



Corneal perforation following arcuate keratotomy in femtosecond laser assisted cataract surgery-a case series

Shreesha Kumar Kodavoor^{a,*}, Preethi V^b, Ramamurthy dandapani^c, Chitra Ramamurthy^d

^a The Eye Foundation, Department of Cornea and Phacorefractive, Diwan Bahadur road, RS Puram, West Coimbatore, Tamil Nadu, 641002, India

^b Fellow in Cornea and Phacorefractive, Department of Cornea and Phacorefractive, The Eye Foundation, Coimbatore, Tamil Nadu, India

^c Department of Cataract and Phacorefractive, The Eye Foundation, Coimbatore, Tamil Nadu, India

^d The Eye Foundation, Department of Glaucoma and Phacorefractive, Diwan bahadur road, RS Puram, West Coimbatore, Tamil Nadu, 641002, India

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ABSTRACT

Purpose: Identification and management of corneal perforation during arcuate keratotomy in femtosecond laser assisted cataract cases (FLACS).

Observation: Low astigmatism correction in patients undergoing FLACS can be done by arcuate keratotomy incision made by femto-laser. Corneal perforation following arcuate keratotomy is commonly noted with manual incision but very few cases have been reported with femtosecond laser assisted arcuate keratotomy (FSAK). In this case series, we have reported cases with corneal perforation following FSAK in patients undergoing FLACS. All the cases were managed by placing suture at the keratotomy site followed by phacoemulsification.

Conclusion and importance: Perforation can be expected in cases with FSAK though rare. Vigilant monitoring of the depth of laser passage and early detections of such perforations is required, for further prevention of complication. Astigmatic arcuate keratotomy is associated with a risk of perforation even if it is performed with femto laser, but risk of perforation is low and undoubtedly the benefit to risk ratio is high.

1. Introduction

With the advances in technology patient's expectations following cataract surgery have increased and surgeons are trying their best to give a better uncorrected distance visual acuity (UDVA). With the advent of premium intraocular lenses (IOL) the results of post cataract surgery are promising for spectacle free vision. Femtosecond laser assisted cataract surgery (FLACS) is been used for increased precision and accurate centering of these IOL's. One of the common causes for reduced UDVA post cataract surgery is pre-existing astigmatism in cataract patients, which needs to be addressed for better visual outcomes. With FLACS preoperative astigmatism can be corrected with arcuate incision, especially those having a low astigmatic error, with promising results.¹ Rarely these incisions can perforate due to movement of eyeball or suction loss. Here we report cases of corneal perforation during arcuate incision in FLACS and its management.

2. Case report

A 75 year old female patient came with complaints of gradually progressing painless diminution of vision in the left. Her UDVA for distance in the left eye was 20/63 and her corrected distance visual acuity (CDVA) was 20/50 (manifest refraction $-1.50/80$). On slit lamp examination left eye had grade 3 nuclear sclerosis. She was advised to undergo FLACS in her left eye. Her Keratometry values with iol master were, K1 43.88 D (diopter) and K2 44.35D. VERION image guided system was used to calculate the length and site of placement of arcuate keratotomy (AK) incision. The K1 and K2 with VERION were 43.67D and 44.29D respectively with astigmatism of $+0.61 @ 180$. The calculated AK length was 23mm @ 180. The pachymetry at the incision site was 627 μ m. The calculated values were entered manually into the femtosecond laser machine.

FLACS was performed on the patient using an OCT based femtosecond laser (Catalys, optimedica corp). This laser has an integral Guidance system – 3D full volume Optical coherence Tomography and automated surface mapping algorithms for the guidance of laser

* Corresponding author.

E-mail addresses: eskay_03@rediffmail.com (S.K. Kodavoor), preethi.vee.31@gmail.com (P. V.), drmmurthy@theeyefoundation.com (R. dandapani), drchitra@theeyefoundation.com (C. Ramamurthy).

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delivery. Catalys uses a wavelength of 1030 nm, pulse duration of 400 femtoseconds, 3–10 μ J pulse energy, and a 1280 kHz repetition rate. A liquid interface was used for docking the eye. The liquid optics interface fills the corneal irregularities with fluid and provides a wide field of view, to perform all the cuts in a single dock. The eye of the patient was properly centered and docked, OCT generated images were analyzed. The patient had a small pupil and the capsulorhexis diameter which was automated by the machine was 3.8 mm (Fig. 1a), the rhexis size was manually increased to 4.6 mm (Fig. 1b). The rhexis was followed by lens fragmentation and softening, which went on smoothly. Anterior penetrating type of AK was done till 80% depth of corneal thickness at 9 mm optic zone. The parameters used for AK are shown in Table 1. Air bubble was seen in the anterior chamber close to arcuate incision towards the end of the procedure (Fig. 2b). The rest of the procedure was aborted and the patient was shifted on to the operating table. During the manual adjustments for rhexis size in the monitor, it was presumed that the patient might have slightly moved her eyes which resulted in a suction loss, because of which full thickness incision occurred at the intended site. The AS- OCT imaged showed posterior displacement of the arcuate incision during the passage of laser (Fig. 2a).

On the operating table, the eye was hypotonous and anterior chamber was flat (Fig. 3a). The anterior chamber was filled with viscoelastic, through paracentesis incision (Fig. 3b). As fluid was leaking and the chamber was flat, a single X-pattern suture was placed with 10 nylon suture at the AK incision (Fig. 3c). Hydrodissection was done followed by phacoemulsification of the cataract. Posterior chamber IOL was placed in the bag and the anterior chamber was formed with saline (Fig. 3d). No other intra-operative complications occurred during phacoemulsification. Post-operatively the patient was started on Loteprednol eye drops 6 times/day for one week, followed by tapering of drops, Moxifloxacin eye drops 4 times/day for 1 week. At 1 week postoperatively, her UCVA was 20/63 and the suture was intact (Fig. 4a). At 1 month postoperatively, her suture was removed (Fig. 4b). Her UDVA at 6 weeks was 20/80 improving to 20/25 with refraction +0.50/-1.50/10.

3. Case 2

65 year old male patient presented with UDVA of hand movements in his right eye. On examination, he had a white intumescent cataract in his right eye with shallow anterior chamber. He was advised for FLACS in that eye. His keratometry values with verion were K1 43.02D and K2 43.85D with astigmatism of 0.83 @ 15. The AK incision calculated using verion was a single arc of 27 mm length @ 10. The surgical procedure followed was same as that mentioned in the above case. The suction loss occurred during the procedure but it was not noticed and full thickness incision occurred. This case was also managed by placing a suture at the keratotomy site and phacoemulsification was completed. The UDVA was 20/32 improving to 20/20 with $-0.25/-0.25/15$ at 6 weeks.

4. Case 3

A similar occurrence of a full thickness incision occurred in 75 year

Table 1
Settings of Arcuate incision.

Type	Anterior penetrating
Center method	limbus
Uncut posterior	20%
Side cut angle	90°
Axis 1	180°
Optical Zone	9.0 mm
Length	48°
Corneal thickness	627 μ
Total energy	2.4 J
Laser time	8.1 s

old patient undergoing FLACS. She had an immature cataract in her left eye. Her calculated keratometry values with Verion were K1 44.7 and K2 45.91 with an astigmatism of 1.21 @176. The calculated Keratotomy incision was 26 mm @ 174 axis. The patient was very un-cooperative from the beginning of the procedure because of which full thickness incision occurred at the AK site. The rest of procedure was managed similarly as mentioned in the first case. Her UCVA at 6 weeks was 20/40 improving to 20/25 with $-0.75/15$.

5. Discussion

Cataract surgery is more of a refractive procedure in the modern era, preoperative astigmatism needs to be corrected. Various options available are on-axis corneal incision (OCI), peripheral corneal relaxing incisions (PCRIs) which include manual or limbal relaxing incision (LRI), and Laser assisted PCRIs or arcuate keratomies (AK), paired opposite clear corneal incision (OCCI), Toric IOLs.²⁻⁴ One of the advantages of FLACS is that the low astigmatism can be corrected with femtosecond laser assisted arcuate keratotomy in the same setting. The Femtosecond laser assisted arcuate keratotomy has been proved to be safe and provides reliable outcomes.⁵ The principle behind it is that the placement of paired or un-paired partial incision on the cornea of a predetermined length and site over the steep axis causes flattening at the steep axis and steeping at the flat axis.

With the increased use of femtosecond laser in cataract surgeries, femtosecond assisted arcuate keratotomy (FSAK) is been commonly performed along with FLACS. The complications associated with manual keratotomy like wound gape, microperforations, infection, epithelial ingrowth have been minimized with the use of femtolasers.⁵ Though not very common, full thickness perforations with FSAK have been reported. Vaddavalli et al.⁶ have reported corneal perforation after FSAK in a patient where they noticed an air bubble in the anterior chamber after the procedure, when the incision was opened with sinskey full thickness incision of the keratotomy was noted. On analyzing the video they noticed an air bubble in the anterior chamber arising from the site of AK incision. They concluded that the bubble in the anterior chamber is one of the indication of a full thickness FSAK incision. In case 1, an air bubble in the anterior chamber was noted and the further procedure was aborted anticipating a full thickness corneal incision. Noticing an air bubble in the anterior chamber before any corneal incisions can be an

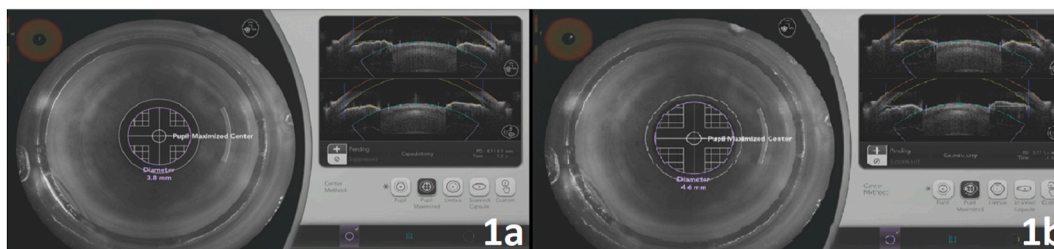


Fig. 1. a: Capsulorhexis size of 3.8 mm automated by the machine after docking. 1b: Manually adjusted rhexis size of 4.6 mm.

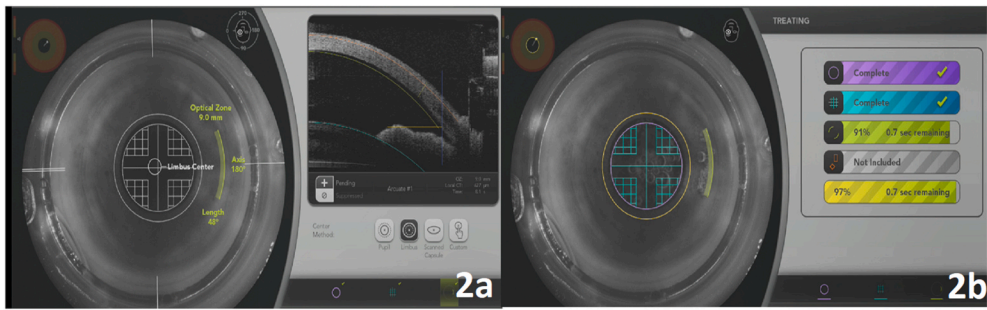


Fig. 2. a: Posterior displacement of the laser at arcuate incision site causing full thickness incision. 2b: Air bubbles seen in the anterior chamber at the keratotomy incision site.

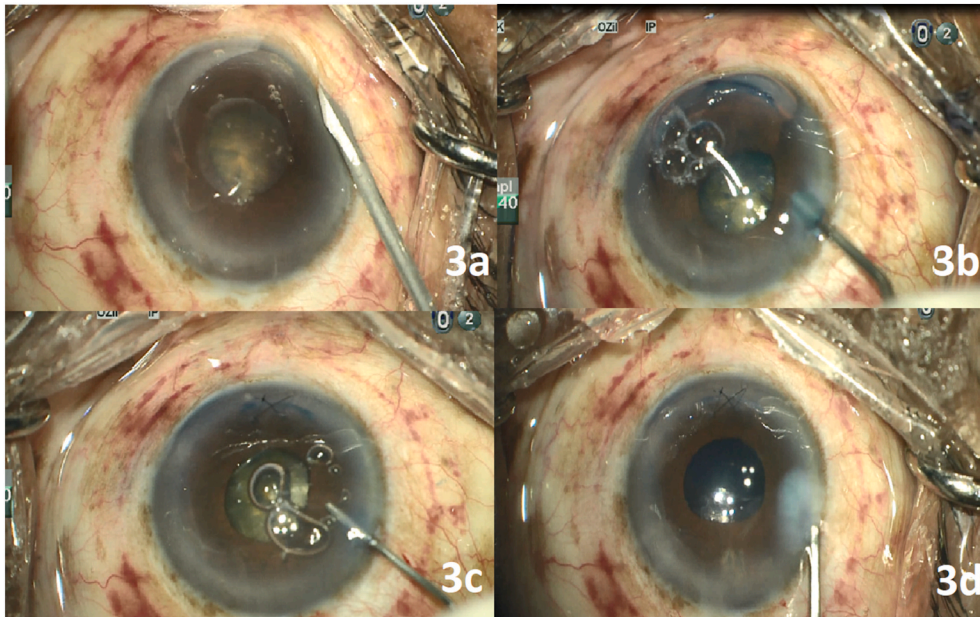


Fig. 3. a: Hypotonous eye with flat anterior chamber. 3b: Injecting of Viscoelastics into anterior chamber, leakage of visco can be noted from the keratotomy site. 3c: Keratotomy incision sutured with 10-0 nylon. 3d: Anterior chamber formed with saline after completion of phacoemulsification.

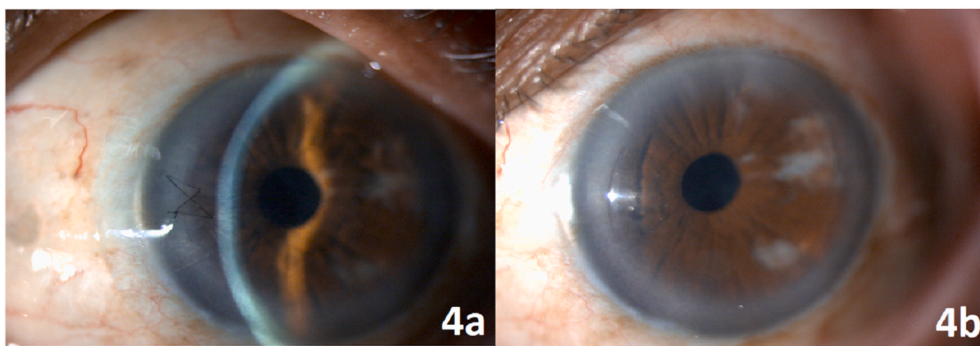


Fig. 4. a: Postoperative 1 week. Suture in-situ, well-formed anterior chamber. 4b: Postoperative-1 month, after the removal of suture.

early indicator of full thickness perforation.

Daniel G. Cherfan et al.⁷ have reported a similar corneal perforation happening during astigmatic keratotomy in a patient undergoing cataract surgery with femtolasar. The case was managed by suturing the keratotomy incision with nylon suture followed by phacoemulsification. We have managed all the three cases mentioned above similarly by suturing the keratotomy wound and proceeded with the phacoemulsification. Though none of the patients had any complications during the phacoemulsification because of the surgeon expertise, it might not be the

same in all cases. Precautions are to be taken to avoid such complications. All the patients should be counseled thoroughly about the procedure before starting the procedure. In case 3, the patient was uncooperative because of which the complication occurred, it's better to avoid FLACS in such patient, and pre-operative counseling plays a major role. In case 1, during the manual modifications of the rhexis size the patient might have lost her concentration and moved her eye, which led to suction loss and a full thickness incision. After docking it's always better to complete the laser procedure with minimal sufficient time, as

there is always a tendency for the patient to lose concentration and move their eye from the target.

Vigilant monitoring of the procedure should be done by the surgeon. It is always safe to abort the procedure during the suction loss. In case 2 due to the suction loss, full thickness incision occurred which was not noticed. The patient had an intumescent cataract with a shallow anterior chamber. The safety mechanism in the machine immediately notifies the suction loss, because of incomplete suction and shallow anterior chamber in the second case, the laser got delivered deeply. Nagy et al.⁸ have reported the endothelial cell layer cut in hyperopic eye with shallow anterior chamber in their study, which can be avoided by an integrated OCT guided system. The impact of AK over the astigmatism correction in these cases cannot be commented on because of the full thickness incision and sutures placed for its management.

In the above case reports, we have reported cases with full thickness incisions occurring during AK in FLACS cases and have tried to analyze the causes. Though it is an uncommon complication, it might lead to difficulties during phacoemulsification. Integrated OCT system helps the surgeons to visualize the passage of laser continuously, the surgeon should monitor the images unremittingly to avoid complications. Even slight eye movement or squeezing of the eye may displace the position of laser delivery. An integrated eye tracker with femtolasers machine will be of great advantage during the procedure.

6. Conclusion

FLACS has proved to be one of the upcoming surgical procedure which might revolutionize the cataract surgeries in future. The surgical procedure is not without complications, but it needs to be minimized for better outcomes. Astigmatic arcuate keratotomy is associated with a risk of perforation even if it is performed with femto laser, but risk of perforation is low and undoubtedly the benefit to risk ratio is high. Loss of concentration, prolonged laser procedure, and poor cooperation are some of the causes which can lead to perforation of these arcuate incisions.

Patient consent

This report does not contain any personal information that could lead to the identification of the patient.

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Intellectual property

We confirm that we have given due consideration to the protection of

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Research ethics

We further confirm that any aspect of the work covered in this manuscript that has involved human patients has been conducted with the ethical approval of all relevant bodies and that such approvals are acknowledged within the manuscript.

IRB approval was obtained (required for studies and series of 3 or more cases).

Written consent to publish potentially identifying information, such as details or the case and photographs, was obtained from the patient(s) or their legal guardian(s).

Authorship

All listed authors meet the ICMJE criteria.

We attest that all authors contributed significantly to the creation of this manuscript, each having fulfilled criteria as established by the ICMJE.

We confirm that the manuscript has been read and approved by all named authors.

We confirm that the order of authors listed in the manuscript has been approved by all named authors.

Declaration of competing interest

None.

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