Post-LASIK Ectasia

What do we know?

BY PERRY S. BINDER, MS, MD

In 1998, Seiler et al[1] brought to our attention the occurrence of ectasia following LASIK surgery. Later that same year, Seiler Quurke[2] reported the same condition occurring in eyes that had preoperative keratoconus, or what is now called *forme fruste keratoconus*. Between 1998 and 2006, more than 145 case reports of post-LASIK ectasia have appeared in the US literature.[3-5] Analysis of many of these cases suggests a commonality of certain risk factors.[6-8] One basic assumption is that, if a surgeon removes sufficient corneal stroma, the residual cornea is not strong enough to resist the IOP-related stresses and strains. Some investigators' theoretical calculations suggest that a "safe" residual stromal thickness is between 200 and 250 µm.[9] Others suggest that removing less than a certain percentage of the preoperative corneal thickness or placing a laser resection at less than 55% of the corneal thickness prevents ectasia.[10]

In order to determine if the published risk factors are predictive of the development of ectasia, I performed a retrospective analysis of my database of all myopic eyes undergoing LASIK surgery.[11] None of the eyes developed ectasia (Table 1).

THE DIVERSITY OF CASE REPORTS OF ECTASIA

Surgery and IOP-Related Issues

Several post-LASIK case reports describe unusual occurrences of ectasia. For instance, some ectasia cases happened

- in one eye of patients who received LASIK in both eyes[12];
- in both eyes of patients who received LASIK in only one eye[13];
- after a partial LASIK flap[14];
- after PRK[15,16];
- after LASIK in one eye, but not in the fellow eye that received PRK[17]; and
- when the IOP is excessive (and the opposite when IOP is reduced).[18]

Preoperative, Intraoperative, and Flap-Thickness–Related Risk Factors

There is a recent report of post-LASIK ectasia in eyes without so-called risk factors (eg, a preoperative corneal thickness of 500 µm or less, a residual stromal bed thick-

TABLE 1. RESULTS OF DATABASE SEARCH FOR EYES UNDERGOING LASIK SURGERY FOR A MYOPIC REFRACTIVE ERROR

	Pachymetry < 500 µm	Residual Stromal Bed Thickness < 250 µm	Age < 25 years old	Mean K > 47.00 D	Oblique Cylinder > 2.00 D	Attempted Correction > -8.00 D
No. of Eyes	117	56	107	86	67	180
Mean	483 ±22 µm	228 ±24 µm	24.2	47.56 D	-2.30 D sphere +2.68 D cylinder	-10.13 D
Range	450 to 500 µm	185 to 250 µm	18 to 25	47.03 to 48.50 D	+2.00 to 6.00 D	N/A
Flap (µm)	113 ±28	151 ±25	128 ±25	119 ±33	125 ±25	124 ±25
Attempted Correction	-4.30 D	-8.51 D	-4.34 D	-5.35 D	-1.25 to -10.75 D	-8.00 to -17.88 D
Percentage Enhanced	28	26.8	19.6	24.4	19	37.8
Follow-up (months)	27	27.8	24.4	30.3	25	33

ness of 250 µm or less, patient's age 25 years or less, operating for high myopic refractive errors, and other factors discussed later).[19] The results of a new longitudinal analysis of eyes undergoing LASIK for high myopia suggests that these eyes can be safely operated upon.[20] Although numerous ectasia case reports suggested that the complication could occur when eyes were operated on for low-to-moderate refractive errors, intraoperative pachymetry was not performed, so one had to assume the flap's thickness was the same as the attempted. If one does not measure the flap's thickness, one cannot accurately estimate the residual stromal thickness. Flaps created with any given mechanical microkeratome can have a wide range of thicknesses.[21] I suspect that many ectactic cases, especially those in lower myopes,[8,22] had significantly thicker flaps than anticipated, which placed the laser ablations much deeper than intended.

Surgeons agree that eyes with preoperative keratoconus or forme fruste keratoconus are at risk for progression of their ectatic condition after any form of laser refractive surgery.[23] Based upon my retrospective analysis and review of the literature, however, I cannot accept a single risk factor as a reason for the onset or progression of ectasia. Other confounding variables associated with ectatic corneal disorders also exist (ie, eye rubbing, atopic diseases, etc.).

A CORNEA'S BIOMECHANICAL CHARACTERISTICS

Certainly, corneal biomechanics must vary between patients, but surgeons' understanding and measurement of these factors are nascent. For example, creating an 8-mm corneal flap in a 12-mm cornea will have a different biomechanical effect than creating a 9-mm flap in an 11-mm cornea. Making a deeper peripheral cut in either of these two examples with a planned central flap thickness that is less than 160 µm is not uncommon with mechanical microkeratomes. Deeper peripheral microkeratome incisions cut more corneal lamellae, thereby biomechanically destabilizing the cornea more than if the flap were of uniform thickness. Creating a central flap thickness of 120 µm or less with a mechanical microkeratome does not mean the peripheral depth of that flap is 120 µm.

CURRENT RISK FACTORS FOR ECTASIA

Abnormal Corneas and/or Those With Preexisting Disorders

Refractive surgeons are in agreement on a variety of points regarding ectasia. LASIK is contraindicated in patients whose corneas have pellucid marginal degeneration, keratoconus, or forme fruste keratoconus.[2,3,23] PRK can be considered on such eyes with the appropriate informed consent, but even normal eyes can develop ectasia after PRK. Measuring the flap's thickness and thereby estimating the residual stromal thickness[24] can prevent unexpectedly deep ablations. Following these simple guidelines will decrease the incidence of post-LASIK ectasia. The complication will not disappear, however, until surgeons agree upon how to diagnose an "abnormal" corneal topographical pattern and/or develop some metric to quantify the biomechanical strength of an individual cornea.[25-28]

Current placido-based topography systems are not perfect in screening for preexisting corneal disorders. Dry eyes,[29] decentered topographical maps, or poor fixation on the part of the patient and corneal warpage from contact lenses[30-32] can produce inferior corneal steepening characteristic of ectatic corneal disorders. In my experience, errors in a topographer's computer software can incorrectly diagnose keratoconus in eyes that have undergone previous refractive surgery.

The Orbscan I and II topography instruments (Bausch & Lomb, Rochester, NY) measure corneal thickness, topography, and changes in the curvature of the anterior and posterior corneal surfaces after refractive surgery.[33,34] In a series of cases of post-LASIK ectasia, the Orbscan I recorded a higher preoperative posterior float in the ectactic eyes compared with eyes that did not develop ectasia; an increase of more than 40 to 50 µm in the posterior float suggested the individual eye was more likely to have developed ectasia.[6,8] There are questions, however, about the accuracy and repeatability of this technology as well as the mathematical assumptions that were used to create the numbers. This one posterior float reading in and of itself therefore currently cannot be accepted as a predictive factor for the risk of ectasia.[35,36]

The Corneal Ectasia Committee, organized under the auspices of the AAO, ASCRS, and the International Society of Refractive Surgeons, recognized that the diagnosis of preexisting ectatic corneal disorders is based upon several factors. Aspects to consider when making a diagnosis include an eye's refractive history, the family history,[37] the clinical examination of the cornea, keratometric quality and symmetry, topography, and the quality of the fundus red reflex and corneal thickness asymmetry maps.[23,38]

HOW SERIOUS IS THE PROBLEM?

Table 2 lists the reports of ectasia in a large series of LASIK cases. It appears that the incidence of reported cases is low, but Stulting has calculated that approximately one in 5,000 LASIK cases will develop ectasia,[5] which is about the incidence of ectatic corneal disorders in the general population.[23] The same conclusion was

TABLE 2. REPORTED INCIDENCE OF POST-LASIK ECTASIA

Report	No. of Incidents/ Total LASIK Procedures	Percentage
Reinstein et al[39]	6/5,212	0.12
Pallikaris et al[40]	19/2,873	0.66
Rad et al[41]	N/A	0.20
Condon et al[20]	3/140	0.80
Binder (current report)	3/9,283 (myopic errors)	0.01
Stulting[5]	1/5,000	N/A

reached by Condon.[42] If one eliminates cases with preoperative ectatic conditions and performs LASIK and leaves a residual corneal bed of more than 300 to 340 µm,[39] one can expect to reduce the incidence of post-LASIK ectasia. Based on this database review, and until scientific studies prove otherwise, one may perform LASIK or PRK on eyes with assumed risk factors as long as all aforementioned screening was appropriately performed and appropriate informed consent was obtained. ■

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