Update on Surface Ablation Procedures: Part One

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

Many people with refractive error who have visual aberrations seek a surgical option, because they are inconvenienced by wearing glasses or are intolerant of contact lenses. Since the early days of laser vision correction, visual outcomes and safety profiles have improved significantly. Success is no longer correlated with 20/20 vision but rather to the percentage of patients who see better than 20/20. LASIK continues to be a popular option, not only because visual recovery is rapid, but also because the procedure and recovery period are relatively painless. Most patients return to work on the first postoperative day.

Despite the economic recession, the advent of a femtosecond laser for creating the flap, and the advantages of LASIK, many refractive surgeons continue to offer surface ablation.[1,2] In fact, the proportion of patients treated with surface ablation increased from 2007 to 2009.[3] As will be discussed in this edition of "Peer Review," evidence suggests that, despite a longer visual recovery period than with LASIK and discomfort in the early postoperative period, the long-term visual results of excimer laser surface ablation are comparable to those of LASIK.

In the first of a two-part series on surface ablation, David O'Brart, MD, FRCS, FRCOphth, focuses on how these excimer laser-based procedures compare, the use of mitomycin C (MMC), and surgical techniques for epithelial removal. 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

LASIK VERSUS PRK

In the early days of laser keratorefractive surgery, with small optical treatment zones and iris diaphragm technology, PRK was associated with iatrogenic haze and poor predictability, especially for the correction of high myopia.[4] By removing the epithelial trigger for corneal stromal wound healing, LASIK afforded greater predictability and far less risk of iatrogenic haze.[5] With the development of wider optical treatment zones,[6] smoother ablation profiles with flying-spot technology, and the pharmacological modulation of wound healing using adjunctive medications such as MMC,[7] however, the long-term outcomes of modern excimer laser-based surface treatments appear to be comparable to those of LASIK.[8-12]

In recent years, several randomized, prospective, clinical studies comparing PRK and LASIK using modern laser technology and techniques have been published.[8-10] Wallau and Campos, in a study of myopic PRK with MMC and LASIK, reported significantly better UCVA and BCVA, better contrast sensitivity, and fewer higher-order aberrations in PRK-treated eyes compared to LASIK-treated eyes.[8] Similarly, in a study comparing wavefront-guided myopic PRK and LASIK, Moshirfar et al found the two procedures to have similar efficacy, predictability, and safety and to achieve

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similar contrast sensitivity, although PRK produced significantly fewer higher-order aberrations.[9] When Manche and Haw compared the safety and efficacy of wavefront-guided LASIK versus PRK, they found no difference between the two procedures 3 months postoperatively, and they did not report haze in the PRK-treated eyes.[10]

Regarding hyperopic corrections, clinical studies using wide-diameter (7-mm) ablations with modern laser platforms have achieved excellent outcomes despite significant initial overcorrection and delayed (up to 6 months) postoperative refractive stabilization.[11] There is a paucity of randomized, controlled trials that compare hyperopic LASIK with hyperopic PRK; nonrandomized trials, however, have demonstrated comparable efficacy.[12]

THE ADJUNCTIVE USE OF MMC

MMC is a DNA alkylating agent derived from *Streptomyces caepitosus*. The agent inhibits DNA and RNA replication in rapidly dividing cells such as fibroblasts, thereby suppressing wound healing. Talamo first suggested the adjunctive use of MMC in PRK more than 20 years ago.[13] Surgeons' renewed interest in surface ablation over the past decade has led to the routine implementation of MMC, especially for high corrections and eyes at risk of developing iatrogenic haze (ie, those that have undergone previous corneal surgery).

In a prospective, randomized, double-masked, paired-eye study of treatments between -6.50 and -10.00 D, Leccisotti reported significantly less haze in eyes treated with MMC 0.2 mg/mL for 45 seconds. The overcorrection rate in this study, however, was approximately 6%.[14] Similarly, Wallau and Campos reported better outcomes for PRK with MMC than LASIK, with no haze observed in eyes treated with PRK and MMC.[8] A recent meta-analysis of clinical outcomes comparing surface ablation with and without 0.02% MMC showed that the agent reduced haze, although the advantages of using MMC in conjunction with LASEK were unclear.[15]

There is some dispute regarding the optimal concentrations of MMC and perioperative application times. In a retrospective study, Thornton et al, using multivariable analysis, found significantly less haze in eyes that underwent myopic corrections greater than -6.00 D and ablations deeper than 75 µm when they were treated with MMC 0.02% versus 0.002%.[16] Virasch et al found no statistically significant difference in BSCVA or haze scores with the administration of MMC 0.02% for 12 seconds compared with the longer application times of 60 and 120 seconds.[17] In contrast, in an ex vivo study of human eyes obtained from an eye bank, Rajan et al found that the use of MMC 0.02% for 60 seconds resulted in optimal modulation of healing that was characterized by reduced keratocytic activation with normal epithelial differentiation.[18] Undoubtedly, there is a need for randomized controlled studies in this area to optimize MMC application.

The use of MMC in keratorefractive procedures is not without controversy. Corneal and scleral melting have been reported, both within months and many years after the agent's use in pterygium surgery.[19] Many refractive surgeons have concerns regarding the potential, unknown, long-term complications of MMC. Reports of delayed epithelial wound healing without any consequent induction of iatrogenic haze with MMC 0.02%[20] are inconsistent with some investigators' findings.[14] In a review of five studies by Roh and Funderburgh, three demonstrated that MMC had no effect on corneal endothelial density, but two found significant cellular loss after MMC's application.[21] A prospective study that evaluated MMC 0.02% applied for 40 seconds showed no change in central endothelial counts 6 months postoperatively.[22] In a randomized, bilateral study using in vivo confocal microscopy, Gambato et al found no changes 5 years postoperatively with the intraoperative use of MMC 0.02% in endothelial cell counts; epithelial thickness; keratocytic density; the number of corneal nerve fibers; or nerve beadings, branching, or tortuosity.[23,24] Studies with large series and longer follow-up are needed to determine the influence of MMC on the cornea and endothelium after PRK. Although the literature appears to support MMC in eyes at risk of the development of iatrogenic haze, preoperatively, patients should be informed of the possibility of rare and long-term complications.

TECHNIQUES FOR EPITHELIAL REMOVAL

Several methods have been proposed for the removal of the epithelium during surface ablation (eg, mechanically with blades and brushes, with alcohol, with modified microkeratomes, and with the excimer laser). There is no clear evidence, however, as to which approach is best.

Einollahi et al compared mechanical versus alcohol-assisted epithelial debridement during PRK in a randomized clinical trial.[25] The investigators reported slower epithelial healing time and reduced retroablation stromal keratocytic density with mechanical debridement. In a meta-analysis of the clinical outcomes of LASEK and PRK in myopic eyes, Zhao et al reported that LASEK-treated eyes demonstrated no significant

benefits compared with PRK-treated eyes in regard to clinical outcomes. The investigators also observed less corneal haze in LASEK-treated eyes 1 to 3 months postoperatively.[26] In a large, randomized, controlled study, Ghoreishi et al found comparable results between alcohol-assisted versus mechanical epithelial removal in PRK.[27]

The use of specially adapted microkeratomes for epithelial removal (epi-LASIK) has been advocated,[28] but clinical results with these instruments are conflicting. When Sia et al compared visual outcomes after epi-LASIK and PRK, they reported superior refractive efficacy and stability but slower re-epithelialization with the former.[29] For myopic corrections, Teus et al reported that, when compared with epi-LASEK, LASEK demonstrated greater safety and efficacy and was associated with faster visual rehabilitation.[30] Hondur et al found comparable results between epi-LASIK and LASEK 12 months postoperatively.[31]

Transepithelial PRK has been shown to result in less pain and haze compared with alcohol-assisted PRK, but the visual outcomes of the two techniques are similar.[32] Similarly, Aslanides et al reported lower pain scores, faster epithelial healing, and less haze 6 months postoperatively with an all-laser technique.[33] In contrast, Luger et al found no difference in efficacy or safety between the two techniques.[34]

Although the results of these studies provide conflicting data, they all report excellent visual and refractive outcomes, and there appears to be little difference in the long-term results of epithelial removal techniques.[25-34] Further prospective, randomized clinical studies are warranted, but at the present time, the technique for epithelial removal is a matter of the surgeon's preference. ■

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