Multivariate correlation analysis of eye cyclotorsion degree in corneal refractive surgery

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Abstract

- **AIM:** To explore the correlation between eye cyclotorsion degrees and patient’s age, gender, dioptr and other factors in corneal refractive surgery.
- **METHODS:** A total of 762 wavefront-guided LASIK patients with 1524 eyes were retrospectively analyzed from January 2010 to December 2013 in our hospital. Iris recognition was accomplished successfully and eye cyclotorsion degrees were recorded intraoperatively for all the patients. The correlations between eye cyclotorsion degrees and patient’s age, gender, different eye, dioptr and the dominant eye or not were statistically analyzed. In which correlation analysis was used to analyze the relationship between eye cyclotorsion degrees and age and dioptr, while the correlations with gender, different eye and the dominant eye or not were analyzed using t-test.
- **RESULTS:** The eye cyclotorsion degrees of patients were 0 to 9.7 degrees with an average of 3.08 ± 2.22 degrees. Amongst the average cyclotorsion of 444 men with 888 eyes were 3.05 ± 2.26 degrees, 318 women with 638 eyes were 3.12 ± 2.15 degrees and there were no significant differences (t = 1.095, P = 0.168). The average age of all the patients was 22.6 ± 5.4 years. No significant correlation was found between cyclotorsion degrees and age (r = 0.012, P = 0.478). The mean spherical equivalent was 4.76 ± 1.77 degrees, and there was no significant correlation between the eye cyclotorsion degrees and spherical equivalent (r = 0.017, P = 0.833). The mean cylinder was — 0.60 ± 0.64 degrees of no significant correlation with eye cyclotorsion degrees (r = 0.004, P = 0.910). The cyclotorsion of dominant eyes of all the patients was 3.0 ± 2.17 degrees, and the non–dominant eyes were 3.11 ± 2.12 degrees. No significant differences were found (t = 0.521, P = 0.603).
- **CONCLUSION:** The eye cyclotorsion degrees occurred in LASIK surgery had no correlation with age, gender, different eye, dioptr and the dominant eye or not.
- **KEYWORDS:** correlation; cyclotorsion; refractive surgery

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INTRODUCTION

When a person moves from the seated to supine position, the eyeballs will rotate in vary degrees. This is caused by vestibular system and exposure of eye cyclotorsion with...
external cyclotorsion based, which is consistent with Bell’s phenomenon.\(^{1,2}\)

A number of studies have found that LASIK surgery exists slow drift and eye cyclotorsion; Changes of body position ( check when sitting to the operation of the supine) can cause eyeball mild to moderate rotation, mainly for external rotation, and 68% of patients with above 2 degree rotation, and 2 degrees above the eye cyclotorsion can cause significant postoperative order aberration\(^ {12}\). With the development of LASIK surgery, the effect of eye cyclotorsion on postoperatively visual quality is growing concern\(^ {13,4}\).

According to the reports, eyes would rotate 0 – 14 degrees during LASIK surgery\(^{9-11}\). However, it has not been reported if there was any regularity in eye cyclotorsion. Thus, we have observed the correlations between eye cyclotorsion degrees and patient’s age, gender, diopter and other factors in corneal refractive surgery.

SUBJECTS AND METHODS

Subjects A total of 1524 eyes in 762 patients with myopic astigmatism of complete data were treated with LASIK using an iris recognition system or femtosecond laser flaps at our hospital from January 2010 to December 2013 were enrolled. There were 444 males with 888 eyes and 318 females with 636 eyes. Their ages were ranged from 18 to 32y with a mean age of 22.6±5.4y. The mean spherical equivalent was -4.76±1.77 degrees and the mean cylinder was -0.60±0.64 degrees. Informed consent was obtained from all patients after the nature of the procedure had been fully explained. Data collection confirmed to all local laws and was conducted according to the principles of the Declaration of Helsinki.

Methods Preoperative examination Preoperative examination items included slit lamp, direct and indirect fundoscopy, comprehensive optometry, noncontact intraocular pressure, ultrasonic corneal pachymeter, anterior eye segment examination by Pentacam and iris recognition and wavefront aberration evaluation with WaveScan WaveFront System of AMO\(^ {12}\).

Operative method VISX STAR S4 was used for LASIK. The operative methods were; microkeratome of Franch Moria One Use-Plus SBK or femtosecond laser of FEMTO LDV from Swiss Ziener Company were used to make corneal flap. The flap thickness was 110mm with a diameter of 8.5–10.0mm. The effective optical area was 6.0–7.0mm ( exclude transition zone ), and the thickness of preoperative designed residual corneal stromal bed was not less than 280μm. After making corneal flap during the operation, dimming the light of operation system to make sure that the pupil size of the patient was proximity to the size of pupil before Wave–Front Sensing, starting eyetracing system and iris registration to measure and record the movement of eye, laser cutting was used after iris registration\(^ {13}\).

Statistical Analysis SPSS 19.0 statistical software was used for statistical analysis. Correlation analysis was used to analyze the relationship between eye cyclotorsion degrees and age, spherical equivalent and cylinder, while the correlations with gender and dominant eye or not were analyzed using t-test. P<0.05 was considered statistically significant.

RESULTS Iris recognition was successfully completed during the surgery for all the patients. Eye cyclotorsion degrees ranged from 0 to 9.7 degrees ( absolute value ) with an average of 3.08±2.22 degrees. The mean cyclotorsion degrees of 888 eyes in 444 males was 3.05±2.26 degrees and it was 3.12±2.15 degrees in 636 eyes of 318 females. There were no statistically significant difference ( t=1.905, P=0.168 ). The mean eye cyclotorsion of all right eye was 3.20±2.24 degrees, and 3.00±2.21 degrees for all the left eyes. No significant difference was found ( t=1.234, P=0.218 ).

Patients aged from 18 to 32y with a mean age of 22.6±5.4y. No significant correlation was found between age and eye cyclotorsion degrees by correlation analysis ( r=−0.012, P=0.748 ). The spherical equivalent was 0 to −10.25 degrees with an average of −4.76±1.77 degrees, and there was no significant correlation with eye cyclotorsion degree ( r = 0.017, P = 0.633 ). The cylinder was 0 to −3.75 degrees with an average of −0.60±0.64 degrees, and no significant correlation with eye cyclotorsion was found ( r =−0.004, P = 0.910 ). The cyclotorsion of dominant eyes were 3.0±2.17 degrees, and non–dominant eyes were 3.11±2.12 degrees. No significant differences were found ( t=−0.521, P=0.603 ).

DISCUSSION With LASIK surgery getting more popular, the complaints about postoperative glare, monocular diplopia, decreased night vision and other visual qualities are increasing in recent years. The effect of intraoperative eye cyclotorsion has a growing concern by scholars. Eye cyclotorsion will change astigmatic axis which, if not corrected and compensated, will affect the accuracy of laser treatment. For greater degrees of astigmatism, such cyclotorsion can result in a greater deviation\(^ {14}\). Venter\(^ {15}\) studied 48 eyes of 24 patients who underwent LASIK treating one eye with active cyclotorsion error correction ( TEC eyes ) and the fellow eye without active cyclotorsion error correction ( without TEC eyes ), and found that TEC eyes had statistically significant lower postoperative cylinder and lower higher order aberration. As early as 1994, two different methods were applied for patients undergoing refractive surgery in different positions to measure the eye cyclotorsion by Smith et al\(^ {16}\), and he suggested that eye cyclotorsion degrees varied with different measurements. With advances in technology, especially in March 2005, after the FDA approved the iris recognition technology used in the wavefront guided surgery ( CustomVueTM system ) of VISX Company, there was a more accurate measurement for eye cyclotorsion degrees.

The theory of this iris recognition technology is to take iris images through wavefront aberration measurement before surgery. The computer automatically identifies those areas with characteristics for quantitative analysis, matches and compares with the iris images in excimer laser equipment during the surgery and calculates the eye cyclotorsion degrees. The laser machine will automatically adjust scanning lenses to
compensate the physiological eye cyclotorsion caused by postural changes[17]. We observed 1524 eyes through this device and found that the eye cyclotorsion ranged from 0 to 9.7 degrees, which is consistent with other research results[18–20].

According to our statistic data, not all the patients had significant cyclotorsion, and the cyclotorsion degree of 0 is not uncommon. Then is there any regularity in eye cyclotorsion during LASIK surgery, and whether age, gender, diopter and other factors will affect the refractive eye degree cyclotorsion?[19]

If there are correlations, for those who do not rotate the eyeballs during the surgery may do not need iris recognition, which can lessen their surgical time and financial burden, and the following patients with eye cyclotorsion should undergo iris recognition procedure. For this purpose, we studied the correlations between eye cyclotorsion degrees and age, gender, diopter and the dominant or not during LASIK surgery.

We compared different gender and the dominant eye or not with eye cyclotorsion degrees and found that there were no significant differences. While in 2010, Xia et al[21] had studied the eye cyclotorsion in 20 eyes of 60 cases and found that the average cyclotorsion of the right eyes was 4.60°±3.04°, while the average cyclotorsion of the left eyes was 3.25°±2.49°. The cyclotorsion degrees of right eyes were significantly greater than left eyes with statistical difference. And Liu et al[22] had also proved that the eye cyclotorsion degrees of two eyes in 93 patients were different. In our study, the cyclotorsion degrees of the right eyes were slightly greater than the left, but with no statistical difference, which is contrary to the two findings above. Because of the less number of samples (no more than 100 patients) in these two studies, we considered our research results more reliable with more than 700 cases. Of course, in order to get more accurate conclusions, it is necessary to study larger samples.

We analyzed the correlation between ages and eye cyclotorsion degrees and found that the eye cyclotorsion degrees did not vary with increasing age. There was also no significant difference in eye cyclotorsion for patients with different spherical equivalent and cylinder. These studies are currently unable to retrieve, especially the studies related to cylinder and eye cyclotorsion are more important. In clinic, we decide if patients need iris recognition procedure based on their degrees of astigmatism when recommend surgical approaches. In this study, we found that even lower preoperative astigmatism, eye cyclotorsion may also occur during the surgery. New astigmatism can generate without iris recognition. Through this research, we conclude that eye cyclotorsion in eye refractive surgery is completely random, there is no law at all. In order to avoid a decline of postoperative visual quality caused by cutting errors because of the eye cyclotorsion, we recommend an iris recognition procedure for every surgical patient if possible.

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