High Astigmatism After PKP

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CASE PRESENTATION

A 38-year-old man with a history of keratoconus and subsequent corneal transplantation (8-mm penetrating keratoplasty [PKP]) in his left eye presents 9 years after his original transplant. No sutures remain in the transplant. His manifest refraction is -7.75 +3.25 X 126 = 20/40 OD and -6.75 +7.00 X 65 = 20/25 OS. Pachymetry measures 488 µm OD and 618 µm OS, and the slit-lamp examination reveals a clear, healthy graft. The patient's right eye shows classic keratoconus with no scarring and has had no treatment (Figure 1). The fundus examination is unremarkable.

The patient is no longer able to wear a contact lens despite trying several options. He has a history of giant papillary conjunctivitis, which responded to treatment and discontinuation of the contact lens. He desires treatment. How would you proceed?

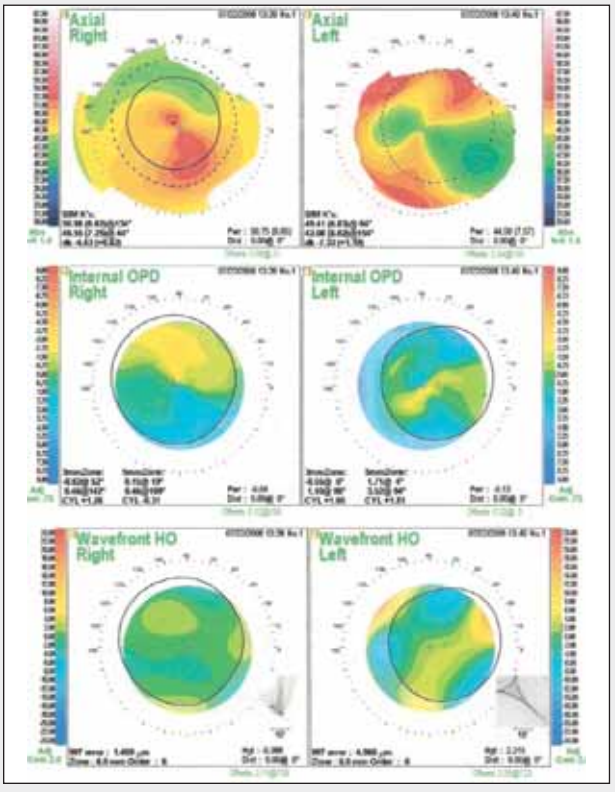

Figure 1. The Nidek OPD-Scan II (Nidek, Inc., Fremont, CA) shows more than 7.00 D of corneal astigmatism at 64° in the patient's left eye and keratoconus in his right eye.

BRIAN S. BOXER WACHLER, MD

Due to the stage of the keratoconus in the patient's right eye and his contact lens intolerance, I would consider less-invasive options than PKP for this eye. I have achieved very good results from combining Intacs (Addition Technology, Inc., Des Plaines, IL) and epithelium-on Holcomb corneal collagen cross-linking with riboflavin (C3-R; not approved in the United States) to improve BCVA, achieve refractive stability, and reduce astigmatism. The procedures are performed on the same day. I implant Intacs as the first procedure, then follow immediately with Holcomb C3-R. I prefer this order because it maintains the integrity of the epithelium, whereas the reverse order has a high risk of epithelial defects. I have also found that the combined procedures have a synergistic effect on corneal flattening.

In terms of the patient's left eye, I have performed both LASIK and PRK after PKP, but I prefer PRK. It is less

invasive and more predictable than LASIK, because cutting the flap can cause an unpredictable refractive shift. Even the results of PRK over PKP, however, are not as predictable as on virgin cornea. I would use two cards to correct the patient's astigmatism. I would aim to keep myopia of between 3.00 and 4.00 D, because his fellow eye will still be myopic after the combined Intacs and Holcomb C3-R procedures. I would apply mitomycin C (MMC) 0.02% to the cornea for 2 minutes, which I have found significantly reduces the risk of corneal haze from PRK over PKP.

Because the patient is intolerant of contact lenses, I would explain preoperatively that the expectation is better vision in glasses.

ROY S. RUBINFELD, MD

This case shows, in stark contrast, some of the major differences in delivering technology-based ophthalmic care in the United States versus Europe. By September 2006, all 25 nations in the European Union had approved corneal collagen cross-linking (CXL; not approved in the United States) as a standard treatment. The procedure is now performed on patients as young as 9 who have early signs of keratoconus in order to prevent the disease from developing. More than 130 peer-reviewed articles have documented the efficacy of CXL, especially compared with corneal transplantation.[1,2] In the United States, CXL remains investigational, with multiple studies ongoing.

Clearly, this patient should undergo CXL in his right eye as soon as possible. Through the CXL-USA physician-sponsored, institutional review board investigational study, I have been performing the procedure on patients like this one since 2009 (http://cxlusa.com). CXL can be effectively performed without removing the corneal epithelium if the cornea is sufficiently thick, as Roberto Pinelli, MD, Dr. Boxer Wachler, and others have found. This patient would qualify for transepithelial CXL, because the corneal thickness in his right eye is 400 µm or more at the thinnest point. Recent international experience has supported the efficacy and potentially greater safety of transepithelial CXL. Reported complications of cross-linking relate to the possibility of infection or delayed healing as a result of the large corneal abrasions required for the epithelium-off procedures. Leaving the epithelium in place, as with epi-on CXL, reduces these risks.

Because of this patient's poor contact lens tolerance and high astigmatism, I would consider performing PRK with an intraoperative application of MMC on his left eye. I have achieved excellent results with this technique. He might obtain better results from PRK using the Allegretto WaveLight T-CAT system (Alcon Laboratories, Inc., Fort Worth, TX), which has been available outside the United States since 2004. Standard wavefront-optimized or even wavefront-guided spherocylindrical excimer ablation is not likely to achieve results as good as would topography-guided ablation in this patient.

> "This case shows ... major differences in delivering technology-based ophthalmic care in the United States versus Europe."
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> —*Roy S. Rubinfeld, MD*

DAVID A. WALLACE, MD

In my opinion, the patient's right eye would definitely benefit from CXL. I have been performing this treatment as part of the CXL-USA Study Group for about 8 months now, so I have only small-volume, preliminary experience. Because this patient required PKP for more advanced keratoconus in his fellow eye, clearly, his right eye is at risk of progression. Properly done, CXL should halt (or dramatically reduce) progression and might achieve mild topographic regularization, but it should not be considered a refractive procedure. It is intended only to halt topographic progression, and if that goal were accomplished, I would be happy. I would wait at least 6 months after the CXL procedure before contemplating any additional refractive care. I recognize that there is a debate about whether enough riboflavin can be loaded into the stroma to effect adequate CXL without removal of the epithelium. Protocols for riboflavin loading with the epithelium on have been embraced by the CXL-USA Study Group, with input from specialists in photochemistry.

A very small number of surgeons outside the United States are having success with topography-guided PRK after CXL, but I do not anticipate that this technology will be available anytime soon in the United States. I would not consider any other excimer treatment option for several reasons. First, the topography is asymmetric. Second, current CXL protocols have the greatest effect on the anterior one-third of the cornea. Treatment of this refractive error would therefore selectively ablate the cross-linked stroma, essentially negating the effect of the first procedure. Certain international investigators are reporting the results of combined PRK and CXL (undertreating the refractive error by some percentage). Although I lack the experience to comment on this approach, I am quite skeptical about its refractive predictability, given what I currently know.

Assuming a minimal change in the patient's refractive error after CXL, I might be inclined to suggest the implantation of a Visian TICL (STAAR Surgical Company, Monrovia, CA) to optically rehabilitate this eye. In minus cylinder, the refraction is -4.50 -3.25 X 36. I do not know, however, when the Visian TICL will become available in the United States.

The patient's post-PKP eye has 7.00 D of astigmatism. The corneal thickness is adequate for PRK. The treatment of up to 6.00 D of astigmatism is within the FDA-approved range for the WaveLight Allegretto laser (Alcon Laboratories, Inc.), which is my platform of choice. The treatment of more than 6.00 D of cylinder is off label, as is the excimer laser treatment of a post-PKP cornea. Some surgeons might prefer LASIK with laser flap creation in this case. In my opinion, surface treatment would be more prudent and possibly more predictable. I would consider a residual refractive error of plano -0.75 to be an excellent result, so I would not double card or otherwise push the envelope for this eye. In a perfect world, I would be able to perform a topography-guided ablation, but I doubt that this technology will be approved in the United States any time soon. Informed consent should therefore review the possibility of a slight imperfection of vision after laser treatment due to post-PKP topographic irregularity.

ARUN C. GULANI, MD

I teach ophthalmologists to approach keratoconus as a refractive disorder (eg, myopia and/or astigmatism) with associated anomalies (ie, a thin cornea, a decentered apex, and a possible scar). Using this viewpoint and my previously described 5 S system[3] assists in creating a surgical plan for emmetropia.

In this case, I would want to establish a 2-year history of refractive stability in the patient's right eye, perform an endothelial cell count, measure the depth of the anterior chamber, and most importantly, conduct a hard contact lens trial, which I think might get his visual acuity to around 20/25- OD.

If the patient's visual acuity improved to 20/25- or 20/25 with a hard contact lens, then I would perform advanced laser surface ablation to correct the full refractive error in his right eye. If his visual acuity did not improve beyond 20/40 with a hard contact lens, then I would implant asymmetrical Intacs on the steep axis of his right eye and perform advanced surface ablation for the residual astigmatic error 3 to 6 months later.[4] If the endothelial cell count and anterior chamber depth were sufficient, an alternative for this patient outside the United States would be the implantation of a Visian TICL. I would aim for a diopter of residual myopic astigmatism, which I would later treat with advanced surface ablation to improve and expand the optical zone.[5,6] I have also implanted the Visian ICL (STAAR Surgical Company), followed 3 months later by PRK for residual refractive error and astigmatism. After any of these surgical plans, CXL could be performed outside the United States to confirm and solidify a relatively stable cornea.[7]

This patient's left eye is a perfect example of why I consider PKP to be a last resort in keratoconus.[8,9] Given the stable, clear transplant and current refraction, I would perform advanced laser surface ablation in two stages. Specifically, I would plan for 4.00 D of astigmatism in stage 1 and wait 3 months to confirm the outcome before proceeding with stage 2 laser surface ablation for the remaining refractive error. I would manually remove the epithelium for laser ablation to ensure its clearance from the graft wound while maintaining the graft's integrity. I would apply MMC 0.02% for 30 seconds during each treatment.

Before the treatment of either eye, the patient requires extensive education. He must understand that he may need glasses or contact lenses postoperatively, although the goal is increased freedom from those modalities and an improved quality of vision.

MITCHELL A. JACKSON, MD

The treatment of classic keratoconus without corneal scarring in contact lens-intolerant patients has typically been either the placement of Intacs or a full-thickness PKP. Newer options include CXL[10] and deep anterior lamellar keratoplasty.[11]

In a retrospective review I presented at the ESCRS 2009 meeting, 50 eyes with keratoconus and a minimum of 3 years' follow-up underwent the implantation of Intacs segments using the manufacturer's 10-step prolate mechanical method. In the study, 95% of eyes had a preoperative distance UCVA of 20/60 or worse. After the procedure, all of the patients regained contact lens tolerance, 80% gained one or more lines of distance BCVA, no eye lost distance BCVA, and 52% had a postoperative distance UCVA of 20/40 or better. There was a mean flattening in keratometry (K) of 5.00 to 6.00 D.[12]

My preference for treating keratoconus without corneal scarring and a steep K reading of less than 52.00 D is Intacs. Intacs SK segments have CE Mark approval and are being evaluated in the United States for steep K above 52.00 D, but they are not yet FDA approved. The placement of Intacs can be facilitated by the IntraLase FS laser (Abbott Medical Optics Inc., Santa Ana, CA). The laser can create stromal channels of varying depth and width, allowing a more pronounced effect from the ring segments in some cases.[13] When CXL is approved in the United States, I plan to perform the procedure

after the placement of Intacs in keratoconic eyes, because this combination has been shown to be more beneficial than either procedure alone.[14]

For this patient's right eye, I would make the incision for the placement of Intacs at the steep axis, at approximately 120º. I would use the 10-step prolate channel technique and asymmetric rings due to the eye's asymmetric astigmatism. I would place a 0.45-mm segment inferiorly and a 0.25-mm segment superiorly.[15] Ten years of postoperative data show that Intacs are a safe, viable, and effective treatment for keratoconus.[16]

The patient's left eye has high residual astigmatism that is typical after PKP. I would perform PRK with MMC 0.02%, as originally described by Majmudar.[17] My usual technique begins with 20-second 20% alcohol epithelial removal. I then perform excimer laser ablation followed by a 15-second application of MMC 0.02% and copious irrigation with balanced salt solution. The patient wears a bandage contact lens for 3 to 5 days until full corneal epithelialization occurs. My postoperative pharmaceutical regimen includes topical loteprednol (Lotemax; Bausch + Lomb) b.i.d. for 3 months, which helps prevent graft rejection and subepithelial haze. Patients also use topical cyclosporine (Restasis; Allergan, Inc.) b.i.d. for 6 months, which I believe helps to reduce post-PRK haze and prevent graft rejection.

When an eye has undergone PKP, I am wary of performing LASIK using a modified, small flap created with a femtosecond laser or excimer laser ablation using a small optical zone. My concerns regard the potential for greater irregular astigmatism, which is typically present after PKP, and a possible accentuation of halo or glare postoperatively. PRK has proven safe and effective after PKP.[18] ■

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