

Single intrastromal corneal ring segment implantation using the femtosecond laser after radial keratotomy in a keratoconic patient

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A 33-year-old woman with irregular astigmatism 6 years after radial keratotomy (RK) for keratoconus was treated with implantation of a single intrastromal corneal ring segment (Keraring) using the femtosecond laser. The segment (0.150 mm thick with a 160-degree arc) was inserted in the steepest area (inferior) with no intraoperative or postoperative complications. Six months postoperatively, the uncorrected visual acuity had improved from 20/40 to 20/25 and the best spectacle-corrected visual acuity, from 20/32 to 20/20. The mean manifest astigmatic correction decreased from -2.50 diopters (D) to -0.75 D, and corneal topography showed improved inferior steepening and less irregular astigmatism. Although the results are encouraging, the long-term effect of this approach in post-RK patients is not known.

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Radial keratotomy (RK) is one of several surgical incisional procedures for myopia correction. The results and side-effects of this procedure have been extensively documented.^{1–4} A shift of the refractive error toward hyperopia has been reported over a 10-year period,⁴ and irregular astigmatism can be found as a result of microperforations, irregular incisions, incisions across the central optical zone, and various incision depths. Radial keratotomy has also been used for optical rehabilitation of patients with mild to moderate keratoconus.^{5–7}

Intrastromal corneal ring segments (ICRS) have been used to correct low myopic refractive errors and are currently used to correct corneal ectatic

disorders such as keratoconus, pellucid marginal degeneration, and post-laser in situ keratomileusis ectasia.^{8–13} The Keraring (Mediphacos Belo Horizonte, Brazil) is a newly-developed ICRS characterized by a triangular cross section. Shabayek and Alió¹⁴ recently reported the results of Keraring implantation using the femtosecond laser in a series of keratoconic patients. They concluded that this method is effective and safe for keratoconus.

We present a case in which a single Keraring segment was implanted using the femtosecond laser (Intralase Corp., Irvine, CA) in a keratoconic patient with abnormal astigmatism 6 years after RK. To our knowledge, this is the first report of such approach.

CASE REPORT

A 33-year-old woman with keratoconus who had an uneventful unilateral RK procedure 6 years earlier was referred for evaluation of decreased vision in the left eye. A comprehensive ophthalmic examination was performed, including uncorrected visual acuity (UCVA) and best spectacle-corrected visual acuity (BSCVA) using the Snellen chart, manifest refraction, and computer-assisted videokeratometry using the Orbscan II (Technolas GmbH Ophthalmologische Systeme Feldkirchen, Germany) and WaveLight Topolyzer (WaveLight Technologie AG Erlangen, Germany). At presentation (6 years post-RK), the UCVA was 20/40, the BSCVA was 20/32, and the manifest refraction was $0.75 -2.50 \times 90$.

Biomechanics revealed 6 healed RK scars and 2 astigmatic keratotomy incisions located from 5 o'clock to 7 o'clock and 11 o'clock to 1 o'clock. Fundoscopic examination

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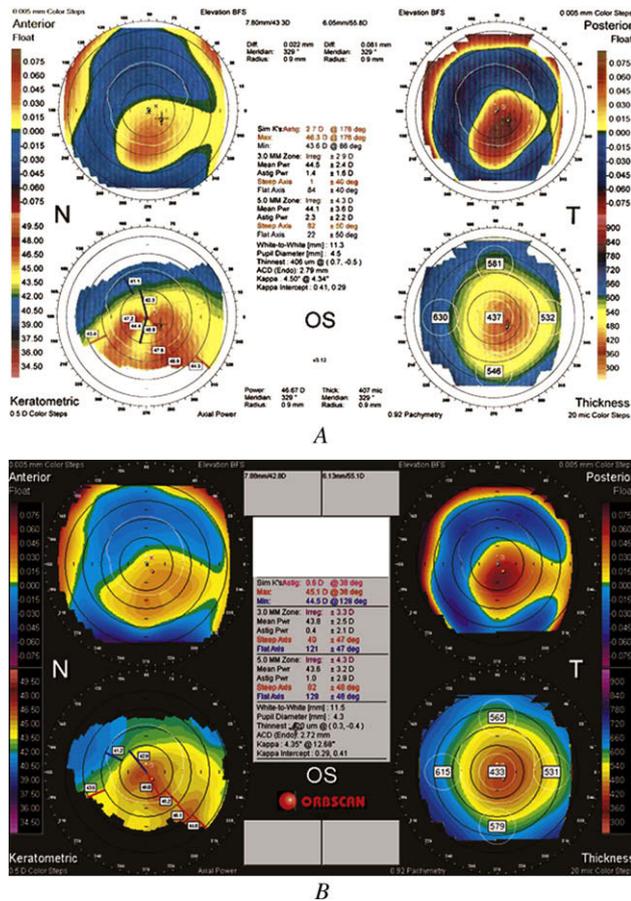


Figure 1. Preoperative topography of the left eye with post-RK irregular astigmatism (*top*) and 6-month postoperative topography after implantation of a single ICRS using the femtosecond laser (*bottom*).

was normal. Corneal topography revealed marked inferior steepening with simulated keratometry readings of 43.6/46.3 with topographic astigmatism of 2.7 diopters (D) (Figure 1, A). The central corneal ultrasound pachymetry (Sonogage 50 Hz, Cleveland, OH) was 437 μ m.

The patient was scheduled for implantation of a single inferior ICRS (Keraring). She was informed of the possible intraoperative and postoperative complications and gave written informed consent in accordance with institutional guidelines and the Declaration of Helsinki.

The surgical procedure was performed under topical anesthesia. The corneal thickness was measured with ultrasonic pachymetry at a 5.0 mm optical zone at the implantation site. A corneal tunnel was created at 80% depth (370 μ m) of the thinnest part of the cornea (462 μ m), using the IntraLase femtosecond laser (IntraLase Corp.). The disposable glass lens was applanated to the cornea to fixate the eye and maintain a precise distance from the laser head to the focal point. The pulse duration was 600 femtoseconds. The IntraLase settings were inner diameter 4.4 mm; outer diameter 5.6 mm; entry cut length 1.1 mm; entry cut thickness 1 μ m; ring energy 1.50; entry cut energy 1.50; duration of tunnel creation 19 seconds. According to the topographic findings, a single Keraring segment (0.150 mm thick with a 160-degree arc) was inserted inferiorly with the incision axis at 16 degrees, far from the RK cut (Figure 2).

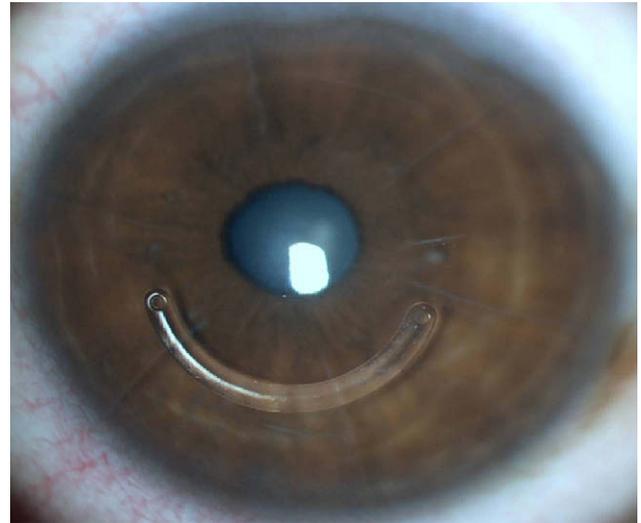


Figure 2. Slitlamp photograph of the post-RK eye after implantation of a single inferior ICRS using the femtosecond laser with a 5.0 mm implantation zone.

After surgery, antibiotic steroid eyedrops 4 times daily for 2 weeks were prescribed. The patient was instructed to avoid rubbing the eye and to use preservative-free artificial tears frequently.

Six months after the procedure, the UCVA improved to 20/25, the BSCVA improved to 20/20, and the manifest refraction decreased to -0.75×110 . The manifest astigmatic correction decreased to 0.75 D, and corneal topography showed improved inferior steepening and less irregular astigmatism (Figure 1, B) with simulated K readings of 44.2/45.6. The patient did not complain of halos or glare.

DISCUSSION

Post-RK refractive complications such as refractive instability and irregular astigmatism continue to be challenging problems.¹⁻⁴ In addition to myopia correction, RK has been used for optical rehabilitation of patients with mild to moderate keratoconus.⁵⁻⁷ In these post-RK keratoconic patients, refractive complications cannot be treated with excimer laser refractive surgery because of corneal instability. Recently, Koppen et al.¹⁵ presented encouraging results after implantation of a single ICRS (Intacs, Addition Technology, Inc.) in a post-RK patient with diurnal variation in refraction. The tunnel for segment implantation was created manually using mechanical devices, and dehiscence of the RK corneal incisions was observed during tunnel creation.

We present a post-RK keratoconic patient who had uneventful implantation of a single ICRS using the femtosecond laser. No intraoperative (RK incision dehiscence) or postoperative complications were observed. To minimize the possibility of RK incision dehiscence, the femtosecond laser, which can deliver energy accurately to a precise depth in a programmed way, was used and an ICRS that can be implanted

through a small optical zone was implanted with no technical difficulty. (Kerarings are implanted at a 5.0 mm optical zone; Intacs are implanted at a 7.0 mm optical zone.) There was significant improvement in visual outcomes (UCVA and BSCVA) and keratometric values, which remained stable during the 6-month follow-up. The pupil size in mesopic conditions was 6.5 mm, but the patient did not experience halos or glare, probably because only a single segment was implanted.

In conclusion, based on topographic findings, a single small-diameter ICRS may be an alternative, minimally invasive treatment for irregular astigmatism in post-RK patients with keratoconus. Segments that require small implantation zones (such as the Keraring) seem promising as they can avoid the previous RK incision areas. Further studies are needed to determine the efficacy and safety of this technique in post-RK patients.

REFERENCES

1. Waring GO III, Lynn MJ, Culbertson W, Laibson PR, Lindstrom RD, McDonald MB, Myers WD, Obstbaum SA, Rowsey JJ, Schanzlin DJ. Three-year results of the Prospective Evaluation of Radial Keratotomy (PERK) Study; the PERK Study Group. *Ophthalmology* 1987; 94:1339–1354
2. Waring GO III, Lynn MJ, Strahlman ER, Kutner MH, Culbertson W, Laibson PR, Lindstrom RD, McDonald MB, Myers WD, Obstbaum SA, Rowsey JJ, Smith RE. Stability of refraction during four years after radial keratotomy in the Prospective Evaluation of Radial Keratotomy Study; the Prospective Evaluation of Radial Keratotomy Study Group. *Am J Ophthalmol* 1991; 111:133–144
3. Waring GO III, Lynn MJ, Nizam A. Results of the Prospective Evaluation of Radial Keratotomy Study (PERK) five years after surgery. *Ophthalmology* 1991; 98:1164–1176
4. Waring GO III, Lynn MJ, McDonnell PJ. Results of the Prospective Evaluation of Radial Keratotomy (PERK) Study 10 years after surgery; the PERK Study Group. *Arch Ophthalmol* 1994; 112:1298–1308
5. Utine CA, Bayraktar S, Kaya V, Kucuksumer Y, Eren H, Perente I, Yilmaz ÖF. Radial keratotomy for the optical rehabilitation of mild to moderate keratoconus: more than 5 years' experience. *Eur J Ophthalmol* 2006; 16:376–384
6. Grandon SC, Weber RA. Radial keratotomy in patients with atypical inferior steepening. *J Cataract Refract Surg* 1994; 20:381–386
7. Maeda N, Klyce SD, Smolek MK. Radial keratotomy on keratoconus: a question of safety [letter]. *J Cataract Refract Surg* 1994; 20:670; reply by R Weber, S Grandon, 670–671
8. Colin J, Cochener B, Savary G, Malet F. Correcting keratoconus with intracorneal rings. *J Cataract Refract Surg* 2000; 26:1117–1122
9. Alió JL, Shabayek MH, Artola A. Intracorneal ring segments for keratoconus correction: long-term follow-up. *J Cataract Refract Surg* 2006; 32:978–985
10. Ertan A, Colin J. Intracorneal rings for keratoconus and keratectasia. *J Cataract Refract Surg* 2007; 33:1303–1314
11. Kymionis GD, Siganos CS, Tsiklis NS, Anastasakis A, Yoo SH, Pallikaris AI, Astyrakakis N, Pallikaris IG. Long-term follow-up of Intacs in keratoconus. *Am J Ophthalmol* 2007; 143:236–244
12. Kymionis GD, Tsiklis NS, Pallikaris AJ, Kounis G, Diakonis VF, Astyrakakis N, Siganos CS. Long-term follow-up of Intacs for post-LASIK corneal ectasia. *Ophthalmology* 2006; 113:1909–1917
13. Ertan A, Kamburoğlu G, Bahadır M. Intacs insertion with the femtosecond laser for the management of keratoconus; one-year results. *J Cataract Refract Surg* 2006; 32:2039–2042
14. Shabayek MH, Alió JL. Intrastromal corneal ring segment implantation by femtosecond laser for keratoconus correction. *Ophthalmology* 2007; 114:1643–1652
15. Koppen C, Gobin L, Tassignon M-J. Intacs to stabilize diurnal variation in refraction after radial keratotomy. *J Cataract Refract Surg* 2007; 33:2138–2141



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