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Original article

Femtosecond astigmatic keratotomy for postkeratoplasty astigmatism

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Abstract

Purpose: To evaluate the initial outcomes of femtosecond laser arcuate keratotomies (AK) to correct high astigmatism after keratoplasty.
Methods: This retrospective non-comparative interventional study included 52 consecutive patients (52 eyes) who underwent Intralase-enabled arcuate keratotomies. Changes in uncorrected visual acuity (UCVA), best spectacle-corrected visual acuity (BCVA), mean refractive and keratometric astigmatism, preoperative and postoperative manifest refraction and complications were the main outcome measures.
Results: The mean follow-up period was 13.77 ± 4.17 months. Mean BCVA and UCVA improved statistically significantly from 0.30 ± 0.18 LogMAR and 0.90 ± 0.43 LogMAR preoperatively to 0.20 ± 0.14 and 0.60 ± 0.39 postoperatively respectively ($P < 0.05$, all comparisons). Mean subjective cylinder decreased statistically significantly from 7.15 ± 1.32 D preoperatively to 5.19 ± 2.25 D at the last postoperative visit ($P = 0.0002$). Two eyes (4%) lost one line or more of BCVA. Three patients (5.8%) had corneal perforation and only one eye required resuturing of the AK wound. Twelve patients (23%) were overcorrected.
Conclusions: AK performed with the femtosecond laser was relatively easy to perform, safe, and effective for treating post-keratoplasty astigmatism. There was a significant improvement in UCVA and BCVA with a very low rate of complications. A larger series is required to refine the nomogram to achieve a greater reduction in cylinder.

Keywords: Astigmatic keratotomy, Astigmatism, Femtosecond

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Introduction

High astigmatism after penetrating keratoplasty can limit visual rehabilitation. Numerous surgical procedures have been used to treat astigmatism including, relaxing procedures, wedge resections, and photorefractive procedures.[1–9] The most commonly used method for reducing post-keratoplasty astigmatism is arcuate keratotomy (AK).[10–16] However, manual AK is often associated with unpredictable outcomes and complications including epithelial ingrowth, infection, scarring, and, rarely, corneal perforation.[17,18]

Recently astigmatic keratotomies have been created with a femtosecond laser.[19–23] The major advantages of the femtosecond laser include greater reproducibility and accuracy of the depth of the incision.[23] The purpose of this study was to report our initial experience with the use of femtosecond laser AK for post-keratoplasty astigmatism.

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Materials and methods

Study design

This study was approved by the King Khaled Eye Specialist Hospital review board. A chart review was performed for patients who underwent femtosecond laser astigmatic keratotomy (FSAK) between January 2010 and December 2012. Data were collected on 52 eyes of 52 consecutive patients (34 males, 18 females) with mean age 31.9 ± 8.88 years (range, 17–66 years). Patients with irregular astigmatism were excluded.

The minimum follow-up period for the patients included in this study was 24 weeks. All the AK procedures were performed on the donor side of the cornea. In all patients, the graft sutures had been removed at least 12 weeks prior to AK.

Outcome measures included uncorrected Snellen visual acuity (UCVA), best corrected Snellen visual acuity (BCVA), manifest and cycloplegic (if available) refractions, corneal topography (Orbscan 2; Bausch and Lomb Inc., Rochester, NY, USA) to assess the amount and axis of the corneal cylinder. Postoperative visits were performed at 1 day, 2–3 weeks, 3 months, 6 months, and 12 months. At each visit pre- and post-operatively, slit-lamp examination and tonometry were performed and outcome measures were recorded. For outcome measurement analysis, both interval and last visit data were used. The efficacy index was calculated as the ratio of the mean postoperative UCVA to the mean preoperative BCVA. The safety index was calculated as the ratio of mean postoperative BCVA to the mean preoperative BCVA.

Surgical technique

Two drops of topical anesthetic proparacaine hydrochloride 0.5% (ALCAINE) were instilled in the eye. The eyelids were cleansed with Betadine sponges. The graft–host junction was marked in the steep and flat axis with a sterile marking pen (Surgical Markers from Accu-line Products Inc., Hyannis, MA, USA). Marking allowed better centration of the graft incisions. Corneal thickness at the incision wound was measured with ultrasonic pachymetry (Corneo-Gage; Sonogage Inc., Cleveland, Ohio, USA). The size of the optical zone was calculated based on the original graft size. Each incision was made 0.5–0.7 mm within the graft–host junction, such that the diameter was set at 1–1.4 mm less than the graft diameter measured by calipers at the time of surgery. Using the keratoplasty software, 2 anterior arcuate incisions were created at 75–85% depth of the thinnest measurement of the graft at the desired optical zone with the femtosecond laser (60 kHz IntraLase. AMO Inc., Chicago, Ill., USA). If the axis of the manifest refraction and the topography differed, we used the topographic axis. The amount of topographic cylinder rather than the manifest cylinder was used to determine the length (degrees) of the keratotomy. The Nordan nomogram was used by most surgeons to create paired symmetric (same length) incisions centered on the steep axis as follows: 1.75–2.5 diopters (D) of cylinder with 50° arc length, 2.75–3.3 D of cylinder with 57° arc length, 3.75–4.5 D of cylinder with 60° arc length, and more than 5 D of astigmatism with 70° arc length.

The laser settings were anterior side-cut energy 2.20 microjoules, anterior side-cut spot separation was set at 3 and anterior side-cut layer separation was set at 3. The IntraLase limbal suction ring was then applied, and the cone was positioned. Applanation was judged as adequate if the fluid meniscus was at least beyond the graft–host junction. There were no suction breaks during treatment in any case. Once complete, suction was released, and the ring was removed. Both incisions were opened with a Sinskey hook immediately after creation and the effect of the incisions was checked with a Placido disc (Maloney handheld keratometer) during surgery. After surgery, antibiotic and steroid eye drops were prescribed four times daily for 4 weeks. The patients were instructed to avoid rubbing their eyes and to use preservative-free artificial tears frequently.

Statistical analysis

The Wilcoxon rank sum test was used to assess the difference between preoperative and postoperative values. Statistical analysis was performed with the Statistical Package for the Social Sciences 20.0 for Windows (IBM Corp., New York, NY, USA). Data were expressed as mean ± standard deviation, and a *P* value less than 0.05 was considered statistically significant.

Results

Preoperative data and clinical characteristics are presented in Table 1. Fifty-two eyes of 52 patients (34 males and 18 Females) were included in this study. Indications for keratoplasty in this study were keratoconus, corneal scar

Table 1. Demographic and preoperative data for patients who underwent femtosecond laser arcuate keratotomies after keratoplasty.

Variable	
Eye (n)	
Right	21 (40.4%)
Left	31 (59.6%)
Total	52 (100%)
Age at surgery (y)	
Range	17–66
Mean ± SD	31.9 ± 8.88
Median	32
Gender (n)	
Male	34 (65.4%)
Female	18 (34.6%)
Preoperative UCVA	
⩾20/40	2 (3.84%)
⩾20/100	17 (32.69%)
⩾20/400	43 (82.69%)
Preoperative BCVA	
⩾20/20	3 (5.79%)
⩾20/40	36 (69.23%)
⩾20/125	52 (100%)
Follow-up (months)	
Range	6–22
Mean ± SD	13.77 ± 4.17
Type of graft	
PKP	36 (69.2%)
LKP	14 (26.90%)
Unknown	2 (3.80%)

UCVA = uncorrected visual acuity. BCVA = best corrected visual acuity. PKP = penetrating keratoplasty. LKP = lamellar keratoplasty.