Intrastromal corneal ring segment implantation for ectasia after refractive surgery

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PURPOSE: To evaluate the clinical outcomes of implantation of Ferrara intrastromal corneal ring segments (ICRS) in patients with corneal ectasia after refractive surgery.

SETTING: Private clinic, Belo Horizonte, Brazil.

METHODS: Charts of patients with corneal ectasia after refractive surgery were retrospectively reviewed. The following parameters were studied: uncorrected distance visual acuity (UDVA), corrected distance visual acuity (CDVA), keratometry, corneal asphericity, and pachymetry. All patients were evaluated by Scheimpflug scanning-slit tomography (Pentacam).

RESULTS: Charts of 25 eyes (20 patients) with corneal ectasia (20 after laser in situ keratomileusis, 4 after radial keratotomy, 1 after photorefractive keratectomy) were reviewed. Postoperatively, the mean UDVA increased from 20/185 to 20/66 (P < .005) and the mean CDVA, from 20/125 to 20/40 (P = .008). The mean asphericity decreased from −0.95 preoperatively to −0.23 postoperatively (P = .006). The mean pachymetry at the apex of the cornea increased from 457.7 μm ± 48.7 μm postoperatively to 466.2 ± 49.8 μm (SD) preoperatively and the mean pachymetry at the thinnest point, from 436.3 ± 46.2 μm to 453.9 ± 49.3 μm (P = .000). The mean keratometry decreased from 45.41 ± 5.63 diopters (D) to 42.88 ± 4.44 D, respectively; the decrease was statistically significant (P = .000).

CONCLUSION: Intrastromal corneal ring segment implantation significantly improved UDVA and CDVA in patients with corneal ectasia.

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Corneal ectasia is an infrequent but potentially serious complication of refractive surgery and occurs more commonly after laser in situ keratomileusis (LASIK). After LASIK, the cornea is structurally weakened, not only by the laser central stromal ablation but also by the creation of the flap. The cornea may assume an irregular conical shape, and this leads to a decrease in visual acuity secondary to high irregular astigmatism, as occurs in primary ectatic corneal disorders such as keratoconus.

Even though corneal ectasia is relatively rare after LASIK, it can have a profoundly negative effect on the refractive properties of the cornea. The cause and the biomechanical changes that induce keratectasia after refractive surgery are unknown. The cause of corneal ectasia has not been clearly established, although collagen abnormalities, as seen in keratoconus, have been reported. The disease usually evolves with progressive deterioration in uncorrected distance visual acuity (UDVA) and corrected distance visual acuity (CDVA) caused by the irregular astigmatism induced by the corneal ectasia.

Several possible alternatives to manage post-LASIK corneal ectasia have been reported, including sclera-fitted gas-permeable contact lenses, collagen...
crosslinking, deep lamellar keratoplasty, and intrastromal corneal ring segment (ICRS) implantation. Intrastromal corneal ring segments were designed to achieve a refractive adjustment by flattening the central corneal curvature while maintaining clarity in the central optical zone. A complete ophthalmologic examination was performed before and after surgery and included UDVA, CDVA, slitlamp, and topographic examinations were performed.

Statistical Analysis
Statistical analysis was performed using Minitab software (version 2007, Minitab, Inc.). The Student t test for paired data was used to compare preoperative and postoperative data.

RESULTS
Twenty-five eyes of 20 patients with corneal ectasia after refractive surgery were evaluated. The refractive surgery was LASIK in 20 eyes, radial keratotomy in 4 eyes, and photorefractive keratectomy in 1 eye. Table 1 shows the characteristics of the patients. The mean follow-up was 39.8 months ± 21.1 (SD). All patients had implantation of a single segment. The arc ring was 160 degrees in 18 eyes and 210 degrees in 7 eyes. The ICRS segment was implanted uneventfully in all cases.

Table 2 shows the postoperative results. The increase in mean UDVA and mean CDVA from preoperatively to postoperatively was statistically significant (P = .005 and P = .008, respectively) (Figure 1). The decrease in mean corneal asphericity was also statistically significant (P = .006). The increase in the mean pachymetry at the apex of the cornea and at the thinnest point of the cornea was statistically significant (P = .025 and P = .000, respectively). There was a statistically significant reduction in keratometric values from preoperative to the last follow-up examination (P = .000) (Figure 2).

One patient required additional surgery to reposition the ring. There were no other complications.

DISCUSSION
The widespread use of LASIK has not resulted in notably serious complications. Despite the number of studies that support the efficacy of LASIK, concern about the occurrence of postoperative keratectasia is growing. The tissue ablation and lamellar cut in LASIK

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<th>Table 1. Preoperative patient characteristics.</th>
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substantially weaken the mechanical strength and effective thickness of the cornea. There is concern that at some point, the tensile strength of the cornea may be reduced to a level that predisposes to postoperative ectasia.20

In our study of ICRS segment implantation for corneal ectasia after refractive surgery, there was a significant improvement in UDVA and CDVA postoperatively. Moreover, there was significant increase in corneal thickness. This can be explained theoretically by the cornea collagen remodeling induced by ICRS implantation.21

We also found a significant decrease in corneal asphericity after ICRS implantation. The mean postoperative asphericity value was −0.23, which is considered normal in the general population.22 This means that the normal physiologic asphericity of the cornea varies significantly among individuals, ranging from mild oblate to moderate prolate.23,24 In an unpublished study, we evaluated corneal asphericity changes induced by ICRS implantation in eyes with keratoconus. We found that ICRS implantation significantly reduced the mean corneal asphericity, from −0.85 to −0.32. It is well known that after ablation laser procedures, most corneas tend to become oblate and when ectasia develops, the corneas usually become prolate. However, the excess prolateness usually found in keratoconus (primary) is much greater than that occurring in ectasia after refractive surgery. That is the probable reason the asphericity value after ICRS becomes closer to normal than when the ICRS is used for keratoconus. Asphericity is one marker of visual quality; a normal asphericity value after treatment can be a predictor of improvement of quality of vision.

In our study, all eyes had significantly lower keratometry values after ICRS implantation. The mean preoperative values in such cases are usually lower than in keratoconus (primary). This can be partially explained by the corneal flattening induced by the refractive procedure, usually in an optic zone of greater extent than the location of the ectasia.

Most ICRS implanted in our study were conventional models, having an arc ring of 160 degrees. The ICRS in the other eyes had an arc ring of 210 degrees. The latter is usually reserved for central cones of the nipple type. Some ectasias assume the same topographic pattern of nipple cones, in which we usually use a 210-degrees arc ring with excellent results.15 This ring is reserved for cases with low astigmatism in which we want to flatten the cornea with minimal induction of astigmatism.

There are several potential advantages of ICRS implantation over keratoplasty in eyes with post-LASIK ectasia. First, ICRS implantation avoids further laser treatment, eliminating central corneal wound healing.
REFERENCES


