Femtosecond laser-assisted refractive capsulorhexis – Precise capsulotomy with accurate toric intraocular lens alignment

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Femtosecond laser-assisted cataract surgery with refractive capsulorhexis and toric intraocular lens (IOL) implantation was performed in 14 eyes with senile cataract and a preexisting regular corneal astigmatism of 1.5 D or more. Intraoperatively, the accuracy of the capsular rim marks was confirmed using the digital overlay of CALLISTO Eye and Z Align (Carl Zeiss Meditec, Germany). Postoperatively, the mean deviation from target axis of implantation was 2.07° ± 1.49°. Refractive capsulorhexis combines the advantages of a femtosecond laser capsulotomy with a one-step visual guide for intraoperative toric IOL alignment as well as postoperative assessment of rotational stability.

Key words: Capsular-rim marks, image-guided systems, refractive capsulorhexis, toric IOL alignment

Toric intraocular lens (IOL) implantation is a predictable, efficacious, and safe procedure for the surgical correction of preexisting regular corneal astigmatism during phacoemulsification.[1] The refractive outcomes and patient satisfaction after toric IOL implantation depend on a precise alignment of the IOL along the intended axis.

Various methods have been described for the intraoperative alignment of the toric IOL, including manual marking of the reference and target axis, image guided systems with digital overlay and intraoperative aberrometry.[1-3]

Recently, the concept of refractive capsulorhexis (IntelliAxis Refractive Capsulorhexis™, LENSAR, Orlando, FL) has been introduced wherein two capsular rim marks are created along the intended axis on the edges of the capsulotomy using femtosecond laser.[4,5] They provide a visual guide to align the toric IOL intraoperatively and allow postoperative assessment of the rotational stability of the IOL.

We herein evaluated the accuracy of toric IOL alignment using the capsular rim marks and compared it with the CALLISTO Eye and Z align-assisted toric IOL alignment.

Case Reports

We performed femtosecond laser-assisted cataract surgery with refractive capsulorhexis and toric IOL implantation in 14 eyes with senile cataract and a preexisting regular corneal astigmatism of 1.5 D or more. The accuracy of the capsular rim marks was confirmed using the digital overlay of CALLISTO Eye and Z Align (Carl Zeiss Meditec, Germany). Cases with ocular comorbidities and prior ocular surgeries were excluded from the study. Written informed consent was obtained from all patients, and we adhered to the tenets of the declaration of Helsinki.

Preoperatively, a reference image was captured using Cassini (for LENSAR) and IOL Master 700 (for CALLISTO Eye and Z Align) to identify the limbal landmarks and correct for cyclotorsion during femtosecond laser application. Femtosecond laser pretreatment with refractive capsulorhexis was performed in all cases using LENSAR laser platform, and capsular rim marks were created along the target axis of IOL implantation [Fig. 1a]. We achieved a free-floating capsulotomy in all cases. In challenging cases, it is always advisable to stain the capsulotomy and manage any micro-adhesions, if present, accordingly. Phacoemulsification was performed as per the standard technique by a single surgeon (JST). A single-piece hydrophobic acrylic toric IOL was implanted in all cases. Intraoperatively, the capsular rim marks corresponded to the reference overlay projected by the CALLISTO Eye and Z align image-guided system [Fig. 1b and c]. The reference overlay consists of three parallel lines, with the central line corresponding to the target axis. In all cases, the capsular rim marks were within the limits of the three parallel lines [Fig. 1b and c]. The toric IOL was aligned as per the capsular rim marks in all cases.

The mean age of the patients was 66.7 ± 8.5 years. Postoperatively, toric IOL alignment was assessed on a slit-lamp and the IOL was well aligned with the capsular rim marks [Fig. 2a]. A well-centered circular capsulotomy with 360° coverage of the IOL optic was observed and the uncorrected distance visual acuity was 20/20 or better in all cases. Toric enhancement software of ray-tracing aberrometry (iTRACE) was used to objectively assess the accuracy of toric IOL alignment [Fig. 2b]. The mean deviation from target axis of

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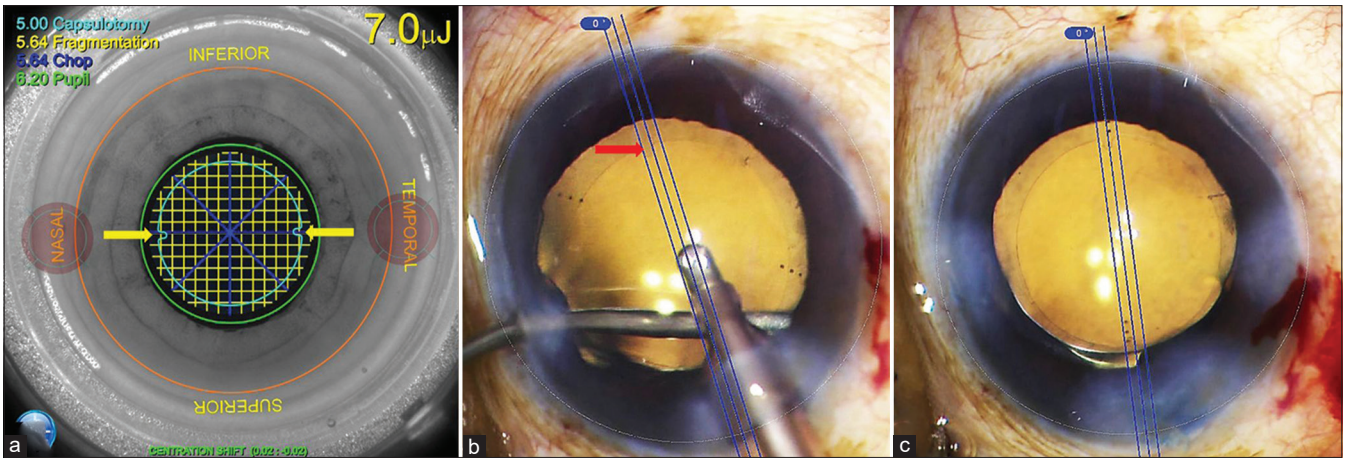

Figure 1: Refractive capsulorhexis for intraoperative alignment of toric IOL. (a) Femtosecond laser planning with capsular rim marks planned at 0° and 180° *(yellow arrows)*. (b) Intraoperatively, the accuracy of capsular rim marks was confirmed with the digital overlay of an image-guided system (CALLISTO Eye and Z Align) *(red arrow)*. (c) Toric IOL aligned along the target axis with the capsular rim marks and digital overlay of CALLISTO Eye and Z Align

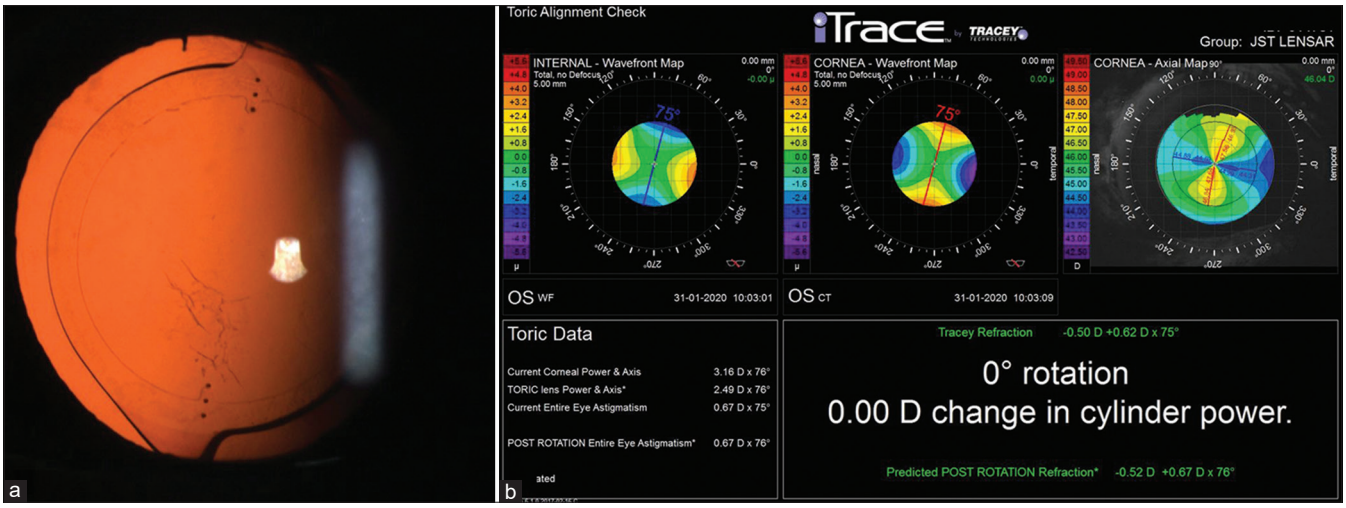

Figure 2: Postoperative assessment of toric IOL alignment using capsular rim marks. (a) Toric IOL perfectly aligned along the target axis with the capsular-rim marks. (b) Toric enhancement software on ray-tracing aberrometry confirms perfect alignment of the toric IOL with no rotation required

implantation was 2.07° ± 1.49° (Range 0-5°), and no significant rotation was recommended based on ray-tracing aberrometry. We did not observe any capsulotomy tears or extension at the site of capsular-rim marks.

Discussion

We observed accurate alignment of toric IOL using capsular rim marks created by femtosecond laser. The precision of the capsular rim marks was confirmed by comparing their position to the digital overlay projected by CALLISTO Eye and Z align.

An experimental study observed similar tensile strength among femtosecond laser capsulotomies with and without capsular-rim marks; however, these capsular marks may be a potential site of weakness and careful capsular polishing should be performed to prevent inadvertent capsular tears.[4,6] The position of capsular rim marks may not be accurate in a case with capsular tear or irregularity, and an alternative corneal or limbal landmark-based method of toric IOL alignment should be preferred in these cases.

A potential disadvantage of using capsular rim marks as a reference for toric IOL alignment is the dynamic changes in the capsulorhexis and capsular bag during phacoemulsification, which may lead to inaccuracies during IOL alignment. A uniform stretching of the capsular bag by an intact lens during laser application leads to the creation of a circular capsulotomy with precise capsular rim marks. However, there is a loss of capsular bag stretch after nuclear emulsification and irrigation aspiration. Further, implantation of IOL may in itself induce ovalization of the capsulotomy edges with capsular bag stretching along the orientation of the IOL haptics. This effect is observed more with rigid IOLs and plate-haptic designs.[7] Single-piece hydrophobic acrylic IOLs with flexible haptic design induce minimal ovaling of the capsular opening with well-maintained capsular bag configuration.[7] We implanted single-piece hydrophobic

acrylic IOL in all cases and observed fairly accurate positioning of the capsular rim marks as compared with image-guided overlay. The precision of capsular rim marks in cases with extremes of axial length and complicated cases with capsular fibrosis is yet to be evaluated.

Conclusion

Refractive capsulorhexis combines the advantages of a femtosecond laser capsulotomy with a one-step visual guide for intraoperative toric IOL alignment as well as postoperative assessment of rotational stability. It may be incorporated in various femtosecond laser platforms to simplify intraoperative alignment of toric IOLs. The accuracy of toric IOL alignment using capsular rim marks is comparable to image-guided systems; however, their predictability in difficult cases and extremes of axial length are yet to be evaluated. Further long-term studies with a large sample size can help validate the efficacy and safety of this technique.

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Conflicts of interest

There are no conflicts of interest.

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