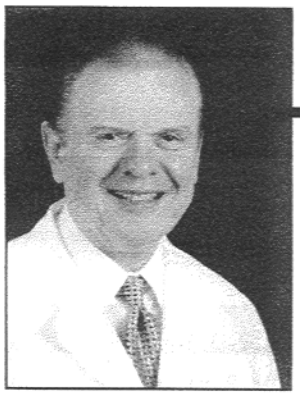

Piggyback Intraocular Lenses

QUESTION

What are your indications for piggyback intraocular lenses? How do you calculate the dioptric power? What style lenses do you use? What problems have you seen?

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ANSWER

Piggyback intraocular lenses (IOLs) can be performed as a primary or secondary surgical procedure. In the case of primary cataract or clear lens removal, 2 IOLs can be implanted in the bag simultaneously as a primary procedure. For a refractive surprise in a pseudophakic patient, a second IOL can be piggybacked in the sulcus in front of the IOL implanted primarily to correct the refractive surprise.

Primary piggyback IOLs are indicated whenever the necessary power of the IOL exceeds the maximum available power from the manufacturer. The calculation for the appropriate combination of dioptric powers must take two factors into account. First, the front IOL in the bag is usually in the normal position for a single IOL, but the back IOL in the bag is displaced posteriorly by the front IOL. Second, the principal planes of the 2 IOLs are somewhere between the principal planes of the individual IOLs and are related to their individual powers. The necessary power usually exceeds the values obtained by standard calculations by 3 to 5 diopters because of the two factors mentioned above.[1] The exact formulas are in the Holladay IOL Consultant Program that performs these calculations automatically; however, they will not be published until later this year.

Although the majority of piggyback lenses have been with PMMA, every combination of PMMA, silicone, and acrylic have been performed. The lenses should be biconvex to minimize the physical contact between the lenses, and the largest power IOL is usually placed in the back of the bag and the remaining power on the front lens in the bag. This combination minimizes the chance of reduced image quality and induced astigmatism if one lens decenters with respect to the other. I have seen two cases in the world (one in Austria and the other in the United States) in which the central part of 2 silicone lenses caused a flat spot at their point of contact, reducing the optical quality of the retinal image to a visual acuity of 23/30.

A refractive complication occurs when both lenses are not placed entirely in the bag. If the front lens is unintentionally placed in the sulcus, a significant

myopic surprise occurs because both lenses will be approximately 0.50 to 1.00 mm more anterior than if they were both in the bag. The myopic error ranges from 1 to 4 diopters depending on the actual power of the implants and their position.

If the front IOL has one loop in the bag and the second in the sulcus, the resulting tilt induces an astigmatism as well as a myopic refractive surprise. The amount of induced astigmatism is dependent on the dioptric power and degree of tilt of the IOL. Typically, the induced astigmatism is in the range of 1 to 3 diopters, but can be much worse.

Secondary piggyback IOLs provide the surgeon with a superb technique for correcting refractive surprises in pseudophakic patients. This is particularly true with the expanded range of lenses into the minus powers by Alcon, Allergan, and Storz. Although the number of refractive surprises from mislabeled IOLs has been reduced by the excellent quality control of most manufacturers, high myopia in patients who have had previous refractive surgery still results in a significant number of refractive surprises in the range from 1 to 5 diopters. The solution is to implant a secondary piggyback IOL in the sulcus to neutralize the refractive surprise.

Secondary piggyback IOL calculations are calculated from the refraction, not the axial length—the axial length is not helpful.[2] The calculation determines the power of the lens necessary at the IOL plane (usually the ciliary sulcus) that is equivalent to the spectacles. The refraction IOL formula requires only the preoperative refraction and vertex, the K readings, a lens constant, and the desired postoperative refraction. It is interesting that, for minus IOLs, the necessary power at the IOL plane is very near the power of the spectacles, so the ratio is approximately 1 to 1. For example, a patient with a -2.00 diopter refractive surprise would need approximately a -2.00 IOL to neutralize the refractive surprise. For plus IOLs, the ratio is nearer 15 to 1; for example, for a +2.00 diopter refractive surprise, the appropriate IOL is approximately +3.00 diopters. Note that these ratios are only approximations; to avoid errors, the exact refractive calculation should be performed for errors greater than 3 diopters.

Because the secondary piggyback is correcting the residual refractive surprise, the cause of the surprise is irrelevant. It does not matter whether the primary IOL was mislabeled, the axial length mismeasured, etc. The only parameter that must be accurate is the current refraction and K readings. I have not seen any complications using this technique, but it is very important that the loop-to-loop diameter of the lens be appropriate for the sulcus—ie, 13.0 mm or greater to avoid poor fixation. This is especially important to note for the foldable IOLs that often have loop-to-loop diameters of 10.5 mm, because they are intended for the bag. It is also important to determine at the slit lamp whether there is enough potential space between the front vertex of the primary lens in the bag and the back of the iris (usually 1 mm) to admit a second IOL. This will prevent the secondary piggyback IOL from causing posterior iris chafing with consequent iritis and pigment dispersion syndrome.

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References

1. Holladay JT, Gills JP, Leidlein J, Cherchio M. Achieving emmetropia in extremely short eyes with 2 piggyback posterior chamber intraocular lenses. *Ophthalmology*. 1996;103:1118–1123.
2. Holladay JT. Refractive power calculations for intraocular lenses in the phakic eye. *Am J Ophthalmol*. 1993;116:63–66.

ANSWER

I implant piggyback lenses for 2 reasons: extreme hyperopia in patients undergoing cataract surgery, and residual refractive error in pseudophakes. If the power required for a high hyperope exceeds the highest lens power available, I implant 2 IOLs in the bag. The power of the lenses is determined by the Holladay IOL Consultant software. We now know that additional measurements are critical to accurately calculate the IOL power in these unusual eyes. Corneal diameter, anterior chamber depth, and lens thickness are all variables that must be entered in Dr. Jack Holladay's formula. By taking these measurements, it is possible to detect anterior segments disproportionate to axial lengths that would have often resulted in power surprises. I divide the power evenly between the 2 lenses. I use 1-piece PMMA lenses. The haptics can be aligned or positioned at right angles to each other.

If a pseudophakic patient is anisometropic or simply unhappy with his or her refractive error, I offer the option of secondary piggyback implantation or lens exchange, depending on which is more appropriate for the individual circumstances. Certainly, there are situations in which exchanging the lens would be an option with minimal risk. If lens exchange is not appropriate, a secondary piggyback lens can be implanted in the ciliary sulcus. The recent availability of low- and minus-power IOLs have allowed me to help a sector of the population that otherwise would have had limited options. The required power is based on the patient's refractive error. The Holladay IOL Consultant software features an option for calculating secondary piggyback IOLs. Alternatively, the following formulas can be used. We developed these formulas based on empirical data evaluation before obtaining the Holladay IOL Consultant software. It is our experience that both methods work well for computing the power required for secondary piggyback IOL implantation.

Overpowered pseudophake (myope)

1. Short eye (<21 mm): P = (1.5 x sph. equ.) - 1
2. Avg. eye (22-26 mm): P = (1.4 x sph equ.) - 1
3. Long eye (>27 mm): P = (1.3 x sph. equ.) - 1

Underpowered pseudophake (hyperope)

1. Short eye (<21 mm): P = (1.5 x sph. equ.) + 1
2. Avg. eye (22-26 mm): P = (1.4 x sph equ.) + 1
3. Long eye (>27 mm): P = (1.3 x sph. equ.) + 1

It is our duty and obligation as cataract surgeons to provide our patients with the best refractive result possible. I believe that piggyback lenses have given us another alternative to do so.

James P. Gills, MD
Tarpon Springs, FL

ANSWER

My indications for piggyback intraocular lenses are:

- High primary hyperopia
- Symptomatic pseudophakic hyperopia
- Symptomatic pseudophakic myopia

In my experience, the highly hyperopic eyes with cataracts have been short eyes, averaging 20 mm in axial length. These eyes have all had more than +8.00D of preoperative hyperopia, even with nuclear sclerosis, and required an average IOL power of +36.00 in the bag.

Pseudophakic eyes with symptomatic residual hyperopia or myopia are candidates for secondary piggyback IOLs. Low plus-power and minus-power IOLs are available in PMMA for simple secondary implantation into the ciliary sulcus under topical anesthesia. This is of particular value in pseudophakic anisometropia with an implant that is well-fixated in a fibrotic capsule. In this type of capsule, attempt at removal of an IOL for exchange risks zonulolysis and possible vitreous loss. Low plus-power and minus-power lenses, currently under investigation by STAAR-AG for phakic sulcus implantation, will be ideal for these cases, as they are implantable through 3.0-mm clear-corneal incisions.

In primary cases, I now prefer to implant 2 plate-haptic foldable silicone IOLs into the capsular bag. The STAAR 4203VE model is used with the large 1.15-mm haptic fenestration. The first lens is implanted in routine fashion and is then rotated so that its long axis is 90° away from the incision. More viscoelastic is added and the second lens is injected into the capsule and positioned 90° away from the first IOL. All viscoelastic is then removed from 3 locations: the capsular bag behind both IOLs, the interlenticular space between the IOLs, and the anterior chamber.

My first case of primary polypseudophakia for high hyperopia was a bag/sulcus combination: a plate-haptic lens in the bag and a 3-piece lens in the ciliary sulcus. The next morning, the eye demonstrated pupillary capture of the anterior lens optic. The eye was dilated and the optic was reposited behind the iris at the slit lamp with a sterile 30 g cannula through the 1-mm side-port incision. No miotic had been used the day before at surgery, which may have prevented the pupillary capture. Obviously, this phenomenon does not occur when plate-haptic IOLs are used and when all lenses are sequestered more posteriorly in the capsular bag.

For primary high hyperopic cases, we use our standard formulae to calculate a single IOL power, factoring in my personal "S factor" derived after 8,000 plate-haptic implantations. We then divide that number between two IOLs. For example, if the calculation calls for a +40.00 IOL in the bag, we would implant two +20.00 IOLs in the bag. If one IOL is to go into the ciliary sulcus, the combined power is reduced by 0.50. In the example above, a +20.00 would be used in the bag and a +19.50 in the ciliary sulcus. Using this method, our first 6 cases with preoperative hyperopia of +8.00 to +9.00, and axial lengths between 19.5 and 20.0 mm, resulted in postoperative spherical equivalents between plano and -0.62, the average being -0.50.

For secondary implantation of the ciliary sulcus for symptomatic pseudophakic hyperopia or myopia, we are presently following the nomograms produced by Jim Gills (Table 1).

TABLE 1

Gills' Nomograms: Secondary Piggyback IOLs

Residual Hyperopia	
Axial Length (mm)	**IOP Power (P)**
≤ 22	P = 1.5 x S.E. + 1
22–25	P = 1.4 x S.E. + 1
≥ 25	P = 1.3 x S.E. + 1
Residual Myopia	
Axial Length (mm)	**IOP Power (P)**
≤ 22	P = 1.5 x S.E. – 1
22–25	P = 1.4 x S.E. – 1
≥ 25	P = 1.3 x S.E. – 1

Harry Grabow, MD
Sarasota, FL

ANSWER

We have no experience with piggyback IOLs.

It has always been our concern that highly myopic and highly hyperopic patients couldn't achieve plano or near plano correction with an implant following cataract surgery because their visual needs fell outside the spectrum of a certain available dioptric range.

In cases in which a manufacturer could produce a suitable lens for an individual patient, the process of obtaining that implant was challenging. The FDA required the sponsoring manufacturer and the surgeon to fulfill a series of paperwork requirements to request a "special power" implant. That process could take 6 months or more for approval. Also, the implants cost 4 to 5 times more than conventional powered lenses.

Today, we can provide this option without the paperwork and without the 6-month delay. As a result of Storz's new range of extended diopters (-18.0 D to +45.0 D) for its 1-piece PMMA equiconvex IOLs, we finally have options available to satisfy the highly myopic and hyperopic patient.

Many ophthalmic surgeons need to use the safest, fastest, and least expensive implant procedure in

today's managed care and Medicare environments. PMMA IOLs satisfy this need.

Until these extended diopters became available, surgeons sometimes had to implant 3 IOLs in piggyback style for some hyperopic patients to equal the necessary power. The need for 3 or 4 implants added to the technical difficulty of the surgery and created a greater potential risk, not to mention the difficulty in predicting final refractive outcome.

With these new extended-range IOLs, if still needed, we can piggyback just 1 or 2 IOLs, reducing surgical risk and achieving better visual results. Also, the need for postcataract implant refractive surgery will be greatly reduced, sparing both the patient and surgeon more time and expense.

The availability of extended-range parameters in a quality 1-piece PMMA lens is a great benefit to our patients. Thanks to these expansions in IOL parameters, we can now offer them optimal visual rehabilitation following cataract surgery.

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