Multifocal intraocular lenses: Relative indications and contraindications for implantation

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This article presents an extensive overview of best clinical practice pertaining to selection and use of multifocal intraocular lenses (IOLs) currently available in the United States. Relevant preoperative diagnostic evaluations, patient selection criteria, counseling, and managing expectations are reviewed, as well as how to approach patients with underlying ocular intricacies or challenges and best practices for intraoperative challenges during planned implantation of a multifocal IOL. Managing the unhappy multifocal IOL patient if implantation has been performed is also addressed.

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Cataract surgery with an intraocular lens (IOL) has the potential to improve a patient's acuity and refine the refractive error to a given target. By design, monofocal IOLs are limited in range, typically achieving distance, intermediate, or near, but rarely encompassing all distances. The "ideal" IOL would restore the patient's vision without undo complications or visual compromises and allow the patient to regain his or her ability to see at all distances.

Achieving spectacle independence is challenging; it may be very challenging when choosing lifestyle IOLs, particularly multifocal IOLs, for certain patients. Not every currently available IOL is suitable for every patient due to the complexity of lifestyle choices and personality dynamics or the inherent anatomy and physiology of the eye. This paper reviews the best clinical practice to approach patients considering multifocal IOLs in conjunction with cataract surgery by reviewing recommended diagnostic testing, patient evaluations, and management choices, especially when dealing with certain anatomical or physiological ocular challenges.

The review does not address multifocal IOL choices in patients having refractive lens exchange. The cataract population will tend to be much more forgiving of the associated optical tradeoffs of diffractive multifocal IOLs compared with a purely refractive population with generally excellent visual quality but spectacle dependence. Refractive patients are more prone to notice the side effects of multifocal IOL correction.

PREOPERATIVE DIAGNOSTIC EVALUATION

Accurate preoperative diagnostics are essential for preoperative patient counseling and surgical planning and are of paramount value in determining whether the patient is likely to achieve anatomic success with the multifocal IOL.

Astigmatism management is vital to the performance of multifocal IOLs. A rule of thumb is that these IOLs perform best with less than three-quarters of a diopter (D) of cylinder. Beyond this, the image may degrade below satisfactory levels to achieve proper visual function. Keratometry (K) outlines the magnitude and axis of astigmatism. No perfect method exists to determine the astigmatism to be treated. If automated Ks, manual Ks, partial coherence interferometry Ks, topography, and the patient's habitual refraction are all similar in quantity and axis, the surgeon can

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move forward with a high degree of confidence. In practice, these measurements often differ.

Topography is an essential preoperative tool, providing necessary information on the regularity of astigmatism, the patient's potential candidacy for laser vision correction enhancements, and often some information on tear-film quality. In addition, the routine preoperative workup should include an anterior corneal aberration profile specifically looking for an elevation of 3rd- and 4th-order aberrations, especially coma and keratoconus.

Recent studies highlight the importance of considering posterior corneal astigmatism in surgical planning.[1] This argues for treating less with-the-rule astigmatism than measured with standard anterior corneal measurements and for treating more against-the-rule astigmatism due to the contribution of posterior corneal astigmatism. Currently, only the Pentacam (Oculus, Inc.) can estimate posterior corneal astigmatism preoperatively. Intraoperative aberrometry (Ocular Response Analyzer, Wavetec Vision) measures the astigmatism after the lens has been removed, and these measurements represent the combined anterior and posterior corneal astigmatism.[2]

Good macular function is required to achieve normal reading speed with currently available multifocal IOLs. Many surgeons choose to obtain an optical coherence tomography (OCT) test to confirm normal macular anatomy where visualization is limited.

Accurate biometry is required to achieve good uncorrected visual acuities and satisfied multifocal IOL patients. Optical axial length (AL) measurements are more accurate and require less examiner expertise than ultrasound (US) measurements.[3–5] Immersion US measurements tend to be more accurate than contact A-scan measurements.

Intraocular lens formulas have evolved over time. Recent advances have come from efforts to better predict the effective lens position and do not necessarily require a personalized surgeon factor with the most modern IOL calculations available. Most modern IOL formulas provide good outcomes for patients with average ALs and keratometry. The SRK/T formula does a particularly good job with long eyes and the Hoffer Q with short eyes.[6,7] Fourth-generation formulas such as the Holladay 2 and the Haigis (if the a0, a1, and a2 constants have been derived) tend to provide good results across the board, even in eyes with extreme ALs.[A]

PREOPERATIVE COUNSELING, PATIENT SELECTION, AND EXPECTATIONS

Preoperative patient selection and counseling is an important aspect of success with multifocal IOLs. A patient who has received a perfect surgical result with a multifocal IOL has the potential to be dissatisfied with the outcome if he or she was not properly selected for temperament and counseled regarding possible optical aberrations, enhancements, and neuroadaptation.

As part of the preoperative counseling, each individual should be warned of the inherent risks of surgery and the particular aspects of their eyes that may make their outcome less than ideal. Pupil size, angle kappa, and significant astigmatism are some variables that may affect the perceived outcome.[8–10] Many patients exist in a grey zone that does not exclude them from multifocal technology but places them at risk for a less than ideal final outcome. In general, emphasizing the potential for unwanted effects while keeping the benefits in mind (underselling and over delivering) prepares patients and can be useful in limiting their dissatisfaction with the procedure should these issues arise.

Patients should be advised of the potential for halos around point sources of light. Although these optical aberrations will improve over many months through a process of neuroadaptation, the possibility of permanent halos that may affect the quality of night vision should be presented to surgical candidates.[11–13] If patients are not willing to accept the possibility of permanent optical aberrations, they should be excluded from multifocal IOL implantation.

There are 2 key issues to address when considering the suitability of any individual for multifocal IOL implantation. The first is to understand the patient's lifestyle needs and visual expectations. This requires a detailed enquiry regarding the patient's work- and leisure-related activities, the amount of time spent doing each, and the relative importance the patient places on them. The second is to select a particular IOL based on the functional benefits and limitations of that IOL. Familiarity with the optical characteristics of different multifocal IOLs is paramount for their success. Specific multifocal IOLs have inherent strengths and weaknesses in regard to their ability to function adequately with residual amounts of corneal astigmatism or in the presence of IOL decentration.[14] In addition, multifocal IOLs may perform better at varying near or intermediate distances depending on the IOL design or near additions.[15] An attempt to match these models with patients' near visual needs and a discussion of the limitations of these IOLs in delivering perfect vision at all distances should transpire.

Another part of preoperative counseling surrounds the potential for postoperative enhancements with piggyback IOLs or corneal refractive surgery to achieve emmetropia. In the best of hands, with the most modern IOL calculation formulas, large refractive surprises or small residual errors may require a

second surgical procedure to deliver a satisfactory result. Making the patient aware of additional expenses to the enhancement procedures before the initial surgery will help avoid aggravation, animosity, or the perception that something was not done correctly at the time of the original procedure.

Patient selection is one of the most challenging aspects of multifocal IOL use—being more art than science. In general, caution should be heeded with demanding patients with type-A personalities or perfectionists, especially those demanding perfect visual needs. A slightly different subset are those who are unable to understand the nuances of optical aberrations, imperfect visual acuity, or the need for surgical enhancements. Regardless of these patients' enthusiasm for multifocal IOLs, they should be fully counseled on multifocal IOL technology and its strengths and weaknesses and perhaps given other options such as monofocal IOLs or monovision. The goal is not to maximize the use of multifocal IOLs but to match the appropriate patient personality and pathology with the appropriate IOL technology to create a satisfied patient. However, we are limited to relying on experience to detect certain attitudes and traits that we have come to identify with a higher risk for dissatisfaction with the visual limitations of multifocal IOLs.

Figure 1 presents pragmatic guidelines to the selection of suitable and the exclusion of unsuitable candidates. A thorough approach to both patient selection and preoperative counseling will yield the highest percentages of satisfied multifocal patients.

CORNEAL/EXTERNAL DISEASE ISSUES

Corneal astigmatism has been categorized as regular (principle meridians are perpendicular) and irregular (principle meridians are not perpendicular). Although regular astigmatism may be corrected with satisfactory outcomes, irregular astigmatism remains a challenge.

Corneal astigmatism of 1.25 D or more is prevalent in approximately 30% of eyes that have cataract surgery.[16–18] Studies have shown that postoperative astigmatism of 1.50 D or more leads to poorer optical quality, compromised distance and intermediate visual acuities, and a greater halo effect in eyes with multifocal IOLs.[10] According to a study evaluating the causes of dissatisfaction after multifocal IOL implantation, residual ametropia/astigmatism was the cause of unsatisfactory visual acuity in nearly 64% of patients.[11]

Patients with irregular astigmatism are not good candidates for multifocal IOL implantation because, as mentioned earlier, the refractive correction is challenging and of questionable outcomes.[19,20] In cases with regular corneal astigmatism, corrections may be applied with predictable and satisfactory outcomes. Limbal relaxing incisions or opposite clear corneal incisions can be performed to reduce astigmatism during cataract surgery.[21,22] After cataract surgery, laser refractive surgery can be used to correct residual refractive errors, including cylinder errors.[19,20,23–25] However, aside from the disadvantage of an additional surgery, these procedures are associated with limitations such as limited predictability, dry eye, and wound-healing problems.[24–26] Toric multifocal IOLs offer the opportunity to correct astigmatism and achieve spectacle independence at all distances in patients with corneal astigmatism.[27] However, these IOLs are not yet available in the United States but are available in other countries. Thus, correcting

Positive Characteristics

- Keenly interested in spectacle independence for most distance and near tasks
- Easy-going personality with a positive demeanor
- Would accept a small compromise in distance acuity
- Willing to understand that it is not a procedure with a guaranteed outcome
- Generally more interested in working with you in something of a partnership,
- Near tasks include mostly reading,
- Moderate to high hyperopia without heavy dependence on computer work or moderate to high myopia, although the latter will tend to be relatively less satisfied.

Negative Characteristics

- Does not mind wearing glasses
- The hypercritical patient with unrealistic expectations will never be satisfied.
- If the sharpest clearest vision is their main concern, then it is back to monofocals.
- Avoid those with a heavy dependence on intermediate vision, night vision, or specific job requirements; eg, commercial pilots, public service vehicle, taxi, or truck drivers.
- Avoid low myopes in general as they are used to excellent uncorrected reading vision that will be difficult to match or surpass.

Figure 1. Positive and negative characteristics to aid in the selection of suitable multifocal IOL candidates.

even the smallest degree of astigmatism may become particularly important in the context of multifocal IOL implantation, presbyopic cataract surgery, and refractive lens exchange, and correction should be offered at the time of the surgery or with postoperative biometry plans.

Many patients who require cataract extraction also have ocular surface disease such as dry-eye syndrome and meibomian gland dysfunction. Regardless of the type of IOL to be implanted (monofocal or multifocal), visual outcomes after cataract surgery may be influenced by tear-film abnormalities, leading to poor visual quality and performance. As patients with multifocal IOLs have high visual and refractive expectations, they should be treated accordingly and informed prior to surgery. Dry-eye and meibomian gland dysfunction should be treated aggressively preoperatively with a good comprehensive regimen.

Other issues that may influence post-cataract visual outcomes are the presence of corneal dystrophies, such as map-dot fingerprint and corneal scars and pterygia. Map-dot-fingerprint dystrophy requires treatment prior to cataract extraction to remove corneal opacification and achieve regular keratometric values. Photorefractive keratectomy (PRK) is the procedure of choice and seems to offer satisfactory outcomes.[28] Corneal scarring should be evaluated preoperatively with emphasis on location depth and induced corneal astigmatism. Peripheral scars that are otherwise asymptomatic are not a contraindication to multifocal IOL implantation. Finally, pterygia should be evaluated preoperatively and a decision made about their impact on visual outcomes and stability.

In patients with Fuchs corneal dystrophy, the quality of vision is compromised, especially in glare conditions and poor ambient light situations. Contrast sensitivity is compromised in otherwise normal eyes following multifocal IOL implantation as an unwanted function of the IOL.[12] Given the progressive nature of the disease, patients identified with even early changes of Fuchs dystrophy should not be considered good candidates as any possible advantages of multifocal IOL implantation are likely to be outweighed by the near certainty of compromised and uncomfortable visual outcome given the progressive nature of the disease over time.

ABERRATIONS/PREVIOUS REFRACTIVE SURGERY

Diffractive optics multifocal IOLs represent a valid option for patients having lens-based surgery who also wish to decrease their spectacle dependence. However, although multifocal IOLs are useful, they also represent something of a visual compromise by which a reduction in image contrast is traded for 2 simultaneous focal points.

Whenever a corneal aberration, such as coma, spherical aberration, or first-order astigmatism, is increased from a zero value, a proportionate decrease in contrast follows. It is well known that the visual quality of a diffractive optics multifocal IOL is best when the spherical equivalent (SE) is close to plano and postoperative regular corneal astigmatism is 0.50 D or less, but other aberrations, such as coma and spherical aberration, may also reduce visual quality. Coma, for example, a 3rd-order aberration, may be thought of as a form of irregular astigmatism. Some studies have found that anterior corneal coma values greater than 0.32 μm may result in intolerable dysphotopsia in the presence of a diffractive optics multifocal IOL.[29,B] Unfortunately, at the present time, there are almost no other guidelines regarding the amount and type of higher-order aberrations (HOAs) that may preclude the use of a multifocal IOL.

Although not necessarily a contraindication, it is important to be aware that patients who have had automated lamellar keratoplasty, laser in situ keratomileusis, PRK, or radial keratotomy (RK) frequently show a complicated across-the-board elevation in many aberrations, with the cornea itself often becoming multifocal. This increase in HOAs results in a decrease in contrast, especially at larger pupil sizes. Placing a multifocal IOL behind a multifocal cornea runs the risk of an additional loss of contrast with a reduction in visual quality. There are wide variations on this theme depending on the magnitude of the change in the SE by refractive surgery and the uniformity of the change. This could be an overlooked cause of patient dissatisfaction.

Patients who require postoperative enhancement following multifocal IOL implantation typically deal with small refractive errors, whose treatment is unlikely to generate significant corneal HOAs.

PUPIL ISSUES

The size and shape of the pupil is important when considering multifocal IOL implantation. Patients with a large pupil are at increased risk for glare dysfunction following surgery.[11,28] Patients with an atrophic iris are at risk for increased glare, photosensitivity, and often zonular weakness (due to past inflammation) with multifocal IOLs just as they are with monofocal IOLs. Patients with a small pupil present some challenges when placing multifocal IOLs. The small pupil may require expansion for a safe capsulorhexis and nucleofractis. A decentered capsulorhexis is a risk factor for a decentered IOL, which can lead to poor function of multifocal IOLs.[12,14,30–32] When expanding

the pupil, the surgeon should be careful to minimize damage to the iris sphincter. Iatrogenic mydriasis could lead to dysfunction of the multifocal IOL with unwanted reflections and image confusion.[11,28] More complex pupils such as an eccentric pupil or iris coloboma may lead to multifocal IOL dysfunction and should be considered an absolute contraindication to multifocal IOL implantation. In addition, pupil abnormalities such as ectopic pupil and coloboma are often associated with weak zonular fibers.

ZONULAR ISSUES

The success of multifocal IOLs relies on proper implantation and centration. When the multifocal IOL is decentered or tilted, there can be decreased contrast sensitivity, aberrations, and ultimately decreased corrected visual acuity.[33] The amount of decentration that results in a significant loss of optical quality, measured by modulation transfer function, is reported to be approximately 0.75 mm to 1.00 mm for refractive and diffractive multifocal IOLs.[10,14]

Several causes of IOL decentration including asymmetric capsule openings and haptic deformation and zonular weakness have been reported.[34] The most common etiology of zonular weakness is pseudoexfoliation. When there is asymmetric zonular laxity, the implanted IOL may shift away from the weakened area toward the intact zonular fibers.[34] Thus, the centration of multifocal IOLs in patients with pseudoexfoliation can be unpredictable and progressive over time. Because of this unpredictability, some patients without significant zonular asymmetric weakness may have a successful outcome with multifocal IOLs, while others may not.

Implantation of a capsular tension ring (CTR) can distribute forces around the equator in situations with asymmetric zonular weakness, leading to improved centration of the IOL. Studies have reported significantly better visual acuity with implantation of a CTR with multifocal IOLs, especially for rotationally asymmetric multifocal IOLs.[35,36] Implantation of a CTR is only recommended in the setting of an intact capsular bag with no anterior or posterior capsule tears.

Whatever the etiology, mild zonular weakness is not a strict contraindication to choosing a multifocal IOL. However, the risks for late decentration and potential visual consequences should be considered.

RETINAL ISSUES

Assessing the appropriateness of a multifocal IOL in the presence of macular disease depends on the stability of the disease, the expected progression of the condition over time, and the availability and usefulness of treatment. While some conditions are absolute contraindications to multifocal IOL use, such as retinitis pigmentosa and Stargardt disease, the more common macular diseases present with such a spectrum and affect such a significant number of patients that clinical judgment becomes paramount. The potential problems are 2-fold: impaired vision for the patient and impaired fundus visualization for the treating physician.

Progression of macular disease after cataract surgery is a challenging issue for the surgeon, specifically in diabetic retinopathy,[37–40,C] macular degeneration,[41–44] and epiretinal membrane.[45] These diseases lead to decreased contrast sensitivity; with multifocal IOL implantation, one would face a compounded reduction in contrast sensitivity and perhaps decreased visual outcomes.

Testing macular function in patients with known macular pathology is important and includes simple near acuity, pinhole testing, super pinhole testing (a pinhole with a +3.00 D lens for near acuity), the red-stripe test, a potential acuity meter, and the Retinal Acuity meter. While these tests help identify the Snellen potential, another useful test for assessing macular function is the photostress test.

Denser cataracts make potential acuity measurements much more difficult. Testing through such dense media as with blue field entoptoscopy or the Purkinje vascular entopic test will suggest potential for visual improvement, but will not properly identify adequate visual function to perform well with multifocal IOLs. One might also chose to perform a macular OCT test to look for subtle or occult pathology, as well as to quantify mild recognized macular disease.

From the perspective of the treating retinal surgeon, impaired fundus visualization during vitrectomy following multifocal IOL implantation has been reported.[46–48] While no significant intraoperative complications were encountered, the multiple images described can significantly challenge the operating physician.

OPTIC NERVE ISSUES

In general, any abnormality of the optic nerve that restricts potential visual acuity, contrast sensitivity, color perception, or field of vision[49,50] can be considered a relative contraindication to multifocal IOLs. Appropriate tests to evaluate optic nerve structure and/or function in the presence of a cataract include pupil reaction (direct and consensual), automated perimetry visual field testing, ophthalmoscopy, and OCT optic nerve evaluation. If there is an abnormality of optic nerve structure and/or function, the next decision is whether the abnormality is potentially progressive. If the abnormality is significant and/or progressive, a

multifocal IOL should be considered a contraindication to the long-term success for this patient.

CENTRAL NERVOUS SYSTEM/MOTILITY ISSUES

Dementia

Multifocal IOLs might represent a reasonable option in some patients with dementia if appropriate informed consent can be obtained. In addition to good uncorrected distance visual acuity (UDVA), the ability to perform common near activities without spectacles, such as reading and viewing photographs, might be advantageous, particularly as the dementia progresses. The involvement of a close family member or power of attorney/caregiver in the decision would generally be advisable because it may be difficult for the ophthalmologist to determine the patient's actual cognitive abilities and comprehension of the issues.

Monocular Performance with Multifocal Intraocular Lenses

Because there is some compromise of contrast sensitivity with multifocal IOLs, patient satisfaction and uncorrected visual function are generally better following binocular implantation. However, monocular multifocal IOL implantation still provides a greater range of uncorrected focus in at least 1 eye. A common situation in which monocular implantation might be elected would be when the patient's fellow eye has a monofocal IOL or is phakic without a significant cataract. These patients should generally not expect to achieve the degree of spectacle independence they would have with bilateral multifocality. However, assuming realistic expectations, they may be very pleased to have the benefit of multifocality in 1 eye.

Alternating monofixators, such as patients with a large-angle alternating strabismus, are not optimally suited for multifocal IOLs because they cannot achieve the summation benefit of simultaneous binocular multifocal vision. In other cases, such as hyperopic patients with a very small-angle esotropia, the monofixation status may be subtle and overlooked. Not only will these patients lack the summation benefit of binocular multifocality, but a mildly amblyopic eye caused by a small undiagnosed esotropia might surprise both the patient and the ophthalmologist with unexpectedly disappointing visual function. A 4.0 D base-out prism test may be necessary to reveal that the patient is a monofixator and might be considered in the preoperative evaluation of a highly hyperopic patient. In general, the value of implanting a diffractive multifocal IOL in eyes with even mild amblyopia must be questioned. This is because with amblyopia, even a mild reduction in contrast sensitivity may produce a disproportionate reduction in visual function.

Functionally 1-eyed patients should certainly not expect to achieve the level of uncorrected visual function that would result from bilateral multifocality. In addition, lacking the compensatory visual contribution of their second eye, the reduction in contrast sensitivity inherent with diffractive multifocal IOLs may be more of a present and future concern in these patients.

INTRAOPERATIVE ISSUES

A centered, properly sized capsulorhexis is important for IOL function and power selection.[51–54] An even anterior capsule overlap of 360 degrees allows IOL centration despite contraction of the anterior capsule.[52] Several studies have shown that IOL centration is critical for multifocal function.[12,14,30–32,51] The use of a computer-controlled femtosecond laser may improve consistency and precision of the anterior capsulotomy,[55–57] especially with increased surgical experience.[58,59] Placement of a multifocal IOL is controversial when an anterior capsule tear is present as these tears may[53,54] or may not[55] lead to IOL decentration in the long term. A well-centered anterior capsulotomy can be used to fixate an IOL when the posterior capsule is not stable; with reverse optic capture, the haptics are placed in the bag and the optic is prolapsed anteriorly into the sulcus.[60,61]

If a posterior capsule rupture occurs, appropriate management becomes crucial, especially when multifocal IOL implantation has been planned. The broad objectives in the management of any posterior capsule rupture are to prevent vitreous prolapse, perform meticulous removal of the vitreous if it does occur, completely remove residual lenticular material, and implant a multifocal IOL in the capsular bag.

In case of a small, relatively central, well-demarcated posterior capsule rupture, converting it into a posterior continuous curvilinear capsulorhexis provides a continuous and strong margin. Not only does this prevent further enlargement of the posterior capsule rupture during subsequent manipulations, but most important, it allows placement of a multifocal IOL in the capsular bag.

In-the-bag IOL placement should be the goal for placement of multifocal IOLs because of the stability this offers. However, in case of a large posterior capsule rupture with inadequate bag support, it may be preferable to implant a monofocal IOL in the ciliary sulcus with capture through the anterior capsulorhexis margin. If possible, it is better to avoid implanting a 1-piece multifocal IOL in the ciliary sulcus due to risk for pigment dispersion, inflammation, and hemorrhage; at the least, it is important to have a 3-piece multifocal IOL available should sulcus placement be required,[62]

preferably with posterior capture of the optic by a centered anterior capsulotomy.[59,62]

MANAGING THE UNHAPPY MULTIFOCAL INTRAOCULAR LENS PATIENT

Even with the best preoperative planning and evaluation, IOL calculations, and preoperative patient counseling, there can be situations in which the cataract surgeon is presented with an unhappy multifocal IOL patient. The most important thing to remember is to listen to the patient and to address the patient's concerns. The most commonly cited reasons for patient dissatisfaction after multifocal IOL implantation are blurred vision due to ametropia; dry-eye syndrome; posterior capsule opacification (PCO); or photic phenomena due to IOL decentration, retained lens fragment, PCO, dry-eye syndrome, and large pupil.[11,12]

Clinical evaluation should include measurement of uncorrected and corrected visual acuity, corneal topography, intraocular pressure measurement, and a dilated funduscopic examination, with OCT if the corrected distance visual acuity (CDVA) is worse than 20/20. Important parts of the history include preoperative UDVA and CDVA, preexisting ocular pathology, history of amblyopia and/or strabismus, the model and power of IOL, and IOL calculation formula including the intended versus actual refractive outcome (if available), date of the cataract surgery including intraoperative or postoperative complications. It is also useful to determine from the patient when his/her visual symptoms first began, differentiating between symptoms that began immediately following surgery from those beginning weeks or months after surgery.

Once the complete history and examination have been performed, the surgeon should be prepared to answer the following questions:

1. Is there residual refractive error?
2. Does the patient complain of glare and halos?
3. Does the patient complain of negative dysphotopsia (temporal shadow in vision)?
4. Does the patient complain of decreased contrast sensitivity?

If there is residual refractive error, determine whether the patient's visual complaints can be resolved with glasses or a trial frame in the office. The surgeon should look carefully at the corneal topography and refraction, since uncorrected astigmatism can be a significant cause of residual refractive error and lead to an unhappy patient. If there is residual refractive error, options including glasses or PRK can be offered to the patient to correct the problem. If the surgery was performed less than 6 to 8 weeks previously and there is significant refractive error (myopia or hyperopia > approximately 1.5 D from intended), IOL exchange rather than PRK can be considered.

If the patient complains of glare and halos, it is important to determine whether the symptoms began immediately after surgery versus weeks to months later. If the symptoms began immediately after surgery and have not diminished in a 4- to 6-week time frame and there is no residual uncorrected refractive error, IOL exchange with a monofocal IOL or an accommodating IOL can be considered. If the complaints of glare and halos began weeks to months after multifocal IOL implantation and there is not an uncorrected refractive error, further evaluation for PCO and a neodymium:YAG (Nd:YAG) capsulotomy should be considered but not rushed into since this can compromise the ability to perform an IOL exchange. In addition, careful evaluation of IOL centration should be performed. If there is decentration of the IOL, options for recentering the IOL should be considered. These may include Nd:YAG or argon pupilloplasty for small decentrations, placement of CTR segments and/or suturing of IOL or IOL–bag complex for larger decentrations, and the option of IOL exchange if the decentration cannot be managed with the aforementioned techniques.

If the patient is complaining of negative dysphotopsia, reassurance and recognition of the issue can sometimes be enough to improve the patient's satisfaction. Negative dysphotopsia can improve with time. If months have elapsed without significant improvement in the symptoms, reverse optic capture or piggyback IOL can be considered. In severe cases, an IOL exchange using a different platform IOL and possibly a sulcus monofocal IOL can be considered.

If the patient is complaining of decreased contrast sensitivity, thorough evaluation including retinal and optic nerve examination and OCT, possible fluorescein angiography, and visual field testing may be required to determine whether it is secondary to glaucoma and/or retinal pathology such as cystoid macular edema. In addition, patients with previous RK and multifocal IOLs may have multiple symptoms including decreased contrast and an increase in glare and halos, and IOL exchange is usually the best option in these cases. If the symptoms occurred immediately after surgery and no other etiology has been elucidated, IOL exchange with a monofocal or accommodating IOL can be considered. If the symptoms had a delayed onset after the procedure, etiologies may include optic nerve pathology, glaucoma, retinal pathology, and/or PCO.

In all cases, proper management of the unhappy multifocal IOL patient requires time, patience, and

familiarity with different medical and surgical options and techniques. If the surgeon does not have the experience with techniques such as IOL exchange or PRK, referral to a colleague familiar with refractive and complex case management should be considered.

DISCUSSION

This review of best practices for multifocal IOLs outlines general recommendations for the currently available multifocal IOLs in the U.S. There is a very small number of prospective random mixed papers on the use of multifocal IOLs and further studies are needed. It is also important to note that there are significantly more multifocal IOL choices available outside the U.S., such as designs with trifocals or toric multifocal IOL combinations. These provide additional possibilities for patients with specific visual needs and may improve outcomes.

Appropriately selected patients can achieve spectacle independence and good visual outcomes at both near and distance with current multifocal IOLs. This begins with proper patient education and individualized weighing of benefits and side-effects of multifocal IOLs.[63–65] Given the high sensitivity of multifocal IOL function to minor ocular aberrations,[63] preoperative clinical evaluation is crucial to postoperative success. Despite careful selection and screening, some patients will experience unsatisfactory outcomes due to issues that are unique to this class of IOLs.[12] Suitable postoperative management of both satisfied and dissatisfied patients will ultimately improve the visual benefits of these IOLs.

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