Evaluation of a New Electronic Pre-Operative Reference Marker for Toric IOL Implantation by Two Different Methods of Analysis: Adobe Photoshop Versus iTrace

Abstract

Purpose: To compare two different methods of analysis of pre-operative reference marking for Toric IOL after marking with an electronic marker

Setting/Venue: Cataract & Intraocular Lens Implantation Service, Shroff Eye Centre, New Delhi, India.

Methods: 52 eyes of 30 patients planned for Toric IOL implantation were included. All patients had pre-operative marking done with an electronic pre-operative two step Toric IOL reference marker (ASICO AE-2929). Reference marks were placed at 3- and 9-o'clock positions. Marks were analyzed with two systems. Firstly, slit-lamp photographs taken and analyzed using Adobe Photoshop (version 7.0). Secondly, Tracey iTrace Visual Function Analyzer (version 5.1.1) was used for capturing corneal topograph exam and position of marks noted. Amount of alignment error was calculated.

Results: Mean absolute rotation error was 2.38 ± 1.78° by Photoshop and 2.87 ± 2.03° by iTrace which was not statistically significant ($p = 0.215$). 72.7% eyes by Photoshop and 61.4% by iTrace had rotation error ≤ 3° ($p = 0.359$); and 90.9% eyes by Photoshop and 81.8% by iTrace had rotation error ≤ 5° ($p = 0.344$). No significant difference in absolute amount of rotation between eyes when analyzed by either method.

Conclusion: Difference in reference mark positions when analysed by two systems suggest presence of varying cyclotorsion at different points of time. Both analysis methods showed an approximately 3° of alignment error, which could contribute to 10% loss of astigmatic correction of Toric IOL. This can be further compounded by intra-operative marking errors and final placement of IOL in the bag.

Keywords: Electronic reference marker; iTrace; Toric IOL

Research Article

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Javed Hussain Farooqui[1]*, Mansi Sharma[2], Archana Koul[3], Ranjan Dutta[3] and Noshir Minoo Shroff[3]

[1]*Department of Ophthalmology, Flying Eye Hospital, Orbis International, USA*
[2]*Department of Ophthalmology, Post Graduate Institute, Chandigarh, India*
[3]*Department of Cataract and IOL services, Shroff Eye Centre, India*

***Corresponding author:** Javed Hussain Farooqui, C-44, Panchsheel Enclave, New Delhi- 110017, India, Tel: 0091-9599444445; Email: jhfarooqui@gmail.com

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Abbreviations: IOL: Intraocular Lens; OCCI: Clear Corneal Incisions

Introduction

Patients with cataract commonly have pre- existing astigmatism. Various studies have shown that the number of patients having pre existing astigmatism of more than 1.5 Dioptres ranges from 15% to 29% [1,2]. Over the years, many treatment options have been described for correcting corneal astigmatism. These may be non surgical options like spectacles or contact lenses, or surgical options like photorefractive keratectomy, laser in situ keratomileusis, and laser-assisted sub epithelial keratomileusis; astigmatic keratotomy using limbal or corneal relaxing incisions; opposite clear corneal incisions (OCCI); and toric phakic or pseudophakic intraocular lens (IOL) [3].

In today's modern age, Toric intraocular lens (IOL) are an integral part of cataract and refractive surgery, and are commonly used to correct preexisting corneal astigmatism in cataract patients [4,5]. Alignment of the toric intraocular lens at the calculated alignment axis is necessary to achieve effective astigmatism correction. This is the most important step of surgery and IOL misalignment may take place either due to inaccurate IOL placement, or IOL rotation, or both [5]. Various methods have been described to align the toric IOL during cataract surgery [6]. However; most methods follow a 3- step procedure. First step is the pre- operative marking where the horizontal axis (0 to 180 degrees) is marked with the patient in sitting position. Usually a reference marker or a slit lamp is used for this purpose. Second step is intra operative, where an angular graduation instrument is used to align the axis of the toric IOL. Lastly, Toric IOL is implanted and rotated to match the alignment marks [5].

In our series, all patients had pre-operative marking of the eye done with an electronic pre-operative Toric IOL reference marker. The reference marks were analysed by two different methods using Tracey iTrace Visual Function Analyser (version 5.1.1) and Adobe Photoshop (version 7). The amount of alignment error (in degrees) from the horizontal, by both methods was calculated. The purpose of this study was to compare two different methods of analysis of pre-operative reference marking for Toric IOL after marking with an electronic marker (e-marker) and also the accuracy of the electronic marker as a means of establishing the reference point for the final alignment of the Toric IOL. This was done to achieve an outcome as close as possible to emmetropia.

Patients and Methods

Study design and patient population

This prospective study comprised recruitment of 52 eyes of 30 patients presenting to the outpatient department of Shroff Eye Centre, New Delhi from July 2014 till January 2015.

Materials and methods

52 eyes of 30 patients planned for Toric IOL implantation were included. All patients had pre-operative marking done using electronic two step Toric IOL reference marker (ASICO AE-2929) designed by Dr. Akahoshi. Prior to the marking, the eye is anesthetized with 0.5% proparacaine drops. The patient is seated in the upright position and made to fixate at a distant target.

Electronic Toric IOL marker (ASICO AE-2929), two step reference marker, was used for marking the reference marks for identifying the 3- and 9-o'clock positions on the limbus (Figure 1a). The electronic head was fitted on the body and the marker was gradually advanced towards the eye while the examiner ensured a central green light without any beep was present when the wedges made contact with the limbus (Figure 1b). The green light ensured that the horizontal wedges of the marker were truly horizontal. An orange light with a slow beep indicated slight tilt and a red light with fast beep indicated severe tilt. A special ultrafine Gentian Violet pen was used to ink the wedges. The advantage of this marker was that the surgeon could concentrate on patient's eye as green light & audio tone confirmed horizontal axis. Also pressing the two buttons on the electronic marker simultaneously calibrated the device. All marking procedures were performed by the same observer, AK.

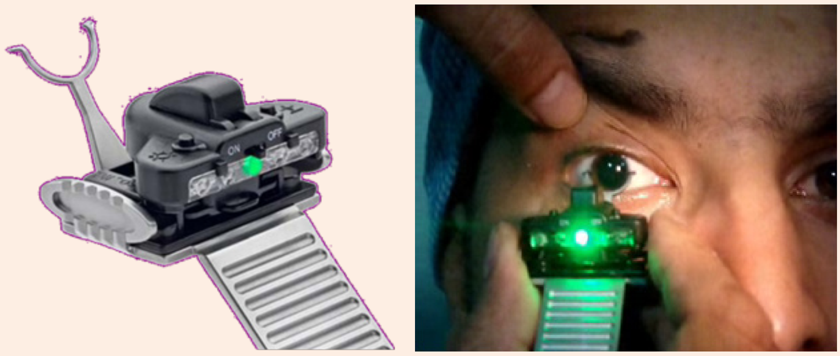

Figure 1 (a): The Electronic Marker (ASICO AE- 2929); **Figure 1(b)** Being used for pre-operative marking.

Image analysis

Slit lamp photographs were analysed using tools in Adobe Photoshop (version 7.0) and were taken by a single masked observer, RD. Amount of alignment error of each eye was calculated. A pre- operative photograph with the reference marks was imported in the Adobe Photoshop. Using the "Single Row Marquee Tool" a straight line was placed on the image adjacent to the limbal reference marks (Figure 2). Using the "Transform Tool", straight line was rotated in such a manner so as to align through the reference marks on the limbus. The amount of rotation (clockwise or anti- clockwise) was noted from the "Set Rotation" dialogue box. Similarly, iTrace Visual Function Analyser (Tracey version 5.1.1) was used to analyse the reference marks. A colour photograph showing the gentian violet marks on the limbus was captured using iTrace Visual Function Analyser. The Toric Planner programme in the iTrace was used to calculate the amount of alignment error (in degrees) of the gentian violet marks from the horizontal axis of 0° and 180° (Figure 3). The Toric Planner display is a comprehensive display designed to assist with selection and placement of Toric IOL implants. The display utilized data from iTrace wavefront and corneal topography measurements and user-entered data to help the surgeon select the best toric lens power and determine the best axis placement for that lens. The Toric Planner also analyses the exact location of the axis of placement in relation to gentian violet marks which are placed pre-surgically. The software displayed two arcs, one from 0° to the closest end of the axis of placement, and one from 180° to the opposite end of the axis of placement. The angular measurements initially displayed, provide the location of the axis of placement if the limbal markings were placed exactly at 0° and 180°. The calliper arcs were moved into position by clicking and holding the reference line at 180° between the angular scale and the beginning of the arc and then dragging it to the gentian violet mark. Same step was repeated for the 0° reference mark. The actual position of the marks was read off from the radial scale.

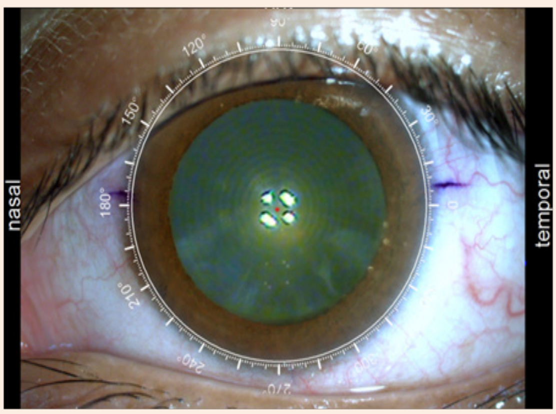

Figure 2: Toric Planner programme in iTrace Visual Function Analyzer (Tracey version 5.1.1).

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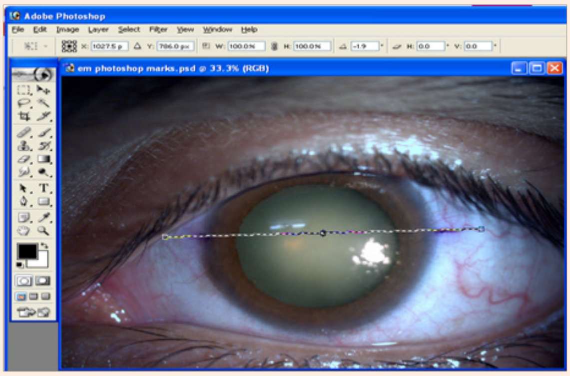

Figure 3: Pre-Operative Photograph with Reference Marks Imported In Adobe Photoshop (Version 7).

Results

The study enrolled 52 eyes of 30 patients. The mean age was 65 years (range from 45 to 80 years). The mean absolute rotation of reference marks in the horizontal axis by iTrace method was 2.44° + 1.36° and by Photoshop method was 2.38° ± 1.78° (p= .193) (Figure 4). We also analysed the percentage of eyes showing absolute rotation of reference marks < 3 degrees and < 5 degrees by both iTrace method and by Photoshop method. 71.1% (37 eyes) by iTrace method and 73.1% (38 eyes) by Photoshop method showed absolute rotation of reference marks < 3 degrees (p= .562). Also, an absolute rotation of reference marks < 5 degrees was seen in 86.5% (45 eyes) of patients analysed by iTrace method and 90.4% (47 eyes) of patients analysed by Photoshop method (p= .298) (Figure 5).

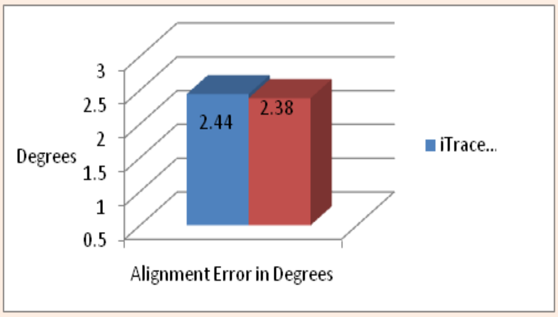

Figure 4: Mean absolute rotation of reference marks in the horizontal axis.

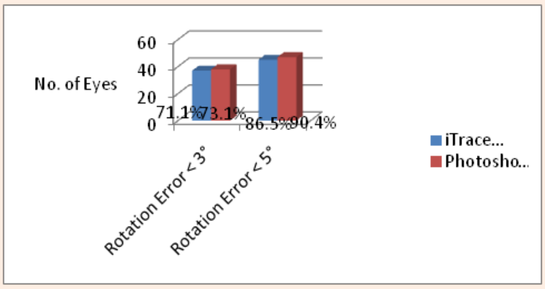

Figure 5: Eyes showing absolute rotation of reference marks ≤ 3 degrees and <5 degrees.

Discussion

We performed all our pre-operative markings in sitting position to avoid cyclotorsion, which may vary from 2 to 4 degrees between sitting and supine position. This may even be up to 15 degrees in certain individuals [7-9].

During our study, there was no statistical difference between the two image analysing techniques and both of them showed that the electronic marker was fairly accurate as evaluated by the two imaging techniques. Also, there were few observations that we made. In the Electronic Toric IOL marker, we found that the device gave both audio and visual confirmation of the correct position of the reference marks without diverting attention from the patient's eye. However, there was no external calibration tool provided to verify horizontal level. Also third wedge for marking the limbus at 6 o'clock was not present (as in cases of Bubble Markers and Pendulum Markers). In a comparative study done by Popps [10] and colleagues in Vienna, the pendulum-marking device showed the least rotational deviation to the reference meridian (mean 1.8 degrees). However, they did not use an electronic two step Toric IOL reference marker in their study for comparison. Also, to the best of our knowledge, we could not find any other study done on Asian eyes where an Electronic marker was used for pre-operative marking techniques [11].

In our study, the Electronic Toric IOL marker showed approximately 3 degrees of alignment error. It can be attributed to the 'menace reflex' causing the patient to blink due to an approaching object. It may also be due to spread of the pre-operative gentian violet marks.

Conclusion

Accuracy of corneal marking before surgery is critical to achieving good surgical-astigmatism correction outcomes, and Electronic Toric IOL marker gave good results. Errors in intra-operative marking and final alignment of the IOL in the bag could possibly add on to this error. We believe that Slit-lamp based methods are cumbersome to perform and require greater patient co-operation; the YAG laser method requires additional instrumentation. Also, sophisticated methods such as iris fingerprinting and intra-operative wavefront aberrometry, although highly accurate, cannot be routinely incorporated in the average ophthalmologist's practice.

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