was 1.6 lines; however, a significant number of eyes had no uncorrected vision data at 1-year follow-up. Of 26 eyes, 14 (53.8%) gained lines of UCVA at day 1, and 3 (11.5%) at 1 year.

**DISCUSSION**

Residual refractive error is the most frequent reason for dissatisfaction after LASIK. Retreatments for residual refractive error can have complications, which may potentially be avoided if epithelial retreatments can provide satisfactory results for some of these patients. Specifically, epithelial ingrowth, flap wrinkling, and diffuse lamellar keratitis theoretically should not occur as a consequence of an epithelial retreatment. In our small study, no eyes had a loss of BSCVA secondary to the retreatment surgery.

One limitation of this study was the low follow-up at 1 year postoperatively. This may be because patients were pleased with their vision and believed follow-up was unnecessary or were frustrated with a lack of improvement in their vision, and consequently did not follow-up.

Guell et al. reported that 52% of eyes treated with a similar technique were within 0.50 D of emmetropia, which is similar to our results of 57% at 1 year. We chose the main endpoint in the current study as progression to flap-lift retreatment as a failure of the treatment due to the lack of a defined data endpoint. A relatively high number of eyes (8 eyes, 29.6%) went on to have another retreatment before 1-year postoperative follow-up. The change in spherical equivalent refraction pre- to postoperatively was not clinically significant, mainly because of the small degree of correction attempted and achieved, with the fluctuation in refractive errors from visit to visit falling in a similar range to the treatment amounts, and thus the number of eyes requesting further retreatment is likely to be a better indicator of success of treatment.

Epithelial retreatment may be a useful consideration for some patients with symptomatic low degrees of refractive error. Because of the low rate of visual improvement and poor predictability at 1 year, its use will likely be limited. Despite the high rate of subsequent retreatment, and the lack of statistically significant change in refractive error, the low rate of complications suggests that it may be useful for some eyes. In addition, if the patient perceives a good response on day 1 that regresses over time, it may suggest that improvement in symptoms can be achieved with either a flap-lift retreatment or surface ablation retreatment with a similar ablation profile.

**REFERENCES**


**Hyperopic Keratoconus**

Juan Carlos Abad, MD; Abraham Awad, MD; Joseph M. Kurstin, MD

**ABSTRACT**

**PURPOSE:** To report three patients (four eyes) with hyperopic keratoconus.

**METHODS:** Patients were evaluated with corneal curvature topography, ultrasonic pachymetry, and rotating Scheimpflug camera.

**RESULTS:** One patient, without other risk factors, developed unilateral ectasia after LASIK following primary hyperopic ablation in an eye suspicious for keratoconus. Two additional hyperopic patients (three eyes) had curvature and elevation findings compatible with keratoconus.

**CONCLUSIONS:** Although rare, keratoconus could present in hyperopia. If keratoconus is suspected, we suggest avoidance of LASIK and its potential for development of corneal ectasia. *J Refract Surg.* 2007;23:520-523.

Most cases of ectasia after LASIK have occurred in patients with myopic refractive errors. We report ectasia after primary hyperopic LASIK in a patient with subclinical keratoconus, and two hyperopic patients with preoperative findings compatible with keratoconus.
CASE REPORTS

CASE 1

A 48-year-old woman presented for refractive surgery in June 2001 with uncorrected visual acuity (UCVA) of 20/60 and best spectacle-corrected visual acuity (BSCVA) of 20/20 in both eyes, and refraction of +1.00 diopters (D) sphere. The patient did not use optical correction for distance, and used over-the-counter +2.25 sphere reading glasses. Keratometry was 44.25/44.00 D @ 46 in the right eye, and 44.50/43.75 D @ 176 in the left eye. Corneal topography with a Humphrey Atlas, Version A11.2 (Carl Zeiss Meditec Inc, Jena, Germany) topographer showed a normal pattern in both eyes (Fig 1). Ultrasonic central corneal thickness with the Pachette 2 (DGHT Technology Inc, Exton, Pa) pachymeter was 530 and 535 µm in the right and left eyes, respectively, and four additional mid-peripheral values were thicker than central values. After 1 week of contact lens monovision testing (+1.00 and +3.00 sphere in the right and left eyes, respectively), the patient opted to have the right eye corrected for distance and the left eye corrected for near vision.

Bilateral LASIK with a manual, 130-head Moria CB (Moria, Antony, France) microkeratome and a VISX Star2 (VISX, Santa Clara, Calif) excimer laser was performed in June 2001. During primary and further enhancement procedures, the active tracking was engaged after the pupil center was found while having the patient look at the coaxial fixation light. In the right eye, spherical laser correction of +1.12 D with an optical zone of 4.5 mm and ablation diameter of 8.5 mm was performed, for a maximum peripheral ablation depth of 8 µm. In the left eye, correction of −3.44 D with an optical zone of 4.5 mm and ablation diameter of 8.5 mm was performed, for a maximum peripheral ablation depth of 25 µm.

In March 2002, the patient complained of “fuzzy” distance visual acuity. Uncorrected visual acuity in the right eye was 20/30, refraction was +0.50 −1.25 × 56 (20/20), K reading was 45.25/44.50 D @ 39, and the topographic difference map showed a well-centered ablation. Trial spectacles with correction in the right eye (leaving the left eye uncorrected) improved the patient’s visual complaints. She subsequently underwent enhancement in the right eye by lifting the flap. Ultrasonic central corneal thickness was 539 µm at retreatment, and the central bed prior to ablation was 331 µm. Laser ablation with a VISX mixed-cylinder card was +0.50 −1.25 × 56, with 5.0-mm optical zone, 9.0-mm ablation diameter, and 4-µm depth of ablation for the hyperopic component, and 6.5-mm optical zone, 5.0-mm ablation diameter, and 7-µm depth of ablation for the myopic component.

In February 2004, UCVA was 20/30 in the right eye with a refraction of plano −0.75 × 87 (20/25), and K reading of 45.55/45.20 D @ 101. In May 2005, the patient was diagnosed with breast cancer and underwent chemotherapy. She presented again in January 2006 with UCVA of 20/30 in the right eye, refraction of plano −4.50 × 65 (20/50), K reading of 50.50/47.00 D @ 73, and steepening compatible with ectasia in the topographic difference map (see Fig 1). A rotating Scheimpflug (Pentacam; OCULUS Inc, Lynwood, Wash) camera analysis of the right eye revealed an anterior localized inferior paracentral protrusion of 32 µm, with a corresponding posterior protrusion of 61 µm. While reprocessing the preoperative topographies using the Pathfinder Corneal Analysis of the Humphrey Atlas (Carl Zeiss Meditec Inc) topographer, the right eye was labeled as “Suspect Subclinical Keratoconus” based on increased prolateness and irregularity of the corneal surface. The left eye was labeled “Normal.”

The patient’s left eye remained stable for 55 months after LASIK, with UCVA of J1+, refraction of −1.50 −0.50 × 76 (20/30), and K reading of 45.75/45.40 D @ 63. Several topographic difference maps throughout the postoperative period showed a well-centered ablation without further steepening. A Pentacam evaluation did not show abnormalities compatible with ectasia.

CASE 2

A 58-year-old man presented for refractive surgery in January 2006. Uncorrected visual acuity was 20/50 in both eyes, and BSCVA was 20/25 in both eyes with refraction of +1.25 −1.75 × 94 in the right eye and +1.75 −0.75 × 180 in the left eye. Keratometry was 45.65/44.90 D @ 53 in the right eye and 44.90/44.20 D @ 177 in the left eye. Corneal topography revealed non-orthogonal astigmatism (Fig 2). The Pathfinder Analysis system labeled both corneas as “Keratoconus Suspects” based on increased irregularity and prolateness of the corneas. Pentacam evaluation of the right eye revealed central corneal thickness of 454 µm and anterior para-central inferior elevation of 13 µm over the best fit

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sphere, with a corresponding posterior protrusion of 32 μm. Pentacam analysis of the left eye showed central corneal thickness of 451 μm and anterior central elevation of 11 μm over the best fit sphere, with corresponding posterior protrusion of 31 μm. No corneal surgery was recommended.

**CASE 3**

A 65-year-old woman presented for refractive surgery in May 2005. Uncorrected visual acuity was 20/200 and 20/60 in the right and left eye, respectively, and BSCVA was 20/60 and 20/25 with +1.25 −1.00 × 35 and +1.25 sphere in the right and left eye, respectively. Keratometry was 47.20/43.00 D @ 31 in the right eye and 43.00/42.92 D @ 15 in the left eye. Pentacam corneal evaluation of the right eye revealed central corneal thickness of 503 μm, a non-orthogonal “snowman” pattern in the calculated curvature topography map, and an asymmetric peninsula in the anterior elevation map, with a corresponding protruding island of 52 μm.
in the posterior elevation map. The left eye had central corneal thickness of 498 μm and a borderline posterior protrusion of 18 μm, but no anterior (curvature or elevation) signs of keratoconus. After the findings were discussed, the patient elected to wear monovision contact lenses.

**DISCUSSION**

Postoperative ectasia is one of the most severe complications of LASIK. No cases of ectasia after LASIK for treatment of primary hyperopia have been reported. However, the literature does contain a theoretical reason why ectasia after hyperopic ablation does not occur. Lyle and Jin reported a patient with consecutive hyperopia after radial keratotomy who developed ectasia following LASIK. The development of ectasia after LASIK appears to be related to undetected keratoconus or to residual stromal beds that are left too thin. In the case reported by Lyle and Jin, underlying keratoconus cannot be excluded. In our patients, case 1 had a normal topography pattern and no increased risk factors, but was labeled as “Suspect Subclinical Keratoconus” by the Pathfinder Corneal Analysis in the eye that developed ectasia after LASIK. Case 2 had definite bilateral keratoconus based on the corneal topography and Pentacam evaluations. Case 3 had findings compatible with keratoconus in the right eye based on Pentacam examination.

Although hyperopic keratoconus is rare, patients with Down syndrome have a higher incidence of hyperopia, and occasionally keratoconus. Each of our patients had an otherwise normal phenotype and mental status. The lower incidence of hyperopic keratoconus may be one reason why occurrence of ectasia after LASIK for primary hyperopia is less common. Other reasons may be biomechanical, as the peripheral cornea is thicker and able to withstand greater amounts of thinning, hyperopic corrections rarely exceed 6.00 D or approximately 90 μm, and the intraocular forces in hyperopic correction are diffused over a much broader area (transition zone) in contrast to myopic correction (center of ablation).

Because a hyperopic ablation steepens the central cornea, detection of progressive steepening in serial topographies may be needed to determine whether ectasia is present. If only one postoperative topography is available, a pre- to postoperative difference map showing steepening of the transition zone or central steepening greater than the planned ablation should raise suspicion of the possibility of ectasia.

We present ectasia after LASIK following primary hyperopic correction, most likely related to an underlying keratoconus. We also present two patients with obvious hyperopic keratoconus. Although rare, the ophthalmic community should be aware that postoperative ectasia could occur in cases of LASIK for primary hyperopia in corneas with subtle signs of keratoconus.

**REFERENCES**


**Corneal Suture for the Correction of Hyperopia Following Radial Keratotomy**

Walton Nosé, MD; Daniela Endriess, MD; Adriana S. Forseto, MD

**ABSTRACT**

**PURPOSE:** To report the visual and refractive changes observed after double concentric corneal suture to correct hyperopic shift after radial keratotomy (RK).

**METHODS:** This retrospective consecutive case series comprised 17 eyes (15 patients) that underwent two concentric corneal sutures (modified Grene Lasso suture) to correct hyperopic shift after RK. All surgeries were performed by the same surgeon between 2000 and 2003.

**RESULTS:** The mean time after RK was 11.6±3.2 years. The mean follow-up was 20.3±11.3 months. The spherical equivalent refraction was reduced from a preoperative mean of +4.38±2.87 diopters (D) to −0.54±2.59 D at last postoperative follow-up (P<.001). No statistically significant difference was observed in mean refractive astigmatism before and after the corneal suture.