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Refractive correction and intraocular pressure changes after cataract surgery

朝鮮大學校 大學院

醫 學 科

梁 城 愿

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白內障 手術 後 屈折校訂과 眼壓의 變化

2010年 2月 25日

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목　　차

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표 목 차

초 록

백내장 수술 후 굴절교정과 안압의 변화

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목적 : 백내장 수술 후 굴절력이 안정화되어지는 기간과 안압의 변화가 안정되어지는 기간을 알아보고자 한다.

대상과 방법 : 2006년 1월부터 2007년 9월까지 조선대학교병원 안과로 내원하여 백내장 수술을 시행한 163명 221안을 대상으로 후향적으로 비교분석하였다. 221안 중 상측 절개한 86안은 그룹1로, 이측 절개한 135안은 그룹2로 분류하였다. 백내장 수술 후 굴절력과 안압을 분석하였다.

결과 : 백내장 수술 후의 굴절력은 술전과 비교하여 1일, 1주일, 그리고 1개월에 통계적으로 유의한 차이를 보였다($p<0.05$). 하지만 2개월 후에는 통계적 유의성이 없었다. 수술 후 1일째 안압은 통계적으로 유의한 차이를 보였고($p<0.05$), 이 후 1주후부터 안정되었으며 3개월간 지속되었다($p>0.05$). 모든 기간에 두 그룹 간에 통계적 유의성은 없었다($p>0.05$).

결론 : 굴절력은 백내장 수술 후 2개월부터 안정화되어지며 안압은 1주부터 안정되어진다. 상측과 이측 각막절개에 의한 백내장 수술 후 각각의 굴절력과 안압의 변화는 차이를 보이지 않았다. 이 연구의 결과로 백내장 수술 후

굴절력과 안압이 안정되는 기간을 알 수 있어서 시력교정이 필요한 경우 2개월 이후 적용해 볼 수 있겠다.

Keywords : Cataract surgery; Intraocular pressure (IOP); Refractive power.

Introduction

In many cases, nearvision or distantvision correction is needed after cataract surgery. The visual correction should be performed at a proper time, in order to reduce the economic burdens of competitive corrections. In addition, medical workers need to explain the necessity of postoperative visual correction including lens prescription and the proper time for examinations in the statistics. Many studies have been carried out to reduce the onset of astigmatism after the cataract surgery, and various operations have been performed. The onset rate and axis of astigmatism, induced from the cataract surgery, are affected by the length and location of the incised wound, the method of suture, the suturing fiber and its tension.[1,2] To minimize surgically-induced astigmatism, various methods have been used. To give examples, intraoperative keratometry is performed and stitches are optional after the operation. In particular, the cataract surgery aims at shorter incision and sutureless finish.[3,4] In recent times the clear corneal incision-based sutureless cataract surgery has been widely performed because the refractive index can be stabilized early and the development of astigmatism is less as compared to extracapsular extraction. Added to this, visual acuity can be recovered in a shorter time and the patient can return faster to normal life. The clear corneal incision-based sutureless cataract surgery has made its appearance thanks in part to phacoemulsification and soft intraocular lenses. Surgically-induced corneal astigmatism occur less and the incised lesion recovers earlier. As a result it shortens the time to recover visual acuity.[5-10] The clear corneal incision-based cataract surgery has lower risk of ophthalmecchymosis or hyphema, in comparison to scleral pocket incision, and also the operative time can be reduced because wider visual field can be secured during the operation. For that reason, the clear corneal incision-based cataract surgery is more advantageous than other cataract surgeries[11] as it is eligible to topical anesthesia and does not leave scars on the conjunctiva. On the other hand, the clear corneal incision-based cataract surgery has a high possibility to induce astigmatism and it has been controversial due to the fact that endophthalmitis, corneal endothelial damage, irregular corneal astigmatism and wound instability may occur. With that view, various transformational methods have been introduced since Fine reported the keratotomy in 1992.[18] Many researchers have studied how long it would take to stabilize the refractive power and how intraocular pressure (IOP) would change after cataract surgery and as a result have reported that such changes are caused by the dynamical changes of aqueous humor, increase in aqueous outflow through the trabecula and uvea-scleral pocket outflow tract, and ultrafiltration caused by scleral pocket incision. The present study was to ascertain how long it would take to stabilize the refractive power after the superior clear corneal incision and the temporal clear corneal incision-based sutureless cataract surgery, and how IOP would change after cataract surgery.

Subjects and Methods

Patient Population

The charts of 163 patients (221 eyes) who underwent clear cornea incision-based sutureless cataract surgery performed by a single surgeon between January 2006 and September 2007 was reviewed retrospectively. Out of 221 eyes, 86 eyes of superior incision were classified as group 1 and 135 eyes of temporal one were classified as group 2 respectively. Enrolled patients fulfilled the criteria for inclusion in the study: minimum age of 50 years; no ocular disease (e.g., corneal opacity, glaucoma and retina disease); no previous refractive surgery or systemic disease likely to affect post-operative results. All patients had a minimum of 12 months of follow-up after surgery. Preoperative examinations included: assessment of clinical manifestations and history taking; measurement of UCVA (uncorrected visual acuity), BCVA (best corrected visual acuity), refractive errors, cycloplegic refractions and IOP; pachymetry; corneal topography; specular microscopy; slit-lamp biomicroscopic examination; dilated fundus examination. The refractive power and IOP were prospectively analyzed after the operation.

Surgical Procedure

After the application of 0.5% proparacaine hydrochloride (Alcane®, Alcon, USA) and retrobulbar anaesthesia with 2% lidocaine (lidocaine HCl, Huons, Korea), the ocular surface was exposed using an eyelid speculum (Moria, Antony, France). The cornea, conjunctiva and conjunctival sac were cleaned with a balanced salt solution (BSS Plus®, Alcon, Fort Worth, TX, USA). To be specific, 2.8mm-clear corneal incision was performed just inside the vascular lake of the superior or temporal corneal limbus by use of the disc blade (K4-300A®, Katena Products Inc., USA) and 1%-sodium hyaluronate (Hyal 2000®, LG, Korea) was administered. Then continuous curvilinear capsulorrhexis was performed by use of the 25 gauge needle and capsulorrhexis forcep. Hydrodissection and hydrodelineation were performed, after that nuclear material was phacoemulsificated by the ultrasonic emulsifier (Millennium®, Bausch & Lomb, USA) and remaining cortex material was removed by the same machine. A 6.0 mm acrylic IOL (SENSAR^{TM}, AR40, AMO, USA) was used for intraocular lens. Specific complications including capsular rupture did not occur during the operation. The 1% sodium hyaluronate was sufficiently administered for capsule expansion before intraocular lens insertion. The viscoelastic substance was removed by the phacomachine (Millennium®, Bausch & Lomb, USA) after intraocular lens insertion. The incised region was not sutured, but hydrated enough to block leakage. If aqueous leakage occurred, 10-0 nylon suture was applied instead of artificial inducement of corneal edema. Such cases were excluded from the present study. The patients were given 0.5% moxifloxacin eyedrops (Vigamox®, Alcon, USA), 0.1% diclofenac sodium (Voltaren®, SDU, Novartis, USA) and 1% prednisolone acetate (Pred Forte®, Allergan, USA) four times per day for the first postoperative week. These medications were tapered from 4 times per day to once per day at intervals of 1 week for 4 weeks. Patients were also given preservative-free 0.5% carboxymethylcellulose (Nunen®, Hanmi, Korea) for artificial tears six times per day for the maintenance of tear film and regular ocular surface.

Follow-up

The refractive power was measured 3 times respectively by use of the automatic keratometer (KR-7100P, Topcon, Japan) and its mean value was evaluated. IOP was measured by use of the noncontact pneumatic tonometer and the Goldmann tonometer.

Statistical Analysis

To increase the reliability of the data, all statistical analysis were repeated three times; the average values were obtained. SPSS for Windows, Version 11.5 (SPSS Inc., Chicago, USA) was used to compute routine statistics. The data was analysed for significance by a repeated-measures ANOVA followed by Duncan's multiple range tests for post hoc comparison. The data is expressed as a mean percentage of the control value plus S.E.M. (structural equation modelling). Ap-value of <0.05 was considered statistically significant.

Results

The 221 eyes of 163 patients (86 eyes of 57 males and 135 eyes of 106 females) were evaluated. The mean age of the subjects was 66.87±13.34 years. The mean UCVA of the subjects were 0.26±0.22D (Group 1) and 0.32±0.22D (Group 2) before surgery. The mean BCVA of the subjects were 0.61±0.42D and 0.60±0.29D. The mean corneal curvature (K) values were 44.06±1.27D and 43.69±1.80D. The mean spherical equivalents of the subjects were −0.90±1.31D (Group 1) and −1.31±1.42D (Group 2) before surgery. There was no statistically significant difference between the two groups before cataract surgery ($p>0.05$) (Table 1). Group 1 and group 2 indicated the spherical equivalents of −0.48±1.17D and −0.03±0.99D at postoperative 1 day. After 1 week, group 1 and group 2 indicated −0.38±1.10D and −0.27±0.95D, and as a result spherical equivalents were changed as much as −0.29±1.35D and 0.12±1.37D respectively. After 1 month, group 1 and group 2 indicated −0.57±1.17D and −0.07±0.99D, and as a result spherical equivalents were changed as much as −0.29±1.35D and 0.12±1.37D respectively. These changes were statistically significant differences ($p<0.05$). But, 2 months after the operation, group 1 and group 2 indicated −0.22±1.37D and −0.14±1.03D and so they were changed as much as −0.25±1.67D and 0.14±1.03D respectively. Three months after the operation, group 1 and group 2 indicated −0.12±0.63D and −0.18±1.05D and so they were changed as much as −0.25±1.67D and 0.14±1.03D respectively. There was no statistically significant difference between the two groups during this period ($p>0.05$). The multivariate regression analysis, applied to the spherical equivalents of two groups, showed that statistically significant changes occurred within 2 months after the operation (Table 2). Within-subject comparative analysis, applied to the spherical equivalents at every point in time, showed statistically significant changes at 1 day, 1 week and 1 month after the operation ($p=0.017$, $p=0.019$, $p=0.015$, $p<0.05$). But 2 and 3 months after the operation, statistically significant changes were not observed in spherical equivalents ($p=0.991$, $p=0.133$, $p>0.05$) (Fig. 1). Before the operation, IOP was 15.21±3.48mmHg in group 1 and 15.88±4.35mmHg in group 2. IOP was somewhat increased (16.94.0±8.31mmHg) 1 day after the operation, but a statistically significant decrease (13.54±3.40mmHg) was observed 1 week after the operation. It had been stable 1 weak after the surgery. In the 2nd month after the operation, IOP indicated 13.29±3.89mmHg. As a result, it decreased with as much as 2.23±4.25mmHg than before the operation, and remained at 13.48±3.85mmHg in the 3rd month. Group 2 also showed a similar tendency. Its preoperative IOP was 15.88±4.35mmHg and was somewhat lowered 1 day after the operation (14.80±4.21mmHg). A statistically significant decrease (13.41±3.13mmHg) was observed 1 week after the operation. IOP had been stable 1 weak after the operation. In the 2nd month after the operation, IOP indicated 13.47±3.50mmHg. As a result, it decreased with as much as 2.41±4.49mmHg than before the operation, and remained at 13.24±2.84mmHg until the 3rd month (Table 3). Statistically significant differences were observed 1 day after the operation ($p<0.05$) and in the values that were continuously measured until 3 months ($p>0.05$) (Fig 2). There was no statistically significant difference between the two groups during this period ($p>0.05$).

Discussion

Clear corneal incision has been widely used since it was reported by Fine et al. in 1992.[18] It has the merits of being simple, light in hand, shorter operative time, less tissue damage, easy lens insertion, and less inflammatory response like iritis. Also, it does not leave bleeding and scars in the manipulation of the conjunctiva and scleral pocket. Thus, it does not cause astigmatism unlike electrocautery.[12-14] The temporal incision is more suitable to get access to the deep-set eye or the eye having a filtering bleb that persisted after trabeculotomy, as compared to superior incision. In comparison to the superior region, the distance between the visual axis and the corneal limbus is longer and the palpebral blink-related pressure is lower. On that score, corneal astigmatism occurs less. In the case of superior incision, the wounded surface widened more due to the superior palpebra that was almost vertically across the incision meridian when it pressed down on the superior corneoscleral limbus, but in the case of temporal incision, the wounded surface was hardly widened because the superior palpebra was perpendicular with the incision meridian. It is more advantageous for Asians having smaller palpebral fissures.[15-18] If clear corneal incision, which is performed near the visual axis, is delayed and many instruments are used, the wound does not heal up cleanly, and results in outflow, an irregular wound, endophthalmitis, corneal endothelial damage and corneal astigmatism may occur. A lot of surgeons have made efforts to minimize astigmatism related to the cataract surgery, and the advancement of incision and suture has been focused on minimizing astigmatism. Nevertheless, every known incision has induced temporary or permanent changes in corneal astigmatism.[19] In patients who underwent typical superior incision, changes in with-the-rule(WR) astigmatism are temporarily observed, and within a year after the operation, at least 60% show the development into against-the-rule(AR) astigmatism.[20] It has been reported that at first WR astigmatism is caused by oppression of the operative wound and suture and also the development into AR astigmatism is caused by enlargement of the operative wound (tissue) and dissolution of the suture.[2,20,21] Length of the incised wound, the type of the suture, the sutured method, and tension of the suture can be the factors that cause astigmatism after cataract surgery.[1,2] In the event that the incision is applied to the cornea or sclera during the operation, the cornea becomes flat along the meridian of incision and becomes steep at the meridian 90 degrees away. It is more as the incised wound gets longer and gets closer to the central part of the cornea.[22] WR astigmatism, caused by the operation and immediately after it, is reduced with time and mechanism of scleral glide[2] and develops into AR astigmatism. Ordinarily astigmatism becomes stable 3 months after the operation, but Parker, Clorfeine[23] and Richards[24] maintained that corneal astigmatism and its axis continuously change for at least 3 years. In case planned extracapsular extraction or phacoemulsification is performed at the superior corneal limbus or its surrounding region, regular astigmatism remarkably occurs due to corneal flattering at the horizontal axis. However, over 60% develops into AR astigmatism because the wound enlarges during the healing process.[24-26] In this case, preoperative regular astigmatism or mild AR astigmatism may be without problems but preoperative moderate AR astigmatism may cause problems including visual disturbance. In connection with ultimate AR astigmatism, the following needs to be reviewed. First, the partial or whole incision of the cornea, the corneoscleral limbus and the sclera causes ultimate flatness of the incision meridian.[2,19,26] Second, the incision meridian becomes flatter as the arcuate or horizontal incision gets near the corneal peak.[27] Lastly, the incision meridian becomes flatter as the accurate or horizontal incision gets longer.[26] The onset of astigmatism may be reduced even in the sutureless cataract surgery, compared to cases where suture is performed after planned extracapsular extraction or phacoemulsification.[28] In most cases, it has been found that it develops into AR astigmatism due to relaxation of the wounded surface or its glide. It has been known that temporal corneal curvature can be gentle and astigmatism can be reduced when the incision is performed in the direction of the axis of the maximum corneal curvature. In the case of superior incision, no method is effective enough to fundamentally reverse changes in corneal astigmatism after the operation or to remove them. Especially in case of when an intraocular lens is inserted into an aphakia, the original tissue loses elasticity and AR astigmatism takes a turn for the worse. Furthermore, safety is debased and the wound heals up very slowly as compared to the case where the incision is performed on the original tissue to which none operative manipulations were applied. It has been already reported in many studies that corneal astigmatism makes less changes and visual acuity is rapidly recovered in inverse proportion to length of the incised wound.[6,7,29,30] Accordingly as ultrasonic emulsification has recently advanced and flexible silicone intraocular lenses have been developed, minimal incision has been widely performed in cataract surgeries. Axt and McCaffery[25] performed extracapsular extraction or ultrasonic emulsification on cataract patients who had AR astigmatisms before operations, and as a result AR astigmatisms were reduced and also astigmatic axes become stable. Astigmatisms were solved in patients who underwent the operation at an early stage. Such effects were prominent in patients who had AR astigmatisms over 2.0D before the operation and who underwent ultrasonic emulsification. Masket[31], who performed secondary intraocular lens insertion through temporal incision, reported that AR astigmatism of 0.58D was ameliorated to WR astigmatism of 0.45D after the operation. Cravy[32], who performed planned extracapsular extraction and phacoemulsification at the superior region and the temporal region respectively performed a long-term follow-up, reported that corneal astigmatism was more stable in temporal incision than in superior incision and astigmatism was generally reduced and visual acuity recovered early. The reason why corneal astigmatism was less after temporal incision was explained as as follows: In the case of superior incision, the wounded surface was widened more due to the superior palpebra that was almost vertically across the incision meridian when it pressed down on the superior corneoscleral limbus, but in the case of temporal incision, the wounded surface was hardly widened because the superior palpebra was parallel with the incision meridian.[25] Additionally, it was reported that temporal incision could secure wider visual field during the operation with regard to patients with enophthalmos or projected foreheads. Joel C. Ax et al. maintained that preoperative AR astigmatism could be reduced by temporal incision.[25] Nielson et al. reported that in sutureless operations, postoperative astigmatic changes occur more in clear corneal incision than in scleral incision.[33] Postoperative astigmatic effect did not change until the 6th week, and that superior incision and temporal incision caused AR astigmatism and WR astigmatism respectively.[33] In order to clarify the pattern of postoperative IOP changes, many studies have been carried out up to now since surgical treatment was applied to cataracts. Also, postoperative IOP management has been developed along with the advancement of surgical techniques. Radius et al.[34], who performed extracapsular lens extraction and intraocular lens insertion in 1984, reported that the average IOP decreased with as much as 0.6 mmHg 24 months after the operations. Savage et al[35] reported similar results. In ultrasonic phacoemulsification, similar results came out. Thus, it has been reported in many studies that postoperative IOP is heightened in the early days but decreases with time.[36-39] After all, there were few reports about refractive power stabilization time and IOP change after cataract surgery.

In the present study, patients were divided into two groups, the superior

clear corneal incision-group and the temporal clear corneal incision-group, and the operation was performed on them. The aim is to ascertain how long it would take to stabilize the refractive power after the superior clear corneal incision and the temporal clear corneal incision-based sutureless cataract surgery, and how IOP would change after cataract surgery. The charts of 163 patients (221 eyes) who underwent clear cornea incision-based sutureless cataract surgery performed by a single operator were retrospectively reviewed. Out of 221 eyes, 86 eyes of superior incision were classified as group 1 and 135 eyes of temporal one were classified as group 2. All patients had a minimum of 12 months of follow-up after surgery. The refractive power and IOP were prospectively analyzed after the operation. The refractive power showed statistically significant changes at 1 day, 1 week and 1 month after the operation, in comparison to the preoperational value ($p<0.05$). After postoperative, 2 months, there was no statistical significance. IOP showed statistically significant changes 1 day after the operation ($p<0.05$), and after that IOP was stable from 1 week after the surgery, in the values that were continuously measured for 3 months ($p>0.05$). There was no statistically significant difference between the two groups during this period ($p>0.05$).

In conclusion, the refractive power stabilises after 2 months and IOP after 1 week. These results indicate the time for refractive correction and IOP stabilization after cataract surgery. As a result, it is recommended that glasses should be prescribed only after 2 months following the cataract surgery.

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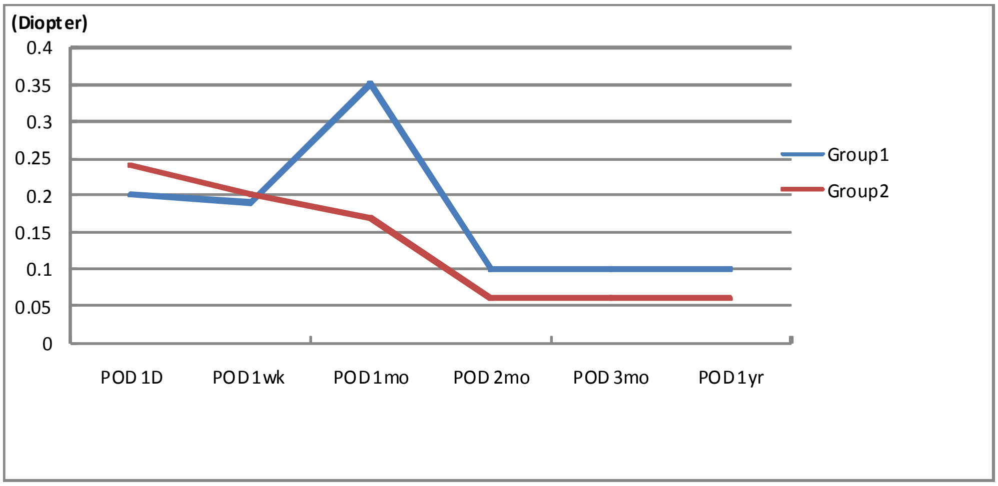

Fig 1. The change of spherical equivalents after cataract surgery between group 1(superior incision approach) and group 2 (temporal incision approach). Within-subject comparative analysis, applied to the spherical equivalents at every point in time, showed statistically significant changes at the 1st day, the 1st week and the 1st month after the operation ($p=0.017$, $p=0.019$, $p=0.015$, $p<0.05$). In the 2nd and 3rd month after the operation, statistically significant changes were not observed in spherical equivalents ($p=0.991$, $p=0.133$, $p>0.05$). There was no statistically significant difference between the two groups during this period ($p>0.05$).

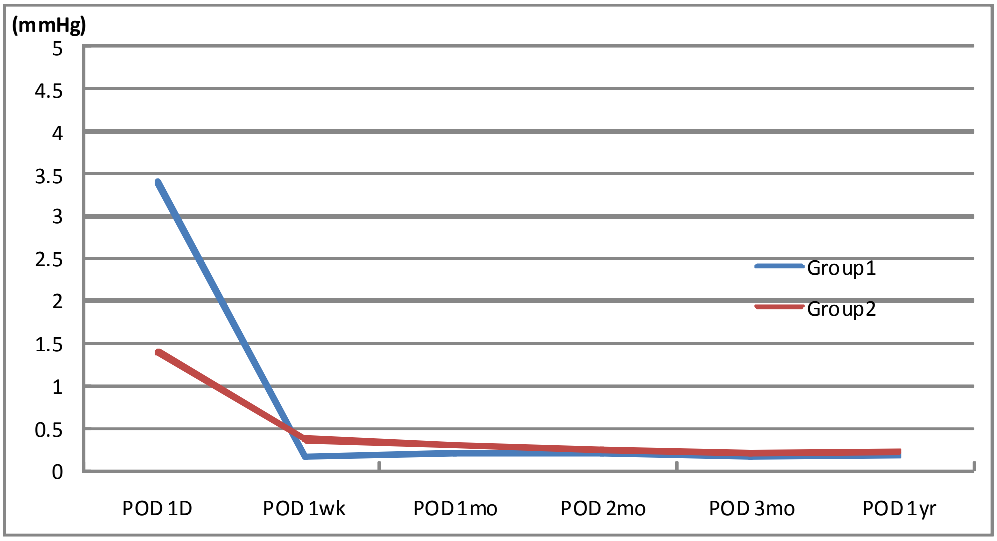

Fig 2. The change of IOP after cataract surgery between group 1(superior incision approach) and group 2 (temporal incision approach). IOP was somewhat increased 1 day after the operation. A statistically significant decrease was observed 1 week after the operation, and IOP had been stable after the postoperative, 1 week. Statistically significant differences were observed 1 day after the operation ($p<0.05$) in the values that were continuously measured until 3 months ($p>0.05$). There was no statistically significant difference between the two groups during this period ($p>0.05$).

Table 1. Baseline characteristics of eyes before cataract surgery

Characteristics	Total (221)	Group 1 (86)	Group 2 (135)
Age, mean(years)±SD†	66.87±13.34	66.65±13.79	67.01±13.11
Gender (male : female)	86 : 135	29 : 57	57 : 78
UCVA*, mean±SD	0.30±0.22	0.26±0.22	0.32±0.22
BCVAΠ, mean±SD	0.60±0.39	0.61±0.42	0.60±0.29
Keratometry, mean(D#)±SD	44.85±1.09	44.06±1.27	43.69±1.80
SE§, mean(D)±SD	-1.15±1.35	-0.90±1.31	-1.31±1.42
IOP%, mean(mmHg)±SD	15.62±3.97	15.21±3.48	15.88±4.35

† SD = standard deviation; *UCVA = uncorrected visual acuity; Π BCVA = best corrected visual acuity; #D = dioptres; §SE = spherical equivalents; %IOP = intraocular pressure

Table 2. Comparison of postoperative change in spherical equivalents between group 1 (superior incision approach) and group 2 (temporal incision approach)

	Preop†	POD* 1day	POD* 1week	POD* 1month	POD* 2month	POD* 3month
Group 1	0.90 ± 1.31	-0.58 ± 1.17	-0.38 ± 1.10	-0.57 ± 1.17	-0.22 ± 1.37	-0.12 ± 0.63
Group 2	1.31 ± 1.42	-0.03 ± 0.99	-0.27 ± 0.95	-0.07 ± 0.99	-0.14 ± 1.03	-0.18 ± 1.05

(Mean ± S.D. diopter)

† Preop = preoperative day; *POD = postoperative day

Table 3. Change of intraocular pressure after superior and temporal clear corneal incision

	Preop[†]	POD[*] 1day	POD[*] 1week	POD[*] 1month	POD[*] 2month	POD[*] 3month
Group 1	15.21±3.48	16.94±8.31	13.54±3.40	13.69±3.12	13.29±3.89	13.48±3.85
Group 2	15.88±4.35	14.80±4.21	13.41±3.13	13.77±3.40	13.47±3.50	13.24±2.84

(Mean ± S.D. mmHg)

[†] Preop = preoperative day; [*]POD = postoperative day