Piggyback IOL implantation, also termed polypseudophakia, was introduced by Gayton and Sanders in 1993.\(^1\) The first report describing the back-to-back placement of two IOLs in a highly hyperopic eye was published by Gills and Fenzl that same year.\(^2\)

Placing an additional IOL in a piggyback manner is an effective way to correct residual refractive error, particularly when high degrees of refractive surprise are encountered. A review of the literature reveals increasing use of piggyback IOL implantation for the correction of residual refractive errors, along with case reports of complications such as interlenticular opacity and methods to prevent these complications from occurring.\(^1\)\(^-\)\(^8\) Pseudophakic supplementary IOLs, including Sulcoflex monofocal, toric, and multifocal lenses (Rayner), are now available.

There are two indications for piggyback IOL implantation. Primary polypseudophakia is used in eyes with high hyperopia and short axial lengths that require high IOL powers (e.g., nanophthalmos and microphthalmos). Secondary polypseudophakia is used to manage postoperative refractive surprise. This article and accompanying video (www.youtube.com/watch?v=dOBNqOTou7s) overview the fundamentals of piggyback IOL implantation, including the indications, techniques, and complications associated with these procedures.

**FUNDAMENTAL 1**

**PREOPERATIVE WORKUP AND PREPARATION**
Meticulous preoperative workup and preparation are essential before planning primary or secondary piggyback IOL implantation. The preoperative workup should include thorough anterior and posterior segment examination with an emphasis on IOP, corneal endothelial cell count, and anterior chamber depth. For secondary piggyback IOL implantation, the first IOL should be well centered in the capsular bag. A preoperative Nd:YAG laser peripheral iridectomy or surgical peripheral iridectomy is not needed in most cases; however, it can be performed in patients with shallow anterior chambers or those predisposed to glaucoma.

**FUNDAMENTAL 2**

**PIGGYBACK IOL POWER CALCULATIONS**

*Primary piggyback IOL implantation.* Warren E. Hill, MD, has described six steps for IOL power calculation for primary piggyback IOL implantation,\(^9\) as detailed below:

- Step No. 1: Measure the axial length accurately;
- Step No. 2: Calculate the total IOL power needed at the plane of the capsular bag;
- Step No. 3: Calculate the residual IOL power;
- Step No. 4: Determine the power adjustment for the anterior (ciliary sulcus) lens;
- Step No. 5: Calculate the power of the anterior IOL; and
- Step No. 6: Select the appropriate lens pair for polypseudophakia.

**AT A GLANCE**

- Primary piggyback IOL implantation provides adequate IOL power in patients with small eyes and/or extreme hyperopia.
- Secondary piggyback IOL implantation is helpful in pseudophakic patients for the correction of residual refractive error.
- Pseudophakic supplementary IOLs are now available for secondary piggyback IOL implantation.
PIGGYBACK IOL IMPLANTATION: CASE REPORTS

Case No. 1: Refractive Lens Exchange and Primary Piggyback IOL Implantation for High Hyperopia

A 50-year-old man presented with a complaint of poor vision without glasses. His refraction was +8.00 +1.75 X 20º with reading add of 2.50 D OD. The patient desired freedom from near and distance glasses. Preoperative keratometry revealed 1.25 D of corneal astigmatism. The IOL power calculation OD was 34.50 D. At the time of surgery, multifocal and toric IOLs were available only in powers up to 30.00 D. We planned for primary piggyback IOL implantation of a 15.00 D multifocal IOL (Acridiff; Care Group India) and a 19.50 D toric IOL (Acriotoric; Care Group India).

The reference marking was done while the patient was seated at the slit lamp, and axis marking was performed in the OR (Figure 1). A sideport incision was made, followed by the injection of OVD (Viscoat; Alcon) into the anterior chamber to coat the corneal endothelium. The main incision was created at the steep axis (20º), followed by the creation of a well-centered 5-mm anterior capsulorrhexis, which is crucial for perfect centration of toric and multifocal IOLs. Cortical cleaving hydrodissection was completed, and phacoaspiration was performed using low ultrasound power and fluidics parameters. This was followed by bimanual irrigation and aspiration (I/A) of cortical matter.

Toric IOL implantation. After filling the capsular bag with OVD (hydroxypropyl methylcellulose 2%), we implanted the toric IOL in the capsular bag using an injector. The IOL haptics were dialed into the capsular bag, and OVD was removed from behind the IOL using bimanual I/A. Final alignment of the toric IOL along the astigmatic axis (20º) was performed.

Secondary piggyback IOL implantation. For secondary piggyback IOL implantation, IOL power calculations are based on residual refractive error. For myopia, the spherical equivalent is multiplied by 1.15. For hyperopia, the spherical equivalent is multiplied by 1.25.

For more advanced IOL power calculations, we prefer the Holladay Consultant & Surgical Outcomes Assessment software (www.hicsoap.com). This program takes into account residual refractive error, keratometry readings, and anterior chamber depth.

Surgical Techniques

For piggyback IOL implantation, we prefer to implant a three-piece IOL in the ciliary sulcus. Surgeons should never implant square-edged hydrophobic acrylic IOLs in the ciliary sulcus because of the risk of iris chafing and glaucoma. In patients with high hyperopia and short anterior chamber depth, care should be taken to minimize endothelial cell loss by using a chondroitin sulfate–based dispersive OVD, such as DuoVisc or Viscoat (both by Alcon). It is also important to remove all OVD from the anterior chamber after surgery to minimize the risk of postoperative IOP spikes. For additional pearls for managing specific surgical scenarios, see Piggyback IOL Implantation: Case Reports.

CONTRAINDICATIONS
Piggyback IOL implantation should not be attempted in patients with poor endothelial cell count, uveitis, or glaucoma, as this procedure can cause worsening of these preexisting ocular problems.

COMPLICATIONS
Interlenticular opacification, also known as inter-pseudophakosopacification or red rock syndrome, is one complication reported with piggyback IOL implantation. It was first reported in 2000 by Gayton et al, who observed the complication in two patients who each underwent implantation of a hydrophobic IOL (AcrySof; Alcon) in the capsular bag through a small capsulorrhexis.

The study authors identified three surgical steps that may help prevent interlenticular opacification: (1) meticulous cortical cleanup, especially in the equatorial region; (2) creation of a relatively large continuous curvilinear capsulorrhexis to sequester retained cells peripheral to the IOL optic within the equatorial fornix; and (3) insertion of the posterior IOL in the capsular bag and the anterior IOL in the ciliary sulcus to isolate retained cells from the interlenticular space.
CONCLUSION
Primary piggyback IOL implantation provides adequate IOL power in patients with small eyes and/or extreme hyperopia. Secondary piggyback IOL implantation is helpful in pseudophakic patients for the correction of residual refractive error. Pseudophakic supplementary IOLs such as the Sulcoflex are now available for secondary piggyback IOL implantation. Combination of monofocal, toric, and/or multifocal IOL implantation in a piggyback manner is a viable and useful option for eyes that require very high IOL powers.

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Case No. 2: Primary Piggyback IOL Implantation for Developmental Cataract
A 12-year-old presented with a developmental cataract OD. We decided to perform piggyback IOL implantation with a monofocal IOL and a multifocal IOL to obtain an excellent visual outcome. A sideport incision was made, followed by injection of a dispersive OVD into the anterior chamber. The main incision was made on the steep axis. We then created a circular anterior capsulorhexis approximately 5 mm in size.

Cortical cleaving hydrodissection was performed, and phacoaspiration of the soft lens matter was achieved using bimanual I/A. Cortical matter was removed from the capsular bag, and a 29.00 D multifocal IOL (Acridiff; Care Group India) was implanted in the capsular bag. This was followed by implantation of a 3.50 D monofocal IOL (Flexifold; Care Group India) in the ciliary sulcus. OVD was removed from between the IOLs and from the capsular bag. The postoperative visual outcome was excellent, as the patient regained UCVA of 20/20 distance and N6 near.

Case No. 3: Secondary Piggyback IOL Implantation of Supplemental IOL
A 14-year-old with a developmental cataract underwent cataract surgery with toric IOL implantation OD. Postoperatively, the patient's UCVA improved to 6/6. The patient and his parents were keen for him to achieve good near vision without glasses. We planned a secondary implantation of the Sulcoflex multifocal IOL (Rayner) to achieve this refractive outcome.

A sideport incision was made, followed by injection of OVD into the anterior chamber. We then created the main incision on the steep axis. We loaded the Sulcoflex multifocal IOL (distance power 0, near add 3.50 D) into the cartridge and implanted the IOL in the ciliary sulcus. The Sulcoflex IOL is designed to be implanted in a piggyback manner in the ciliary sulcus; it has a rounded optic edge and undulating haptics that minimize the risk of iris chafing.

The secondary piggyback IOL haptics can be aligned in the same direction as the primary IOL haptics, or they can be aligned at 90° to the primary IOL haptics. In this case, care was taken not to disturb the alignment of the toric IOL. The OVD was removed from between the IOL optics and from the anterior chamber. The combination of placing one IOL in the capsular bag and the other in the ciliary sulcus minimizes the risk of interlenticular opacification. The patient achieved excellent UCVA of 20/20 and N5 near.