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ORIGINAL

Palpebral fissure widening after different types of strabismus surgery

Ensanchamiento de la fisura palpebral después de diferentes tipos de cirugía de estrabismo

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Abstract

Objectives: Strabismus surgery may be associated with postsurgical complications such as palpebral fissure widening. For a better understanding of this finding, we studied the surgical outcome of patients undergoing strabismus surgery at our center and its effect on palpebral fissure alterations.

Methods: In this cross-sectional study, 58 patients who underwent strabismus surgery at Amir–Almomenin Hospital, Rasht, Iran during March 2015-2016 were investigated for the changes in eye deviation and palpebral fissure height (PFH) 1 and 3 month(s) after surgery compared with the pre-surgical status. Also, their corneal light reflex of upper eyelid margin to reflex distance (UMRD) and lower eyelid margin to reflex distance (LMRD) was clinically evaluated.

Results: Evaluation of 97 eyes of 58 patients (47 left and 50 right eyes; 63.8% women; mean age of 19.7±13.8 years) undergoing strabismus surgery showed significant changes in deviation, PFH, and LMRD, 1 and 3 month(s) after surgery compared with the pre-surgical status with significant differences based on the type of surgery. Correction of deviation had a significant effect on PFH change (3 months after surgery compared with baseline) in medial and lateral rectus recession techniques (P<0.001).

Conclusion: The results of this study showed significant effect of medial and lateral rectus recession on PFH, UMRD, and LMRD, which emphasizes on the need to inform patients about the possibility of such changes after surgery and search for intra-operative strategies to reduce such changes.

Key words: Strabismus, eyelids, palpebral fissure, medial rectus, lateral rectus.

Resumen

Objetivos: La cirugía de estrabismo puede estar asociada a complicaciones postquirúrgicas como el ensanchamiento de la fisura palpebral. Para una mejor comprensión de este hallazgo, estudiamos el resultado quirúrgico de los pacientes sometidos a cirugía de estrabismo en nuestro centro y su efecto sobre las alteraciones de la fisura palpebral.

Métodos: En este estudio transversal, se investigaron los cambios en la desviación ocular y la altura de la fisura palpebral (PFH) de 58 pacientes que se sometieron a cirugía de estrabismo en el Hospital Amir-Almomenin, Rasht, Irán, durante marzo de 2015-2016, en comparación con el estado prequirúrgico. Además, se evaluó clínicamente su reflejo luminoso corneal del margen del párpado superior a la distancia del reflejo (UMRD) y del margen del párpado inferior a la distancia del reflejo (LMRD).

Resultados: La evaluación de 97 ojos de 58 pacientes (47 ojos izquierdos y 50 ojos derechos; 63,8% mujeres; edad media de 19,7±13,8 años) sometidos a cirugía de estrabismo mostró cambios significativos en la desviación, la PFH y la LMRD, 1 y 3 meses después de la cirugía en comparación con el estado prequirúrgico, con diferencias significativas en función del tipo de cirugía. La corrección de la desviación tuvo un efecto significativo en el cambio de la PFH (3 meses después de la cirugía en comparación con el estado inicial) en las técnicas de recesión del recto medial y lateral (P<0,001).

Conclusión: Los resultados de este estudio mostraron un efecto significativo de la recesión del recto medial y lateral sobre la PFH, la UMRD y la LMRD, lo que enfatiza en la necesidad de informar a los pacientes sobre la posibilidad de que se produzcan dichos cambios tras la cirugía y buscar estrategias intraoperatorias para reducirlos.

Palabras clave: Estrabismo, párpados, fisura palpebral, recto medial, recto lateral.

Introduction

Strabismus is a common visual disorder, which typically starts at early childhood, mainly by a genetic, structural, or developmental disorder. It involves the extraocular muscles[1], and can cause diplopia, stereopsis, and asthenopia, or result in amblyopia[2].Different prevalence rates of strabismus (0.3-4.4%) and its subtypes, namely esotropia, exotropia, and hypertropia, have been reported in different ethnicities, highest in European countries[3,4].In Asian children, a prevalence of 3.5% is reported for strabismus[5],and in most cities of Iran, the prevalence of strabismus is reported at about 2%[6,7].

Considering the treatment of strabismus, some conservative treatments, like prisms, occlusion, and orthoptic exercises, have been suggested to help realign the visual axes[8].However, surgical correction seems to be the only curative treatment of strabismus, which aims to recover binocular vision, promote fusion of eye's images, and restore normal eye contact, while the cosmetic improvement can also have positive psychological impact[9,10].Strabismus surgery can be performed by different techniques including muscle recession and resection, selected by the surgeon based on the type and severity of the patients' strabismus[10]. Beside the debate on the surgical technique with the best surgical success on correction of eye's deviation[11,12], postoperative complications are the important aspects in strabismus surgery, during which the change in the position of adjacent structures, such as palpebral fissure widening, can cause negative esthetic outcomes, eye dryness, ptosis, and further problems for the patient[13,14].

Vertical widening of the palpebral fissure is reported by some researchers after surgical correction of horizontal strabismus by recession of lateral rectus muscle[15,16],while muscle resection is reported to cause narrowing of the palpebral fissure[17]. As suggested, transposition of horizontal rectus muscle to posterior position during strabismus surgery can change the orbital globe's position and increase the palpebral fissure height (PFH)[18]. Accordingly, researchers have been looking for surgical techniques to reduce these complications, suggesting intermuscular septum dissection in lateral rectus muscle recession[19,20].

Because of the fact that few studies have investigated the change in PFH and the negative effects of these complications on patients, we aimed to study the surgical outcome of all patients undergoing strabismus surgery at our center and the effect of muscle recession and resection on palpebral fissure widening in order to identify the change in PFH after different surgical techniques and investigate the possible cause underlying this change.

Methods

Study design

In this cross-sectional study, patients who underwent strabismus surgery at Amir–al–Momenin Hospital, Rasht, Iran, during March 2015-2016, were considered as the study population. The study's protocol was approved by the Ethics Committee of Guilan University of Medical Sciences, Rasht, Iran (cod: IR.GUMS.REC.1394.217). The sample size of the study was calculated at 60, based on the study by Lima and colleagues[15], considering the confidence interval of 95% and study power of 90%. The participants were selected based on the following inclusion criteria: patients who were candidate of strabismus surgery, who had no palpebral or orbital disorder, no history of surgery on orbital extraocular muscles, eye trauma, or ocular nerve palsy. Before recruitment of patients into the study, the researcher explained the design and objectives of the study to eligible patients and asked them to read and sign the written informed consent form. The eligible patients who gave consent for participation were enrolled into the study by convenient sampling method.

One day before surgery, all the participants underwent physical examination by an expert ophthalmologist (AR.M). During this visit, the physician measured the vertical PFH by considering the widest point between the upper and lower eyelid along pupil's axis, while the patient was asked to look at a far object in primary position. The corneal light reflex of the eyelids was measured by margin to reflex distance (MRD) in upper (UMRD) and lower eyelid (LMRD). Also, the physician performed complete eye examination for all the patients, including the measurement of central vision by central steady maintenance (CSM) for the children <4 years old and by Snellen chart for the patients >4 years old, measurement of eye deviation by prism, and cycloplegic refraction by 0.5% atropine eye drop (one drop each 8 hours). The same examinations were performed 1 and 3 month(s) after surgery. A single ophthalmic surgeon performed the surgical procedures.

Statistical analysis

The categorical variables were described by frequency (percentage) and the numeric variables by mean and 95% confidence interval (CI), according the results of Kolmogorov Smirnov test for evaluating the normal distribution of variables. To compare the changes in the numeric variables 1 and 3 month(s) after the surgery with the preoperative values, paired t test or Wilcoxon test were performed, based on the results of normal distribution of the variables. To determine the value of change according to variables such as type of surgery, eye side, patients' sex, and age, independent samples *t* test or ANOVA was used, while for variables without normal distribution, non-parametric tests, Mann Whitney U test, or Kruskal Wallis test were used. Association of variables was tested by Pearson's or Spearman's correlation coefficient, according to the normal distribution of data. For the statistical analysis, the statistical software IBM SPSS Statistics for Windows version 21.0 (IBM Corp. 2012. Armonk, NY: IBM Corp.) was used. Significance level was considered as two-sided test results and P values <0.05.

Results

Of 58 patients who completed the study, 37 (63.8%) were female patients and 21 (36.2%) were male patients. Of 97 eyes, 47 were left eyes and 50 were right eyes. Mean±SD of the participants' age was 19.7±13.8 years (minimum of 1 year and maximum of 50 years). The most common type of surgery was medical rectus recession (38.1%), lateral rectus recession (20.6%), and lateral rectus recession+medial rectus resection (15.5%). The mean±SD of eye's deviation before and after the surgery in each type of surgery are shown in **table I**. As shown in this table, comparison of the postsurgical values with the pre-surgical values showed significant changes in all types of surgery (P<0.05; **table I**).

Mean changes in UMRD, LMRD, and PFH 1 and 3 month(s) after the surgery were compared with their baseline values and categorized based on the surgical type, and the results are shown in **table II**. As shown, significant differences were observed among different surgical types in LMRD 1 and 3 month(s) after the surgery compared with the baseline (P=0.003 and 0.002, respectively), as well as PFH 1 and 3 month(s) after the surgery compared with the baseline, and 3 months after the surgery compared with 1 month after the surgery (P<0.05; **table II**).

Studying the effect of time showed significant change in LMRD 1 and 3 month(s) after the surgery compared with the baseline in medial and lateral rectus recession, indicating an increasing trend (95% CI), but not in other types of surgery. Considering the effect of time, significant change in UMRD, 1 and 3 month(s) after the surgery compared with the baseline in vertical and lateral rectus recession, indicating an increasing trend (95% CI), but not in other types of surgery. Considering PFH, there were significant changes 1 and 3 month(s) after the surgery compared with the baseline in lateral and lateral rectus recession, indicating an increasing trend (95% CI), and 3 months after the surgery compared with the baseline in medial rectus recession+inferior oblique myomectomy (95% CI), indicating an increasing trend; however, the changes were not significant in other types of surgery. The trend of changes in UMRD, LMRD, and PFH are illustrated in **figure 1**.

The results of regression analysis for the effect of eye deviation correction with changes in UMRD, LMRD, and PFH 3 months after the surgery compared with the baseline values are shown in **table III**, according to the surgical type. As indicated, significant effects were observed in LMRD in medial and lateral rectus recession surgery (r=0.61 and 0.68, respectively; P<0.001) and PFH (r=0.60 and 0.75, respectively; P<0.001).

Discussion

The present study investigated the effect of each type of strabismus surgery on the change of PFH, UMRD, and LMRD, which showed that medial and lateral rectus recession surgery had significant effects on LMRD, and PFH, 3 months after the surgery compared with the baseline values. The mean age of our study population was about 20 years and the patients' age ranged from 1 to 50 years. Strabismus is mainly considered as a pediatric disease, as it is commonly observed because of the developmental disorder in childhood, for which most studies have focused on pediatric population[21,22]. However, adults may also have strabismus, uncorrected from childhood or because of the other reasons, such as trauma[23]. Considering no age range for patients' enrollment into our study confirmed the presence of strabismus in adults, as well as children and adolescents. As suggested by the related guidelines, strabismus surgery can be performed by different techniques, based on the type and severity of patients' strabismus[10]. In the present study, nine different surgical techniques were

Table I: The mean prism diopter of eye deviation before and after surgery in each surgical type.

	Total count	Before surgery	3 months after surgery	P value*
Esotropia – medial rectus recession	19	33.68±14.80	2.89±3.63	<0.001
Exotropia – lateral rectus recession	11	34.55±15.24	3.45±3.45	<0.001
Vertical tropia – superior – inferior rectus recession	5	33.00±17.18	6.60±8.23	0.003
Exotropia – lateral rectus recession + medial rectus resection	13	49.23±14.84	7.31±6.56	<0.001
Esotropia – lateral rectus recession+medial rectus resection	6	30.83±9.70	0	0.001
Hypertropia – inferior oblique myomectomy	3	5.77±13.33	3.33±5.77	0.003
Esotropia+superior – inferior rectus recession, lateral rectus recession+medial rectus resection and hypertropia – medial rectus recession+inferior oblique myomectomy	3	45.00±8.66	4.33±4.04	0.005
Exotropia+hypertropia – lateral rectus recession+inferior oblique myomectomy	1	45.00±00	4.00±00	0.005
Hypertropia – recession+anterior transposition inferior oblique muscle	1	15.00±0	0	<0.001

*The results of ANOVA, considered as significant at P<0.05. All values are reported as mean±standard deviation

Table II: Comparison of mean changes in UMRD, LMRD, and PFH 1 and 3 month(s) after surgery based on the surgical type.

	A	B	C	D	E	F	G	H	I	P value*
UMRD change 1 month after surgery vs. baseline	0.19±0.84	0.35±0.75	0.71±0.49	-0.07 ±0.70	0±0.63	0.33±0.58	0.17±0.58	0	0	0.577
UMRD change 3 months vs. 1 month	-0.03 ±0.60	0±0.65	-0.29 ±0.76	0±0.65	-0.33 ±0.52	0.33±0.58	0.17±0.75	-1.00 ±0	0	0.374
UMRD change 3 months vs. baseline	0.16±0.65	0.35±0.53	0.43±0.53	-0.07 ±0.88	-0.33 ±0.52	0.67±0.58	0.33±0.82	1.00±0	0	0.058
LMRD change 1 month vs. baseline	0.54±0.87	0.60±0.60	0.57±0.79	-0.20 ±1.01	-0.17 ±0.41	-1.00 ±0	0±0.63	1.00±0	0	0.003
LMRD change 3 months vs. 1 month	0.08±0.49	0.05±0.69	-0.14 ±0.38	0.13±0.74	0±0.63	0	0.17±0.75	0	-1.0±0	0.800
LMRD change 3 months vs. baseline value	0.62±0.92	0.65±0.67	0.43±0.79	-0.07 ±0.88	-0.17 ±0.41	-1.00 ±0	0.17±0.41	1.00±0	-1.00 ±0	0.002
PFH change 1 month vs. baseline	0.73±1.17	1.00±0.97	-1.71 ±4.42	-0.13 ±0.99	-0.17 ±0.75	–0.33 ±0.58	0.50±0.55	1.00±0	0	0.009
PFH change 3 months vs. 1 month	0.05±0.52	0±0.65	2.43±4.54	0.07±0.46	-0.33 ±0.82	0	0.17±0.41	-1.00 ±0	-1.00 ±0	0.003
PFH change 3 months vs. baseline value	0.78±1.11	1.00±0.92	0.71±0.95	-0.07 ±0.96	-0.50 ±0.55	-0.33 ±0.58	0.67±0.52	0	-1.00 ±0	0.003

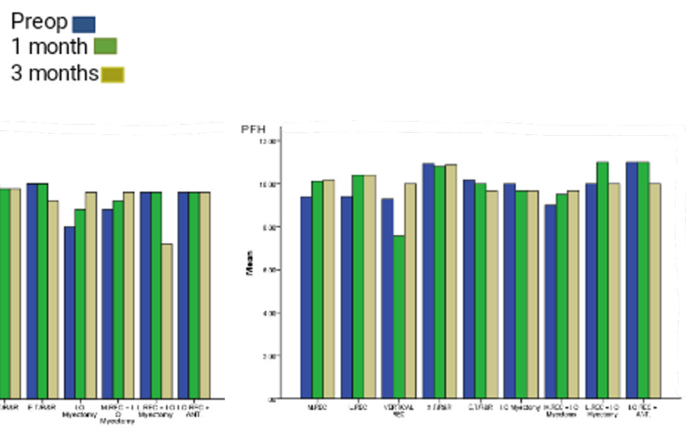
*The results of ANOVA, considered as significant at P<0.05. All values are reported as mean±standard deviation, A: Esotropia – medial rectus recession, B: Exotropia – lateral rectus recession, C: Vertical tropia – superior–inferior rectus recession, D: Exotropia – lateral rectus recession+medial rectus resection, E: Esotropia – lateral rectus recession+medial rectus resection, F: Hypertropia – inferior oblique myomectomy, G: Esotropia+superior – inferior rectus recession, lateral rectus recession+medial rectus resection and hypertropia – medial rectus recession+inferior oblique myomectomy, H: Exotropia+hypertropia – lateral rectus recession+inferior oblique myomectomy, I: Hypertropia – recession+anterior transposition inferior oblique muscle, MRD; margin to reflex distance, PFH; palpebral fissure height

Table III: Regression analysis for the effect of eye deviation correction with changes in UMRD, LMRD, and PFH 3 months after surgery compared with baseline values, based on the surgical type.

		A	B	C	D	E	F	G	H
LMRD	β–coefficient	0.611	0.698	0.031	0.092	0.343	1.00	0.345	1.00
	R square	0.373	0.488	0.001	0.009	0.118	1.00	0.119	1.00
	P value	<0.001	<0.001	0.941	0.734	0.451	0	0.448	0.014
	Lower bound 95% CI	0.065	0.038	-0.162	-0.169	-0.126	-0.167	-0.039	0.64
	Upper bound 95% CI	0.166	0.112	0.152	0.122	0.244	-0.167	0.076	0.114
UMRD	β–coefficient	0.204	0.550	0.650	0.150	0.485	0.816	0.398	1.00
	R square	0.042	0.302	0.422	0.023	0.235	0.667	0.159	1.00
	P value	0.219	0.010	0.081	0.579	0.270	0.184	0.376	0.014
	Lower bound 95% CI	-0.014	0.012	-0.013	-0.182	-0.126	-0.128	-0.070	-0.114
	Upper bound 95% CI	0.060	0.075	0.172	0.106	0.361	0.350	0.154	-0.064
PFH	β–coefficient	0.600	0.755	0.211	0.096	0.594	0.577	0.797	
	R square	0.361	0.570	0.045	0.009	0.353	0.333	0.635	
	P value	<0.001	<0.001	0.616	0.725	0.160	0.423	0.032	
	Lower bound 95% CI	0.076	0.069	-0.162	-0.184	-0.098	-0.295	0.011	
	Upper bound 95% CI	0.201	0.168	0.251	0.131	0.451	0.183	0.158	

Abbreviations: A; Esotropia – medial rectus recession, B; Exotropia – lateral rectus recession, C: Vertical tropia – superior–inferior rectus recession, D; Exotropia – lateral rectus recession+medial rectus resection, E; Esotropia – lateral rectus recession+medial rectus resection, F; Hypertropia – inferior oblique myomectomy, G; Esotropia+superior – inferior rectus recession, lateral rectus recession+medial rectus resection and hypertropia – medial rectus recession+inferior oblique myomectomy, H; Exotropia+hypertropia – lateral rectus recession+inferior oblique myomectomy.

Figure 1: The trend of changes in UMRD, LMRD, and PFH.



used for correction of the patients' strabismus. The most common types included medical rectus recession (38.1%), lateral rectus recession (20.6%), and lateral rectus recession+medial rectus resection (15.5%). The results of postsurgical assessment of eye deviation showed that all of these techniques resulted in significant decrease in eye deviation and the surgical results were thus considered as successful in all patients, undergoing different surgical types. These results are in line with the results of previous studies, indicating medial and lateral rectus recession as effective procedures[24]. However, several errors and complications have been reported for strabismus surgery, and it is suggested to be performed with great precision[25].

Complications related to eyelid position is one of the rarely reported complications of strabismus surgery, reported recently (since 2005)[17], which can be observed after strabismus by releasing and changing the position of extraocular muscles[13,14]. Nevertheless, it is of great importance, as it may not only affect the patients' appearance and interfere with the cosmetic correction purpose of strabismus surgery, but may also cause ocular problems for the patient. The results of our study showed significant increase in UMRD, 1 and 3 month(s) after the surgery in vertical and lateral rectus recession methods and in LMRD and PFH in medial and lateral rectus recession methods, which indicated that not all of the surgical types had significant effects on PFH, UMRD, and LMRD, although these results may also be resulted from the small number of sample size in the groups (≤6 patients). Lee and colleagues investigated palpebral fissure widening in 20 patients with intermittent exotropia who underwent unilateral rectus muscle recession and compared the baseline values with postsurgical measurements 1 week, 1 month, and 6 months after surgery[16]. They defined >6mm change in PFW as significant change and reported significant increase in PFW in 50% of patients after 1 week, in 35% after 1 month, and in 35% after 6 months[16]. These findings are in line with the results of the present study, indicating increased PFH in medial and lateral rectus recession surgical techniques. In another study, performed in Iran, Zandi and colleagues investigated PFH changes in 26 eyes of 19 patients with strabismus after lateral rectus recession and reported a mean PFH of 11.4 mm, 3 months after surgery, significantly higher than the pre-surgical values, and reported that the group undergoing intermuscular septum dissection had a lower mean PFH, 3 months after surgery[20]. The findings of the study by Zandi and colleagues, indicating an increase in PFH after 3 months in patients undergoing lateral rectus recession confirm the results of the present study, although we had no intervention to compare the results with, and the changes in the measurements of patients undergoing different surgical techniques were compared. In another study by de Sauza Lima and colleagues, 42 patients with esotropia and 17 with exotropia underwent extraocular muscle recession. The results of their study showed about 12% increase in vertical palpebral fissure 3 months after surgery[15], which is consistent with the results of the present study. Similar reports have been released by other studies, which measured PFH changes after muscle recession in patients with thyroid disorders[26,27] and some others have suggested combination of eyelid surgery with strabismus surgery[28].

As indicated above, the few studies on the measurement of the change in PFH after strabismus surgery have reported different outcomes, some have considered a cut-off point and reported the prevalence of patients with increased PFH[16] and some others have reported mean values[20]. In the present study, we considered the change in mean values and the effect of each type of surgery on this change. Based on the results of regression analysis, each unit change in medial and lateral rectus recession surgery resulted in about 0.6-0.7 mm increase in LMRD and PFH. These results are close to that reported by de Sauza Lima and colleagues, which showed a mean increase of about 1mm, 3 months after surgery; 0.9 mm in patients with esotropia and 1 mm in patients with exotropia[15]. Lagrèze and co-workers have also reported 1 mm increase in PFH by 7.7 mm change in muscle's position[17]. The researchers of the above mentioned studies[15,17] have also measured the variables manually, like us, while some others have suggested that digital measurement of PFH can result in more accurate values[29,30].

The present study had some limitations. The first limitation was related to the small sample size in some surgical groups, which could have affected the results. The second limitation of this study could be the short follow-up, as we only measured 1 and 3 months' results, while longer follow-ups may indicate other results. Furthermore, the measurements were manual, while digital measurements can provide more accurate results. Considering the fact that the patients were selected from one center, it is suggested not to generalize the results to all study groups.

Conclusion

The results of the present study showed that PFH, UMRD, and LMRD significantly increased after strabismus surgery. Therefore, it is important to inform patients about the possibility of these complications and increase surgeons' awareness about the adverse effects of these complications. Comparison of the results among different types of surgery showed significant effect of medial and lateral rectus recession surgery on PFH and LMRD. Considering the limitations of the present study, this issue has to be evaluated in future studies to indicate the eyelid changes after each type of surgery and suggest strategies to reduce this undesirable complication.

Conflict of interest
Authors do not have any conflict of interest to declare.

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