Refractive Procedures for the Keratoconic Patient

An examination of LASIK and PRK, with an emphasis on PARK.

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Lamellar surgery performed on a cornea that has a preexisting ectatic process will cause an adverse effect on the disease course by the destabilization of the corneal integrity. This corneal ectasia can occur idiopathically (as in keratoconus, keratoglobus, and pellucid or Terrien's marginal degeneration), but it can also occur after incisional surgery such as LASIK and to a lesser extent with PRK and photoastigmatic refractive keratectomy (PARK).

When assessing a patient for corneal refractive surgery, the refractive surgeon should routinely follow effective guidelines that will determine whether the patient has an unacceptable risk of ectasia after LASIK and should therefore only undergo surface ablation. It also needs to be established whether the cornea has any signs that predispose it to naturally occurring ectasia or that surface ablation might disturb the integrity of its structure and accelerate the ectatic process.

DIAGNOSING KERATOCONUS

Advances in corneal topographers have enabled sophisticated methods of viewing the cornea and allowed the early detection of keratoconus or oddly shaped corneal profiles. Curvature variations between the corneal hemidivisions is quantified in various ways by indices such as the corneal irregularity measurement, the inferior/superior dioptric asymmetry, the skewed radial axis index displaying the present irregular astigmatism, and the KISA% index,[1] which is the product of four indices that each quantifies a topographic feature of keratoconus and posterior float with or without any decentration. Furthermore, Fourier analysis of the topographic data can provide additional information on corneal irregularity and hence identify keratoconus suspects early.[2]

Forme fruste keratoconus is a noninflammatory thinning of the cornea with no clinical signs, but it has the potential to progress over time to clinically evident keratoconus. The topographic diagnosis of this condition is made based on excessive inferior/superior asymmetry values, sometimes with only a marginally thinner-than-average inferior cornea (Figure 1). Cases of mild keratoconus exhibit some distortion on the manual keratometric mires that indicates subtle irregular astigmatism in addition to inferior steepening on topography. The

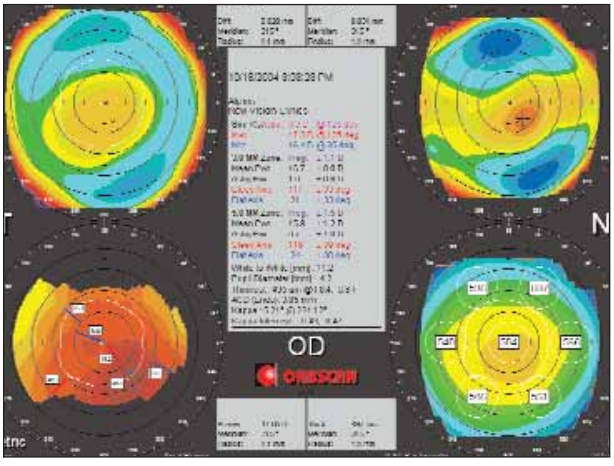

Figure 1. Forme fruste keratoconus displayed via topography shows a pronounced inferior steepening and only a slightly less-than-average central corneal thickness (504µm). The posterior float is slightly decentered and coincides with the thinnest point of 495µm; note also that the magnitude of the posterior float is within normal parameters (0.031mm). This patient had a BCVA of 20/15 with no clinical signs of keratoconus.

patient is usually not aware of either condition if he experiences no reduction of BCVA.

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The selection criteria applied in choosing candidates for the refractive treatment of keratoconus with excimer laser surgery partly depend on the severity of the disease.[3] Corneas steeper than 50.00D, signs at the slit lamp of corneal thinning or scarring, a recent decrease in BCVA, and an age in the teens or early 20s can indicate a likely natural progression of the disease.[4]

REFRACTIVE CORRECTIONS

LASIK

The risk factors associated with LASIK are well known and include thinner-than-average corneas (< 500µm), excessive inferior/superior asymmetry (> 1.50D), an insufficiently thick residual stromal bed (< 250µm), and a high posterior float (> 40µm) (Figure 2). However, a patient with a normal topography and no clinical signs of risk factors may still develop ectasia after LASIK.

PRK

The adjunctive use of mitomycin C permits PRK treatment for higher refractive errors than in the past. High myopes can achieve excellent outcomes without experiencing corneal haze. Surgeons are less inclined to approach the recommended residual stromal bed limits with LASIK treatments on corneas of inadequate thickness with the availability of this highly effective alternative.

The risk factors for ectasia after PRK are largely unknown, and the occurrence of this complication raises the question of whether the patient would have developed this condition regardless of undergoing laser vision correction. A recently published article reporting the onset of ectasia in a 22-year-old who had not demonstrated corneal topographic stability is not convincing evidence that PRK is unsafe in properly selected patients.[5]

Keratoconus is generally considered a contraindication for refractive laser surgery. The reason is largely attributable to past complications with incisional surgery (eg, RK and LASIK), adverse visual outcomes reported in the literature, and the uncertainty of the origin of the ectasia should the disease progress.[6-9] A number of recently published articles have commented on the safety of PRK in patients with mild forme fruste keratoconus, but the reports lack a sufficient number of cases and have a relatively short-term follow-up.[10-13] Careful selection criteria, including routine corneal topography,[14] have been advocated in determining whether LASIK or PRK is the appropriate option.

PARK

When deciding on the suitability of PARK for a keratoconus suspect, the surgeon must consider several subtle factors. The first is stability in both refractive and corneal measurements (with topography) over at least a 2-year period. Second, corneal topography should be a routine component of all refractive laser surgery assessments and asymmetric bow tie patterns should be identified. Third, ophthalmologists must question patients specifically regarding an existing family history of keratoconus, which can be as common as 6% to 8%.[15] One differential diagnosis of which to be aware is pellucid marginal degeneration with an appearance like a crab's claw on topography with corneal thinning located inferiorly, 1 to 2mm inside the limbus, and extending in a band from 4 to 8 o'clock. Another is Terrien's marginal degeneration in which superior, nasal, peripheral corneal thinning can increase regular and irregular astigmatism.

Very little information exists on the risks of PARK for keratoconus. When corneal stability is assured, a surgeon can only advise patients that their risk of developing ectasia is significantly lower with PARK than LASIK, but by how much the former procedure increases their chances of developing ectasia is unknown. In our opinion, PARK is not contraindi-

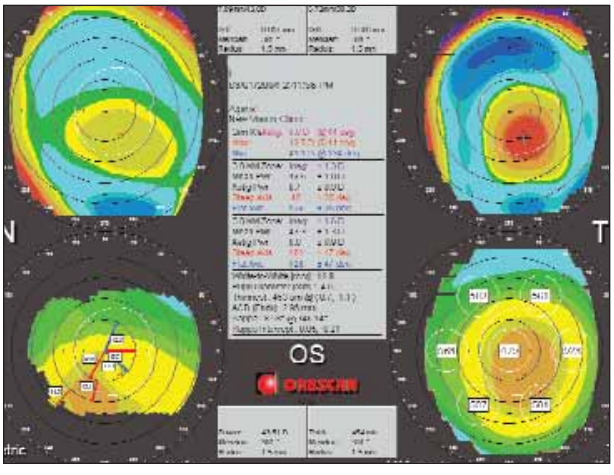

Figure 2. Pictured is an Orbscan topography indicative of keratoconus; inferior steepening together with the thinnest point (453µm) decentered inferiorly and a high posterior float (60µm) that coincides with thinnest point. The inferior-superior asymmetry at the 5-mm zone is approximately 2.40D.

cated for patients with keratoconus (forme fruste and mild), but surgeons must carefully assess the severity of the disease and the possibility of its progression postoperatively before proceeding with refractive treatment.

> "In our experience, PARK treatment on mild and forme fruste keratoconus is safe and effective with careful patient selection."

Dr. Alpins has performed PARK on 45 eyes with forme fruste and mild keratoconus. All of the patients had myopic astigmatism and follow-ups ranging from 4 to 10 years. No treated eye has progressed to clinically overt keratoconus. Patients' mean age was 40 years. All signed a consent form that identified the potential risk of developing ectasia after PARK for the treatment of forme fruste and mild keratoconus. Additional inclusion criteria were ≥ 1.50D inferior/superior asymmetry, better than 20/40 BCVA, and keratometry readings of < 50.00D.

Treating such irregular corneas by refractive parameters alone—manifest or wavefront—does not allow the corneal astigmatism to be minimized adequately. Excessive astigmatic distortion can occur as a result in some patients. I have found it essential to factor the topographic parameters into the treatment plan. In all of my patients, the refractive and corneal astigmatism did not correlate well in magnitude, orientation, or both. One therefore calculates a greater mean ocular residual astigmatism (ie, the vectorial difference between the refractive and corneal astigmatism) than what exists in normal astigmatic eyes.[16,17] This mean ocular residual astigmatism of 1.07D preoperatively, instead of being neutralized completely on the cornea, was apportioned in part to the refraction and in part to the cornea, effectively targeting less astigmatism remaining on the cornea. Treating by refractive astigmatic values alone leaves an excess amount of corneal astigmatism,[16] which can cause adverse optical effects, particularly on a keratoconic cornea.

Using vector planning, corneal parameters can be incorporated into the refractive treatment strategy. In this way, the amount of corneal astigmatism remaining is reduced without compromising the refractive astigmatic outcome. At 12 months postoperatively, all eyes had 20/30 vision or better uncorrected at distance, and there was no loss of BCVA. Leaving less corneal astigmatism postoperatively has the potential to reduce higher-order aberrations and improve patients' BCVA.

CONCLUSION

In our experience, PARK treatment on mild and forme fruste keratoconus is safe and effective with careful patient selection. The key parameters indicating the risk of ectasia associated with PARK treatments will become more apparent with further advances in technology and more data. Until then, using topographic as well as refractive data that have been constant over at least 2 years, together with the likely nonprogression of the keratoconus, provide guidance for extremely satisfying outcomes for patients and their surgeons. ■

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