

Predictors of Success in Horizontal Strabismus Surgery: Insights from a Prospective Study

Aurellia Valmai Tjuitno¹, Reni Prastyani^{2*}, Joni Susanto³, Rozalina Loebis²,
Luki Indriaswati², Lely Retno Wulandari⁴

¹Faculty of Medicine, Universitas Airlangga, Surabaya, Indonesia.

²Department of Ophthalmology, Faculty of Medicine, Universitas Airlangga/Dr. Soetomo General Academic Hospital, Surabaya, Indonesia.

³Department of Anatomy, Histology, and Pharmacology, Faculty of Medicine, Universitas Airlangga, Surabaya, Indonesia.

⁴Department of Ophthalmology, Faculty of Medicine, Universitas Brawijaya, Malang, Indonesia.

* Correspondence: reni-p@fk.unair.ac.id

ABSTRACT

Introduction: Strabismus is an eye disorder characterized by misalignment of the eyes, which can occur in individuals of any age. This study explored the surgical outcomes of horizontal strabismus correction in patients, aiming to provide insights into the factors influencing success.

Methods: A prospective study was conducted with 17 patients (n=17) who underwent surgery at Dr. Soetomo General Academic Hospital, Surabaya, Indonesia. Preoperative factors, including age, duration of misalignment, and preoperative angle of strabismus, were analyzed for their impact on surgical success. The International Business Machines Corporation (IBM) Statistical Package for the Social Sciences (SPSS) for Macintosh version 27.0 was used for data analysis.

Results: This study reviewed the medical records of 17 research samples (n=17). A significant change in the median angle of deviation prism diopters (PD) preoperatively was indicated by the median Postoperative Deviation (PD) ($p < 0.001$). A significant difference in median age at surgery was observed between successful and unsuccessful cases ($p = 0.035$), with younger individuals exhibiting a higher success rate. The duration of misalignment emerged as a crucial factor, with a shorter duration correlating positively with a higher probability of surgical success ($p < 0.001$). Notably, successful outcomes were achieved by all children (100%), suggesting a potential trend indicating age as a predictor of success. While the preoperative angle of strabismus did not significantly impact success, a trend emerged ($p = 1$), indicating a potential threshold effect for more significant angles.

Conclusion: Knowing the significance of age and duration of misalignment on the success rate of strabismus surgery allows for enhanced preoperative assessments, optimized timing of surgery, and developed predictive models to assist in clinical decision-making, ultimately leading to more efficient and successful surgical outcomes.

Highlights:

1. The younger age and shorter duration of misalignment are significant predictors of success in horizontal strabismus surgery. Younger patients tend to have higher success rates, and shorter durations of misalignment correlate with better surgical outcomes.
2. Despite variations in population and surgical methods, the overall success rate of 82.3% for horizontal strabismus surgeries aligns with previous studies. This consistency underscores the reliability of surgical outcomes in different settings.

ARTICLE INFO

Article history:

Received 15-07-2024

Received in revised form

06-12-2024

Accepted 18-12-2024

Available online 10-01-2025

Keywords:

Human & health,
Ocular misalignment,
Onset,
Strabismus,
Surgery.

Cite this as:

Tjuitno AV, Prastyani R, Susanto J, Loebis R, Indriaswati L, Wulandari LR. Predictors of Success in Horizontal Strabismus Surgery: Insights from a Prospective Study. *JUXTA J Ilm Mhs Kedokt Univ Airlangga* 2025; 16: 57–62.

Introduction

Strabismus is etymologically rooted in the Greek term "ocular obliquity" or "ocular misalignment." Frequently, strabismic ocular presentations are labeled as "ocular squints," "strabismus," or "ocular misalignment."¹ Strabismus is a prevalent pediatric ocular ailment characterized by misalignment, resulting in ocular deviation or squinting. In adulthood, it typically originates from neurological etiologies or can manifest as a sequela of pediatric strabismus. When promptly diagnosed and managed, strabismus exhibits a favorable clinical prognosis.^{2,3} The worldwide incidence of strabismus in children spans from 0.14% to 5.65%.⁴ When combining the prevalence rates for strabismus, exotropia (XT), and esotropia (ET), the overall occurrence was determined to be 1.93%, 1.23%, and 0.77%, respectively. To put it differently, this translates to 106 to 221 individuals out of every 10,000 in the population having strabismus, 100 to 146 with XT, and 59 to 123 with ET.⁵ Kumari, *et al.* (2017), as cited by Putri, *et al.* (2020), reported that the prevalence of strabismus in Asia ranges from 1.3% to 5%.⁶ Overall, the prevalence of strabismus in Indonesia requires further investigation as the available studies are limited and conducted in different regions.⁷

Strabismus surgery restores regular eye alignment, enhances binocular abilities, and eliminates double vision.³ The main goal of addressing strabismus is reestablishing correct eye alignment. There are three primary categories of strabismus surgery, which include procedures that weaken the eye muscles (recession), strengthen them (resection), and adjust their direction (vector adjustment).² When strabismus surgery is undertaken to correct the misalignment of an eye with diminished visual acuity, it frequently achieves a notable success rate (60-80%).^{6,8,9} Nonetheless, the quantity of research examining the results of strabismus surgery in individuals with one-sided vision impairment is restricted, and it encompasses various age groups, surgical methods, and criteria for measuring success.^{8,10-14}

Improving eye health, directly or indirectly, supports achieving Sustainable Development Goals (SDGs), such as reducing poverty, boosting productivity, enhancing health, and advancing education.¹⁵ Reliable data is essential for addressing eye health concerns, serving as a solid indicator to track progress in this area. This study aimed to analyze the surgical outcome of strabismus surgery in patients with horizontal strabismus.¹⁶

Methods

Study Design and Setting

This prospective study involved reviewing medical records for 17 patients with strabismus who underwent horizontal strabismus surgery at Dr. Soetomo General Academic Hospital, Surabaya, Indonesia, between March and September 2023.

Study Population

The inclusion criteria encompassed all patients with strabismus who underwent horizontal strabismus surgery during the study period. All surgeries were performed by a single surgeon specializing in strabismus surgery (RP). This study excluded patients with follow-up (FU) periods of less than two weeks and incomplete records.

Data Collection

Before surgery, all patients underwent a comprehensive ophthalmic assessment, which included a review of their medical and ophthalmologic history and an evaluation of visual acuity and ocular motility. Ocular deviations were measured before and after surgery with appropriate refractive correction. The methods used for these measurements included cover testing, Hirschberg, alternating cover test, and Krimsky. In cases of poor fixation, this study employed the modified Krimsky technique. Surgery was always conducted based on the most significant angle of deviation measured during either near or distance fixation. The criteria for a successful outcome were defined as achieving a Postoperative Deviation (PD) of less than 10 prism diopters (PD).

Ethics Consideration

This study received approval from the Health Research Ethics Committee of Dr. Soetomo General Academic Hospital, Surabaya, Indonesia, under reference number 0604/KEPK/II/2023. Additionally, the ethics committee granted permission to access hospital records and a waiver of the need for informed consent.

Data Analysis

Possible predictor variables such as age at the time of surgery, Preoperative Deviation (PD), duration of misalignment, age group, sex, type and degree of ocular deviation, and number of muscles operated on were listed. The analysis of this study considered measurements taken during preoperative and the most recent available postoperative visits. This study defined a successful outcome as a final manifest ocular deviation of 10 PD or less, indicating orthophoria. Statistical analysis was conducted using the International Business Machines Corporation (IBM) Statistical Package for the Social Sciences (SPSS) for Macintosh version 27.0.¹⁷ The alpha level for statistical hypothesis testing was 5%. This study used the Mann-Whitney U test to compare patients' ET and XT characteristics by the median age at surgery and median Preoperative Deviation (PD).¹⁸ A Wilcoxon test was employed to analyze preoperative and Postoperative Deviations (PD),¹⁹ and Fisher's exact test was used to assess surgical success based on age group, type of strabismus, preoperative angle of deviation, and the number of muscles operated on.²⁰

Results

This study encompassed a cohort of 17 patients (Table 1), comprising 10 males and 7 females. This group included 6 children (mean age: 7.6 ± 4.8 years old, range: 3 to 16

years old) and 11 adults (mean age: 30.8 ± 15 years old, range: 19 to 59 years old). Among the patient population, 12 individuals (71%) displayed XT, while 5 individuals (29%) exhibited ET.

Table 1. Clinical features of patients enrolled in this study

No.	Age (y)	Sex	Deviation ^a	Preoperative Deviation (PD)	Onset (years old)	Duration of Misalignment (year)	Surgery (mm)	Postoperative Deviation (PD)	FU (d)	Success ^b
1	20	M	XT	-90	13	7	ODS LRs 10.0 & OD MRc 6.5	0	42	Yes
2	10	M	XT	-60	1	9	OS LRs 9.0 & MRc 7.0	0	84	Yes
3	25	F	XT	-50	13	12	OS LRs 9.0 & MRc 6.5	0	32	Yes
4	56	F	XT	-30	55	1	OD LRs 6.5 & MRc 5.0	0	112	Yes
5	7	M	ET	60	0	7	OD MRs 6.5 & LRc 7.5	0	16	Yes
6	22	F	XT	-70	0	22	ODS LRs 10.0 & OD MRc 5.5	0	65	Yes
7	16	M	XT	-50	13	3	OD LRs 10.00 & MRs 9.0	0	23	Yes
8	24	M	XT	-90	1	23	ODS LRs 11.5 & OD MRc 6.5	-15	14	No
9	19	M	ET	50	0	19	OD MRs 6.0 & OS MRs 5.5	0	44	Yes
10	19	F	ET	70	16	3	OD MRs 6.0 & LRc 6.5	0	5	Yes
11	26	F	XT	-40	14	12	OS LRs 8.5 & MRs 6.5	0	9	Yes
12	3	M	XT	-70	0	3	ODS LRs 9.0 & OS MRc 6.5	0	18	Yes
13	45	F	XT	-80	0	45	ODS LRs 12.0	-15	31	No
14	7	M	ET	30	0	7	OS MRs 4.0 & LRc 5.0	0	23	Yes
15	59	F	ET	60	1	58	OS MRs 6.5 & LRc 7.5	15	14	No
16	24	M	XT	-50	17	7	OS LRs 11.5 & MRc 6.5	0	5	Yes
17	3	M	XT	-80	1	2	ODS LRs 11.5	0	5	Yes

Y: year; PD: prism diopters; FU: follow-up; d: day; ET: esotropia; MRc: medial rectus recession; XT: exotropia; LRc: lateral rectus recession; MRs: medial rectus resection; LRs: lateral rectus resection; OD: oculus dextra; OS: oculus sinistra; ODS: oculus dextra sinistra

^aPositive values are for esotropia, and negative values are for exotropia.

^bIf "yes," the final deviation was within 10 PD or orthophoria. If "no," the final deviation was greater than 10 PD.

All patients underwent either unilateral or bilateral surgical procedures. Specifically, 10 patients (59%) underwent unilateral recession–resection, 5 patients (29%) underwent bilateral recession–resection, and 2 patients (12%) underwent a bilateral procedure. The maximum medial rectus recession (MRs) was 9.0 mm, and the maximum lateral rectus recession (LRs) was 11.5 mm. Regarding resection, the maximal MRs measured 7.0 mm, and the maximal LRs were 7.5 mm. The average duration of follow-up (FU) was 33.8 ± 28.4 days (range: 14 to 112 days).

Preoperative and Postoperative Deviation

The median angle of deviation was 60 prism diopters (PD) preoperatively (range: 30 to 90 PD). Following the intervention, there was a significant change, as indicated by the median Postoperative Deviation (PD), which was reduced to zero. This reduction suggested a successful

correction of the eye misalignment through the applied treatment or surgery (range: 0 to 15 PD). Notably, 82.3% of the patients (14 out of 17) achieved a successful surgical outcome, with final ocular deviation measuring 10 PD or less in cases of unsuccessful surgery. The statistical significance of these findings (Table 2) was underscored by the p-value being less than 0.001. This low p-value indicated a high confidence level that the observed changes in deviation were not due to random chance but were a result of the intervention.

Table 2. Comparison of preoperative and postoperative deviation following surgical correction

	Median	p-value
Preoperative Deviation (PD)	60	<0.001
Postoperative Deviation (PD)	0	

Characteristics of Patients with Successful and Unsuccessful Strabismus Surgery

Table 3 shows that the median age at surgery for the success group was 19 years old, while for the unsuccessful group, it was 45 years old. The difference was statistically significant, with a p-value of 0.035. This suggests that younger individuals have a higher success rate in the surgery than older individuals. The median Preoperative Deviation (PD) for the success group was 55, while for the unsuccessful group, it was 80. Although there was a numerical difference, the p-value was 0.122, suggesting that this difference was not statistically significant. Preoperative Deviation (PD) might not strongly predict surgical success in this context. The duration of misalignment was significantly associated with surgical success, as indicated by the p-value of 0.001. The success group had a median duration of misalignment of seven years, whereas the unsuccessful group had a much longer duration of 45 years. This suggests that a shorter misalignment duration correlates with a higher likelihood of surgical success.

Table 3. Comparison of age, Preoperative Deviation (PD), and duration of misalignment to successful and unsuccessful strabismus surgery outcomes

Characteristic	Successful	Unsuccessful	p-value
Median age at surgery (year)	19	45	0.035
Median preoperative deviation (PD)	55	80	0.122
Median duration of misalignment (year)	7	45	0.001

PD = prism diopters

There was no statistically significant difference in the success of the surgery based on the patients' age ($p=0.515$). All children (100%) achieved a successful outcome, as did 8 out of 11 adults, with a 72.2% success rate. The success of the surgery did not show a significant difference based on gender ($p=0.537$). The success rate was slightly higher for males (90%) than females (71.4%). The type of strabismus seemed to have a minimal impact on the success of the surgery ($p=1$). Both XT (83.3%) and ET (80%) showed high success rates. There was no statistically significant difference in the success of the surgery based on the preoperative angle of strabismus ($p=0.228$). However, patients with a preoperative angle less than 60 PD had a 100% success rate, while those with an angle greater than or equal to 60 PD had a success rate of 70%. There was no statistically significant difference in the success of the surgery based on the number of muscles operated on ($p=1$). The success rate was slightly higher for patients who operated on two muscles (84.6%) than three muscles (75%).

Table 4. Study enrollment data: characteristics of successful and unsuccessful cases in strabismus surgery

Characteristic	Successful ^a	Unsuccessful	P-value
Age group at the time of surgery			.515
Children ^b	6 (100%)	0 (0%)	
Adult ^c	8 (72.7%)	3 (27.3%)	
Sex			0.537
Male	9 (90%)	1 (10%)	
Female	5 (71.4%)	2 (28.6%)	
Type of strabismus			1
Exotropia	10 (83.3%)	2 (16.7%)	
Esotropia	4 (80%)	1 (20%)	
Preoperative angle of strabismus (PD)			.228
<60	7 (100%)	0 (0%)	
≥60	7 (70%)	3 (30%)	
No. of muscle operated on			1
Two muscles	11 (84.6%)	2 (15.4%)	
Three muscles	3 (75%)	1 (25%)	

PD = prism diopters

^aDefined by final deviation within 10 PD or orthophoria.

^bPatients are classified as children if they are less than 18 years old.

^cPatients are classified as adults if they are more than or equal to 18 years old.

Discussion

This study assessed the impact of some potential preoperative factors that could influence the outcome of strabismus surgery. Consistent with previous studies,^{3,9,21,22} this study revealed a noteworthy enhancement in stereopsis following strabismus surgery. The success rate of horizontal strabismus was 82.3% compared to previous studies.^{6,8,10,13,23} Although some studies vary slightly regarding population, surgical procedures, and the definition of success, one study closely aligns with this: a study in Jordan reported a more than 80% success rate for strabismus surgery.⁶ Other studies reported that the success rate remained consistent even when different surgeons performed surgeries.^{6,13} However, to mitigate potential bias in this study, the data were specifically collected from patients operated on by a single surgeon to preclude the surgeon factor from exerting any influential role.

Based on the results, several key findings emerge that shed light on factors influencing the success of strabismus surgery. Firstly, the median age at surgery differed notably between the successful and unsuccessful groups, with younger individuals demonstrating a statistically significant higher success rate. This implies that age plays a significant role in the outcomes of strabismus surgery, with a trend favoring success in surgeries performed on individuals at a younger age. Repka, *et al.* (2020) discovered an association between successful surgery and being under 6 years old.²⁴ This study is also closely related to that study.²⁴ A study by Awadein, *et al.* (2014), as cited by Hinterhuber, *et al.* (2024), found that worse surgical

outcomes were highest for patients older than 12 years old.⁸ In contrast, the study by Hinterhuber, *et al.* (2024) found that age at initial surgery was not predictive of success.⁸

Although the data indicated that in successful cases, the median age was younger than across age groups of children and adults, it did not show significant differences, as indicated by the p-value of 0.515. However, interestingly, all children achieved a successful outcome, contributing to a 100% success rate, while among adults, the success rate was slightly lower at 72.2%. This discrepancy suggests a potential trend indicating that younger age may be associated with a higher likelihood of success in strabismus surgery.²⁴⁻²⁸

Secondly, the duration of misalignment emerges as a significant factor influencing surgical success. The statistical significance of the association, as indicated by the low p-value of 0.001, underscored the importance of considering the duration of misalignment in predicting the likelihood of success. The success group, with a notably shorter median duration of misalignment (median=7 years), was contrasted with the unsuccessful group (median=45 years), which exhibited a substantially longer duration. This suggests that a shorter duration of misalignment is positively correlated with a higher probability of achieving success in strabismus surgery. This is consistent with a previous study indicating that a shorter duration of misalignment is associated with a more favorable prognosis.^{21,29} Nevertheless, favorable postoperative stereopsis outcomes can be achieved even in cases of chronic misalignment. It has been reported that adults with long-standing horizontal strabismus, lasting over 10 years, achieved satisfactory stereopsis following surgical correction.^{6,21,30}

The examined preoperative angle of strabismus showed no statistically significant difference in surgical success ($p=0.228$). However, an interesting trend emerges considering the preoperative angle. Patients with an angle less than 60 PD have a 100% success rate, while those with an angle greater than or equal to 60 PD have a success rate of 70%. This observation suggests a potential threshold effect, where more significant angles may pose additional challenges in achieving successful outcomes, as explained by Kumari, *et al.* (2017), cited by Putri, *et al.* (2020).⁷

Strength and Limitations

There are several limitations in this study. The sample size was relatively small, limiting the generalizability of findings. This study focused on patients from a specific location (Dr. Soetomo General Academic Hospital, Surabaya, Indonesia), and extrapolating these results to a broader population should be conducted cautiously. The retrospective design and reliance on medical records also introduce inherent biases and potentially incomplete data. Future research with larger, diverse samples and prospective designs could address these limitations, providing a more comprehensive understanding of factors influencing strabismus surgery outcomes. The outcomes

were based on the performance of a single surgeon, which might introduce bias related to individual surgical techniques and expertise. Future research involving multiple surgeons and institutions could address these limitations. Nevertheless, this study contributed valuable insights into the factors influencing strabismus surgery outcomes. The findings underscored the importance of age, misalignment duration, and potential angle thresholds in predicting surgical success, offering clinicians essential considerations for optimizing patient outcomes in strabismus correction procedures. Further research with larger sample sizes and diverse populations is encouraged to validate and expand upon these findings.

Conclusion

This study demonstrated significant results on the success of strabismus surgery by considering the age and duration of misalignment. Successful surgical outcomes tended to be achieved by patients of younger age and those with a shorter duration of misalignment. Additionally, while the preoperative angle of strabismus showed a trend toward significance, it did not significantly impact success. These insights emphasize the importance of considering the age and duration of misalignment in preoperative assessments to improve surgical outcomes.

Acknowledgments

The authors express their deepest gratitude to all the participants who participated in this study and sincere appreciation to the Department of Ophthalmology, Dr. Soetomo General Academic Hospital, Surabaya, Indonesia, for their invaluable contribution to the data collection for this study.

Conflict of Interest

The authors declared there is no conflict of interest.

Funding

This study did not receive any funding.

Ethical Clearance

This study received approval from the Health Research Ethics Committee at Dr. Soetomo General Academic Hospital in Surabaya, Indonesia, under reference number 0604/KEPK/II/2023 on 24 February 2023. Additionally, the ethics committee granted permission to access hospital records and a waiver of the need for informed consent.

Authors' Contributions

Study conception and design, data analysis and interpretation, revising, giving final approval, providing study materials, offering statistical expertise: AVT, RP, JS, RL, LI, and LRW. Data collection and assembly: AVT.

References

1. Bommireddy T, Taylor K, Clarke MP. Assessing Strabismus in Children. *Paediatr Child Health (Oxford)* 2020; 30: 14–18. [Journal]
2. Kanukollu VM, Sood G. Strabismus. Treasure Island (FL), 2024. [PubMed]
3. Howard MA. Considerations in Surgical Correction of Adult Strabismus. *American Academy of Ophthalmology*, (2020, accessed 17 July 2024). [Website]
4. Agaje BG, Delelegne D, Abera E, Desta K, Girum M, Mossie M, et al. Strabismus Prevalence and Associated Factors among Pediatric Patients in Southern Ethiopia: A Cross-Sectional Study. *J Int Med Res* 2020; 48: 300060520964339. [PubMed]
5. Hashemi H, Pakzad R, Heydarian S, Yekta A, Aghamirsalam M, Shokrollahzadeh F, et al. Global and Regional Prevalence of Strabismus: A Comprehensive Systematic Review and Meta-Analysis. *Strabismus* 2019; 27: 54–65. [Journal]
6. Al-Omari R, Jammal HM, Khader Y, Atoum D, Al-Dolat W, Khatatbeh M. Adults with Longstanding Strabismus: Psychosocial and Functional Impacts and Reasons behind Surgery Delay. *J Ophthalmol* 2022; 2022: 8682675. [Journal]
7. Putri P, Julita J. Profil Strabismus Horizontal di RSUP Dr. M Djamil Padang Januari-Desember 2017. *J Kesehat Andalas* 2020; 9: 83. [Journal]
8. Hinterhuber L, Rezar-Dreindl S, Schmidt-Erfurth U, Stifter E. Postoperative Outcome and Influencing Factors of Strabismus Surgery in Infants Aged 1-6 Years. *Graefes Arch Clin Exp Ophthalmol* 2024; 262: 2299–2307. [Springer]
9. Arblaster G, Buckley D, Barnes S, Davis H. Strabismus Surgery for Psychosocial Reasons-A Literature Review. *Br Ir Orthopt J* 2024; 20: 107–132. [PubMed]
10. Alajbegovic-Halimic J, Jovanovic N, Halimic T. Success Rate of Strabismus Surgery in Adult Patients. *Acta Medica Salin*; 49. 7 January 2020. [ResearchGate]
11. Fu JJ, Hsieh MW, Lee LC, Chen PL, Wen LY, Chen YH, et al. A Novel Method Ensuring an Immediate Target Angle after Horizontal Strabismus Surgery in Children. *Front Med*; 9, (2022). [Journal]
12. Jones AM, Jones DR. A Novel Bayesian General Medical Diagnostic Assistant Achieves Superior Accuracy with Sparse History. *Front Artif Intell*; 5, (2022). [Journal]
13. Kopmann S, Grenzebach U, Ehrt O, Biermann J. Effectiveness of Strabismus Surgery in Intermittent Exotropia and Factors Influencing Outcome. *J Clin Med*; 13. February 2024. [PubMed]
14. Kumari N, Amitava AK, Ashraf M, Grover S, Khan A, Sonwani P. Prognostic Preoperative Factors for Successful Outcome of Surgery in Horizontal Strabismus. *Oman J Ophthalmol* 2017; 10: 76–80. [PubMed]
15. Burton MJ, Ramke J, Marques AP, Bourne RRA, Congdon N, Jones I, et al. The Lancet Global Health Commission on Global Eye Health: Vision Beyond 2020. *Lancet Glob Heal* 2021; 9: e489–e551. [Journal]
16. Dagi LR, Velez FG, Archer SM, Atalay HT, Campolattaro BN, Holmes JM, et al. Adult Strabismus Preferred Practice Pattern. *Ophthalmology* 2020; 127: P182–P298. [Journal]
17. Nie NH, Bent DH, Hull CH. Statistical Package for the Social Sciences (SPSS), (2019). [Website]
18. Sundjaja JH, Shrestha R, Krishan K. McNemar And Mann-Whitney U Tests. Treasure Island (FL), 2024. [PubMed]
19. Hao R, Wang YC, Zhang TY, Liu Y, Niu R, Yin Z, et al. [Clinical Characteristics and Surgical Outcomes in Pediatric Progressive Restrictive Strabismus]. *Zhonghua Yan Ke Za Zhi* 2024; 60: 35–42. [PubMed]
20. Sun T, Wang Z, Shen T, Yan J, Xie C, Li X. Characterization of Intelligence in Children with Exotropia. *Int J Environ Res Public Health*; 16. August 2019. [PubMed]
21. Eshaghi M, Arabi A, Banaie S, Shahraki T, Eshaghi S, Esfrandiari H. Predictive Factors of Stereopsis Outcomes Following Strabismus Surgery. *Ther Adv Ophthalmol* 2021; 13: 25158414211003000. [PubMed]
22. Littlewood RA, Rhodes M, Burke J. A Post-Surgical Stereovision Surprise in an Adult with an Exotropia Since Infancy Previously Managed, at Two Years With Surgery. *Br Ir Orthopt J*. 2021. [Journal]
23. Waheeda-Azwa H, Norihan I, Tai ELM, Kueh YC, Shatriah I. Visual Outcome and Factors Influencing Surgical Outcome of Horizontal Strabismus Surgery in a Teaching Hospital in Malaysia: A 5-Year Experience. *Taiwan J Ophthalmol*; 10, (2020). [Journal]
24. Repka MX, Chandler DL, Holmes JM, Donahue SP, Hoover DL, Mohny BG, et al. The Relationship of Age and Other Baseline Factors to Outcome of Initial Surgery for Intermittent Exotropia. *Am J Ophthalmol* 2020; 212: 153–161. [PubMed]
25. Heo H, Lambert SR. Effect of Age on Reoperation Rate in Children undergoing Exotropia Surgery. *Acta Ophthalmol* 2021; 99: e1206–e1211. [Journal]
26. Pineles SL, Demer JL, Isenberg SJ, et al. Improvement in Binocular Summation after Strabismus Surgery. *JAMA Ophthalmol* 2015; 133: 326–332. [PubMed]
27. Oke I, Elze T, Miller JW, et al. Surgical Approach and Reoperation Risk in Intermittent Exotropia in the IRIS Registry. *JAMA Ophthalmol* 2024; 142: 48–52. [Journal]
28. Dong Y, Liu LN and YY. Surgery at Early versus Late for Intermittent Exotropia: A Meta-Analysis and Systematic Review. *Int J Ophthalmol*; 14: 582–588. [Journal]
29. Oystreck DT, Lyons CJ. Comitant Strabismus: Perspectives, Present and Future. *Saudi J Ophthalmol* 2012; 26: 265–270. [ScienceDirect]
30. Ersin MO, Sefik SA. Effects of Surgical Timing on Surgical Success and Long-term Motor and Sensory Outcomes of Infantile Esotropia. *J Pediatr Ophthalmol & Strabismus* 2020; 57: 319–325. [Journal]