Original Article

Anterior stromal puncture with staining: A modified technique for preoperative reference corneal marking for toric lenses and its retrospective analyses

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Introduction: Toric intraocular lenses (IOLs) are an effective way of compensating preexisting corneal astigmatism during cataract surgery. To achieve success, it is imperative to align the toric IOLs in desired position and preoperative reference marking is one among the three important steps for accurate alignment. To make the marking procedure simpler and effective, we have modified the conventional three-step slit lamp-based technique. **Materials and Methods:** Patient is seated in front of the slit lamp and asked to keep the chin over chin rest. A 26-gauge bent needle with tip stained by sterile blue ink marker is used to make anterior stromal puncture (ASP) at the edges of horizontal 180° axis near the limbus. **Results:** A total of 58 eyes were retrospectively evaluated. Mean (+/-SD) IOL deviation on day 1 and day 30 was 5.7 ± 6.5° and 4.7 ± 5.6°, respectively. Median IOL misalignment on day 1 and day 30 was 3°. Redialing of IOL was required in 2 (3.4%) eyes only, all of which were performed within 1 week of surgery. In total, 2 (3.7%) eyes had a residual astigmatism of − 0.5 Dcyl and − 1.0 Dcyl, respectively. **Conclusion:** ASP is an effective technique for reference marking, technically simpler and can be practiced by most of the surgeons. It avoids the necessity of high-end sophisticated machinery and gives a better platform for the reference corneal marking along with the benefit of reproducibility and simplicity.

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In the present era, refractive cataract surgery is the choice and demand of patients undergoing cataract surgery. An estimated 15–29% of cataract patients have more than 1.50 diopter (D) of preoperative corneal astigmatism.[1-3] Multiple procedures have been studied for reducing preoperative astigmatism;[4,5] recent one among them is toric intraocular lenses (IOLs), which are effective in compensating for preoperative corneal astigmatism.[6,7] Accurate alignment of toric lenses is crucial for effective reduction of astigmatism. Three important steps involved in toric IOLs placement are preoperative reference axis marking, intraoperative alignment axis marking, and IOL alignment.[8]

Different methods have been introduced for the marking of reference axis, and comparative studies have been done to evaluate their precision.[9,10] Sources of errors associated with such methods are smudging or fading of dye, broad marking leading to variation of few degrees,[9] Bell's phenomenon, and intorsion effect of superior oblique muscle.[9] Instrument-specific problems such as weight of pendular marker,[10] wider marking with tonometer marker,[10] and sophisticated computerized evaluation for new mapping method[9] make things more complicated. On the other hand, least rotational misalignment (pendular marker) and least vertical misalignment (slit lamp method) are the advantages.[10]

Video Available on: www.ijo.in

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Slit lamp method though simple still has the possibility of spreading and washing out of dye due to tear flow.

Therefore, a need for simpler and reproducible technique of preoperative reference marking was felt. We modified the conventional slit lamp-based three-step technique[8] to fulfill the goal.

Materials and Methods

Preoperative workup, reference corneal marking, and surgical technique

Preoperative workup for toric IOLs included refraction, manual keratometry (Bausch and Lomb), optical biometry by IOLMaster 500 (IOLMaster Carl Zeiss Meditec AG, Germany), and anterior and posterior segment examination. An online toric calculator (http://aurolab.com/optical/loginpage.aspx) was used to determine the axis of placement. Corneal topography was done in patients suspicious of early keratoconus or irregular astigmatism. The study adhered to the code of ethics as per the Declaration of Helsinki. Written informed consent was obtained from all the patients before surgery. Patients were explained about the procedure and need of reference corneal marking.

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The patient was seated at the slit lamp with chin placed on the chin rest and asked to look at a distant object with the contralateral eye to achieve straight gaze. We did not use any speculum as it makes the patient uncomfortable and can act as a source of error due to mechanical compression over the globe. Anesthesia was achieved by topical proparacaine hydrochloride ophthalmic solution 0.5% (Aurocaine, Aurolab, India). Slit beam of size 14 mm × 1 mm was oriented at 0–180° and was focused on the corneal apex, identification of which was aided by the first Purkinje image [Fig. 1]. This Purkinje image will appear as a small, cylindrical reflection of light bulb. Focusing at the center of Purkinje image ensures centration of slit beam. A sterile 26-gauge straight needle [Figs. 2 and 3] was used with the tip stained by sterile blue ink marker (Viscot Surgical Skin Marker, Viscot, LLC, USA) [Fig. 4]. Needle tip can be bent either as a cystitome or as a single bend near the hub [Fig. 3]. Using stained needle, anterior stromal puncture (ASP) [Fig. 5] at 0 and 180° was made just inside the limbus [Video]. Further, the patient was asked to blink for 2–3 times, and after reverification of the marking, the patient was taken for the surgery. Intraoperatively, Mendez ring was used to localize the incision site and IOL placement axis. ASP with bent 26-gauge needle was used to mark the incision axis and actual IOL placement axis. Standard phacoemulsification with toric IOL (Auroflex Toric, series FH560T1.5/T2.0/T2.5/T3.0, Aurolab, India) implantation was performed. Postoperatively, antibiotic eye drops for 20 days with tapering dose of steroid eye drops were used as per routine protocol. To know the actual IOL placement axis (on day 1 and day 30), patient's pupil was pharmacologically dilated and coaxial slit lamp beam was oriented along the IOL markings. Axis reading was recorded from the marking on slit lamp. To calculate the IOL misalignment, actual IOL axis was subtracted from the intended axis which was derived from online calculator. Since the rotation could occur in clockwise or anticlockwise direction, "–" sign was prefixed to the IOL alignment error for anticlockwise direction and "+" sign prefixed for clockwise direction rotation.

To analyze the performance of the technique, we retrospectively reviewed case record of the patients who underwent uneventful phacoemulsification with toric IOL implantation by two specific surgeons (MN, MRV) during a period of 1 year (August 2014–2015). Only the cases who underwent reference marking by ASP technique were included. Data from the case sheet regarding demographics, intended axis placement (online toric calculation sheet), actual IOL axis on day 1 and day 30, IOL axis misalignment on day

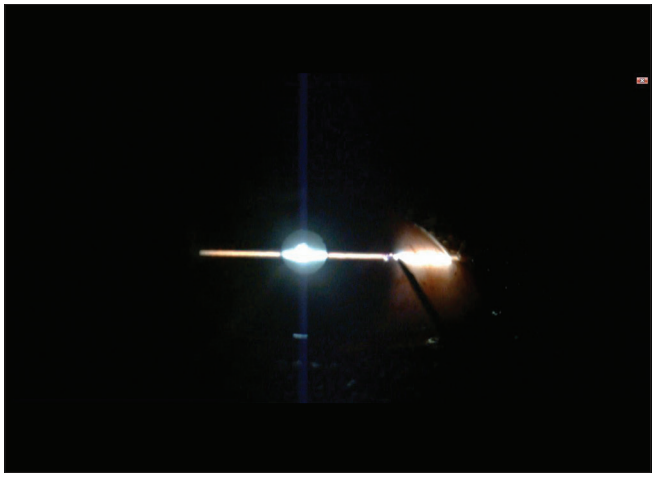

Figure 1: Purkinje image with centration of horizontal slit beam

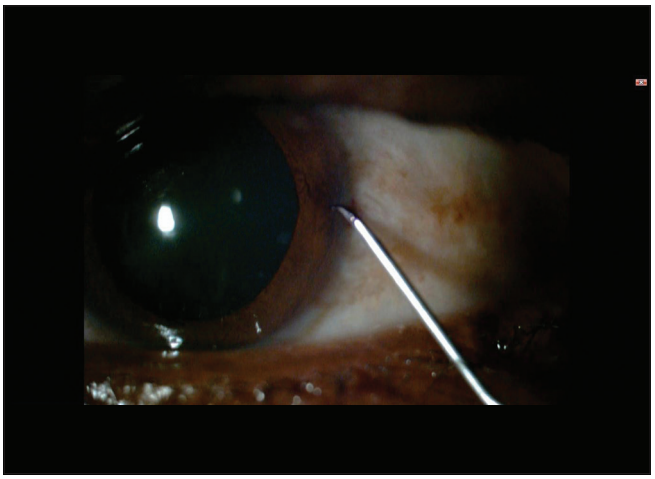

Figure 2: Diffuse illumination image showing the pattern of marking with 26-gauge bend needle

Figure 3: Bent 26-gauge needle

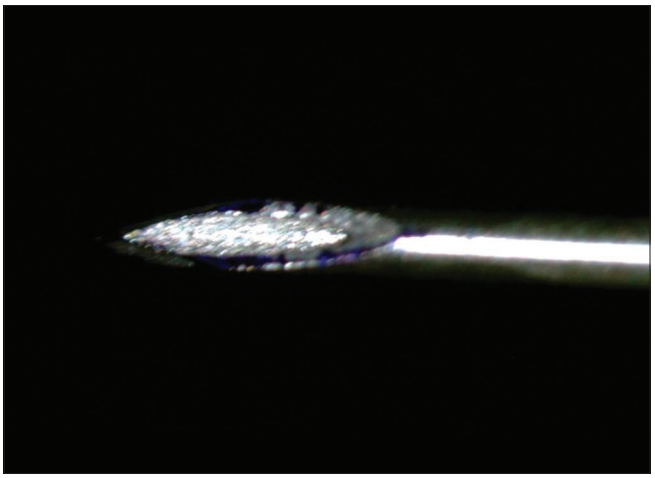

Figure 4: Tip of needle smudged with sterile blue ink

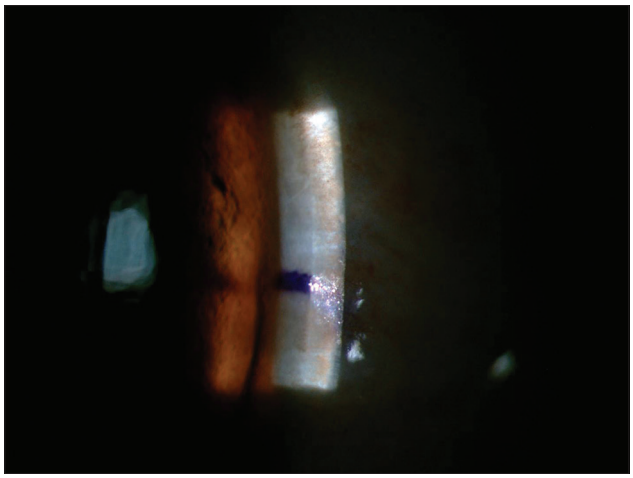

Figure 5: Anterior stromal puncture showing the sharp blue ink marking

1 and day 30, IOL redialing, and residual astigmatism by 1-month postoperatively were entered in Microsoft Excel sheet (Microsoft Office Standard 2010). Primary outcomes such as mean deviation of IOL, incidence of IOL redialing, and residual astigmatism were considered to analyze the clinical efficacy of the technique.

Results

A total of 63 patients (63 eyes) were operated, out of which 5 were excluded due to insufficient data. The mean age was 57 years. Male to female ratio was 1.9:1. Preoperative corneal astigmatism ranged from 1.3 to 3.1 D (mean 1.93 D). Out of 58 eyes, 39 eyes had against the rule astigmatism and rest with the rule astigmatism. Keratometric (K1 and K2) readings ranged from 40.8–47.6 D (mean = 44.15 D) to 42.48–50.37 D (mean = 46.1 D), respectively.

On the 1st postoperative day, 47/58 (81%) were found to have some degree of deviation. Out of 58 eyes, less than half of the eyes (26/58 eyes [44.8%]) had a deviation ranging between −5° and +5° (i.e., 5° anticlockwise to 5° clockwise) on day 1. A good number of 80% eyes were within ±10° (0–10°) from intended axis on day 1.

Day-30 data were available for only 49 eyes out of which 41 eyes (83.6%) had some degree of deviation. A deviation of ±5° and ±10° from intended axis was observed in 29 (60%) and 34 (70%) eyes, respectively. Eighty-five percent of eyes were within ±10°. Mean(+/-SD) deviation of IOL on day 1 and day 30 was 5.7 ± 6.5° and 4.7 ± 5.6°, respectively. Median IOL misalignment on day 1 and day 30 was 3°. Redialing of IOL was required in 2/58 (3.4%) eyes only, all of which were performed within 1 week of surgery. In total, 2 (3.7%) eyes had a residual refractive astigmatism of −0.5 Dcyl and − 1.0 Dcyl, respectively.

Discussion

Several preoperative axis marking techniques for toric IOLs have been described and compared previously.[8-10] Popp *et al*.[10] evaluated four corneal marking methods, i.e., pendular marker, slit lamp-based marking, bubble marker, and tono-marker. The pendular marker showed the least horizontal deviation, and slit lamp marker showed the least vertical deviation.[10] They also noted that slit lamp marker was easiest to handle and pendular more difficult. Newer computer-based technique[9] has the advantage of precision, but there is complexity of technique and a disadvantage of economic burden. In this regard, we aim to bring out a technique which is an agglomeration of simplicity and reproducibility.

Our technique is a modification of the already known slit lamp-based technique.[8] The standard slit lamp-based technique includes making of gentle scratches and then staining it with dye. Scratches lead to epithelial erosion which reduces the precision of markings. Staining after the scratches leaves a broad mark leading to few degrees of error. Our technique demonstrates the benefit of ASP which creates a point mark without any epithelial erosion, and the simultaneous staining helps in perfect and longtime retention of dye thus, removing the problem of smudging and fading. Such a procedure can be equated to tattooing of corneal tissue. As compared to pendular marker, bubble marker, or tono-marker, ASP is much easier to use and learning curve for the technique is short. In a study by Visser *et al*.,[8] the mean error in IOL placement by three-step ink-marker procedure was 5° much similar to ASP (5.7°); however, we compared the postoperative axis deviation (i.e., difference between intended axis and actual axis) with respect to what was derived from online toric calculator under slit lamp at postoperative day 1 which was not the case in Visser *et al*. study.[8] A long-term study conducted by Miyake *et al*.[11] reported mean ± SD IOL misalignment on day 1 and 2 years of 4.5 ± 4.9° and 4.1 ± 3.0°, respectively, which is comparable to our results although the authors used a different method of axis registration and horizontal marking on both conjunctiva and cornea for preoperative reference marking. Surgical redialing in a study by Miyake *et al*.[11] was required only in 1.05% of cases which is nearly one-third of what our study reports probably due to difference in IOL properties, large sample size, and variation in the IOL biometric characteristics (axial length, keratometry).

Auroflex Toric IOL (model number FH560T, Aurolab, India) was implanted in all the patients. It is a hydrophilic, 360° square edge, plate haptic design with toric power on anterior surface. Overall diameter is 12 mm with 0° angulation. Efficacy and stability of a similar design IOL but different company were analyzed by Entabi *et al*.[12] In terms of rotational stability, the results were far better in Entabi *et al*.[12] (mean error of 3.4° vs. 5.7° in our study); however, with respect to efficacy at 4 months (i.e., mean spherical equivalent and IOL redialing), our study demonstrated similar results. Therefore, even though our study was not powered enough to calculate the stability and efficacy of IOL, results suggest an overall comparable outcome of Auroflex Toric IOL.

The low incidence of IOL redialing, low mean and median value of IOL misalignment, majority of patients achieving IOL axis alignment within 10° of the intended value, and minimal residual astigmatism are all indicators of successful outcome through ASP reference marking.

Since it is a retrospective study, it has its own inherent limitation. Confounding factors such as selection bias, technical difficulties, surgeon's experience in accurate marking, IOL misalignment due to intraocular factors, absence of vector analysis, and IOL design could have altered the results. Sophisticated computerized comparison for deviation of reference marking, rotational misalignment or

vertical misalignment, and axis marking error[9] could not be performed. The follow-up duration of 1 month is inadequate to comment on long-term results of the technique.

Conclusion

ASP is an effective technique for reference marking, technically simpler and can be practiced by most of the surgeons. Advantage of this modified ASP technique is that it does not require any additional instrumentation and can be done by anybody who knows slit lamp. Thus, it avoids the necessity of high-end sophisticated machinery which adds onto operating cost for both patient and surgeon.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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