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Effects of steroid induced ocular hypertension on visual performance in post – LASIK patients: preliminary evidence

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激素性高眼压对 LASIK 术后患者视功能影响的初步研究

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摘要

目的:探讨激素敏感者 LASIK 术后早期出现的异常眼压波动对视功能的影响及其潜在机制。

方法:共 15 例 LASIK 术后发生激素性高眼压的患者纳入试验组并给予及时有效治疗,另 15 例未出现高眼压的 LASIK 术后患者纳入正常对照组。两组患者均嘱定期随访,随访期间所有患者的裸眼视力、对比敏感度、波前像差、角膜地形图等数据被采集用于对比分析。

结果:试验组:患者术后高眼压与术前相比,眼压波动幅度达 10.6±4.4mmHg(21.3~32.9mmHg);患者术后眼压正常时与术后高眼压时相比,裸眼视力、对比敏感度、波前像差、角膜地形图等数据均存在统计学差异。1)裸眼视力:术后眼压正常时优于术后高眼压时的裸眼视力($P<0.001$);2)对比敏感度:术后眼压正常时,患者在 3、6、12、18 c/d 各频率的对比敏感度均优于高眼压时的对比敏感度(均为 $P<0.05$);3)波前像差:术后眼压正常时与术后高眼压时相比,患者在总高阶像差、三叶草像差、球差等指标上存在统计学差异(均为 $P<0.05$);4)角膜地形图:术后眼压正常时与术后高眼压时相比,在 Q 值、后表面 Diff 值、角膜中央厚度等指标上存在统计学差异(均为 $P<0.05$)。对照组:随访期内,除角膜中央厚度随时间而增厚外,其它检测指标均无明显变化。

结论:LASIK 术后激素易感者发生的短期异常眼压波动可引起显著的视功能改变,而控制眼压波动则可明显改善患者的视觉表现。

关键词:眼压;裸眼远视力;对比敏感度;波前像差;角膜地形图

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Abstract

• AIM: To investigate the effect of intraocular pressure (IOP) fluctuations on the visual performance in steroid responders after laser *in situ* keratomileusis (LASIK).

• METHODS: Fifteen post-LASIK patients who underwent steroid-induced IOP fluctuations were enrolled as study group. And all received effective therapy when identified. Another 15 matched post-LASIK patients who used topical steroids for the same duration without developing hypertension were selected as control group. During the follow-up visits, uncorrected distant visual acuity (UDVA), photopic contrast sensitivity, wavefront aberrations, and corneal topography, were measured. These aimed at comparing the differences in postoperative changes between the groups.

• RESULTS: In study group, comparison of preoperative and postoperative IOP, the amplitude of abnormal IOP fluctuations reached 10.6±4.4mmHg (ranged from 21.3 to 32.9mmHg). Compared with postoperative ocular hypertension, statistics demonstrated significant changes such as UDVA, photopic contrast sensitivity, and wavefront aberrations, and corneal topography under the condition of normal tension. 1) UDVA: a significant difference was seen in UDVA between ocular hypertension and normal tension ($P<0.001$); 2) Contrast sensitivity: results showed significant differences in 3, 6, 12, and 18 cycles/degree of photopic contrast sensitivity (all $P<0.05$); 3) Wavefront aberrations: statistics indicated significant differences in higher order aberrations (HOA), trefoil and spherical aberration ($P<0.05$ for all); 4) Corneal topography parameters such as Q-value,

difference value (Diff-value) between the posterior corneal surface and the best fit sphere in the central region (Φ=6mm), and central corneal thickness (CCT) showed significant differences ($P<0.01$ for all). However, in control group, except for the increased CCT with time, no other significant changes were observed during the follow-up visits.

• CONCLUSION: Transient abnormal IOP fluctuations might induce remarkable optical and visual changes, and limiting the IOP fluctuations might improve the visual performance in steroid responders after LASIK.

• KEYWORDS: intraocular pressure; uncorrected distant visual acuity; contrast sensitivity; wavefront aberrations; corneal topography

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INTRODUCTION

Laser *in situ* keratomileusis (LASIK) is one of the most popular alternatives to spectacles for correcting refractive errors. Continuous innovations and incorporating new technology such as latest generation microkeratomes, femtosecond laser[1], and wavefront technology[2] to this field enabled the prosperity and progress of LASIK over the world. And clinical outcomes of LASIK also gained traction and studied amply. Among the vast majority of publications, postoperative outcomes and visual quality assessment, especially postoperative complications have drawn much attention[3,4].

Ocular hypertension is such a hot topic in this domain. Topical corticoid is routinely prescribed for corneal wound healing in early post-LASIK patients. However, it may induce elevation of intraocular pressure (IOP), and serious consequences in steroid-sensitive patients, such as steroid-induced lamellar keratitis[5], interface fluid syndrome[6], refractive regression[7], visual acuity loss[8], and even visual field defects[9]. Early recognition of these signs and symptoms, followed by proper treatment might be a brake to ocular hypertension and reverse deteriorating consequences.

Recently, IOP fluctuation and variation was highlighted as a risk factor for glaucoma progression[10,11]. However, the influence of abnormal IOP fluctuations on visual performance has received little attention[12]. And does it matter to steroid-sensitive patients who underwent LASIK surgery? To address this issue, we conduct this prospective study to get an insight into the effect of greater-than-normal IOP fluctuations on visual performance in steroid responders, and to compare these with those patients who did not have steroid induced ocular hypertension after refractive surgery.

SUBJECTS AND METHODS

In a single-blind, two sites, controlled cohort study, 15 consecutive post-LASIK patients diagnosed as steroid responders (postoperative IOP above 21 mm Hg and elevation of more than 5 mm Hg after treatment with steroids) in Center for Optometry and Visual Science were enrolled as study group. Another 15 matched post-LASIK patients who used topical steroids for the same duration without developing hypertension in Medal Eye Institute were recruited as control group. Patients with glaucoma or previous ocular surface diseases such as corneal injury or illness, ocular surgery, any sign of keratoconus, soft contact lens wear during the 2wk prior to presentation, and those who were pregnant were excluded. None of the 30 patients reported a history of systemic or ophthalmic diseases. Our study was performed with the approval of Institutional Review Board in the People's Hospital of Guangxi Zhuang Autonomous Region. All procedures were performed in accordance with the ethical standards of Declaration of Helsinki, and informed consent was obtained from all patients prior to the study.

Laser *in Situ* Keratomileusis Procedure LASIK surgery consisted of two major steps: flap creation and laser ablation. Flap diameters of 8.5 to 9.0 mm were created with Moria One use-Plus microkeratome (Moria, Antony, France) or IntraLase femtosecond laser (Abbott Medical Optics Inc., USA), and the optical zones ranged from 5.5 to 8.0 mm in diameter. All eyes underwent LASIK profiles (VISX, Santa Clara, CA, USA) using a VISX STAR S4 excimer laser (Abbott Medical Optics Inc., USA). Standard LASIK performed conventional ablation procedure, and wavefront-guided LASIK performed CustomVue™ procedure (CustomVue™ System, VISX, USA). All eyes had uneventful procedures.

Postoperative Management Routine postoperative management included topical application of 0.1% fluorometholone eye drops (Santen Pharmaceutical Co., Japan) 4 times a day for the first week, and then tapered one time a week for the following 3wk. Topical TobraDex® (tobramycin and dexamethasone ophthalmic suspension; Alcon Laboratories Inc., USA) was used 4 times a day and BioTears® (Alcon Laboratories, Inc., USA) twice daily for the first 7 postoperative days. After the first day's visit, all patients in both groups scheduled next two follow-up visits at post-1wk and 1mo. But patients identified with ocular hypertension had scheduled additional visit in 1wk and each of them had received immediate hypotension therapy, such as topical corticosteroids discontinued and topical 0.5% timolol maleate twice daily till to normal tension. In general, the final examination for both groups was performed at post-1mo, except for case 15 in study group at post-5wk.

Postoperative Outcomes Assessment Patients in control group were consecutively evaluated at postoperative 1wk and 1mo, and patients in study group were consecutively evaluated under the condition of ocular hypertension and normal tension at their final examination, respectively. UDVA, IOP, photopic contrast sensitivity, wavefront aberration, and corneal topography examinations were performed successively

Table 1 Baseline comparison between study and control groups in LASIK patients $n=30$

Parameters	Study group	Control group
Sex (M/F)	7/8	6/9
Age (a)	24.6±4.6	26.2±6.7
IOP (mmHg)	17.9±2.3	13.4±2.5[a]
SEQ (D)	−4.45±1.54	−5.19±1.55
CCT (μm)	545±28	549±26
Ablation depth (μm)	81±23	90±22
Custom *vs* conventional treatment	3/12	7/8

IOP: Intraocular pressure; SEQ: Spherical equivalent; CCT: Central corneal thickness. [a]Comparing with control group, the difference is significant ($P<0.01$).

for both groups. IOP was measured with Goldmann applanation tonometry (GAT) and then the corrected IOP was calculated according to the Ehlers method by taking into account the postoperative pachymetry (measured by ultrasonic pachymetry: model 200P, Sonomed, NY, USA) and the IOP measured with GAT[13]. Contrast sensitivity was measured using a CSV-1000E system (Vector Vision Co., Greenville, Ohio, USA). Wavefront aberration was obtained with WaveScan™ system (VISX, Santa Clara, CA, USA), and corneal topography was detected with Orbscan Ⅱz (Bausch & Lomb, Rochester, NY, USA) for study group and the Sirius topography system (CSO, Italy) for control group. Among the wavefront aberration and corneal topography records, only measurements with a high quality according to the manufacturer were included in the statistical analyses. To decrease the effect of diurnal fluctuation, all measurements were performed at the same time of the first examination dates during follow-up appointments. All instruments involved were the same except for corneal topography between the two sites.

Statistical Analysis Data were analyzed using SPSS 13.0 (SPSS Inc., Chicago, Illinois, USA). Sexual (male/female) and laser ablation procedure (custom *vs* conventional) ratio between the two groups were separately analyzed by Pearson Chi-square test for baseline comparison. Other parameters were compared by paired t-test. And $P<0.05$ was considered statistically significant.

RESULTS

BaselineComparison and Intraocular Pressure Fluctuations Preoperative baseline analysis showed comparability between the two groups except for mean IOP (Table 1). In study group, two eyes were excluded because one was in single eye operated patient and the other in unilateral ocular hypertension patient. And at the final examinations, all 28 hypertensive eyes recovered to normal tension, and 18 eyes of them gained 1 line and the other 10 eyes maintained stable (Table 2). Compared with preoperative value, the amplitude of postoperative abnormal IOP fluctuations in study group reached 10.6±4.4mmHg (IOP ranged 21.3-32.9mmHg) (Figure 1). In contrast, the control group presented slightly postoperative IOP fluctuations, and it was 12.7±2.2mmHg at post-1wk and 13.1±2.1mmHg at post-1mo, respectively.

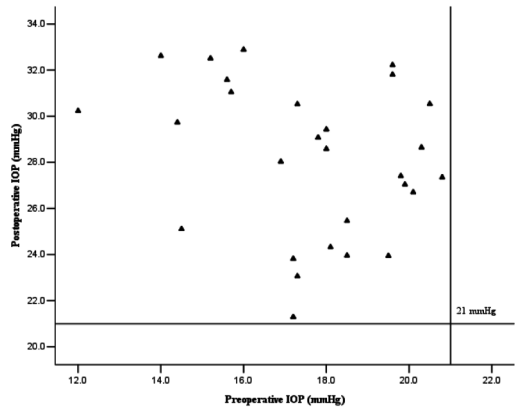

Figure 1 Steroid induced IOP elevation in post-LASIK patients in study group The black solid lines inside the graph represented 21mmHg and all IOP values were above 21mmHg after topical steroid eye drops.

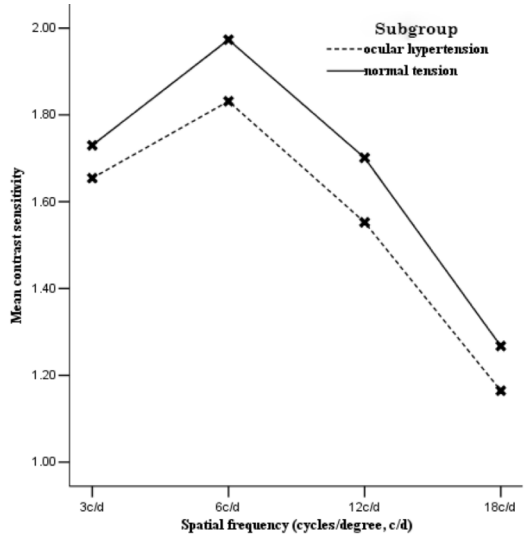

Figure 2 Effect of steroid induced IOP fluctuations on photopic contrast sensitivity in post-LASIK patients in study group This graph demonstrated better photopic contrast sensitivity at 3, 6, 12, 18 c/d in normal tension than in ocular hypertension.

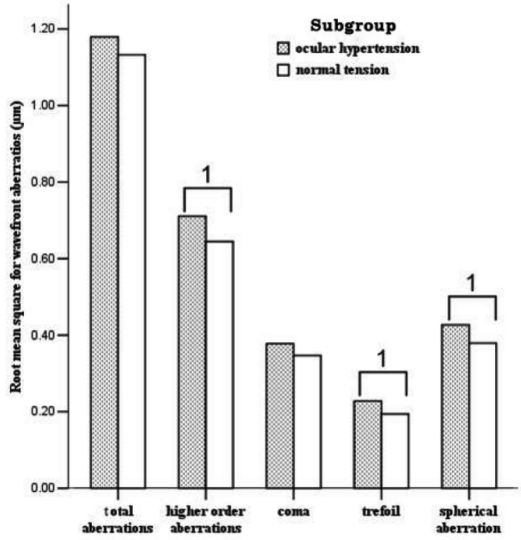

Figure 3 Effect of steroid induced IOP fluctuations on wavefront aberrations in post-LASIK patients in study group [1] Significant differences in HOA, trefoil and spherical aberration between ocular hypertension and normal tension in study group ($P<0.05$ for all).

Table 2 Clinical profiles for steroid responders before and after LASIK in the study group

No./sex/age (a)	Surgery	Exam date (d)	Preoperative		Postoperative		Finalexamination	
			SEQ/IOP	BCVA	DE/IOP	UDVA	DE/IOP	UDVA
1/M/22	SBK	7	−4.25/14.5	20/20	0.43/25.1	20/20	0.45/14.1	20/20
			−3.5/18.5	20/20	0.23/25.5	20/20	0.31/16.4	20/20
2/F/25	SBK	20	−5.75/19.5	20/20	1.27/23.9	20/16	1.16/15.6	20/12.5
			−4.88/20.3	20/20	1.79/28.6	20/16	1.49/13.8	20/12.5
3/F/23	SBK	12	−5.75/17.8	20/20	1.05/29.1	20/16	0.81/17.3	20/16
			−4/17.2	20/20	0.56/23.8	20/16	0.35/19.6	20/16
4/F/26	SBK	14	−4.63/16.9	20/20	0.79/28.0	20/16	0.17/12.2	20/12.5
			−4.38/18	20/20	0.43/28.6	20/16	0.12/11.4	20/12.5
5/F/21	WG-SBK	14	−5.75/20.5	20/20	0.5/30.5	20/16	0.38/18	20/16
			−6.75/19.9	20/20	0.77/27.0	20/20	0.23/18	20/16
6/M/22	SBK	10	−1.75/15.7	20/20	0.6/31.0	20/16	0.32/14.8	20/16
			−2.25/14.4	20/20	0.84/29.7	20/16	0.72/14.7	20/16
7/M/21	SBK	5	−0.75/18.5	20/20	0.32/24.0	20/16	0.26/19.5	20/12.5
			−1.25/16.6	20/20	0.59/18.0	20/16	0.51/20.4	20/16
8/F/31	SBK	7	−5.25/17.3	20/20	0.22/23.1	20/16	0.28/12.1	20/12.5
			−4/18.1	20/20	0.29/24.3	20/16	0.36/11.2	20/12.5
9/M/25	SBK	26	−3.5/12	20/20	0.61/30.2	20/16	1.09/18.4	20/12.5
			−3.25/14	20/20	1.07/32.6	20/16	1.38/16	20/12.5
10/M/23	SBK	7	−5.5/15.6	20/20	0.28/31.6	20/16	0.46/16.5	20/16
			−5.25/15.2	20/20	0.76/32.5	20/16	0.52/19.9	20/16
11//F/30	SBK	7	−5.75/18	20/20	0.04/29.4	20/16	1.2/14.4	20/16
			−4.63/19.6	20/20	0.25/32.2	20/16	0.11/17	20/16
12/F/27	SBK	7	−6.75/19.8	20/20	0.51/27.4	20/20	0.9/14.7	20/16
			−6.5/20.1	20/20	0.81/26.7	20/20	1/12	20/16
13/M/20	WG-SBK	7	−4.75/16	20/20	0.89/32.9	20/20	0.89/9.7	20/16
			−4.5/20.8	20/20	0.48/27.3	20/20	0.71/8.9	20/16
14/M/18	WG-SBK	7	−5.38/17.3	20/20	0.16/30.5	20/16	0.27/15.2	20/12.5
			−5.75/19.6	20/20	0.32/31.8	20/16	0.25/16.3	20/12.5
15/F/35	SBK	29	−4.25/20.3	20/20	1.03/16.3	20/20	0.88/15.1	20/16
			−3.00/17.2	20/20	0.09/21.3	20/20	0.17/15.3	20/16

SEQ: Spherical equivalent; IOP: Intraocular pressure; BCVA: Best corrected visual acuity; DE: Defocus equivalent; UDVA: Uncorrected distant visual acuity; SBK: Sub-Bowmann's keratomileusis; WG-SBK: Wavefront guided sub-Bowmann's keratomileusis.

Table 3 Changes in UDVA and contrast sensitivity during IOP fluctuations postoperatively $\bar{x}\pm s$

Groups	UDVA (logMAR)	Photopic contrast sensitivity (cycles/degree)			
		3	6	12	18
Study group					
Ocular hypertension	−0.07±0.05	1.65±0.14	1.83±0.13	1.55±0.19	1.16±0.19
Normal tension	−0.13±0.06[a]	1.73±0.09[b]	1.97±0.13[b]	1.70±0.13[b]	1.27±0.15[b]
Control group					
Post-1wk	−0.10±0.06	1.70±0.11	1.85±0.17	1.49±0.28	1.04±0.17
Post-1mo[c]	−0.10±0.05	1.71±0.13	1.93±0.18	1.52±0.23	1.08±0.20

UDVA: Uncorrected distant visual acuity. [a]Comparing ocular hypertension and normal tension, the difference is significant ($P<0.01$); [b]Comparing ocular hypertension and normal tension, differences in photopic contrast sensitivity at 3, 6, 12, and 18c/d are significant, as well ($P=0.029$, 0.000, 0.000, 0.031, respectively); [c]Comparison between post-1wk and 1mo, differences in UDVA and photopic contrast sensitivity show no significance ($P>0.05$).

Uncorrected Distant Visual Acuity and Contrast Sensitivity During the abnormal IOP fluctuations in study group, remarkable changes in UDVA and photopic contrast sensitivity were observed (Table 3; Figure 2). UDVA and photopic contrast sensitivity in normal tension were much better than these in ocular hypertension.

Wavefront Aberrations In study group, significant changes were also found in wavefront aberration parameters such as higher order aberrations (HOA), trefoil and spherical aberration [(SA) $P<0.05$ for all], and these three parameters all got smaller when elevated IOP recovered to normal (Table 4; Figure 3).

Corneal Topography In study group, corneal morphological parameters such as Q-value, central corneal thickness (CCT)

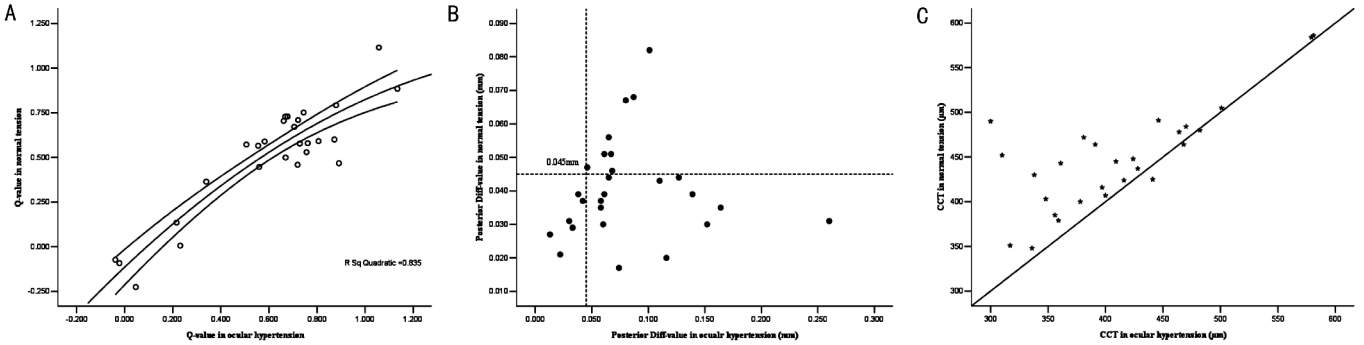

Figure 4　Effect of steroid induced IOP fluctuations on corneal topography parameters such as Q-value, posterior Diff-value and CCT in post-LASIK patients in study group　A: Q-value decreased when elevated IOP recovered to normal; B: Dotted lines in this graph represented 0.045 mm in posterior Diff-value which demonstrated that most corneal posterior surface got more flattened in normal tension than in ocular hypertension; C: Compared to ocular hypertension, CCT became thicker in normal tension due to corneal wound healing.

Table 4　Changes in wavefront aberrations during IOP fluctuations postoperatively　$\bar{x}\pm s$

Groups	Wavefront aberrations						
	RA (D)	TA (μm)	HOA (μm)	HOA (%)	Coma (μm)	Trefoil (μm)	SA (μm)
Study group							
Ocular hypertension	−0.33±0.19	1.18±0.49	0.71±0.17	58.9±20.8	0.38±0.20	0.23±0.13	0.43±0.21
Normal tension	−0.32±0.19	1.13±0.53	0.64±0.17[a]	59.6±22.5	0.35±0.18	0.19±0.11[a]	0.38±0.21[a]
Control group							
Post-1wk	−0.46±0.29	0.93±0.70	0.38±0.17	52.8±22.1	0.26±0.18	0.13±0.06	0.10±0.10
Post-1mo[b]	−0.42±0.28	0.88±0.59	0.38±0.17	53.1±22.5	0.26±0.18	0.12±0.09	0.11±0.12

RA: Residual astigmatism; TA: Total aberrations; HOA: Higher order aberrations; SA: Spherical aberration. [a]Comparison of ocular hypertension and normal tension, the differences in HOA, Trefoil and SA are significant ($P<0.05$); [b]Comparison between post-1wk and 1mo, differences in wavefront aberration parameters show no significance ($P>0.05$).

Table 5　Changes in corneal topography between study and controlgroup in post-LASIK patients　$\bar{x}\pm s$

Groups	Q-value	CCT (μm)	Posterior Diff-value (μm)
Study group (Orbscan Ⅱz)			
Ocular hypertension	0.61±0.30	410±74	81±53
Normal tension[a]	0.51±0.31	448±57	40±15
Control group (Sirius)			
Post-1wk	0.83±0.42	446±37	5.5±4.5
Post-1mo	0.82±0.42	454±40☆	6.1±3.8

Q-value represents corneal anterior asphericity. CCT: Central corneal thickness. [a]Comparing with ocular hypertension, the differences in Q-value, CCT and posterior Diff-value are significant ($P<0.01$).

and posterior Diff-value also showed significant changes ($P<0.01$ for all), and statistics indicated that the corneal anterior and posterior surface got flattened, and CCT increased with time (Table 5; Figure 4).

In contrast, the control group showed no significant changes in UDVA, photopic contrast sensitivity, wavefront aberrations, and corneal topography except for the increased CCT with time.

DISCUSSION

The demand for better visual outcomes after LASIK has led to the emphasis on the perioperative management, especially patients in the first postoperative month with topical corticoid eye drops to regulate corneal wound healing[1,14]. Among them, some steroid-sensitive patients may risk ocular hypertension, even worse consequences. Fortunately, the greater-than-normal IOP fluctuations could be limited if identified and managed in time. However, it was rarely known what and how it changed in visual performance of post-LASIK patients during the abnormal IOP fluctuations. So we conducted this controlled, cohort study to monitor a series of postoperative variation along with IOP fluctuations. And we found that abnormal IOP fluctuations might cause remarkable changes in optical and visual performance after LASIK.

Some earlier publications had observedthe role of IOP in glaucoma, and found that reduced contrast sensitivity prior to the visual field defect in chronic simple glaucoma patients and considered that contrast sensitivity was a sensitive and available method for glaucoma screening in population[15-18]. Another studies had concentrated on evaluating the hypotension effects on contrast sensitivity in glaucoma

patients. For instance, data from a randomized placebo controlled trial suggested that color contrast sensitivity improved after Nimodipine administered to normal tension glaucoma patients[19]. And reduction of IOP accompanied with improvement of contrast sensitivity after surgery in unilateral glaucoma patients, without evidence of visual acuity and field damage[20]. Our data originated from steroid-sensitive patients in study group provide new evidence to the relationship of IOP and visual performance, showing that abnormal IOP elevation could affect postoperative contrast sensitivity, and hypotension treatment could improve contrast sensitivity and UDVA. By contrast, there was no such change in control group. So that, these changes were not the normal pattern after LASIK and it could be ascribed to abnormal IOP fluctuations in steroid responders.

Literatures have documented the associations of IOP and wavefront aberrations, and demonstrated that IOP was significantly correlated with ocular aberrations such as trefoil and spherical aberration in myopic eyes[21]. And persistent ocular hypertension increased wavefront aberrations in glaucoma patients, however, hypotension treatment decreased coma and spherical aberration in these patients[12]. Our results offer new evidence about the associations of IOP and wavefront aberrations. Data in study group showed that HOA, trefoil and spherical aberration improved along with the IOP reduction. However, there were no such significant changes observed in control group. Thus, the wavefront aberrations in study group improved with time most likely to be due to IOP reduction. In addition, those differences in wavefront aberration parameters between our results and others could due to a difference in subject samples. Previous study included glaucoma patients, and our study was postoperative steroid responders.

In order to make sure that the variation in outcome was not related to CCT, orpre-operative refraction, or custom *vs* conventional procedure and so on, we performed baseline analysis and found no significant differences between the groups except for preoperative IOP. We conjectured that this difference might because steroid responders innate have larger amount of mean IOP than normal populations. After ruled out these plausible factors, we could safely conclude that abnormal IOP fluctuations could deteriorate visual performance in post-LASIK patients. Furthermore, we were urged to get insights into the underlying mechanism, and then corneal topography was applied on purpose. We found, for study group, that the corneal anterior Q-value and posterior Diff-value were apparently greater when IOP elevated than those in normal tension, which were not observed in control group. This result demonstrated that corneal moved forward and Q-value got more positive and oblate in ocular hypertension condition. Here someone might assume that two types of corneal topography devices for two groups separately would cause the data incomparable. But we pay more attention to the within-group changes, so the results are still reliable. As is well-known, an optimum corneal asphericity is important for decreasing ocular aberrations and thus maximizing image quality. If the cornea becomes more oblate, that will be worsening of spherical aberration[22]. And previous literature indicated that Q-value was directly proportional to spherical aberration[23], when Q-value became more positive in ocular hypertension, spherical aberration simultaneously increased, and vice versa. Hence, Q-value might be an endogenous promoter, initiating a series of effect such as the increment of spherical aberration and trefoil, and the decrement of UDVA and contrast sensitivity, by a potential approach.

Putting our results all together, we can model this cascade effects that exogenous corticosteroid induced abnormal IOP elevation in steroid responders, then corneal moving forward accompanied by increment of Q-value, and the later affected HOA, causing increment of spherical aberration and trefoil which deteriorating image quality. So that steroid responders finally performed poor UDVA and contrast sensitivity. To the best of our knowledge, it was the first study directly demonstrating the mechanism of abnormal IOP fluctuations affecting visual performance in post-LASIK patients. Because of the limited samples and short-term follow-up in our study, statistical analysis of the relationship of optical zone to Q-value is not available. Larger scales and long-term follow-up are needed to further evaluate the effect of steroid-induced ocular hypertension on visual quality in those patients. In addition, real visual perception cannot be thoroughly quantified or mathematically characterized by contrast sensitivity and wavefront aberrations, some mathematical descriptors for image quality, such as optical transfer function, point spread function, and Strehl ratio are supplemented to describe the optical quality in human eyes[24]. So there is a need to improve the methods for measuring and representing visual performance in the clinical environment. These newly approaches will help us better use the available information in the event of ocular hypertension, and further interpret how an induced biomechanical change can affect the visual performance in the steroid responders after LASIK[7,25-27].

In summary, abnormal IOP fluctuations might lead to notableoptical and visual changes in early post-LASIK patients. However, these changes are not the normal pattern after LASIK. Limiting the IOP fluctuations could improve the visual performance in those steroid responders.

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