

# Visual outcome after optimized aspheric transition zone laser *in situ* keratomileusis compared to conventional LASIK

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## Abstract

• **AIM:** To compare the visual effects of optimized aspheric transition zone Laser *in situ* keratomileusis (OATz -LASIK) versus conventional Laser *in situ* keratomileusis (con. LASIK).

• **METHODS:** In a prospective study 44 patients (88 eyes) underwent OATz -LASIK and 50 patients (92 eyes) received conventional LASIK surgery. Visual acuity, refractions, contrast sensitivity (CS), glare sensitivity (GS), and increment of Q-value after surgery were studied.

• **RESULTS:** All of operations on 94 cases were successful without severe complication after 3 months' follow-up. There was no significant difference in term of postoperative refractions between the two groups (*t*-test). The uncorrected visual acuity (UCVA), CS, GS, and increment of Q-value of OATz group were significantly better compared to the tradition group 3 months after the surgery ( $P < 0.05$ ).

• **CONCLUSION:** OATz - LASIK is a more effective procedure to improve visual quality compared to conventional LASIK.

• **KEYWORDS:** myopia; laser *in situ* keratomileusis; aspheric transition zone; contrast sensitivity; glare sensitivity; visual quality

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## INTRODUCTION

With the rapid development of LASIK, more and more attention was paid to visual quality changes not only the recovery of vision. Nowadays, some scholars presumed that the spherical tendency of cornea after traditional surgery is the main factor leading to visual quality reduces<sup>[1-3]</sup>.

OATz -LASIK was designed to reduce the spherical tendency of cornea in order that better visual quality to be achieved. Here we report a prospective study result of OATz -LASIK compared with that of conventional LASIK.

## PATIENTS AND METHODS

**Clinical Data** Patients who received LASIK in our department from June to September 2006 were included. All patients were checked to rule out contraindications. Fifty patients (92 eyes) received traditional LASIK surgery. The average spherical equivalent refractive error before surgery was  $-5.47 \pm 2.18D$  ( $-0.50 \sim -10.00D$ ), and the average age was  $22.5 \pm 5.25$  years (18-36 years); Forty-four patients (88 eyes) underwent OATz -LASIK; the mean spherical equivalent refractive error before surgery was  $-5.13 \pm 1.79D$  ( $-1.00 \sim -9.50D$ ), and the average age was  $21.0 \pm 3.79$  years (18-35 years). Preoperatively, there were no significant differences regarding the best-corrected visual acuity (BCVA), SE, CS, GS, and Q-value between the two groups.

**Items Observed** Preoperative BCVA, postoperative UCVA, Postoperative residual refractive error, 3,6,12, 18cyc/d spatial frequency of CS and GS, and the increment of Q-value within 6mm region after operation were comparatively studied.

**Methods** It was a prospective single-blind study. The results were compared between the two groups after one week, one month, and three months. CS and GS were evaluated with the CSV-1000 (vectorvision, USA) at 3, 6, 12, and 18cyc/d. The NIDEK OPD-ScanII wavefront aberration device of Japan was employed for aberration measurements. LASIK was performed using the Nidek EC-5000CXII excimer laser system. Corneal flap was produced with Moria automated lamellar corneal knife. All the procedures were performed by the same senior doctor.

**Statistical Analysis** SPSS11.0 data processing packages was applied to analyze the outcomes by means of mean  $\pm$  standard deviation (mean  $\pm$ SD) and using *t*-test.  $P < 0.05$  was considered statistically significant.

## RESULTS

### Visual Acuity and Postoperative Residual Refraction

After 3 months, there were no patient's postoperative BCVA

**Table 1 BCVA of preoperation and UCVA of postoperation**

Group	preoperation	<i>P</i>	1d	<i>P</i>	1wk	<i>P</i>	1mo	<i>P</i>	3mo	<i>P</i>
Tra.	1.16±0.12		0.98±0.21		1.08±0.16		1.13±0.15		1.12±0.14	
OATZ	1.16±0.17	0.928	1.08±0.16	0.001	1.16±0.16	0.001	1.15±0.17	0.306	1.21±0.17	0.001

**Table 2 CS and GS of preoperation and postoperation for the two groups** (mean±SD)

Group	preoperation	<i>P</i>	1wk	<i>P</i>	1mo	<i>P</i>	3mo	<i>P</i>
CS3c/d	Tra.	1.718±0.172	1.642±0.183		1.603±0.193		1.585±0.201	
	OAT z	1.716±0.140	0.920	1.700±0.139	0.02	1.742±0.153	0.000	1.744±0.126
CS6c/d	Tra.	1.964±0.179	1.843±0.219		1.950±0.200		1.735±0.177	
	OAT z	1.982±0.145	0.541	1.941±0.173	0.001	1.960±0.216	0.624	1.961±0.167
CS12c/d	Tra.	1.618±0.196	1.479±0.234		1.471±0.216		1.418±0.228	
	OAT z	1.611±0.181	0.790	1.618±0.224	0.000	1.605±0.255	0.001	1.655±0.177
CS18c/d	Tra.	1.172±0.222	1.046±0.228		1.048±0.199		1.052±0.234	
	OAT z	1.153±0.202	0.531	1.153±0.198	0.001	1.191±0.248	0.000	1.225±0.202
GS3c/d	Tra.	1.686±0.170	1.611±0.167		1.663±0.155		1.598±0.151	
	OAT z	1.694±0.124	0.895	1.736±0.142	0.000	1.747±0.173	0.002	1.766±0.141
GS6c/d	Tra.	1.914±0.185	1.784±0.209		1.793±0.165		1.734±0.168	
	OAT z	1.928±0.145	0.572	1.889±0.148	0.000	1.941±0.204	0.000	1.927±0.185
GS12c/d	Tra.	1.587±0.219	1.418±0.231		1.425±0.246		1.381±0.228	
	OAT z	1.572±0.240	0.669	1.526±0.227	0.002	1.581±0.249	0.000	1.628±0.221
GS18c/d	Tra.	1.156±0.230	1.047±0.242		1.054±0.202		1.099±0.234	
	OAT z	1.152±0.242	0.911	1.131±0.192	0.013	1.196±0.233	0.000	1.199±0.212

**Table 3 Increment of Q-values in 6mm regional after operation** (mean±SD)

Group	1wk	<i>P</i>	1mo	<i>P</i>	3mo	<i>P</i>
Tra.	0.39±0.60		0.41±0.67		0.44±0.71	
OAT z	0.17±0.51	0.009	0.19±0.47	0.001	0.21±0.36	0.001

lost more than two lines compared with preoperation in all patients. However, the UCVA was 1.21±0.17 in OATz group and 1.12±0.14 in traditional LASIK group, which were significantly different between the two groups (*t*-test, *P*<0.05). Preoperative BCVA were 1.16±0.17 and 1.16±0.12 respectively (*P*>0.05, Table 1). Postoperative residual refraction were 0.128±0.165D in OATz group and 0.187±0.193D in traditional LASIK group that although there was difference between the two groups but not significant.

**Contrast Sensitivity and Glare Sensitivity** Contrast sensitivity and glare sensitivity of OATz Group in 3,6,12,18cyc/d spatial frequency were significantly better than traditional group (Table 2).

**Increment of Q-values within 6mm Region After Operation** Q-value of both groups increased compared to the preoperation level, but the increased level of traditional surgery was significantly higher than OAT z group. (Table 3).

## DISCUSSION

Within the past 20 years, corneal refractive surgery has developed from PRK surgery to the LASIK and LASEK. LASIK surgery is accepted by both doctors and patients for its safety, reliability and indolence. With the widespread application of LASIK and advancement of technology, the success of corneal refractive operation means not only the recovery of vision, but also better visual quality. Patients should obtain comfortable and satisfactory vision under various intensity of illuminations and contrasts. Nowadays,

the mostly used evaluations of visual quality are contrast sensitivity and glare sensitivity test. Contrast sensitivity function is a measure of contrast sensitivity for a range of spatial frequencies and characterizes how well the visual system performs in a complex environment better than visual acuity measurement [4]. Chan *et al* [5] had shown a general depression in the contrast sensitivity function after LASIK; 1.5 cpd and 3.4 cpd were the most affected frequencies and recovery took at least 6 months. Seiler *et al* [6] showed that visual quality, contrast sensitivity, and glare sensitivity declined after traditional surgery and were relevant with increasing of higher-order aberrations significantly. Compared with preoperation the best corrected visual acuity decreased (*P*=0.02), contrast sensitivity decreased (*P*=0.001), glare sensitivity decreased (*P*=0.03), and total higher-order aberrations increased 17.65 times than preoperation that spherical aberration was the maximum.

To improve the visual quality of patients, with the design of customized ablations, major researches were topography-guided customized ablation and wavefront aberration-guided customized ablation. Customized ablation refractive surgery is a kind of ablation surgery which is performed according to each patient's corneal condition; it can improve the quality of retinal imaging. But there are still some problems which make the effects of the operation in question such as:  
 ① We don't have the equipment which could accurately measure the aberration, and with good repeatability. In

addition wavefront aberration itself is a dynamic concept<sup>[7]</sup> under the influence of various factors such as body position, tear-film and so on. ② Intraoperative active eye tracking system or fixed system, the measure results of aberration whether can be accorded with laser cutting system and eye tracking system accurately; corneal whether can endure the complex personal cutting. ③ Aberration changes after operation. Corneal biomechanical response to laser ablation is a complex processes<sup>[8]</sup>; Aberrations change constantly with the age in the life. Nio *et al*<sup>[11]</sup> indicated that the sudden and marked variation in the corneal curvature gradient between the central treated area and the peripheral untreated area in traditional myopic ablations is a major factor in reducing visual quality that induce increase of spherical aberration, therefore use OATz based on the topographic and aberrometric data provided by Final Fit ablation software, which features the OATz software algorithm, to keep corneal shape and improve visual quality<sup>[9]</sup>. In our study all of the 94 cases were successful without severe complications. The postoperative residual refractions were not significantly different between the two groups ( $P > 0.05$ ), and no eye required retreatment. At 3 months the UCVA of OATz group was significantly better than traditional group ( $P = 0.001$ ); OATz group had faster visual recovery than traditional group; the UCVA were  $1.08 \pm 0.16$  and  $0.98 \pm 0.21$  at one day,  $1.16 \pm 0.16$  and  $1.08 \pm 0.16$  at one week, preoperation were  $1.16 \pm 0.17$  and  $1.16 \pm 0.12$ , respectively. The results of this study demonstrated that OATz -LASIK is as well as conventional LASIK at the aspects of safety, reliability, and higher predictability as other studies have reported<sup>[10]</sup>. However, not holo-concorded with Paolo Vinciguerra *et al*<sup>[9]</sup>, who presumed in stromal and surface ablation, marked variation of the curvature in peripheral portion leads to a response to reduce curvature variation, but this may induce regression and restriction of the effective optical zone and reduce the predictability of the correction. Our study showed that CS and GS almost in every space frequency of OATz Group were significantly better than traditional group on all the follow-up time except CS6.0c/d in the first month. Meanwhile, CS and GS in the OATz group recovered faster than the control group and it took one month after surgery to recover to preoperative levels on all space frequency. We found that some patients complained about glare and poor night vision after traditional LASIK despite the fact that visual acuity had been raised in fact. The increment of Q-values within 6mm region after operation could explain this phenomenon; the increased level of traditional LASIK group was significantly higher

than that of the OATz LASIK group ( $P < 0.05$ ). Several studies had investigated these effects<sup>[1-3]</sup>. Physiological state of human corneal curvature distribution is that the central corneal curvature is steep and peripheral corneal relatively flat, shape of negative non-spherical, expressed by Non-spherical index of Q-values. After traditional corneal refractive surgery corneal surface becomes spherical, corneal surface curvature distribution characteristics transform steep center and flat surrounding to the level center and steep surrounding, spherical aberration increases, Q-values increases, this can reduce the contrast sensitivity of images on the retina and influence their visual quality and particularly night vision. With OATz -LASIK, the corneal curvature gradient from the center to the periphery is reduced and made more gradual to keep corneal shape and improve visual quality<sup>[10]</sup>.

In summary, OATz -LASIK could induce desired change of corneal shape and do obtain more ideal effect than traditional LASIK. However, in our study the time of our follow-up visit was short and on the other hand, the heal of cornea flap is a complicate biological process, also there are other factors influencing visual quality don't included in our study such as preoperative corneal thickness, inlaocular pressure<sup>[11]</sup>, so further research is necessary.

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