CLINICAL GUIDELINES FOR SURFACE ABLATION

Advances have made PRK a mainstream option once again.

BY DAVID T.C. LIN, MD, FRCSC; SIMON P. HOLLAND, MD, FRCSC, MRCP, FRCOPH; AND SAMUEL ARBA-MOSQUERA, MSC, PHD

Our clinical guidelines for PRK have evolved since the first PRK surgeries at Pacific Laser Eye Centre (PLEC) were performed in 1991. Today, we perform PRK and trans-PRK for a variety of indications, including very low myopia, high myopia, thin corneas, and irregular or asymmetric astigmatism. With the aim of selecting the best procedure for each individual patient, in this article we highlight the best indications for this procedure in clinical practice.

A BRIEF HISTORY

Our early PRK cases were associated with slow visual recovery and pain—some of which was treated with morphine—and incidence of 4+ haze in about 0.5% of cases. After 1994, LASIK was preferred because of its faster visual recovery and less associated pain. However, keratome issues such as buttonholes and incomplete flaps, although rare, were complications that we did not see with PRK.

Starting in 2004, PLEC offered both PRK and all-laser LASIK. All-laser LASIK

was good for marketing, but it was associated with early postoperative inflammation and higher costs. Although flap complications were fewer with all-laser LASIK, ectasia was still an unpredictable complication that we did not see with PRK.[1,2]

In parallel with all-laser LASIK, we began to perform two-step transepithelial PRK (trans-PRK) in eyes with no associated ectasia, thin corneas, and asymmetrical astigmatism. In the past 10 years, PRK (and in particular trans-PRK) has seen a revival in interest, with percentages worldwide increasing from 10% to 15% in 2009 to greater than 30% in 2019.[3]

In 2014, PLEC began using Smart Pulse (now SmartSurface, Schwind eye-tech-solutions), a technology developed to improve the postablation corneal surface. Since then, the transepithelial approach has moved from a mostly therapeutic niche in our practice to a mainstream option for laser vision correction (LVC).[4,5] For eyes with irregular corneas, trans-PRK is now proving to be our main treatment of choice.

The clinical guidelines we present here for PRK and trans-PRK, although based on our experience with SmartSurface on the Schwind Amaris laser, can be applied more generally for PRK with modern excimer laser technologies.

MYOPIC CORRECTIONS

Very low myopic corrections. The optical zone (OZ) in PRK is not limited by the boundaries of a flap or cap as it is in LASIK and SMILE. Therefore, truly large OZ diameters (even exceeding 7.8 mm) can be used for low corrections to provide better quality of vision.[6,7] We employ PRK for corrections as low as -0.50 D with OZs as large as 7.8 mm, with good results.[8]

High myopic corrections. Unlike in LASIK or SMILE, the residual stromal thickness (RST) after PRK is not affected by the sub-Bowman depth of a flap or cap. This preserves between 25 and 75 µm of RST. For high corrections, therefore, a safer RST level can be achieved after ablation.

In highly myopic eyes (greater than -7.00 D), it has been demonstrated that almost 90% reach an uncorrected distance visual acuity (UDVA) of 20/20 or better and are within ±0.50 D of target spherical equivalent refraction.[9,10] We employ PRK for corrections as high as -15.00 D with good results.[2]

THIN CORNEAS

Though rare, iatrogenic corneal ectasia is one of the most feared complications that can occur after uneventful corneal laser surgery. Ectatic changes can appear as early as 1 week postoperative or delayed up to several years after surgery. The actual incidence of ectasia is undetermined, but incidence rates of 0.04% to almost 2.8% have been reported.[11] Ectasia occurs most commonly after LASIK, but cases have been reported after PRK and other corneal refractive procedures.

It has been shown that PRK affects the biomechanical integrity of the eye less than LASIK or SMILE.[11] For this reason, and because PRK preserves a greater amount (~50 µm) of RST, we prefer PRK over LASIK or SMILE for eyes with thin corneas. A safer RST level can be achieved after ablation in these eyes. At PLEC, we routinely choose PRK to treat eyes with thin corneas (< 500 µm), as long as the RST will be greater than 320 µm, and we have experienced no ectasia to date using these guidelines.

HYPEROPIC CORRECTIONS

Although it may seem counterintuitive compared to commonly reported experiences, treatment of hyperopia with LVC is challenging, regardless of whether the technique used is LASIK, PRK, or SMILE. In these eyes, PRK and trans-PRK may provide relevant advantages relative to the other approaches. In particular, using an aberration-neutral profile with wide OZs in PRK for high hyperopic correction has been shown to provide good efficacy, safety, predictability, and visual outcomes.[12,13] In the first 3 postoperative years, relatively low changes in corneal spherical aberrations and low increases of hyperopia were observed.[14]

We tend to be conservative in using hyperopic PRK, treating only up to +3.00 D. Expectations for hyperopic patients must be managed carefully, as the initial postoperative myopia is quite disturbing if not explained preoperatively. Also, progressive and latent hyperopia can confound the predictability of algorithms. Improvements of algorithms, along with the use of extremely large OZ diameters and large, progressive transition zones, may be keys for success in hyperopic corrections.

HIGHLY ABERRATED CORNEAS

A number of conditions are better suited for PRK than for any other laser ablation modality, and these include correction of decentrations or enlargement of OZs;[15] correction in corneas with previous RK;[16] and corrections of severe corneal irregularities,[17] corneal pathologies,[18] or corneal grafts.

The efficacy and safety of corneal wavefront-guided trans-PRK after CXL in keratoconic patients has also been reported.[19] Preoperatively, eyes in this series had irregular astigmatism of up to 8.00 D; no eye lost 2 Snellen lines of corrected distance visual acuity, and 40% of eyes had an increase of more than 2 lines. Additionally, favorable results have been reported for the combined use of ocular wavefront-guided trans-PRK plus CXL.[20]

At PLEC, the treatment of highly aberrated corneas and the correction of corneal pathologies is an important aspect of our mission. We use corneal wavefront-guided PRK for these corrections, and the resulting therapeutic ablations provide relevant

PARACENTRAL CORNEAL SCAR: OFTEN MISSED INDICATION FOR PRK

BY MATTHEW M. KRUGER, MD

In daily practice, there are many reasons why a patient might be a better candidate for PRK or advanced surface ablation (ASA) rather than LASIK. These range from a thin cornea to a mildly irregular topography. Another reason to prefer a surface approach—and one that can be missed during a slit-lamp examination—is a paracentral contact lens-related corneal scar.

It is not uncommon to see contact lens patients in their early to middle 20s who had periods of poor contact lens hygiene earlier in life. This often results in their having one or more paracentral, depressed, non–light-blocking anterior stromal scars, typically less than 1 mm in diameter. These areas represent small disruptions in the Bowman layer, and, if they are deep enough, they increase the risk of a vertical gas breakthrough during femtosecond laser flap creation.

LOOKING FOR ISSUES

Without a careful slit-lamp examination, paracentral corneal scars are easy to overlook. Careful attention must always be paid to the corneal biomicroscopy section of any corneal refractive surgery consult, looking for issues such as map-dot-fingerprint dystrophy, corneal scars, corneal neovascularization, and cornea guttata.

Any large corneal scar would be a contraindication to corneal refractive surgery, but eyes with small, non–light-blocking, paracentral anterior stromal scars can still safely undergo corneal refractive surgery.

For me, the main determinant is corneal topography. These small scars do not alter the topography due to overlying epithelial thickening, which smooths the corneal surface. I prefer PRK/ASA in these situations because this approach takes any flap-based complication off the table.

HOW IT'S DONE

My PRK/ASA technique in these eyes remains basically the same as a routine procedure. I use an appropriately sized alcohol well (8–8.5 mm, depending on the white-to-white distance), applying 20% ethanol for 20 seconds to devitalize the central epithelial layer. Then I remove it with a Weck-Cel spear (Beaver-Visitec International).

At this point, the smoothness of the Bowman layer can be assessed. With careful observation, the surgeon often notices a tiny divot in the Bowman layer, although these are easy to miss. Ablation proceeds normally, followed by a 20-second application of 0.02% mitomycin C and a thorough rinse with balanced saline solution. A bandage contact lens is placed, and drops of antibiotic, steroid, and an NSAID are applied.

I find that, with appropriate pain control, most patients have an uneventful recovery without significant pain. We make up 0.05% proparacaine in a bottle of sterile preserved artificial tears in case the patient experiences significant discomfort.

CONCLUSION

This is my standard regimen, and it works well. Overall, PRK/ASA is a great refractive surgical option. It is highly versatile and ideal for patients with contact lens–related anterior corneal scars.

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improvements in functional vision, including UCVA and visual quality.

We have found PRK to be highly effective in the management of astigmatism across a range from 0.75 to 7.50 D. Highly aberrated corneas, such as those following keratoplasty, are best treated with topography-guided PRK. A recent study of our long-term outcomes in eyes with highly aberrated corneas found that mean astigmatism improved from -4.40 ±0.26 D preoperatively to -2.40 ± 0.26 D at final follow-up ($P < .0001$). Further, 55% of eyes had less than 2.00 D of astigmatism at the final visit, compared with 9% of eyes preoperatively. Keratometric astigmatism decreased from 5.24 ±0.36 D preoperatively to 2.98 ±0.34 D at final follow-up (t-test, $P < .0001$). Postkeratoplasty topography-guided PRK had good long-term efficacy and safety, resulting in significant improvements in UDVA, refraction, and keratometry.[21]

OTHER CLINICAL USES AND ADVANTAGES

In addition to the indications outlined above, PRK ablation is well suited for use as a rescue approach when other techniques may not be suitable[22] and for all corrections requiring the treatment of higher-order aberrations. Relevant situations include retreatments,[23] corneal repairs,[24] and therapeutic corneal ablations.[25]

Correcting treatment-induced spherical aberration and preexisting coma in any patient's cornea has the benefit of improving visual quality.[3] We often use corneal wavefront–guided PRK for conditions such as asymmetric astigmatism and forme fruste keratoconus, and have obtained good to excellent results to date.

CONCLUSION

For the right candidates, PRK offers positive features such as no need for flap or incision, maximization of corne-

al stability, and fast epithelial healing.[26]

PRK has had a long journey of more than 30 years. In the decade from 2000 to 2010, PRK was mainly reserved for corneal repairs and therapeutic procedures in which improvement in corrected distance visual acuity was the primary goal and refractive accuracy and UDVA were secondary aims. Ten years ago, with the help of technological advancements, PRK witnessed a rebirth and reestablished itself as a mainstream procedure beside the other laser vision correction techniques, competitive with LASIK and SMILE.

Today, PRK is better suited for the treatment of thin corneas, irregular or asymmetric astigmatism, and keratoconus. PRK It is also the treatment of choice for enhancements and for addressing complications from other refractive surgeries, including radial keratotomy, LASIK, and SMILE.

We anticipate a strong future for PRK. With further refinement, evolution, and innovation, the procedure will continue to strengthen its position as a well-rounded treatment of choice for many indications. ■

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