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CLINICAL STUDY

Surgically induced astigmatism after 23-gauge transconjunctival sutureless vitrectomy

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Abstract

Purpose: To evaluate surgically induced astigmatism (SIA) after 23-gauge transconjunctival sutureless vitrectomy (23GTSV).
Methods: We studied 56 patients (56 eyes) who underwent 23GTSV between January 2006 and December 2007 and who underwent preoperative and 1- and 3–4-months postoperative corneal topography. Fifteen of the 56 patients underwent combined 23GTSV and cataract surgery. SIA was evaluated with Naeser's polar method using the simulated keratometric values obtained with corneal topography. Preoperative and postoperative KP and ΔKP values were compared in the 23GTSV only group and the combined 23GTSV and cataract surgery group.
Results: There were no significant serial changes between the preoperative and postoperative Sim K astigmatism or KP values in the 23GTSV only group. In the 23GTSV only group, the ΔKP (90) was negative (-0.10 ± 0.78) at 1 month postoperatively, but it became positive (0.13 ± 0.85) at 3–4 months postoperatively. The ΔKP (135) showed serially decreasing negative values, -0.02 ± 0.80 at 1 month postoperatively and -0.08 ± 0.60 at 3–4 months postoperatively. In the combined cataract surgery group, the 1- and 3–4-month postoperative ΔKP (135) values were -0.64 ± 0.50 and -0.71 ± 0.48, respectively, which represented a significant decrease compared with the 23GTSV only group ($P < 0.001$, Mann–Whitney _U_-test). Although statistically insignificant, the ΔKP (135) value was more negative in the sclerotomy-sutured group ($n = 6$) than the sclerotomy non-sutured group ($n = 35$) at 1 month postoperatively (-0.67 ± 1.19 _vs_ 0.09 ± 0.67, $P = 0.110$, Mann–Whitney _U_-test).
Conclusion: The 23GTSV does not induce significant SIA in the early postoperative period.
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Keywords: surgically induced astigmatism; 23-gauge transconjunctival sutureless vitrectomy; corneal topography

Introduction

Recently, transconjunctival sutureless vitrectomy (TSV) has gained in popularity, as several clinical studies have shown its clinical efficacy.[1–8] By eliminating the need for scleral cautery or suture, TSV might reduce postoperative surgically induced astigmatism (SIA). There have been a few studies looking at astigmatic changes after TSV. Yanyali _et al_[9] reported no significant corneal surface or astigmatic changes in the early postoperative period after 25-gauge TSV. Okamoto _et al_ compared changes in regular and irregular corneal astigmatism after 25-gauge TSV and 20-gauge standard vitrectomy using Fourier harmonic analysis. The 20-gauge vitrectomy group showed significant changes in corneal topography, whereas the 25-gauge TSV group did not.[10] The sclerotomy size in 23-gauge transconjunctival sutureless vitrectomy (23GTSV) is 0.7 mm and has a greater potential for causing SIA than 25-gauge sclerotomy does (0.5 mm). However, most of the reports on postoperative astigmatic changes after TSV have evaluated the 25-gauge system, so no data is available to determine whether SIA is significant after 23GTSV. Thus, we performed

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this study to evaluate SIA after 23GTSV with the polar method using serial corneal topography.

Materials and methods

Patients

In this retrospective study, we studied 56 patients (56 eyes) who underwent 23GTSV under the care of a single surgeon (KHP) at the retina and vitreous disease referral centre of Seoul National University Bundang Hospital between January 2006 and December 2007. Forty-one patients underwent 23GTSV without cataract surgery, and 15 patients underwent combined 23GTSV and cataract surgery. This study adhered to the Declaration of Helsinki and was approved by the institutional review board of the clinical research institute. We performed preoperative corneal topography, as well as at least two consecutive postoperative (1 and 3–4 months) corneal topographies. Those patients with a history of corneal trauma, long-term contact lens use, severe dry eye with an irregular corneal surface, scleromalacia, earlier ocular surgery (except cataract surgery at least 6 months before 23GTSV), or corneal diseases (dystrophies, degenerations, ulcers, etc.) that might influence corneal topography were excluded from the study. Those patients who were not able to cooperate in the performance of serial corneal topography and those with complications that required additional scleral buckling, cryotherapy, or silicone oil injection were also excluded. Eight eyes required intraoperative sclerotomy site sutures because of persistent leakage after cannula removal. None of the patients showed postoperative hypotony or serious complications such as retinal detachment, suprachoroidal haemorrhage, or endophthalmitis. Patient demographics, preoperative diagnosis, and operative procedures are summarized in Table 1.

Table 1 Patient demographics, preoperative diagnoses, and operative procedures in patients who underwent 23-gauge transconjunctival sutureless vitrectomy (23GTSV)

	23GTSV only	*Combined group*
Demographics		
Number of patients	41	15
Male : female	15 : 26	4 : 11
Age	60.2 ± 10.1	64.9 ± 8.3
Right : left	16 : 25	5 : 10
Preoperative diagnosis		
PDR TRD, VH	16 (39.0%)	5 (33.3%)
BRVO VH	6 (14.6%)	2 (13.3%)
Idiopathic ERM	17 (41.5%)	3 (20%)
CRVO, ERM	1 (2.4%)	0
Retinoschisis	1 (2.4%)	0
Macular hole	0	5 (33.3%)
Operative procedures		
PE and PCL	0	15 (100%)
Membrane peeling	34 (82.9%)	13 (86.7%)
Endolaser	23 (56.1%)	7 (16.3%)
Intravitreal gas injection	2 (4.9%)	5 (11.6%)
Intravitreal Avastin injection	6 (14.6%)	2 (4.6%)
IVTA	1 (2.4%)	2 (4.6%)
Suture of sclerotomy wound	6 (14.6%)	2 (13.3%)

Abbreviations: BRVO, branch retinal vein occlusion; CRVO, central retinal vein occlusion; ERM, epiretinal membrane; IVTA, intravitreal triamcinolone acetonide injection; PDR, proliferative diabetic retinopathy; PE and PCL, phacoemulsification and posterior chamber lens insertion; TRD, tractional retinal detachment; VH, vitreous haemorrhage. Combined group: 23GTSV and cataract surgery.

Topographic evaluation

Corneal topography was performed with the Orbscan II system (Bausch and Lomb, Orbtek Inc., Salt Lake City, UT, USA) before surgery and at 1 and 3–4 months after surgery.

Surgical procedure

After local anaesthesia was achieved with a retrobulbar injection of 2–3 ml of 3% lidocaine, a 23-gauge stiletto blade (45° angle, DORC, Zuidland, Holland) was inserted at a 15–30° angle through the conjunctiva, sclera, and pars plana 3.5 mm from the corneoscleral limbus at three points: superotemporal, superonasal, and inferotemporal quadrants. A microcannula (DORC, Zuidland, Holland) was then inserted through the conjunctival incision and into the scleral tunnel using a specially designed blunt inserter. At the conclusion of the operation, the cannulae were simply withdrawn from their scleral tunnels. The conjunctiva was pushed laterally using a cotton-wool applicator. If there was persistent leakage from the wound, the sclerotomy site was sutured with 8–0 vicryl. Combined phacoemulsification and IOL insertion was performed before microcannula insertion in those patients who needed it. A clear corneal incision was made at the 10 o'clock position with a disposable metal blade. The width and length of the overall corneal incision were approximately 3.2 and 2.0 mm, respectively. An additional puncture for the insertion of the second instrument was made with a super-sharp blade at the 2 o'clock position on the limbus. After phacoemulsification of the nucleus and irrigation and aspiration of the remnant lens cortical material, an acrylic foldable IOL (MA60BM, AcrySof, Alcon, Fort Worth, TX, USA) was inserted in the capsular bag.

The corneal incision was sutured temporarily with a stitch of 10–0 nylon before vitrectomy for prevention of eyeball collapse during TSV. At the conclusion of the surgery, 10–0 nylon was removed routinely. No cases required suturing of the corneal incision because of wound leakage.

Astigmatism evaluation

Simulated keratometry (Sim K) values were taken from the topographic data, and preoperative Sim K astigmatism was compared with postoperative values.

We also evaluated SIA using the polar method of Naeser in the form of KP (90) and KP (135), where[11–13]

$$\mathrm{KP}\,(90) = M\{sin^2(\alpha) - cos^2(\alpha)\}$$

$$\mathrm{KP}\,(135) = M\{sin^2(\alpha - 45) - cos^2(\alpha - 45)\}$$

$$\text{SIA expressed as KP (90)} = \Delta\mathrm{KP}(90) = \mathrm{KP}(90)_{\mathrm{postop}} - \mathrm{KP}(90)_{\mathrm{preop}}$$

$$\text{SIA expressed as KP (135)} = \Delta\mathrm{KP}\,(135) = \mathrm{KP}\,(135)_{\mathrm{postop}} - \mathrm{KP}\,(135)_{\mathrm{preop}}$$

in which M is the magnitude of the net astigmatism (diopters) and α is the direction of the steepest meridian (degrees). We calculated KP values using simulated keratometric readings and their axes. It is known that any pair of polar values, separated by an arc of 45°, characterizes a net astigmatism completely (eg KP (90) and KP (135), or KP (180) and KP (45), etc.).[14] As the vitrectomy was performed mainly in a vertical plane (operating instruments were inserted through microcannulae in the superotemporal and superonasal sclerotomy quadrants) and the clear corneal incision during cataract surgery was performed in an oblique plane, we investigated two KP values for the evaluation of SIA: KP (90) and KP (135). When looking at the two orthogonal planes—90 and 180°—a positive ΔKP (90) indicates a steepening of the vertical meridian, or with-the-rule (WTR) change. A negative ΔKP (90) indicates flattening of the vertical meridian or against-the-rule (ATR) change. A positive ΔKP (135) indicates induced anticlockwise torque, and a negative ΔKP (135) indicates induced clockwise torque.[13]

Statistical analysis

SPSS software version 12.0 (SPSS Inc., Chicago, IL, USA) was used for all statistical analyses. The preoperative and postoperative Sim K astigmatism, KP (90), and KP (135) were compared using repeated measures ANOVA. Comparison of ΔKP values between the 23GTSV only and combined 23GTSV and cataract surgery groups was carried out using the Mann–Whitney *U*-test. *P*-values <0.05 were considered statistically significant.

Results

There were no significant changes between the preoperative and postoperative Sim K astigmatism or KP values in the 23GTSV only group (Table 2). The ΔKP (90) was slightly negative (-0.10 ± 0.78) at 1 month postoperatively, but it was positive (0.13 ± 0.85) at 3–4 months postoperatively. The ΔKP (135) showed serially decreasing negative values, -0.02 ± 0.80 at 1 month and -0.08 ± 0.60 at 3–4 months postoperatively (Table 3).

However, the combined 23GTSV and cataract surgery group showed significant increases in Sim K astigmatism and significant decreases in KP (135) values after surgery (Table 2). The ΔKP (90) changes showed a pattern similar to those in the 23GTSV only group, with negative values at 1 month postoperatively (-0.33 ± 0.88) and positive value at 3–4 months postoperatively (0.07 ± 0.55). The ΔKP (135) also showed similar patterns with serially decreasing negative values, whereas the change was significantly larger than that seen in the 23GTSV only group (Table 3).

There were no significant differences in ΔKP values between the right and left eyes in the 23GTSV only group (Table 4). Six of 41 patients who underwent 23GTSV only had sclerotomy site suturing performed because of persistent leakage after cannula removal. The sclerotomy-sutured group ($n = 6$) showed more negative ΔKP (135) values at 1 month postoperatively than the sclerotomy non-sutured group ($n = 35$) did. However, the difference was statistically insignificant (-0.67 ± 1.19 *vs* 0.09 ± 0.67, $P = 0.110$, Mann–Whitney *U*-test; Table 5).

Discussion

Earlier studies that showed corneal topographic changes after vitrectomy have evaluated only topographic parameters or decomposed indices, which represents only the magnitude of astigmatic changes without considering the direction of astigmatism.[9,10,15] We evaluated astigmatic changes after 23GTSV using Naeser's polar method, and we were able to evaluate not only changes in astigmatism magnitude, but changes in its direction, as well. To our knowledge, this is the first report to use corneal topography to evaluate postsurgical astigmatism induced by 23GTSV.

In the 23GTSV only group, the ΔKP (90) value was negative at 1 month postoperatively, but it was positive at 3 months postoperatively (Table 3 and non-suture

Table 2 Serial changes in Sim K astigmatism and KP values in the 23-gauge transconjunctival sutureless vitrectomy (23GTSV) only group and in the combined 23GTSV and cataract surgery group

		Preoperative	*Postoperative 1 month*	*Postoperative 3–4 months*	*P-value*[a]
23GTSV only ($n=41$)	Sim K astigmatism	1.13 ± 0.74	1.22 ± 0.89	1.20 ± 0.68	0.702
	KP (90)	0.28 ± 1.18	0.18 ± 1.24	0.41 ± 1.19	0.240
	KP (135)	−0.14 ± 0.61	−0.16 ± 0.85	−0.24 ± 0.54	0.661
Combined group ($n=15$)	Sim K astigmatism	0.88 ± 0.44	1.37 ± 0.62	1.34 ± 0.65	0.001
	KP (90)	0.08 ± 0.95	−0.25 ± 1.26	0.15 ± 1.28	0.306
	KP (135)	0.04 ± 0.36	−0.60 ± 0.59	−0.67 ± 0.44	<0.001

[a]Repeated measures ANOVA.

Table 3 Comparison of surgically induced astigmatism between the 23-gauge transconjunctival sutureless vitrectomy (23GTSV) only group and the combined 23GTSV and cataract surgery group

	23GTSV only (n = *41*)	*Combined group* (n = *15*)	*P-value*[a]
ΔKP (90)			
Postoperative 1 month	−0.10 ± 0.78	−0.33 ± 0.88	0.341
Postoperative 3–4 months	0.13 ± 0.85	0.07 ± 0.55	0.523
ΔKP (135)			
Postoperative 1 month	−0.02 ± 0.80	−0.64 ± 0.50	<0.001
Postoperative 3–4 months	−0.08 ± 0.60	−0.71 ± 0.48	<0.001

[a]Mann–Whitney *U*-test.

Table 4 Comparison of surgically induced astigmatism between the right and left eyes in the 23-gauge transconjunctival sutureless vitrectomy (23GTSV) only group

	Right eye (n = *16*)	*Left eye* (n = *25*)	*P-value*[a]
ΔKP (90)			
Postoperative 1 month	−0.14 ± 0.69	−0.06 ± 0.84	0.947
Postoperative 3–4 months	0.04 ± 0.91	0.19 ± 0.81	0.500
ΔKP (135)			
Postoperative 1 month	−0.22 ± 0.86	0.11 ± 0.75	0.761
Postoperative 3–4 months	−0.08 ± 0.36	−0.09 ± 0.72	0.534

[a]Mann–Whitney *U*-test.

Table 5 Comparison of surgically induced astigmatism between the sclerotomy suture group and the non-suture group in the 23-gauge transconjunctival sutureless vitrectomy (23GTSV) only group

	Suture (n = *6*)	*Non-suture* (n = *35*)	*P-value*[a]
ΔKP (90)			
Postoperative 1 month	−0.05 ± 1.36	−0.10 ± 0.66	0.577
Postoperative 3–4 months	−0.25 ± 0.96	0.20 ± 0.82	0.356
ΔKP (135)			
Postoperative 1 month	−0.67 ± 1.19	0.09 ± 0.67	0.110
Postoperative 3–4 months	−0.14 ± 0.20	−0.07 ± 0.64	0.900

[a]Mann–Whitney *U*-test.

group in Table 5). This suggests that there might have been ATR astigmatic changes at 1 month postoperatively, but WTR astigmatic changes at 3 months postoperatively. The ΔKP (135) changes suggest that there is serial clockwise torque after surgery. We compared preoperative and postoperative KP values in the 23GTSV only group and found no significant serial changes, so those ΔKP values that are calculated from the differences between preoperative and postoperative KP values should also be negligible (Tables 2 and 3).

However, in the combined 23GTSV and cataract surgery group, Sim K astigmatism was significantly increased after the surgery, and KP (135) was significantly decreased (Table 3). These findings suggest that, after combined surgery, the net magnitude of astigmatism was increased and there was flattening along the direction of the corneal incision wound made at the 10 o'clock position.

Low astigmatic changes in the TSV systems are thought to be related to the absence of scleral sutures.[10,15–17] We performed sclerotomy incisions at three points: superotemporal, superonasal, and inferotemporal quadrants. These were located at symmetrical points between the right and left eyes. If SIA is related to wound construction and sclerotomy site healing, SIA might vary in the opposite or symmetrical direction in the right and left eyes. However, we noted no significant differences based on laterality (Table 4).

Although the difference was not statistically significant because of the small number of cases, the sclerotomy site-sutured group showed more negative ΔKP (135) values (-0.67 ± 1.19) than the non-sutured group (0.09 ± 0.67) did at 1 month postoperatively; this difference diminished at 3–4 months postoperatively (-0.14 ± 0.20 *vs* -0.07 ± 0.64). Six patients received sclerotomy site sutures: three had all three sclerotomy sites sutured, one patient had the two superior sites sutured, and one patient each had only the superotemporal or superonasal wound sutured. Despite the small bite of 8-0 vicryl suture parallel to limbus, a transient astigmatic effect might have been induced by sclerotomy wound suturing. However, the number of patients in the sutured group was too small and the sutured sclerotomy wounds were too diverse to obtain meaningful, statistically significant data depending on the suture site.

In this study, we evaluated SIA with Naeser's polar method and concluded that 23GTSV does not induce significant SIA in the early postoperative period.

As the methods of astigmatic evaluation were different, we could not directly compare our results with those of other studies on astigmatic changes after 25-gauge TSV or after standard 20-gauge vitrectomy. We calculated the 1- and 3-month postoperative ΔKP (90) and ΔKP (135) values for 20-gauge vitrectomy using the study of Domniz *et al*,[16] which reported the corneal surface changes after pars plana vitrectomy and scleral buckling surgery. The postoperative ΔKP (90) was 0.40 at 1 month and 0.52 at 3 months. The postoperative ΔKP (135) was -0.30 at 1 month and -0.37 at 3 months. The ΔKP (90) and ΔKP (135) were larger than those seen in our 23GTSV only group, whereas the ΔKP (135) was less than that of the combined 23GTSV and cataract surgery group in our study. This might imply that SIA is larger after 20-gauge vitrectomy than it is after 23GTSV, but is still smaller than that seen after cataract surgery.

Our study was limited because of the fact that it was a small retrospective case series, it had limited follow-up, and there was no comparison group. Earlier studies have shown no significant corneal topographic index changes in the early postoperative period (<1 month) after 25-gauge TSV. In cases of 20-gauge vitrectomy, significant corneal topographic changes in the early postoperative period have been shown to disappear at 1–3 months after surgery.[9,10,15] Although we could not obtain early postoperative data, we measured not only corneal topographic indices at the examination point, but also astigmatic changes constituted from the magnitude and direction, and found that there were no significant radial or torsional astigmatic changes during the period spanning 1–4 months after 23GTSV.

Owing to the small number of cases and low suture rate, there were too few patients to evaluate the effect of sclerotomy site sutures on SIA. Although we could not prove the influence of sclerotomy site sutures on SIA, we believe that even a small sclerotomy site suture could induce a transient astigmatic effect. Besides the short operation time, early recovery, and reduction in postoperative discomfort, the absence of sutures is also an important advantage in TSV in terms of SIA, compared with traditional vitrectomy. Further prospective, case control studies with larger numbers of patients should be considered to compare SIA between patients undergoing 23GTSV and those undergoing 25- or 20-gauge TSV.[18,19] Such a study would allow for assessment of the effect of sclerotomy wound size on SIA.

In conclusion, 23GTSV did not induce significant SIA in the early postoperative period. Even if the sclerotomy size and suture bite are very small, sclerotomy sutures might induce astigmatism at up to 1 month postoperatively. Further study is needed to determine the SIA as it relates to sclerotomy size.

Conflict of interest

The authors declare no conflict of interest.

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