

Outcome of Esotropia Surgery in 2 Tertiary Hospitals in Cameroon

This article was published in the following Dove Press journal:
Clinical Ophthalmology

Viola Andin Dohvoma^{1,2}
Stève Robert Ebana Mvogo¹
Jean Audrey Ndong¹
Caroline Tsimi Mvilongo²
Côme Ebana Mvogo^{1,2}

¹Faculty of Medicine and Biomedical Sciences, University of Yaoundé I, Yaoundé, Cameroon; ²Yaoundé Central Hospital, Yaoundé, Cameroon

Purpose: To evaluate the ocular alignment following esotropia surgery in our setting.

Patients and Methods: We conducted a cross sectional descriptive study which spanned 19 years, from October 1999 to September 2018 at the Douala General Hospital and the Yaoundé Central Hospital. Complete medical records of patients who underwent surgery for esotropia during the study period were included. Data collected included age at diagnosis, sex, age of onset of esotropia, age at surgery, refractive error, type of surgery performed, pre and post-operative angle of deviation. The outcome was considered good when the post-operative angle was ≤ 10 prism diopters (PD).

Results: Four hundred and ninety patients with primary esotropia were seen during the study period. Only 155 returned for follow-up after wearing the full cycloplegic correction for a minimum period of 3 months. Accommodative esotropia was found in 32 cases (20.6%). Among the 123 cases requiring surgery, 63 cases underwent surgery (51.2%). Fifty-nine complete records were included (59.3% females and 40.7% males). The mean age at the time of diagnosis was 6.5 ± 6.1 years and the mean age at the time of surgery was 8.7 ± 6.1 years. The mean preoperative angle at distance was 42.8 ± 10.8 PD. The outcome was good in 91.5% of cases. No factor influenced the outcome of surgery.

Conclusion: The outcome of esotropia surgery was good in this study. This could serve to increase patient motivation to accept surgery in our setting.

Keywords: esotropia, infantile esotropia, esotropia surgery

Introduction

Esotropia could be of early or late onset. Infantile or early-onset esotropia is a well-defined entity with onset prior to 6 months of age. Due to recall bias, some authors admit onset within the first year.¹ The generally accepted goal of esotropia management is to achieve 10 prism diopters (PD) of orthotropia.^{2,3} This will stimulate binocular fusion and maintain alignment in the absence of amblyopia. It can be achieved in those with fully accommodative esotropia with the full cycloplegic optical correction alone. Those with partially accommodative or non-accommodative forms will require surgical correction.

Different surgical procedures maybe used including: bilateral recession of the medial rectus muscles as procedure of choice,^{4,5} though limited by the high variability in surgical dose-response⁶ and three-horizontal muscle surgery (bilateral medial rectus recession and a lateral rectus resection in the non-dominant eye) for the correction of large-angle esotropia.^{2,3} Bilateral posterior fixation of the medial rectus muscles has also been shown to give good results in patients with essential infantile esotropia showing overacting medial rectus muscles, variable angles, and non-accommodative convergence excess. This can be done as a single procedure⁷

Correspondence: Viola Andin Dohvoma
Faculty of Medicine and Biomedical Sciences, University of Yaoundé I, P.O. Box 3851 Messa, Yaoundé, Cameroon
Tel +237 6 99735506
Email andinv@gmail.com

or to augment bilateral medial rectus recessions.⁸ Botulinum toxin-augmented bilateral medial rectus muscle recessions has also been used with good outcome.⁹ Unilateral medial rectus recession and lateral rectus resection surgery can be used successfully to treat moderate-angle infantile esotropia,¹⁰ with results comparable to bilateral medial rectus recession surgery.¹¹

Success rates for esotropia surgery vary in the literature. They depend on several factors, amongst which the type of esotropia, the surgical procedure(s) used, the duration of follow up and the criteria for success. Success rates vary from 45% at 5 years to 87.7% at 1 year.^{12–15}

In our setting, the general population has insufficient knowledge on strabismus. Many patients do not seek for care. Two out of every three patients with strabismus do not present at consultation for the deviation, but do so for other ocular morbidities.¹⁶ Those who seek for care, do so late.¹⁷ There are also challenges in the acceptance of surgery. In a study to evaluate the surgical outcome of primary exotropia, a surgical rate of 26.6% was reported.¹⁸ Socio-economic barriers, traditional beliefs and customs could be responsible for this low surgical rate.

Monitoring the outcome of a health intervention such as esotropia surgery is important for the physician, for policy makers as well as for patient information prior to surgery. The surgical outcome of exotropia in our setting has been reported.¹⁸ In the absence of that of esotropia, we carried out this study to assess the motor outcomes of esotropia surgery.

Patients and Methods

This was a cross-sectional descriptive study which was carried out at the ophthalmology units of the Douala General Hospital (DGH) and the Yaoundé Central Hospital (YCH). These are referral hospitals in the two main cities of Cameroon. Medical records of patients seen at the DGH between October 1999 and December 2012 as well as those of patients seen at the YCH between January 2013 and September 2018 were reviewed. This period represents the practice period of the senior author in the two tertiary hospitals. Our study was reviewed and approved by the Institutional Ethical Clearance Committee of the Faculty of Medicine and Biomedical Sciences of the University of Yaoundé I. The need for individual informed consent was waived by the ethics committee because of the retrospective nature of the study. In compliance with the Declaration of Helsinki,

confidentiality was maintained during the review of patient records and data obtained was anonymized.

We included complete medical records of patients who underwent surgery for esotropia during the study period. All patients had never undergone extraocular muscle surgery before. Records of patients with sensory or paralytic esotropia as well as those of patients with a post-operative follow up period of less than 3 months were excluded. Information was obtained from the pre-operative examination, post-operative examinations at 3 months and at last follow-up. Cycloplegic refraction was obtained in children by instilling one drop of Atropine twice daily for 7 days prior to refraction. In adults, cycloplegia was obtained by alternatively instilling one drop of cyclopentolate 0.5% and one drop of tropicamide 0.5% at intervals of 5 mins, for a total of three drops per cycloplegic agent. Refraction was measured 20–30 mins after the last drop. Refraction was measured by retinoscopy in children and automatic refractometer in adults. The full cycloplegic refraction was prescribed to all patients and they were reviewed periodically.

Early-onset (infantile) esotropia was defined as esotropia occurring within the first year of life.⁷ Accommodative esotropia was defined as an esotropia that was fully corrected within 10 prism diopters (PD) for near and distance with the full cycloplegic correction. Convergence excess was considered when the angle with the full cycloplegic correction at near exceeded the angle at distance by at least 15 PD.

The angle of deviation (with the full cycloplegic correction) was remeasured for far and near on the day before surgery by the alternate cover prism test. Surgical technique was based both on the amount of pre-operative deviation and the position of the eyes under general anesthesia. Surgery was bilateral for large angles (bilateral medial rectus recession, bilateral medial rectus recession with lateral muscle resection in the more deviating eye under general anesthesia) or unilateral for small angles (unilateral medial rectus muscle recession and lateral rectus muscle resection). Posterior fixation sutures (PFS) were placed on the medial rectus in case of far-near disparity or straightening of the eyes under general anesthesia, evaluated by the position of the corneal reflexes under deep and stable general anesthesia. Medial rectus recession ranged from 3 to 5 mm and lateral rectus resection, from 6 to 9 mm. The PFS were placed at 13–14 mm from the insertion of the medial rectus. No adjustable sutures were used.

Post-operatively, antibiotic and steroid-containing eye-drop and ointment were administered into the operated eyes for a duration of 1 month. Alignment was assessed at each

visit. Successful outcome was defined as a post-operative angle of deviation within 10 prism diopters (PD) of orthophoria at distance. It was defined at 3 months and at least 1 year post-operatively.

Data collected included age at diagnosis, sex, age of onset of esotropia, age at surgery, refractive error, surgical technique, pre and post-operative angles of deviation. Data was analyzed using Microsoft Excel. Data were summarized as means \pm standard deviation for continuous variables and as proportions (%) for categorical variables. Student's *t*-test was used to compare means, Chi² test and Fischer's exact test to compare proportions. Significance level was set at $p < 0.05$.

Results

During the study period, 490 new cases of primary esotropia were seen. The full cycloplegic correction was prescribed to all patients. Of the 490 patients, only 155 returned for follow up after at least 3 months of wearing the full cycloplegic correction. Esotropia was fully corrected within 10 prism diopters (PD) for near and distance with the full cycloplegic correction in 32 patients (20.6%). Of the 123 patients eligible for surgery, 63 underwent surgery (51.2%). Complete records of 59 cases were included in this analysis.

The mean age at the time of diagnosis was 6.5 ± 6.1 years and the mean age at the time of surgery was 8.7 ± 6.2 years. Females represented 59.3% ($n=35/59$) and males 40.7% ($n=24/59$). Early-onset (infantile) esotropia represented 89.8% of cases ($n=53/59$). The most frequent refractive error was hypermetropic astigmatism, as shown in Table 1. Other associated findings present at the first visit are presented in Table 2.

The pre-operative angle of deviation was less than 30 PD in 11.9% of cases ($n=7$). The mean pre-operative angle of deviation was 42.8 ± 10.8 PD at distance and 42.3 ± 11.8 PD at near ($p=0.349$). There was no case of convergence excess.

Surgery was done only on horizontal muscles. Various surgical techniques were carried out, amongst which the most frequent was bilateral medial rectus recession with

Table 1 Distribution of Type Refractive Error

	n	%
Hypermetropic astigmatism	61	51.7
Hypermetropia	30	25.4
Myopic astigmatism	17	14.4
Mixed astigmatism	6	5.1
Myopia	4	3.4
Total	118	100

Table 2 Associated Findings

	n	%
Anomalous head posture	44	51.7
Nystagmus	29	25.4
Amblyopia	20	14.4
Vertical imbalance*	13	22.0

Note: Vertical imbalance*: inferior oblique muscle overaction and dissociated vertical deviation.

bilateral PFS and unilateral lateral rectus muscle resection. It was done in 61% of cases as shown in Table 3. Three-muscle surgery was done in 64.4% of cases.

The mean angle at distance was 2.9 ± 5.2 PD at post-operative month 3. The surgical success rate at this point was 91.5%. Residual esotropia was present in 5.1% of cases ($n=3$) and consecutive exotropia in 3.4% ($n=2$). There was only one case of reoperation for a consecutive exotropia of 18 PD. Amongst the 59 patients, 40 (67.8%) were followed up postoperatively for a minimum of 1 year. The mean follow-up period was 3.3 ± 2.5 years (range: 1–11 years). The mean angle of deviation at the last follow-up was 3.5 ± 5.5 PD. There was no significant difference with the mean deviation at postoperative month 3 ($p=0.599$). Table 4 shows the success rate at 3 months and at last follow-up. Comparing the proportions of good and poor outcomes at 3 months and at last follow-up, revealed no significant difference ($p=0.514$).

We analyzed the effect of certain factors (sex, age at diagnosis, age at surgery, amblyopia, angle of deviation and type of surgery) on surgical outcome. No factor influenced surgical outcome ($p > 0.05$, Table 5).

Discussion

The study period was long due to the high rate of lost to follow-up and the low surgical acceptance rate. Lost to

Table 3 Surgical Techniques

	n	%
Bilateral medial rectus recession (MRR)	4	6.7
Bilateral MRR + bilateral posterior fixation suture (PFS)	6	10.2
Bilateral MRR + unilateral lateral rectus resection (LRR)	2	3.4
Bilateral MRR + bilateral PFS + unilateral LRR	36	61
Unilateral MRR + unilateral LRR	6	10.2
Unilateral MRR + unilateral PFS + unilateral LRR	1	1.7
PFS only (unilateral or bilateral)	2	3.4
Unilateral MRR + unilateral PFS	2	3.4
Total	59	100

Abbreviations: MRR, medial rectus recession; PFS, posterior fixation suture; LRR, lateral rectus resection.

Table 4 Success Rates at Various Follow-Up

	Three Months		Last Visit	
	n	%	n	%
Good results (orthophoria \pm 10PD)	54	91.5	35	87.5
Residual esotropia (esotropia > 10PD)	3	5.1	3	7.5
Consecutive exotropia (exotropia > 10PD)	2	3.4	2	5.0
Total	59	100	40	100

Abbreviation: PD, prism diopters.

Table 5 Effect of Variables on Success

		Success		p
		n	%	
Age at first consultation	< 5years	24/27	88.9	0.652
	>5years	30/32	93.8	
Age at surgery	< 5years	11/11	100	0.573
	>5years	43/48	89.6	
Sex	Male	24/24	100	0.073
	Female	30/35	85.7	
Angle of deviation	<30 PD	6/7	85.7	0.481
	\geq 30 PD	48/52	92.3	
Amblyopia	Yes	17/19	89.5	0.653
	No	37/40	92.5	
Vertical imbalance	Yes	12/13	93.2	1
	No	42/46	91.3	
Surgical technique	BMRR+BPFS+LRR	32/36	88.9	0.639
	Others	22/23	95.7	

Abbreviation: BMRR+BPFS+LRR, Bilateral medial rectus recession + bilateral posterior fixation suture + unilateral lateral rectus resection.

follow-up is a major problem in chronic diseases. The medical treatment of esotropia which normally precedes surgery, permits the correction of refractive errors and the treatment of amblyopia. This leads to decreased variability in the deviation and promotes the best possible visual conditions for better surgical outcomes. The 68.4% rate of lost to follow-up in this study is very high, compared to the 3.1% reported by Davis et al¹⁹ after reviewing health records of all patients lost to follow-up over a 5-year period in an ophthalmic hospital. This difference could be explained by differences in the health systems. In our setting, which is that of a developing country, factors such as cost (no health insurance), access barrier (long journey to hospital), service barriers (absence of a clerical support in hospitals for booking and reminding appointments) could explain the high rate of lost to follow-up. In one

study, mobile phone text messaging reminders increased attendance at health-care appointments compared to no reminders.²⁰ A better organized outpatient booking system and a simple reminder could potentially prevent at least 40% of non-attendances at ophthalmology outpatient clinics.²¹

The mean age at the time of surgery in this study was 8.7 years, despite that the majority had infantile esotropia. Although authors still disagree on optimal age for surgery, others suggest that earlier ocular alignment should be sought for a better functional outcome. Accurate alignment by 2 years of age yields a binocularity that is within the confines of a monofixation syndrome in infantile esotropia.²² In late-onset esotropia, delayed surgery in children with an age of onset beyond 30 months does not seem to be detrimental to regaining bifoveal fixation.²³ The delay in surgery in our study is due to late presentation and low acceptance of surgery.

The most used surgical technique was bilateral medial rectus recession with bilateral posterior fixation suture (PFS) and unilateral lateral rectus resection on the more deviating eye. The choice of a PFS was guided by the presence of overacting medial rectus muscle pre-operatively and the significant decrease of the deviation under general anesthesia. Thouvenin et al used this technique in esotropias that totally disappeared under anesthesia, regardless of the amount of deviation in waking hours and recommended that the position of the eyes under general anesthesia be considered for the surgical approach of esotropias.²⁴ Some authors used PFS for convergence excess esotropia with the recession of medial rectus.^{25,26} No case of convergence excess was noted in this study. Mitchel and Kowal reported a decrease in the mean near-distance disparity from 26.4 PD pre-operatively to 4.5 PD in 26 patients in whom PFS was used in addition to bilateral medial rectus muscle recessions.⁸ Bilateral PFS has also been reported to give good results in non-accommodative esotropia with criteria indicative of infantile-onset, such as variable angles and adduction overshooting.⁷ Other techniques such as slanted and augmented recessions have also been shown to give good results.^{27,28}

The traditional surgical approach for esotropia surgery maintained by several authors, is bilateral medial rectus recession.^{29,30} The optimal surgical technique for large angle esotropia correction is still controversial. Techniques reported include augmented medial rectus recession to exceed the traditional 5 mm maximum recession,^{5,31,32} simultaneous

botulinum toxin A injection³³ and three-muscle surgery including bilateral medial rectus muscle recession and one lateral rectus muscle resection surgery.^{3,34} After a long-term evaluation of post-operative motor outcomes in infantile esotropia, Maglia et al suggested a two-horizontal muscle approach in small-angle esotropias and a multiple-muscle surgery in large-angle esotropias.³⁵ Since many of our patients had large-angle esotropia, three-muscle surgery was frequently done. The choice of surgical technique was also guided by the need to reduce the probability of reoperations.

The rate of reoperation was low in this study (1.7%). Rates between 9.9% and 32.4% have been reported by other authors.^{13,35,36} Factors such as surgical techniques, pre-operative angle of deviation, duration of follow-up and age at surgery may play a role. In our practice, we do not follow standard surgical tables. Dosage of surgery was based on the surgeon's experience. Ethnicity may play a role in the outcome as extraocular muscle insertion locations may vary between ethnic groups.³⁷ Although studies suggest that early surgery in patients with infantile esotropia affords better sensory outcome, it may be associated with a higher reoperation rate. Other factors such as dissociated vertical deviation, oblique muscle dysfunction, and nystagmus have not been shown to be associated with an increased incidence of horizontal reoperation.³⁸ The fact that our patients had late surgery could also account for the low rate of reoperation.

Surgical success rate varies depending on the duration of follow-up and the surgical techniques used. Some authors report success rate at 8 weeks.³ Success rates of up to 66% have been reported with the use of only bilateral medial rectus recession.^{4,6} Surgical success with bilateral medial rectus recessions in infantile esotropia is limited by the high variability in surgical dose-response.⁶ Wan et al in their cohort of 88 patients with large-angle infantile esotropia reported an overall success of 23%.³⁹ They found treatment modality to be the only factor significantly associated with a good outcome. The high success rate in our study could be due to the fact that several techniques were used based on both pre-operative and per-operative data of each patient.

Risk factors for poor outcomes identified by other authors include early surgery, large pre-operative angle and the presence of dense amblyopia.^{12,38,40,41} No factor influenced surgical outcome in this study.

This study is limited by the small sample size which could be explained by the high rate of loss to follow-up and the low rate of acceptance of surgery in our setting.

This could be the reason why no factor was found to influence surgical outcome. A similar finding has however been reported by Kim and Choi after analyzing the results of surgery in 35 patients with late-onset esotropia.¹³

Conclusion

This study showed that patients usually present late for esotropia surgery in our setting. Infantile large-angle esotropia was the commonest form of esotropia and three-muscle surgery was done in most patients. Motor outcome of surgery was good. This good outcome will serve as information for patient education in order to boost uptake of surgery.

Disclosure

The authors report no conflict of interest in this work.

References

- Hunter DG, Ellis FJ. Prevalence of systemic and ocular disease in infantile exotropia: comparison with infantile esotropia. *Ophthalmology*. 1999;106(10):1951–1956. doi:10.1016/S0161-6420(99)90407-4
- Bayramlar H, Gurturk AY, Sari U, Karadag R. Overcorrecting minus lens therapy in patients with intermittent exotropia: should it be the first therapeutic choice? *Int Ophthalmol*. 2017;37(2):385–390. doi:10.1007/s10792-016-0273-9
- Chatzistefanou KI, Ladas ID, Droutsas KD, Koutsandrea C, Chimoniidou E. Three horizontal muscle surgery for large-angle infantile or presumed infantile esotropia: long-term motor outcomes. *JAMA Ophthalmol*. 2013;131(8):1041–1048. doi:10.1001/jamaophthalmol.2013.704
- Tolun H, Dikici K, Ozkiris A. Long-term results of bimedial rectus recessions in infantile Esotropia. *J Pediatr Ophthalmol Strabismus*. 1999;36(4):201–205.
- Weakley DR, Parks MM. Results from 7-mm bilateral recessions of the medial rectus muscles for congenital esotropia. *Ophthalmic Surg*. 1990;21(12):827–830.
- Issaho DC, Wang SX, Freitas DD, Weakley DR. Variability in response to bilateral medial rectus recessions in infantile Esotropia. *J Pediatr Ophthalmol Strabismus*. 2016;53(5):305–310. doi:10.3928/01913913-20160629-02
- Rizk A. Bilateral posterior fixation sutures on the medial rectus muscles for correction of nonaccommodative Esotropia with infantile onset criteria. *J Pediatr Ophthalmol Strabismus*. 1999;36(6):320–325.
- Mitchell L, Kowal L. Medial rectus muscle pulley posterior fixation sutures in accommodative and partially accommodative esotropia with convergence excess. *J AAPOS*. 2012;16(2):125–130. doi:10.1016/j.jaapos.2011.11.013
- Wan MJ, Gilbert A, Kazlas M, et al. The effect of botulinum toxin augmentation on strabismus surgery for large-angle infantile Esotropia. *Am J Ophthalmol*. 2018;189:160–165. doi:10.1016/j.ajo.2018.02.010
- Chatzistefanou KI, Brouzas D, Droutsas KD, Koutsandrea C, Chimoniidou E. Unilateral recession-resection surgery for infantile Esotropia: survival of motor outcomes and postoperative drifts. *Semin Ophthalmol*. 2018;33(4):498–505. doi:10.1080/08820538.2017.1312465
- Wenner Y, Kuhli-Hattenbach C, Kohnen T. [Unilateral combined strabismus surgery to correct esotropia: video article on recession of the medial rectus muscle and plication of the lateral rectus muscle]. *Ophthalmologie*. 2018;115(11):961–966. doi:10.1007/s00347-018-0784-z

12. Louwagie CR, Diehl NN, Greenberg AE, Mohny BG. Long-term follow-up of congenital esotropia in a population-based cohort. *J AAPOS*. 2009;13(1):8–12. doi:10.1016/j.jaapos.2008.06.013
13. Kim E, Choi DG. Outcomes after the surgery for acquired nonaccommodative esotropia. *BMC Ophthalmol*. 2017;17:130. doi:10.1186/s12886-017-0527-y
14. Castro PD, Pedroso A, Hernández L, Naranjo RM, Méndez TDJ, Arias A. Results of surgery for congenital esotropia. *MEDICC Rev*. 2011;13(1):18–22.
15. Forrest MP, Finnigan S, Finnigan S, Gole GA. Three horizontal muscle squint surgery for large angle infantile esotropia. *Clin Experiment Ophthalmol*. 2003;31(6):509–516. doi:10.1046/j.1442-9071.2003.00713.x
16. Ebana CM, Bella-Hiag AL, Epesse M. [Strabismus in Cameroon]. *J Fr Ophtalmol*. 1996;19(11):705–709.
17. Ebana C, Ellong A, Omgwa E, Ebana S, Dohvoma V, Bella L. Caractéristiques du strabisme en milieu Camerounais. *Revue SOAO*. 2013;1:38–44.
18. Mvogo CE, Bella AL, Ellong A, Didier O, Eballe AO, Tambi FT. Surgical management of primary exotropia in Cameroon. *Clin Ophthalmol*. 2007;1(4):471–474.
19. Davis A, Baldwin A, Hingorani M, Dwyer A, Flanagan D. A review of 145 234 ophthalmic patient episodes lost to follow-up. *Eye*. 2017;31(3):422–429. doi:10.1038/eye.2016.225
20. Gurol-Urganci I, De Jongh T, Vodopivec-Jamsek V, Atun R, Car J. Mobile phone messaging reminders for attendance at healthcare appointments. *Cochrane Database Syst Rev*. 2013;2013:12. doi:10.1002/14651858.CD007458.pub3.21
21. Potamitis T, Chell PB, Jones HS, Murray PI. Non-attendance at ophthalmology outpatient clinics. *J R Soc Med*. 1998;87:591–593.
22. Ing MR. The timing of surgical alignment for congenital (infantile) esotropia. *J Pediatr Ophthalmol Strabismus*. 1999;36(2):61–68; quiz 85–86.
23. Chan TYB, Mao AJ, Piggott JR, Makar I. Factors affecting post-operative stereopsis in acquired nonaccommodative esotropia. *Can J Ophthalmol*. 2012;47(6):479–483. doi:10.1016/j.jcjo.2012.09.005
24. Thouvenin DA, Sotiropoulos MC, J-L A, Fournié PR. Esotropias that totally resolve under general anesthesia treated exclusively with bilateral fadenoperation. *Strabismus*. 2008;16(4):131–138. doi:10.1080/09273970802505284
25. Inal A, Ocak OB, Aygit ED, et al. Medial rectus bridge faden operations in accommodative and partially accommodative Esotropia with convergence excess. *J Pediatr Ophthalmol Strabismus*. 2017;54(6):369–374. doi:10.3928/01913913-20170801-03
26. Akar S, Gokyigit B, Sayin N, Demirok A, Yilmaz OF. Medial rectus Faden operations with or without recession for partially accommodative esotropia associated with a high accommodative convergence to accommodation ratio. *Br J Ophthalmol*. 2013;97(1):83–87. doi:10.1136/bjophthalmol-2012-302175
27. Ellis GS, Pritchard CH, Baham L, Babiuch A. Medial rectus surgery for convergence excess esotropia with an accommodative component: a comparison of augmented recession, slanted recession, and recession with posterior fixation. *Am Orthopt J*. 2012;62:50–60. doi:10.3368/aoj.62.1.50
28. Gharabaghi D, Zanjani LK. Comparison of results of medial rectus muscle recession using augmentation, Faden procedure, and slanted recession in the treatment of high accommodative convergence/accommodation ratio esotropia. *J Pediatr Ophthalmol Strabismus*. 2006;43(2):91–94. doi:10.3928/0191-3913-20060201-08
29. Keskinbora KH, Puler NK. Long-term results of bilateral medial rectus recession for congenital esotropia. *J Pediatr Ophthalmol Strabismus*. 2004;41(6):351–355. doi:10.3928/01913913-20041101-02
30. Sulayem LM, Bin-Khathlan AA. Outcomes of esotropia surgery in Saudi Arabia: an audit from a single center. *Saudi J Ophthalmol*. 2018;32(4):280–285. doi:10.1016/j.sjopt.2018.07.006
31. Hess JB, Calhoun JH. A new rationale for the management of large angle esotropia. *J Pediatr Ophthalmol Strabismus*. 1979;16(6):345–348.
32. Willshaw HE, Mashhoudi N, Powell S. Augmented medial rectus recession in the management of esotropia. *Br J Ophthalmol*. 1986;70(11):840–843. doi:10.1136/bjo.70.11.840
33. Khan AO. Two horizontal rectus eye muscle surgery combined with botulinum toxin for the treatment of very large angle esotropia. A pilot study. *Binocul Vis Strabismus Q*. 2005;20(1):15–20.
34. Camuglia JE, Walsh MJ, Gole GA. Three horizontal muscle surgery for large-angle infantile esotropia: validation of a table of amounts of surgery. *Eye*. 2011;25(11):1435–1441. doi:10.1038/eye.2011.185
35. Magli A, Carelli R, Matarazzo F, Bruzzese D. Essential infantile esotropia: postoperative motor outcomes and inferential analysis of strabismus surgery. *BMC Ophthalmol*. 2014;14:35. doi:10.1186/1471-2415-14-35
36. Rajavi Z, Ferdosi AA, Eslamdoust M, et al. The prevalence of reoperation and related risk factors among patients with congenital esotropia. *J Pediatr Ophthalmol Strabismus*. 2013;50(1):53–59. doi:10.3928/01913913-20120804-11
37. Lai Y-H, Wu W-C, Wang H-Z, Hsu H-T. Extraocular muscle insertion positions and outcomes of strabismus surgery: correlation analysis and anatomical comparison of Western and Chinese populations. *Br J Ophthalmol*. 2012;96(5):679–682. doi:10.1136/bjophthalmol-2011-300632
38. Trigler L, Siatkowski RM. Factors associated with horizontal reoperation in infantile esotropia. *J AAPOS*. 2002;6(1):15–20. doi:10.1067/mpa.2002.120644
39. Wan MJ, Chiu H, Shah AS, Hunter DG. Long-term surgical outcomes for large-angle infantile Esotropia. *Am J Ophthalmol*. 2018;189:155–159. doi:10.1016/j.ajo.2017.11.006
40. Ehrenberg M, Nihalani BR, Melvin P, Cain CE, Hunter DG, Dagi LR. Goal-determined metrics to assess outcomes of esotropia surgery. *J AAPOS*. 2014;18(3):211–216. doi:10.1016/j.jaapos.2013.12.016
41. 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(2):76–80. doi:10.4103/ojo.OJO_133_2016

Clinical Ophthalmology

Publish your work in this journal

Clinical Ophthalmology is an international, peer-reviewed journal covering all subspecialties within ophthalmology. Key topics include: Optometry; Visual science; Pharmacology and drug therapy in eye diseases; Basic Sciences; Primary and Secondary eye care; Patient Safety and Quality of Care Improvements. This journal is indexed on PubMed

Submit your manuscript here: <https://www.dovepress.com/clinical-ophthalmology-journal>

Dovepress

Central and CAS, and is the official journal of The Society of Clinical Ophthalmology (SCO). The manuscript management system is completely online and includes a very quick and fair peer-review system, which is all easy to use. Visit <http://www.dovepress.com/testimonials.php> to read real quotes from published authors.