DOI:10.14744/bej.2018.57060
Beyoglu Eye J 2018; 3(2): 58-62

Original Article

The Change in Deviation Measurements After Refractive Surgery for Partially Accommodative Strabismus: Early Postoperative Evaluation

Burcin Kepez Yildiz, Mehmet Goksel Ulas, Ebru Demet Aygit, Ceren Gurez, Nilay Kandemir Besek, Yusuf Yildirim, Alper Agca, Korhan Fazil, Birsen Gokyigit, Ahmet Demirok

University of Health Sciences Prof. Dr. N.Resat Belger Beyoglu Eye Training and Research Hospital, Istanbul, Turkey

Abstract

Objectives: The aim of this study was to evaluate the postoperative change in the angle of deviation in patients with partially accommodative esotropia or exotropia who underwent keratorefractive surgery.

Methods: The records of patients with partially accommodative esotropia or exotropia who underwent keratorefractive surgery (small incision lenticule extraction [SMILE], laser in situ keratomileusis [LASIK]) at Beyoglu Eye Training and Research Hospital between January 2017 and June 2017 were retrospectively reviewed. Preoperative and postoperative third month uncorrected and best corrected visual acuity, the angle of deviation in prism diopters, and titmus stereoacuity measurements were compared. Any preoperative strabismus surgery was also recorded.

Results: A total of 19 eyes of 11 patients with partially accommodative esodeviation or exodeviation who underwent keratorefractive surgery between January 2017 and June 2017 were included in the study. Eight patients had bilateral surgery and 3 patients had unilateral surgery. The mean age of the patients was 24.9±5.78 years. Eight patients (72%) were men and 3 (28%) were women. Four patients had esotropia (36%), 5 had exotropia (45%) and 2 (18%) had exophoria. Five patients (45%) underwent a SMILE procedure and 6 patients underwent femtosecond LASIK surgery. No complications occurred preoperatively or postoperatively. One patient (0.9%) had a history of strabismus surgery before the keratorefractive procedure. No significant difference was detected in the ocular alignment and angle of deviation before and after keratorefractive surgery at postoperative third month.

Conclusion: Refractive surgery seems to be ineffective at providing orthophoria for patients with partially accommodative esodeviation or exodeviation.

Keywords: Binocularity, refractive surgery, strabismus.

Introduction

Refractive surgery is a procedure commonly used to correct myopia, hypermetropia, astigmatism, and anisometropia. Refractive surgery in strabismus patients is a special subject that continues to be studied (1-3). It has been reported in the literature that strabismus and diplopia can also occur de novo after different refractive procedures performed in ametropic patients (4, 5). This has led ophthalmologists to perform preoperative orthoptic examinations to identify patients at risk (6). In myopic and hypermetropic patients with accommodative strabismus, refractive surgical applications have the potential to heal ocular misalignment by correcting refractive errors (7). There are case series with different results for nonaccommodative and partially accommodative deviations (8-10). It is well known that it is very important to inform the patient about how the deviation will change after refractive surgery.

Address for correspondence: Burcin Kepez Yildiz, MD. University of Health Sciences Prof. Dr. N.Resat Belger Beyoglu Eye Training and Research Hospital, Istanbul, Turkey
Phone: +90 532 460 06 50 **E-mail:** burcinkepez@hotmail.com

Submitted Date: May 31, 2018 **Accepted Date:** July 31, 2018 **Available Online Date:** August 08, 2018

The objective of this study was to evaluate changes in preoperative manifest and latent ocular misalignments following keratorefractive surgery in patients with esodeviations or exodeviations.

Methods

The files of patients who had been treated by the University of Health Sciences Prof. Dr. Reşat Nuri Belger Beyoglu Eye Training and Research Hospital strabismus and refraction departments and who had undergone corneal refractive surgery between January 2017 and June 2017 were evaluated retrospectively. The study adhered to the tenets of the Declaration of Helsinki. Detailed anamnesis of our patients, including family history was taken in terms of strabismus. A fundus examination, detailed ophthalmological examination, and orthoptic examination were routinely performed. Preoperative and postoperative third-month corrected and uncorrected visual acuity, manifest refraction spherical equivalents, orthoptic examinations with deviation values in prism diopter (PD), stereoacuity, and diplopia examination findings were recorded. Any complications occurring during refractive surgery and any history of preoperative strabismus surgery were recorded. Visual acuity was measured using a Snellen chart projector and recorded in decimals. Uncorrected and corrected best visual acuity was recorded for distance (6 m) and near (33 cm) vision. Cycloplegic refraction with 1% cyclopentate was evaluated in each patient. Ocular misalignment examinations were performed for distance (6 m) and near (33 cm) vision, and for 9 diagnostic positions using the prism cover test. Alignment deviation values were evaluated both with and without refractive correction. During the stereoacuity evaluation, a titmus stereoacuity test was used after correction of refractive errors with contact lenses or glasses. The dominant eye was identified for each patient. Inclusion criteria for the study were 1) age greater than 20 years, 2) no ocular/systemic disease, 3) normal topographical findings with regular retinoscopic reflexes, 4) central corneal thickness >500 µm, 4) stable refraction for the last 2 years, 5) latent hypermetropia (if any) <2 D, 6) registered near and distance deviation in PD. Informed consent was obtained from all of the patients for refractive surgery procedures.

In cases of bilateral refractive surgery, the procedure was performed on both eyes on the same day with a goal of emmetropia. Corneal refractive surgery was performed under bupivacaine topical anesthesia. The devices used were a Schwind Amaris 750 laser (Schwind eye-tech-solutions GmbH & Co. KG, Kleinostheim, Germany) and VisuMax laser (Carl Zeiss Meditec AG, Jena, Germany). Topical fluorometholone, topical moxifloxacin, and artificial tears were prescribed for 10 days after the operation. All statistical analyses were performed using SPSS version 20 (SPSS Inc, Chicago, IL, USA). The mean values were standardized to within 1.0 standard deviation for all determined values. Statistically significant differences were determined using a paired t-test. Values were considered statistically significant if p was less than 0.05. Since there was a small number of cases with exophoria, statistical analyses of these patients were performed together with exotropia patients.

Results

Refractive surgery was performed on 19 eyes of 11 patients. Eight patients underwent bilateral surgery and 3 patients underwent unilateral refractive surgery. The mean age of the patients was 24.90±5.78 years. Of the group, 8 (72%) were male and 3 (28%) were female. The etiology of strabismus was esotropia (ET) in 4 (36%), exotropia (XT) in 5 (45%), and exophoria (XF) in 2 patients (18%). Small incision lenticule extraction (SMILE) was performed on 5 patients (45%) and femtosecond-assisted laser in situ keratomileusis (femto-LASIK) on 6 patients (55%). One patient (0.9%) had a history of strabismus surgery before the refractive procedure. Detailed demographic features of the patients are presented in Table 1.

The mean manifest refraction spherical equivalence was 3.29±2 D preoperatively and 0.37±0.75 D postoperatively in esotropic eyes (n=8). In exotropic eyes, the preoperative mean manifest refraction spherical equivalent was -2.98±4.74 D and -0.57±1.42 D postoperatively (n=10) In eyes with exophoria, (n=4) the mean manifest spherical equivalent was -3.53±0.79 D preoperatively and -0.28±0.35 D postoperatively. Four patients (2 patients with ET, 1 patient with XT, 1 patient with XF) had successful outcomes with <10 PD angle of deviation in both distance and near vision after the refractive surgery procedure.

The distance and near vision testing values and the preoperative and postoperative deviation measurements are shown in Table 1. There were no statistically significant differences between groups in terms of preoperative and postoperative values (Table 2) There were no significant changes in the preoperative and postoperative titmus stereoacuity test results in our patients, and no patients complained of diplopia in the postoperative period (Table 1).

Discussion

In 1983, Trokel et al. (11) presented excimer laser corneal refractive surgery for the first time and corneal refractive surgery became increasingly popular in the treatment of refractive errors. Patients with strabismus have a much more specific status as candidates for refractive surgery as the correction of the refractive error and removal of the prismatic effect of glasses on ocular alignment can have unpredictable effects on deviation values. Previous studies revealed that

Table 1. Demographic and clinical features of the patients (esotropia, exotropia, exophoria)

a. Preoperative

Patient No	Gender	Age	Previous strabismus surgery	Misalignment values (PD) (+glasses)	BCVA (Snellen)		Refractive surgery	MRSE (Diopter)		Stereoacuity
					Right	Left		Right	Left	
1	M	39	NO	N 14 ET D 10 ET	20/20	14/20	Bilateral	0.5	4.63	TITMUS -
2	M	21	NO	N 30 ET D 30 ET	18/20	18/20	Bilateral	4.25	5.5	TITMUS +
3	M	21	NO	N 12 ET D 6 ET	18/20	12/20	Unilateral	3.63	4.63	TITMUS +
4	M	21	YES	N 18 ET D 14 ET	20/20	20/20	Bilateral	3.25	3.25	TITMUS +
5	M	21	NO	N 30 XT D 40 XT	18/20	18/20	Bilateral	-4.5	-4.25	TITMUS +
6	M	22	NO	N 4 XT D 35 XT	18/20	18/20	Bilateral	-8.75	-5.5	TITMUS +
7	F	26	NO	N 10 XT D 18 XT	20/20	20/20	Bilateral	-7.5	-7	TITMUS +
8	M	20	NO	N 30 XT D 25 XT	14/20	10/20	Bilateral	-0.25	0.13	TITMUS +
9	M	23	NO	N 6 XT D 14 XT	20/20	4/20	Bilateral	1,5	6.25	TITMUS -
10	F	29	NO	N 16 XF D 14 XF	20/20	16/20	Bilateral	-2.62	-4.5	TITMUS +
11	F	31	NO	N 6 XF D 8 XF	18/20	16/20	Unilateral	-3.75	-3.25	TITMUS +

b. Postoperative third month

UCVA (Snellen chart)		MRSE		Misalignment values (PD)	Stereoacuity
Right	Left	Right	Left		
20/20	12/20	1.25	1	N 10 ET D 6 ET	TITMUS -
18/20	18/20	0.75	1	N 25 ET D20 ET	TITMUS +
18/20	12/20	1.38	0.38	N 0 D 0	TITMUS +
20/20	20/20	-1	0	N 14 ET D 10 ET	TITMUS +
18/20	18/20	-0.12	-0.12	N 20 XT D 30 XT	TITMUS +
16/20	16/20	-2.75	-1.75	N 0 D 30 XT	TITMUS +
20/20	20/20	-1.75	-1.5	N 14 XT D 20 XT	TITMUS +
14/20	10/20	-0.75	0	N 45 XT D 50 XT	TITMUS +
20/20	4/20	2	1	N 4 XT D 10 XT	TITMUS -
20/20	16/20	-0.37	0.25	N 16 XF D 12 XF	TITMUS +
18/20	16/20	-0.5	-0.5	N 4 XF D 4 XF	TITMUS +

BCVA: best corrected visual acuity; D: distance; ET: esotropia; EXT: exotropia; F: female; M: male; MRSE: manifest refraction spherical equivalent; N: near; PD: prism diopter; UCVA: uncorrected visual acuity; XF: exophoria.

Table 2. Preoperative and postoperative misalignment values

a. Patients with esotropia			
Esotropia (ET) (p=4)	**Preop ET**	**Postop 3d Month ET**	**p (n=4) (paired t-test)**
DISTANCE (PD)	15±9.73	12±7.78	0.164
NEAR (PD)	18.5±7.46	14.2±9.57	0.097
b. Patients with exotropia and exophoria			
Exophoria (n=2)/Exotropia (n=5) (XT) (n=7)	**Preop XT**	**Postop 3rd month XT**	**p (n=7) (paired t-test)**
DISTANCE (PD)	11±3.46	11±5.77	0.706
NEAR (PD)	8±4.61	10±6.92	0.837

ET: esotropia; Preop: preoperative; Postop: postoperative;
XT: exotropia+exophoria.

in particular, patients with accommodative esotropia benefit from refractive surgery, and it becomes possible to eliminate both refractive errors and misalignments at the same time in this group of patients. High hypermetropia can lead to increased convergence, and greater convergence can lead to esotropia, even though the fusional divergence amplitude is acceptable. The underlying reason for this cascade is hypermetropia. Correction of hypermetropia with refractive surgery disrupts this sequence and results in orthophoria or microesotropia (12). In our study, there were no patients with fully accommodative esotropia. All were classified as partially accommodative esotropia.

There are quite a number of case series in the literature related to these groups of patients. Hutchinson et al. (13) studied 40 patients with a preoperative deviation value of 18.6 PD (distance-near) esotropia who underwent photorefractive keratectomy surgery, and they reported orthophoria after a mean follow-up of 3.4 years. Hoyos et al. (12) reported outcomes of LASIK surgery used to treat refractive accommodative esotropia in 9 adults ranging in age from 18 to 38 years. Postoperatively, all of the patients were orthophoric without optical correction or maintained their eyeglasses-corrected pre-operative microesotropia. Shi et al. (14) performed LASEK and LASIK surgeries on 26 eyes of 13 patients with accommodative esotropia and amblyopia and reported that the preoperative 37.92±9.12 PD of deviation regressed to 2.76±2.8 PD after 6 months of postoperative follow-up. Sabetti et al. (15) observed that after excimer laser surgery, refractive errors substantially decreased accompanying the improvement in misalignment in 18 patients at the second year; however, this decrease was not statistically significant.

Studies in patients with partially accommodative or nonaccommodative esotropia have noted that there is usually a decrease in the degree of misalignment after refractive surgery, but not as dramatic as that seen in the accommodative group. Polat et al. (8) reported a decrease in deviation values in 5 patients with partially accommodative esotropia after LASIK surgery. Nemet et al. (2) also reported a slight decrease in the misalignment of eyes with partially accommodative esotropia and exotropia after a LASIK procedure.There are also studies with less encouraging results. Godts et al. (16) found no change in misalignment values in 42% of a groupu of 14 patients with partially accommodative or nonaccommodative esotropia who underwent LASIK surgery. In our study, we found a decrease in the misalignment for both near and distance after corneal refractive surgery in our patient group with esotropia, but this decrease was not statistically significant (p=0.097, p=0.164, respectively) Furthermore there was no statistically significant difference in patients with exotropia or exophoria after refractive surgery (p=0.706, p=0.837, respectively). The postoperative distance and near deviation of 1 patient in the exotropia group increased.

In the literature, among these patients, those who are myopic with anisometropia benefit most from this procedure (2, 16). Alio et al. (17) and Singh (18) reported that excimer laser surgery can be valuable for pediatric amblyopic patients because of the positive effects on the prognosis of amblyopia. In our study, 1 patient in the exotropia group had bilateral myopia and anisometropia, and another patient in the same group had bilateral hypermetropia and anisometropia. Both of these patients had substantially decreased deviation values postoperatively. If corneal refractive surgery is considered in patients with misalignment, it is important to expect the patient to stabilize for accommodative and refractive aspects. In our clinical practice, we perform refractive surgery on patients aged 21 years or older and the average age of the patients included in our study was 24 years. However, there are also pediatric studies in the literature. For example, in a study of 30 eyes of 15 patients with a mean age of 13.9 years, patients with high hypermetropia and partially or complete accommodative esotropia underwent LASIK surgery. Seven patients developed inadequate correction and diplopia, but despite this, all of the patients were reported to have continued orthophoria at the postoperative 15th month (9).

Accurate evaluation of stereopsis is helpful in assessing the effects of treatment. Some authors have reported a change in stereopsis before and after surgery (19-21). In our study, no patient with preoperative stereopsis (titmus fly test) lost stereopsis postoperatively.

Another problem of refractive surgeries performed on strabismic patients is postoperative diplopia. This condition can be due to deterioration of binocularity after refractive

surgery, myopic hypercorrection, residual hypermetropia, and visual instability as a result of change in dominance (22). In our study, no diplopia developed in any of the patients. Only 2 patients had unilateral refractive surgery and they had successful outcomes with <10 PD angle of deviation postoperatively. It should be emphasized that any refractive surgery on a single eye can cause a disparity between the 2 eyes and may result in impairment of fusion, leading to strabismus (23). Our patients who underwent unilateral surgery had no problems postoperatively.

The limitations of our study are the number of patients and the length of follow-up. Further studies with larger patient groups and longer follow-up will give more precise results.

In conclusion, we found that keratorefractive surgery alone is not effective to provide orthophoria for patients with partially accommodative esotropia or exotropia. A detailed preoperative orthoptic examination should be performed and the patient should be informed about the possibility of misalignment after refractive surgery to prevent unrealistic expectations.

Disclosures

Acknowledgement: This study was presented as an oral presentation at the Turkish Ophthalmology Foundation 51st National Congress (October 24-29, 2017).

Peer-review: Externally peer-reviewed.

Conflict of Interest: None declared.

Authorship Contributions: Involved in design and conduct of the study (BKY, EDA, YY, MGU); preparation and review of the study (BKY, AA, BG, AD); data collection (NKB, EDA, CG, MGU); and statistical analysis (BKY, KF, CG).

References

1. Bilgihan K, Akata F, Or M, Hasanreisoğlu B. Photorefractive keratectomy in refractive accommodative esotropia. Eye (Lond) 1997;11:409–10. [CrossRef]
2. Nemet P, Levenger S, Nemet A. Refractive surgery for refractive errors which cause strabismus. A report of 8 cases. Binocul Vis Strabismus Q 2002;17:187–90.
3. Nucci P, Serafino M, Hutchinson AK. Photorefractive keratectomy for the treatment of purely refractive accommodative esotropia. J Cataract Refract Surg 2003;29:889–94. [CrossRef]
4. Marmer RH. Ocular deviation induced by radial keratotomy. Ann Ophthalmol 1987;19:451–2.
5. Kushner BJ, Kowal L. Diplopia after refractive surgery: occurrence and prevention. Arch Ophthalmol 2003;121:315–21.
6. Godts D, Tassignon MJ, Gobin L. Binocular vision impairment after refractive surgery. J Cataract Refract Surg 2004;30:101–9.
7. Minnal VR, Rosenberg JB. Refractive surgery: a treatment for and a cause of strabismus. Curr Opin Ophthalmol 2011;22:222–5.
8. Polat S, Can C, Ilhan B, Mutluay AH, Zilelioğlu O. Laser in situ keratomileusis for treatment of fully or partially refractive accommodative esotropia. Eur J Ophthalmol 2009;19:733–7.
9. Phillips CB, Prager TC, McClellan G, Mintz-Hittner HA. Laser in situ keratomileusis for high hyperopia in awake, autofixating pediatric and adolescent patients with fully or partially accommodative esotropia. J Cataract Refract Surg 2004;30:2124–9.
10. Kirwan C, O'Keefe M, O'Mullane GM, Sheehan C. Refractive surgery in patients with accommodative and non-accommodative strabismus: 1-year prospective follow-up. Br J Ophthalmol 2010;94:898–902. [CrossRef]
11. Trokel SL, Srinivasan R, Braren B. Excimer laser surgery of the cornea. Am J Ophthalmol 1983;96:710–5 [CrossRef]
12. Hoyos JE, Cigales M, Hoyos-Chacón J, Ferrer J, Maldonado-Bas A. Hyperopic laser in situ keratomileusis for refractive accommodative esotropia. J Cataract Refract Surg 2002;28:1522–9.
13. Hutchinson AK, Serafino M, Nucci P. Photorefractive keratectomy for the treatment of purely refractive accommodative esotropia: 6 years' experience. Br J Ophthalmol 2010;94:236–40.
14. Shi M, Jiang H, Niu X, Dai H, Ye Y. Hyperopic corneal refractive surgery in patients with accommodative esotropia and amblyopia. J AAPOS 2014;18:316–20. [CrossRef]
15. Sabetti L, Spadea L, D'Alessandri L, Balestrazzi E. Photorefractive keratectomy and laser in situ keratomileusis in refractive accommodative esotropia. J Cataract Refract Surg 2005;31:1899–903. [CrossRef]
16. Godts D, Trau R, Tassignon MJ. Effect of refractive surgery on binocular vision and ocular alignment in patients with manifest or intermittent strabismus. Br J Ophthalmol 2006;90:1410–3.
17. Alió JL, Artola A, Claramonte P, Ayala MJ, Chipont E. Photorefractive keratectomy for pediatric myopic anisometropia. J Cataract Refract Surg 1998;24:327–30. [CrossRef]
18. Singh D. Photorefractive keratectomy in pediatric patients. J Cataract Refract Surg 1995;21:630–2. [CrossRef]
19. Stidham DB, Borissova O, Borissov V, Prager TC. Effect of hyperopic laser in situ keratomileusis on ocular alignment and stereopsis in patients with accommodative esotropia. Ophthalmology 2002;109:1148–53. [CrossRef]
20. Magli A, Iovine A, Gagliardi V, Fimiani F, Nucci P. LASIK and PRK in refractive accommodative esotropia: a retrospective study on 20 adolescent and adult patients. Eur J Ophthalmol 2009;1:188–95.
21. Nucci P, Serafino M, Hutchinson AK. Photorefractive keratectomy followed by strabismus surgery for the treatment of partly accommodative esotropia. J AAPOS 2004;8:555–9. [CrossRef]
22. Gómez de Liaño-Sánchez R, Borrego-Hernando R, Franco-Iglesias G, Gómez de Liaño-Sánchez P, Arias-Puente A. Strabismus and diplopia after refractive surgery [Article in Spanish]. Arch Soc Esp Oftalmol 2012;87:363–7.
23. Kim SK, Lee JB, Han SH, Kim EK. Ocular deviation after unilateral laser in situ keratomileusis. Yonsei Med J 2000;41:404–6.