How Do You Choose Between a Multifocal and an Accommodating IOL?

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An Iterative, 3 Step Process

There are 3 essential steps that help guide the ophthalmologist in advising patients who are deciding between accommodating and multifocal IOL options. This premium group of lens implants has sometimes been referred to as “lifestyle IOLs”. Appropriately, the first step in the decision tree is taking the time to understand each individual’s lifestyle, functional needs, and expectations.

Each presbyopia-correcting IOL has inherent strengths and weaknesses. IOL design features that achieve an expansion of through-focus often are counterbalanced by some limitations or unwanted side effects. Understanding the inherent optical performance of each specific accommodating or multifocal IOL and balancing this with the patient’s lifestyle and visual priorities is the second critical step in this iterative process.

The final step in the determination is appreciating each individual’s distinctive ocular traits and characteristics that may impact the performance of an IOL in that individual. Examples of this step include evaluating pupil size, shape and dynamics, corneal wavefront, angle kappa, and macular status.

Step1: Understanding The Patient’s Lifestyle and Shaping Their Expectations

Every refractive lens surgeon understands that there is no pseudophakos that mimics the elegant fusion of form and function of an 18 year old’s crystalline lens. While with time we have seen iterative improvements in accommodating and multifocal IOL design, empathizing with the patient that unfortunately there is no “perfect” man-made substitute for the lens they were given by their creator aligns you with the patient as their honest advisor and advocate. Starting out by sharing this simple but important acknowledgement of the limitations of current IOL technology in comparison to the youthful crystalline lens goes a long way towards setting the stage for realistic expectations, the need for some compromise with either a multifocal or accommodating IOL, along with our inability to promise or guarantee total spectacle independence at all object vergences and lighting conditions. Within this framework, a very important part of the decision between a specific multifocal versus accommodating IOL is dependent on the patient’s lifestyle, visual needs and expectations, which can best be assessed with a series of open ended and directed questions.

Patients should be required to serially rank in order and priority their desire for optimized uncorrected distance, intermediate and near vision. While everyone would naturally want “perfect” vision at all vergences and almost everyone would be dissatisfied without good uncorrected distance vision, the patient should be asked if they frequently use computer, smart phones or perform other intermediate tasks. With regard to near vision, does the patient enjoy knitting or fly fishing or have other particularly close visual needs? Given their body habitus, how close do they hold things when reading? Would the patient consider the need for reading glasses for smaller print a failure of IOL?
implantation? Does the patient frequently drive after it becomes dark? Note that the patient may not themselves view as “night driving” as this could be as early as 5PM in the fall. Would some degree of halos around point sources of light at night be an acceptable or completely unacceptable exchange for improved uncorrected near vision? Is the patient currently emmetropic, hyperopic or myopic and how does this impact their post-operative expectations of uncorrected vision at various distances given their current status? In the next section, we see how the answers to these questions brings the doctor to the second step in optimizing the selection of the multifocal or accommodating IOL to best meet each patient’s needs.

**Step 2: Matching the Patient’s Visual Needs to IOL Performance, Limitations and Side Effects**

Clinical and optical bench studies both demonstrate important differences in the performance of accommodating versus specific multifocal IOL at various vergences\(^1\)\(^2\). A randomized, prospective study of patients randomized to bilateral implantation of the Crystalens AO (Bausch + Lomb) versus ReSTOR 3.0 (Alcon Laboratories) versus Tecnis multifocal IOL (Abbott Medical Optics) demonstrated that patients implanted with Crystalens achieved a better intermediate vision at 32 inches (~81 cm) compared to either multifocal (both in terms of uncorrected and best corrected vision)\(^3\). In contrast, patients implanted with either multifocal achieved better uncorrected and best corrected near vision. The near focal point of the Tecnis multifocal (~31-33cm)\(^4\)\(^5\) is closer than the ReSTOR 3.0 (~37cm)\(^6\), as the Tecnis has a 4.0D add as compared to the ReSTOR’s 3.0D add at the IOL plane. However, since the diffractive elements on the Tecnis are on the posterior surface of the IOL in contrast to the ReSTOR apodized rings on the anterior surface, this serves to push the Tecnis’ near point further out than the near point on the ReSTOR 4.0 (~31cm), but closer than the ReSTOR 3.0. Objective and subjective tests of glare and halos show that these are greater with the Tecnis than the ReSTOR and least with Crystalens AO\(^3\).

The Tecnis multifocal IOL has a modified prolate anterior surface and a diffractive bifocal posterior surface consisting of 32 concentric rings with equal step heights of approximately 0.25 mm. The central zone is 1.00 mm. The anterior surface has a spherical aberration of -0.27 mm at a 6.00 mm zone, which completely offsets the average corneal spherical aberration\(^5\). At all pupil sizes, the diffractive elements split light equally between near and far (41% each) and 18% of light is lost to higher diffractive orders. The functional impact of this design with regard to visual performance at distance, intermediate and near and the impact of pupil size and ambient light is discussed in the following sections.

In comparison, the ReSTOR 3.0 (SN6AD1) aspheric multifocal IOL combines the functions of an apodized diffractive region and a refractive region. The apodized diffractive optics localized within the central 3.6 mm optic zone of the anterior surface of the IOL are comprised of 9 concentric steps of gradually decreasing height, creating multifocality from near to far, with 2 primary foci. The refractive region of the optic surrounds the apodized diffractive region. This area directs light to a distant focal point for a larger pupil diameter and is dedicated to distance vision\(^6\). The impact of enlarging pupil size shifts the distribution of light energy from near to more distance foci, with less light lost to higher
diffractive orders. The IOL has a symmetric biconvex design with an anterior aspheric optic to reduce, but not totally offset the average corneal spherical aberration (IOL negative spherical aberration of -0.10 µm at a 6.0mm zone).

**Step 3: Matching the Patient’s Ocular Traits and Characteristics to Specific IOL Performance**

The performance of both accommodating and multifocal IOLs depends upon a number of factors. Residual defocus and astigmatism impacts the function of all IOLs, but both clinical and bench studies have shown that both distance and near vision is generally more affected in patients with multifocal IOLs with 0.75D or more of residual astigmatism². Similarly, image quality in eyes implanted with multifocal IOLs is adversely affected by high degrees of higher order aberrations, such as coma and spherical aberration. A number of topographers and combined topography/wavefront systems are capable of assessing the corneal wavefront preoperatively. Patients with greater than 0.3 microns of vertical or horizontal coma at a 6 mm optical zone may not be ideal candidates for multifocal IOLs (Figure 1) as this may be associated with glare, waxy vision and reduced image quality.

The performance of apodized diffractive IOLs like ReSTOR is very dependent on changes in pupil size to shift light energy from near to far foci. It is important to assess pupil size, shape and dynamics preoperatively (Figure 2), in that patients with small, miotic, poorly reactive pupils in both mesopic and photopic conditions may have light energy chronically shifted towards near foci and elicit a waxy distance image quality. Conversely, patients with very large pupils that do not constrict well on accommodation, may not achieve the near vision that they are seeking with a ReSTOR multifocal. Whereas the Tecnis multifocal splits light evenly between near and far at all pupil diameters and may thereby allow reading vision even in lower illumination, studies have shown that intermediate vision is worse in patients with the Tecnis IOL with pupils ≥4mm compared to those with smaller pupils⁴,⁵.

Angle kappa⁷ is defined clinically as the angular distance in object space between the line of sight (i.e., line connecting the pupillary center and the fixation point) and the pupillary axis (i.e., the line passing through the center of the pupil perpendicular to the cornea). A prospective study of patients with refractive multifocal IOLs showed that patient’s complaints of glare and halos were positively correlated with preoperative values of angle kappa⁸. One explanation for this observation is that if angle kappa 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 IOL has a central optical zone of 0.8 mm and the Tecnis MF has a central optical zone of 1 mm. As a reasonable referent, it may be that an angle kappa of less than 0.4mm for ReSTOR 3.0 and 0.5mm for Tecnis MF would greatly lessen the chances of the primary ray traversing the diffractive ring.

Since multifocal IOLs may, in some patients, reduce contrast sensitivity since the light energy is split between near and distance images simultaneously cast on the retina, patients with other independent reasons to have reduced contrast sensitivity may not be ideal candidates for multifocal IOLs. For example, contrast sensitivity may be reduced in patients with epiretinal membranes, macular degeneration, diabetic retinopathy or glaucoma. In comparison, accommodating IOLs have not been shown to reduce contrast sensitivity when compared to aspheric monofocal control IOLs.
Integrating the Results of the 3 Step Process In Surgical Planning

The final recommendation between a specific multifocal or accommodating IOL involves integrating and synthesizing all of the information that has been accumulated. For example, patients who do little night driving and whose main interests are knitting and watching television may be ideally suited for a Tecnis multifocal IOL, if they can accept the possibility of some halos and night glare which may diminish somewhat with neuro-adaptation over the course of months. Patients who work in low lighting conditions, such as a waiter in a low-lit restaurant or an x-ray technologist or someone who hunts at dusk, may not achieve adequate near vision with a ReSTOR IOL and may not be accepting of photic phenomenon or night glare with a Tecnis or ReSTOR. Such a patient might be offered a Crystalens accommodating IOL with some degree of myopic offset of the non-dominant eye up to around -0.75D, with the warning that they may still require low powered reading glasses. Patients with 4 mm mesopic pupils that react briskly to accommodation and who spend a lot of time on computer and also read a lot may find the Tecnis IOL to give a closer near point than their computer monitor (requiring them to move the screen closer or use low add readers) and may be better candidates for either a ReSTOR 3.0 or Crystalens with a myopic offset of the non-dominant eye to mini-monovision. Listening to each patient’s needs, appropriately modifying their expectations, and assessing their ocular traits allows the ophthalmologist to synthesize this information and to use the forementioned framework as a decision tree in choosing between a multifocal and accommodating IOL.

References