The Outcomes of Horizontal Strabismus Surgery and Influencing Factors of the Surgical Success

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Objectives: *To evaluate the surgical outcomes of horizontal strabismus and identify the influencing factors of the surgical success.*

Material and Method: *The medical records of 304 patients who underwent their first strabismus surgery for treatment of horizontal deviation at Siriraj Hospital were reviewed retrospectively from January 1998 to December 2003. The main outcome measure for successful surgery was defined as eye deviation 10 prism diopters or less at 6 weeks post-surgery. The outcomes of postoperative binocular function and visual acuity improvement were also evaluated. The pre operative deviation, diagnosis, binocular function, visual acuity and age were analyzed as influencing factors of surgical success. The patients were divided into two groups, the first group was 6 years or less (161 cases) and the second group was older than 6 years (143 cases). The statistical methods for analysis the data were Chi-square test, Mann-Whitney U test and Logistic regression.*

Results: *The follow- up period was from 3 to 12 months. 187 patients (61.5%) for esotropia and 117 patients (38.5%) for exotropia were identified. Mean patient's age was 10.5 $\pm$ 10.2years(median6, min0.5, max53), mean preoperative deviation was 44.9 $\pm$ 16.6 prism diopters and mean VA was 20/30(no PL, 20/20). The success rate was 62.0% for esotropia and 57.0% for exotropia. There was no statistical difference between the two groups of diagnosis. The average final deviation postoperative in the success group was 6 $\pm$ 4.9 prism diopters. The comparison of difference visual acuity between pre and post-operation showed no statistical significance but the presence of binocular vision was increased in number of patient by two times. The complication rate was 0.7%(2/304), one case showed conjunctival wound dehiscence and the other had globe perforation. Re-operative rate was 12.9%(39/304) after one year.*

Conclusion: *The surgical success rate of horizontal strabismus surgery was 60.2% and revealed no statistically significant improvement of visual acuity after surgery. The successful surgery was related to the age younger than 6 years and preoperative deviation less than 30 degrees.*

Keywords: *Strabismus surgery, Success rate, Outcomes, Influencing factors*

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Strabismus is a common problem in ophthalmology, the prevalence ranges from 3% to 5%[1-4]. The management involves careful assessment of patient, treatment of amblyopia, refractive errors and surgery.

The first documented surgical treatment for strabismus occurred in 1839 and was performed by Johann Friederich Dieffenbach, a general surgeon[5]. Strabismus surgery is the effective treatment particular in unsuccessful conservative treated patients. Post surgical ocular alignment of visual axis will be improved and restored stereopsis in some patients especially in intermittent deviation or recent onset. The indications for surgery are

1. Elimination of double vision
2. Improvement of three dimensional vision
3. Expansion of visual field
4. Elimination of abnormal head posture
5. Improvement of psychological function
6. Improvement of vocation status

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Various studies have reported outcomes and success rates for strabismus surgery ranging from 30% to 80%[6-9]. No documentation of conventional surgery in Thailand has been reported. The authors set out to determine whether the present results are different from other studies.

Material and Method

The medical records of 304 patients (145 males and 159 females) who underwent their first horizontal strabismus surgery at Siriraj Hospital from January 1998 to December 2003 were reviewed retrospectively. Patients with restrictive muscular disease or neuromuscular junction disease (e.g. thyroid ophthalmopathy, myasthenia gravis) were excluded from the present study because postoperative angles of deviation are affected by many factors. Patients' age ranged from 0.5 to 53 years, with a mean of 10.5 $\pm$ 10.2 years and median of 6 years.

The collected clinical data included diagnosis, age group, visual acuity, binocular function, extraocular movement, pre and postoperative deviation, complications and re-operative requirement.

Visual acuity was measured by Snellen chart or Allen pictures but in preverbal children was assessed by the CSM method. Binocular function was evaluated by Titmus fly test, Random dot and Worth-four dot test.

Angles of deviation were evaluated by prism cover test and modified Krimsky's test. The patients were divided into two age groups, the first group was 6 years or less and the second group was over 6 years, since the distribution of population age was not a normal curve form and also due to concern of efficiency of amblyopia treatment at different ages.

Guidelines in planning surgical amounts for esotropia and exotropia were followed Marshall Parks's formula (Table 1, 2)[10].

Table 1. Surgical amounts for esotropia (modified from Marshall Park's formula)

	Symmetric surgery		Unilateral surgery	
Deviation (Δ)	Recession MR OU or Resection LR OU (mm)	(mm)	Recession MR and Resection LR (mm)	(mm)
15	3.0	3.5	3.0	3.5
20	3.5	4.5	3.5	4.0
25	4.0	5.5	4.0	5.0
30	4.5	6.0	4.5	5.5
35	5.0	6.5	5.0	6.0
40	5.5	7.0	5.5	6.5
50	6.0	8.0	6.0	7.0
60	6.5		6.5	7.5
70	7.0		7.0	8.0

Table 2. Surgical amounts for exotropia (modified from Marshall Park's formula)

	Symmetric surgery		Unilateral surgery	
Deviation (Δ)	Recession MR OU or Resection LR OU (mm)	(mm)	Recession MR and Resection LR (mm)	(mm)
15	4.0	3.0	4.0	3.0
20	5.0	4.0	5.0	4.0
25	6.0	5.0	6.0	4.5
30	7.0	5.5	6.5	5.0
35	7.5	6.0	7.0	5.5
40	8.0	6.5	7.5	6.0
50	9.0		8.0	6.5

The success of surgery was defined by eye deviation less than 10 prism diopters at 6 weeks after operation. The influencing factors for surgical success (diagnosis, age group, visual acuity, binocular function, and angle deviations) were analyzed by Chi-square test, Mann-Whitney U test and Logistic regression.

The study protocol was approved by the research Ethics Committee of Siriraj Hospital, Mahidol University.

Results

Three hundred and four patients were included in the present study.

One hundred and forty-five males (47.7%) and 159 females (52.3%) were enrolled. The mean age $\pm$ SD was 10.5 $\pm$ 10.2 years and median was 6 years (range = 0.5-53 years). One hundred and eighty seven cases (61.5%) were esotropia and 117 cases (38.5%) were exotropia. The mean of deviations pre-operation $\pm$ SD was 44.9 $\pm$ 16.6 prism diopters. Binocular function was present in 69 (22.6%) patients, absent in 193 (63.3%) and 42 (14.1%) patients could not be evaluated. The mean visual acuity was 20/30 (No PL - 20/20) (Table 3).

The overall successful surgery was 60.2% (183/304). The success rate in the esotropic group was 62% (116 cases in 187 cases) and in the exotropic group was 57% (67 cases in 117 cases). The average final deviations postoperative in the successful success group were 6 $\pm$ 4.9 prism diopters.

Table 3. Demographics of study population

Demographic	N = 304 cases (No. %)
Sex	
Male (cases)	145 (47.7%)
Female (cases)	159 (52.3%)
Age	
Mean $\pm$ SD	10.5$\pm$10.2
Median (min, max)	6 (0.5, 53)
Age group 1 ($\leq$ 6 years)	161
Age group 2 (> 6 years)	143
Diagnosis	
Esotropia (cases)	187 (61.5%)
Exotropia (cases)	117 (38.5%)
Angle of deviation preoperative	
Mean $\pm$ SD (prism diopters)	44.9$\pm$16.6
Binocular vision preoperative	
Present (cases)	69 (22.6%)
Absent (cases)	193 (63.3%)
Cannot evaluate (cases)	42 (14.1%)
Visual acuity preoperative	
Mean (min, max)	20/30 (no PL, 20/20)

PL = light perception

Table 4. Univariate analysis of factors and success

Parameters	Success group N = 183 cases (%)	Failure group N = 121 cases (%)	p value
Diagnosis			0.3
Esotropia	116 (63.4%)	71(58.7%)	
Exotropia	67 (36.6%)	50 (41.3%)	
Binocular function			0.6
Present	73 (39.9%)	49 (40.5%)	
Absent	96 (52.5%)	63 (52.1%)	
Cannot evaluate	14 (7.7%)	9 (7.4%)	
*Angle of deviations	-	-	<0.001
Age groups			0.015
$\leq$ 6 years	108 (59%)	53 (44.2%)	
> 6 years	75 (41%)	68 (55.8%)	
*Preoperative visual acuity	-	-	0.5

* Angles of deviation and visual acuity analysis were analyzed by logistic regression analysis

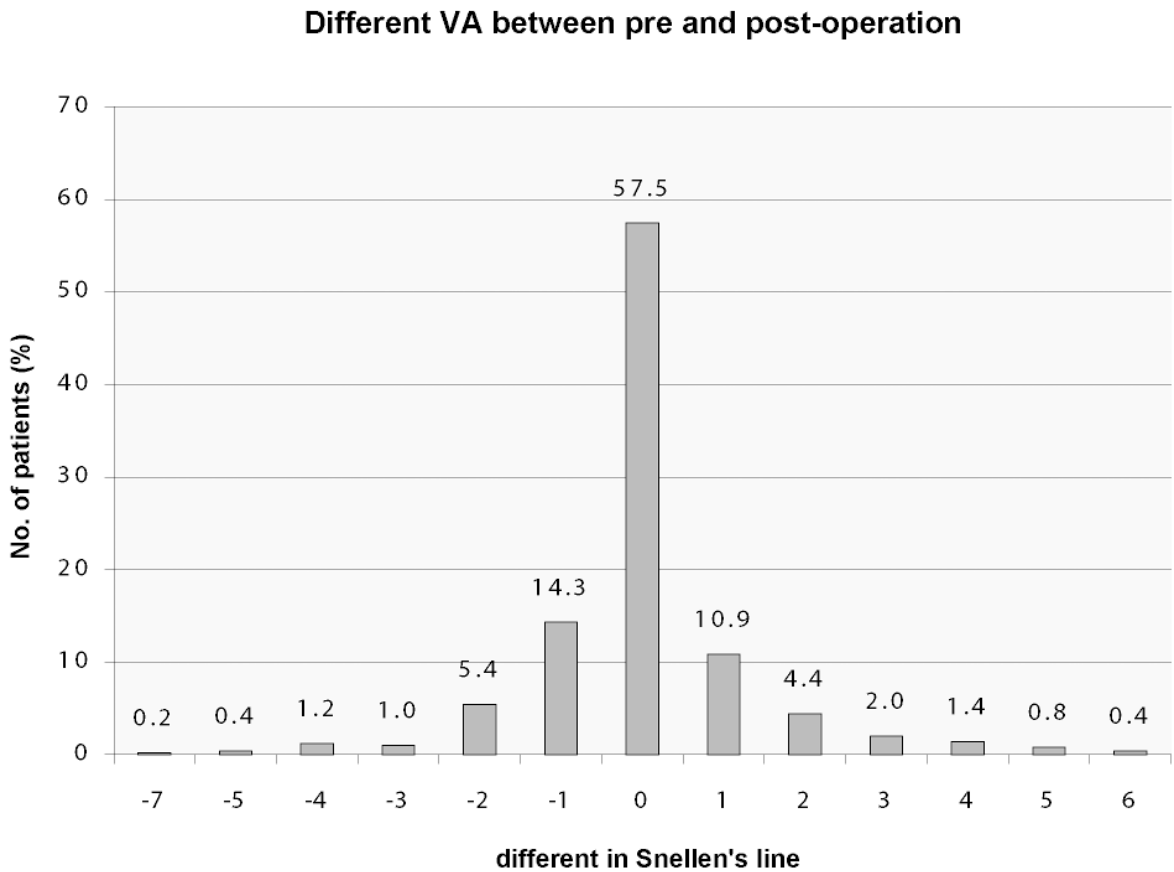

Fig. 1 Diagram of distribution of the difference in visual acuity between pre and post-operation

The number of patients who gained binocular function had increased about two-fold from 69 cases (22%) pre-operation to 122 cases (40.5%) post-operation. The comparison between pre and post-operative visual acuity by Logistic regression analysis showed no difference (Fig. 1).

The influencing factors of successful surgery were analyzed by Chi-square, Mann-Whitney U test and Logistic regression analysis (Table 4, 5). There was statistical significance in the pre-operative angle deviations related to surgical success ($p < 0.001$). The pre-operative deviations cutoff point from ROC curve analysis was 30 prism diopters. The patients over 6 years old had a significantly lower success rate than the younger group ($p = 0.015$ in univariate analysis, $p = 0.04$ in multivariate analysis). Other parameters such as diagnosis, binocular vision and preoperative VA were not statistically significant related to the surgical success.

Among 304 patients, 39 (12.9%) patients required a second operation within one year after the first surgery. Complications were found in 2 cases (0.7%). One case was conjunctival wound dehiscence and the other was globe perforation.

Table 5. Logistic regression analysis of factors and surgical success

Parameters	p value
Diagnosis	0.7
Binocular function	0.6
Angles of deviation	<0.001
Age group	0.04

Discussion

Many scientific studies have reported success rates of strabismus surgery ranging from 30% to 80%[6-9]. In the present study the surgical success rate was 60.2% and that was acceptable. The authors did not include the surgeon factor in the analyses process. However, the study from Eastern Virginia medical

school showed no statistical significance between residents and attending physicians in strabismus surgical success rate (58% and 69% respectively)[6]. The biased data was visual acuity and binocular function in preverbal and uncooperative children which the authors could not perform and analyze in the present study. Predictors of the good result in the present study were age below 6 years old and preoperative deviations less than 30 prism diopters. Trigler L. and Siatkowski RM [11] found that deviations of less than 30 prism diopters were associated with fewer horizontal reoperations in infantile esotropia.

Why did younger age and presenting angle deviations seem to influence the surgical success?

1. Currently, the exact cause of strabismus and its pathophysiology is still not clear. Although strabismus surgery does not cure the primary cause, it does alleviate motor function and affects in developing of sensory function, especially in younger children.

2. Amblyopia may affect the ocular alignment post operation. In the younger age group, the present had to treat amblyopia before surgery, but in the older age group, there were some patients with amblyopia who underwent surgery for cosmetic reasons.

3. Krimsky's method for evaluation of angle deviation is less accurate than the alternate prism cover test and there is difficulty in appreciating differences of 5 prism diopters, reported by Choi RY and Kushner BJ[12]. From this conclusion the accuracy of eye deviation measurement in amblyopia and impaired visual acuity patients may be affected.

4. Small angle deviation measurements may be more accurate than large angle deviations.

5. In large angle deviation patients, the authors had to do more millimeters in extraocular muscle surgery, which may violate muscle pulleys, orbital fat in resection and cause errors in curved and linear measurements along the sclera in recession.

The present study showed improvement of binocular function by the increase in number of patients who had binocular function from 69 cases in pre-operation to 122 cases in post-operation. This result exhibited the role of good ocular alignment in the development of binocular function.

Conclusion

In the present study the surgical success rate was 60.2%. The influencing factors of surgical success were preoperative deviations and the age group. The predictors of a good result were age below 6 years old and preoperative deviations less than 30 prism diopters.

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การศึกษาย้อนหลัง ผลการผ่าตัดกล้ามเนื้อตาเพื่อรักษาโรคตาเข และปัจจัยที่มีผลต่อความสำเร็จของการผ่าตัด ในโรงพยาบาลศิริราช

สุชาดา กัมปนาทแสนยากร, ธรรมนูญ สุรชาติกำธรกุล, ไธวดี ดุลยจินดา, มิ่งขวัญ จำเริญดารารัศมี, ศศิมา ทองศรี

วัตถุประสงค์: *เพื่อศึกษาผลการผ่าตัดกล้ามเนื้อตาในการรักษาโรคตาเข และปัจจัยที่มีผลต่อความสำเร็จในการผ่าตัด*

วัสดุและวิธีการ: *ทำการรวบรวมและศึกษาข้อมูลทางคลินิกของผู้ป่วย จำนวน 304 คน ที่ได้รับการผ่าตัดกล้ามเนื้อตาเป็นครั้งแรก เพื่อรักษาโรคตาเขเข้าในหรือออกนอก ตั้งแต่ปี พ.ศ. 2541-2546 ที่ภาควิชาจักษุวิทยา โรงพยาบาลศิริราช โดยแบ่งผู้ป่วยเป็นกลุ่มที่มีอายุ 6 ปีหรือน้อยกว่า และมากกว่า 6 ปี, ข้อมูลที่ศึกษาประกอบด้วยผลสำเร็จของการผ่าตัด ซึ่งประเมินโดยมุมเขของตาหลังผ่าตัดที่ 6 สัปดาห์ น้อยกว่า หรือเท่ากับ 10 prism diopters การมองเห็นและความสามารถในการมองภาพสามมิติหลังผ่าตัด ผลข้างเคียงของการผ่าตัดและอัตราการผ่าตัดซ้ำเพื่อแก้ไขมุมเขที่เหลือ ปัจจัยที่คาดว่ามีผลต่อความสำเร็จในการผ่าตัด ได้แก่ อายุ, การมองเห็น, ความสามารถในการมองภาพสามมิติ, ขนาดมุมเขก่อนผ่าตัด*

ผลการศึกษา: *จากการศึกษาผู้ป่วยจำนวน 304 คน เป็นตาเขเข้าใน 187 คน, ตาเขออกนอก 117 คน มีอายุ ระหว่าง 10.5 $\pm$ 10.2 ปี, มุมเหล่ก่อนผ่าตัดเฉลี่ย 44.9 $\pm$ 16.6 prism diopters, การมองเห็นเฉลี่ยเท่ากับ 20/30 อัตราความสำเร็จของการผ่าตัดโดยรวม เท่ากับ ร้อยละ 60.2 (183/304) โดยมีมุมเขเฉลี่ยเท่ากับ 6 $\pm$ 4.9 prism diopters และพบว่ามีจำนวนผู้ป่วยที่สามารถมองเห็นภาพสามมิติได้ เพิ่มขึ้นประมาณ 2 เท่า การวิเคราะห์ปัจจัยที่มีผลต่อความสำเร็จด้วยกระบวนการทางสถิติ พบว่ามีเพียงอายุและขนาดของมุมเขก่อนผ่าตัดที่มีนัยสำคัญทางสถิติ โดยค่า P = 0.04 และ P < 0.001 ตามลำดับ ในผู้ป่วยกลุ่มอายุ 6 ปี หรือน้อยกว่า พบว่ามีผลสำเร็จที่สูงกว่า, พบผู้ป่วยที่มีผลข้างเคียงจากการผ่าตัด 2 ราย เป็น globe perforation 1 รายและ conjunctival wound dehiscence 1 ราย , อัตราการผ่าตัดซ้ำร้อยละ 12.9 หลังการผ่าตัดครั้งแรก 1 ปี*

สรุป: *อัตราความสำเร็จของการผ่าตัดเท่ากับ 60.2% และหลังผ่าตัดมีจำนวนผู้ป่วยที่สามารถมองเห็นภาพสามมิติได้มากขึ้นประมาณ 2 เท่า, ความสำเร็จของการผ่าตัดสัมพันธ์กับผู้ป่วยที่มีอายุน้อยกว่า 6 ปีและมุมเหล่ก่อนผ่าตัดน้อยกว่า 30 prism diopters*