Original Article

Astigmatism following Small Incision Cataract Extraction through Superotemporal Incision

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Abstract

Purpose: To investigate the occurrence of corneal incision-induced astigmatism following small incision extracapsular cataract extraction through a superotemporal incision combined with intraocular lens (IOL) implantation.

Methods: A total of 255 cases (301 eyes) who received small incision extracapsular cataract extraction through a superotemporal incision with IOL implantation in the Department of Ophthalmology, Yuyan District Hospital of Guiyang were enrolled in this clinical trial. Postoperative best-corrected visual acuity and astigmatism were measured. The patients underwent 24-week follow-up.

Results: In total, 166 patients (65.1%, 166 eyes) completed follow-up. Astigmatism gradually declined between 1 and 12-week postoperatively, and stabilized after 12 weeks. Among 166 patients, 125(75.3%) had astigmatism > 0.5 D at 24 weeks post-operatively, showing mostly with-the-rule astigmatism. Visual acuity steadily improved up to 12 weeks, and tended to stabilize subsequently. Over the period of 24-week postoperatively, visual acuity was negatively correlated with astigmatism ($r=-0.691$, $P<0.05$).

Conclusion: Superotemporal small incision extracapsular extraction combined with IOL implantation is associated with modest astigmatism which declines over the post-operative period. (***Eye Science 2012; 27: 94-97***)

Keyword: cataract; surgery; surgical approach; small incision; astigmatism

Cataract is the primary cause of blindness in China. Although phacoemulsification has been widely applied in first- and second-tier cities, small incision non-phacoemulsification remains the main approach in some underdeveloped regions, especially at basic-level hospitals. Nowadays, the patients not only simply require visual acuity recovery, but also seek better visual acuity. Previous studies[1-3] revealed that intra- and post-operative complications and the occurrence of surgically induced corneal astigmatism are the main factors influencing the visual acuity following small incision non-phacoemulsification. Some scholars[4-7] also confirmed that surgical incision (incisional location, shape and size), suture, etc. may affect the incidence of surgically-induced corneal astigmatism[1-5]. In this study, the postoperative astigmatism was measured in 255 age-related cataract patients(301 eyes) who underwent combined surgery of small incision cataract extraction and IOL implantation between November, 2009, and November, 2011, at Yuyan District Hospital of Guiyang to investigate the regularity of the occurrence of surgically-induced corneal astigmatism and relevant influential postoperative factors.

Patients and methods

General information

A total of 255 aged-related cataract patients (301 eyes), aged between 51 and 87 years, (67.5±11.9) years, 135 males (170 eyes) and 120 females (131 eyes), underwent combined surgery of small incision cataract extraction and IOL implantation between November 2009 and November 2011 at Yuyan District Hospital of Guiyang.

Inclusion and exclusion criteria

Inclusion criteria: preoperative corrected visual acuity ≤0.1; lens nucleus hardness ≥III (Emery-Little classification).

Exclusion criteria: hyper-mature cataract; having a history of corneal ulcer, ocular trauma, corneal, or intraocular surgery; complicated with corneal lesions, such as keratoconus, corneal degeneration, etc.; having a history of pterygium or pterygium resection; severe surgical complications occurred intra-

DOI: 10.3969/j.issn.1000-4432.2012.02.009

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operatively, such as iris prolapse, posterior capsule rupture, vitreous loss, failed in-the-bag IOL implantation, incisional suture, etc.

Surgical procedure

a. Surface anesthesia was given by alcaine eye drops, and topical anesthesia by retrobulbar injection of 2% lidocaine; b. Superior rectus was suspended; c. Superotemporal incision was made on bulbar con junctiva and stopped bleeding by cauterization; d. Scleral incision was made, approximately 5.5 to 6.5 mm in size. The central incision had a distance of about 2 mm from the corneoscleral limbus; e. Scleral tunnel incision was created approximately 1 mm inside transparent cornea, puncture into the anterior chamber, and viscoelastic agent was injected, then continuous curvilinear capsulorhexis and water separation were performed; f. Incision size was enlarged, a lens with a diameter of 5.5 mm was implanted after nucleus delivery and cortex suction; g. Self-healing incisions were kept watertight without suture.

Detection method

All patients underwent visual acuity test, slit-lamp examination, and astigmatism measurement at 1 day, 1 week, 4 weeks, 12 weeks, and 24 weeks post-operatively. Corneal astigmatism of various time points was measured by using Gravy vector analysis method[8]. The meridians with the maximal refractive power in 90°±30° was defined as with-the-rule astig matism (+), and the meridians with the maximal refractive power in 180°±30° was defined as against-the-rule astigmatism (-). The remaining cases were recorded as oblique astigmatism.

Statistical analysis

SPSS 12.0 software was used for data analysis. The right eyes' measurement data were chosen for statistical analysis. The visual acuity and astigmatism at various time points were compared using one-way ANOVA. The correlation between visual acuity and astigmatism at 24-week post-operatively was analyzed using linear correlation. $P<0.05$ was considered statistically significant.

Results

Patients' information

A total of 166 (166 eyes) in 255 patients, 85 males (85 eyes) and 81 females (81 eyes) (aged between 51 and 83 years; (69.6±13.2) years on average) met the inclusion criteria and successfully completed the 24-week follow-up. Preoperative cataract nucleus hardness grading: 35 eyes with grade III (21.1%), 65 eyes with grade IV (39.2%), and 66 eyes with grade V(39.8%). Eighty-nine cases were excluded from this study, including 19 cases of hyper-mature cataract, 15 cases with a history of pterygium and eye surgery, 9 cases presenting with intra-operative complications, and 26 patients who lost contact during follow-up.

Post-operative astigmatism

Astigmatism could not be measured due to corneal edema at 1 day postoperatively. The astigmatism at 1-, 4-, 12- and 24-week after surgery was shown in Table 1. The results indicated that the astigmatism at each time point gradually decreased. One-way ANOVA showed that the astigmatism among various time points significantly differed($P<0.05$). Pair-wise comparison found that the visual acuity at various time points (except at 12- and 24-week) significantly differed (all $P<0.05$). At 24 weeks post-operatively, 125 of 166 cases had astigmatism >0.5D, astigmatism axis lay between 58° and 131° (with-the-rule astigmatism). Thirty nine (31.2%) among those lay between 58° and 90°, and 86 between 90° and 131°.

Correlation between postoperative visual acuity and astigmatism

Table 1 Visual acuity and astigmatism at various time points post-operatively (n=166)

Follow-up duration	Visual acuity	Astigmatism
1 day	0.10±0.32	–
1 week	0.39±0.22	+2.55±0.25
4 weeks	0.53±0.17	+1.92±0.23
12 weeks	0.65±0.12	+1.16±0.13
24 weeks	0.63±0.14	+1.08±0.16

As Table 1 shows, the postoperative visual acuity was gradually improved over time, and stabilized at 12 weeks after operation. The visual acuity at each time point significantly differed ($P<0.05$). Pair-wise comparison found that the visual acuity at various time points (except at 12- and 24-week) significantly differed (all $P<0.05$). As revealed in Table 1, postoperative astigmatism steadily declined, and vi-

sual acuity gradually increased over time. At 24-week postoperatively, visual acuity and astigmatism were negatively correlated (r=–0.691, P<0.05).

Discussion

Postoperative visual acuity is considered a vital index for evaluating the success of cataract surgery. Previous studies revealed that the visual acuity following small incision cataract extraction was also affected by surgically-induced astigmatism in addition to intraoperative complications and lens refractive error, etc[1-3]. Some scholars[9-10] found that surgically-induced astigmatism, changes in corneal refraction and refractive index, and asymmetrical arrangement of refraction elements (cornea and lens) were mainly caused by surgically-induced changes in corneal morphology. The astigmatism and axial direction may be altered before postoperative astigmatism is finally stabilized. Some investigations[5-15] reported that surgically-induced astigmatism was caused by a variety of potential factors including incisional site, shape, size, suture skill (degree of tightness, intensity, span and depth), suture type, and postoperative glucocorticoid administration, among which incisional size and location, and suture skill, are the main influential factors. It has been generally suggested that incisional length was positively correlated with postoperative astigmatism. In addition, the distance between incision and cornea was negatively correlated with astigmatism. Incisional position was correlated with the axial direction of astigmatism.

A previous study[13] indicated that the changes in astigmatism following cataract surgery adhered to the principle of astigmatism regression. At early stage after surgery, tissue edema surrounding incision enlarged the corneal profile slope of vertical meridian and flattened that of the horizontal meridian and presented with with-the-rule astigmatism. Incisional edema was relieved, and corneal astigmatism evolved into against-the-rule astigmatism over time. Axt et al[14]. confirmed that sutureless temporal incision was able to reduce the amounts of against-the-rule astigmatism preoperatively, and corneal astigmatism tended to evolve into with-the-rule astigmatism. In addition, they also found that the temporal incision increased the possibility of changing from with-the-rule astigmatism preoperatively into against-the-rule astigmatism postoperatively. Xia et al[15]. proposed that superior incision might cause with-thee-rule astigmatism to evolve into against-the-rule astigmatism, whereas temporal incision yielded opposite outcomes. Alternative studies indicated that most patients receiving temporal incision presented with with-the-rule astigmatism postoperatively[13].

In the present study, the patients with severe intraoperative complications including iris prolapse, posterior capsule rupture, vitreous loss, failed in-the-bag IOL implantation, or incisional suture were excluded to enhance the accuracy of study outcomes. The results proved that 125 cases had astigmatism > 0.5D postoperatively, and all were with-the-rule astigmatism, which is consistent with previous outcomes. Moreover, 66 eyes (39.8%) were classified as grade V nucleus; thus, intraoperative nucleus delivery was difficult to perform due to the relatively big size. We adopted manual nucleus-chop technique with small incisions—that is, guaranteeing the success of nucleus delivery from small incisions by dividing nucleus into halves, to minimize the incidence of surgically induced corneal astigmatism as much possible, to avoid severe damage, and to reduce the incidence of postoperative astigmatism.

Corneal astigmatism stems from a difference in the degree of curvature refraction of the two different meridians. Previous studies found that the astigmatism tends to occur in directivity, and is likely to change over time before corneal astigmatism stabilizes, mainly because serious incisional edema and heightened collagenous fiber tension lead to higher degrees of astigmatism, while incisional edema gradually recovers over time, which decreases the degrees of astigmatism instead. In the current investigation, the patients' astigmatism steadily decreased between 1- and 12-week postoperatively, and tended to stabilize at 12- and 24-week, indicating that the incisional injuries were basically healed, and astigmatism was stabilized at 12 weeks after cataract surgery. Correspondingly, postoperative visual acuity gradually increased before 12 weeks and then stabilized after 12 weeks. Related studies indicated that visual acuity was negatively correlated with astigmatism, confirming that corneal astigmatism is a key

factor for determining the visual acuity post-cataract surgery. Hence, much attention has been paid to incision design, incision protection, avoiding avulsion, and ensuring as sutureless an incision as possible when kept under watertight condition. Additionally, the results indicated that it is more appropriate for the patients presenting with ametropia to wear corrected glasses after 12 weeks following cataract surgery with small incisions.

To sum up, the results in this clinical study reveal that small incision cataract extraction through superotemporal incision has a relatively mild influence on the incidence of corneal astigmatism postoperatively. Most patients present with with-the-rule astigmatism. Such a surgical approach brings benefits to blindness preventions for the cataract population, which deserves widespread application in basic-level hospitals.

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