A New Slit Lamp Based Method for Corneal Marking for Toric IOL Implantation and A Comparative Series of 60 Eyes Comparing the Results of the New and Conventional Marking Techniques

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Purpose: To compare a new slit lamp based technique using Purkinje images for corneal marking prior to toric IOL implantation with conventional techniques of corneal marking

Methods: 30 consecutive eyes were marked using the new technique and another 30 consecutive eyes were marked using conventional (bubble) marker. The results were evaluated photographically using a dedicated planimetry software on pre and post-operative photographs. The astigmatic results and the difference between actual and anticipated residual astigmatism were also compared statistically between the two groups.

Results: Accurate bisection of the cornea through the optical centre was more consistently obtained by our technique, which also obviated the need for separate placement axis marking on table. Software based analysis showed significantly more accurate placement of the corneal marks as well as IOL placement. Post-operative outcome at 6 months showed significantly better correlation with anticipated residual astigmatism in the group marked with the new technique.

Conclusions: This technique was found to be more accurate and reproducible than currently used techniques. Surgeons found it easier to align the toric IOLs to the marks because of the accurate corneal centration of the marks.

Accurate corneal axis marking is an important first step in Toric IOL surgery to correct corneal astigmatism. Conventionally, first the ‘reference’ marks or the 0–180 degree meridian is marked to bisect the cornea. Reference marking also includes marking the 6 o’clock point on the limbus to ensure that the horizontal reference marks are through the ‘middle’ of the cornea and not above or below. However, because the cornea is not a true circle and often varies in diameter and because the corneal markers are instruments of fixed diameters the chances of displacing the marks above or below is high. Furthermore, the currently available markers obstruct view of the marking studs which are hidden from the surgeon.

Currently used marking systems are the Gimble marker (ASICO) and the Nuits/Lane Pre-op Toric Reference Marker (bubble). It is important for the marks to be centred on the cornea i.e. aligned to the geometric centre of the limbal ring because the IOL, when implanted in the bag, tends to centre itself
within the limbal ring. There is also another issue with most current marking systems – the 0–180 degree reference marking is arbitrary i.e. alignment with the lateral canthus is taken to be horizontal. However, the lateral canthus is not a fixed landmark and varies from race to race. The second generation of markers use a spirit level concept to ensure horizontality. Even with the Nuits/Lane marker a few degrees of error can be expected because the bubble is not a point structure. The recently introduced Electronic Marker from ASICO claims to address this issue but even this instrument cannot ensure bisection of the cornea through its optical centre by the marks.

Current corneal markers also require a second placement axis marking on table when the required axis of placement of the Toric IOL does not lie on the 0–180 corneal meridian. Two markers in recent times have tried to address these problems – the Neuhann modification of the Nuits/Lane marker and the Tomark.

We describe herein a simple technique that allows calibration of a slit beam to ensure true horizontality or exact axis and then uses the first Purkinje image to align the marking axis to the optical centre of the cornea ensuring a bisection of the cornea by the axis marks. It also removes the necessity of a second placement axis marking on table.

**MATERIALS AND METHODS**

**Part A: Description of the technique**

A gravity dependent slit lamp calibrator (Figure 1) is clamped to the chin rest of the slit lamp. The weighted dial is designed to align itself to the horizontal. The slit lamp’s illuminating column is made co-axial with the viewing column. For 0–180 reference marking the slit lamp beam is narrowed to a thin slit and aligned with the 0–180 marks of the calibrator (Figure 2). The calibrator is then unclamped from the chinrest and the patient’s head is positioned on the slit lamp. The patient is asked to keep the contralateral eye closed with his/her hand and asked to look into the slit lamp light with the other eye. The slit beam is moved up or down until the beam passes through the bright first Purkinje image. Once alignment is achieved the Purkinje image is at its brightest (figure 4). With the patient maintaining steady fixation a gentian violet marker pen or a sterile 26G needle on a...
2 ml syringe is used to mark the peripheral cornea where the slit beam cuts the limbus (Figures 3, 4 and 5). If the axis of final placement of the toric IOL is not 0–180 then the slit beam is rotated to align with the required axis on the calibrator and the patient placed on the slit lamp. The slit beam is aligned with the first Purkinje image and the peripheral cornea is marked in a similar fashion (Figure 6).

**Part B: Clinical study**

Results of 60 consecutive eyes were studied. The first 30 eyes had corneal marking using a conventional method (either the Niuts/Lane bubble marker) followed by AcrySof Toric IOL implantation. The second group of 30 eyes had corneal marking by the technique described above followed by AcrySof Toric IOL implantation. All markings and surgery were done by the same surgeon (BRC). The same technique of Phacoemulsification using the same machine was followed in all patients. Keratometry was done on a manual keratometer and A scan was done by contact ultrasound biometry. IOL power calculation was done using SRK/T formula. The on-line Toric Calculator software (Alcon Laboratories, Fort Worth, Texas) was used to calculate the placement axis and IOL series. The incision location was used to calculate the least anticipated residual astigmatism by trial and error.

**RESULTS**

| Table 1: Distribution of astigmatism (pre and post-operative) |
|-------------------------|------------------------|-----------------------------|-----------------------------|-----------------------------|
|                         | Range of Astigmatism correction attempted | Mean corneal pre-operative astigmatism | Mean anticipated residual astigmatism | Mean actually achieved residual astigmatism (objective) | Mean actually achieved residual astigmatism (subjective) |
| Group A                 | 1.25 to 4.0             | 2.75                        | 0.43 (+ 0.10)                | 0.35                        | 0.5                                         |
| Group B                 | 1.25 to 4.0             | 2.80                        | 0.32 (+ 0.10)                | 0.66                        | 0.75                                        |
Table 2: Axis of placement on 8th post-operative day (studied by a planimetry analysis of retro-illumination photographs)

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<th>Range</th>
<th>Mean</th>
<th>SD</th>
<th>t statistic</th>
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<tbody>
<tr>
<td>Group A (n = 30)</td>
<td>0 – 20</td>
<td>8.733333333</td>
<td>4.008037901</td>
<td>0.0000000257</td>
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<tr>
<td>Group B (n = 30)</td>
<td>0 - 12</td>
<td>3.366666667</td>
<td>2.189053225</td>
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A two tailed Student’s t-test with the assumption of two-sample equal variance (homoscedastic) using Microsoft Excel 2007 Statistical Analysis Pack: TTEST (Array1, Array2, 2, 2).

DISCUSSION

Reference axis marking for Toric IOL implantation has always been unsatisfactory – a fact proven by the emergence of new marking instruments every year.

Manual hand-held markers are by far the more popular systems.

A recent study found errors for different marking methods. For the Cionni marker, the average axis-marking error was 3.69_1.49° (range: 1.17° to 6.60°), for slit lamp marking, the average axis marking error was 3.14_1.64° (range: 0.43° to 6.46°), for a new mapping method suggested by the authors, the average axis marking error was 2.29_1.06° (range: 0.32° to 4.41°). The axes in this study were measured on anterior segment photographs using a protractor image aligned on the limbus. There is no description in the article as to how the protractor was aligned co-axial to the optical centre of the cornea or how its horizontality was ensured.

While there are several techniques of marking there are few techniques of assessing whether the marks are correct. Most studies comment on rotational stability rather than an absolute measurement of the actual axis of placement of a toric IOL.

The standard for measuring the axis of placement of toric IOL is photography in retro-illumination. In 2004, Viestenz et al. reported on standardized bifocal photography using a telecentric fundus camera capable of minimizing the rotational error by superimposing 2 images of the fundus and the toric IOL taken in immediate succession. However, standard fundus photography has its own errors. Viestenz et al. reported on autorotation of the eye in the range of 0 to 11.5 degrees with the mean absolute autorotation being 2.3 degrees in their series. Potential causes of artificial eye rotation induced by the photographic technique included camera adaptation (3 degree intrinsic error), slide mounting (<1 degree), slide projection (<0.5 degree), marking of characteristic fundus details (<1 degree), and head inclination. They concluded that digital
photography may reduce the intrinsic errors of standard fundus photography. Older studies have preferred the use of fundus photography over slit lamp based evaluation of cyclotorsion.

None of the markers available in the market or found in the literature actually addresses the problem of centering the mark on the optical/visual axis. We felt this was important because if the marks were not aligned to the visual axis parallax errors would make accurate positioning intra-operatively difficult. The best option would be to align the IOL on the visual axis but, unfortunately, IOLs in the bag tend to centre themselves on the bag, which is most closely represented by the optical centre of the cornea. This is because the optical centre of the cornea is more closely associated with the physical centre of the cornea (and therefore the limbal ring) than the visual axis. The visual axis is most notably displaced from the optical axis of the cornea in persons with large angle Kappa. Practically when we do the final rotational placement of toric IOLs we align the two Purkinje images (one from the cornea and the other from the IOL) to avoid parallax errors. Thus we thought that using the first Purkinje image would be a good idea to centre the pre-operative limbal marks on the optical centre of the cornea. The calibrator tool was developed to align the slit beam accurately in any axis in the gravity defined physical space.

The software is a dedicated planimetry tool that had been developed to study IOL centration. It was extended for this study to enable a user to draw a line on the image and read the angle this line formed with the lower border of the image. The difference between this ‘horizontal’ of the image and the ‘true’ gravity defined horizontal was determined as described above using the calibrator.

We have here a simple tool to ensure accurate axis of the slit lamp beam and a scientifically solid technique to ensure alignment on the optical axis of the cornea. No other marker to date has both features. This is the only logical way of avoiding parallax errors on table.

REFERENCES


