More Thoughts on Post-LASIK Ectasia

Striving for a unified view on this surgical complication.

BY LEE T. NORDAN, MD

The issues of major LASIK complications and post-LASIK ectasia continue to be of high importance. Over the past several years, I have discussed postoperative ectasia with many refractive surgeons, corneal experts, and ophthalmologists who have encountered this serious complication of LASIK. I have also sat recently on several panels at major ophthalmic meetings addressing this topic. This column represents my attempt to unify the varied clinical theories on corneal ectasia in general and on post-LASIK ectasia specifically. For me, this task is perhaps similar to Albert Einstein's lifelong attempt to unite the theories of general relativity with those of thermodynamics.

THE FACTS

Here are the clinical facts, as I understand them:

- Corneal ectasia is a weakness of the cornea associated with corneal thinning;
- This weakness allows the IOP to create an irregular corneal surface;
- Corneal ectasia generally occurs in two different patterns—central (keratoconus) and inferior (corneal pellucid marginal degeneration);
- The histopathological stromal change associated with corneal ectasia (keratoconus and corneal pellucid marginal degeneration) is currently unknown. It is therefore possible that two different mechanisms of ectasia exist, but it is more likely that the stromal pathology of the two conditions will be similar or identical; and
- In corneal ectasia, the cornea weakens, then thins to some degree, then becomes too weak to resist the IOP. Irregular astigmatism develops as a result. In other words, corneal thinning is a physical sign of the stromal disease process.

Based on the aforementioned statements and Figure 1, I believe I can present some useful, unifying concepts.

UNIFYING CONCEPTS

No. 1

If an early central corneal ectasia is present (path A in Figure 1), then the best indicator of central corneal ectasia (aside from biochemical evidence) is progressive central corneal thinning. A confounder is the overlap of normal corneas that are thin centrally with those that are thin due to weak stromal tissue. In my opinion, there is a theoretically identifiable value of central corneal thickness that should indicate that mild or forme fruste keratoconus is likely present. Ophthalmologists must ascertain for themselves what this numerical value is. Because it has not been conclusively determined, surgeons must select a value depending upon how much risk they are willing to undertake for a given patient. Other factors such as the patient's age and family history, the slit-lamp examination, and topography may

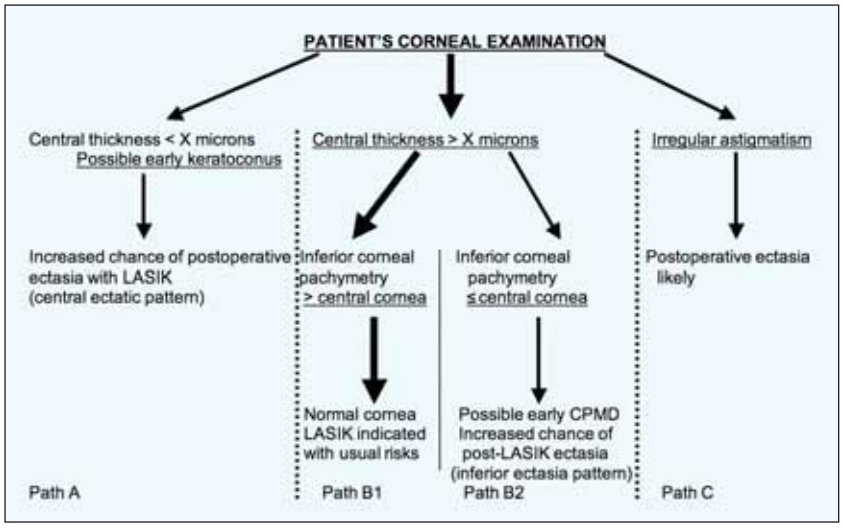

Figure 1. The surgeon's decision-making process on LASIK and possible corneal ectasia is based upon corneal pachymetry and irregular corneal astigmatism.

factor into this complex decision.

After performing tens of thousands of LASIK procedures and hundreds of penetrating and hand keratoplasties for corneal ectasia, I believe that a cornea with a central pachymetry reading of 500 µm or less has at least a 10% chance of being or becoming abnormal after LASIK. I would not perform keratorefractive surgery on a cornea that I believed had a 10% chance of a major complication. Some of my colleagues feel that a reasonable value is 480 µm, and others say 460 µm. These values are also arbitrary and selected based upon their experience. I am aware of studies showing no ectasia in eyes with corneas thinner than 500 µm that underwent LASIK.[1,2] The results are compatible with the idea that some of these thin corneas are normal and some are abnormal with forme fruste corneal ectasia. The surgeon who is choosing a limit on central corneal pachymetry should realize, however, that the criteria of the choice are not to show that many eyes with this value will tolerate LASIK but rather to determine the chance of post-LASIK ectasia that the patient and he are willing to tolerate.

No. 2

Why are there studies reporting that post-LASIK ectasia occurs with normal and even thick central corneal pachymetric values (paths B1 and B2 in Figure 1)? Those eyes could have a pattern of inferior ectasia, corneal pellucid marginal degeneration (path B2). Normal central pachymetry is not a useful screening method for mild corneal pellucid marginal degeneration. Although a topographic evaluation in these cases is paramount, probably the best pachymetric approach at present is the relative difference in thickness between the central and inferior cornea. Once again, these measurements may be difficult to interpret, because this relationship varies among normal corneas and documented progressive changes are useful but generally not available. Nevertheless, many LASIK surgeons consider less than a 10-µm difference between the central and inferior cornea (7-mm optical zone) to be a warning sign of corneal pellucid marginal degeneration. I would appreciate input from the authors of these studies on post-LASIK ectasia regarding the measurements of central/inferior pachymetry. Usually, this information is not available.

No. 3

Any cornea with ectasia-related irregular astigmatism preoperatively should not undergo LASIK, because it is already too weak relative to the IOP (path C in Figure 1). The question becomes how to define irregular astigmatism and how subtle a change constitutes clinically significant irregular astigmatism. The sensitivity of the topographer must be high enough that it can detect patterns of irregular astigmatism. A corneal sensitivity of 1.00 D means that 1.99 D of variation can exist between adjacent colors. That sensitivity is clearly too low. The pattern is the most important issue, not the absolute dioptric values. Any cornea that has an "abnormal" pattern (such as a localized area of steepness inside an area of cornea that exhibits a consistent curvature) requires scrutiny.

DISCUSSION

What is unique about the concepts I have outlined? First, mild corneal pellucid marginal degeneration was not generally recognized as a significant and unexpectedly common corneal problem until perhaps 2001 by corneal specialists and about 2003 by LASIK surgeons. Second, because refractive surgeons now recognize two general patterns of corneal ectasia (central and inferior), central pachymetry is not a useful screening method for inferior corneal ectasia. In most cases, post-LASIK ectasia occurs in corneas with a pattern of inferior ectasia. As a result, surgeons should consider the relationship between central and inferior pachymetry instead of simply evaluating central pachymetry alone. Central/inferior relative measurements are certainly no more infallible than is central pachymetry, and they may be difficult to interpret. The information, however, merits consideration before LASIK. Third, small amounts of preoperative irregular astigmatism are extremely significant, and they should be considered in the context of the other physical findings.

LASIK weakens the cornea to some extent. Refractive surgeons' goal is to predict which corneas will not be able to withstand this weakening and will proceed to irregular astigmatism and ectasia. Because there is no biochemical means of testing for corneal stromal strength, surgeons must rely on measurements of thickness and shape when making predictions. These measurements are relatively crude, and surgeons' predictive abilities are somewhat limited. Recognizing the different patterns of corneal ectasia and their association with specific pachymetric values, however, should greatly assist ophthalmologists in identifying appropriate candidates for LASIK. ■

Lee T. Nordan, MD, is a technology consultant for Vision Membrane Technologies, Inc., in San Diego. Dr. Nordan may be reached at (858) 487-9600; laserltn@aol.com.

1. Binder PS. Analysis of post-LASIK ectasia risk factors. Poster presented at: The AAO Annual Meeting; November 13-14, 2006; Las Vegas, NV.
2. Caster AI. Keratectasia in LASIK patients with preoperative central corneal thickness less than 500 µm. Paper presented at: The ASCRS Symposium on Cataract, Refractive and IOL Surgery; April 17, 2005; Washington, DC.

Have something to add to this discussion? Contact Dr. Nordan via e-mail, and he may share your comments in an upcoming column.