Cataract Surgery in Children: Trends and Controversies

Senior Instructor: M. Edward Wilson, MD

Instructors: Erick D Bothun MD
Edward G Buckley MD
Scott R Lambert MD
David A Plager MD
In this course, surgical videos will be utilized to illustrate both routine approaches and controversial ones. An expert panel will provide a diversity of opinion on how these pediatric cataract cases should be approached. Each panelist will be asked what he/she is doing differently this year compared to last year. Open discussion with the audience will be encouraged as well. Our expert panel will likely disagree with some steps but in general will support the notion that pediatric cataract surgery differs significantly from adult phacoemulsification.

The aim of pediatric cataract surgery is to provide and maintain a clear visual axis and a focused retinal image. The long-term visual outcome is often negatively affected by the development of amblyopia secondary to the cataract itself, or due to postoperative re-opacification of the ocular media. Cataract surgery in children remains complex and challenging. One of the major challenges for pediatric cataract-intraocular lens (IOL) surgery has been the adaptation of techniques used for adult cataract-IOL surgery. However, pediatric cataract-IOL surgery is quite different from surgery for cataracts in the elderly. A propensity for increased postoperative inflammation and capsular opacification, a refractive state that is constantly changing due to growth of the eye, difficulty in documenting anatomic and refractive changes due to poor compliance, and a tendency to develop amblyopia are among the factors that make the cataract surgery in the child different from that in the adult. In addition, the lack of a hard nucleus, vastly reduced scleral and corneal rigidity, and enhanced posterior vitreous pressure demand a surgical approach that differs in many ways from the adult procedure.

This handout by Wilson and Trivedi highlights a step-by-step approach for managing pediatric cataracts. It also serves as an overview of pediatric cataract surgery.

**Preoperative and intraoperative medications**

1. **Topical antibiotic:** On check-in (approximately 1 hour before surgery), we advise using the antibiotic drop (4th generation fluoroquinolone) every 5 minutes (3 times).
2. **The dilating drops** (peds combo, 2 mL 2% cyclopentolate, 0.5 mL 10% phenylephrine, 0.5 mL 1% tropicamide) are also given every 5 minutes (3 times).
3. **0.5 mL epinephrine 1:1000 solution** (Hopsira, Inc., Lake Forest, IL) should be added to the 500 mL bottle of irrigating solution.

**The Incision**

Children have thin sclera and, as mentioned above, markedly decreased scleral rigidity when compared with adults. Scleral collapse results in increased positive vitreous pressure. Collapse of the anterior chamber is much more common when operating on pediatric eyes. Pediatric cataracts can be removed through a relatively small wound, as the lens has no hard nucleus. Therefore, wounds should be constructed to provide a snug fit for the instruments that pass into the anterior chamber. When an IOL is not being implanted, two stab incisions are usually made at or near the limbus. These incisions should not be larger than necessary for the instruments being used. For instance, a micro vitreoretinal (MVR) blade can be used that creates a 20-gauge opening for a 20-gauge vitrector to aspirate into the anterior chamber. A 20 gauge blunt tipped irrigating cannula can also be used through a separate MVR blade stab incision. If the instrument positions need to be reversed, the snug fit is maintained. If 23 gauge or 25 gauge instruments are used, an MVR for that gauge opening can be utilized. While some surgeons prefer phaco-aspiration (aspiration utilizing a standard phacoemulsification handpiece), bimanual technique using an irrigating handpiece or an anterior chamber maintainer and a separate aspiration handpiece is more commonly used by pediatric cataract surgeons. Anterior chamber stability is maintained by limiting wound leak and using a high irrigation setting.

When a foldable IOL is being implanted a corneal or scleral tunnel is used. A corneal tunnel is preferred since it leaves the conjunctiva undisturbed. The corneal tunnel should begin near the limbus for maximum healing and should be sutured with a synthetic absorbable suture. Corneal tunnel incisions for children range from 2.2 mm to 2.75 mm depending on the implant being used.

Unlike adults, tunnel incisions do not usually self-seal in children. According to one study, self-sealing wounds failed to remain watertight in children below 11 years of age, especially when an anterior vitrectomy was combined with cataract extraction. In older (> 11 years) children the wounds may remain self-sealing. Even in these older children, suturing is recommended since postoperative eye rubbing is common. The authors attribute the poor self-sealing to low corneal rigidity resulting in fish mouthing of the wound leading to poor approximation of the internal corneal valve to the overlying stroma. The recommended closure material is a 10-0 synthetic absorbable suture.

In the rare occasions when a rigid IOL is being implanted, a larger scleral tunnel wound is utilized. A half thickness scleral incision is made initially approximately 2 or 2.5-mm from the limbus and dissected into clear cornea. It is enlarged to the size necessary for IOL insertion. Closure is recommended using a 9-0 synthetic absorbable suture.

While the temporal wound presents the same advantages in children as it does in adults, the location is more easily traumatized by children. The superior approach allows the wound to be protected by the brow and the Bell’s phenomenon in the trauma-prone childhood years. Both scleral tunnels and corneal tunnels can be easily made from a superior approach since children rarely have deep set orbits or overhanging brows. Positioning the patients on the operating table with a slight chin-up posture also helps made the superior approach easier. Located the site of the tunnel according to the pre-existing astigmatism (e.g. temporally in against-the-rule astigmatism) has not been done as often in younger children since most of these patients will wear glasses after surgery anyway. Whether the preoperative astigmatism can be altered by the site of the tunnel incision has not been studied well in children. While wound
related astigmatism is common immediately after surgery in children, due to low corneal and scleral rigidity, these eyes tend to return to their preoperative state by 1-month after surgery. Commonly, 2 paracentesis wounds are made (10 o’clock and 2 o’clock position). One of these is enlarged for the IOL entry, usually the one on the surgeon’s dominant side.

Anterior Capsulotomy

The anterior capsule is highly elastic in the pediatric patient and poses challenges in the creation of the capsulotomy. When performing a manual CCC in a child, the following technical recommendations are offered:

1. Use of an ophthalmic-viscosurgical-device (OVD) which has high viscosity to fill the anterior chamber and flatten the anterior capsule. A slack anterior capsule will be easier to tear in a controlled fashion.

2. Re-grasp the capsulorhexis edge frequently and begin with a smaller capsulotomy than desired. Because of the elasticity, the opening will be larger than it appears once the forceps release the capsule flap.

3. Force when tearing must often be directed more toward the center of the pupil in order to control the turning of the CCC edge along a circular path.

4. If the capsule begins to extend peripherally, stop before the edge is out of sight under the iris. Converting to a vitrector cut capsulotomy or a radio frequency diathermy capsulotomy is recommended when this occurs. Using a small incision capsulorhexis forceps will allow conversion to vitrector instruments when needed without leakage around the vitrector handpiece during use.

While a CCC is a reasonable option at any age, it will be very difficult for even the experienced surgeon when attempted on an infant eye. Alternative anterior capsulotomy methods as discussed may offer more consistent success than manual CCC in infancy.

A mechanized circular anterior capsulorhexis has been tested in both laboratory and clinical settings by the authors. This technique, now known as vitrectorhexis, has proved to be a very effective alternative for CCC for young children where the CCC may be difficult to control.

When creating a vitrectorhexis, the following surgical caveats are offered. Use a vitrector supported by a Venturi pump. Peristaltic pump systems will not cut anterior capsule easily. A separate infusion port is recommended. Maintain a snug fit of the instruments in the incisions through which they are placed. The anterior chamber of these soft eyes will collapse readily if leakage occurs around the instruments, making the vitrectorhexis more difficult to complete. A microvitreoretinal (MVR) blade can be used to enter the eye. The vitrector and the blunt-tip irrigating cannula (Greishaber irrigation handpiece or disposal Alcon/Greishaber bimanual irrigation/aspiration sets) fit snugly into the MVR openings. An anterior chamber maintainer can also be used if the surgeon prefers. Do not begin the capsulotomy with a bent-needle cystotome. When the capsule begins to extend peripherally, stop before the edge is out of sight under the iris. Converting to a vitrector cut capsulotomy or a radio frequency diathermy capsulotomy is recommended when this occurs. Using a small incision capsulorhexis forceps will allow conversion to vitrector instruments when needed without leakage around the vitrector handpiece during use.

While a CCC is a reasonable option at any age, it will be very difficult for even the experienced surgeon when attempted on an infant eye. Alternative anterior capsulotomy methods as discussed may offer more consistent success than manual CCC in infancy.

A mechanized circular anterior capsulorhexis has been tested in both laboratory and clinical settings by the authors. This technique, now known as vitrectorhexis, has proved to be a very effective alternative for CCC for young children where the CCC may be difficult to control.

Cataract Surgery in Children: Trends and Controversies
necessary in children when the posterior capsule is left intact. Larger amounts of laser energy are often needed as compared to adults, and the posterior capsule opening may close, requiring repeated laser treatments or a secondary pars plana membraneotomy. Primary posterior capsulotomy and anterior vitrectomy is common practice while managing younger children with cataract. Posterior capsulotomy can be performed manually or with a vitrector. An important question that remains is, when should the posterior capsule be left intact? We answer this question looking at several factors (age, association of posterior capsule plaque or defect, availability of YAG laser, expected cooperation of child approximately 12-24 months after cataract surgery for YAG). As a rough guideline, in children below 5 years of age, we prefer to do primary posterior capsulotomy and vitrectomy. In children, 5-8 years of age, we will do a posterior capsulotomy with or without vitrectomy, as needed. In children above 8 years of age, we keep an intact posterior capsule more often. Anterior segment surgeons are often more accustomed to, and more comfortable with, a limbal (or anterior) approach. Our current strategy is to perform these procedures via the pars plana/plicata preferentially, whenever we intend to use a primary vitrectomy in children.

**Primary IOL Implantation**

General consensus exists that IOL implantation is appropriate for most older children undergoing cataract surgery. In contrast, the advisability of IOL implantation during the first year of life is still being questioned. Results of the Infant Aphakia Treatment Study suggest that until long-term follow-up data are available, caution should be exercised when performing IOL implantation in children aged 6 months or younger given the higher incidence of adverse events and the absence of an improved short-term visual outcome compared with contact lens use.

When placing an IOL in a child's eye, in-the-bag implantation is strongly recommended. However, placement of haptics in the ciliary sulcus and IOL optic capture through the PCCC is a safe alternative to IOL implantation in the capsule bag. Care should be taken to avoid asymmetrical fixation with one haptic in the capsular bag and the other in the ciliary sulcus. This can lead to decentration of the IOL. Foldable hydrophobic acrylic IOLs are used increasingly in children. The AcrySof® hydrophobic acrylic IOL (Alcon Laboratories, Ft. Worth, Texas) has been shown to be very biocompatible for the child's eye, as per the authors' experience. The one-piece AcrySof® is especially suited for small soft eyes and can be inserted into the capsular bag with ease. Implantation of the AcrySof® single-piece hydrophobic acrylic IOL is safe in the pediatric eye. We use the AcrySof® SN-60 IQ which has a blue-blocker chromophore and is designed using Wavefront technology. It is important to customize the "A"-constant after analysis of your own results. The "A"-constant on the IOL package is calculated using contact "A"-scan ultrasound globe axial length measurements. We recommend using immersion "A"-scan in children because of higher accuracy. The "A"-constant will usually be higher (by 0.2 to 0.3) when immersion measurements are used. We utilize a 119.2 "A"-constant for the SN-60IQ IOL. When capsular fixation is not possible, sulcus placement of an IOL in a child is acceptable. To avoid decentration, a rigid PMMA IOLs should be considered or when a foldable lens (such as the 3-piece AcrySof® IOL) is used, optic capture through the anterior or combined anterior/posterior capsulorhexis should be attempted. The PMMA IOL we prefer is the MC-60-BM (Alcon Laboratories, Ft. Worth, Texas). We have also found that single-piece hydrophilic C-fex IOL (Rayner Intraocular Lenses Ltd. East Sussex, BN3 7AN, UK) can be used for either sulcus or bag fixation.

**Multi-focal and Accommodating IOL Implantation**

The Crystalens (Eyeonics Inc.), AcrySof® ReSTOR® (Alcon Inc.), Tecnis (Abbott Medical Optics, Inc.) and Re-Zoom™ IOL (Abbott Medical Optics Inc.) are being implanted in larger numbers in adults. The Crystalens accommodating IOL is engineered with a hinge designed to allow the optic to move back and forth in response to change of focus. It is unknown whether the fibrosis that often occurs throughout the pediatric lens capsule after surgery would influence the IOL movement. This IOL is not recommended when a primary posterior capsulotomy and anterior vitrectomy has been performed. Each of the multifocal IOLs represents a compromise based upon the simultaneous vision principle. Two or more images are formed on the retina at the same time, one image at near and the other at distance focus. The brain selects the image it wants to see. Some loss of contrast is inherent to simultaneous vision since the available light is split between the near focus and the distance focus. Uncorrected refractive error (cylinder of more than 1 diopter or the changes in sphere that occur with eye growth) may result in more significant blur because of the simultaneous vision concept. Alternating vision, which is provided by a monofocal IOL and bifocal glasses, results in only one object being in focus at a time and all incoming light is directed to this focus. While the increased use of multifocal and accommodative IOLs for implantation during the teen-age years is predictable, we would caution surgeons that these lenses may not be advantageous in growing or amblyopic eyes. With residual refractive error, especially the myopia that develops after eye growth, multifocality may (ironically) result in more spectacle dependence compared to a monofocal IOL with residual myopia. This deserves further study.

**Secondary IOL Implantation**

The vast majority of children undergoing secondary IOL implantation have had a primary posterior capsulotomy and anterior vitrectomy. If adequate peripheral capsular support is present, the IOL is placed into the ciliary sulcus or in the re-opened capsular bag. Viscodissection and meticulous clearing of all posterior synechiae between the iris and the residual capsule is mandatory. An all-PMMMA heparin-surface-modified IOL is ideal for sulcus placement. However, these IOLs are now very difficult to get. The most common IOL used in secondary implantation is the 3-piece AcrySof® IOL. It has a posterior angulation that helps make it suitable for the sulcus. However, the haptics are soft and decentrations are common, especially in eyes with large anterior segments and axial length measurements greater than 23 mm. Prolapsing the IOL optic through the fused anterior and posterior capsule remnants is very useful in preventing decentration and also eliminating the possibility of inadvertent pupillary capture. Recently, we have found that the Rayner C-fex IOL also performs well as a secondary implantation in the bag or in the sulcus. When inadequate capsular support is present for sulcus fixation in a child, implantation of an IOL is not recommended unless every contact lens and spectacle option has been explored fully. Anterior chamber IOLs and scleral or iris-fixated posterior chamber IOLs are used in children when other viable options are absent but the long-term
consequences of these placements are unknown. Anterior chamber IOLs should be of an open-loop flexible design and sized appropriately for the anterior chamber. Scleral-sutured IOLs are usually fixated with 9-0 prolene suture in the hope of avoiding the biodegradation documented with 10-0 prolene. However, concerns of late decentration remain, even with 9/0 prolene suture. A new 10-0 polyester suture has now been tried. Some surgeons are also using 8-0 Gortex. Iris-fixation is also an alternative in children when inadequate capsule is present for sulcus or bag fixation. A three-piece acrylic lens can be placed through a pharmacologically constricted pupil so as to purposefully pupil-capture the optic. The haptics are secured to the undersurface of the iris with one full-thickness iris suture each. The sutures are placed in the immobile peripheral iris. This technique has the advantage of a small incision since a foldable IOL is utilized. Iris fixation as in the “lobster-claw” style lenses (Verisysse™) are utilized in some children as a phakic IOL for high myopia. A compassionate use IDE has been approved by the FDA for the phakic Artisan version of the “lobster claw” IOL design. It will now be used as a viable alternative to suturing an IOL. Another sutureless alternative is the technique reported by Dr. Agarwal, where the haptics of a three-piece IOL are externalized and placed into an intrascleral tunnel created with a 26g needle under a scleral flap. The flap is then sealed with fibrin glue.

IOL Power Selection

Selecting the best IOL power to implant in a growing child presents unique challenges. While Gordon and Donzis have documented the axial growth pattern of normal eyes in children, the axial growth of cataractous eyes is different. In the normal phakic child, there is little change in refraction (0.9 diopters from birth through adulthood on average) because the power of the natural lens decreases dramatically as the eye grows axially. However, an IOL placed in a child’s eye cannot change in power to match the growth of the eye. An IOL chosen for emmetropia in early childhood is likely to leave the patient highly myopic in adulthood. For children beyond age 2, studies are available to help the surgeon predict average growth of the eye. When operating on children between the ages of 2 and 8 years, many surgeons have advised selecting an IOL power that will leave mild to moderate hyperopia, leaving less hyperopia with increasing age. Other authors have advocated aiming for emmetropia regardless of age when operating beyond age 2. This approach avoids potentially amblyogenic residual hyperopia but is likely to lead to the development of significant myopia later.

Postoperative Management

After the surgical wounds have been closed, we place intracameral antibiotics in the eye. Generally we are using 0.1 cc of a 50% solution of Moxifloxacin (Vigamox, Alcon laboratories inc., Fort Worth, TX, USA). Alternatively, 0.05 cc of undiluted Vigamox can be used. There is no preservative in Vigamox and its safety in the anterior chamber has been studied. We also inject 2 mg (0.05 cc) of Triamcinolone (Triesence, Alcon laboratories Inc. Fort Worth, TX, USA) intracamerally at the end of surgery in most children. The Triamcinolone crystals are visible in the anterior chamber for 5-7 days and help control the aggressive early inflammation that can be present in children. Immediately at the end of surgery, a drop of dilute (5%) Povidone iodine is placed on the operative eye. An antibiotic steroid ointment and atropine ointment are placed on the eye. A patch and Fox shield are placed over the eye. We prefer to secure the shield with 2 Tegaderm sheets instead of standard tape. The patch and shield should remain on the eye until the morning after surgery. We remove it in the office, examine the eye and show the parents how to apply the postoperative drops. There are some variances from the protocol in certain situations. With older children, the atropine may be deleted. Babies who are left aphakic do not receive the ointment. We use topical drops for these eyes, and rather than patching the eye, we apply a Silsoft contact lens (usually a 7.5 base-curve and +/-2 D power) at the end of surgery. The parents can then begin the drops right away. For older children (above age 6-7 years), the parents are allowed to remove the patch and shield 4-5 hours after the surgery and begin the postoperative drops. The eye is still examined on the first postoperative day. Topical atropine (0.5% in children less than 1 year of age, and 1% thereafter) is utilized once per day for 2 - 4 weeks in children up to age 4 years. Prednisolone acetate (1%) is used topically 4 times per day for 4 weeks. An antibiotic drop (the same fluoroquinolone used pre-operatively) is used 4 times per day for one week after surgery. Any residual refractive error is corrected after the wound stabilizes and the synthetic absorbable sutures dissolve. We rarely use oral steroids except in some uveitis patients or some trauma cases. We schedule postoperative examinations at 1 week, 4 weeks, 3 months, and 6 months postoperatively. We also consider yearly examinations under anesthesia (EUA) in order to measure intraocular pressure, examine the peripheral retina, monitor eye growth using A-scan ultrasound and examine the position of the IOL and detect any secondary membrane or after-cataract formation. Once children become old enough and cooperative enough to undergo these examinations awake, the yearly EUA becomes unnecessary. With the addition of the icare rebound tonometer, we are more successful at checking IOP at every visit in most children.

Management of Pediatric Traumatic Cataracts

Trauma is a common cause of unilateral cataract in children. At the time of presentation after the trauma to the eye, primary repair of a corneal or scleral wound may be needed along with a complete evaluation of damage to the intraocular structures (e.g., posterior capsule rupture, vitreous hemorrhage, and retinal detachment). The authors prefer to defer cataract surgery and IOL implantation in traumatic cataract patients, even when anterior lens capsule has been ruptured. A delay of 1-4 weeks may be helpful to allow corneal healing and to reduce the inflammatory response. Longer delays are avoided in children within the amblyopic ages. Implantation of an IOL is preferred in traumatic cataract associated with corneal injuries, because contact lenses may be difficult to fit. Placement of the IOL in the capsular bag is preferred when capsular support is available. Ciliary sulcus fixation of the IOL can also be done in the absence of adequate capsular support for in-the-bag placement, but a greater incidence of uveitis and pupillary capture has been reported.
Summary

Surgical management of cataracts in children is markedly different from adults. The eyes are not only smaller because of age but many are also microophthalmic. Decreased scleral and corneal rigidity and increased vitreous up-thrust make surgical manipulations within these eyes more difficult. The anterior chamber is often unstable; the capsule management requires special considerations and the propensity for postoperative inflammation is increased. Ocular growth makes selection of an intraocular lens power difficult. Normal childhood behavior can make compliance with postoperative instructions difficult, and examinations of the eye after surgery are also often challenging. The long expected life span after surgery for children also deserves consideration when surgical decisions are made. These special patients are uniquely challenging. The best surgical techniques for children will evolve most efficiently with optimal cooperation and collaboration between pediatric ophthalmologists and adult cataract surgeons. Our recommendation for step-by-step approach to pediatric cataract-IOL surgery, summarized in this handout may be helpful for surgeons to learn and fine-tune the pediatric cataract-IOL surgical procedure. Detailed descriptions of the surgical technique, complications and management are found in our book on pediatric cataract surgery and book chapters.

References