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Refractive Surgery Primer for Primary Care

Zale Mednick, MD

Introduction

When a patient expresses a desire to become 'glasses-free,' the conversation that follows can quickly become overwhelming. Patients often have a specific procedure in mind (most commonly laser-assisted *in-situ* keratomileusis [LASIK]) and can become frustrated if this is not the primary option recommended. From the physician's perspective, it can be challenging to simplify a vast array of options without confusing the patient. In this article, I aim to offer a simplified approach for navigating the many contemporary refractive surgery options. The goal is to provide both patients and physicians with an overview of the currently available treatment modalities and to elucidate the multiple variables that influence the surgical decision-making process, guiding the selection of the most appropriate surgery for each patient (**Table 1**).

What are the Main Variables to Consider?

When a patient presents for a refractive surgery consultation, two primary factors must be considered: efficacy and safety.

Efficacy

The primary question is which procedure is most effective to achieve the patient's goal of reducing or eliminating the need for glasses. Certain glasses prescriptions are more amenable to corneal procedures such as LASIK or photorefractive keratectomy (PRK), while others are better treated with lens-based procedures such as implantable Collamer lenses (ICL) or refractive lens exchange (RLE).[1-3] Key considerations include whether the patient is myopic (nearsighted) or hyperopic (farsighted). In cases where the glasses prescription is low or very high, even initially successful procedures may lose effectiveness over time, resulting in a return to dependence on glasses. For patients seeking to become glasses-free, it is therefore essential to select the procedure most likely to achieve that goal.[1,2]

Safety

While rare, the main complication refractive surgeons seek to avoid is corneal ectasia.[4,5] Corneal ectasia occurs when the cornea decompensates after excessive

Corneal Procedures	Indications	Advantages	Disadvantages
LASIK	• Normal corneas	• Quick recovery • Minimal pain • Treats a wide range of prescriptions	• Higher ectasia risk than with other corneal procedures • Increased dryness risk compared with other corneal procedures
PRK	• Normal corneas • Thinner corneas	• Lower ectasia risk than with LASIK	• Slower healing, longer recovery time • More postoperative pain than with LASIK
SMILE	• Normal corneas • Thinner corneas	• A good option for patients with concerns about dryness	• Less long-term data than with LASIK and PRK • Not indicated for hyperopia
Lens Procedures			
ICL	• Abnormal corneas • Very high prescriptions	• Can correct significantly higher prescriptions compared to the corneal procedures	• Additional risks of any intraocular procedure
RLE	• Over the age of 55 • Not a candidate for other refractive options	• More appropriate for older patients who are already presbyopic	• Additional risks of any intraocular procedure • Possible dependence on reading glasses

Table 1. Refractory surgery options; *courtesy of Zale Mednick, MD.*

Abbreviations: ICL: implantable Collamer lenses; **LASIK:** laser-assisted in-situ keratomileusis; **PRK:** photorefractive keratectomy; **RLE:** refractive lens exchange; **SMILE:** small incision lenticule extraction

weakening, resulting in outward bulging. When ectasia develops, the cornea transitions from a spherical shape to a more 'cone-like' shape. Ectasia can present as a primary condition, known as keratoconus, or as a secondary condition in patients who have undergone certain refractive surgeries.[4,5]

During the preoperative assessment, one of the main goals of the ophthalmologist is to screen for patients whose corneas may be at risk of such decompensation.[5,6] The risk of ectasia is a particular concern when the surgery in consideration involves reshaping the cornea, as is the case with LASIK, PRK, and small incision lenticule extraction (SMILE).[4,5] Each of these procedures involves thinning and structurally weakening the cornea. Tissue is being ablated or removed from the cornea, resulting in a mechanically weakened structure.[5] When corneal integrity is compromised, the tissue becomes more susceptible to bulging and the development of ectasia.

A variety of diagnostic tests can help us identify corneas at risk for ectasia; however, two of the most fundamental criteria are whether the cornea is too thin at baseline, and a history of eye rubbing.[6,7] When a cornea is thin before surgery, there is a limited margin of corneal tissue that can be safely removed during the refractive procedure. Furthermore, reduced corneal thickness may reflect an underlying weakness that has not yet manifested clinically as ectasia. Eye rubbing represents a significant modifiable risk factor, as it is strongly associated with both keratoconus progression and post-operative corneal instability.[6,7] Even in cases in which a preoperative cornea appears normal, chronic eye rubbing after surgery may contribute to ectatic changes in susceptible individuals.[6]

Cornea-based Refractive Surgeries

Laser-Assisted In-Situ Keratomileusis

When most people think of refractive surgery, they typically are referring to LASIK, and for good reason. LASIK is one of the most extensively studied elective surgical procedures in medicine, with over 25 years of outcome data.[1,2,8]

The average cornea measures approximately 540 microns in thickness.[5] In the first step of the LASIK procedure, a femtosecond laser is used to create a corneal flap measuring approximately 90–120 microns in thickness.[8] In the second step, the flap is lifted to expose the underlying cornea, which is subsequently ablated using an excimer laser according to the patient's refractive error.[1,2] The flap is then repositioned without sutures, and adheres to the underlying cornea via natural hydrostatic forces.

LASIK has demonstrated high levels of efficacy, predictability, and patient satisfaction.[1,2,8] Visual recovery is rapid, with many patients achieving uncorrected visual acuity of 20/20 or better shortly after surgery.[1,2] Post-operative discomfort is typically mild and transient, and refractive predictability is particularly strong in cases of low to moderate myopia.[1,2] Taken together, these advantages make LASIK the preferred option for most patients who are eligible for the procedure.

Photorefractive Keratectomy

PRK predates LASIK and remains a well-established procedure supported by long-term safety data.[3,9] In PRK, the corneal epithelium is removed, allowing the excimer laser to directly ablate the anterior stroma.[3,9] Because no corneal flap is created, corneal biomechanical integrity may be better preserved in certain patients, potentially reducing the risk of ectasia compared to LASIK.[5]

Because the epithelium is removed—essentially causing a corneal abrasion—visual recovery following PRK is slower than with LASIK, and early post-operative discomfort is more pronounced.[3,9] A bandage contact lens is typically used during re-epithelialization. Despite these differences in recovery, long-term visual outcomes are comparable to those of LASIK in appropriately selected patients.[1,3]

PRK is associated with a small risk of corneal haze, particularly in cases involving higher refractive corrections.[9,10] The intraoperative application of mitomycin C has significantly reduced the incidence of clinically significant haze.[10] However, both refractive regression and haze are more common in higher myopic treatments.[9,10]

Given the post-operative pain and lengthier healing process, PRK is typically reserved for patients who are not candidates for LASIK.

Small Incision Lenticule Extraction

SMILE is a newer refractive surgery technique that has been in clinical use for more than a decade. It is more commonly performed in Europe, where it was developed, as well as in Asia. While SMILE is increasingly adopted among surgeons in North America, LASIK remains the primary refractive surgery option offered to patients by most ophthalmologists.

SMILE is a flapless refractive procedure in which a femtosecond laser creates an intrastromal lenticule that is removed through a small incision.[11] By avoiding flap creation, SMILE may preserve a greater proportion of anterior corneal nerves, potentially reducing early post-operative dry eye symptoms compared to LASIK.[11,12]

Studies suggest similar refractive efficacy and safety profiles between SMILE and LASIK for treating myopia.[11] Some studies demonstrate faster recovery of corneal sensitivity and tear film parameters after SMILE; however, whether this translates to long-term differences in dryness remains an area of ongoing debate.[12] Currently, SMILE is primarily indicated for myopia and myopic astigmatism and is not approved for hyperopic correction in most regions.[11]

As longer-term data emerges, SMILE may gain broader acceptance and may even overtake LASIK as the procedure of choice. For now, however, LASIK remains the more commonly performed option in North America.

Lens-based Procedures

Implantable Collamer Lenses

In some cases, neither LASIK, PRK, nor SMILE are appropriate treatment options. For patients with high refractive errors or thin corneas unsuitable for corneal laser surgery, phakic intraocular lenses (IOL) such as the ICLs offer an effective alternative.[13] ICLs are implanted within the eye, positioned posterior to the iris and anterior to the crystalline lens.

The benefit of ICLs is that they expand the range of patients eligible for treatment while avoiding any corneal ectasia risk. ICLs can correct a wide range of myopia and hyperopia, often exceeding the effective treatment range of corneal laser procedures.[13] Multiple studies have demonstrated excellent visual outcomes, high predictability, and good long-term stability with ICL.[13] Whereas LASIK typically corrects up to -10.00 Diopters of myopia and +4.00 Diopters of hyperopia, ICLs can address a much wider range, from approximately -3.00 to -18.00 Diopters of myopia and +3.00 and +10.00 Diopters of hyperopia. While such extreme prescriptions are uncommon, these patients often derive the greatest benefit from refractive surgery.

The limitation of ICLs, however, is that implantation is an intraocular procedure. In corneal procedures, which do not involve entering the eye, there is no real concern about endophthalmitis, glaucoma, or cataract formation. Because ICL implantation is an intraocular procedure, it carries risks inherent to intraocular surgery, including infection, cataract formation, increased intraocular pressure, and endothelial cell loss.[13] Advances in lens design, particularly the introduction of models with central ports, have reduced the risk of pupillary block and improved safety profiles.

Refractive Lens Exchange

In some patients, even ICL implantation is not an option. Safe ICL placement requires a certain amount of intraocular space, and in smaller eyes, there may be inadequate room to accommodate the additional lens. In such patients, an RLE can be considered. RLE is essentially cataract surgery performed for refractive purposes,[14] in which the crystalline lens is removed and replaced with an IOL to correct refractive error.

RLE is generally considered in older patients, particularly those approaching presbyopia or early cataract formation.[14,15] While modern multifocal and extended depth-of-focus IOLs provide an improved range of vision, they do not fully replicate the accommodative capacity of the natural crystalline lens.[15] Thus, RLE is generally not offered to younger patients, such as those in their 20s or 30s.

As an intraocular procedure, RLE carries the same risks associated with cataract surgery, including retinal detachment (particularly in high myopes), endophthalmitis, cystoid macular edema, and posterior capsule opacification.[14]

Summary

Modern refractive surgery offers a range of effective options that can be tailored to a patient's refractive error, corneal anatomy, age, and visual goals.[1-3] LASIK and PRK remain preferred procedures with extensive long-term safety and efficacy data.[1-3,8,9] SMILE offers a flapless alternative with potentially reduced early dry eye symptoms.[11,12] ICLs expand treatment options for patients with high refractive errors or thin corneas,[13] while RLE is generally reserved for older patients and those approaching presbyopia.[14,15]

Patients should be reassured that many of these procedures are indeed highly safe and are supported by long-term data. At the same time, they should be counselled that all surgical procedures carry inherent risks, and even seemingly 'routine cases' can have unexpected complications. Although LASIK has a reputation for being a straightforward procedure, it remains surgery. Patients should therefore carefully consider their motivations for seeking independence from glasses and whether the benefits outweigh the risks.

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