Binocular function: Age of 1st signs varied between 9-16 years with a mean age of 12.31 ± 1.84 years. Mean age of the patients at last appointment (AAP) was 21.60 ± 5.58 with an age range of 19-41 years (Table 3).

4 DISCUSSION

Stability of sequence, age, and time. They suggested a sign-synchronous adoption strait directed at 1 Reemerging a new angle to less foundations the whole b Sensitive per- 

nancy, we are a strain, an age v this cohort, it is an adult and the brain cells in adult 

5 CONCLUSION

Stemming up from age and the i Am proposed condition, at are tients and be
Table 2. Results of stereoscopic parameters (%)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Standard deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Near</td>
<td>200</td>
<td>40</td>
<td>86.57</td>
<td>55.50</td>
</tr>
<tr>
<td>Distance</td>
<td>400</td>
<td>60</td>
<td>176</td>
<td>135.20</td>
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</table>

Table 3. Results of age of emergence of BF and age of last appointment (ALA)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Standard deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age of BF emergence (years)</td>
<td>9</td>
<td>16</td>
<td>12.21</td>
<td>1.84</td>
</tr>
<tr>
<td>ALA</td>
<td>11</td>
<td>41</td>
<td>21.60</td>
<td>7.55</td>
</tr>
</tbody>
</table>

Fine-lags: BF emergence and follow-up: from AFA to the first detection of BF and from AFA to the achievement of a stable monofixation sensory-motor status (Table 4).

Table 4. Emergence of binocular function and time of follow-up (years)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Standard deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Follow-up</td>
<td>6</td>
<td>36</td>
<td>16.62</td>
<td>6.68</td>
</tr>
<tr>
<td>Time-lag</td>
<td>AFA to BF</td>
<td>5</td>
<td>16</td>
<td>10.31</td>
</tr>
<tr>
<td>Time-lag</td>
<td>AFA to stable BF</td>
<td>10</td>
<td>30</td>
<td>15.49</td>
</tr>
</tbody>
</table>

Refraction: With 4 exceptions, hyperopia was low (-1.00D). This finding contrasted with significant astigmatisms (-2.00D), noticeable in the large majority of the cohort (95.55%, n = 43).

4 DISCUSSION

Stability is arguably the basis for BF, but the latter is, in turn, a guarantor of stability. In consequence, we might subsume and hypothesize a putative setting off in motion of a motor-sensory loop. This study provides evidence to corroborate it. The fact that most of these patients presented a significant degree of astigmatism acted as a positive spur in prompting a frequent and spontaneous correction of the frame position; thus contributing to a stable binocular input. The adopted strategy, whereby at the disclosure of the first signs of binocularity, every effort was directed at fine-tuning and correcting motor variables is the core of this medical approach. Remaining horizontal binocularity angles were collapsed, namely the horizontal subjective angle to less than 4°, which might act as a filter in stereoinduction. By laying the foundations for an MN which can occasionally adapt and may decompenstate, thought on the whole being still a vector for a stable vector alignment.

Sensitive period for recovery: From the four critical infancy and childhood periods of ontogeny, we are chiefly concerned with this interval of time. It corresponds to the first 5-7 years of life, an age where the visual system still has a high plasticity and potential for recovery. In this cohort, binocularity resurfaced later (age of 9 years), way above that limit.

In recent years, though, a contrario bent stressed to a degree that both the vision system and the brain are plastic,19,20 pliable to adaptation and even capable of creating new neurons in adulthood.21,22 Examples are found in adult treatment of amblyopia19,23 and binocularity.24 Those concepts, that of brain and vision as short-term plasticity systems and that of long-term plasticity systems might seem to be opposed. In the end, however, short-term and long-term plasticity might not be opposing but complementary mechanisms where the latter, comes along as a second phase with some remaining albeit possibly weaker adaptative capacity.

5 CONCLUSION

Summing up, we might highlight that most therapy consensus about BF stresses its poor functional prognosis, the sine qua non urge for very early surgery, preferably before six months of age, and the implicit agreement that whenever BF appeared it manifested shortly after surgery. As opposed to that, this work might express a somewhat better functional prognosis for this condition, along with the message that to achieve sensory results it is worth following BF patients and keeping track for a syndrome monofixational or microphoric condition in BF, if some-
tor (surgery) and isosensory (prisms, off-centered lenses) prerequisites are carefully monitored.
BF may emerge even after a gap of several years.

To the best of our knowledge this is the first published work, where, with late operated IE, BF emerged following years of post-operative treatment.

**Take-home message:**
(i) Long follow-ups coupled with constant endeavor for isosensory and isomotor ocular conditions, seem to be essential in the delayed functional outcomes;
(ii) Binocular outcomes, emerging a large time-lag (6-36 years) after surgery, are achievable.

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Edited by
Daniela Eleonora Cioplean
Ophthalmology Clinic OFTAPRO
Bucharest, Romania