What Makes a Good Refractive Procedure?

Surgeons discuss their preferred treatments for various refractive errors.

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Refractive Procedures for Low Myopia

By Frik J. Potgieter, MB CHB (Stell), FCS (SA), MMed (PreT), FRCS (Edin)

The ideal refractive procedure for the treatment of low myopia should be safe, quick, effective, and meet the patient’s expectations. The success of any refractive surgical intervention is dependent on a number of aspects, namely a thorough preoperative evaluation, selection of the correct surgical procedure, appropriate counseling of the prospective patient, meticulous attention to detail in the planning and execution of surgery, and first-class care in the postoperative period.

The excimer laser has elevated the bar on refractive surgical outcomes over the past 15 to 20 years to levels impossible with older incisional techniques.1,2 Currently, corneal laser treatments with the excimer laser still top the list of available options for the correction of low myopia—generally considered to be in the range of -1.00 D to -6.00 D.3

For this treatment range, LASIK likely remains the most commonly practiced procedure worldwide, keeping in mind our definition of the ideal refractive procedure, whether it is done by means of a simple spherical ablation; an aspheric treatment; or a tissue-saving, wavefront-guided or wavefront-optimized ablation.

Most of the potential complications of LASIK are flap-related. Dramatic improvements have been made over the past 10 years concerning safety with respect to the development of mechanical microkeratomes, and in the hands of an experienced refractive surgeon flap complications may be minimal.

Recently, the femtosecond laser has made yet another impact on corneal refractive surgery. For the patient, the most appealing feature of this technology is that it enables an all-laser procedure, eliminating the blade from the equation. Despite the cost and maintenance of these devices, there are certain distinct advantages for the surgeon, as well as the patient, that are not obvious at first glance. With the addition of femtosecond laser technology to LASIK, it is now possible to create a flap with higher precision and safety than before.

The femtosecond laser has also enabled the addition of two new refractive procedures to the armamentarium of the refractive surgeon, ReLEx flex (femtosecond lenticule extraction) and smile (small incision lenticule extraction). For the ReLEx flex procedure, a lamellar flap is made with the femtosecond laser, along with a deeper refractive cut to excise a lenticule of corneal tissue. The lamellar flap is managed in a fashion similar to the LASIK technique, along with manual removal of the redundant corneal tissue.

The ReLEx smile technique entails the intrastromal creation of a refractive lenticule of desired power and dimensions, linked to the corneal surface by an intrastromal pocket with an external incision of 3 to 4 mm. Following the laser incisions, the pocket is opened with a semi-sharp instrument, the refractive lenticule is separated from the surrounding tissues using a lamellar spatula, and the lenticule is extracted with delicate forceps to complete the procedure.

The refractive outcome of this procedure is remarkably consistent, with a spherical equivalent within ±0.50 D of plano in more than 95% of patients with 1.00 to 10.00 D of myopia.4 This is achieved due to the submicron level of incisional accuracy of the laser, partly due to the fact that the femtosecond laser beam is relatively unaffected by environmental changes.

This procedure is a safe, quick, effective, and minimally invasive intervention on the cornea with rapid visual recov-
The Treatment of High Myopes: Time to Reconsider PRK?

By David T.C. Lin, MD, FRCS; and Simon P. Holland, MD, FRCS, MRCP, FRCOphth

Options to consider when performing refractive surgery for extreme myopia (more than -10.00 D) include laser refractive surgery (PRK or LASIK), refractive lensectomy, and phakic IOL implantation. Evaluating the efficacy and safety of these approaches is crucial to guiding surgeons in advising highly myopic patients of their surgical options.

Recent studies have shown better results for phakic IOLs compared with LASIK, in terms of long-term visual outcomes for high myopes, including improved contrast sensitivity and reduction of higher-order aberrations.

Most currently used phakic IOL models are nontoric, and patients also having significant astigmatism may then require additional procedures to achieve the best UCVA postoperatively. Advantages of phakic IOLs include rapid recovery, reversibility, and the ability to be used in patients with ocular surface disorders. Disadvantages include those of any intraocular procedure, such as the possibility of endophthalmitis, toxic anterior segment syndrome, and glaucoma. Concerns also include the possible induction of endothelial damage with anterior chamber phakic IOLs and cataracts with posterior chamber phakic IOLs.

Refractive lens exchange (RLE) in extreme myopes has advantages similar to those of phakic IOLs; however, it also has increased risks of long-term retinal complications and the need for presbyopic correction or multifocal IOL implantation.

In patients with high myopia, LASIK can achieve good visual outcomes but carries risks such as ectasia and flap complications. Recent improvements in quality of vision have been attributed to wavefront-optimized and wavefront-guided techniques.

In our experience, PRK has shown improved outcomes following the introduction of several features: intraoperative use of mitomycin C, transepithelial phototherapeutic keratectomy (PTK), better pain control, and the promotion of rapid epithelialization. Recent analysis of our 1-year outcomes since 2008 (Figure 1) showed that more eyes achieved 20/20 UCVA postoperatively with PRK than with LASIK (36% vs 25%). The same was true at 20/25 UCVA with 68% of PRK eyes and 50% of LASIK eyes achieving that result, but the difference did not reach statistical significance. Both groups achieved similar results at 20/40 UCVA.

Figure 1. More eyes achieved 20/20 UCVA postoperatively with PRK than with LASIK; the same was true at 20/25 UCVA, although the difference did not reach statistical significance. Both groups achieved similar results at 20/40 UCVA.


ries less risk of ectasia in older patients, but epithelial and dry eye issues are more common.

Excellent surgical options are now available for patients with extreme myopia. In our experience, PRK is trending toward giving better visual outcomes and safety than LASIK.

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The Optimal Approach in Patients With Hyperopia

By Glenn Carp, MBBCh, FCOphth (SA)

The optimal approach to treating hyperopia involves a multifactorial methodology geared toward obtaining increased accuracy and efficacy of results. Preoperatively, special attention must be paid to the method of refraction. At all levels of hyperopia, it is best to treat the maximum hyperopic manifest refraction and use the cycloplegic refraction only as a guide as to how much plus to push within the patient’s tolerance. Of course, the difference between the cycloplegic refraction and the manifest refraction will be more apparent in younger patients, as the amount of latent hyperopia decreases with age.

Surgically, special consideration must be given to the type of laser, and therefore to the ablation profile used and the treatment parameters chosen. It has been shown that the wider the effective optical zone the greater the postoperative stability. Regression after hyperopic LASIK was common with previous generations of excimer lasers using smaller ablation zones. The effective optical zone achieved compared with that attempted through treatment programming may still be markedly reduced with some current excimer laser platforms due to epithelial compensation; hence, the large variation

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in consistency among different excimer lasers in treating hyperopia. This variability has been responsible for both decreased accuracy in initial treatment outcomes (over- or under-corrections and induction of cylinder) and increased regression rates in the early postoperative period. Additionally, the LASIK flap and the ablation profile must be aligned with the patient’s visual axis. The corneal vertex is used as the best approximation of the intercept of the visual axis with the cornea. This can be determined clinically as the first Purkinje reflex with an ophthalmoscope exam. Hyperopic patients have a larger angle kappa than myopic patients, and therefore greater appreciation in centering the treatment on the corneal vertex and not on the center of the entrance pupil (line of sight) is required. Centering the treatment on the entrance pupil center rather than the corneal vertex in patients with a large angle kappa will result in a postoperative topographic decentration with reference to the corneal vertex and night vision complaints. It is also because of the large angle kappa that wavefront-guided hyperopic ablations should be avoided, as they require the treatment to be centered on the entrance pupil, where the whole-eye wavefront is measured.

When assessing higher-order aberrations postoperatively, front-surface corneal aberrations better represent the amount of aberrations that the patient sees, as they are centered on the corneal vertex, where the treatment was also centered. In contrast, whole-eye ocular aberrations measured by aberrometers are centered on the entrance pupil center; this will result in measuring higher levels of coma aberrations induced by the different location of the corneal vertex and the entrance pupil center.

Maximum permissible hyperopic treatment for each individual eye in low or high hyperopia is governed not only by residual stromal thickness parameters but also by the minimum central epithelial thickness and the rate of change of corneal curvature induced during treatment. The maximum hyperopic treatment is not necessarily limited by the steepness of the predicted postoperative keratometry levels. My colleagues at the London Vision Clinic have shown that some eyes have relatively flat corneas but thin epithelium, which would therefore render them unsuitable for retreatment. Conversely, some eyes have a very steep keratometry but thick epithelium and would be suitable for retreatment.

Although it is currently assumed that the limits for hyperopic LASIK should be determined by preoperative keratometry, epithelial thickness might be a more reliable determinant of the amount of hyperopic ablation that can be performed, particularly in enhancement surgery.

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**Treatment of High Hyperopia**

By Paul H. Hughes, BSc, MBBS, DO (London), FRACS, FRANZCO

The treatment of hyperopia is one of the most satisfying refractive procedures performed today. The happiness and delight one sees on patients’ faces after a successful surgery is wonderful to experience. The reason for their satisfaction is that most hyperopes never experienced the near vision that is common to myopic patients throughout their lives.

What constitutes high hyperopia varies from country to country; for example, in Asia, where myopia is the norm, a patient with 1.00 D of hyperopia would be considered to have high hyperopia. However, in Australia, greater than 3.00 D would be considered high hyperopia.

I divide hyperopic patients into two main age groups: those who are 20 to 40 years of age and those over 40 years of age.

I prefer to treat the younger group with LASIK if corneal thickness is greater than 500 µm or with PTK combined with PRK if the corneal thickness is less than 500 µm. With LASIK, I use a femtosecond laser to create the flap. Currently, I have the WaveLight Refractive Suite (Alcon Laboratories, Inc.), with the FS 200 capable of creating the flap in 6 seconds. I use a temporal-hinged flap, as hyperopes are usually decentered nasally, and this maneuver allows me to place all excimer laser shots in the stromal bed. The EX 500 ablates 1.00 D in 1.4 seconds, reducing the corneal dehydration that accompanies slower lasers.

I further subdivide patients in the younger age group based on the degree of hyperopia to be treated with the laser. My limit for maximum dioptic power is 6.00 D, and that is subject to the patient’s keratometry. I am reluctant to steepen the cornea beyond 49.00 D due to the problems associated with steepened corneas, namely irregular astigmatism and dry eye. I warn all
LASIK patients about the possibility of regression and the resulting need for an enhancement. I also make certain that they have a normal tear film and tear break-up time before proceeding with any laser procedure.

If the patient’s hyperopia is greater than 5.00 D, then my choice would be a Visian ICL (STAAR Surgical) or an anterior chamber phakic IOL such as the Artisan (Ophtec BV). However, in keeping with our consideration of a good refractive procedure, I would advise against implanting these devices in patients younger than 30 years of age.

Currently, there is reluctance among ophthalmologists to implant these so-called reversible IOLs due to concerns regarding their effect on endothelial cell count. Before proceeding down this path, it is important to check baseline endothelial cell count and anterior chamber depth, as many high hyperopes have very shallow anterior depth and are unsuitable for phakic IOLs.

In patients who are older than 40 years, it is necessary to deal with their incipient presbyopia in addition to their high hyperopia. This group contains the baby boomers, whose expectations are high, and I strongly recommend spending additional time counseling them to avoid disappointment for both the surgeon and patient. If patients are happy to wear reading glasses and meet my criteria outlined above for younger patients, then I would recommend LASIK or PTK combined with PRK. Dry eye is more prevalent in this group, so one must be cautious to eliminate it if present preoperatively and stress the need for artificial tears postoperatively.

Dealing with patients’ associated presbyopia can be achieved by performing monovision, correcting their nondominant eye for near vision and dominant eye for distance. Be warned, however, that monovision is not for everyone.

Ideally, a contact lens trial is the gold standard, but a simple test I use is to correct both eyes for distance and to tell the patient that this represents 100% vision. I then put the hyperopic add over the nondominant eye and ask, “What percentage is your vision now?” If the patient replies that it is better than 80%, then I feel confident that this approach will be suitable.

Some patients prefer to have their dominant eyes corrected for near, especially if they are older or have near-oriented occupations such as accounting. Always warn patients, especially in the 45- to 55-year group, that an enhancement will be necessary because their presbyopia will continue to progress.

Be careful when recommending monovision that you check for steep keratometry and be careful not to over-steeplen the cornea when creating the monovision. If patients are not suitable for monovision because they
wish to retain binocular vision, then RLE is the treatment of choice.

RLE involves removing the human crystalline lens and implanting an IOL in the capsular bag. This surgery is becoming more precise, and, with laser cataract surgery, results are better than previously possible. I have been using the LenSx femtosecond laser (Alcon Laboratories, Inc.) to perform RLE for the past 12 months, and my results are significantly better than my previous manual results.

The number of different types of presbyopia-correcting IOLs available today, plus those coming onto the market in the near future, indicates that the last frontier of refractive surgery (presbyopia) is about to be conquered. The pseudoaccommodative IOLs available include multifocal (refractive and diffractive) and accommodating lenses; recently a trifocal lens has become available.

In summary, when treating high hyperopic patients younger than 40 years of age, I prefer LASIK or PTK plus PRK. If this is not possible, I encourage patients to wait for technology to catch up with a solution for them. For patients older than 40 years, femtosecond laser-assisted RLE is my first choice of treatment for high hyperopes.

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The Surgical Correction of Astigmatism

By Peter Ingham, BMBS, FRANZCO

When considering the surgical correction of astigmatism, age is an important issue. For younger people, the loss of accommodation resulting from refractive lens procedures is, in my view, a profound disadvantage. The spherical equivalent, magnitude of astigmatism, and corneal topography also all play important roles in determining the best approach.

Although incisional surgery can correct small amounts of mixed astigmatism, the mainstay of surgical correction remains laser vision correction. LASIK can precisely treat astigmatism up to 6.00 D when no other contraindications exist. PRK can also be successful, although for higher levels of astigmatism the outcomes are less favorable. Young patients with astigmatism warrant particular caution because there is a greater onus to exclude eyes at risk of ectasia. This is particularly true when against-the-rule astigmatism is present.

The Pentacam (Oculus Optikgeräte GmbH) is a crucial tool in evaluating this risk and in planning the most appropriate laser profile to employ. With the WaveLight EX500 (Alcon Laboratories, Inc.), I most frequently use the wavefront-optimized profile for laser vision correction, but when any asymmetry is present in the topography, or significant offsets exist between the position of the corneal apex and pupil center, a topography-guided (T-CAT) treatment is employed. When, in the absence of lens changes, a conflict exists between the refractive and keratometric astigmatism, then wavefront-guided (A-CAT) treatment is used.

When contraindications to laser vision correction are present in a younger patient, I offer the patient a Toric Visian ICL. The availability of the ICL with Aquaport has simplified the procedure. These lenses correct up to 6.00 D of astigmatism alone and can be used with laser vision correction for higher levels or when residual correction is required. These lenses can be especially beneficial for mild degrees of stable keratoconus. The young patient with high hyperopic astigmatism is often not suitable for an ICL and remains a challenge.

In older patients, the surgical landscape changes. Patients with good ocular surfaces and no lenticular changes remain excellent candidates for laser vision correction, but a significant proportion of these patients have either ocular surface disease or some early lens changes. These patients are well suited for RLE with a toric IOL to neutralize the corneal astigmatism. An important consideration is how to manage near vision expectations for these patients. Many—indeed most—patients are content to wear reading glasses or have a monovision outcome, but if this is not acceptable, then I discuss the pros and cons of multifocal toric IOLs. Surgeons who are comfortable implanting accommodating IOLs could use them with laser vision correction in a two-stage procedure.

Regardless of the method employed, when correcting astigmatism in older patients, I aim for a postop refraction of 0.50 D with-the-rule. I no longer use relaxing incisions except for small amounts of corneal astigmatism, or I consider on-axis wound placement. With the acceptance of laser cataract surgery, I anticipate a change in this view. I also anticipate improved accuracy of toric IOL outcomes, especially as methods to determine corneal astigmatism evolve.

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