

Premium Intraocular Lenses Use in Patients with Cataract and Concurrent Glaucoma: a Review

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INTRODUCTION

The prevalence of cataract and glaucoma increases with age, therefore combined pathology is commonly encountered in elderly. Patients with visual field and optic nerve defects are not straight forward cases. Those who cumulate both conditions present unique functional and structural differences that affect pre, intra and postoperative results. We need to consider this when selecting intraocular lenses (IOL).

There are some characteristics of the patients with coexisting cataract and glaucoma that should be taken into account: the crystalline lens can generate various types of secondary glaucoma (1), hypotensive drugs potentially influence the development of cataract (2,3), cataract decreases the sensitivity of diagnostic tests that document glaucoma progression, glaucoma surgery may be associated with increased risk of cataract worsening postoperatively (4), phacoemulsification has a complex and dynamic effect on IOP (5,6).

Nowadays, cataract surgery is not anymore synonymous with lens extraction; it evolved in

a more refined procedure due to advances in phacoemulsification and IOL technology. Premium IOLs are designed to achieve the best possible refractive outcome with restoration of vision for near and distance without spectacles.



PREMIUM IOLS

Accommodation is the capacity of the eye to actively change its refractive power to create a sharp image on the retina of distant, intermediate and near objects (7); it consists in a multifactorial mechanism. Traditional intraocular lenses (IOLs) are monofocal, most patients needing spectacles after implantation, at least for near vision. The goal for premium IOLs is to allow the presbyopic patient to regain the ability to accommodate.

Multifocal and accommodative IOLs are considered premium IOLs; they are used mainly in patients with presbiopia +/- cataract, but without any other ocular commorbidities. Toric IOLs, designed to compensate corneal astigmatism, are also considered premium IOLs. Glaucomatous eye has a number of particularities that can influence the way the implants are indicated and used (8).

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Multifocal IOLs

Multifocal IOLs were first introduced in 1980s (9,10). Since then, improvements of previous lens models have increased patient satisfaction and quality of life. As if betrays the name, multifocal IOLs, focus light in more than one point. These intraocular lenses present multiple circular, concentric areas that provide a continuous variation of the refractive power (Figure 1). They are described as refractive, diffractive and combinations of both optical principles.

Multiple studies confirmed the efficacy of multifocal lenses in providing a better near and intermediate visual acuity, without correction, compared to monofocal lenses, with a similar level of distance visual acuity (11-13).

Diffractive multifocal artificial lenses are based on the Huygens-Fresnel principle (14), presenting concentric rings that result in two or more coexisting retinal images. These IOLs provide very good reading and distance visual acuity and are independent of pupil size. Refractive multifocal artificial lenses provide excellent intermediate and distance visibility.

Refractive IOLs show usually good near visual acuity, but may not be enough to see very small prints (such as medical prospectuses) and depend on pupil size (15). Recent studies report very good results in most cases after implantation of a multifocal IOL, diffractive (16-18), refractive (17,18), or hybrid diffractive-refractive (19). Diffractive and refractive multifocal IOLs produce similar uncorrected visual acuity, but the former provides better uncorrected near visual acuity (20-23), resulting in a higher spectacle independence.



FIGURE 1. Multifocal IOL - AcrySof® IQ ReSTOR® (Alcon Surgical, Novartis, Fort Worth, US).

Recently, aspheric multifocal IOLs were introduced, with optical properties that decrease higher-order aberrations of the ocular optical system, primarily by compensating for the increased positive spherical aberration of the cornea in older subjects (24,25). Aspherical design provides a significantly better near visual acuity compared to spherical multifocal IOLs, but it has no significant influence on night vision symptoms and contrast sensitivity (26).

Multifocal lenses, whether refractive or diffractive, have certain drawbacks:

- lower contrast sensitivity compared to monofocal IOLs (27) because one image is always blurred and defocused light energy creates disturbances (28). This problem becomes more clinically relevant in patients with decreased contrast sensitivity due to ocular pathology (ie glaucoma).
- photic phenomena (haloes, glare) with or without blurred vision are more frequently reported in patients with multifocal IOLs, than in those with monofocals (29). This appears to be most frequently associated with postoperative dissatisfaction and posterior capsular opacification; residual astigmatism and large pupil were the most encountered etiologies (30).

However, the evolution of the multifocal designs has reduced the incidence of glare and other photic phenomena compared to earlier designs.

Accommodative IOLs

No accommodative IOL will restore the level of accommodation of a presbyopic individual. But such lens is capable to provide vision at various distances by similar mechanisms than natural lens. This artificial lens is mobilized by the action of the ciliary muscles, mimicking natural ability to focus. They can be classified according to design into single-optic, dual-optic and curvature change IOLs (31) (Figure 2 and 3). They provide very good distance and intermediate correction, better contrast sensitivity, but poor near vision and reading performance. Positional accommodative IOLs were developed to avoid the optical side effects of multifocal IOLs. Contraction and relaxation of the ciliary muscle result in a backward and forward movement of the flexible lens (pseudo-phakic pseudoaccommodation) (32). These IOLs have some advantages compared to mul-

tifocal lenses: they act like monofocal lenses, but they provide better visual acuity for intermediate and distance vision; they do not depend on pupil size; provide less dysphotopsic effects and do not decrease contrast sensitivity. They have some disadvantages: variability of the postoperative outcome; the need for further correction for near vision; higher risk for capsular contraction and opacification (33). □

PREMIUM IOLS IN GLAUCOMA PATIENTS

Functional changes

Contrast sensitivity

Both cataract and glaucoma decrease contrast sensitivity, but changes due to cataract can be reversed after surgery, unlike those induced by glaucoma. Careful patient selection is mandatory when using premium IOLs.

Glaucoma causes a decrease in visual acuity late in the disease course; therefore monitoring it is not useful to determine the progress of glaucoma until the terminal stages (34). It has been demonstrated that glaucoma preferentially alters contrast sensitivity as compared to visual acuity (35). Reduction in contrast sensitivity, especially in mesopic levels, occurs early (pre-perimetric), is correlated with visual field loss and provides highly valuable insights into quality of life assessment (36). There is a close correlation between contrast sensitivity and the ability to perform daily activities.

On the other hand, independently of glaucoma, the aging process of the lens causes a decrease in visual acuity and contrast sensitivity. Cataract patients often report sensitivity to glare, which may vary in severity from a decrease in contrast sensitivity in brightly lit environments to disabling glare in the daytime or with oncoming car headlights. The physiopathology of photic phenomena is related to the corneal positive spherical aberrations; in young people, they are balanced by the lens capacity to induce negative spherical aberrations. As the lens ages, it also produces positive spherical aberrations.

As we already mentioned, multifocal IOLs were known to reduce contrast sensitivity. This theory applies best to old spherical multifocal IOLs; nowadays, aspherical IOLs (including premium aspheric IOLs), that induce negative or no spherical aberrations, have the potential to decrease glare, haloes and other unwanted photic phenomena (37). Most studies investi-

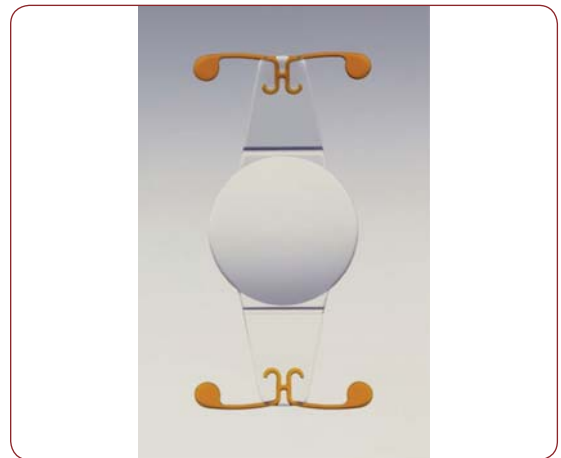


FIGURE 2. Single-optic accommodating Crystallens IOL Advanced Optics (AO), Bausch and Lomb, Rochester, NY, US.



FIGURE 3. Dual optic accommodating Synchrony IOL Abbott Medical Optics, AMO, Santa Ana, Calif., US.

gating the effects of aspheric IOLs documented improvement of mesopic and scotopic contrast sensitivity (38,39), which suggest that such implants may be especially useful in glaucoma patients. There has been much debate about the benefits of using multifocal IOL in patients with glaucoma, accentuated by the lack of clinical studies. Kameth et al studied 133 eyes with concurrent eye disease, and 29 of them had either glaucoma or ocular hypertension (40). The sole difference in the outcome of patients with monofocal versus multifocal implants was the improvement of near-visual acuity in patients with multifocal IOL implants.

Other options are accommodative lenses, which might be better suited for glaucoma patients, because apparently they do not decrease contrast sensitivity.

Visual field

There have been many studies regarding cataract extraction impact on visual field in glau-

coma patients, but none of them was centered on multifocal IOLs. Subsequently, visual field parameters, namely mean deviation (MD) and pattern standard deviation (PSD) changed after cataract extraction. MD was shown to improve after cataract surgery in the majority of studies (41,42). Concerning PSD values, the data are not so coherent; some studies have shown no change in PSD postoperatively (41), while others have demonstrated deterioration of PSD (42).

Structural changes

A valuable tool for examining glaucoma patients is optical coherence tomography (OCT). OCT examinations in eyes with implanted multifocal IOLs, have found wavy artifacts in the image on the line-scanning ophthalmoscope, which is a fundoscopic monitor built into the OCT. These artifacts can be due to the diffractive design of multifocal IOLs (43) (Figure 4 and 5). On the other hand, the diffractive design does not interfere with HRT imaging.

Anatomical considerations

Predicted refraction

Many studies have demonstrated that axial length decreases after trabeculectomy and after phacotrabeculectomy (the decrease ranges between 0,1 and 0,9) (44). Although the refractive outcome depends on axial length variations, it might still be reasonably predicted. For accurate IOL calculation, 3 parameters are needed: axial length, corneal curvature and anterior chamber depth. Changes of the above parameters after glaucoma surgery have been reported (45). If premium IOLs are considered in a patient with previous glaucoma surgery it is advisable to utilize noncontact biometry; some authors also recommending slight myopic target refraction (37).

Nowadays glaucoma surgery is being used more frequently at an earlier stage rather than as a last resort, if inadequate control of IOP is achieved by other forms of therapy. Trabeculectomy may induce many refractive changes including a "with-the-rule" astigmatism. Corneal astigmatism is greater with trabeculectomy than with other glaucoma surgeries (46). We should be cautious in some special situations: high myopic eyes, young patients (due to sclera elasticity) and eyes with high preoperative intraocular pressures (the risk of hyperopic shift) (37).

Apart from decreased contrast sensitivity, ocular refractive changes after glaucoma surgery represent another reason for advising against multifocal lens implantation in patients whose glaucoma is poorly controlled by medication or progressive (33).

Zonular weakness and capsular issues

Some types of glaucoma (especially pseudoexfoliative syndrome, the most frequently identified cause of open-angle glaucoma and also related to cataract) are associated with higher risk of zonular instability. Minding the fact that multifocals and toric IOLs need perfect centration and also a stable capsule, they should be avoided in these patients. Zonular weakness can result in descentration of multifocal IOLs and rotation of toric IOL; it confers also an unpredictability regarding long-term behavior of the capsular bag.

Pseudoexfoliative syndrome impacts also on the postoperative recovery; IOL dislocation, inflammation, capsular opacification and phimosis represent some of the possible complica-

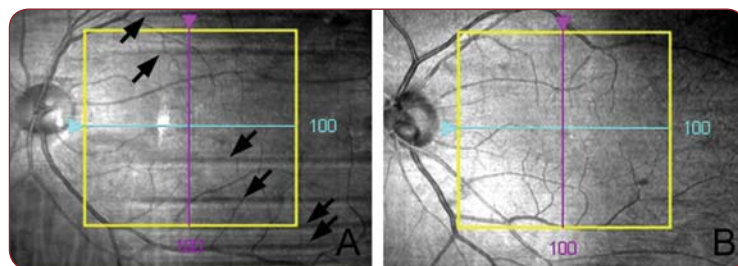


FIGURE 4. A multifocal diffractive IOL (A) versus a monofocal IOL (B).

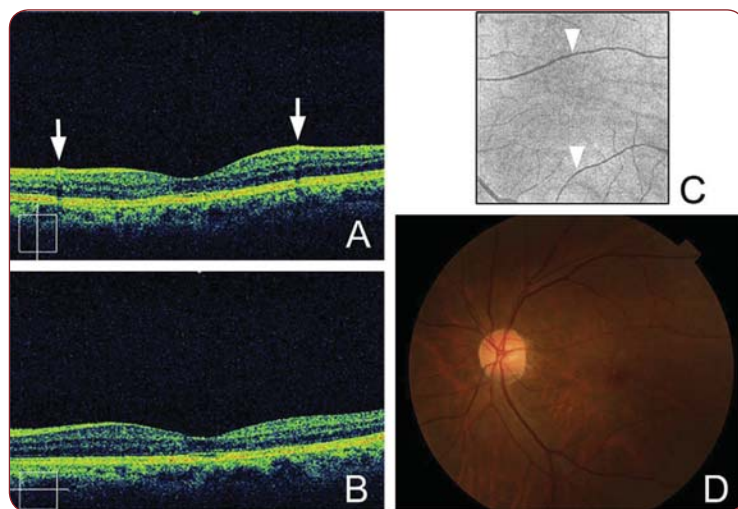


FIGURE 5. Optical coherence tomography (OCT) in a patient with a multifocal diffractive IOL, on longitudinal section (A) and on lateral section (B). Image generated by OCT (C) and fundoscopic image (D) showed no artifacts.

tions (47,48). Accommodative lenses are especially influenced by anterior capsule phimosis.

Pupil

As we mentioned before, there are multifocal IOLs that are either pupil dependent or pupil independent. The poor dilation, experienced in some patients with glaucoma, makes surgical procedure more complicated and can also alter the performance of a multifocal implant. In cases of small pupil, multifocal IOLs that are pupil-dependent should not be implanted, because small pupils can jeopardize distance or near vision (49).

Large pupils caused by prior surgical manipulation can generate greater photic phenomena, even in daylight. Pupil irregularity also results in greater photopic symptoms.

Ocular surface disease

The vast majority of glaucoma patients experiences ocular surface disease (approximate 59%) (50). These conditions can be correlated with topical glaucoma medication, large filtering blebs, meibomian gland dysfunction, conjunctival inflammation and scarring, tear film instability (37). For optimizing postsurgical visual outcomes, ocular surface disease must be treated. Premium IOLs are best technology to date, but they also need optimal conditions for implantation. □

DISCUSSION

Concomitant cataract and glaucoma represents nowadays a relative contraindication for implanting premium IOLs.

Implanting premium IOLs in patients with cataract and concurrent glaucoma requires always careful patient selection. The following groups could be considered as potential candidates for premium IOL implantation:

- glaucoma suspects
- ocular hypertensive patients with no disc or visual field damage
- patients with early or mild glaucoma damage that has been controlled and stable
- no signs of glaucoma progression
- similar level of glaucoma in the fellow eye, but not severe, advanced or progressive (51).

Glaucoma and multifocal IOLs decrease the contrast sensitivity, especially under mesopic conditions, so implanting this type of lens in

patients with glaucoma is a matter of controversy (52). As already known, visual function decreases with advanced disease and the deterioration is irreversible; multifocal IOLs are justified only for mild, maybe moderate glaucoma involvement and in patients without signs of progression. Predicting glaucoma progression is very important in decision regarding the type of IOL to be implanted. The decision is almost always individualized. Accommodative IOLs might be better suited for glaucoma patients, because it seems that they do not decrease the contrast sensitivity.

Astigmatism correcting lenses (toric lenses) can compensate corneal astigmatism and may be useful in patients with glaucoma, but should be avoided in some patients with advanced pseudoexfoliative glaucoma because of the zonular instability (53).

Asphericity is a very important characteristic for any premium IOL that will be implanted in a glaucoma patient; so it is better to choose aspheric rather than spheric premium IOLs for patients with combined pathology.

We mentioned before that premium IOLs were designed for patients with presbiopia +/- cataract. When implanting a premium IOL we take into account the functional, structural and anatomical parameters in that particular moment, considering them baseline. Any further change in this baseline may compromise surgery outcome. So it is not advisable to use premium lens implantation in patients that may require additional glaucoma surgery or in combined procedures, considering the dynamic effect on ocular structures.

Considering that pupilar response in glaucoma patients can be altered, and as we know that pupil size can influence some types of premium IOLs performances, it is advisable to choose a premium IOL model independent of pupil's size (ie. diffractive versus refractive multifocal IOLs). Pseudoexfoliative glaucoma can be considered a contraindication.

Functional and structural evaluation of glaucoma patient should be repeated soon after the eye has recovered following cataract surgery, because, as already mentioned, all the investigations can be compromised by crystalline opacification, and a new baseline can be established. □

CONCLUSIONS

Premium IOLs implantation in patient with cataract and concurrent glaucoma is controversial. The evolving nature of the disease, the defects in visual function that can be induced and the presence of anatomic characteristics that can compromise the surgical outcome make difficult the decision of using premium IOLs in glaucoma patients. The lack of large randomized trials of premium IOLs use in patients with glaucoma makes it difficult to summarize clear indications for their use in these patients. The optimum choice has to be made on an individual basis. The goal is to meet patient's expectations, without adversely influencing glaucoma progression.

On the other hand, despite the fact that premium IOLs have gone through several modifications to improve their quality compared with the previous models (to obtain better un-

corrected distance, intermediate and near visual acuity, to minimize unwanted side-effects, like haloes and glare for multifocal IOLs and inconsistent near vision results for accommodating IOLs), and although the results have improved they are far from perfect. All premium IOLs entail varying degrees of visual compromise. This is the reason why these lenses fit best an eye without structural and functional abnormalities for optimal outcomes (54).

Therefore, the quest for better premium IOLs continues. Multifocal lenses have the limitation of splitting light and decrease contrast sensitivity. They can be improved, but they will not be perfect. Permanent developments are taking place in the accommodating IOLs field, in which new technologies, innovative designs and flexible materials concur for best results.

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