The Effect of Successful Surgical Alignment on Improvement of Binocular Vision in Adults with Childhood Strabismus

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Abstract

***Purpose*:** To evaluate the effect of successful surgical alignment on improvement of binocular vision in adults with childhood strabismus

***Methods*:** In a prospective interventional study, consecutive patients with childhood-onset, comitant, horizontal and constant strabismus who had successful postoperative alignment were enrolled. Preoperative and postoperative binocular vision testing was performed using the Bagolini striated lenses and the Worths 4-dot test. Improvement of binocular vision was defined as conversion of suppression to fusion response in Bagolini test and conversion of suppression to fusion or monofixation response in Worth 4-dot test at three months after surgery.

***Results*:** A total of 34 patients (15 females and 19 males) were included. The mean age at the time of surgery was 26.08±10.53 years (range, 14-53 years). The mean angel of deviation was 40.29±14.35 prism diopter (range, 20-75 prism diopter). Binocular vision was improved in 20 of 34 patients (58.8%) in Bagolini test, also, binocular vision was improved in 20 of 34 patients (58.8%) in Worth 4-dot test. There was no significant correlation between duration of misalignment and sensory outcome (p=0.67). There was a statistically insignificant increase in improvement of binocular vision in exotropic group (65%) compared with esotropic group (50%) (p=0.48). Also, there was a statistically insignificant increase in improvement of binocular vision in nonamblyopic group (60.8%) compared with amblyopic group (54.5%) (p=0.5). The angel of preoperative deviation had no influence on improvement of binocular vision (p=0.08).

***Conclusion*:** Surgical realignment leads to improvements in binocular vision in 58.8% of adults with childhood strabismus regardless of the type and angle of preoperative deviation, duration of strabismus, or amblyopia.

***Keywords*:** Strabismus, Binocular Vision

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Introduction

Strabismus surgery in adults is not merely cosmetic in most cases. The majority of adults will experience some improvement in binocular function after strabismus surgery.[1,2] High-grade binocular vision is essential for skilled precision grasping.[3] Binocular vision provides a considerable advantage over monocular vision when particles partly obstruct the view (external visual noise).[4] Binocular visual and motor changes affect body sway; adaptive mechanisms induced by eye re-alignment after surgery allow improved postural control.[5]

The development of binocularity with the Bagolini lenses after surgery appears to be related to the stability of the postoperative ocular alignment.[6] Therefore, restoration of binocular vision is very useful.

Now it is a matter of investigation under which conditions and to which degree binocular fusion can be acquired in adulthood. Therefore, in this prospective study, we evaluated the effect of successful surgical alignment on improvement of binocular vision in adults with childhood strabismus (before visual maturation) to determine the prognostic factors for sensory outcome.

Methods

The study was performed at Tabriz Nikookari Eye Hospital as a prospective interventional study from 2012 to 2013. The study was approved by the Institutional Review Board of Tabriz University of Medical Sciences. Consecutive patients with childhood-onset, comitant, horizontal and constant strabismus who had successful postoperative alignment were enrolled. All surgeries were performed by one strabismus surgeon (D.A.). Successful alignment was defined as orthotropia or horizontal heterotropia (esotropia or exotropia) of 10 prism diopter or less at distance and near as measured by the simultaneous prism and cover test at three months after surgery. The duration of strabismus was determined by history taking and by studying patient's old photographs when available.

Patients were excluded if any of following was encountered: restrictive strabismus, extraocular muscles paresis, near and distance deviation disparity, previous ocular disease or surgery, history of ocular trauma, associated developmental or neurologic abnormality, unreliable responses in binocular vision tests.

A consent to participate in the study was signed by patients.

All patients underwent a comprehensive ophthalmic examination, including visual acuity, ocular motility, slit-lamp and fundus examinations. All preoperative measurements of ocular deviation (prism alternate cover or modified krimisky tests), postoperative measutments of ocular deviation (using the simultaneous prism and cover or modified krimisky tests) and strabismus surgeries were performed by a single strabismus surgeon (D.A.). Preoperative and postoperative binocular vision testing were performed using the Bagolini striated lenses and the Worths 4-dot test at 6 and 0.33 meter by a single ophthalmologist (B.P.). In the Worth 4-dot test, a red glass is worn in front of one eye and a green glass in front of the other. The standard Worth 4-dot flashlight project onto patient. The test was performed separately for distance and near vision. In fusion response, the patient would report four dots in distance and near. In suppression response, the patient would report two or three dots in distance and near. In monofixation response, the patient would report two or three dots in distance and four dots in near. In Bagolini test, the patient fixates a small light, after being provided with plano lenses with narrow fine striations across one meridian. If the patient drew two streaks crossed in the center or with fixation point scotoma, the response was fusion. If the patient drew single line, the response was suppression. Fixation point scotoma with peripheral fusion, if shift >10 prism diopter occurs in cover test, the response was expressed in ARC.

Binocular vision was improved if the following conditions were encountered: conversion of suppression to fusion response in Bagolini test and conversion of suppression to fusion or monofixation response in Worth 4-dot test at three months after surgery.

Descriptive statistics, including the mean and standard deviation were calculated for all variables. Statistical analysis was performed using the χ^2, the Fisher exact, the Independent Samples *t* tests to determine the prognostic factors affecting sensory outcome. A p-value

less than 0.05 was considered statistically significant.

Results

A total of 34 patients (15 females and 19 males) were included. Baseline characteristics of patients are given in table 1.

Twenty-one of 34 patients (68.1%) achieved ortotropia at three months after surgery. Thirteen of 34 patients (38.2%) achieved horizontal heterotropia (esotropia or exotropia) of 10 prism diopter or less at distance and near as measured by the simultaneous prism and cover test at three months after surgery.

Preoperative and postoperative responses of patients in Bagolini test are given in table 2.

Preoperative and postoperative responses of patients in Worth 4-dot test are given in table 3.

Binocular vision was improved in 20 of 34 patients (58.8%) in Bagolini test. Also, binocular vision was improved in 20 of 34 patients (58.8%) in Worth 4-dot test.

Five of seven patients (71.4%) who had a misalignment of less than 10 years' duration achieved postoperative fusion, whereas 15 of 27 patients (55.5 %) who had a misalignment of 10 years' duration or longer achieved postoperative fusion. However, duration of misalignment was not a prognostic factor for improvement of binocular function (p=0.67).

There was a statistically insignificant increase in improvement of binocular vision in exotropic group (13 of 20 patients) compared with esotropic group (seven of 14 patients) (p=0.48).

Also, there was a statistically insignificant increase in improvement of binocular vision in nonamblyopic group (14 of 23 patients) compared with amblyopic group (six of 11 patients) (p=0.5).

The angel of preoperative deviation had no influence on improvement of binocular vision (p=0.08).

Table 1. Baseline characteristics of patients

Type of deviation	
Esotropia	14 (41.2%)
Exotropia	20 (55.8%)
The mean age of the patients	26.08±10.53 years (14-53)
The mean angel of deviation	40.29±14.35 prism diopter (20-75)
Esotropia	41.78±17.05 prism diopter (20-75)
Exotropia	39.25±12.48 prism diopter (20-75)
Duration of strabismus	
<10 years	7 (20.6%)
≥10 years	27 (79.4%)
Amblyopia (based on BCVA)	
Existence of amblyopia	11 (32.4%) (severe only in two patients)
Absence of amblyopia	23 (61.8%)

Table 2. Preoperative and postoperative responses of patients in Bagolini test

Type of response	Before surgery	At three months after surgery
Suppression	33	13
Fusion	0	20
ARC	1	1

Table 3. Preoperative and postoperative responses of patients in Worth 4-dot test

Type of response	Before surgery	At three months after surgery
Suppression	33	13
Fusion	1	18
Monofixation	0	3

Discussion

In this study, improvement of binocular vision was achieved in 20 of 34 patients with childhood strabismus (58.8 %). Also, in a study by Dickmann et al, 13 of 20 patients with childhood strabismus (65%) demonstrated an increase of sensory status with Bagolini striated glasses.[7] Fatima et al reported that the fusion response was achieved in eight of 15 adults with longstanding strabismus (53.3%) in wotrh 4-dot test. Restoration of binocular vision in Bagolini test was occurred in 66% of patients in this study.[8]

However, in a study by Mets et al, only three of 72 adults demonstrated binocularity by Worth 4-dot testing.[9] Also, Ganguly and Pradhan reported that the restoration of binocular vision occurred only in three of 40 adults.[10]

In our study, 13 of 20 patients in exotropic group (65%) demonstrated improvement of binocular vision. Also, Gill and Arnoldi reported that the fusion response was achieved in 80% of adults with longstanding exotropia.[11]

In our study, seven of 14 patients in esotropic group (50%) demonstrated improvement of binocular vision. Also, Keskinbora et al reported that the fusion response was achieved in 42.8 % of adults with longstanding esotropia.[12] Furthermore, in a study in which a group of 17 adults and older children of at least eight years of age received surgery for untreated infantile esotroia, 88% of patients showed binocular fusion when tested with Bagolini lenses.[13]

Although, the recovery of binocular vision in exotropia occurred further than esotropia in our study, however, we found that the type of horizontal deviation was not a predictive factor for sensory outcome (p=0.48).

We found that the amount of horizontal strabismus before surgery was not a predictive factor for sensory outcome (p=0.08). Also, in a study by Gill and Arnoldi, surgical realignment leads to improvements in binocular vision in most patients, even in the case of large deviations.[11] Furthermore, Fatima et al reported that the majority of patients with good vision and non-fusing large angle (≥40 prism diopter) and chronic strabismus can regain fusion after successful surgical alignment.[8]

In our study, duration of misalignment more than 10 years was not a predictive factor for failure in recovery of binocular vision (p=0.67). Also, in a study by Gill and Arnoldi, surgical realignment led to improvements in binocular vision in most patients, even in the case of very long-standing deviations (present for ≥20 years).[11] However, in period of visual maturation, early surgery minimizes the duration of misalignment and is associated with better binocular vision outcome.[14,15]

Binocularity can improved with treatment of amblyopia.[16] However, in our study, amblyopia was not a predictive factor for failure in recovery of binocular vision (p=0.5). Binocular dysfunction is primary and monocular visual acuity loss is secondary.[17] Furthermore, Hess et al demonstrated a novel procedure in treatment of amblyopia based on re-establishing binocular vision. In thisnew method of treatment, concomitant improvement in monocular acuity of the amblyopic eye occurs with reduction in suppression and strengthening of binocular fusion.[18] Therefore, it seems amblyopia could not influence on recovery of binocular vision.

Conclusion

Our findings indicate that surgical alignment was associated with restoration of binocular vision in adult with strabismus before visual maturation. Also, duration of misalignment, type and angel of preoperative deviation and amblyopia had no influence on improvement of binocular vision.

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