

Extremely Thin Corneas

BY ANDREW I. CASTER, MD; ELIZABETH A. DAVIS, MD; RICHARD A. NORDEN, MD;
AND J. BRADLEY RANDLEMAN, MD

CASE PRESENTATION

A 31-year-old ophthalmology resident presents to you for a refractive surgery consultation. He currently uses daily disposable soft contact lenses without complication. His refractive error is -3.50 D = 20/20 OD and -4.00 D = 20/20 OS. The mesopic pupil measures 6 mm, corneal topography reveals symmetrical bowtie astigmatism, and imaging with the Pentacam

Comprehensive Eye Scanner (Oculus Optikgeräte GmbH) shows no abnormalities in the posterior elevation. The patient's central corneal pachymetry is 440 μm OD and 450 μm OS.

How would you counsel this patient? Would you recommend LASIK, PRK, phakic IOLs, or no treatment?

—Case prepared by Parag A. Majmudar, MD.

ANDREW I. CASTER, MD

I am not a proponent of either of the phakic IOLs available in the United States, the Visian ICL (STAAR Surgical Company) and the Verisyse (Abbott Medical Optics Inc.). I do not use the former in my practice because of the risk of visually significant cataract, reported in the FDA studies to be 1% to 2%. Based on anecdotal discussions, I am concerned that the rate in the real world is higher. Regardless, I feel that even a 1% to 2% risk of visually significant cataract is too high for an elective procedure performed on a young, highly myopic population (with the attendant increased risk of pseudo-phakic retinal detachment). The other available phakic implant, the Verisyse iris-fixed lens, is cosmetically noticeable and thus not acceptable to my patients.

The major concern with laser vision correction in this case is the risk of ectasia. This patient has a corneal thickness that is within the thinnest 1% of the population in a thickness range for which there are limited data.

There is widespread agreement among ophthalmic surgeons that two types of patients are at considerably increased risk of ectasia: (1) those with abnormal topography, particularly combined with an increased posterior elevation, and (2) those with postoperative beds of less than 250 μm . (How much thinner than 250 μm can be safely tolerated by an otherwise normal cornea is unclear. Nor has it been determined if there is a dangerous bed-thickness "cliff" or if the risk of ectasia rises in a linear or other rate as the bed thins.) The general feeling is that the thicker the postoperative bed, the better, so some physicians choose 275 or 300 μm as a minimum. These factors are less well understood for PRK than for LASIK. Of course, for any given patient, fewer corneal fibers are

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—Andrew I. Caster, MD

disturbed and the bed is thicker for PRK than for LASIK, so PRK is generally recommended in cases where an increased risk of ectasia is feared.

For this patient, with a flap that is 100 μm thick, the LASIK bed would be greater than 275 μm . With PRK, even using a 6.5-mm optical zone, the posttreatment stromal thickness would be above 325 μm , which is well within the accepted range.

I would be very cautious here, however, regarding laser vision correction. There is no credible evidence that preoperatively thin corneas are at increased risk of ectasia when the patient has normal topography, a normal posterior elevation, and a bed that is more than 250 μm thick postoperatively. In several studies, including one I conducted,¹ no LASIK patient with thin corneas but normal topography and a bed thicker than 250 μm postoperatively developed ectasia. These studies in totality involve several hundred patients. It is important to note, however, that very few of the patients in these studies had corneas that were this thin. If patients with otherwise normal but thin corneas were at heightened risk of ectasia, I would expect to see case reports in the literature. There is a notable absence of case reports of patients with thin corneas,

normal preoperative topographies, and postoperative beds that measured above 250 μm who have developed ectasia. That stated, none of the aforementioned studies or the lack of negative case reports proves that there is no increase in the risk of ectasia, only that no ectasia has been noted, and we must be aware that the data are limited in this range of thicknesses.

In short, there is no credible evidence that LASIK on otherwise healthy eyes with thin corneas is dangerous, but the data showing that it is safe on corneas of this thickness range are rather sparse. With all of this in mind, in this case, I would not perform LASIK but would recommend PRK. Cases of ectasia after PRK on patients with normal corneal topography are exceedingly rare (they are rare in LASIK but much more so in PRK).

ELIZABETH A. DAVIS, MD

The corneal thickness in this case is several standard deviations below average. Despite the patient's low level of myopia (requiring the removal of only a modest amount of tissue), the pachymetry measurements fall below my comfort level for laser vision correction. Thus, I would not be willing to perform LASIK or PRK. As long as the patient was a candidate for a phakic IOL (normal specular microscopy and adequate anterior chamber depth), I would offer this option to him. I have attained excellent results with both the Verisyse and Visian phakic IOLs and believe the patient could achieve a successful outcome. Certainly, the implantation of an IOL is a more invasive and expensive procedure with a different set of risks compared with laser ablation, as I would inform the patient. It would, however, be my procedure of choice here.

RICHARD A. NORDEN, MD

I believe that any of the four recommendations is an acceptable alternative, because there is now a remedy (corneal collagen cross-linking, not approved in the United States but performed by many surgeons) for the most worrisome complication of two of the three procedures being considered. After all, contact lens-related complications can and do occur. Risks and benefits should be presented to the patient for all three procedures and the continued use of contact lenses.

The Visian ICL is typically indicated for patients in this age range if they have severe myopia, severe dry eye disease, or a cornea that is irregular or too thin to avoid violation of a 275- μm residual stromal bed. The theoretical risk of infection is, of course, more serious with an intraocular procedure, however, and greater if one has to exchange an incorrectly powered implant.

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—Elizabeth A. Davis, MD

(If the surgeon believes that LASIK should not be performed on thin corneas, he or she should not fine-tune a patient's residual refractive error with LASIK.)

In this case, a starting pachymetry of 440 μm and a 100- μm flap created with a femtosecond laser or microkeratome would leave you at a depth of 340 μm . A 56- μm (3.50 D \times 16 μm) ablation depth at a 6.5-mm optical zone or a 45.5- μm (3.50 D \times 13 μm) ablation depth at a 6-mm optical zone would leave a residual stromal bed of 284 to 294.5 μm . In my experience, one could create an even thinner flap of 80 to 90 μm with a Moria M2 disposable microkeratome head (Moria), particularly when used on a “thin” cornea.

Surgeons have promulgated the idea that thin corneas (ie, more than two standard deviations below the median thickness of 550 μm) are at greater risk for ectasia after corneal refractive procedures. A number of early retrospective studies found a higher incidence of ectasia in such eyes, specifically the well-known Randleman criteria.² In most of the cases Randleman and colleagues studied, however, the investigators either did not perform subtraction pachymetry to verify the flap's thickness, or they used only first-generation topography without looking at posterior elevation to rule out forme fruste keratoconus. More recent studies have assessed a far greater numbers of eyes with pachymetry readings of less than 500 μm , none of which developed ectasia. At the American Society of Cataract and Refractive Surgery's symposium in 2012, William Trattler, MD, and I presented the results of a retrospective series of 159 eyes with a starting corneal thickness of less than 500 μm , some as thin as 442 μm , that underwent LASIK. After up to 10 years of follow-up, none developed ectasia.¹ Anecdotally, I have subsequently performed LASIK on two eyes with pachymetry readings of 430 μm without incident. I do not believe that thin corneas place a patient at risk of ectasia any more so than morbid obesity or eating broccoli.

If it is safe to perform LASIK on a thin cornea using an 80- to 100- μm flap, it is equally safe to perform PRK using 50- to 55- μm epithelial removal in terms of the

residual stromal bed and the risk of ectasia. My preference would be to perform thin-flap LASIK on this patient.

J. BRADLEY RANDLEMAN, MD

This case is challenging because the central corneal thickness is so far outside the “normal” range. That does not mean this patient has a definitively abnormal cornea, but the possibility must be thoroughly evaluated. It is easy to say “no” based on thickness alone, and this is not an unreasonable approach, especially for less experienced surgeons. Cases like this one require advanced biomechanical testing before the ophthalmologist makes a decision, and not all surgeons have ready access to this additional testing equipment.

Although the topography is listed as symmetrical, I would certainly review this parameter in detail for any evidence of within-eye or between-eye asymmetry, because those findings would be of additional concern in this case. The posterior elevation is reportedly normal, but there is no substantial evidence to support this as a specific screening criterion; thus, it would not influence my decision one way or another. Corneal thickness profiles—both in terms of the location of the thinnest point and comparisons of central to peripheral corneal thickness—have shown some promise for detecting biomechanical changes, and these data would be important to me. One can attain the data using either the Scheimpflug device listed earlier or, ideally, by also using high-resolution optical coherence tomography. In this case, epithelial thickness mapping would also be valuable, because subtle changes have been found in ectatic corneas as compared to normal corneas. Assuming that all testing appeared normal, I would discuss surgical options with the patient.

When counseling this individual, I would eliminate LASIK as an option due to corneal thickness. The available data show that low preoperative corneal thickness is a risk factor for ectasia after LASIK.^{2,3} Although surgeons apply different criteria to define “low,” 450 μm is three standard deviations below average, and this by definition would be an exceptionally rare finding (< 0.1%) in “normal” corneas. Because other surgical alternatives have an equal chance of providing excellent visual quality and possess a more favorable risk profile, I do not feel offering LASIK is prudent here.

The risk of ectasia after surface ablation is less well defined. This individual may be a candidate for PRK. Assuming a normal epithelial thickness, he should have more than 300 μm of residual stromal tissue after surface ablation.

In addition, the patient is a candidate for a phakic

IOL based on his refraction, albeit on the lower end of the approved IOL powers. I would discuss but not recommend this option, because the risks of an intraocular procedure outweigh the benefits for this contact lens-tolerant patient. If, in the future, he becomes contact lens intolerant and spectacles are not a reasonable option for his lifestyle, then the option of a phakic IOL could be revisited.

If all additional testing were completely normal, I would offer PRK after discussing the very low, but potentially increased, risk of postoperative ectasia, even after surface ablation. If any of the additional corneal testing were suspicious, I would not recommend any surgery at this time. ■

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