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Changes in Refractive Status after Strabismus Surgery- A Clinical Study

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Abstract

Aim: *To analyse the changes in the refractive status occurring in the eyes after strabismus surgery.*

Materials and Methods: *An analytical study was conducted in 90 patients who underwent strabismus surgery for concomitant horizontal strabismus. The patients were divided into two groups of 45 each. Group 1 comprises of patients with concomitant exotropia and Group 2 patients with concomitant esotropia. Pre operative cycloplegic refraction was done and post operative cycloplegic refraction was done at one week, four week, three month and six months post operatively. Pre and post operative refraction was compared in terms of spherical equivalent and cylindrical power.*

Results: *The spherical equivalent showed a change to myopic trend in both the groups which was maximum in the first post operative week. The changes were persisting at 12 weeks post operatively in both the groups, having stabilized by about four to six weeks. The difference from preoperative values were not statistically significant in both the groups. Astigmatism also showed a myopic trend post operatively. The mean change in the meridional equivalent at 180 degree was statistically significant in both the groups. The mean change in the meridional equivalent at 90 degree was not statistically significant in both the cases. The changes in the refractive status occurring when two muscles are encountered in the same eye showed more change in refractive status than when only one muscle was encountered and was also statistically analysed using paired t test and was found to be significant.*

Conclusion: *Strabismus surgery changes the refractive status post-operatively. Hence appropriate prescription of glasses is important following strabismus surgery especially in children to prevent amblyopia and to maintain stable fusion.*

Key Words: *Strabismus , Spherical equivalent, Astigmatism, Corneal topography, Refractive error.*

Introduction

Strabismus is a significant problem both in paediatric and adult age groups because of its visual disability and cosmetic disfigurement. The prompt recognition and timely intervention will save many patients from the crippling consequence of mono-ocular vision. The need for better cosmetic appearance and stereopsis for highly skilled jobs has brought many patients with concomitant strabismus to the ophthalmologists. Strabismus surgery is considered to be a reconstructive rather than a cosmetic surgery.

However inspite of a best surgical outcome, binocular sensory motor co-ordination may not be attained if refractive status is ignored post-operatively. Changes in refraction following surgery for strabismus was reported by Don Marshall[1] in 1936. He studied the postoperative refraction of 55 patients in both the operated and un-operated eye and concluded that 60% of patients undergoing squint surgery developed changes in corneal astigmatism in the operated eye. The change in refractive status of an eye that has undergone muscle surgery appears to be due to corneal changes[2]. While not all patients are affected, a moderate number will show enough change in astigmatism to cause a decrease in visual acuity from a few letters to two lines difference. These changes, more commonly an increase in with the rule astigmatism, tends to disappear in time, although in an occasional patient they may persist. Such a change is especially noted when two nonadjacent recti muscles are operated on the same eye. One advantage in operating on the fixing eye is that of allowing a surgically induced amblyopic therapy to continue into the postoperative period. A noncycloplegic or dry retinoscopy seems to be a quick and effective way of determining the existence, though not the amount, of such a change in refractive status. The purpose of this study was to investigate the surgically induced refractive error following horizontal muscle surgery in a tertiary eye care centre in South India.

Materials and Methods

This analytical study was conducted in 90 patients who underwent strabismus surgery for horizontal concomitant strabismus at a tertiary eye care centre in South India during the period from June 2002 to June 2004.The following was the study protocol. Patients were divided into 2 groups of 45 each comprising of

Group 1 – Patients with exotropia

Group 2 – Patients with esotropia

Exclusion Criteria

Patients who were operated once and sensory strabismus were excluded from the study

Strabismus assessment was done including history taking, visual acuity by Snellen's chart in verbal and Cambridge crowding card matching test in children less than 5 years. Preoperative refraction was carried out under full cycloplegia using atropine 1% eye ointment in children less than 5 years and 2% homatropine in children aged more than 5 years and appropriate correction of refract-tive error was prescribed. Best corrected visual acuity was recorded. Preoperative keratometry was done. Orthoptic assessment included assessment of angle of strabismus using with and without glasses, for near and distance with prism bar cover test, BSV with Bagolini's striated glasses, extraocular movements, presence of pattern deviation was noted, AC/A ratio was checked in appropriate cases, measurement of fusional convergence was assessed in intermittent exotropes. Fundus was examined in detail for any fundus pathology and to assess the type of fixation.

All patients underwent horizontal muscle recession alone or resection recession using a limbal approach. Muscles were sutured with 6-0 vicryl and conjunctiva with 8-0 silk. Bilateral LR recession was performed in 18 patients in Group 1 and bimedial rectus recession was perfomed in 30 patients in Group 2. Unilateral Resection – Recession was performed in 27 patients in Group 1 and 15 patients in Group 2. Patients were followed up at 1 week, 4 weeks, 3 months and 6 months post-operatively. Complete examination and evaluation was done at each visit similar to pre-operative assessment. Pre and post-operative refraction was compared in terms of spherical equivalent and cylindrical power. Post-op keratometry was also done.

Results

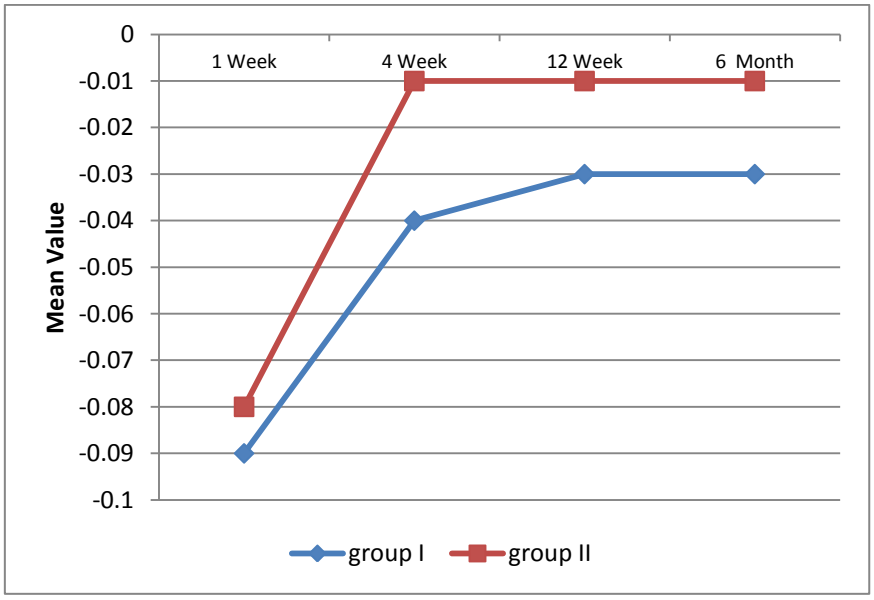
The results were statistically analysed, with help of unpaired t-test and paired t-test. The average age at surgery was 14.27 years in Group 1 and

8.09 years in Group 2 with an average age of 11.18 years (there was no statistically significant difference between the two groups). 81.23% eyes in Group 1 and 73.26% in Group 2 had a BCVA of 6/9 to 6/6 for distance. 16 patients in Group 1 and 19 patients in Group 2 were treated with occlusion therapy pre operatively for amblyopia. Prior to surgery in Group 1, 25.37% eyes were emmetropic, 24.63% were myopic and 50% had astigmatism. In Group 2, 21.13% were emmetropic, 22.2% were hypermetropic, 3.34% were myopic and 53.33% had astigmatism .Post-operatively there was a diminution in the uncorrected visual acuity in both the groups in 70.93% and the changes were more significant in group 1. The changes in distant vision took about 4 weeks to stabilize in both group 1 and group 2 . At 12 weeks post-operatively 93% eyes in group 1 and 88% in group 2 had a BCVA of more than or equal to 81.2% in group 1 and 73.3% in group 2 pre-operatively. The spherical equivalent showed a change to myopic trend in both the groups, which was maximum on the first post-operative week (-0.09+/-0.37 in group 1 and -0.08+/-0.50 in group 2). The changes were persisting at 12 weeks post-operatively in both the groups, having stabilized by about 4-6 weeks. The difference from pre-operative values were not statistically significant in both the groups.

Table I : Comparison of change in spherical equivalent

Spherical equivalent	Group I			Group II			t	p
	Mean	SD	N	Mean	SD	N		
1 Week	-0.09	-0.37	45	-0.08	-0.5	45	0.107	p>0.05
4 Week	-0.04	-0.42	45	-0.01	-0.56	45	0.284	p>0.05
12 Week	-0.03	-0.39	45	-0.01	-0.52	45	0.204	p>0.05
6 Month	-0.03	-0.41	45	-0.01	-0.49	45	0.208	p>0.05

Fig 1: Comparison of change in spherical equivalent

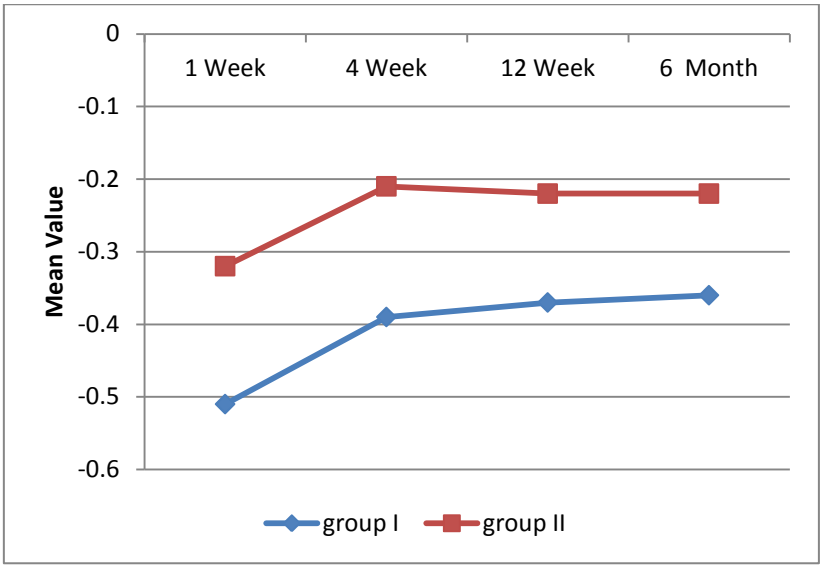


The astigmatism also showed a myopic trend post-operatively. The mean change in meridional equivalent at 180^0 in group 1 was -0.39+/-0.34 and in group 2, it was -0.20+/-0.28. The change was statistically significant in both the groups. 37.3% of operated eyes in group 1 and 26% of group 2 had a statistically significant change in refraction at 12 weeks post-operatively.

Table II : Comparison of change in cylindrical equivalent

Change in cylinder power at 180 degree	Group I			Group II			t	p
	Mean	SD	N	Mean	SD	N		
1 Week	-0.51	-0.3	45	-0.32	-0.02	45	4.192**	p<0.01
4 Week	-0.39	-0.34	45	-0.21	-0.2	45	3.027**	p<0.01
12 Week	-0.37	-0.3	45	-0.22	-0.31	45	2.306 *	p<0.05
6 Month	-0.36	-0.3	45	-0.22	-0.3	45	2.189 *	p<0.05

Fig 2 . Comparison of change in cylinder power at 180 degree

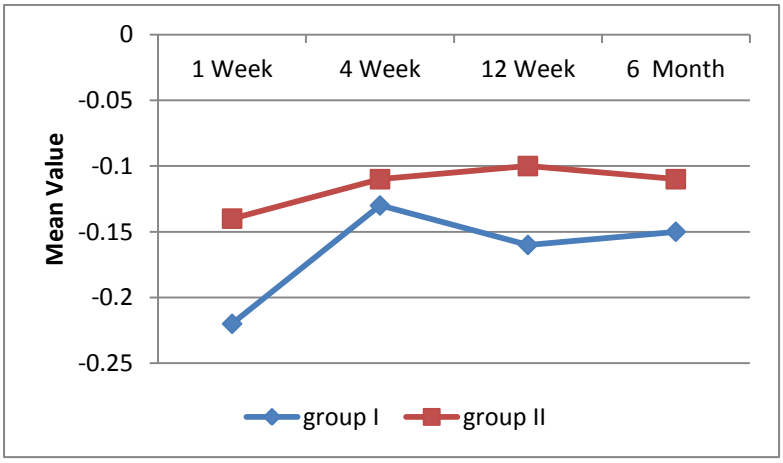


The mean change in meridional equivalent at 90 degrees in group 1 was -0.13+/-0.26 and in group 2-0.11+/-0.22 and the changes were not statistically significant in both the groups. Only in 9% of operated eyes in group 1 and 12% in group 2 had a change > 0.5D.

Table III : Comparison of change in cylinder power at 90 degree

Change in cylinder power at 90 degree	Group I			Group II			t	p
	Mean	SD	N	Mean	SD	N		
1 Week	-0.22	-0.2	45	-0.14	-0.2	45	1.876	p>0.05
4 Week	-0.13	-0.31	45	-0.11	-0.2	45	0.36	p>0.05
12 Week	-0.16	-0.24	45	-0.1	-0.23	45	1.197	p>0.05
6 Month	-0.15	-0.24	45	-0.11	-0.23	45	0.798	p>0.05

Fig 3: Comparison of change in cylinder power at 90 degree



The changes in refractive status occurring when two muscles were encountered in the same eye and when only one muscle was encountered was also statistically analysed using the paired t-test and was found to be statistically significant . The mean change in refraction in recession – resection group was -0.25+ 0.17 and in eyes where recession alone was done showed a mean change of -0.13+0.18. In the recession-resection group 35.7% had a change in refraction of more than or equal to 0.5D compared to only 12.5% in recession alone group

Discussion

Strabismus has a significant effect on refractive status of the eyes producing significant astigmatic changes. In the present study, we prospectively evaluated the influence of strabismus surgery on visual acuity and refraction. There was a diminution in the uncorrected visual acuity post-operatively in 70.93% of operated eyes, the change being more significant in exotropes. The BCVA of more than or equal to 6/9 could be given to 93% in group 1 and 88% in group 2 post-operatively compared to 81.2% and 73.3% in group 1 and group 2 pre-operatively . The change in refractive status showed a myopic trend in both spherical and astigmatic component. The study conducted by Preslan M W et al.[3] on refractive error changes following strabismus surgery in 68 patients in whom prospectively pre and post operative cycloplegic refraction was done, the adult patients were also subjected to computerized corneal topography recorded using the Corneal modeling system (Computed Anatomy, Inc ,New York, NY). Pre and post operative refraction were compared using spherical equivalent and meridi-onal equivalent (90^0 and 180^0 meridian). They found no significant change in spherical equivalent between the pre and post operative measurements. However, a significant increase in the astigmatic power at 180^0 (meridional equivale-nt at 180^0) was detected in both pediatric and adult patients. They did not observe any qualitative change in corneal topography pre and post operatively. The change in astigmatic power at 180^0 is equivalent to additional plus – cylinder correction at 90^0 and was persistent throughout the 4 month postoperative period. In another study conducted at Guru Nayak Eye Centre, New Delhi[4] has reported almost similar results with both the changes in spherical equivalent and meridional equivalent to be statistically significant. Daphna Mezad – Koursh et al[5] in their study found that myopic shift and induced change in astigmatism in with the rule astigmatism were significant side effects of strabismus surgery among adults. The mean change was not clinically significant but there is a clinical significant change in 50% of the patients which may be long lasting. C.F. Gomi et al.[6] revealed that significant changes in cylind-rical measurements were observed before and after horizontal strabismus surgery. Clinically signifi-cant changes in refraction affect a large portion of eye.

Snir et al[8] reported a myopic inclination in 87% of eyes at 2 months (mean 1.3+/-0.9D) in a study of 23 children who underwent bilateral medial rectus recession . This is much higher than the results in our study (0.13+/-0.17). Another observation made in our study was that the change in refraction was more when 2 muscles are encountered in one eye (-0.25D+/-0.17) compared to when only one muscle was tackled (-0.13+/-0.18). The study conducted by Hainsworth DP[9] et al. (Mason Eye Institute , University of Missouri – Columbia, USA) on corneal topographical changes after extraocular muscle surgery on 63 eyes of 43 patients who underwent either strabismus or optic nerve sheath fenestration (ONSF) surgery was measured before and after operation. The ONSF surgery involved removing and reattaching the medial rectus muscle, thus acting as a control for the strabismus procedures. All groups showed a significant change in preoperative to postoperative corneal power ($P < 0.01$). A significant change was seen between all grouped procedures except when the resection was compared with ONSF and compared with recession. The study showed that the change in

tension of one muscle does not produce a change in adjacent quadrant as much as it produces a significant change in the entire corneal surface, which illustrates the interaction and interdependence all corneal position have with respect to each other. Several uncontrolled retrospective studies have suggested that permanent changes in refractive error can be seen following strabismus surgery. A study conducted by Abbas Bagheri,[7] et al. found that recession of both horizontal rectus muscles, the same as has been reported for recession of one horizontal rectus muscle and recession-resection surgery on both horizontal rectus muscles, tends to induce a change in astigmatism in the with-the-rule direction. Thus the changes in refraction can be attributed to a change in the vector forces exerted on the cornea , resulting in alteration in the corneal curvature due to an alteration in the location of the extraocular muscle insertions.

The study conducted by Kwito S[10] et al. (Department of Ophthalmology, University of Southern California School of Medicine , Los Angeles) on the effect of extraocular muscle surgery on corneal topography in 36 eyes of 18 rabbits using computerized video keratoscopy system. Topographic analysis revealed a significant flattening of the cornea in the superior and superotemporal quadrants after superior rectus recession (mean +SE,-1.78+0.16Δ) compared with control eyes undergoing a sham procedure (-0.17+ 0.18Δ; P< 0.05). Excision of all rectus muscle caused a generalized corneal flattening (1.42+0.13Δ; p<0.001). A computerized finite element model of the globe ,including the rectus muscles, demonstrated corneal deformation as a result of extraocular muscle tension ; recession of an extraocular muscle in this model caused corneal flattening in the quadrant of recessed muscle. These data suggest that corneal topography is affected by extraocular muscle tension, corroborating clinical reports of refractive changes after strabismus surgery. Fix and Barker[11] reported changes of more than 1D in 2% of pediatric cases and in 25% of adult cases, which they attributed to the decreased corneal pliability in adults. Loupe DN et al.[12] also revealed that induced astigmatism occurred in patients undergoing scleral buckling surgeries thereby showing the effect of corneal topography following extraocular muscle manipulations. However, other anatomical factors like axial length and distance of insertion of muscle also probably contribute to the changes, which may be the reason for the difference in response of the 2 groups. H. D. Schworm[13] et al. in their study demonstrated that strabismus surgery can induce transitory but usually no long term changes of corneal topography. But they recommend that patients should be informed, that in rare cases an induced astigmatism may persist. Nardi et al [14] also concluded that the change in refractive error after horizontal muscle surgery was transient and insignificant although they did find residual astigmatism in their patients. In another study conducted by Zhale Rajavi,[15] et al. it was found that in spite of being statistically significant in some parts, the amounts of refractive and corneal topographic changes were not clinically remarkable. Therefore, it does not seem necessary to perform cycloplegic refraction early after horizontal rectus muscle recession; however, a precise refraction in all cases of strabismus should not be deferred later than 3 months.

Conclusion

Changes in refraction after horizontal muscle surgery in patients with good pre-operative visual acuity are significant enough to cause a diminution in visual acuity.

Post-operative refraction with appropriate prescription of glasses is important following strabismus surgery especially in children to prevent amblyopia and to maintain stable fusion.

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