Refractive Lens Exchange Candidate Selection

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Refractive lens exchange (RLE) is a popular procedure in presbyopic patients who desire the full range of vision. Advances in IOL designs can allow patients to achieve distance, intermediate, and near vision without the need for glasses. Seeing a smart phone or computer without correction is a significant lifestyle benefit. Patient satisfaction has been very high with both multifocal and extended depth of focus implants.

Candidates for RLE may have any refractive error and are usually presbyopic and desire the full range of vision. Presbyopic low hyperopes are very motivated, as they never wore distance glasses when they were younger, started with readers in their early 40s, and now need glasses for both distance and near activities.

Most hyperopic, myopic, and astigmatic refractive errors can be treated with a RLE. Patients should have a normal cornea, macula, optic nerve, and peripheral retina. Diagnostic testing should demonstrate a normal corneal topography without evidence of irregular astigmatism.

Achieving excellent outcomes is dependent on proper patient selection, advanced IOL calculations, meticulous surgery, and careful postoperative care. This RLE overview reviews important information on patient selection, surgical options, and postoperative care:

1. Indications and contraindications

2. Options for vision correction

3. Surgical techniques and IOL designs

4. Potential complications and treatment

Understanding these important factors allows the clinician to educate patients and provide optimum care. RLE is an exciting area of vision correction that is growing around the world. Clinical outcomes have improved in recent years secondary to many factors.

Eye Condition:

A complete eye examination is necessary to detect any abnormalities of the tear film, lids, cornea, lens, vitreous, macula, optic nerve, and retina. In addition, angle kappa, as defined as the distance between the center of the pupil and line of sight is an important measurement to determine lens implant choice. Patients with a high angle kappa of 0.6 mm or greater have an increased chance of positive dysphotopsias with multifocal lenses. Understanding the indications and contraindications for RLE increases the likelihood of having a successful outcome and a happy patient. (See Table 1)

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Table I

FINDINGS	COMMENTS	INDICATION
Presbyopia[1]	It is unusual for a nonpresbyopic patient to undergo RLE. Possible indications include a noncandidate for hyperopic LASIK or PRK secondary to a high degree of hyperopia, anticipated postop curvature 50 D or greater, and/or too thin a cornea, and does not qualify for an implantable contact lens (AC depth < 3.0 mm).	✓
Refractive Error: No limit as long as the power of the implant is available[2,3]	High myopes with an axial length > 25 mm are at greater risk of retinal tears and retinal detachment. If no significant lenticular changes, to consider an implantable contact lens if AC depth = or > 2.8 mm. High hyperopes are more likely to have a high positive angle kappa, and if = or > 0.60 mm may be better candidates for an extended depth of focus lens or monofocal implant.	✓
Cataract	If visual acuity and/or quality of vision are affected by lenticular changes, then cataract surgery is indicated. If visual acuity and/or quality of vision are normal, then consider RLE. Although RLE and Cataract surgery are the same procedures, government and/or or private insurance programs pay either the full amount or partial payment for cataract surgery depending on lens choice and the type of procedure.	?
Keratoconus, Pellucid Marginal Degeneration, Corneal Scarring and Irregular Astigmatism[4]	Patients with reduced best-corrected spectacle visual acuity (BCSVA) may be candidates for TG-PRK to reduce irregular astigmatism. When there is both refractive and topographic stability this can be followed by vision correction. Presbyopic patients with early lenticular changes may benefit by RLE with a toric or aspheric implant. A multifocal implant with diffractive optics is considered a contraindication.	?
EBMD or Salzmann's Nodular Degeneration[4]	Epithelial basement membrane dystrophy (EBMD) and Salzmann's dystrophy can cause a loss of BCSVA secondary to irregular astigmatism. Treatment is with a superficial keratectomy, which is essentially a debridement. When there is refractive and topographic stability an RLE can be performed. Patients should be counselled that EBMD and Salzmann's can recur and may require a retreatment.	?
Dry Eye[5,6]	Ocular surface disease can impact uncorrected-visual acuity and quality of vision. If there is a superficial punctate keratitis, this should be cleared up prior to surgery. Treatment may consist of management of an aqueous deficiency or meibomian gland dysfunction.	?
Blepharitis[7]	Inflammation of the lid margins can progress to a blepharokeratitis with a decrease in vision. Blepharitis should be treated prior to surgery to optimize the ocular surface and reduce the chance of infection.	?
Pseudoexfoliation[8]	Increased risk of a zonular dialysis at the time of surgery or subluxation of the implant postoperatively. If patient is really motivated, to consider RLE with a monofocal or toric implant. Patients are at higher risk of open angle glaucoma.	?
Age-Related Macular Degeneration[9]	Not a candidate for RLE with a multifocal implant. Surgery should be delayed until there is a visually significant cataract. Consideration at that point should be for a monofocal or toric implant.	✗
Epi-retinal membrane (ERM) or other macular conditions[10]	Not a satisfactory candidate as macular changes can impact both visual acuity and quality of vision.	✗
Angle Kappa > 0.6 mm[11,12]	High risk of halos or glare with a multifocal implant. Difficult for the surgeon to centre the implant on the line of sight. An extended-depth of focus implant can be considered, such as the Vivity, or a monofocal implant, which are not affected by a high-angle kappa.	?
Amblyopia[13]	Patients with essentially one functioning eye are at higher risk of compromised vision if there is an intraoperative or postoperative complication. Encourage glasses or contact lenses. If patient is only interested in a surgical option, then RLE can be performed with proper informed consent.	?
Glaucoma[14]	If intraocular pressures are under control and there is no significant field defect, then RLE can be performed. Patients with uncontrolled glaucoma or a significant field defect are not satisfactory candidates	?

✓ = YES ? = USE CAUTION ✗ = NO

Table 1 continued		
FINDINGS	COMMENTS	INDICATION
Lattice degeneration and/or retinal holes[15]	Patients are at higher risk of a retinal detachment with intraocular surgery. Consideration can be given to PRK over LASIK because of less pressure on the eye and theoretically a lower chance of a posterior vitreous detachment resulting in a retinal tear.	✗
Fuchs' Corneal Dystrophy[16]	The presence of corneal guttata and an increase in corneal thickness is considered a contraindication to RLE. There is a high risk of progressive corneal edema with loss of vision requiring corneal surgical intervention (DSEK, DMAK).	✗

Personality and Lifestyle:

Knowing both the personality of your patient and their lifestyle is valuable in determining candidacy for RLE and the type of implant. Patients that are hypercritical may not be accepting of any perceived imperfections in their vision. It is also important to understand the patient's occupation, hobbies, and how much time per day they are involved in near activities (computer work, smart phone, reading a book, etc) versus distance activities. Patients that do considerable night driving may not be ideal candidates for multifocal implants. (See Table 2)

Table 2		
FINDINGS	COMMENTS	INDICATION
Type A or Hypercritical Individuals[17,18]	Usually best to avoid multifocal implants in this group as the visual aberrations, no matter how minimal, may not be well tolerated. Patients may be a candidate for extended-dept of focus or monofocal/toric implant.	?
Drive for a Living[17,18]	As above.	?
Significant Night Driving[17,18]	As above.	?
Pilot, Police Officer, Military[17,18]	As above.	?

Prior Eye Surgery:

A history of previous eye surgery can impact the final uncorrected visual acuity and quality of vision. Patients that have had previous refractive surgery (LASIK, PRK, or RK) can do well with RLE but there is an increased chance of a residual refractive error because of difficulty in determining the ideal implant power of both the sphere and cylinder. Patients should be counselled that a secondary procedure may be required to enhance vision. (See Table 3)

Table 3		
FINDINGS	COMMENTS	INDICATION
LASIK or PRK[19,20]	Presbyopic patients that have normal corneal topography without evidence of ectasia can be considered for an RLE. Patients often desire the full range of vision and a multifocal or extended depth of focus implant are reasonable options. There is a greater risk of a refractive surprise in this group requiring a touch-up with PRK, a secondary IOL, or lens exchange. Determining the exact power of the sphere and cylinder of the implant is more difficult in the post-refractive group.	✓
RK[21]	RK corneas often create significant higher-order aberrations. Best to avoid a multifocal implant. May be a candidate for extended depth of focus implant and/or a monofocal or toric implant.	✓
Penetrating Keratoplasty[22]	Usually best to proceed with PRK or an implantable contact lens. Increased risk of loss of corneal endothelial cells with a RLE and graft failure.	✗
Retinal Detachment Repair[23]	Best not to proceed with intraocular surgery given the history of a retinal tear and retinal detachment. LASIK or PRK are preferred options. For high degrees of myopia to consider an implantable contact lens, which carries less retinal risk than an RLE.	✗

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VISION OPTIONS

Vision Options:

Presbyopic patients typically want the full range of vision. Understanding the indications and contraindications to RLE with various implants allows the clinician to counsel patients with the best options to meet expectations. (See Table 4)

Table 4

FINDINGS	COMMENTS
Full range of vision[24]	Most patients are interested in seeing the full range of vision. There is a great desire to see a smartphone and a computer without the need for glasses. With a multifocal implant there is an increased risk of halos and glare. This typically decreases over time.
Distance, intermediate, and some near[17,18,24]	Multifocal implants are considered a contraindication in type A individuals, anyone who would not tolerate any persistent halos or glare, or ocular conditions that may not allow an excellent level of vision. The extended depth of focus implants like the Vivity and Eyhance can provide an enhanced range of vision compared to a monofocal or toric implant.
Distance only[24]	Prior to the development of the new extended depth of focus implants this was a reasonable option. However, with the new EDOF lenses which have an incidence of halos or glare similar to monofocal lenses there are no downsides to achieving distance, intermediate, and some near.
Monovision[25]	The best candidates for monovision are patients that are successful with monovision contact lenses. Others that may be interested in monovision RLE can do a contact lens trial prior to deciding on the best vision option.

SURGICAL OPTIONS

Traditional vs Laser:

Both traditional and laser RLE can provide excellent outcomes. Patients may be more comfortable with the precision of the femtosecond laser that can create a perfectly round capsulotomy centered on the visual axis and fragmentation of the lens with minimal or no phacoemulsification. In addition, femtosecond laser can make surgery easier to perform and therefore potentially safer in a variety of conditions. (See Table 5)

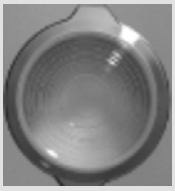
Table 5

FINDINGS	COMMENTS
Traditional Surgery[26]	In traditional surgery, the surgeon does all steps manually. Outcomes can be very good.
Femtosecond laser[27]	Using the femtosecond laser, many of the steps are automated including limbal relaxing incisions, the capsulorehexis, and fragmentation of the lens. Ultrasound energy is eliminated in over 95% of eyes, which usually results in clearer postoperative corneas and a quicker return of vision. Automated steps are particularly helpful in eyes with shallow or deep anterior chambers, pseudoexfoliation, or zonular laxity.

IMPLANT OPTIONS

Understanding Lens Implants:
Advances in implant designs have lead to the development of aspheric, toric, extended-focus, and multifocal implants. These innovations allow patients to improve uncorrected vision for distance, intermediate, and/or near vision. (See Table 6)

Table 6

FINDINGS	COMMENTS
Aspheric Monofocal Implant[28] 	An aspheric implant attempts to compensate for corneal spherical aberration to improve quality of vision and improve contrast sensitivity under both mesopic and photopic conditions. The average cornea has +0.27 microns of spherical aberration. A lens that reduces this higher-order aberration can enhance quality of vision. Aspheric implants are available from Alcon, J & J, B&L, and others.
Toric Implant[29] 	Correction of astigmatism can be accomplished by the insertion and alignment of a toric implant. When the astigmatism level is 0.7D or greater, a toric implant is typically used. If the astigmatism is less than 0.7 D, then limbal corneal relaxing incisions can be effective. Astigmatism that requires correction is the total corneal astigmatism, which is calculated from both the anterior and posterior cornea. It is important to recognize that this often differs from the refractive astigmatism as well as keratometry.
Trifocal Implant[30,31,32,33]  	Trifocal implants can provide the full range of vision with a very high patient satisfaction rate. Patient selection is important to achieve the best outcomes and satisfaction levels. Some halos and/or glare are common in the early postop period but typically resolve or diminish with time. The most popular trifocal lenses in North America are the PanOptix (Alcon) and Synergy (J & J). These are both diffractive implants that can be visualized postop with concentric rings. The Panoptix lens (Alcon) is labelled as a trifocal but has a quadrifocal design. It has a 6 mm optical zone, a central 4.5 mm region with 15 diffractive rings, and an outer annulus that is refractive. Three step heights give three focal points including 40 cm, 60 cm, 120 cm, in addition to distance. The anterior surface is aspheric and posterior surface is spherical. Diffractive structure allows the lens to transmit 88% of light to the retina at a 3 mm pupil size for high light utilization. The Synergy lens (J & J) is a combination of extended depth of focus lens (Symfony lens) and a multifocal lens (Tecnis Multifocal). The lens filters violet light. Like the Tecnis Multifocal, the Synergy has two distinct focal points at approximately 33 cm (near) and infinity. Like the Symfony IOL, the Synergy provides continuous vision from 33 to 80 cm. Like the Tecnis Multifocal it extends the distance from 60 cm to infinity.
Extended-Depth of Focus (EDOF) Implant[34,35,36,37]  	EDOF lenses provide distance, intermediate, and some near vision. Similar to a monofocal lens, it is rare to have any halos or glare. If one eye is made slightly myopic -0.50 to -.1.00 then reading can be greatly enhanced. The Vivity (Alcon) and Eyhance (J&J) are examples of these lenses. The Vivity lens uses X-wave technology to stretch and shift the wavefront. Has a monofocal-like visual disturbance. It has a one-micron elevation that stretches the wavefront at 2.2 mm. The Eyhance has a continuous change in power from periphery to center. Appears like a standard Tecnis monofocal lens on examination. It has an aspheric anterior surface and a spherical posterior surface. The Eyehance provides improved intermediate vision over a standard monofocal lens but limited near vision.

POTENTIAL COMPLICATIONS & TREATMENTS

Potential Complications & Treatments:

Although complications are rare, all patients must be counselled on potential risks. Patients need to be aware of any acute symptom of concern and report back to their eye doctor. These symptoms include a decrease in vision, wavy vision, hazy vision, field loss, floaters, and flashing lights. Clinicians need to recognize the symptoms and signs of any complication and provide appropriate care or refer back to the surgeon. (See Table 7)

Table 7

COMPLICATION	SYMPTOM(S)	TREATMENT
Positive dysphotopsia[38,39,40]	Halos and/or glare	Usually decreases or resolves over 2 to 6 months secondary to neuroadaptation. Important to rule out a residual refractive error, which can be treated with LASIK or PRK. Ocular surface disease (eg dry eye or epithelial toxicity from medications) may also cause halos and/ or glare and requires treatment. Very rare cases require an IOL exchange.
Negative dysphotopsia[38,41]	Most commonly	Secondary to the capsule overlying the nasal edge of the optic of the implant. Symptoms typically resolve with time, but may take 6 months or longer. Rare case that does not resolve can be managed by elevating the nasal optic above the capsule.
Residual refractive error[42,43]	Sphere and/or cylinder	A residual refractive error especially with a multifocal implant can degrade the quality of vision. Usually best to wait 3 or more months before treatment with LASIK or PRK. At Bochner this is performed at no charge.
Posterior capsule opacification[44,45]	Capsule opacification	If associated with a decrease in visual acuity or there if there is a change in quality of vision, then a YAG capsulotomy should be performed. There is a slight increase in risk of retinal tears and retinal detachment, especially in highly myopic eyes with long axial lengths.
Cystoid macular edema (CME)[46,47]	OCT shows CMS	Usually associated with a decrease in visual acuity or quality of vision. Patients at higher risk are those with diabetes, age-related macular degeneration, or macular traction. Treatment is with a topical steroid four times per day, and a nonsteroidal two times per day. The drops can be discontinued when the OCT shows resolution of the edema.
Posterior Vitreous Detachment (PVD)[47]	Flashing lights and/or floaters	Very common, with or without surgery, is a PVD resulting in flashing lights and/or floaters. Important to rule out a retinal tear that requires treatment. Floaters usually decrease over time and rarely require removal with a vitrectomy.
Epiretinal membrane[48]	OCT shows epiretinal membrane	May be associated with diminished vision. Important to be sure it is not associated with CME that requires topical medication. Rare cases of epiretinal membranes that are visually significant can be managed by an epiretinal membrane peel.

Summary

Refractive Lens Exchange is a popular procedure in presbyopic patients that desire the full range of vision. Innovations in intraocular lens implants can allow enhanced vision without optical aids for distance, intermediate, and near. Clinicians need to understand the indications, contraindications, intraocular lens options, and postoperative risks and management to assure a high probability of success. Freedom from glasses and/or contact lenses after decades of wear can result in high patient satisfaction. It is important to educate all patients that even though their vision may be excellent following surgery they still need to see their eye doctor to maintain the health of their eyes.

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