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Outcomes of surgically treated adult strabismus

Nuntawan Thamwarakul* Sudarat Yaisawang*
Wasee Tulvatana* Parima Hirunwiwatkul*

Thamwarakul N, Yaisawang S, Tulvatana W, Hirunwiwatkul P. Outcomes of surgically treated adult strabismus. Chula Med J 2004 Oct; 87(10): 667 - 77

- Objective** : *To study the outcomes of strabismus surgery in adults according to their motor results, sensory results and psychological implication.*
- Design** : *Prospective and descriptive study.*
- Setting** : *King Chulalongkorn Memorial Hospital, Department of Ophthalmology.*
- Material and Method** : *The study was conducted in February 2002 to December 2003. Strabismus patients with indication for surgery, who were 9 years of age or older and had at least 12 weeks postoperative follow-up were recruited. The subjects were classified into 2 groups, namely; "before visual maturation" (BVM) group which included patients who had strabismus onset before 9 years of age, and "after visual maturation" (AVM) group which included patients who had strabismus onset after the age of 9. Successful results of this clinical study are divided into 3 types: motor success, sensory success, and subjective success.*
- Results** : *This study recruited 90 patients (48 females and 42 males) whose age ranged between 9 and 70 years. Sixty-five patients (72 %) were in BVM group, and 25 patients (28 %) in AVM group. Most of the patients reported that the strabismus moderately or severely. Motor success was seen in 57 % in BVM group, and 60 % in AVM group. Sensory success was 43 % and 44 % in BVM group and AVM group, respectively. Subjective success was found in 92 % of BVM group, and 88 % of AVM group. Among 20 patients who had preoperative diplopia, only one patient needed re-operation. Of those patients who did not have diplopia preoperatively, only 3 patients in BVM group developed transient diplopia postoperatively which later disappeared.*

Conclusion : *The success and benefit of surgical correction of adult strabismus is that the condition is more than cosmetic problem, since sensory fusion and improve psychological function have been shown.*

Keywords : *Adult strabismus, Surgery, Outcome.*

Reprint request : Thamwarakul N. Department of Ophthalmology, Faculty of Medicine,
Chulalongkorn University, Bangkok 10330, Thailand.

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นันทวรรณ ธรรมวรากุล, สุดารัตน์ ใหญ่สว่าง, วลี ตุลวรรณะ, พริมา หิรัญวิวัฒน์กุล. ผลการผ่าตัดรักษาตาเหล่ในผู้ใหญ่. จุฬาลงกรณ์เวชสาร 2547 ต.ค.; 48(10): 667 - 77

วัตถุประสงค์ : เพื่อศึกษาและวิเคราะห์ผลการผ่าตัดรักษาตาเหล่ในผู้ใหญ่ โดยจำแนกตามผลด้านแนวตำแหน่งตา ด้านการมองเห็นโดยใช้ตาสองข้างร่วมกัน และด้านความรู้สึกของผู้รับการรักษา

รูปแบบการวิจัย : การศึกษาเชิงพรรณนาแบบไปข้างหน้า

สถานที่ : ภาควิชาจักษุวิทยา โรงพยาบาลจุฬาลงกรณ์

วัสดุและวิธีการ : การศึกษาเริ่มดำเนินการตั้งแต่ กุมภาพันธ์ พ.ศ. 2545 ถึง ธันวาคม พ.ศ. 2546 โดยรวบรวมผู้ป่วยที่มีข้อบ่งชี้ในการผ่าตัดซึ่งมีอายุเท่ากับ หรือมากกว่า 9 ปีขึ้นไป และมาตรวจหลังผ่าตัดอย่างน้อย 12 สัปดาห์ แบ่งผู้ป่วยเป็น 2 กลุ่ม ได้แก่ กลุ่มที่เกิดตาเหล่ก่อนการพัฒนาการมองเห็นเจริญเต็มที่ (BVM) คือผู้ป่วยที่เกิดตาเหล่ก่อนอายุ 9 ปี และ กลุ่มที่เกิดตาเหล่หลังการพัฒนาการมองเห็นเจริญเต็มที่ (AVM) คือผู้ป่วยที่เกิดตาเหล่หลังอายุ 9 ปี ผลสำเร็จของการรักษาแบ่งเป็น 3 กลุ่ม คือ ผลสำเร็จด้านแนวตำแหน่งตา (motor success) ผลสำเร็จด้านการมองเห็น (sensory success) และ ผลสำเร็จด้านความรู้สึกของผู้รับการรักษา (subjective success)

ผลการศึกษา : ผู้ป่วยจำนวน 90 คน (ผู้หญิง 48 คน ผู้ชาย 42 คน) อายุระหว่าง 9 - 70 ปี 65 คน (72 %) อยู่ในกลุ่ม BVM และ 25 คน (28 %) อยู่ในกลุ่ม AVM ผู้ป่วยส่วนใหญ่ได้รับผลกระทบจากอาการตาเหล่ในชีวิตประจำวัน ผลสำเร็จด้านแนวตำแหน่งตาพบ 57 % ในกลุ่ม BVM และ 60 % ในกลุ่ม AVM ผลสำเร็จด้านการมองเห็นพบ 43 % และ 44 % ในกลุ่ม BVM และ AVM ตามลำดับ ส่วนผลสำเร็จด้านความรู้สึกของผู้รับการรักษาพบ 92 % ในกลุ่ม BVM และ 88 % ในกลุ่ม AVM ในผู้ป่วย 20 คนที่มีอาการภาพซ้อนก่อนผ่าตัดพบมีเพียงรายเดียวที่ต้องผ่าตัดซ้ำ และในกลุ่มผู้ป่วยที่ไม่มีอาการภาพซ้อนก่อนผ่าตัดพบมี 3 รายที่มีอาการภาพซ้อนหลังผ่าตัดซึ่งเป็นอยู่ระยะหนึ่งแล้วหายไปตัวเอง

สรุป : ผลการความสำเร็จและประโยชน์หลังการผ่าตัดแก้ไขตาเหล่ในผู้ใหญ่ ได้แสดงให้เห็นว่าปัญหาตาเหล่ในผู้ใหญ่ไม่ได้เป็นแค่ปัญหาด้านความสวยงามเท่านั้นเพราะผู้ป่วยเหล่านี้พบว่าสามารถใช้สองตาร่วมกันในการมองเห็นได้ดีขึ้น และผลด้านการเข้าสังคมดีขึ้นด้วย

คำสำคัญ : ตาเหล่ในผู้ใหญ่, การผ่าตัด, ผลการรักษา

For several generations it has been felt that little could be done for misaligned eyes in adults. The patients were told that nothing could or should be done to correct their conditions. As a result, proper treatment was not made available for them. Hence, they suffer from loss of binocular vision and stereopsis. Many of them have limitations of visual field, especially the "side" or peripheral vision. Some patients have intolerable diplopia.

In addition to the affected eye function, misaligned eyes or abnormal head posture (torticollis) may hamper normal eye-to-eye contact and thus interfere with communication and social interaction.⁽¹⁾ This often leads to impaired self confidence and development of abnormal head posturing during social interaction. Generally, patients with these problems are accustomed to looking down or looking away from the person they are talking to. The other party is then confused with the position of the eye the strabismus patient is using, leading to a distraction from whom the patient is trying to communicate with. Impairment of normal communication skills may then result in deprivation of job and promotion opportunities.⁽²⁾

Misalignment of the eyes is a deformity that handicaps individual's social and economic potential. A study using simulated condition showed that negative attitude towards strabismus emerges at approximately 6 years of age.⁽³⁾ Many of the affected persons had these problems since they were in school. Straightening of the eyes improves their social communication and ability to get jobs or dealing with more complicated performances. It will also lead to some helpful binocularity in the vast majority of cases, even in some instances where the onset of the strabismus has occurred in childhood or in

longstanding strabismus.⁽⁴⁻⁶⁾

During the last decade, there were many studies about the value of surgery in adult strabismus.⁽⁷⁻¹⁴⁾ Baker⁽¹⁵⁾ concluded that the benefits include elimination of diplopia and torticollis, restoration of binocularity, expansion of peripheral binocular field in patients with esotropia, improvement in psychosocial functioning and better opportunity for employment and economic success.

The strabismus repair, therefore, is not just for "cosmetic" purpose but it should be more appropriately considered a "reconstructive" surgery, i.e. to change an abnormal appearance to the one that is more normal.⁽¹⁶⁻¹⁷⁾

In Thailand, adult strabismus patients are not infrequent. At the Department of Ophthalmology, King Chulalongkorn Memorial Hospital, 339 strabismus patients (>15 years old) with different causes were operated between 1996 and 2001. Unfortunately, retrospective data did not provide thorough information about their motor results, sensory results and psychosocial implications. We therefore performed a prospective study to evaluate the outcomes.

Material and Methods

A prospective descriptive study from February 2002 to December 2003 was conducted at the Department of Ophthalmology, King Chulalongkorn Memorial Hospital. Inclusion criteria were set to recruit patients who underwent strabismus surgery at the age older than 9 years old and had at least 12 weeks of postoperative follow-up.

The patients were operated under at least one of the following purposes: correction of ocular alignment, elimination of diplopia, restoration of

binocular vision, elimination of anomalous head posture, or improvement of psychosocial function.

Generally, causes of adult strabismus can be congenital or childhood onset of misaligned eyes, neurological disorder that involves the third, fourth, or sixth cranial nerve, ophthalmologic diseases or iatrogenic conditions. In this study, classification system previously reported by Scott *et al*, was used.⁽¹⁴⁾ The patients were classified in two groups according to the onset of the disease. The first group contained patients with the onset of strabismus before visual maturation, i.e. 9 years of age or younger (BVM) and the other group, those whose onset began after visual maturation (AVM). This system allows fair comparisons among comparable treatment outcomes.⁽¹⁸⁾

For each patient, general information including age, sex, medical history, previous eye surgery, other eye surgery, best corrected Snellen visual acuity, status of amblyopia and refractive errors was recorded. Motor tests including preoperative strabismic angle of deviation at near and distance in primary position, versions, ductions, forced duction, active forced generation and presence or absence of abnormal head position were recorded. Postoperative deviations were followed at 1, 4, and 12 weeks. Sensory tests consisted of the presence or absence of preoperative diplopia, Bagolini test, Worth-four-dot test at near and distance, and Titmus stereoacuity at near were recorded before surgery. Re-examination was done at 12 weeks postoperatively.

Regarding the psychosocial evaluation, patients were asked to rate the impact of their strabismus on various aspects of their lives. Items included the effect on relationship (with friends of the

same-sex and opposite-sex), self esteem, academic applications and employments.⁽¹²⁾ Because of possible difference of attitudes among diverse characteristics of the patients, we divided them into student group and non-student group. A rating scale of five points was used (1 indicated advantageous or good; 2, no effect; 3, slight problem; 4, moderate problem; and 5, severe problem).

Three different levels of success were defined in order to stratify the results of the study in a practical way based on the parameters that constitute clinical success.⁽¹⁸⁾

1. Sensory success is defined when restoration of a functional field of single binocular vision or the regaining of central or peripheral fusion with orthotropic or heterophoria in primary position and at near.

2. Motor success is defined when the horizontal alignment less than 8 prism diopters and vertical alignment less than of 5 prism diopters in the primary position and at near.

3. Subjective success is based on patient's subjective interpretation of improvement in position, binocular function, and appearance. This included "happy" or "unhappy" with the position, "tolerant" or "intolerant" of residual diplopia, and "happy" or "unhappy" with the movement of the eyes.

The study protocol has been approved by the Ethics Committee of the Faculty of Medicine, Chulalongkorn University. (approval number 138/2002)

Results

Ninety patients met the inclusion criteria. Their age at the time of surgery ranged from 9 to 70 years old (Table 1). Eye diseases other than strabismus were

present in 21% of the patients. Twenty-seven percent of BVM patients had amblyopia. Visual acuity varied from no light perception (in one patient) to 20/20. Their causes of strabismus in BVM group were congenital ET, accommodative ET, intermittent XT, congenital superior oblique palsy, dissociated vertical deviations, inferior oblique over activity, congenital CN III palsy, Crouzon syndrome and other acquired forms. In AVM group, the causes were paralytic type (CN IV, CN VI palsy), restrictive type (Graves' disease, skull base fracture), status post Molteno implantation, ocular MG and sensory deviation.

The most common chief complaint of the patients in BVM group was abnormal ocular alignment followed by psychosocial problems. In AVM group, their complaints included abnormal ocular alignment, diplopia and psychosocial problems.

The psychological aspect in strabismus was evaluated by use of a questionnaire generated in cover 6 topics as previously described. Graded score by the patient was reported (Table 2 and 3). The student group was separately described due to some different attitudes, especially on employment domains.

Table 1. Demographic data and baseline characteristic of the patients.

	BVM	AVM
Number of patients	65	25
Female	37	11
Age		
9-20 years	32	2
21-40 years	26	19
41-60 years	6	3
> 60 years	1	1
median	24	25
Deviation		
ET congenital ET	22	0
acquired ET	8	3
XT intermittent XT	16	0
others	13	15
HT	4	2
MP	3	5
Preoperative diplopia		
At primary position or at near	2 (3 %)	10 (40 %)
Gaze	4 (6 %)	16 (64 %)

*ET = esotropia

HT = hypertropia

XT = exotropia

MP = multiplanar deviation

Gaze = diplopia in gazes other than primary position or at near

Table 2. Number of patient reporting psychological effect on their strabismus (student group).

	Same-sex relationship	Opposite-sex relationship	Cosmetic	Abnormality	Self esteem	Academic application and employment
Advantageous or good	1	0	0	0	0	0
No effect	10	9	9	8	8	22
Slight problem	12	12	11	11	10	10
Moderate problem	9	9	10	12	14	2
Severe problem	2	4	4	3	2	0

Table 3. Number of patients reporting psychological effect on their strabismus (non-student group).

	Same-sex relationship	Opposite-sex relationship	Cosmetic	Abnormality	Self esteem	Academic application and employment
Advantageous or good	0	0	0	0	0	0
No effect	11	8	2	1	3	2
Slight problem	15	13	12	10	10	5
Moderate problem	18	19	24	24	22	20
Severe problem	12	16	18	21	21	29

Preoperative diplopia was found in 20 of 90 patients (22 %), mostly in AVM group. Only one patient in AVM group with intolerable diplopia in primary position needed re-operation while the others had some improvement for their double visions. Three patients in BVM group who had no preoperative diplopia developed transient postoperative diplopia which disappeared in one and three months later. No persistent postoperative diplopia was observed in patients with preoperative sensory fusion in both groups.

Sensory success after surgical correction is shown in Table 4. In the BVM group, sensory success was seen in 28 of 65 patients (43 %). In this group if we excluded intermittent XT group in which the patients usually had preoperative fusion and stereopsis, sensory success decreased to 18 % (12 out of 65 patients). However, improvement in stereopsis was observed in 4 patients of intermittent XT group. Interestingly, some patients with congenital ET who had no preoperative fusion developed their sensory success, demonstrated by sensory fusion in

three patients with Bagolini striated glasses test and two patients with Worth-4-Dot test. In the BVM group excluding the intermittent XT patients, sensory success level was usually found at Bagolini striated glasses test for fusion. In the AVM group, 11(44 %) patients had successful sensory results and success was found by both Worth-4-Dot test and stereoacuity test.

Motor success was achieved in 52 of 90 patients (58 %) (Table 5). In BVM group, motor

success was found in 37 of 65 patients (57 %) and 15 of 25 patients (60 %) in AVM group. Four patients with abnormal head posture were present in BVM group and all of them improved after strabismus surgery. In AVM group, however, it was present in 5 patients and improved in 2 patients after surgery.

Cumulative subjective success was 92 % in BVM group and 88% in AVM group (Table 6). The unsatisfied operative results and re-operation need were also shown.

Table 4. Sensory success after surgical correction according to type of deviation.

	BVM number/ total patients (%)	AVM number/ total patients (%)
ET congenital	5/22(22%)	
acquired	1/8(13%)	1/3(33%)
XT intermittent	16/16(100%)	
acquired	3/13(23%)	9/15(60%)
HT	3/ 4(75%)	1/2(50%)
MP	0/3(0%)	0/5(0%)
Improvement of preoperative diplopia		
at primary position or near	1/2(50%)	8/10(80%)
on gaze position	2/4(50%)	10/16(63%)

Table 5. Motor success after surgical correction as related to strabismus onset and deviation.

Deviation	BVM number/ total (%)	AVM Number/ total (%)
ET Congenital ET	10/22 (45 %)	1/3 (33 %)
Acquired ET	6/8 (75 %)	
XT Intermittent XT	13/16 (81 %)	13/15 (86 %)
Others	5/13 (3 %)	
HT	2/4 (50 %)	1/2 (50 %)
MP	1/3 (33 %)	0/5 (0 %)

Table 6. Patient satisfaction after one procedure as related to strabismus onset .

	BVM	AVM
Happy	60/65 (92 %)	22/25 (88 %)
Unhappy	5/65 (8 %)	3/25 (12 %)
Re-operation need	3/65 (5 %)	2/25 (8 %)

Discussion

The positive effects of performing strabismus surgery on adults have previously been discussed. Numerous studies reported improvement in the psychosocial aspect,^(1,7,12,19) cosmetic and function,^(16-17,20) diplopia,⁽²¹⁻²³⁾ fusion and binocularity,^(46,24-25) and visual field expansion^(11,13) after the treatment. The results presented here illustrate that strabismus surgery restore both the alignment and binocular function.

In a multi-centered prospective study on the accuracy of strabismus surgery by Lipton *et al*,⁽²⁶⁾ there was no significant difference between the results in the accuracy of surgical alignment achieved by strabismus specialists and general ophthalmologists. As in our study, we collected the results from different surgeons and we found no significant differences among them.

The classification of adult strabismus according to the age of onset is crucial for predicting prognosis because of the extreme physiologic discrepancy between the two groups.^(14,18)

The maturation of visual system ends the strabismic patients' ability to develop amblyopia and begins the sensory adaptation with suppression and anomalous retinal correspondence. After the age of 8 to 9 years, constant diplopia is generally result of strabismus. This does not preclude the development of diplopia in adults, if the patients developed strabismus BVM. If the adult deviation is greater than

or different from the "adapted" childhood deviation, no pattern of suppression of anomalous retinal correspondence is "remembered." Then the patients experience diplopia as if the childhood deviation never existed. This was reported by Kushner that the onset of diplopia in adults with long-standing strabismus correlates with a change in the patient's ocular alignment, refractive needs, or refractive management.⁽²³⁾ Our results showed that 6 % of BVM patients complained of diplopia in some position of gaze preoperatively, with 3 % having diplopia in primary position or near, which is lower than a previous report by Hertle.⁽¹⁸⁾ On the other hand, AVM patients had already had binocular fusion before the development of strabismus. Diplopia was usually found and the surgical correction was the mean to eliminate the symptom and restore their binocular single vision.

Successfully "cured" strabismus includes creating or restoring subjective binocular function, i.e. both the motor and sensory fusion. Sensory success was obtained in 44 % of AVM patients. In BVM patients, the success rate varied. However, many patients gained some degree of sensory fusion. As previously reported,^(4-6,14,18,24-25) sensory success may occur regardless of the type of deviation preoperatively, the duration of strabismus, or the depth of amblyopia in the deviating eye.

Intractable diplopia after strabismus surgery without previous diplopia was very rare.⁽²²⁾ Our result shows that the risk is very low: we found two patients with transient diplopia. Furthermore, preoperative diplopia decreased from 64 % to 40 % in AVM group and from 6 % to 3 % in BVM group.

Motor success after one procedure is found in 51% of AVM patients and 53 % of BVM patients. Multiplanar deviation (MP) patients did not achieve motor success. Our results yield lower success rate than previous reports.^(14,18) Among these in our series, there were a few difficult cases, for instance, S/P Molteno implantation and ocular myasthenia gravis. Some of the patients had too large angle of deviation, which needed more than one correcting procedure.

Psychosocial difficulties have been found to relate to socially noticeable strabismus and recently, there was a report about the age of the emergence of negative attitude toward strabismus, which was approximately 6 years.⁽³⁾ Therefore, correction of strabismus should be performed as soon as possible to reduce this negative effect and for psychosocial functional improvement especially the opportunity to employment in adults.

An interesting addition to this report is the patients' self-reported attitudes on their appearance after the procedure. Although motor success was not high, subjective success was high in both groups of the patients (92 % in BVM, and 88 % in AVM patients). They also reported positive social effects after their treatment, including better appearance, eye contact and social performances.

In conclusion, the results of the success and benefits after surgical correction of adult strabismus have shown that adult strabismus is more than just a

cosmetic problem, and the surgical correction is therefore essential.

References

1. Menon V, Saha J, Tandon R, Mehta M, Khokhar S. Study of the psychosocial aspects of strabismus. *J Pediatr Ophthalmol Strabismus* 2002 Jul-Aug; 39(4): 203 - 8
2. Coats DK, Paysse EA, Towler AJ, Dipboye RL. Impact of large angle horizontal strabismus on ability to obtain employment. *Ophthalmology* 2000 Feb; 107 (2): 402 - 5
3. Paysse EA, Steele EA, McCreery KM, Wilhelmus KR, Coats DK. Age of the emergence of negative attitudes toward strabismus. *J AAPOS* 2001 Dec; 5(6): 361 - 6
4. Kushner BJ, Morton GV. Postoperative binocularity in adults with longstanding strabismus. *Ophthalmology* 1992 Mar; 99(3): 316 - 9
5. Morris RJ, Scott WE, Dickie, CF. Fusion after surgical alignment of longstanding strabismus in adults. *Ophthalmology* 1993 Jan;100(1): 135 - 8
6. Lal G, Holmes JM. Postoperative stereoacuity following realignment for chronic acquired strabismus in adults. *J AAPOS* 2002 Aug; 6(4): 233 - 7
7. Burke JP, Leach CM, Davis H. Psychosocial implications of strabismus surgery in adults. *J Pediatr Ophthalmol Strabismus* 1997 May-Jun; 34(3):159 - 64
8. Helveston EM. The value of strabismus surgery. *Ophthalmic Surg* 1990 May;21 (5):311-7
9. Hunter DG. Benefits of strabismus surgery in patients with one blind eye. *Arch Ophthalmol*

- 1995 Apr;113(4): 404
10. Keltner JL. Strabismus surgery in adults. Functional and psychosocial implications. Arch Ophthalmol 1994 May;112(5): 599 - 600
 11. Kushner BJ. Binocular field expansion in adults after surgery for esotropia. Arch Ophthalmol 1994 May;112(5): 639 - 43
 12. Satterfield D, Keltner JL, Morrison, TL Psychosocial aspects of strabismus study. Arch Ophthalmol 1993 Aug;111(8):1100 - 5
 13. Wortham E 5th, Greenwald MJ. Expanded binocular peripheral visual fields following surgery for esotropia. J Pediatr Ophthalmol Strabismus 1989 May-Jun; 26(3):109 - 12
 14. Scott WE, Kutschke PJ, Lee WR. 20th annual Frank Costenbader Lecture-adult strabismus. J Pediatr Ophthalmol Strabismus 1995 Nov-Dec; 32(6): 348 - 52
 15. Baker JD. The value of adult strabismus correction to the patient. J AAPOS 2002 Jun;6(3): 136 - 40
 16. Rosenbaum AL. Adult strabismus surgery: the rehabilitation of a disability. J AAPOS 1999 Aug;3(4):193
 17. Rosenbaum AL The goal of adult strabismus surgery is not cosmetic. Arch Ophthalmol 1999 Feb;117(2): 250
 18. Hertle RW. Clinical characteristics of surgically treated adult strabismus. J Pediatr Ophthalmol Strabismus 1998 May-Jun;35(3): 138 - 45
 19. Olitsky SE, Sudesh S, Graziano A, Hamblen J, Brooks SE, Shaha SH. The negative psychosocial impact of strabismus in adults. J AAPOS 1999 Aug; 3(4): 209 - 11
 20. Bronlarczyk-Loba A, Nowwakowska O. Latecka-Krajewska B. Results of strabismus surgery in adolescent and adults: cosmetic or functional recovery ? Klin Oczna 1995 Mar-Apr; 97(3-4): 68 - 71
 21. Scott WE, Kutschke PJ, Lee WR. Diplopia in adult strabismus. Am Orthoptic J 1994;44:66-9
 22. Kushner BJ. Intractable diplopia after strabismus surgery in adults. Arch Ophthalmol 2002 Nov; 120(11): 1498 - 504
 23. Kushner BJ. Recently acquired diplopia in adults with long-standing strabismus. Arch Ophthalmol 2001 Dec;119(12): 1795 - 801
 24. Fawcett SL, Herman WK, Alfieri CD, Castleberry KA, Parks MM, Birch EE. Stereoacuity and foveal fusion in adults with long-standing surgical monovision. J AAPOS 2001 Dec; 5(6): 342 - 7
 25. Ohtsuki H, Hasebe S, Kobashi R, Okano M, Furuse T. Critical period for restoration of normal stereoacuity in acute-onset comitant esotropia. Am J Ophthalmol 1994 Oct 15; 118(4): 502 - 8
 26. Lipton JR, Willshaw HE. Prospective multicentre study of the accuracy of surgery for horizontal strabismus. Br J Ophthalmol 1995 Jan;79(1): 10 - 1