· Original article ·

Multivariate correlation analysis of eye cyclotorsion degree in corneal refractive surgery

Xiao-Guang Niu, Man Xu, Xiao-Yang He

Hankou Aier Ophthalmology Hospital, Wuhan 430030, Hubei Province, China

Correspondence to: Xiao – Guang Niu. Hankou Aier Ophthalmology Hospital, Wuhan 430030, Hubei Province, China. 13476186008@163.com

角膜屈光手术中眼球旋转程度的多因素相关分析

牛晓光,徐　曼,何小阳

(作者单位:430030 中国湖北省武汉市,武汉爱尔眼科医院)
作者简介:牛晓光,毕业于山东省眼科研究所,硕士,副主任医师 研究方向:眼表疾病及屈光手术。
通讯作者:何小阳,毕业于咸宁医学院,硕士,住院医师 研究方向:屈光不正的治疗. 419987821@qq.com

摘要

目的:观察角膜屈光手术中眼球旋转程度与患者年龄、性别、屈光度等因素是否存在相关性。

方法:回顾性分析 2010-01/2013-12 来我院进行波前像差引导的 LASIK 手术患者 762 例 1524 眼。所有患者术中均顺利完成虹膜识别并记录眼球旋转的角度。将眼球旋转角度与患者年龄、性别、眼别、屈光度以及是否主视眼进行统计学分析。其中对眼球旋转角度与年龄和屈光度的关系分别进行相关分析,而与性别、眼别和是否主视眼的关系则分别进行 t 检验。

结果:患者眼球旋转角度为 0 ~ 9.7 度,平均 3.08±2.22 度。其中男性 444 例 888 眼,平均旋转 3.05±2.26 度,女性 318 例 636 眼,平均旋转 3.12±2.15 度,两者之间比较差异无显著性($t=1.905,P=0.168$);患者平均年龄 22.6±5.4a,年龄与眼球旋转程度之间无明显相关性($r=-0.012,P=0.748$);平均球镜度数为 -4.76±1.77 度,与眼球旋转程度无明显相关性($r=0.017,P=0.633$);平均柱镜度数为 -0.60±0.64 度,与眼球旋转无明显相关性($r=-0.004,P=0.910$)。所有患者主视眼旋转 3.0±2.17,非主视眼为 3.11±2.12,两者之间差异无显著性($t=-0.521,P=0.603$)。

结论:准分子手术中发生眼球旋转的程度与年龄、性别、眼别、屈光度数及是否主视眼均无明显相关性。

关键词:相关性;眼球旋转;屈光手术

Abstract

• AIM: To explore the correlation between eye cyclotorsion degrees and patient's age, gender, diopter 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, diopter 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 diopter, 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 636 eyes were 3.12 ± 2.15 degrees and there were no significant differences ($t=1.905$, $P=0.168$). The average age of all the patients was 22.6 ± 5.4y. No significant correlation was found between cyclotorsion degrees and age ($r=-0.012$, $P=0.748$). The mean spherical equivalent was – 4.76 ± 1.77 degrees, and there was no significant correlation between the eye cyclotorsion degrees and spherical equivalent ($r = 0.017$, $P = 0.633$). 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, diopter and the dominant eye or not.

• KEYWORDS: correlation; cyclotorsion; refractive surgery

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[3]. With the development of LASIK surgery, the effect of eye cyclotorsion on postoperatively visual quality is growing concern[4-8].

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.

SUBEJCTS 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 examination 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 Ziemer 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? 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 in120 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.

REFERENCES

1 Hori-Komai Y, Sakai C, Toda I, Ito M, Yamamoto T, Tsubota K. Detection of cyclotorsional rotation during excimer laser ablation in LASIK. *J Refract Surg* 2007;23(9):911-915

2 Chang J. Cyclotorsion during laser in situ keratomileusis. *J Cataract Refract Surg* 2008;34(10):1720-1726

3 Ciccio AE, Durrie DS, Stahl JE, Schwendeman F. Ocular cyclotorsion during customized laser ablation. *J Refract Surg* 2005;21(6):S772-S774

4 Alio JL, Pachkoria K, El Aswad A, Plaza-Puche AB. Laser-assisted in situ keratomileusis in high mixed astigmatism with optimized, fast-repetition and cyclotorsion control excimer laser. *Am J Ophthalmol* 2013;155(5):829-836

5 Gauthier L. Astigmatism correction with Excimer laser. *J Fr Ophtalmol* 2012;35(3):206-211

6 Aslanides IM, Toliou G, Padroni S, Arba Mosquera S, Kolli S. The effect of static cyclotorsion compensation on refractive and visual outcomes using the Schwind Amaris laser platform for the correction of high astigmatism. *Cont Lens Anterior Eye* 2011;34(3):114-120

7 Fang L, Wang Y, He X. Theoretical analysis of wavefront aberration caused by treatment decentration and transition zone after custom myopic laser refractive surgery. *J Cataract Refract Surg* 2013;39(9):1336-1347

8 Jie LM, Wang Q, Zheng L. Clinical analysis of real-time iris recognition guided LASIK with femtosecond laser flap creation for myopic astigmatism. *Zhonghua Yan Ke Za Zhi* 2013;49(8):711-715

9 Narváez J, Brucks M, Zimmerman G, Bekendam P, Bacon G, Schmid K. Intraoperative cyclorotation and pupil centroid shift during LASIK and PRK. *J Refract Surg* 2012;28(5):353-357

10 Febbraro JL, Koch DD, Khan HN, Saad A, Gatinel D. Detection of static cyclotorsion and compensation for dynamic cyclotorsion in laser in situ keratomileusis. *J Cataract Refract Surg* 2010;36(10):1718-1723

11 Arba-Mosquera S, Arbelaez MC. Three-month clinical outcomes with static and dynamic cyclotorsion correction using the SCHWIND AMARIS. *Cornea* 2011;30(9):951-957

12 Park SH, Kim M, Joo CK. Measurement of pupil centroid shift and cyclotorsional displacement using iris registration. *Ophthalmologica* 2009;223(3):166-171

13 Wang TJ, Lin YH, Chang DC, Chou HC, Wang IJ. Comparison of the effects of cylindrical correction with and without iris recognition technology in wavefront laser-assisted in situ keratomileusis. *Clin Experiment Ophthalmol* 2012;40(3):239-246

14 Arba-Mosquera S, Merayo-Lloves J, de Ortueta D. Clinical effects of pure cyclotorsional errors during refractive surgery. *Invest Ophthalmol Vis Sci* 2008;49(11):4828-4836

15 Venter J. Outcomes of myopic LASIK with and without NIDEK active torsion error correction. *J Refract Surg* 2009;25(11):985-990

16 Smith EM Jr, Talamo JH, Assil KK, Petashnick DE. Comparison of astigmatic axis in the seated and supine positions. *J Refract Corneal Surg* 1994;10(6):615-620

17 Narayanswamy R, Johnson GE, Silveira PE, Wach HB. Extending the imaging volume for biometric iris recognition. *Appl Opt* 2005;44(5):701-712

18 Wang WQ, Cai HM, Li Z. Measurement of pupil displacement and ocular cyclotorsion using iris registration in LASIK. *Chinese Journal of Ocular Trauma and Occupational Eye Disease* 2012;34(6):427-430

19 Neuhann IM, Lege BA, Bauer M, Hassel JM, Hilger A, Neuhann TF. Static and dynamic cyclotorsional eye tracking during LASIK treatment of myopic astigmatism with the Zyoptix laser platform and Advanced Control Eye Tracker. *J Refract Surg* 2010;26(1):17-27

20 Lucena AR, Mota JA, Lucena DR, Ferreira Sde L, Andrade NL. Cyclotorsion measurement in laser refractive surgery. *Arq Bras Oftalmol* 2013;76(6):339-340

21 Xia LK, Zhou J, Zhou JZ, Gao DW. Effect of initiative corrected eyeball rota-tion in LASIK by iris localization on remnant degrees of astigmatism and higher-order aberrations in patients with myopic astigmatism. *Recent Advances in Ophthalmology* 2010;30(6):543-546

22 Liu YL, Yeh PT, Huang JY, Wang IJ, Chen WL, Hu FR, Hou YC. Pupil centroid shift and cyclotorsion in bilateral wavefront-guided laser refractive surgery and the correlation between both eyes. *J Formos Med Assoc* 2013;112(2):64-71