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Static and dynamic cyclotorsion measurement and evaluation of related factors in patients candidates for PRK

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ABSTRACT

To evaluate the degree of static and dynamic cyclotorsion and related factors in patients candidate for photorefractive keratectomy. In this analytic-descriptive study, 400 patients (aged 18-55 years) who were candidates for photorefractive keratectomy with laser excimer (zyoptix 100 HZ) by a single ophthalmologist in Khatam-al-Anbia Hospital were enrolled. The patients' age, sex, myopic and astigmatism degrees and static and dynamic cyclotorsion degree were measured and registered. Finally, the data was analyzed statistically. 73% of patients (n=146) were female and the mean age of all patients was 29.8±5.7 years (19-49). The mean preoperative sphere and cylinder degree of patients was -3.24±1.72 and -1.06±1.04, respectively. The mean spheric equivalent (SE) was -3.78±1.69, the mean total static excyclotorsion and incyclotorsion were 3.81±2.65 (48.5%) and -2.99±2.13 (27.8%), respectively and 23.8% had no static cyclotorsion. The mean dynamic excyclotorsion and incyclotorsion were 3.66±2.65 (65.8%) and -2.62±2.13 (27.5%), respectively, and 23% had no dynamic cyclotorsion. There was no significant relationship between static or dynamic cyclotorsion and age and no significant relationship between static cyclotorsion and sex, but women showed higher degrees of dynamic cyclotorsion (P=0.04). Also, sphere and cylinder degree had no significant relationship with cyclotorsion, however, there was a linear significant correlation between static and dynamic cyclotorsion (p=0.05). The amount of dynamic cyclotorsions during photorefractive keratectomy is higher in female and correlate straight with static cyclotorsions.

Keywords: Astigmatism, myopia, photo refractive keratectomy (PRK),cyclotorsion.

INTRODUCTION

Measurement of torsional eye movement is important for perfect outcome of excimer laser refractive surgery, because torsional eye movement causes under correction of astigmatism, so that 15 degrees deviation from correct axis of astigmatism causes 50% decrease in the amount of astigmatism correction [6]. Even cyclotorsion during laser ablation may induce astigmatism postoperatively [7]. Also, theoretical modeling shows that as the axis error increases, there is concomitant under correction of astigmatism or induced astigmatism .The residual astigmatism can be calculated using the formula: C = 2F × sin a, where C is the residual astigmatism, F is the original astigmatic power in diopter, and a is the amount of axis misalignment [8].

The amount of torsional eye movement when imaging is performed in sitting position is different from the supine position in which excimer laser is applied and is called static cyclotortion. On the other hand, even during laser application there is torsional eye movement which is called dynamic cyclotorsion.

This torsional compensation is imperative in eyes having laser ablation for high astigmatism specially in those having wavefront and topography-guided profile for the treatment of HOAs.

To detect and compensate this cyclotorsional eye movement, most excimer laser systems incorporate static iris-registration eye trackers; however, because continuous cyclotorsions exist during laser ablation, dynamic rotational eye tracker enables greater precision in excimer laser ablation delivery [9].

The most modern systems are based on iris recognition systems. The image of the iris is acquired and digitized during preoperative examinations (wave front analysis) with the patient seated. The image is transferred to the laser via a computer, and treatment can then be carried out with the patient horizontal, while considering the position of each impact calculated during the preoperative examination [10].

A literature review shows that some studies evaluate the amount of cyclotorsion in laser refractive surgery, but there few studies on factors affecting this cyclotorsional movement.

In this study, we measured static and dynamic cyclotorsions and evaluated related factor in myopic patients undergoing PRK.

MATERIALS AND METHODS

This was an analytic-descriptive prospective study on 400 myopic eye candidates for PRK with excimer laser zyoptix-100Hz in Khatam-al-Anbia Eye Hospital of Mashhad University of Medical Sciences. Informed written consent was obtained from all patients before laser surgery.

Preoperative examination included: slit lump examination, manifest and cycloplegic refraction, applanation tonometry, and dilated fundus exam. Corneal topography with (TOMY TMS-4) performed. Corneal tomography and wave front measurements were performed in seated position using the (Orbscan IIz ,Tecnolas Gmbh), (Zywave II, Tecnolas Gmbh-) respectively. For all patients the amount of cyclotorsion during the surgical procedure in supine position was measured by iris registration system of Zyoptix 217 Z100 excimer laser. The difference between preoperative measurement in seated position with the supine position showed the amount of cyclotorsion.

The inclusion criterion was being aged 18-55 years, myopia less than -10 D, astigmatism less than -5 D, and stable refraction for at least one year.

Exclusion criteria included: Corneal opacity due to long term contact lens usage, history of ocular problems such as tear disturbance, corneal dystrophy, keratoconus, unstable refraction, cataract, glucoma. Patients with systemic diseases such as autoimmune disease, collagen vascular, diabetes, pregnancy and lactation, history of isotritinoin use during the last 6 months, and any other contraindication for PRK also excluded.

All surgeries were performed by one experienced surgeon with Technolas217z (Bausch & Lomb) flying spot excimer laser with 193 nm wavelength, pulse repetition rate of 100 Hz and laser spot diameter of 1-2 mm. Data analysis was performed by SPSS 20. For description of data, suitable statistical indices such as mean were used.

In statistical analysis, first the normality of data was evaluated with Kolmogorov-Smirnov test with Lilliefors correction and then suitable parametric methods such as student's T-test and ANOVA were used. If the data were not normal, Mann-Whitney and Kruskal- Wallis tests were used. Also, Pearson Chi-Square test was used for analysis of data with numerical scale. For the analysis of correlation between quantitative variable due to abnormality of data, Pearson correlation test used. Statistical level of significance was set at 0.05.

RESULTS

In this prospective study, 400 eyes of 200 patients were enrolled. Of these, 54 (27%) were male and 146 (73%) were female. The age of the patient ranged between 19-49 years with an average of 29.8 (5.7) years. Moreover, 95.8% of eyes had myopia of -0.25 to -10 D with a mean of -3.39 (1.61) and 4.3% had no myopia.

Also, 84.5% of the eyes had astigmatism of -0.2 D to -5 D with a mean of -1.26 D (1.017). Additionally, 62 eyes (15.5%) had no stigmatism. Because some patients had myopia or astigmatism alone, spherical equivalent for the study group was calculated which was -0.5 D to -10 D with a mean of -3.78(1.69) (Table 1).

Table 1. Baseline measurement of the study group

	Right eye	left
Mean myopia	- 3.4D	-3.37D
Mean astigmatism	-1.2D	-1.29D
Totally spherical equivalent	-3.78D	- 3.78D
Static excyclotorsion(mean)	3.73 ˚	3.9˚
Static incyclotorsion (mean)	- 2.64 ˚	-3.28˚
Dynamic excyclotorsion (mean)	3.39˚	3.93˚
Dynamic incyclotorsion (maen)	- 2.47˚	- 2.8˚
Static cyclotorsion<5˚	86%	83.5%
Static cyclotorsion 5-9.9 ˚	13%	14%
Static cyclotorsion >10˚	1%	2.5%
Dynamic cyclotorsion<5˚	81.5%	76%
Dynamic cyclotorsion 5-9.9˚	16%	19.5%
Dynamic cyclotorsion≥ 10˚	2.5%	4.5%

To evaluate the relation between age and cyclotorsions, the study group was divided into three age groups, but there was no statistically significant relationship between static and dynamic cyclotorsion and age (P=0.52 and P=0.41), respectively.(Table 2)

Table 2. Correlation of age with static and dynamic cyclotorsion

P-value	Test type	S.D	mean	max	min	number	age	cyclotorsion
		2.72091	2.7298	12.7	0	242	19-30	
0.52		2.55328	2.5299	12.7	0	134	31-40	
		2.55169	3.0625	7.00	0	24	> 40	static
		2.65292	2.6828	12.7	0	400	Total	
	Kruskal wallis	2.87509	3.2054	12.9	0	242	19-30	
		2.88185	2.9373	12.6	0	134	31-40	dynamic
0.41		3.23660	3.4417	9.2	0	24	>40	
		2.89600	3.1298	12.9	0	400	Total	

An evaluation of sex and static and dynamic cyclotorsions showed no statistically significant relationship with static cyclotorsions (P=0.74), but a significant relation with dynamic cycotorsions (P=0.04), so that the mean of dynamic cyclotorsions in females was statistically more significant than males.(Table 3)

Table 3. Correlation between sex and static and dynamic cyclotorsion

P-value	Test	S.D	mean	max	min	number	Sex	cyclotorsion
0.74		2.76537	2.7759	12.7	0	108	male	static
	Mann-Whitney	2.61414	2.6483	12	0	292	female	
		2.96946	2.8231	11.6	0	108	male	dynamic
0.04		2.86521	3.2432	12.9	0	292	female	

The scatter plot showed no linear correlation between the amount of myopia and static and dynamic cyclotorsions, so that the Spearman correlation coefficient was 0.06 (P=0.2) and 0.09 (P=0.056), respectively. In addition, there was no linear correlation between the amount of astigmatism and static and dynamic cyclotorsions, Spearman correlation coefficient was 0.08 (P=0.1) and 0.009 (P=0.8), respectively.

There was a linear correlation between true and absolute amounts of static and dynamic cyclotorsions with Spearman correlation test, so that the correlation coefficient was 0.8 (P-value<0.001) and 0.68 (p-value<0.001), respectively.

This correlation separately evaluated for each eye and results showed this correlation for both right and left eye with correlation coefficient 0.76 (p-value<0.001) and 0.6(p-value<0.001) respectively.

DISCUSSION

With regard to the effect of cyclotorsional eye movement on the outcome of laser refractive surgery and new development in torsional movement measurement with iris registration system and dynamic eye-tracker and few epidemiologic information about static and dynamic cyclotorsion, in this study we measured static which means cyclotorsion in sitting position and dynamic which means cyclotorsion in supine position of the eyes and related factors in myopic patients and astigmatism patients who were candidates for PRK.

In our study, dynamic excyclotorsions were more than static excyclotorsions, but most of the patients had less than 5˚ cyclotorsions and dynamic and static incyclotorsions were similar.

In a similar study, in comparison to our study, the prevalence of dynamic cyclotorsion was lower, but clinically significant dynamic cyclotorsion (more than 2˚) was observed in 36.5% of the patients [11].

In another study, the amount of excyclotorsion was similar to our study, but it was a little more than our results [12]. However, because in our study the limit was 5˚, no comparison can be made. On the other hand racial factors may influence on changes between static and dynamic cyclotorsions. In another study, the amount of static and dynamic cyclotorsions was very close to our results [13]. In overall, literature review showed results similar to our study.

For the evaluation of correlation between static and dynamic cyclotorsion and the age of patients, the study group was divided into three groups, but no significant correlation was observed. Nonetheless, in evaluation of the correlation between sex and cyclotorsion, although the amount of static cyclotorsion showed no significant difference, but the mean of dynamic cyclotorsion in females was statistically significant (P=0.04) and higher than the males.

This difference may be due to higher stress and anxiety in females and the probability of weakness of extraocular muscle in them.

In another study, the factors affecting static and dynamic cyclotorsions were evaluated and age, sex, and duration of operation had significant correlation with dynamic cyclotorsion [14] .probably because longer duration of treatment may lead to fixation losses and resultant cyclotorsional movement. Although age was a significantly correlated factor, the correlation was not very strong ,this may shows that age is only one of the factors which determining the level of cooperation.

Between the amount of myopia and astigmatism with dynamic and static cyclotorsions, no correlation was found, yet, a statistically significant correlation between both absolute and true amounts of static and dynamic cyclotorsion was observed (p=0.001). In other words, an increase in one induced an increase in the other and this relation was linear. The only similar study evaluating this correlation showed results contrary to our study with no significant correlation between static and dynamic cyclotorsion (13).This difference may be due to higher sample size in our study (n=400) in comparison to that study (n=74). In addition because the cooperative patients want to fixate the red beam, the amount of cyclotorsional movement during laser ablation is similar to preablation cyclodeviasion.

CONCLUSION

Therefore, regarding that cyclotorsional eye movement during PRK causes under correction and even induction of new refractive error, the need for mobilization of all center to iris registration system and dynamic eye tracker has special importance. Because the static and dynamic cyclotorsion relationship was performed in few studies and our results showed a linear relationship between them, more studies are required for the evaluation of this correlation and probable factors affecting the results of them. In addition, with regard to higher incidence of dynamic

cyclotorsion in females, it is suggested that in future studies the relation between genetic and hormonal factors and cyclotorsions be evaluated. Finally, because ignoring the fact that the amount of cyclotorsion induces astigmatism in high amounts may be the cause of patients dissatisfaction with complain of blurred vision, it is suggested that in all patients with more than 5˚ static cyclotorsion, active eye tracker for control of dynamic torsion be considered during surgery.

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