

Surface Ablation for Keratoconus

With caveats, studies suggest it may be a surgical option.

BY WILLIAM B. TRATTLER, MD

Refractive surgeons have learned that diagnostic tests such as corneal topography and Orbscan (Bausch & Lomb, Rochester, NY) and Pentacam (Oculus, Inc., Lynnwood, WA) imaging can help identify patients who may have an increased risk of developing ectasia following LASIK. However, many patients who are poor candidates for LASIK are still highly motivated to have laser vision correction. Some patients' occupational needs require them to be free of both spectacles and contact lenses. At first glance, procedures that thin the corneas of patients with any type of keratoconus seem risky. However, surgeons have been studying the safety and efficacy of surface ablation for these patients for many years, and the results to date are favorable.

To understand why surface ablation may have a lower risk of inducing ectasia compared with LASIK, and why it is perhaps a viable surgical option for keratoconic patients, we can turn to the research performed by Michael Smolek, PhD, of New Orleans. Dr. Smolek has shown that the collagen fibers in the anterior portion of the cornea have interlamellar bridging fibers that help maintain the structural strength of the cornea.¹⁻³ These bridging fibers bifurcate at various depths in the anterior stroma. The bifurcation helps tie all of the anterior lamellar fibers together for structural support. However, in deeper parts of the cornea, there are fewer bridging fibers. Because the posterior lamellar fibers run parallel to each other and lack these bridging fibers, the posterior (or deeper) part of the cornea is less stable and more susceptible to sheering motions and distension.

With this background in mind, surgeons can understand that treatments to the superficial portion of the cornea will thin the cornea but still leave enough of the bridging fibers in place to maintain structural integrity. Conversely, deeper ablations that remove the anterior lamellae will leave just the posterior lamellae in place. Because the posterior lamel-

"To date, a number of surgeons have described good results performing surface ablation for forme fruste keratoconus and frank keratoconus."

lae do not have a significant degree of bridging fibers, the cornea is weakened and becomes more susceptible to distension or ectasia (Figure 1).

SUCCESSFUL RESULTS REPORTED WITH SURFACE ABLATION

To date, a number of surgeons have described good results with performing surface ablation for forme fruste keratoconus and frank keratoconus. In 2003, Sylvia Norton, MD, of Syracuse, New York, presented data on the treatment of keratoconus with PRK. In Dr. Norton's study,⁴ of the 24 patients who underwent PRK with mild-to-moderate keratoconus, 80% achieved 20/40 or better BCVA. Two patients with severe keratoconus did not achieve sufficient quality of vision following PRK and underwent corneal transplants.

In 2004, Percy Amoils, FRCS, of Johannesburg, South Africa, presented data on the safety and efficacy of surface ablation for patients with forme fruste keratoconus or frank keratoconus. Dr. Amoils' study⁵ evaluated 65 eyes with forme fruste keratoconus and 14 eyes with frank keratoconus that received PRK. At the 7-year follow-up mark,



Figure 1. This diagram shows the anterior cornea with interlamellar bridging fibers that help maintain the structural strength of the cornea. Posteriorly, there are minimal interlamellar bridging fibers.

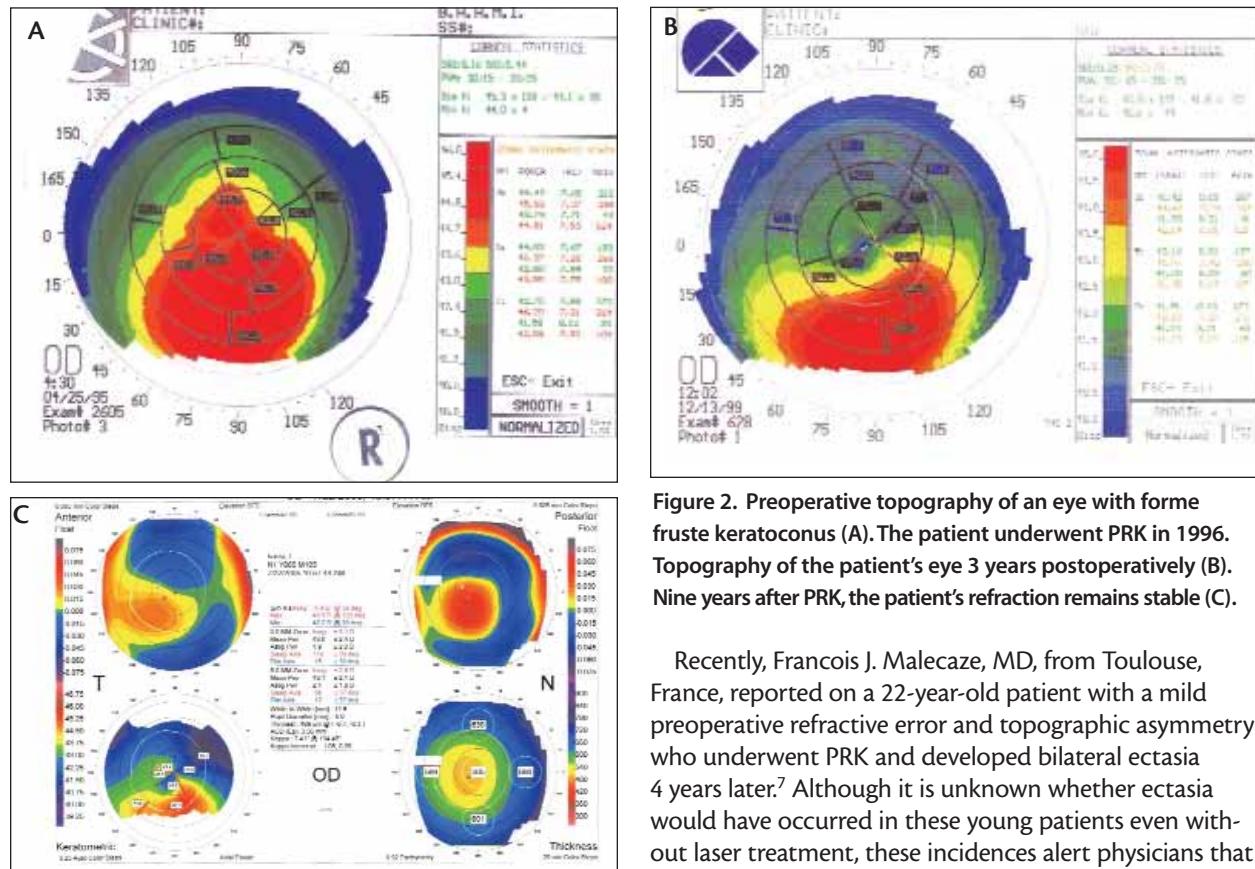


Figure 2. Preoperative topography of an eye with forme fruste keratoconus (A). The patient underwent PRK in 1996. Topography of the patient's eye 3 years postoperatively (B). Nine years after PRK, the patient's refraction remains stable (C).

Recently, Francois J. Malecaze, MD, from Toulouse, France, reported on a 22-year-old patient with a mild preoperative refractive error and topographic asymmetry who underwent PRK and developed bilateral ectasia 4 years later.⁷ Although it is unknown whether ectasia would have occurred in these young patients even without laser treatment, these incidences alert physicians that there is a risk of ectasia even with surface ablation.

(Courtesy of Percy Amoils, FRCR.)

most of the study's patients achieved good UCVA and BCVA postoperatively. Although some patients in his study experienced regression, in general, the patients were extremely pleased with their results postoperatively. One 29-year-old patient (Figure 2) with a preoperative refraction of -5.00 -0.50 X 098 underwent PRK in her right eye in 1996. Preoperatively, the patient had significant inferior steepening consistent with forme fruste keratoconus. Following the procedure she has had a stable topography and stable refraction for 9 years. Although the patient ended up undercorrected, she is extremely happy with her result.

Surgeons at other centers, such as the Minnesota Eye Consultants in Minneapolis, have also been performing surface ablation successfully on patients who preoperatively had forme fruste keratoconus.⁶ Of course, it is prudent to obtain extensive informed consent, as ectasia can occur following PRK. Mark Torres, MD, of Tacoma, Washington, recently shared with me the results of a case of a 23-year-old patient with corneal pachymetry of 505 μ m OD and 510 μ m OS who had PRK in 2003 with ablation depths of 33 μ m OD and 51 μ m OS (oral communication, March 13, 2006). The preoperative topographies were suspicious for early pellucid marginal degeneration. By 2005, the patient had developed ectasia.

FUTURE DIRECTIONS

For surgeons who are considering offering surface ablation to patients with slightly suspicious corneas, it is important to understand that every individual will theoretically have a different risk of developing ectasia following surface ablation procedures, depending on the patient's degree of collagen strength (or weakness). In 2006, we still do not have a validated test for measuring corneal strength. Our only option is to review parameters such as corneal topography, Orbscan and Pentacam measurements, corneal thickness, and even age to get an idea of patients' degree of corneal instability.

In evaluating individuals with early forme fruste keratoconus or early pellucid marginal degeneration, one should try to determine the degree of severity of the corneal topographic irregularity and also take into consideration the thickness of the cornea and the depth of the laser ablation. For example, a patient with 2.00D of inferior steepening, a normal corneal thickness, and a 2.00D correction would theoretically have a lower risk of developing ectasia compared with a patient with more advanced topographic changes, a thin cornea, and a high refractive

(Continued on page 83)

(Continued from page 82)

error. Just as important is age. A patient in his early 20s may still be in the formative process of developing keratoconus as compared to a patient in his late 30s.

Another important consideration is whether or not to perform customized surface ablation treatments. On the one hand, if there is inferior steepening, the customized treatment may remove more corneal tissue in the area of steepening, which is typically the thinnest part of the cornea. However, a recent study by Bahar et al looked at this issue in detail and found otherwise.⁸ Forty patients with thin corneas and topographies consistent with forme fruste keratoconus underwent surface ablation with the Zyoptix system (Bausch & Lomb), and they achieved excellent visual results and stable refractions through the follow-up period of up to 40 months. The Bahar study suggests that customized treatments can provide excellent visual results, but clearly long-term follow-up is necessary.

IN SUMMARY

As more data become available on the safety and efficacy of surface ablation for patients with forme fruste keratoconus and early pellucid marginal degeneration, we will be able to provide a more accurate informed consent to patients who would like to proceed with refractive surgery. In the meantime, it is important for practitioners to carefully identify all of the risk factors for ectasia and discuss them in great detail with their patients. It is imperative to point out that we still do not have long-term data, so progressive corneal weakening may still be a concern 10 or 15 years after a patient's procedure. ■

William B. Trattler, MD, is a corneal specialist at the Center for Excellence in Eye Care in Miami and a volunteer assistant professor of ophthalmology at the Bascom Palmer Eye Institute in Miami. He acknowledged no financial interest in the products or companies mentioned herein. Dr. Trattler may be reached at (305) 598-2020; wtrattler@earthlink.net.



1. Smolek MK, McCarey BE. Interlamellar adhesive strength in human eyebank corneas. *Invest Ophthalmol Vis Sci*. 1990;31:1087-1099.
2. Smolek MK. Interlamellar cohesive strength in the vertical meridian of human eyebank corneas. *Invest Ophthalmol Vis Sci*. 1993;34:2962-2969.
3. Smolek MK, Klyce SD. Corneal stromal cohesive strength: demonstration of structural anisotropy. *Invest Ophthalmol Vis Sci*. 1992;33(suppl):895.
4. Norton S. Keratoconus laser treatment results. Paper presented at: The ASCRS/ASOA Symposium on Cataract, IOL and Refractive Surgery; April 14, 2003; San Francisco, CA.
5. Amoils P. PRK in latent keratoconus, and high myopia after RK. Paper presented at: The ASCRS/ASOA Symposium on Cataract, IOL and Refractive Surgery; May 4, 2004; San Diego, CA.
6. Lindstrom R. PRK for keratoconus suspects. Paper presented at: The ASCRS Summer Refractive Congress, August 2005; Seattle, WA.
7. Malecze F, Coullet J, Calvas P, et al. Corneal ectasia after photorefractive keratectomy for low myopia. *Ophthalmology*. 2006;113:742-746.
8. Bahar I, Levinger S, Kremer I. Wavefront-supported photorefractive keratectomy with the Bausch & Lomb Zyoptix in patients with myopic astigmatism and suspected keratoconus. *J Refract Surg*. 2006;22:533-538.