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Changes of Corneal Topographic Measurements and Refractive Errors after Horizontal Muscle Surgery

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Abstract

Background: Refractive and corneal topographic changes after routine strabismus surgery have been reported and can occur even after a successful surgery .

Objective: Study aims to evaluate the effect of horizontal muscle surgery on refractive errors and corneal measurements.

Patients and methods: This study includes 25 eyes of 22 patients who have manifest strabismus. The patients were divided into two groups. Group A (10 eyes of 7 patients) subjected to unilateral lateral rectus recession. Group B (15 eyes of 15 patients) all of them subjected to lateral rectus recession and medial rectus resection in the same eye. Cycloplegic automated refraction (including spherical equivalent, astigmatic error and astigmatic axis) were recorded preoperatively, one month and 3 months after surgery. Corneal topography including flat K, steep K were recorded preoperatively, one month and 3 months after surgery.

Results: A significant change of spherical equivalent towards myopic shift after horizontal rectus muscle recession was observed (P=0.000). A significant change of refractive cylindrical power with rule was found in both groups (P=0.000). Corneal topographic parameter (flat k) showed a significant change in the both groups (P=0.000). . These changes persisted till the last postoperative visit .

Conclusion: Horizontal muscle surgery induced a statistically significant change of astigmatism power that persists till the 3rd. postoperative month. A significant change of spherical equivalent was found in the postoperative period after horizontal strabismus surgery only in recession group.

Keywords: Corneal Topographic; Measurements; Refractive Errors; Horizontal Muscle Surger

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INTRODUCTION

The cornea represents the eye's most anterior optical surface. Subtle changes in the cornea's shape therefore have the potential to have considerable effects on vision. Knowledge of the normal corneal shape allows us more easily to diagnose abnormal corneas and to understand how these abnormalities may affect the vision.[1]

Indications for extraocular muscle surgery vary depending on the age and the particular needs of the patient. In children, the primary indication for strabismus surgery is often to align the eyes to permit the development of binocular vision. Other indications in children include anomalous head postures that can be associated with nystagmus or ocular misalignment.[2] Strabismus surgery has been shown to cause either transient or long term changes in refractive error,[3] or also significant changes in astigmatism[4, 5] and corneal topography.[6]

The changes in refraction caused by strabismus surgery, have been thought to be related to changes in corneal curvature secondary to the alteration in tension of the extraocular muscle transmitted via the sclera to the cornea.[7]Hutchison has reported the importance of factors related to suture technique or muscle placement. Theoretically, these factors could also lead to change in refractive error and anterior chamber parameters after strabismus surgery.[8] Lateral rectus recession induces changes in corneal

topographic measurements and these changes might explain some patients' complaints about poor quality of vision.[9]

PATIENTS AND METHODS

This was a prospective interventional non comparative descriptive case series study, performed at Al-Azhar university hospitals from December 2018 to November 2019, including the follow up period. Twenty five eyes with Horizontal strabismus were included in the study. The patients were divided into two groups. Group A (10 eyes of 7 patients) were subjected to a unilateral or bilateral lateral rectus muscle recession and group B (15 eyes of 15 patients) were subjected to unilateral LR recession and MR resection in the same eye. All patients were informed about the details and the potential risks of the procedure of choice and a written informed consent were obtained from the patients or their guardians.

Inclusion criteria consisted of horizontal concomitant strabismus, clear ocular media, normal posterior segment and patients older than 4 years old, to get reliable measurements and exclusion criteria consisted of Patients with irregular astigmatism, Patients with previous refractive surgery, Patients with previous strabismus surgery, Patients with ocular media opacities as corneal scars and cataract, Patients with vertical pattern strabismus, patients with incomitant strabismus and patients unable to maintain reliable fixation on the measurement devices All patients were subjected to a detailed ocular and medical history including previous refractive documents and glasses, history of contact lenses use, systemic illness and previous medical treatment.

Data sheets were completed according to the patients' demographic characteristics and ophthalmic examinations. The examinations included visual acuity :(UCVA and BCVA) and cycloplegic refraction where 3 readings were recorded using the Topcon® KR800, adjusted in minus cylinder form 0.12 D steps. The following parameters were recorded: spherical equivalent, astigmatic error and astigmatic axis, cover test, measurement of the angle of deviation using a prism bar. The amount of muscle resection and/or recession were based on the pre-operative angle of deviation. Slit lamp examination of the anterior segment of the eye. Fundus examination using indirect ophthalmoscope.

Corneal topography was performed preoperatively for all patients using SIRIUS® 3D rotating Scheimpflug camera & topography system. Images were captured according to manufacturer's instructions. We recorded power readings in the flat and steep axes (flat K and steep K) and corneal astigmatism from the anterior surface of the cornea for the central 3 mm zone .

The whole surgical procedure was performed under the operating microscope under general anesthesia by the same surgeon. A limbal silk traction suture with silk (6-0) was applied to rotate the eye ball away from the field of surgery. A limbal periotomy with tow radial relaxing incision was performed over the muscle (Harms incision). With blunt Westcott scissors the episcleral tissue was separated from the muscle sheet and sclera. When the border of the muscle was identified, the muscle was hooked. Then a meticulous dissection of the check ligaments and intramuscular septum was performed.

For recession: Vicryl sutures (6-0) were placed at the upper and lower poles of the muscle insertion, locked and secured, then the muscle was cut at the insertion and the muscle was carefully resutured at sclera at the planned position after measuring the distance with caliber according to the type and the amount of deviation based on Parks (18) guidelines.

The surgical procedure was completed by readapting the conjunctiva, applying four to six sutures with vicryl (8-0). At the end of surgery, combination of antibiotic and steroid ointment was applied. Postoperatively cycloplegic refraction and corneal topography was repeated at one month and three months by the same instruments and methods .

All statistical analyses were conducted using the Statistical Package for the Social Science.V.23.0 (SPSS Inc, Chicago, Illinois, USA). Paired T-test were performed for normally distributed variables. The significance was taken at (0.05). So, p value > 0.05 was insignificant and p value $\leq$ 0.05 was significant .

RESULTS

This study included 25 eyes of 22 patients who had manifest strabismus. Group A included 10 eyes of 7 patients (4 female and 3 males) with mean age 12.80 ± 4.89. Three patients subjected to bilateral lateral rectus recession and 4 patients subjected to unilateral lateral rectus recession. Group B included 15 eyes of 15 patients (9 females and 6 males) with mean age 15.29±5.23. All of them subjected to lateral rectus recession and medial rectus resection in the same eye. (Table 1)

Results for changes in spherical equivalent and astigmatism were summarized in tables 2 and 3 respectively. Table (2) shows that: for group A, there was a statistically significant difference between preoperative spherical equivalent compared to spherical equivalent after one month (P=0.044). Also there was a statistically significant difference between preoperative spherical equivalent compared to spherical equivalent after three months (P=0.000). For group B, that there was a statistically significant difference between preoperative spherical equivalent compared to spherical equivalent after one month (P=0.004). But there was no statistically significant difference between preoperative spherical equivalent compared to spherical equivalent after three months (P=0.077).

Variables	Group A	Group B
No. of patients	7	15
No. of eyes	10	15
Sex : - **Male** - **Female**	3 (42.9%)	6 (40%)
	4 (57.1%)	9 (60%)
Age(years) : **Mean ±SD** **Range**	12±4.89 6-22	15±5.23 7-25
Laterality: - **Bilateral** - **Unilateral**	3 cases (42.9%)	Non
	4cases (57.1%)	15 cases (100%)

Table 1: Characteristic data of the studied groups

Table (3) shows that: there was a statistically significant difference between preoperative corneal astigmatism compared to corneal astigmatism after one month for both groups A & B (P=0.004 & 0.001 respectively). Also there was a statistically significant difference between preoperative corneal astigmatism compared to corneal astigmatism after three months for both groups A & B (P=0.000).

Topographic changes: Results for changes in corneal measurements: corneal steep axis, flat K and steep K were summarized in tables 4, 5 & 6 respectively.

Table (4) shows that Steep axes mean changes were not statistically significant after one month (P=0.112 & 0.631; group A & group B respectively), nor after three months (P=0.714 & 0.316 group A & group B respectively). Table (5) shows that there was a statistically significant difference between preoperative flat K compared to flat K after one month and after three months for both groups A & B (P=0.000). Table (6) shows that mean steep K changes were not statistically significant after one month (P=0.700 & 0.860; group A & group B respectively), nor after three months (P=0.702 & 0.184; group A & group B respectively).

DISCUSSION

Traditionally, the goal of strabismus treatment has been to re-align the visual axes in order to eliminate diplopia, or to produce, maintain, or restore binocular vision. Additionally, surgery to improve an abnormal head posture, eliminate abnormal eye movements, or simply to restore the normal anatomical position of the eyes are well-accepted indications for surgery.[10]

A common cause for a change in vision following strabismus surgery is a change in refractive error. Changes in refractive error have been noted in several studies but the results were debatable.[11] Horizontal strabismus surgery has been shown to affect corneal topography.[1] This study observed the effect of two different techniques: single lateral rectus (LR) recession in group A and medial rectus (MR) resection with LR recession in the same eye in Group B. The follow-up was at one and three months.

For group A the SE shows mild myopic shift which was clinically significant when compared to the peroperative results at 1st month and 3rd month, these results agreed with that of Al-Tamimi et al.[13] However for group B beside a transient change in SE towards myopic shift after one month, the results after three months showed insignificant changes in spherical equivalent by 3rd month. These results agreed with that obtained by Rajavi et al [7], Hong et al [14] and by the same study done by Hegazy et al.[15]

El-zawahry reported that only the early postoperative period showed significant change in the SE value with myopic shift that necessitates early postoperative visual rehabilitation for the fear of recurrence of the deviation or development of amblyopia.[16] In the current study there is a statistically significant increase of astigmatism in the with-the-rule direction in both groups compared with the preoperative astigmatism after one and three months follow-up (P=0.000) .

The results in this study regarding astigmatism agreed with that of al Hong et al.[14] who evaluated the changes of astigmatism after horizontal rectus muscle surgery in intermittent exotropic children, and found statistically significant change in astigmatism in the with- the-rule direction within the first 3 months after surgery. In the postoperative period after horizontal strabismus recession procedures that persists till the 3rd. postoperative month. Horizontal muscle surgery induced a statistically significant change of flat K reading. On the other hand, no significant change of astigmatism axis was found after horizontal muscle surgery. Recession–resection strabismus surgery has insignificant effect on refractive errors or corneal topographic changes

They stated that, astigmatism induced by surgery should be checked and corrected at least 3 months after horizontal strabismus surgery. The results of the present study disagreed with that of Al-Tamimi et al.[13] who did not find any significant astigmatic changes following horizontal strabismus surgery. Also the result of the current study disagreed with the results of Mun et al.[4] who found only a transient astigmatic change following horizontal strabismus surgery which disappeared within one month postoperatively.In the current study no statistically significant difference was seen between preoperative steep axis and steep axis after 1st month and 3rd month.

The etiology of refractive changes after strabismus surgery is not completely established. The present study agreed with the studies that explain causes of refractive changes in the with-the-rule astigmatic direction which are explained by flattening in the horizontal meridian and steeping of the vertical -

Spherical equivalent		Paired Differences				t	Sig. (2-tailed)
		Mean (D)	Std. Deviation	95% Confidence Interval of the Difference			
				Lower	Upper		
Group A	Preop – 1st month	-0.226	0.304	-0.444	-0.007	-2.34	0.044
	Preop – 3rd month	-0.789	0.342	-1.033	-0.544	-7.29	0.000
Group B	Preop - 1st month	-0.295	0.327	-0.476	-0.114	-3.49	0.004
	Preop—3rd month	-0.329	0.668	-0.699	0.041	-1.91	0.077

Table 2: Change in Mean Spherical equivalent within the studied groups
(D: diopters, Std.: standard, t: test result, Sig. significance)
p value ≤ 0.05 was significant

Steep axis		Paired Differences				t	Sig. (2-tailed)
		Mean change	Std. Deviation	95% Confidence Interval of the Difference			
				Lower	Upper		
Group A	Preop – 1st month	-1.60	2.876	-3.657	0.457	-1.76	0.112
	Preop – 3rd month	0.400	3.339	-1.989	2.789	0.38	0.714
Group B	Preop -1st month	0.400	3.158	-1.349	2.149	0.49	0.631
	Preop - 3rd month	0.867	3.227	-0.920	2.653	1.04	0.316

Table 3: Change in Mean Astigmatism within the studied groups
* (D: diopters, Std.: standard, t: test result, Sig. significance)
*p value ≤ 0.05 was significant

Flat K (D)		Paired Differences				t	Sig. (2-tailed)
		Mean change	Std. Deviation	95% Confidence Interval of the Difference			
				Lower	Upper		
Group A	Preop – 1st month	0.500	0.278	0.300	0.699	5.67	0.000
	Preop – 3rd month	1.080	0.358	0.823	1.336	9.53	0.000
Group B	Preop- 1st month	0.553	0.253	0.413	0.693	8.46	0.000
	Preop-3rd month	1.027	0.357	0.829	1.224	11.12	0.000

Table 4: Steep axis mean change within the studied groups

(D: diopters, Std.: standard, t: test result, Sig. significance) p value ≤ 0.05 was significant

Astigmatism		Paired Differences				t	Sig. (2-tailed)
		Mean (D)	Std. Deviation	95% Confidence Interval of the Difference			
				Lower	Upper		
Group A	Preop – 1st month	-0.534	0.437	-0.847	-0.221	-3.86	0.004
	Preop - 3 month	-1.127	0.583	-1.544	-0.709	-6.11	0.000
Group B	Preop -1st month	-0.525	0.473	-0.786	-0.263	-4.29	0.001

Table 5: Mean Flat K changes within the studied groups

(D: diopters, Std.: standard, t: test result, Sig. significance)

p value ≤ 0.05 was significant

Steep K (D)		Paired Differences				t	Sig. (2-tailed)
		Mean change	Std. Deviation	95% Confidence Interval of the Difference			
				Lower	Upper		
Group A	Preop – 1st month	-0.036	0.286	-0.241	0.169	-0.39	0.700
	Preop – 3rd month	-0.049	0.392	-0.329	0.231	-0.39	0.702
Group B	Preop – 1st month	0.015	0.330	-0.168	0.198	0.18	0.860
	Preop-3rd month	0.086	0.238	-0.046	0.218	1.39	0.184

Table 6: Mean steep K changes within the studied groups

(D: diopters, Std.: standard, t: test result, Sig. significance)

p value ≤ 0.05 was significant

- meridian of the cornea. Also agreed that the change of muscle tension on corneal power is thought to be a major mechanism.[7, 9, 16, 17,18] In the present study there was a statistically significant change in flat K in group A and group B when comparing preoperative result with the postoperative one at 1st and 3rd month. These results agreed with that of Rajavi et al.[7], and Also these results agreed with Kwitko et al.[17] who found inferiorly steepened cornea with superiorly reciprocal flattening in corneal topography after inferior rectus muscle recession in patients with Graves' disease. Kwitko and colleagues suggested that corneal topography is affected by extraocular muscle tension and demonstrated that recession of an extraocular muscle in rabbits caused corneal flattening in the quadrant of the recessed muscle.[17] On the other hand, in the current study there was a statistically insignificant dereference for steep K in group A and B

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CONCLUSION

In conclusion, there is a significant change of spherical equivalent and astigmatic power is present in the postoperative period after horizontal strabismus recession procedures that persists till the 3rd. postoperative month. Horizontal muscle surgery induced a statistically significant change of flat K reading. On the other hand, no significant change of astigmatism axis was found after horizontal muscle surgery. Recession–resection strabismus surgery has insignificant effect on refractive errors or corneal topographic changes

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