

# Update on Surface Ablation Procedures: Part Two

BY DAVID P.S. O'BRART, MD, FRCS, FRCOPHTH



*Refractive excimer laser surface ablation offers an alternative to LASIK in eyes with corneal disease or in eyes that have undergone previous corneal surgery such as a corneal transplant. In such cases where the cornea is already abnormal, a LASIK flap may introduce another element of unpredictability with respect to healing and postoperative outcome. In post-LASIK cases in which an enhancement is necessary, many surgeons prefer to perform a surface ablation procedure 18 to 24 months postoperatively to prevent the risk of epithelial ingrowth. Long-term follow-up data on eyes that underwent surface ablation before LASIK was readily available have demonstrated excellent stability over time.*

*Corneal collagen cross-linking (CXL) has revolutionized the treatment of keratoconus. Combining surface ablation with CXL in patients who are contact lens intolerant affords modern cornea and refractive surgeons the potential to delay or prevent the need for a corneal transplant. Expertise not only in corneal surgery but also in laser refractive surgery is essential to appropriately manage these patients.*

*In the first of a two-part series on surface ablation, David O'Brart, MD, FRCS, FRCOphth, compared surface ablation to LASIK in normal corneas and described the use of mitomycin C (MMC) and epithelial removal techniques (see the November/December 2012 issue of *Cataract & Refractive Surgery Today*). In this second part, Dr. O'Brart summarizes the latest research on surface excimer ablation in keratoconus and eyes that have had previous corneal surgery. He also discusses the long-term safety and stability of these procedures. I hope you enjoy this installment of "Peer Review," and I encourage you to seek out and review the articles in their entirety at your convenience.*

—Allon Barsam, MD, MA, FRCOphth, section editor

## COMBINED PRK AND CXL FOR KERATOCONUS

Although ectasia has been reported after PRK,<sup>1,2</sup> it occurs much less frequently after PRK than LASIK.<sup>3</sup> This is not surprising, given the greater degradation of corneal biomechanics that the LASIK flap induces.<sup>4</sup> Several case series have reported successful and stable outcomes of topography-guided PRK in eyes with mild keratoconus (Amsler-Krumeich's grade I to II).<sup>5,6</sup>

CXL with riboflavin and ultraviolet A light therapy is the first treatment modality that appears to halt the progression of keratoconus and, to a limited extent,

improves both refractive and topographic parameters. Multiple clinical studies, including a recently published randomized, bilateral study by O'Brart et al<sup>6</sup> demonstrated the efficacy and safety of CXL with riboflavin and ultraviolet A light therapy. As an isolated treatment, CXL has been used in combination with topography-guided PRK to optimize visual outcomes in patients with keratoconic and even post-LASIK ectasia.<sup>7-9</sup> Combined CXL and limited topography-guided PRK with ablation depths generally less than 50  $\mu\text{m}$  in selected eyes with moderate keratoconus and post-LASIK ectasia has been shown to be effective,

with marked improvements in visual, refractive, and topographic parameters and stabilization of the ectatic process in most eyes.<sup>7-9</sup> In a series of 32 eyes with post-LASIK ectasia treated with transepithelial topography-guided PRK and sequential CXL, Kanellopoulos and Binder<sup>7</sup> reported visual and/or topographic improvement in all but one case 18 months postoperatively. Kymionis et al<sup>8</sup> reported significant improvements in refractive, visual, and topographic outcomes in 26 patients (31 eyes) with progressive keratoconus with a mean follow-up of over 19 months.

Similarly, Tuwairqi and Sinjab<sup>9</sup> evaluated 1-year visual and topographic outcomes and the safety and efficacy of CXL combined with topography-guided PRK to achieve near emmetropia in eyes with low-grade keratoconus. Fifteen patients (22 eyes) with low-grade keratoconus with evidence of progression, no scarring, a corneal thickness greater than 440  $\mu\text{m}$ , and a maximum keratometry reading less than 51.00 D were included. After 1 year, statistically significant improvement was noted in all measured visual, refractive, and topographic parameters, with no evidence of progression in any of the eyes.

Such results for often visually devastating conditions are encouraging. Labiris et al<sup>10</sup> demonstrated that combined CXL treatments are associated with significant improvements in quality-of-life scores. Follow-up for these studies, however, is limited to only 1 to 3 years; long-term biomechanical stability has not been fully elucidated.

PRK reduces the biomechanical strength of the cornea,<sup>3</sup> and progression after PRK with CXL has been reported<sup>7</sup> as well as the rare occurrence of significant corneal haze and scarring.<sup>11</sup> Despite these limitations, in carefully selected contact lens intolerant patients with low-grade ectasia, combined CXL and topographic-PRK treatments may be considered with adequate counselling and fully informed consent as to the risk of ectasia progression.

## **SURFACE ABLATION IN EYES WITH PREVIOUS CORNEAL SURGERY**

Excimer laser surface ablations to treat postkeratoplasty ametropia and iatrogenic astigmatism were first reported 20 years ago.<sup>12</sup> Initial results with PRK, although encouraging for that time, demonstrated limited efficacy and safety, with a reduction in cylinder limited to only a few diopters, frequent occurrences of significant iatrogenic haze, and a loss of more than 2 lines of BSCVA.<sup>12-14</sup> The development of LASIK in the mid-1990s afforded surgeons better outcomes for treating patients with postkeratoplasty

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astigmatism by avoiding epithelial/stromal wound healing interactions.<sup>15</sup> Results were generally better than standard PRK, with no haze and less lines lost of BSCVA.<sup>15</sup>

With the development of modern laser platforms and the use of adjunctive medications such as MMC, surface ablation has once again become a viable option for managing complex cases. Leccisotti<sup>16</sup> conducted a prospective study of 10 eyes with compound myopic astigmatism treated for keratoconus with PRK and adjunctive MMC 0.02% for 45 seconds after deep anterior lamellar keratoplasty. Postoperatively, the safety index was 1.15, and the efficacy index was 0.81. No lines of BSCVA were lost. Trace haze was observed in two eyes, and the endothelial counts were unchanged. Sixty percent of eyes were within  $\pm 1.00$  D of defocus equivalent. Leccisotti reported a significant improvement in BSCVA.

In a prospective study, Forseto Ados et al<sup>17</sup> assessed the safety and efficacy of PRK with MMC in 36 eyes to correct refractive errors after corneal transplantation. Sixteen months postoperatively, more than 60% of eyes were within  $\pm 1.00$  D of emmetropia, and more than 50% had a UCVA of 20/40 or better. Eleven months postoperatively, endothelial cell decompensation was observed in one eye, and haze developed in 8.3% of eyes.

Hodge et al<sup>18</sup> conducted a consecutive series of 41 patients (49 eyes) with refractive cylinders above or below 6.00 D who underwent PRK with MMC after penetrating keratoplasty for keratoconus. Similar to other published series of postkeratoplasty eyes treated with LASIK, no cases of severe iatrogenic haze occurred.

Ward et al<sup>19</sup> retrospectively evaluated the efficacy, refractive predictability and stability, and complications of PRK with adjunctive MMC in patients with postkeratoplasty anisometropia. Out of 20 cases, 100% reported they were satisfied, with 90% having a BSCVA of greater than 20/40 and 50% gaining 1 to 2 lines of BSCVA. The mean reduction in astigmatism was 2.90 D. A 2-line loss of BSCVA was reported in one eye.

Astigmatism after corneal surgery in these problematic cases is typically irregular. Topography-guided and corneal wavefront-guided ablations have proved invaluable for the correction of irregular refractive errors, because they address both high- and low-order aberrations.<sup>20</sup> Because the epithelium will typically try to “smooth out” underlying stromal irregularities, and as the vast majority of high-order aberrations are located at the anterior corneal surface, a surface approach rather than directing treatment under a flap seems logical.

Rajan et al<sup>20</sup> assessed topography-assisted corneal wavefront excimer laser surface ablation for the correction of ametropia and irregular astigmatism after keratoplasty. Fifteen patients (16 eyes) who were intolerant of spectacle and contact lens correction due to astigmatic anisometropia after keratoplasty (15 penetrating and one lamellar) underwent topography-assisted customized excimer laser treatments. The investigators reported significant improvements in UCVA, BSCVA, and significant reductions in both low- and high-order aberrations. They also documented less haze in the eyes treated with MMC.

Koch et al<sup>21</sup> investigated the outcomes of wavefront-guided PRK with MMC in 32 eyes that had previously undergone RK. According to the study, 100% of eyes that underwent myopic corrections and 74% of eyes that underwent hyperopic corrections were within  $\pm 1.00$  D of the intended correction. None of the eyes lost more than 2 lines of BSCVA, and there were no cases of postoperative haze greater than grade 1. Similarly, Camellin and Arba Mosquera,<sup>22</sup> in a study of 26 patients (35 eyes) with previous keratoplasty and RK, performed transepithelial corneal wavefront-guided topography PRK. Sixty percent of eyes achieved a UCVA or 20/40 or better, 71% were within  $\pm 1.00$  D of the attempted correction, none of the eyes lost lines of BSCVA, and only one eye developed trace haze.

These results are encouraging and comparable to LASIK but without any of the complications associated with the flap.

### LONG-TERM FOLLOW-UP OF PRK

Although the short- and medium-term outcomes of surface ablation procedures are excellent, for any keratorefractive procedure to be viable, the induced corrections need to be stable for many decades without the occurrence of long-term complications that may degrade either the transparency or biomechanics of the cornea. Many previous keratorefractive procedures such as RK were unsuccessful, as continued biomechanical instability led to progressive peripheral ectasia

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and hyperopic shift.<sup>23</sup> Recently, several long-term follow-up studies demonstrated reasonable refractive and excellent biomechanical stability after PRK. In a retrospective study of 29 patients (42 eyes) 10 years postoperatively, Koshimizu et al<sup>24</sup> demonstrated mild myopic regression of approximately -0.50 D, with minimal haze scores and no more than a 1-line loss of BSCVA. Interestingly, the investigators noted a slightly higher rate of endothelial cell loss than would be expected with the patients' age.

Guerin et al<sup>25</sup> reported 16-year follow-up for 23 patients (39 eyes) after PRK with 5-mm optical zones and corrections up to -7.00 D. They found slight regression of correction over the follow-up period, but none of the eyes lost more than 1 line of BSCVA, and all patients reported being satisfied. In a randomized study of myopic PRK and LASIK with 7-year follow-up, Ivarsen and Hjortdal<sup>26</sup> reported stabilization of corneal power from 1 to 7 years in PRK-treated eyes. In contrast, corneal power continued to increase from 1 to 7 years after LASIK.

In a study of 44 patients (44 eyes) treated 17 to 20 years earlier with PRK with a 6-mm optical zone for corrections between -2.00 and -7.00 D, O'Brart et al reported an increase in myopic spherical equivalent of only -0.30 D over the follow-up period (data not yet published). The safety index was 1.01. None of the eyes lost more than 1 line of BSCVA, only two eyes had trace haze, and there was no evidence of ectasia on Scheimpflug topographic examination.

The results of these studies suggest acceptable refractive stability over 2 decades for surface ablation procedures, with no long-term sight-threatening complications regarding corneal transparency and biomechanical stability.

### CONCLUSION

The literature supports the use of advanced surface ablation in select cases of keratoconus when combined with CXL. There is also good evidence to support its use

in eyes that have previously undergone corneal surgery. Long-term stability and safety appear to be satisfactory. ■

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