

Toric markers–assisted implantation of the scleral–fixated intraocular lens

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Abstract

• **AIM:** To evaluate the efficacy of toric intraocular lens markers –assisted implantation of the scleral –fixated intraocular lens (SFIOL).

• **METHODS:** From October 2010 to December 2013, all patients who had undergone secondary SFIOL implantation were assigned to group 1 and 2, in group 1 SFIOL was performed with the assist of radial keratotomy (RK)–marker, and in group 2 SFIOL was performed with the assisted of toric intraocular lens markers (T–and axis markers). Patients' demographic data and information on baseline preoperative visual acuity, indication for surgery and latest postoperative visual acuity were collected and analyzed. The haptic and optic positions were determined by ultrasound biomicroscopy. The optic tilt angle and decentration distance were measured.

• **RESULTS:** The study evaluated 43 eyes of 43 patients ranging in age from 3 to 66y. Group 1 comprised 24 eyes (24 patients) and group 2, 19 eyes (19 patients). Uncorrected reoperative acuity was improved on all the eyes postoperatively. The improved postoperative acuity was significantly more in group 2 than that in group 1 (1.11 ± 0.38 vs 0.82 ± 0.45 logMAR; $F=4.85$, $P=0.03$). Ultrasonic biomicrograph examination showed that the rate of haptic asymmetry was significantly higher in group 1 (42%, 10/24) than that in group 2 (11%; 2/19) (Chi square=3.68, $P=0.04$). The mean tilted degree in group 1 was significantly higher than that in group 2 ($P=0.04$). Mean decentration distance in group 1 was greater than that in group 2 ($P=0.03$).

• **CONCLUSION:** During SFIOL the toric markers help the surgeon identify the placement of fixation more precisely than that with the use of RK marker.

• **KEYWORDS:** scleral fixation; intraocular lens; aphakia; toric markers

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INTRODUCTION

In aphakic correction, intracapsular posterior chamber intraocular lens (IOL) implantation offers superior visual rehabilitation in comparison to aphakic spectacles or contact lenses. In the absence of sufficient capsular support, scleral–fixated intraocular lens (SFIOL) is an accepted alternative in both nonvitrectomised and vitrectomised eyes^[1-2]. Ideally, the SFIOL is replaced in ciliary sulcus, behind the iris plane, and is not tilt and decentration^[3]. Because of the absence of adequate capsule support, the placement of SFIOL is mainly dependent on the positional symmetry of the fixated haptics. During the initial set-up of SFIOL, careful attention to the placement of the site for haptic suture fixation is important^[4]. Radial keratotomy (RK) marker had been used to localize the site of haptic fixation in the literature, but to our knowledge, few report related to the use of toric IOL markers (T-marker and axis marker) during this process.

T-marker and axis marker are tools which have been used in the implantation of toric IOL. Using these markers to localize the reference points, a toric IOL can be implanted in the eyes in the correct axis. In this paper, we used the toric IOL markers to help us to localize the site of the fixation.

SUBJECTS AND METHODS

Subjects A consecutive series of candidates for SFIOL from October 2010 to December 2013 were reviewed. Patients were assigned to two groups, in group 1 SFIOL was assist by RK marker, and in group 2 transscleral fixation was assisted by toric IOL markers (T- and axis markers). Patients' demographic data and information on baseline preoperative visual acuity (VA), indication for surgery and latest postoperative VA were collected and analyzed. The Snellen VA was converted into logarithm of the minimum angle of resolution (logMAR) units for statistical analysis. The VA values higher than 1.0 were arbitrarily assigned an equivalent of 0.0 logMAR unit. VAs of counting fingers and hand movements were arbitrarily assigned an equivalent of 1.7 logMAR units and 1.8 logMAR units, respectively.

Radial Keratotomy Marker –assisted of the Fixation Place Localization Under the local anesthesia, the patients were supinate on the operation bed, the circular RK marker was centered on the pupillary axis, and then the ink marks

were made on the cornea to delineate the 12-o'clock and 6-o'clock position. The places 2.0 mm posterior to these two points were marked and looked as the scleral fixation points.

Toric Intraocular Lens Markers–assisted of the Fixation Place Localization¹⁵⁻⁶¹ Under the local anesthesia, the patient was seated at the surgical table and instructed to gaze at a distant target to correct for eyeball cyclotorsion. Using the toric T- marker, the corneal limbus was marked at the 3-, and 9-o'clock positions. Intraoperatively, a toric axis marker was aligned over the 3-, and 9-o'clock reference points, and the 12-, and 6- o'clock positions of corneal limbus were marked on the cornea with the surgical marking pen. The places 2.0 mm posterior to these two points were marked and looked as the scleral fixation points.

Surgical Technique¹⁷¹ All surgeries were performed by the same surgeon (Song HP). All patients had scleral fixation using an ab externo approach in which 2 rectangular scleral flaps were created at the 12 and 6 o'clock positions. A 3.2 mm corneal tunnel was prepared at about 10:00 o'clock to opening the anterior chamber, a foldable IOL (AMO AR 40, Advanced Medical Optics, Inc., Santa Ana, CA, USA) was placed in the cartridge and the inferior haptic suturing with the lens body inside the cartridge. The inferior haptic and lens body were inserted into the eye trough corneal tunnel by IOL injector. And then the superior haptic was inserted into the eye and the inferior and superior haptics were sutured at the 12 and 6 o'clock scleral fixation points previously marked.

Haptic Symmetry Measurement¹⁸⁻¹⁰¹ The haptic symmetry was measured by ultrasound biomicroscopy (UBM) examination. All patients had UBM two weeks postoperatively by the same examiner and to detect the position of optic and each haptic. UBM was performed using the Dicon P45 UBM Plus biomicroscope (Paradigm Medical Instruments) with a 50 MHz probe, 25 mm axial resolution, 50 mm lateral resolution, and 5.0 mm tissue penetration. The haptic locations were determined by tracing the high reflection obtained from the haptic to a position closest to the eye wall. The clock hour of each haptic was determined. If the two haptics were not at 12 and 6 o'clock positions or were not 180° apart, then the two haptics were considered as asymmetry.

Optic Decentration and Tilt Measurement The IOL optic tilt and decentration were measured using the method described by Kothari *et al*¹¹¹ with some modifications. A standard UBM photograph passing through both the haptics' end was taken. Both the scleral spurs were identified and indicated as letters a and b and draw a line along a and b, marking this line as the plane of reference. The edge points of the optic of the IOL were identified, indicated as letters c and d, and draws a line along the two points, marking this line as the represent of optic position. When the reference

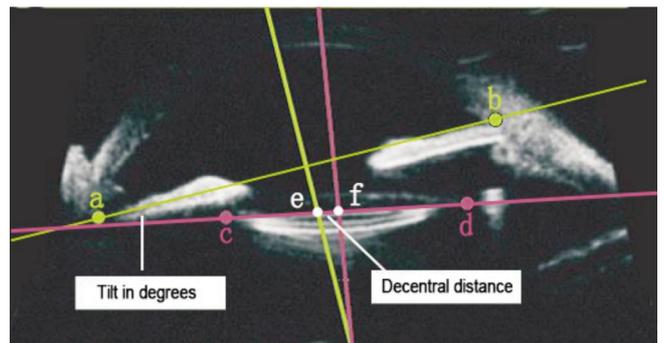


Figure 1 Measurement of IOL tilt and decentered distance from an ultrasonic biomicrograph using a mathematical compass.

plane line and the optic plane line were parallel, the IOL was considered to be not tilted. If not, then the IOL was considered to be tilted. The angle between the two plane lines was calculated as the tilt degree.

To measure the optic central or not, a perpendicular bisector of the reference line from a-b and optic lines from c to d were drawn with the help of basic gold-standard mathematical compass. The joined points of these two bisectors to optic line were indicated as points e and f, respectively. When the two bisectors were overlapping or joined on the same point of optic line, the optic was considered to be central. If not, then the optic was considered as decentered. The distance between the points of e and f was calculated as the decentered distance (Figure 1).

Statistical Analysis All analyses were performed using the SPSS statistical package for Windows version 17.0. One-way analysis of variables (ANOVA) was used for between-group comparisons of continuous variables, and the Chi square test was used for categorical variables. The paired *t*-test was used to compare the pre- and postoperative logMAR values of the same group. All tests were considered to be statistically significant if the *P* value was 0.05 or less.

RESULTS

A total of 43 eyes were identified for this study. All of the eyes had trauma involving both the anterior and posterior segment and lacked capsular support for an IOL. Table 1 presents a summary of the demographic data of the patients. The mean age of the patients in group 1 was 33.54±18.97y (range 5-66), in group 2 was 25.05±17.47y (range 3-62). The two groups were similar for age and follow-up period. More male patients underwent SFIOL than female, largely because of the higher rate of trauma in male patients.

As show in Table 1, the causes of aphakia in the two groups were similarly. Eyes were commonly left aphakic during the primary repair and the SFIOL was placed at the time of silicone oil removal when the eyes appeared to have macular potential.

The difference between the two groups of preoperative VA was not significant (1.67±0.22 *vs* 1.60±0.29, *F*=0.88, *P*=

Table 1 Patient's demographics

Parameters	Group 1 (n=24)	Group 2 (n=19)	n (%)	
			F	P
Mean age at surgery (a)	33.54±18.97	25.05±17.47	2.27	0.14
Mean postop. follow-up (mo)	9.45±11.7	12.89±10.20	1.02	0.31
Sex				
M	16 (66)	16 (84)		
F	8 (34)	3 (16)		
Cause of SFIOL				
Traumatica endophthalmitis	6 (25)	3 (16)		
Intraocular foreign body	5 (21)	5 (26)		
Other serious injuries	13 (54)	11 (58)		

0.35), but the postoperative VA was significantly improved in group 2 than that in group 1 (0.60 ± 0.36 vs 0.88 ± 0.34 , $F=6.24$, $P=0.02$). All eyes had improved final postoperative VA. In group 1, mean VA improved from approximately 1.67 ± 0.22 logMAR units preoperatively to 0.88 ± 0.34 logMAR units after surgery, the difference was significant ($t=9.56$, $P=0.00$). In group 2, the preoperative mean VA was 1.60 ± 0.29 logMAR units to 0.60 ± 0.36 logMAR units after surgery, the difference was significant ($t=13.90$, $P=0.00$). The mean improvement in distance VA was 1.06 ± 0.32 logMAR in group 2, and 0.78 ± 0.40 logMAR units in group 1, the difference between them was statistically significant ($F=6.27$, $P=0.02$).

Asymmetry of the haptic positioning was observed in 10 eyes in group 1 and 2 eyes in group 2. The rate of haptics asymmetry was statistically significantly higher in the group 1 (42%, 10/24) than that in group 2 (11%; 2/19) (Chi square=3.68, $P=0.04$). Table 2 showed the clock hour of the haptics position of the 12 eyes.

Table 3 showed the tilt and decentration data of the two groups. The mean tilted degree in group 1 was significantly greater than that in group 2 ($F=4.39$, $P=0.04$). Mean decentration in group 1 is significantly larger than that in group 2 ($F=5.34$, $P=0.03$). Both tilting of more than 10 degrees and decentration greater than 1.0 mm patients were more in group1 than that in group 2.

As shown in Table 4, correlation was found between the presence of optic tilt and haptic position.

The position of the haptics had effect on optic decentration as show in Table 5.

DISCUSSION

In this study, we used toric IOL markers to measure the site of fixation and analyzed the effect of toric IOL markers-assisted implantation of SFIOLs. Our results showed that the improved VA postoperative was higher in group 2 than that in group 1. Meanwhile, the rate of haptic asymmetry, optic tilt and decentration were all statistically significantly lower in the group 2 than that in group 1.

As far as we are aware, no previous studies had used the toric IOL markers to measure the site of fixation. In previous

Table 2 The data of clock hour position of the asymmetric haptics

Eye	Haptic 1	Haptic 2
Group 1		
1	12:00	7:00
2	1:00	6:00
3	12:00	5:00
4	1:00	6:00
5	11:00	6:00
6	12:00	7:00
7	2:00	7:00
8	12:00	7:00
9	1:00	6:00
10	2:00	6:00
Group 2		
1	12:00	7:00
2	1:00	6:00

reports, RK marker had been used in the measurement of fixation site [12]. We considered that using RK marker to localize the site of fixation may be inaccurate. Because, firstly, when a person is supinate, the eyeball has a little degree cyclotorsion; and secondly, the centre of the pupil may not represent a true centre of the eye especially when the patient has pupillary abnormalities owing to intraocular surgery or trauma. Even under physiological conditions, the pupillary axis does not correlate with the optical axis (angle lambda) or visual axis (angle Kappa)[11]. Compared with the RK marker, the using of toric IOL markers as a tool to measure the fixated site had counteracted the cyclotorsion of eyeball and was not interfere by pupillary abnormalities.

IOL tilt and decentration can lead to astigmatism, change in optical higher-order aberrations, and loss of best-corrected VA. Tilt and decentration after IOL implantation have been measured quantitatively recently [13-19]. Eye model studies of Piers *et al* [17] showed a maximum tilt of 10° and a maximum decentration of 0.8 mm. Clinical studies showed, that if IOLs are implanted correctly in the capsular bag, the lenses do not exceed these experimentally found amounts of tolerable tilt and decentration, thus avoiding deterioration of optical

Table 3 Tilt and decentration by group

Measurement	Group 1	Group 2	F	Chi-square	P
Mean tilt (degree)	6.62±4.33 (0-15)	4.31±2.31 (1-11)	4.39		0.04
>10 degree	7	1		2.57	0.04
Mean decentration (mm)	0.95±0.75 (0.20-3.0)	0.52±0.34 (0.1-1.3)	5.34		0.03
>1.0 mm	8	2		1.94	0.08

Table 4 Haptic location in correlation to tilted optic

Haptic	Tilt >10 degree	Tilt <10 degree	Chi-square	P
Symmetry	1	30	16.94	0.00
Asymmetry	7	5		

P values were calculated by Fisher exact test.

Table 5 Haptic location in correlation to optic decentration

Haptic	Decentration >1.0 mm	Decentration <1.0 mm	Chi-square	P
Symmetry	2	29	17.16	0.00
Asymmetry	8	4		

P values were calculated by Fisher exact test.

quality [18]. Durak *et al* [19] quantitatively measured tilt and decentration after transscleral IOL implantation using Purkinje images. They found a mean decentration of 0.67 mm and a mean tilt of 6.09 degrees after transscleral IOL implantation. In our study, the mean tilted degree and decentration were similar to the results of Durak *et al* [19] except the value of mean decentration in group 1. In group 2, both tilt and decentration were all lower than that in group 1. Meanwhile, the rates of optic tilt more than 10 degree and decentration more than 1.0 mm were all lower than that in group 1, which may explain why the improved VA postoperative was so different between groups 1 and 2. As to the aberration-correcting optics, the observed amounts of tilt and decentration in the group 2 were both in the limits for tolerable tilt and decentration. If these limits are considered, the toric IOL markers-assist technique would allow for the fixation of the aberration-correcting IOLs.

Ideal position of SFIOLs is dependent on the symmetry and positional stability of the haptics. In theory, when SFIOLs was implanted, both haptics should be placed in the sulcus. But current surgical techniques do not guarantee ciliary sulcus placement of the haptics of a scleral-fixated IOL [20]. One of the critical aspects in evaluating SFIOLs is whether or not the two haptics is placed coaxial. So in this study, we choose the clock hour of each haptic but not ciliary sulcus to judge the symmetry of haptics. Our results showed that the rate of haptics asymmetry was statistically significantly higher in the group 1 than that in group 2. This reflects the limitation of the RK-marker assisted for precise suturing in group 1.

As to the relationship of optic tilt and decentration with haptic asymmetry, we found that the asymmetry of the haptics had effect on optic tilt and decentration. This

indicated the important role of the localization of haptic fixation site in the SFIOLs.

In conclusion, our results showed that the toric IOL markers assisted SFIOL technique could get better results than that with RK marker. It suggests that during SFIOL the toric markers help the surgeon identify the placement of fixation more precisely than that with the use of RK marker.

However, the limitations of the study are the small size of the sample and the overlooking of the pre- and post-operative astigmatism, which maybe influence the results of this study. So, there are many areas which are worthy of further study.

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