Visual outcome and factors influencing surgical outcome of horizontal strabismus surgery in a teaching hospital in Malaysia: a 5-year experience

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Abstract

**Background:** The available data on strabismus surgery in South East Asian countries is scarce. This study aimed to identify visual outcome and factors influencing surgical outcome of horizontal strabismus surgery in a South East Asian cohort.

**Methods:** A retrospective review of patients who underwent horizontal strabismus surgery between 2013 and 2017 in Hospital Universiti Sains Malaysia was conducted. Surgery was considered successful if the post-operative deviation was within 10 prism dioptres at six months post-operative period. Factors influencing outcome of surgery at six months were identified. Chi-square and Fisher exact test were used in data analysis.

**Results:** 98 patients were included. Both genders were equally affected. Exotropia (58.2%) was the most common type. 65.3% of patients had alternating strabismus, while 51.0% had angle of deviation more than 45 prism diopters. Amblyopia was documented in 14.3% of patients. Those operated upon below 10 years of age comprised 64.3%. Ninety four patients completed follow-ups at six months after the surgery. The success rate was 81.6%. Approximately 92% of the patients had best corrected visual acuities of 6/12 and better at six months post-operative period. There was no significant association between age of onset, gender, presence of amblyopia, type of deviation, amount of deviation and post-operative best corrected visual acuity with surgical outcome at six months post-operative period (p>0.05).

**Conclusions:** The success rate was good. Post-operative best corrected visual acuity was promising. Age of onset, gender, presence of amblyopia, type of deviation, amount of deviation and post-operative best corrected visual acuity did not influence the outcome of horizontal strabismus surgery in our review.

**Keywords:** Visual outcome, horizontal strabismus surgery, factors influencing surgical outcome

**Background**

Strabismus surgery aims to improve the ocular alignment of the visual axis and the cosmetic appearance of patients with strabismus. The most common functional benefits are restoration of binocular vision, with elimination of diplopia and compensatory head posture [1]. Significant
improvement in interpersonal interactions has also been observed following strabismus surgery [2]. The outcome of strabismus surgery in Asian countries has been reported by researchers in Thailand, Korea, Hong Kong and China [3-8]. However, apart from Thailand, we found no other data from South East Asian countries [3]. We describe the surgical outcome in our institution, which acts as a referral center for strabismus consultation and surgery in the north-eastern states of Peninsular Malaysia. This study aimed to identify the visual outcome and factors influencing the outcome of horizontal strabismus surgery at six months post-operative period.

Methods
We conducted a retrospective record review study of 98 patients (aged 2 to 49 years old) with strabismus who underwent horizontal strabismus surgery in Hospital Universiti Sains Malaysia, Kelantan, Malaysia from January 2013 to December 2017. This study adhered to the tenets of the Declaration of Helsinki and was approved by the Human Research Ethics Committee of Universiti Sains Malaysia (USM/JEPEm/16030105). Permission to access hospital records and waiver of the need for informed consent was also granted by the aforementioned ethics committee.

The inclusion criteria were all patients with strabismus who underwent horizontal strabismus surgery within the study duration. All surgeries were performed by a single surgeon trained in strabismus surgery. The exclusion criteria were (a) associated vertical muscles involvement in horizontal surgery such as superior or inferior oblique muscle; (b) pre-existing ocular disease such as corneal opacity, cataract, congenital optic atrophy or glaucoma; (c) history of ocular surgery; and (d) presence of systemic disease such as Down syndrome, Marfan syndrome and cerebral palsy.

The following data was documented and analyzed; demographic characteristics including age at onset and gender. Pre-operative details including laterality, cause of strabismus, type of strabismus, amount of deviation, best corrected visual acuity before the surgery, presence of refractive error, amblyopia and binocular single vision. Patients with refractive errors were corrected with glasses. All patients with amblyopia had maximum patching treatment of two hours per day. The optimum best corrected visual acuity was documented at two weeks before the surgery.

Number of muscles operated and post-operative details were also documented, including magnitude
of strabismus (if any), best corrected visual acuity and presence of complications. Outcome at six months was classified as straight (orthophoria), under correction or overcorrection. All patients with a post-operative deviation less than 10 prism diopters at six months were considered to have a successful outcome (orthophoria). Best corrected post-operative visual acuity was also documented. A consultant paediatric ophthalmologist completed the Strabismus Registry Forms. Chi-square test and Fisher Exact test in Stata 14 software (StataCorp LLC, USA) were used to analyse the association between identified variables and surgical outcome of strabismus surgery.

Results

Ninety eight patients were recruited in this study. Of these, only 94 participants had complete data at six months after surgery. The majority were below 10 years of age (63 patients, 64.7%). The population sample was evenly distributed among males and females. Only 10.2% (10 patients) had a positive family history of strabismus. Most patients had alternating strabismus (65.3%, 64 patients). The majority (83.7%, 82 patients) had congenital/infantile strabismus, followed by 8.1% (8 patients) with accommodative type, 5.1% (5 patients) with sensory deprivation strabismus and 3.1% (3 patients) with abducens nerve palsy due to trauma.

The most common type of deviation was exotropia (58.2%, 57 patients). The majority (85.7%, 84 patients) had no amblyopia or had been successfully treated for amblyopia before surgery. Half of our cohort (51.0%, 50 patients) had large angle deviations (more than 45 prism dioptre). Binocular single vision was absent in most patients (63.3%, 62 patients). Approximately 85% (83 patients) had a best corrected visual acuity of 6/12 and better before the surgery. The above data are presented in Table 1.

Eighty two patients (83.7 %) had surgery performed on two muscles which were recession of medial or lateral rectus on both sides. The remaining patients had eye deviations of more than 50 prism dioptre and required three/four muscles surgeries. These included recession of medial rectus on both sides only/and unilateral resection of lateral rectus (for esotropia) or lateral rectus recession on both sides only/and unilateral medial rectus resection (for exotropia). None of these patients had concurrent vertical muscle surgery, either inferior oblique, superior rectus or superior oblique
muscles. The success rate was 81.6%, in which 80 patients achieved satisfactory alignment at six months post-surgery. 87 patients (88.8%) had an uneventful post-operative outcome. Suture granuloma (4.4%, 4 patients) was the main complication observed during the first one month post-operative period. Six months post strabismus surgery, 91.8% (90 patients) had best corrected visual acuity of 6/12 and better. These figures are tabulated in Table 2.

We found no significant association between of demographic (i.e. age of onset and gender), pre-operative factors (i.e. amblyopia before surgery, type of deviation, pre-operative amount of deviation) and surgical outcome at six months post-operative period (p>0.05). Table 3 shows the p-values for each of these variables. Likewise, post-operative best corrected visual acuity was not statistically associated with the surgical outcome at six months post operation (p=0.588).

Discussion
Reported success rates of strabismus surgery vary widely, ranging from 35.6 to 80.5% [3-8]. However, the criteria for successful surgery vary among researchers. Most researchers defined according to motor criteria, or a post-operative deviation of 5-10 prism dioptre esotropia or 10-15 prism dioptre exotropia [3-4,6-7]. Table 4 summarizes published reports of strabismus surgery outcome in Asian countries over the past 15 years, including our study.-

We documented a success rate of 81.6% at six months post-surgery. Our outcome criteria were similar to criteria used by Kampanartsanyakorn et al. from Thailand [3]. Success rates of strabismus surgery tend to be higher (60 to 80%) when satisfactory alignment is the sole criterion for a successful outcome [3-8]. We did not include measurement of sensory outcome during the post-operative period. We experienced significant difficulties in performing tests of stereopsis in our cohort of young children, especially in those aged less than seven years old.

Age at surgery [3,6,9], pre-operative deviation [3-4,6-7,10-11], amblyopia [4], refractive error [5,10], and post-operative deviations [4] have been reported to influence the outcome of strabismus surgery. In contrast, our study found no significant association between these factors and a successful outcome of strabismus surgery at six month postoperative period.
We found no significant association between age of onset and outcome of surgery at six months post-operative period (p=0.314). The outcome of surgery was similar in both younger and older patients in our review. Approximately 64.3% of our patients were children younger than 10 years old. Good post-operative outcome has been reported in published studies involving Asian children [3,5,8]. Jung et al. and Raiyawa et al. also revealed satisfactory post-operative results in adult patients with exotropia [4,7].

In contrast to the above studies, Yam et al. observed that older age at surgery was associated with early surgical success [6]. This was explained by more accurate measurement of pre-operative deviation for older children. Secondly, children with intermittent deviation usually need surgery later because they have better control, stereopsis and fusion [6]. We agree that inaccuracy in measurement of the angle may lead to unpredictable and unfavourable results in uncooperative young children. Thus, more than a single clinical assessment is essential when planning for strabismus surgery.

Our analysis showed absence of significant association between amount of deviation and success rate of ocular alignment (0.365). The majority (91.8 %) of our patients had angle deviation of more than 20 prism dioptre exotropia or esotropia before the surgery. This was probably due to the large number (83.7%) of patients with congenital or infantile onset of strabismus. Our findings are consistent with Jung et al. and Raiyawa et al., who achieved a high success rate of surgery (72-75%) despite larger pre-operative deviations (51.40 ±17.9 PD and 62.10 ± 10.8 PD respectively) [4,7].

In contrast, Yam et al. noted that a smaller pre-surgery distance deviation was associated with a smaller final distance deviation at one year post surgery, and thus a more favourable long-term surgical outcome [6]. Kampanartsanyakorn et al. believed that this was partly because small angle deviations can be more accurately measured than large angle deviations [3]. They reported that successful surgery was related to pre-operative deviation less than 30 prism diopters [3]. Gezer et al. also concurred that patients with smaller degrees of pre-operative deviation tended to have more favourable outcomes of surgery [10].

We also noted the absence of any significant association of amblyopia and outcome at six months
after the surgery (p=0.387). Our study documented a small number of patients (14.3%) who had amblyopia before they underwent surgery. These patients had monocular patching of a maximum 2 hours per day and were monitored closely during follow-up visits. Their pre-operative best corrected visual acuities ranged from 6/60 to 6/18.

These findings are in agreement with Jung et al., who observed a relatively high success rate (72.0 %) in a group with a low prevalence (3%) of amblyopia [4]. Kampanartsanyakorn et al. explained that older patients undergo surgery for cosmetic reasons, and the presence of amblyopia in these patients might affect the ocular alignment during post-operation period [3]. We strongly believe that all patients require optimum time for amblyopia treatment before strabismus surgery to reduce the chance of strabismus recurrence.

We found that post-operative visual acuity had no significant association with surgical outcome (p=0.588). 91.8% of our patients had best corrected visual acuity of 6/12 or better at six months after the surgery. This is likely related to a high percentage (65.3%) of alternating type of strabismus in our review. The remaining subjects (34 patients, 34.7%) with unilateral strabismus underwent intensive amblyopia treatment pre-operatively; 20 patients showed improvement of best corrected visual acuity before the surgery, while 14 patients (14.3%) were still on patching treatment when the surgery was performed.

Conclusions
The success rate of strabismus surgery in our institution was parallel with published reports from other Asian countries. The post-operative best corrected visual outcome was good. Age of onset, gender, presence of amblyopia before the surgery, type of deviation, amount of deviation and post-operative best corrected visual acuity did not influence the outcome of horizontal strabismus surgery in our patients.

Declarations
**Ethics approval and consent to participate**
This study adhered to the tenets of the Declaration of Helsinki and was approved by the Research and Ethical Committee of the School of Medical Sciences, Universiti Sains Malaysia
Consent for publication

Not applicable.

Availability of data and material

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

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Authors’ contributions

IS and TLME planned the study. IN and TLME collected the data. YCK performed the statistical analysis. HWA wrote the first draft. IS and TLME revised the manuscript.

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Tables
Table 1  Demographic and pre-operative clinical characteristics
| Characteristic                              | n   | (%) |
|--------------------------------------------|-----|-----|
| **Gender**                                 |     |     |
| Male                                       | 47  | (48.0) |
| Female                                     | 51  | (52.0) |
| **Age at surgery (years)**                 |     |     |
| < 5                                        | 31  | (31.6) |
| 6-10                                       | 32  | (32.7) |
| 11-15                                      | 11  | (11.2) |
| 16-20                                      | 6   | (6.1) |
| >20                                        | 18  | (18.4) |
| **Family history**                         |     |     |
| Yes                                        | 10  | (10.2) |
| No                                         | 55  | (56.1) |
| Unknown                                    | 33  | (33.7) |
| **Laterality**                             |     |     |
| Alternating                                | 64  | (65.3) |
| Unilateral                                 | 34  | (34.7) |
| **Cause of strabismus**                    |     |     |
| Congenital                                 | 82  | (83.7) |
| Accommodative                              | 8   | (8.2) |
| Sensory deprivation                        | 5   | (5.1) |
| Paralytic                                   | 3   | (3.1) |
| **Amblyopia**                              |     |     |
| Yes                                        | 14  | (14.3) |
| No                                         | 84  | (85.7) |
| **Type of squint**                         |     |     |
| Esotropia                                  | 41  | (41.8) |
| Exotropia                                  | 57  | (58.2) |
| **Pre-operative deviation (PD)**           |     |     |
| < 20                                       | 8   | (8.2) |
| 21-45                                      | 40  | (40.8) |
| > 45                                       | 50  | (51.0) |
| **Binocular single vision**                |     |     |
| Present                                    | 22  | (22.4) |
| Absent                                     | 62  | (63.3) |
| Not able to examine                        | 14  | (14.3) |
| **Pre-operative best corrected visual acuity** |     |     |
| 6/12 and better                            | 83  | (84.7) |
| 6/18 – 6/60                                | 11  | (11.2) |
| 6/60 and worse                             | 4   | (4.1) |

PD: Prism Dioptre

Table 2 Intra and post-operative characteristics
### Intra and post-operative details

| Number of muscles operated | n (%) |
|----------------------------|-------|
| 1                          | 0 (0.0) |
| 2                          | 82 (83.7) |
| 3                          | 12 (12.2) |
| 4                          | 4 (4.1) |

| Post-operative deviation | n (%) |
|--------------------------|-------|
| ≤ 10 prism diopter       | 80 (81.6) |
| > 10 prism diopter       | 14 (14.3) |
| Incomplete data          | 4 (4.1) |

| Post-operative complication | n (%) |
|-----------------------------|-------|
| Post-operative infection    | 1 (1.0) |
| Conjunctival cyst/scar      | 1 (1.0) |
| Suture granuloma            | 4 (4.4) |
| Diplopia                    | 1 (1.0) |
| Nil                         | 87 (88.8) |
| Incomplete data             | 4 (4.1) |

| Post-operative best corrected visual acuity | n (%) |
|--------------------------------------------|-------|
| 6/12 and better                            | 90 (91.8) |
| 6/15 - 6/60                                 | 4 (4.1) |
| 6/60 and worse                             | 0 (0.0) |
| Incomplete data                            | 4 (4.1) |

**Table 3** Analysis of factors affecting horizontal strabismus surgery at six months (n=94)
## Table 4 Published articles regarding outcome of strabismus surgery in Asian countries

| Factors                      | Straight | Under-correction | Over-correction | p-value |
|-------------------------------|----------|-------------------|------------------|---------|
| **Outcome**                  | n (%)    | n (%)             | n (%)            |         |
| **Gender**                   |          |                   |                  |         |
| Female                       | 36 (50.7)| 12 (54.5)         | 1 (100.0)        | 0.982   |
| Male                         | 35 (49.3)| 10 (45.5)         | 0 (0.0)          |         |
| **Age at onset**             |          |                   |                  |         |
| 0-5                           | 24 (33.8)| 5 (22.7)          | 1 (100.0)        | 9.298   |
| 6-10                          | 24 (33.8)| 7 (31.8)          | 0 (0.0)          |         |
| 11-15                         | 6 (8.5)  | 5 (22.7)          | 0 (0.0)          |         |
| 16-20                         | 6 (8.5)  | 0 (0.0)           | 0 (0.0)          |         |
| > 21                          | 11 (15.5)| 5 (22.7)          | 0 (0.0)          |         |
| **Amblyopia before surgery** |          |                   |                  |         |
| No                            | 59 (83.1)| 21 (95.5)         | 1 (100.0)        | 2.508   |
| Yes                           | 12 (16.9)| 1 (4.5)           | 0 (0.0)          |         |
| **Type of deviation**        |          |                   |                  |         |
| Esotropia                     | 33 (46.5)| 6 (27.3)          | 1 (100.0)        | 3.774   |
| Exotropia                     | 38 (53.5)| 16 (72.7)         | 0 (0.0)          |         |
| **Pre-operative deviation**  |          |                   |                  |         |
| < 20 PD                       | 6 (8.5)  | 2 (9.1)           | 0 (0.0)          | 4.510   |
| 21-45 PD                      | 33 (46.5)| 6 (27.3)          | 0 (0.0)          |         |
| > 45 PD                       | 32 (45.1)| 14 (63.6)         | 1 (100.0)        |         |
| **Post-operative best corrected visual acuity** | | | | |
| 6/12 and better              | 67 (94.4)| 22 (100.0)        | 1 (100.0)        | 2.202   |
| 6/15 - 6/60                   | 4 (5.6)  | 0 (0.0)           | 0 (0.0)          |         |
| Authors                        | Year | Country     | Type of strabismus                        | Age (years, Mean ± SD) | Success rate (%) | Preoperative deviation, PD (Mean ± SD) |
|-------------------------------|------|-------------|------------------------------------------|------------------------|------------------|---------------------------------------|
| Kampanartsanya Korn et al.    | 2005 | Thailand    | Esotropia, Exotropia                     | 10.50 ± 10.2           | 60.2             | 44.90                                 |
| Jung et al.                   | 2016 | South Korea | Exotropia, Intermittent Exotropia        | 37.70 ± 13.6           | 72.0             | 51.40                                 |
| Kim et al.                    | 2015 | South Korea | Group 1: Intermittent Exotropia with Hyperopia | 7.02 ± 4.48           | 60.4 (motor)     | 27.03                                 |
|                               |      |             |                                          |                        |                  | 55.1 (motor and sensory)              |
|                               |      |             | Group 2: Intermittent Exotropia with Emmetropia | 7.73 ± 3.94           |                  | 26.85                                 |
|                               |      |             |                                          |                        |                  |                                       |
|                               |      |             | Group 3: Intermittent Exotropia with Myopia | 10.47 ± 6.35          |                  | 26.54                                 |
| Yam et al.                    | 2013 | Hong Kong   | Exotropia, Intermittent Exotropia        | 70.50 ± 46.7 (months)  | 64.0 (6 weeks)   | 31.00 (Successful)                    |
|                               |      |             |                                          |                        |                  | 48.0 (1 year)                         |
|                               |      |             |                                          |                        |                  | 39.00 (Unsuccessful)                   |
| Raiyawa et al.                | 2015 | Thailand    | Exotropia                                | 31.20 ± 14.5           | 69.0 (last follow up) | 62.10                                 |
|                               |      |             |                                          |                        |                  | 75.0 (after 2 years)                   |
| Yang et al.                   | 2016 | South China | Intermittent Exotropia                   | 13.70 ± 8.8            | 80.5 (Motor)     | 40.00 (Near)                          |
|                               |      |             |                                          |                        |                  | 35.6 (Motor and sensory)              |
|                               |      |             |                                          |                        |                  | 41.00 (Distant)                       |
| Present Study                 | 2018 | Malaysia    | Esotropia, Exotropia                     | 12.73 ± 12.03          | 81.6 (6 months)  | 46.13                                 |
