Objective measurements to improve multifocal intraocular lens implantation outcomes

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With the recent advancements in multifocal intraocular lens designs, such as single piece, asphericity and appropriate add, refractive outcomes and patient satisfaction has improved dramatically. Occasionally, however, patients are dissatisfied with the results. Identifying the patient’s visual goals is always the first step to determine the most appropriate lens implant for the patient. However, the patient’s visual goals must be consistent with the capabilities of the patient’s optical system. Objective measurements can help improve outcomes and decrease unwanted side effects of multifocal IOLs.

1. **Assess the ocular surface**

   Given the aging changes that occur in the ocular surface microenvironment and fluctuations in tear film with hormonal changes, ocular surface disease is very common in the cataract population. Since the air/tear interface is responsible for 70% of the eye’s refractive power, ocular surface optimization is critical to maximizing IOL performance. A poor tear film can result in inaccurate keratometric values leading to improper IOL selection. Additionally, the variable refraction and decreased contrast sensitivity caused by a poor tear film can significantly degrade the image quality created by a multifocal IOL. The clinical exam is the gold standard for diagnosing ocular surface disease, but objective measurements like TearLab osmolarity testing can be helpful in quantifying the problem. Treatment with Azasite, Restasis, a short course of a mild topical steroid and/or preservative free artificial tears during the perioperative period can dramatically improve visual function. Surgeons should also consider oral omega-3 fatty acids and punctal occlusion in their ocular surface optimization regimen.

2. **Assess Corneal and Lenticular Astigmatism**

   Corneal Astigmatism of greater than 0.5D can decrease visual acuity and contrast sensitivity in the setting of a multifocal IOL. Furthermore, a large variation exists among patient for sensitivity to residual astigmatism. Adjusting the location of the incision, performing astigmatic keratotomy, or planning for laser vision enhancement will decrease astigmatism and improve vision. Surgeons should identify the source of astigmatism by comparing manifest refraction with keratometry and address it appropriately in the surgical planning as clinically significant lenticular astigmatism is not uncommon. Toric multifocal IOLs have quickly gained popularity outside the United States, and will hopefully become available to US surgeons soon.
3. **Evaluate Topography and Tomography**
   Irregular astigmatism and multifocal IOLs do not mix. Topography will identify irregular astigmatism and should deter multifocal IOL implantation in such patients. An accommodative IOL may be a better solution for patients seeking presbyopia correcting lens implants with clinically significant irregular corneal astigmatism.

4. **Quantify Higher Order Aberrations**
   Higher order aberrations degrade image quality and contribute to glare, which is compounded in the setting of Multifocal IOLs. A wavefront aberrometer can measure HOA’s induced by the cornea and identify patients who may experience unacceptable glare following IOL implantation. Aberrometers such as the Nidek OPDIII scan among others can indentify HOA’s and guide the surgeon to avoid multifocals when the Root Mean Squared is greater than 0.3 (Figure 1)

5. **Measure Angle Kappa**
   Angle Kappa describes the distance between the center of pupil and the visual axis. Cataract surgeons typically center the lens based on the dilated pupil. However, the visual axis can be significantly different than the center of the pupil. If angle kappa (as measured on the corneal surface) is greater than half the diameter of the central optical zone of a multifocal IOL, the primary path of light may traverse one of the multifocal rings instead of the central optic, leading to glare. The Restor 3.0 lens has a central optical zone of 0.8mm and the Tecnis Multifocal has a central optical zone of 1.0mm. Thus an angle kappa of less than 0.4mm for the Restor 3.0 and 0.5mm for the Tecnis Multifocal are probably acceptable. As the macula is anatomically supero-temporal, either a centered or slight infero nasal position can be effective. Slit lamp biomicroscopy is not reliable for assessment of centration as there is no coaxially fixated light source. Preoperatively, the NIDEK OPDIII is useful for quantification of angle kappa and surgical planning. Intraoperatively, patient assisted fixation on a coaxially fixated light source in the surgical microscope is critical, and surgeons should be familiar with manipulated their scope and lights to instruct the patient. Caution should be used when assessing postoperative centration at the slit lamp as there is no coaxially fixated light source. A hand held direct ophthalmoscope can be useful, in addition to the aforementioned techniques.

6. **Determine 3mm and 5mm refractive zones**
   Many patients experience night myopia as a result of increased curvature of the peripheral cornea. This is particularly true in patients that had prior refractive surgery with smaller ablation zones. Instruments such as the Nidek OPDIII can measure refraction at both the 3 and 5mm optical zone. Similar information can be obtained by performing refraction under both photopic and mesopic conditions. If a patient has more
than 1 diopter difference under mesopic conditions, a multifocal lens may be susceptible to glare because of nighttime defocus and spherical aberration.

7. **Obtain an SD-OCT of the macula**
   Multifocal IOLs work best with a pristine macula. Any macular problem that causes distortion, decreased contrast sensitivity or decreased visual acuity can lead to difficulties with a multifocal IOL. Many conditions like vitreomacular traction, a subtle epi-retinal membrane or a small subfoveal drusen can easily be overlooked on clinical exam, but are readily identified by SD-OCT.

8. **Use the proper IOL formula**
   Achieving a plano target is important for multifocal IOLs. In normal eyes this generally straightforward. However, extremes in corneal curvature and axial length, or axial anisometropia can make prediction more challenging. In these cases a more sophisticated formula like an optimized Haigis or Holladay II are helpful. Of course, the data used in the formulas should be accurate, most importantly, axial length biometric and keratometric readings. Axial length or keratometric asymmetry should be investigated and accounted for. Post-refractive IOL calculations are also challenging and require additional data. Patients should be informed of the increased change of a refractive enhancement in such cases.

9. **Consider intraoperative aberrometry**
   Interoperative aberrometry with devices like ORange, can help identify the proper lens selection prior to implantation and can help verify the lens power immediately after implantation. Also intraoperative aberrometry can help determine more precise use of astigmatic keratotomies to treat astigmatism.

10. **Enhance when needed**
    All multifocal IOL require a precise refractive endpoint that is very close to plano. If the patient has refractive error an eximer laser enhancement can decrease the refractive error and turn a dissatisfied patient into a happy one. Decentered multifocal IOLs should be recentered, not enhanced.

Figure 1: Below: Image demonstrating a different refraction at that 3mm and 5mm refractive zones. The change in refraction could lead to night time defocus and glare in a multifocal patient. Also notice the elevated HOAs at the 5mm zone which could degrade image quality.
Cornea Index: n=1.3375 (Ax, ins), n=1.3760 (Ref, TRef) Qm: 6.0mm λ: 587.6nm

OPD-ScanII Workstation Serial No. 45678 v2.14.01Mw
Figure 2: Below: Image showing an angle kappa of 0.61mm. Centering the IOL on the pupil may result in glare because the visual axis and the pupil center are significantly different.

References

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