Gains beyond cosmesis: Recovery of fusion and stereopsis in adults with longstanding strabismus following successful surgical realignment

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We evaluated recovery of binocularity in 15 chronically strabismic, non-fusing (with neutralizing prisms) adults following successful surgical alignment. We included ≥12-year-olds, with best corrected visual acuity (BCVA) ≥20/60, and excluded those with: anisoaucuity >2 lines-Snellen; failed realignment judged by >10 prism diopters (PD) horizontal and >4 PD vertical. Six-week outcomes were: fusion by Worth Four-Dots (WFDT) and Bagolini striated glasses (BSG) and stereopsis by Titmus test and the Netherlands organisation for applied scientific research (TNO) test. Baseline data in medians (range): age 18 (12-40) years, strabismus 45 (19-95) PD, duration 14 (0.5-24) years, 12 females; 12 exotropes, three esotropes; visual acuity was 20/20 in 10, while none had BCVA <20/60. Postoperative strabismus measured 6 PD (range:0-10). By six weeks none suppressed: WFDT findings showed eight fused at distance and 13 at near; and on BSG figures were 10 and 13 respectively. Stereopsis was demonstrated by 13 on Titmus and by 10 on TNO tests. It is concluded that longstanding strabismic adults with good vision can recover fusion and stereopsis following successful squint surgery.

Key words: Adult strabismus, binocularity, fusion, stereopsis

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Apart from cosmesis, adults undergoing strabismus surgery stand to gain from recovery of fusion, stereopsis, expanded field (in esotropia), elimination of torticollis, better psychosocial functioning and enhanced job opportunities.\(^1\) Factors adversely affecting recovery of stereopsis are visual acuity (VA)<20/60 due to any cause, optic neuritis, anisometropia and strabismus. Earlier, surgery was considered beneficial provided patients had good VA and achieved successful alignment. Subsequent reports\(^2\) indicated recovery of some fusion\(^3\) and stereopsis even in those who had strabismus onset before visual maturity (<nine years).\(^4\) Significant factors predictive of postoperative fusion were the absence of previous surgery, VA ≥20/40, and normal retinal correspondence in exotropes and fusion during prism adaptation, absence of infantile esotropia, and an increase in vertical deviation in esotropes. Duration of misalignment did not predict the recovery of stereoaucuity.\(^5\) In acquired strabismus, better stereopsis was achieved if misalignment was of <12 months although patients with longer duration did demonstrate fusion and stereopsis.\(^6\)

The aim of the study was to assess the recovery of fusion and...
stereopsis after squint surgery in adults with chronic strabismus that demonstrated no binocularity preoperatively.

Materials and Methods

After obtaining ethical approval from the institutional review board, we included patients with constant strabismus, age ≥12 years and best corrected visual acuity (BCVA) ≥20/60 Snellen in the deviated eye, and excluded those with any measurable stereopsis or sensory fusion using neutralizing prisms, anisoacuity (BCVA) >2 Snellen’s line or failed surgical realignment. Successful alignment was considered to be ≤10 prism diopters (PD) horizontal and ≤4 PD vertical.

Main outcome measures were fusion (central and peripheral) using Worth Four Dots (WFDT) and Bagolini striated glasses (BSG), and stereopsis, employing the Titmus and the Netherlands organisation for applied scientific research (TNO) tests.

After informed consent, we assessed VA, cycloplegic refraction, BCVA, and performed biomicroscopy and ophthalmoscopy. Stereopsis was considered gross (3000 arc-sec) if the patient passed only the Titmus ‘fly’ test, coarse: 60-800 arc-sec and fine as 15-60 arc-sec, and true if ≤100 arc-sec.

Results

The demographic details, preoperative and postoperative results are presented in Table 1. Most had a long history of constant strabismus. Large angles (>40 PD) were measured in nine; five had 20-40 PD, while one had <20 PD. Median strabismus was 45 PD (range 18-95) preoperatively and 6 PD (range 0-10) at six weeks postoperatively. Patients 5 and 6 underwent bilateral surgeries.

Postoperative fusion responses are depicted in Table 2. By six weeks none suppressed. Postoperative stereopsis is presented in Table 3. By six weeks, some stereopsis was present in 13 on Titmus

### Table 1: Pre- and six weeks postoperative characteristics of adult strabismus patients (n=15)

| Age (yrs)/ Gender | Strabismus duration (years) | Spherical equivalent in Diopters RE/ LE | BCVA (Snellen) | Pre-surgical deviation (prism diopter) | Post-surgical deviation (prism diopter) | Fusion at distance | Fusion at near | Stereopsis (arc-sec) |
|-------------------|-----------------------------|-----------------------------------------|----------------|----------------------------------------|----------------------------------------|--------------------|---------------|---------------------|
| 20/F              | 19                          | 0/0                                     | RE 20/20       | 65 AXT                                 | 0                                      | Yes                | Yes           | 100                 |
| 28/F              | 22                          | 0/0                                     | RE 20/20       | 40 AXT                                 | 6 AXT                                  | Yes                | Yes           | 100                 |
| 25/F              | 7                           | 0/0                                     | RE 20/20       | 65 AXT                                 | 10 AXT                                 | Yes                | Yes           | 3000                |
| 14/F              | 13                          | +0.5/+0.5                               | RE 20/20       | 60 AXT                                 | 6 AXT                                  | Yes                | Yes           | 800                 |
| 25/M              | 24                          | -2.25/-1.25                             | RE 20/20       | 85 AXT                                 | 10 AXT                                 | No                 | No            | 800                 |
| 12/F              | 10                          | +3/+3                                   | RE 20/30       | 95 AET                                 | 6 AET                                  | Yes                | Yes           | 200                 |
| 22/M              | 21                          | 0/0                                     | RE 20/20       | 40 LXT                                 | 8 LXT                                  | Yes                | Yes           | 400                 |
| 12/F              | 6                           | +0.5/0                                  | RE 20/30       | 60 LXT                                 | 0                                      | Yes                | Yes           | 100                 |
| 25/F              | 24                          | +0.5/+0.5                               | RE 20/20       | 18 RET                                 | 0                                      | No                 | Yes           | 800                 |
| 16/F              | 15                          | +2/0                                    | RE 20/20       | 45 RET                                 | 6 RXT                                  | Yes                | Yes           | 3000                |
| 40/F              | 0.5                         | -225/0                                  | RE 20/30       | 35 RXT 8LHT                            | 0                                      | Yes                | Yes           | Nil                  |
| 18/F              | 17                          | 0/0                                     | RE 20/20       | 45 RXT                                 | 0                                      | No                 | Yes           | 40                  |
| 15/F              | 14                          | +3.75/+0.5                              | RE 20/40       | 35 RXT 10RXT                           | No                                     | No                 | No            | 3000                |
| 18/M              | 1                           | 0/-1                                    | RE 20/40       | 6 RHT 2RHT                             | 0                                      | Yes                | Yes           | Nil                  |
| 15/F              | 12                          | 0/0                                     | RE 20/20       | 55 AXT 10AXT                           | No                                     | Yes                | Yes           | 60                  |

BCVA=Best corrected visual acuity, AXT=alternating exotropia, AET=alternating esotropia, RET=right esotropia, RXT=right exotropia, LXT=left exotropia, LET=left esotropia, RHT=right hypertropia, LHT=left hypertropia, RE=Right eye, LE= left eye
circles and 30% on the Randot Preschool stereoacuity test.\cite{8,9}

In our study the majority of adults with longstanding strabismus and no prior binocularity, demonstrated both fusion and stereopsis following successful postoperative alignment. Various studies have reported recovery of binocularity postoperatively in adults.\cite{7-10} Lal et al. retrospectively analyzed 21 adults (median age= 59 years) with large angled acquired strabismus and reported measurable stereoacuity in 67% and fine (≤ 60 arc-sec) in 44%.\cite{7} This was irrespective of the duration of strabismus. In Fawcett’s series of 23 cases of acquired strabismus, 96% recovered some measurable stereopsis; 70% demonstrating fine stereopsis (≤ 60 arc-sec) on the Titmus circles and 30% on the Randot Preschool stereocuity test.\cite{8} Such excellent results were probably accounted for by a period of binocularity preceding strabismus and/or occasions (due to intermittency) or fields (in incomitancy) wherein fusion was possible. In Fawcett’s series a significant proportion regained fine stereopsis when aligned ≤12 months of misalignment as compared to those aligned after >12 months. Age, strabismus type, or pre-surgical sensory fusion did not predict stereopsis. Patients demonstrating pre-surgical capacity for true stereopsis (40-100 arc-sec) were more likely to demonstrate stereopsis postoperatively (P<0.05).

Although recovery is more likely if there has been a period of binocularity during the critical period of visual development, this notion is now being questioned.\cite{11} Moreover, even visually mature patients lose stereocuity following strabismus.\cite{8} In acquired strabismus following head trauma, the latter may itself disrupt central fusional pathways adversely affecting recovery of stereopsis.\cite{7} Two of our patients who did not recover stereopsis had a history of head trauma (Patients 11 and 14, Table: 1).

Does binocularity improve with time? Lal et al.\cite{7} followed their patients for one year and reported continued improvement. However, five of our patients who completed follow-up of one year did not demonstrate further improvement.

Can ≤10 PD of horizontal deviation be considered as successful motor alignment consistent with sensory success (true stereopsis)? Recent research suggests that a horizontal deviation ≤4PD will enable macular fusion (<100 arc-sec) whereas larger angles (5-10 PD) may be just sufficient for binocularity.\cite{11} Interestingly, two of the five patients who showed stereopsis <100 arc-sec had a deviation between 5-10 PD.

Titmus tests consistently yielded a better response than the TNO, although both provide monocular clues. The Frisby test and the new Preschool Randot test are considered more valuable for quantification, but were not available to us.

Our study was not without limitations. It has a small sample of 15 patients which did not justify subgroup analyses. Since 12 of the 15 patients were exotropes, the results may be biased towards them.

Nevertheless, we found that the majority of patients with good vision with non-fusing large angle chronic strabismus can regain fusion and stereopsis after successful surgical alignment. Some may recover true stereopsis. Larger studies need to validate whether better motor alignment yields more favorable results and which tests of binocularity should be considered best. Meanwhile all adults presenting with strabismus should have their eyes aligned promptly for functional gains, namely: fusion and, stereopsis.

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