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Visual rehabilitation and outcomes for ectasia after corneal refractive surgery

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Abstract

PURPOSE—To analyze the visual outcomes and method of final visual correction in eyes with corneal ectasia after laser in situ keratomileusis (LASIK) or photorefractive keratectomy (PRK).

SETTING—Emory University Department of Ophthalmology and Emory Vision, Atlanta Georgia, USA.

METHODS—This retrospective review comprised 74 eyes of 45 patients with corneal ectasia after LASIK (72 eyes) or PRK (2 eyes). Outcomes included postoperative uncorrected visual acuity (UCVA), best spectacle-corrected visual acuity (BSCVA), best corrected visual acuity (BCVA), and refraction; method of final visual correction; and time to rigid gas-permeable (RGP) contact lens failure.

RESULTS—Corneal ectasia developed a mean of 19.2 months after surgery. Postoperatively, the mean UCVA was 20/400, the mean BSCVA before ectasia management was 20/108, and the mean BCVA was 20/37. After ectasia management, the final BCVA was 20/40 or better in 78% of eyes. Final visual correction was achieved with RGP lenses in 77% of eyes, spectacles in 9%, collagen crosslinking in 3%, intracorneal ring segments in 1%, and penetrating keratoplasty (PKP) in 8%. Two eyes with intracorneal ring segments required segment explantation and subsequent PKP. One eye that had PKP had a graft-rejection episode; there were no graft failures. Two eyes (3%) did not require a visual device to improve visual acuity. The mean time to successful RGP lens wear was 24.8 months; 80% of cases initially managed with RGP lenses were successful with this form of treatment.

CONCLUSIONS—The majority of eyes developing postoperative corneal ectasia achieved functional visual acuity with RGP lens wear and did not require further intervention. Penetrating keratoplasty can usually be postponed or avoided by alternative methods of visual rehabilitation; however, PKP, when necessary, can provide good visual outcomes.

Corneal ectasia can be a serious complication after excimer laser corneal refractive surgery. Its clinical onset can be months or years after seemingly successful surgery.¹ Initial

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publications report that 30% of eyes developing ectasia required corneal transplantation for visual rehabilitation,² and some authors predict that corneal transplantation may be inevitable in most, if not all, cases of postoperative ectasia.³ In 2003,² however, we reported a small case series in which only 10% of eyes required corneal transplantation and our clinical impression is that most of these patients were successfully visually rehabilitated without corneal transplantation. Here, we report our experience with visual rehabilitation in a large population of patients with ectasia after corneal refractive surgery.

PATIENTS AND METHODS

This retrospective review comprised all cases of postoperative corneal ectasia that presented to the Emory Eye Center or Emory Vision, Atlanta, Georgia, from 1997 through December 2006 that met previously published criteria for ectasia,² including progressive inferior corneal steepening, loss of uncorrected visual acuity (UCVA) with increasing myopia in most cases, and astigmatism with loss of best corrected visual acuity (BCVA).

Preoperative information abstracted from the clinical records included patient age and sex, type and year of surgery, operative eye, best spectacle-corrected visual acuity (BSCVA), manifest refractive spherical equivalent (MRSE), corneal thickness, and topographic pattern. In many instances, the patients were referred to the cornea or contact lens service; therefore, their preoperative records were not available for review.

Postoperative information analyzed included time to the development of ectasia, length of postoperative follow-up, final MRSE, astigmatism, UCVA, BSCVA, BCVA, and method of visual correction, which included observation, spectacle correction, soft contact lens (SCL) or rigid-gas permeable (RGP) contact lens correction, intracorneal ring segment implantation (Intacs, Addition Technology), collagen crosslinking, and penetrating keratoplasty (PKP). If patients used RGP lenses for vision correction, the success of RGP wear (defined as BCVA acceptable to the patient and months of RGP wear) and length of time to RGP failure (if applicable) were evaluated. Statistical analyses included the Student *t* test, chi-square analysis, and survival analysis for RGP lens wear.

RESULTS

Seventy-four eyes of 45 patients were analyzed. Table 1 shows the preoperative patient demographics. Patient characteristics in this series were similar to the cumulative reported ectasia case demographics. Preoperative topographies were available for 31 eyes, 13 with normal or suspicious patterns (asymmetric bow tie or inferior steepening) and 18 with abnormal topographic patterns (keratoconus, pellucid marginal corneal degeneration, or forme fruste keratoconus). The mean follow-up was 42 months $\pm$ 40 (SD) (range 1 to 180 months).

Outcomes After the Development of Ectasia

Ectatic eyes developed increased myopia and astigmatism with decreased UCVA and BSCVA after the onset of ectasia (Table 2). The mean postoperative UCVA (20/400) and BSCVA (20/108) were significantly worse than the mean preoperative BSCVA (20.9) (both $P < .00001$).

Outcomes After Ectasia Management

The final mean BCVA was 20/37 (range 20/20 to 20/80); 58 eyes (78%) achieved a final BCVA of 20/40 or better (Figure 1), which was a statistically significant improvement over the postoperative UCVA or BSCVA before ectasia management ($P < .00001$). Based on

preoperative topography, there were no differences in final BCVA, method of final correction, or likelihood of success with RGP lenses.

The final visual correction was achieved with RGP lenses in 57 eyes (76%), with 6 eyes (8%) having PKP (Figure 2). The mean BCVA in RGP wearers was 20/35 (range 20/20 to 20/70); 43 eyes (75%) achieved a BCVA of 20/40 or better. The mean duration of RGP lens use was 43 ± 40.4 months (range 1 to 180 months). As of the final follow-up, RGP lenses were a successful treatment in 80% of patients (Figure 3). No RGP lens wearers developed corneal ulcers.

Final visual acuities in eyes managed with other strategies are shown in Table 3. Intacs were implanted in 4 eyes; 3 of these eyes required segment explantation because of significant discomfort or lack of visual improvement and subsequently had PKP. Two eyes had collagen crosslinking with a BCVA of 20/30 or better over the first 6 months.

The mean BCVA after PKP was 20/41 (range 20/20 to 20/80). Patients were followed for a mean of 27 months (range 6 to 60 months) after PKP. One eye that had PKP had a graft-rejection episode that resolved; there were no graft failures during the study.

Although these methods of visual correction significantly improved vision in most ectatic eyes, the postoperative BCVA was still significantly worse than the preoperative BSCVA (20/37 versus 20/20.9) ($P < .00001$). Compared with the preoperative BSCVA in ectatic eyes, the BSCVA dropped by a mean of 6.0 ± 2.9 lines (range -1 to -10 lines) after the development of ectasia and BCVA decreased by a mean of 2.2 ± 1.9 lines (mean -7 to +1 lines) after final ectasia management; 72% of eyes lost 1 or more lines of postoperative BCVA from the preoperative BSCVA (Figure 4).

DISCUSSION

Corneal ectasia is a rare complication of laser in situ keratomileusis (LASIK) that can have a devastating effect on visual function. In this study, all eyes lost at least 1 line of BSCVA after ectasia developed and most eyes had a final visual acuity, correctable by any method, that was worse than the preoperative BSCVA. Recent studies identify preoperative risk factors for corneal ectasia including abnormal corneal topography, low residual stromal bed thickness, young patient age, low preoperative corneal thickness, and high myopia,¹ and additional topographic screening strategies have been proposed.^{4,5} Therefore, improved patient screening should significantly reduce the incidence of postoperative ectasia. However, when ectasia develops, it must be addressed to improve the patient's visual function. This study shows that when postoperative ectasia occurs, nonsurgical management can usually provide functional vision in these eyes, perhaps indefinitely.

Soft contact lenses, RGP lenses, tandem SCL-RGP lenses (piggyback), and scleral contact lenses can be used to fit an ectatic cornea. Soft contact lenses can correct simple ametropia but do not correct the irregular astigmatism associated with ectasia. Rigid contact lenses provide the best vision by creating a spherical anterior refractive surface over the ectatic cornea, allowing tears to provide an optical bridge between the posterior contact lens surface and the irregular cornea.⁶⁻⁹ Large-diameter RGP lenses are usually needed to provide adequate centration. A soft silicone hydrogel lens can be fitted between the RGP lens and cornea to provide comfort and improve fitting characteristics. This tandem SCL-RGP lens can be used for initial lens adaptation or as a long-term solution. Occasionally, very large diameter scleral or semiscleral RGP lenses are needed in cases in which smaller diameters are unstable.

In this study, 20% of patients could not tolerate RGP lenses. Most failures occurred within the first 2 years of lens wear. Patients with postoperative ectasia appear to have difficulty wearing RGP lenses for the same reasons as patients with keratoconus; that is, because of discomfort and intolerance to lens wear, inability to fit the shape of the ectatic cornea properly, or poor visual acuity with lenses.^{10–12}

Intracorneal ring segments (Intacs) are being used to treat post-LASIK ectasia.^{13–18} The most effective ring placement technique in terms of wound location, segment size, and orientation is still under debate. Rings can be placed symmetrically or asymmetrically and oriented about the cone or based on steep keratometric axis. Many studies^{13–16} report promising early outcomes with Intacs. However, in our study, only 1 eye achieved acceptable visual acuity with Intacs segments and 3 eyes required Intacs explanation and subsequent PKP.

Collagen crosslinking procedures using riboflavin as a photosensitizer followed by ultraviolet-A exposure have also shown promise in improving corneal stability in eyes with keratoconus.¹⁹ Wollensak et al.¹⁹ report that collagen crosslinking can halt the progression of keratoconus by stiffening the corneal stroma. This technique can also be applicable in eyes developing postoperative ectasia. In our study population, 2 eyes had the crosslinking procedure in Germany with good initial success. Collagen crosslinking procedures may prove to be effective for postoperative ectasia; however, most of the crosslinking effect occurs in the anterior stroma,²⁰ a region of the cornea that is functionally decoupled from the posterior stroma after creation of the LASIK flap. Thus, the full potential effect of collagen crosslinking for postoperative ectasia remains to be determined. Collagen crosslinking is currently not approved by the U.S. Food and Drug Administration.

This large series of eyes with postoperative ectasia confirms our group's previous findings that corneal transplantation is infrequently required for visual rehabilitation.² However, PKP for keratoconus has been shown to have a high success rate.^{21–23} Thompson et al.²³ report the success rate of corneal transplantation for keratoconus to be 97% and 92% for 5 years and 10 years, respectively. In a 2005 consensus opinion, a committee of refractive surgeons concluded that eyes that require corneal transplantation should have similar outcomes whether ectasia developed from keratoconus or after refractive surgery.²⁴ In this study, 5 eyes achieved a BCVA after corneal transplantation ranging from 20/20 to 20/80, with 1 rejection episode and no graft failures. Another alternative to full-thickness PKP for postoperative corneal ectasia is deep anterior lamellar keratoplasty (DALK) via the big-bubble technique^{25,26} Our group does not routinely perform DALK, nor do we believe this procedure offers the same quality of vision as PKP in most eyes; however, further research is necessary to determine the best procedure for patients with keratoconus or postoperative ectasia.

The results in this study should not be interpreted to indicate that postoperative ectasia is a benign condition simply because most patients regained functional visual acuity without surgery. The final BCVA by any method was worse than preoperative BSCVA in most cases. Furthermore, for many patients, RGP contact lens wear requires great dedication. Nonetheless, in patients who have developed ectasia, it is imperative to achieve visually rehabilitation using the safest, most efficient strategy available.

Thus, although ectasia remains a potentially devastating complication after refractive surgery, most patients can regain functional visual acuity with appropriate management. Rigid gas-permeable contact lenses remain the mainstay of treatment; however, when necessary, other minimally invasive techniques can be used and corneal transplantation is

infrequently indicated. Initial treatment in coordination with expert contact lens fitting providers offers the best opportunity for successful conservative management.

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Figure 1. Final Best Corrected Visual Acuity After Ectasia Management
Final BCVA after the development of postoperative ectasia

Figure 2. Relative Frequency of Ectasia Management Options Utilized
Management options after ectasia.

RGP = rigid gas permeable contact lens

Cross Linking = collagen cross linking

PK = penetrating keratoplasty

Figure 3. Rigid Gas Permeable Contact Lens Wear Success in Eyes With Postoperative Ectasia
Rigid gas-permeable contact lens success.

Figure 4. Change in Visual Acuity after Postoperative Ectasia Compared to Preoperative BSCVA
Lines of visual acuity gained or lost after postoperative ectasia compared with preoperative BSCVA.

Table 1

Preoperative demographics of patients with postoperative ectasia.

Demographic	Ectasia Cases (N = 74)
Age (y)	
Mean $\pm$ SD	42 $\pm$ 8
Range	28 to 66
Male sex (%)	64
MRSE (D) (n = 49)	
Mean $\pm$ SD	-4.69 $\pm$ 4.00
Range	+2.75 to -12.75
Astigmatism (D) (n = 49)	
Mean $\pm$ SD	1.31 $\pm$ 1.03
Range	0.00 to +4.50
BSCVA (20/x) (n = 50)	
Mean $\pm$ SD	20.9 $\pm$ 4.00
Range	15 to 30
Corneal thickness (μ m) (n = 36)	
Mean $\pm$ SD	518 $\pm$ 37
Range	466 to 585
Abnormal topography (%) (n = 31)	58
Type of surgery, eyes (%) (n = 74)	
LASIK	72 (97.3)
PRK	2 (2.7)
Year of surgery, eyes (%) (n = 71)	
1996	2 (2.9)
1997	5 (7.0)
1998	16 (22.5)
1999	6 (8.5)
2000	12 (16.9)
2001	10 (14.1)
2002	8 (11.3)
2003	4 (5.6)
2004	5 (7.0)
2005	3 (4.2)

BSCVA = best spectacle-corrected visual acuity; LASIK = laser in situ keratomileusis; MRSE = manifest refractive spherical equivalent; PRK = photorefractive keratectomy

Table 2

Postoperative outcomes before ectasia management.

Parameter	Ectasia Cases (N = 74)
Time to ectasia (mo) (n = 63)	
Mean $\pm$ SD	19.2 $\pm$ 20.9
Range	0.25 to 84.00
MRSE (D)	
Mean $\pm$ SD	-2.84 $\pm$ 3.25
Range	+2.00 to -11.75
Astigmatism (D)	
Mean $\pm$ SD	2.65 $\pm$ 2.10
Range	0.00 to 7.75
UCVA	
Mean	20/400
Range	20/30 to CF
BSCVA	
Mean	20/108
Range	20/20 to 20/400

BSCVA = best spectacle-corrected visual acuity; CF = counting fingers; MRSE = manifest refractive spherical equivalent; UCVA = uncorrected visual acuity

Table 3

Final visual acuity by method of correction other than RGP lenses.

Eye	Method of Visual Correction	BCVA (20/x)
1	None	20/25
2	None	20/30
3	Spectacle correction	20/40
4	Spectacle correction	20/30
5	Spectacle correction	20/40
6	Spectacle correction	20/40
7	Spectacle correction	20/25
8	Spectacle correction	20/25
9	Spectacle correction	20/20
10	Intacs	20/40
11	Collagen crosslinking	20/25
12	Collagen crosslinking	20/30
13	PKP *	20/40
14	PKP *	20/80
15	PKP *	20/25
16	PKP *	20/20
17	PKP *	20/40
18	PKP *	20/40

BCVA = best corrected visual acuity; PKP = penetrating keratoplasty

* All patients with PKP used RGP lenses postoperatively.