Original Article

Surgically induced astigmatism after 3.0 mm temporal and nasal clear corneal incisions in bilateral cataract surgery

Je Hwan Yoon, Kyun-Hyung Kim, Jong Yeon Lee, Dong Heun Nam

Aims: To compare the corneal refractive changes induced after 3.0 mm temporal and nasal corneal incisions in bilateral cataract surgery. Materials and Methods: This prospective study comprised a consecutive case series of 60 eyes from 30 patients with bilateral phacoemulsification that were implanted with a 6.0 mm foldable intraocular lens through a 3.0 mm horizontal clear corneal incision (temporal in the right eyes, nasal in the left eyes). The outcome measures were surgically induced astigmatism (SIA) and uncorrected visual acuity (UCVA) 1 and 3 months, post-operatively. Results: At 1 month, the mean SIA was 0.81 diopter (D) for the temporal incisions and 0.92 D for nasal incisions ($P = 0.139$). At 3 months, the mean SIA were 0.53 D for temporal incisions and 0.62 D for nasal incisions ($P = 0.309$). The UCVA was similar in the 2 incision groups before surgery, and at 1 and 3 months post-operatively. Conclusion: After bilateral cataract surgery using 3.0 mm temporal and nasal horizontal corneal incisions, the induced corneal astigmatic change was similar in both incision groups. Especially in Asian eyes, both temporal and nasal incisions (3.0 mm or less) would be favorable for astigmatism-neutral cataract surgery.

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The aims of modern cataract surgery are rapid visual rehabilitation and the best uncorrected visual acuity (UCVA) possible with minimal post-operative astigmatism.[1] Modern cataract surgery techniques allow rapid visual recovery but surgically induced astigmatism (SIA) remains a common obstacle to achieving an excellent UCVA.[2] SIA is related to the type, length and location of the incision, and the suture closure technique.[3,4]

Previous studies examined the astigmatism induced after an incision in various locations including the superior, superotemporal, superonasal, temporal, and nasal.[5] These studies on the use of ranges from 3.5 mm to 4.0 mm corneal incisions in phacoemulsification concluded that nasal locations induced greater refractive changes than temporal regions, and temporal incisions induced the smallest SIA.[2,5] Therefore, a temporal incision in a temporal position has been a popular method in modern phacoemulsification cataract surgery (temporal approach). On the other hand, recent evidence suggests that a small (ranges from 2.8 mm to 3.0 mm) clear corneal incisions (CCIs) induce little refractive change.[6] Furthermore, locating the incision temporally in the right eye and nasally in the left eye might be comfortable for a right-handed cataract surgeon, who prefers to work from the 12 o'clock position relative to the patient (superior approach). This study compared the effect of 3.0 mm temporal and nasal CCIs on SIA in bilateral cataract surgery using the superior approach.

Materials and Methods

This prospective study included 60 eyes of 30 consecutive patients with bilateral senile cataract. The patients were scheduled to undergo separate bilateral cataract surgery with an interval of 1 day between procedures. None of the patients had a history of previous ocular surgery or diseases that would affect the corneal refraction. Written informed consent was obtained from each patient.

All eyes underwent a complete ophthalmological examination pre-operatively and post-operatively at 1 month and 3 month, including a manifest refraction using a refractometer and snellen projector chart. Astigmatism was measured from the keratometry readings. Data on gender, age, UCVA, manifest refraction, and automatic keratometry (ARK-510A, NIDEK) were collected.

All operations were performed by a single experienced surgeon using the same technique and sub-tenon anesthesia in all cases. The surgeon sat in the superior position. Three-step, CCIs were made with a 3.0 mm disposable blade. Temporal CCIs and nasal CCIs were used in all right and left eyes, respectively. The depth of the first cut, a precut, was approximately one third of the corneal depth; the tunnel length was 1.50 mm to 1.75 mm. After injecting sodium hyaluronate (Hyal plus®), capsulorhexis (approximately 5.0 mm in diameter), a side port incision and hydrodissection were performed. After phacoemulsification and cortex removal, a 1-piece foldable acrylic intraocular lens (TECNIS® 1-Piece intraocular lens (IOL), AMO) was then inserted. At the conclusion of surgery, a single, radial, 10-0 Nylon suture was passed across the wound in the center of the incision and closed to achieve simple apposition of the wound without tension or gape. The suture was removed 7 days after surgery.

SIA was calculated by vector analysis using the Holladay-Carvy-Koch formula.[7] A paired Wilcoxon test was performed to determine if there was a significant effect on induced astigmatism depending on the incision location (temporal or nasal). An intra-individual comparison of the 2 groups was considered significant if $P < 0.05$.

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Results

Each group contained 30 bilateral cases. The mean age of the patients at the time of the baseline was 66.2 ± 7.6 years; there were 17 men and 13 women. The pre-operative corneal astigmatism in both groups ranged from 0.0 to 2.58 diopter (D). The level of pre-operative astigmatism was similar in the two groups (0.71 ± 0.43 in temporal incision group, 0.58 ± 0.53 in nasal incision group, $P = 0.100$).

Table 1 lists the change in the mean corneal astigmatism over time. Total astigmatism between temporal and nasal incision group was not different. Corneal astigmatism of the temporal incision group was unchanged, whereas, corneal astigmatism of the nasal incision group increased slightly, but the change in the nasal group was not significant.

Table 2 and Fig. 1 show the surgically-induced astigmatic change at 1 and 3 months post-operatively calculated by vector analysis using the Holladay-Cravy-Koch method. The mean SIA in the temporal and nasal CCI groups at 1 month was 0.81 ± 0.64 and 0.92 ± 0.53, respectively. The SIA of the temporal and nasal groups decreased to 0.53 ± 0.39 and 0.62 ± 0.48 at 3 months, respectively, but the difference in SIA between the groups was not significant.

Table 3 shows the mean UCVA over time. The UCVA of both groups at 1 and 3 month was higher than that before surgery, and there was no significant difference between the groups. Nevertheless, the UCVA of the nasal incision was slightly better than that of the temporal incision.

Discussion

Most modern cataract surgeons sit at the temporal aspect of the patient and use temporal CCIs (temporal approach). On the other hand, some cataract surgeons prefer to sit at the superior aspect of the patient and use horizontal CCIs (superior approach). Superior approach cataract surgery has several potential advantages over the temporal approach. The surgeon always operates from the head of the table and does not need to change position during the procedure. Therefore, for a right-handed surgeon, the horizontal incision at 180° is temporal in the right eye and nasal in the left. The advantage of a horizontal incision at 180° is that the surgical technique is identical for the right and left eyes.[8] The surgeon operates from the top of the operating table in both cases. In addition, cataract surgery using the superior approach is advantageous to combined operations with pars plana vitrectomy, trabeculectomy, and simultaneous bilateral cataract surgery. In the temporal approach, the surgeons and assistants need to arrange the situation with the operating table and move their operating position. Most operating tables are not constructed for a surgeon sitting at the side of the patient.

In horizontal incisions, however, the nasal incision has several potential disadvantages over a temporal incision. First, horizontal, CCI phacoemulsification induces with-the-rule astigmatism of a larger magnitude in the left eyes (nasal incision) than in the right eyes (temporal incision). The optical center of the cornea is not identical to the geometrical center; the optical center is located somewhat more nasally and

Table 1: Mean preoperative and postoperative corneal astigmatism

	Total astigmatism (mean±SD†) (*n*=30)		*P* value*
	Temporal incision	Nasal incision	
Pre-operative	0.71±0.43	0.58±0.53	0.100
Post-operative			
1 month	0.78±0.67	0.88±0.52	0.397
3 month	0.64±0.44	0.78±0.64	0.178

*Wilcoxon signed ranked test, †SD: Standard deviation

Table 2: Surgically-induced mean astigmatic change by vector analysis using the Holladay-Cravy-Koch formula

	Surgical induced astigmatism (mean±SD†) (*n*=30)		*P* value*
	Temporal incision	Nasal incision	
Post-operative			
1 month	0.81±0.64	0.92±0.53	0.139
3 month	0.53±0.39	0.62±0.48	0.309

*Wilcoxon signed ranked test, †SD: Standard deviation

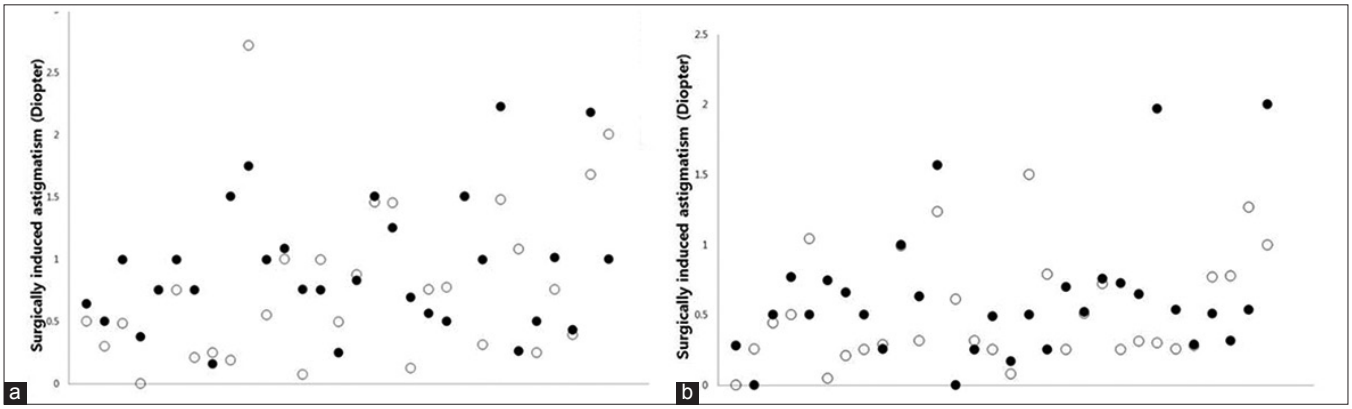

Figure 1: (a) Scatter diagram of surgically induced astigmatism at 1 month post-operatively calculated by vector analysis. (b) Scatter diagram of surgically induced astigmatism at 3 months post-operatively (Empty circle: Temporal incision; Nasal incision: Black circle)

Table 3: Mean pre-operative and post-operative uncorrected visual acuity

	Uncorrected visual acuity (LogMAR, mean±SD†) (*n*=30)		*P* value*
	Temporal incision	Nasal incision	
Pre-operative	0.37±0.30	0.40±0.28	0.782
Post-operative			
1 month	0.21±0.20	0.15±0.14	0.276
3 month	0.25±0.30	0.17±0.15	0.338

*Wilcoxon signed ranked test, †SD: Standard deviation, LogMAR: Logarithm of the minimum angle of resolution

inferiorly.[9] Therefore, a nasal incision will be closer to the center of the cornea than a temporal incision, and will have a greater effect on the changes in corneal curvature. Second, the difference in induced astigmatism might be related to the surgical approach. The surgeon must operate in the left eye over the back of the patient's nose and eyebrow. This leads to a steeper angle of approach, particularly during the use of an incision keratome and phaco hand-piece. The steeper access of the phaco hand-piece might result in more wound stress and stretching of the corneal tissue.[5] In particular, nasal incision cataract surgery would be technically difficult in patients with deep-set globes.

The main aim of this study was to compare the SIA caused by 3 mm temporal and nasal incisions for each individual. The study was designed to avoid inter-individual variations. In this study, a 3.0 mm corneal incision was used, and the effects on the SIA and corneal astigmatism of the temporal CCI in the right eye and nasal CCI in the left eye were compared over a 3 month follow-up. The UCVA in the 2 types of incision were also compared. Both the SIA and UCVA were similar between the temporal and nasal CCIs, pre-operatively and post-operatively.

Recently, the size of the corneal incision has become gradually smaller, and previous studies indicated that a smaller incision size is associated with earlier refraction stabilization and a reduced magnitude and variability of SIA.[10-14] Although, an astigmatic axis shift is affected by the size, location, and shape of the incision, it was reported that the incision size has a major impact on SIA.[15] The appropriate size for a self-sealing corneal incision is 3.0-3.5 mm,[16] and the allowable limit of the keratometric shift for refraction and visual rehabilitation is approximately 0.50 D.[12,13] This can be achieved with a 3.0 mm incision. With the introduction of micro-incisions (2.2 mm or less), it is now possible to minimize the SIA compared to larger incisions.[10] This means that in the future there will be no need to consider the incision locations, temporally or nasally.

Moreover, surgical equipments and skills in modern cataract surgery have been advanced gradually. Therefore, wound stress and stretching of the corneal tissue might be decreased, particularly in a nasal incision. In Asian people, the heights of the nose and eyebrow are lower than other ethnic groups, so the operators can ease surgical manipulations. Decreased wound stress and stretching can make a smaller SIA. Therefore, the differences in SIA between a nasal incision and temporal incision in the present study could be smaller than in previous studies. In this study, the amounts of SIA were similar in temporal and nasal CCIs.

In modern cataract surgery, the considering factors for optimum UCVA are surgical experience, preexisting corneal astigmatism, biometry prediction, and induced astigmatism.[2] Currently, surgical complications and biometry prediction errors are rather low. Induced astigmatism shows a diminishing tendency. In the present study, the SIAs following both 3.0 mm temporal and nasal CCIs were similar, approximately 0.50 D. The induced corneal astigmatic change would be minimal with the introduction of micro-incision cataract surgery. Therefore, induced astigmatism may not be a limiting factor for an improved UCVA. Both temporal and nasal horizontal incisions (3.0 mm or less) are suitable for astigmatism-neutral cataract surgery, especially in Asian eyes.

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References

1. Rainer G, Menapace R, Vass C, Annen D, Findl O, Schmetterer K. Corneal shape changes after temporal and superolateral 3.0 mm clear corneal incisions. J Cataract Refract Surg 1999;25:1121-6.
2. Barequet IS, Yu E, Vitale S, Cassard S, Azar DT, Stark WJ. Astigmatism outcomes of horizontal temporal versus nasal clear corneal incision cataract surgery. J Cataract Refract Surg 2004;30:418-23.
3. Simşek S, Yaşar T, Demirok A, Cinal A, Yilmaz OF. Effect of superior and temporal clear corneal incisions on astigmatism after sutureless phacoemulsification. J Cataract Refract Surg 1998;24:515-8.
4. Roman SJ, Auclin FX, Chong-Sit DA, Ullern MM. Surgically induced astigmatism with superior and temporal incisions in cases of with-the-rule preoperative astigmatism. J Cataract Refract Surg 1998;24:1636-41.
5. Kohnen S, Neuber R, Kohnen T. Effect of temporal and nasal unsutured limbal tunnel incisions on induced astigmatism after phacoemulsification. J Cataract Refract Surg 2002;28:821-5.
6. Giansanti F, Rapizzi E, Virgili G, Mencucci R, Bini A, Vannozzi L, *et al*. Clear corneal incision of 2.75 mm for cataract surgery induces little change of astigmatism in eyes with low preoperative corneal cylinder. Eur J Ophthalmol 2006;16:385-93.
7. Holladay JT, Cravy TV, Koch DD. Calculating the surgically induced refractive change following ocular surgery. J Cataract Refract Surg 1992;18:429-43.
8. Ermiş SS, Inan UU, Oztürk F. Surgically induced astigmatism after superotemporal and superonasal clear corneal incisions in phacoemulsification. J Cataract Refract Surg 2004;30:1316-9.
9. Duke-Elder S, Wybar KC. System of Ophthalmology. Vol 2: The Anatomy of the Visual System. London: Henry Kimpton; 1961.
10. Wang J, Zhang EK, Fan WY, Ma JX, Zhao PF. The effect of micro-incision and small-incision coaxial phaco-emulsification on corneal astigmatism. Clin Experiment Ophthalmol 2009;37:664-9.
11. Wei YH, Chen WL, Su PY, Shen EP, Hu FR. The influence of corneal wound size on surgically induced corneal astigmatism after phacoemulsification. J Formos Med Assoc 2012;111:284-9.
12. Long DA, Monica ML. A prospective evaluation of corneal curvature changes with 3.0-to 3.5-mm corneal tunnel phacoemulsification. Ophthalmology 1996;103:226-32.
13. Kohnen T, Dick B, Jacobi KW. Comparison of the induced

astigmatism after temporal clear corneal tunnel incisions of different sizes. J Cataract Refract Surg 1995;21:417-24.

14. Luo L, Lin H, He M, Congdon N, Yang Y, Liu Y. Clinical evaluation of three incision size-dependent phacoemulsification systems. Am J Ophthalmol 2012;153:831-9.
15. Anders N, Pham DT, Antoni HJ, Wollensak J. Postoperative astigmatism and relative strength of tunnel incisions: A prospective clinical trial. J Cataract Refract Surg 1997;23:332-6.
16. Monica ML, Long DA. Nine-year safety with self-sealing corneal tunnel incision in clear cornea cataract surgery. Ophthalmology 2005;112:985-6.

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