Complications of Lens Surgery at Pediatric Age

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Abstract

Despite the notorious advances in pediatric lens surgery and significant improvement of surgical results, children are at higher risk of developing lens complications during and after surgery compared to adults given their structural differences and exacerbated inflammatory response. The present chapter brings awareness to surgeons of the intraoperative and postoperative complications secondary to pediatric lens surgery to help reduce complication rates and promote early detection and better management of these adverse events.

Keywords

Lens complications · Pediatric lens surgery · Posterior capsule rupture · Dislocated lens · Secondary opacification of visual axis

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Introduction

Lens surgery performed in the pediatric population is not the same as in adults given the small sizes of the ocular structures, more elastic anterior capsule, increased vitreous pressure, thinner sclera, smaller pupils, and restricted working space [1]. These additional challenges related to lens surgery in children impose a higher risk of intraoperative complications, which can be devastating and have meaningful impact on visual prognosis and quality of life of children [2]. In addition, pediatric lens surgery is fraught with more robust inflammatory response, high tendency for lens cortex reproliferation and visual axis opacification, and greater chance of wound leakage if not sutured properly [3].

Epidemiology

Despite the reduction of serious complications following childhood cataract surgery since 1960 with the introduction of the aspiration technique, its occurrence was not completely eliminated, which directly affects visual prognosis of operated eyes [4]. Current studies show that the incidence of complications and adverse events following lens surgery varies according to the studied population age and the chosen surgical technique [5–7]. These complications are classified as intraoperative or postoperative according to the moment that they occur [5–7].

The Infant Aphakia Treatment Study (IATS), a multi-center clinical trial, as well as the British Isles Congenital Cataract Interest Group (BICCIG), a prospective cohort study, reported higher intraoperative complication rate in eyes that underwent primary intraocular lens (IOL) implantation (21% of eyes and 16%, respectively) compared to those eyes that were left aphakic (11% and 6%, respectively) [5, 6]. In these two studies children were under 1 year and 2 years of age, respectively. In contrast, the Pediatric Eye Disease Investigator Group (PEDIG) performed a 5-year longitudinal study that included children who underwent lensectomy from birth to less than 13 years of age from 61 centers in Canada, Unites States, and the United Kingdom and they reported a similar incidence of complications in eyes with and without IOL implantation [5–7]. In their study, intraoperative complications were present in 5% of the total eyes and postoperative complications in 16% [7].

- The intraoperative complications of lens surgery include iris prolapse, iris damage, hyphema, posterior capsule rupture (PCR), retained cortex, and lens fragment in vitreous [5].
- Postoperative complications include acute intraocular pressure elevation, corneal edema, uveitis, visual axis opacities, pupillary deformities, retinal hemorrhages, retinal detachment, endophthalmitis, and phthisis bulbi [7].

Intraoperative Complications

Iris Prolapse and Damage

Iris damage is a complication that can be identified in up to 2.6% of eyes and are most commonly related to IOL positioning [6]. Iris prolapse, on the other hand, is the most common intraoperative complication reported in the IATS study and BICCIG study in 5% and 11% of eyes, respectively [5, 6]. Iris prolapse occurs when the forces pulling on the iris toward the wound exceed the ability of the iris' tone to maintain its position in the anterior chamber and iris damage [6, 8]. Factors that contribute to iris prolapse include posterior incision position, enlarged incision, large leak from wound, shallow anterior chamber, high irrigating velocity, and atonic iris [6, 8]. In eyes that undergo IOL implantation, iris prolapse usually occurs after enlargement of the superior wound before IOL placement [6]. To avoid iridodialysis, hyphema, and later sectorial iris atrophy, the iris prolapse must be resolved by repositioning the iris gently [9]. In some cases, an additional incision can be the best management approach to prevent additional complications [10].

Bleeding

Bleeding in cataract surgery ranges from simple subconjunctival hemorrhage, to significant intraocular hemorrhages [1, 11–14]. Anterior chamber hemorrhage during surgery is usually related to iris injury including cyclodialysis and iris prolapse [5, 6]. Hyphema has been reported in 3.1% of eyes and commonly resolves spontaneously with no further complications [11, 12]. However, in cases of recurrent hyphema following lens surgery in children, physicians may need to rule out Swan Syndrome and Uveitis-Glaucoma-Hyphema (UGH) Syndrome [15, 16].

Swan Syndrome is a rare disorder and has been described after intracapsular and extracapsular cataract extraction, including clear corneal incisions [15]. To confirm the diagnosis, abnormal ingrowth of episcleral vessels on the wound site is visualized during gonioscopy [15].

The UGH Syndrome is also a rare entity that has been described following congenital cataract surgery and is caused by the dislocation of the posterior chamber intraocular lens to the anterior chamber [16]. In these cases, explantation of the posterior chamber IOL may be required to control the intraocular inflammation and hyphema [16].

Vitreous hemorrhages, on the other hand, has been reported in up to 10% of eyes and range from mild to severe [12, 13]. Flame-shaped retinal hemorrhages and small vitreous hemorrhage can occur in the first postoperative days after lens surgery, which resolves spontaneously within the first postoperative month [14]. No correlation has been identified between the occurrence of retinal hemorrhages and factors such as patient's age, race, sex, or duration of surgery [14]. However, it has

been strongly associated with persistence of fetal vasculature [12]. Therefore, dilated fundus evaluation is strongly recommended in these eyes during initial follow-ups [14].

Posterior Capsule Rupture

One of the most common intraoperative complications among pediatric eyes that undergo lens surgery with or without IOL implantation is the PCR [5–7]. In the PEDIG study, PCR was reported in 1% of eyes [7]. Although PCR may occur at any step of the lens surgery, eyes with history of trauma, vitrectomy, and preexisting congenital defects such as polar cataracts, posterior lenticonus, persistent fetal vasculature are at higher risk of having this complication [5, 17].

Whenever PCR occurs, prompt detection is essential to avoid additional complications associated including anterior displacement of the vitreous to the anterior segment and lens fragment dislocation to the posterior cavity [17].

Retained Cortex and Lens Fragment in the Vitreous

Small amount of retained cortex usually have no lasting effect and causes no postoperative complications [5]. However, if significant lens cortex is retained, eyes can progress with opacification of visual axis, increased IOP, and inflammation that require additional surgical intervention [3].

The dislocation of fragments of the crystalline lens into the vitreous cavity can produce corneal edema, glaucoma, uveitis, and vitreous opacification that results in decreased vision [17, 18]. Anterior and posterior vitrectomy are effective and frequently needed to remove vitreous from the anterior chamber and lens fragments from the vitreous cavity [17, 18].

Postoperative Complications

Ocular Hypertension and Glaucoma

During the postoperative period the IOP commonly fluctuates given that children are more susceptible to steroid-induced ocular hypertension [2, 19, 20]. The incidence of ocular hypertension during first postoperative year varies between 2 and 17% and may occur in both aphakic and IOL eyes [7, 19]. This intermittent complication usually happens at 1 to 2.5-month follow-up and has a mean duration of 30 days [19]. Although ocular hypertension is managed with antiglaucomatous drops, closely monitoring the IOP as well as the optic disc cupping is essential due to high risk early and late onset glaucoma [3, 19].

With the advance of surgical techniques and the introduction of vitrectomy instruments for childhood cataract surgery, the incidence of angle-closure glaucoma with pupillary blockage after lensectomy had decreased [20]. However, postoperative chronic open angle glaucoma is yet considered the most common and most important visually disabling complication following pediatric lens surgery [1, 3, 4, 19–24]. Its incidence ranges from 6 to 58.7% depending on the population studied, surgical technique, and length of follow-up [23]. Studies show that this complication can develop many years after surgery with a higher frequency after 6 years of follow-up [21–23].

Treatment of secondary glaucoma in these pediatric eyes is challenging [21, 23–24]. Antiglaucoma drops usually temporizes measures, but surgery and laser treatments are usually required [21, 23–24]. In the IATS, 4.4% of patients requires surgical management for glaucoma within the first postoperative year, and 7% during the first 5 postoperative years [5]. This gradual increase in number of cases requiring surgical intervention suggests that pediatric patients are at continuous risk of developing glaucoma after cataract surgery and consigned to frequent and indefinite follow-ups, and often multiple surgical interventions [3, 21–24]. Unfortunately, the outcomes of surgical interventions in these cases are often disappointing long-term [17, 23, 24].

The precise etiology of postoperative glaucoma in pediatric lens surgery is incompletely understood [1, 20]. However, studies show that eyes with other coexisting anomalies, retained lens cortex, and those that need secondary membrane surgery increase the risk of developing chronic glaucoma [21, 24]. Other factors such as young age at cataract surgery and aphakia or pseudophakia, remain controversial according to studies [1, 2, 4, 20–27].

Persistent Corneal Edema

Corneal edema is a rare and transient postoperative complication in children [5, 28]. The main underlying condition that can increase the risk for developing corneal edema is the intraocular inflammation that often follows surgery [28]. This complication can last for 2 weeks and resolves with intensified topical steroids [28].

With regards to endothelial cells loss secondary to lens surgery in the pediatric population, a long-term follow-up study showed a low rate of 9.2% endothelial cells loss 12 years after surgery [12].

Secondary Opacification of Visual Axis: Capsular Opacity, Lens re-Proliferation and Pupillary Membranes

Visual axis opacification (VAO) can be caused by posterior capsular opacity, lens re-proliferation, and/or pupillary membrane formation [1, 4]. The proliferation of residual epithelial cells on the posterior capsule leads to the posterior capsular opacity (Fig. 57.1) [1]. The lens re-proliferation in aphakic eyes results in the

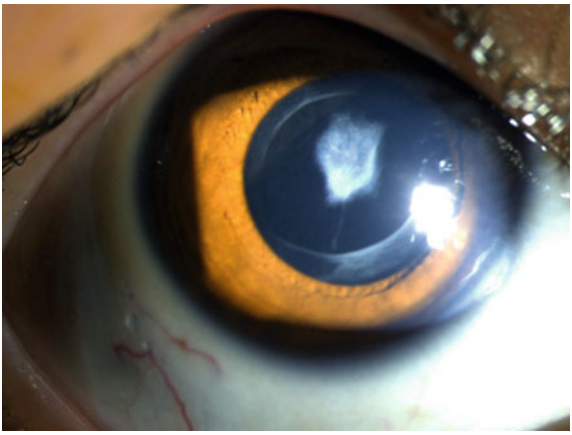

Fig. 57.1 Dense posterior capsular opacification observed in a pediatric eye submitted to congenital cataract surgery with no posterior capsulotomy

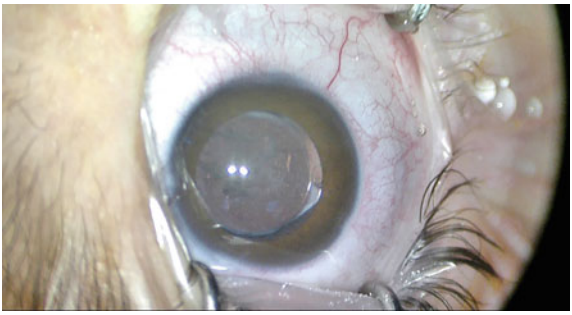

Fig. 57.2 Visual opacification caused by lens re-proliferation (Elschnig pearls) in a pediatric eye submitted to congenital cataract surgery with no posterior capsulotomy

formation of the Sommering's ring behind the iris. Whereas, in pseudophakic eyes the re-proliferation results in Elschnig pearls present outside the capsular leaflets (Fig. 57.2) [1]. Pupillary membrane, on the other hand, typically occludes the pupil and causes posterior synechiae because of the inflammatory response (Fig. 57.3) [1].

Clinically VAOs are identified by the absence or alteration of the red reflex (Fig. 57.4). All causes of VAO are considered amblyogenic given that they reduce visual acuity and hamper optimal refractive correction by limiting retinoscopy [4]. As a consequence, this postoperative complication frequently need to be addressed surgically [1, 3].

Studies report high rates of reoperation to resolve VAOs following pediatric lens surgery [3, 5, 6]. In the Infant Aphakia Treatment Study (IATS), 47% of infant eyes required surgical removal of a visual axis opacity during the first postoperative year

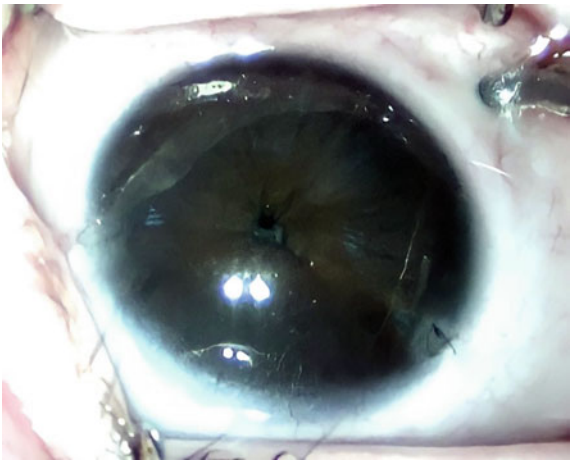

Fig. 57.3 A 2-month-old baby presenting a pupillary blockage and bombé iris 1-week after being submitted to lensectomy and anterior vitrectomy. Intraocular pressure was 30 mmHg in that eye

Fig. 57.4 Absence of red reflex in the left eye of a child caused by visual axis opacification

[5]. To corroborate with this finding, Jackson et al. [3] suggest that VAOs are more likely to occur within the first 3 postoperative months [3].

Unfortunately, these additional surgical interventions are directly related to chronic glaucoma and retinal detachment in pediatric eyes, as previously mentioned [4]. Thus, by confectioning a wide posterior capsulotomy and performing a thorough anterior vitrectomy during the primary procedure, as well as intensifying steroid therapy postoperatively when doing lens surgery in children especially under 5 years old may reduce the incidence of VAOs and additional surgery [1, 4, 6].

Pupil Abnormalities

Although most postoperative pupil abnormalities such as corectopia occur as a direct damage to the iris when manipulating instruments in the eye, they can also be related to IOL mispositioning and subluxation and synechial sequelae [29].

Pupil abnormalities may have an impact on cosmetics, but most importantly, these alterations may influence visual development in children [29]. After surgery,

the pupillary aperture must be centered to avoid amblyopia as well as other visual symptoms such as photophobia and glare [29]. In some cases of pupillary aperture displacement additional surgical approaches such as membranectomy or a pupilloplasty may be needed [30].

Dislocated Lens

The incidence of dislocated lens in pediatric lens surgery is lower when compared to adults. The PEDIG study reported an incidence of 0.1% of lens dislocation in pediatric eyes (Fig. 57.5) [7]. Whereas, Lee et al. reported in a nationwide population-based cohort study an incidence of 0.7% of IOL dislocation in adults [31]. Although lens dislocation following pediatric lens surgery is considered rare, studies show that when present, additional surgical intervention is needed to center the lens and avoid vision loss and amblyopia [7, 32].

Retinal Detachment

Although prognosis of retinal detachments in the pediatric population has improved in the past decades given the advances in pediatric retinal detachment surgery including wide angle viewing systems, faster cutting speed vitrectors, and better surgical techniques, it is considered a serious complication of pediatric lens surgery given that these patients are at high risk of blindness [33–35].

Studies show a higher incidence of retinal detachment in children submitted to lens surgery compared to adults and its incidence varies according to the chosen technique given and follow-up time [33, 36]. Retinal detachments in aphakic pediatric patients have been estimated at 1.5% in a 5-year follow-up study [4].

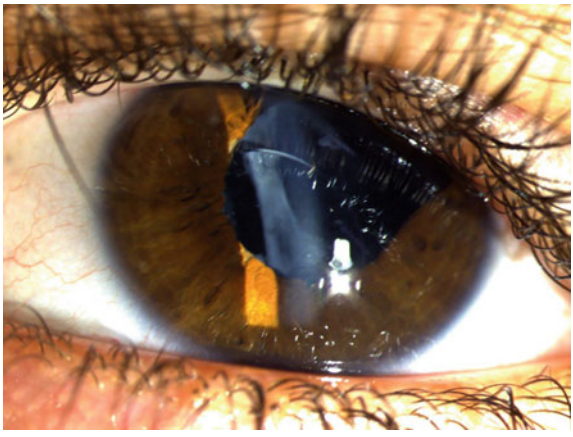

Fig. 57.5 Intraocular lens dislocated inferiorly and posterior capsule opacification in a child submitted to lens surgery

Whereas previous studies on groups of at least 100 eyes without IOL implantation have identified a retinal detachment frequency ranging from 0.6 to 5% [34, 36–38].

Although retinal detachments in children does occur during the first postoperative year, they usually tend to have a late onset [4, 33, 36]. Studies estimate that the mean interval between cataract surgery and retinal detachment is approximately 30 years [33]. However, retinal detachments tend to occur in a shorter time frame—approximately 8 years—in eyes submitted to lensectomy [33].

It appears that chronic vitreoretinal traction in the anterior vitreous caused by lens removal is the major factor in the pathogenesis of retinal detachment after congenital cataract surgery [39]. The chronic vitreoretinal traction may cause undetected retinal breaks commonly identified in the upper nasal quadrant near the ora serrata that progress to regmatogenous retinal detachments [33, 39].

Most retinal detachments have been identified in the male population [33]. However, it is not clear whether males have an increased risk of congenital cataract, or an increased risk of retinal detachment following lens surgery [33, 36]. To date, the risk factors identified in previous studies that are associated with retinal detachment include myopia, aphakia refraction, and wound dehiscence [1, 34, 36]. Studies show that vitreous disturbance plays an important role in the pathophysiology of retinal detachment [4, 36]. Myopia's association with peripheral retinal degenerations and retinal breaks may explain its relationship to retinal detachment in this population [36]. Aphakia and wound dehiscence, on the other hand, may predispose retinal detachments due to the disturbance of the vitreous that leading to vitreoretinal traction and breaks formation [36]. Moreover, children that present additional ocular abnormalities such as persistent fetal vasculature and retinopathy of prematurity have a higher risk of retinal detachment [4, 12, 36].

To manage this complication, studies have shown that an internal approach improves the likelihood of anatomical success as it allows a thorough inspection of the peripheral retina and identification of retinal breaks [34, 40, 41]. The primary reattachment rate in these eyes vary between 59.3 and 82%, and with additional surgery between 81.4 and 93.3% [33].

Endophthalmitis

The estimated incidence of endophthalmitis in children submitted to lens surgery is 7 cases per 10,000 operations [1, 42, 43]. Cases of pediatric endophthalmitis are mostly related to nasolacrimal duct obstruction or upper respiratory infection at the time of lens extraction [1]. The signs of endophthalmitis are usually present by the third postoperative day and gram positive microorganisms are the most common associated agents to these cases [1, 42, 43]. Despite being considered a rare event, it is usually a dramatic complication usually associated with poor visual outcomes [1, 42].

Phthisis Bulbi

Phthisis bulbi is an extremely rare complication of pediatric lens surgery that leads to permanent visual loss. This complication is mostly related to multiple surgical interventions in the same eye [5]. In the IATS cohort, the sole phthisis bulbi was related to an eye that progressed with retinal detachment [5]. Additionally, patients with retinopathy of prematurity that undergo aggressive laser photocoagulation treatment may develop anterior segment ischemia and are specifically under high risk of developing phthisis bulbi secondary to ischemia after cataract surgery [44].

Video Case

We present the case of a 14-month-old male patient, presented visual axis opacification due to capsular phimosis, Soemmerring ring formation, and epithelial proliferation noted 1 year after phacoaspiration surgery with no IOL implantation in the right eye. The patient was submitted to anterior vitrectomy and surgical removal of the fibrotic tissue and visual axis clearance was again obtained.

Conclusions

Over the years, pediatric lens surgery made substantial leaps that resulted in better visual and functional prognosis for children. However, their small and complex ocular structure increase the risk of intraoperative and postoperative complications. The incidence of intraoperative complications when performing pediatric lens surgery varies between 5 and 21%, whereas postoperative complications are reported in 16% of eyes. Surgeons should be aware that iris prolapse, hyphema, and posterior capsule rupture are the most common intraoperative complications, and that open angle glaucoma and visual axis opacification are the most frequent postoperative complications identified in these eyes. In addition, unlike adults, children are most likely to have late onset retinal detachments. Therefore, close monitoring of pediatric eyes submitted to lens surgery is essential for early detection and prompt surgical intervention of this serious postoperative complication.

Review Questions

1. When performing a pediatric lens surgery, what is the most likely intraoperative complication that you might encounter?

a. Hyphema
b. Iris prolapse

c. Cloudy cornea
d. Posterior capsule rupture

2. You are performing an exam under anesthesia of a 3-yo female child that was submitted to lens surgery one year ago. What is the most common post-operative complication that you might encounter?

a. Retinal detachment
b. Uveitis
c. Glaucoma
d. Lens dislocation

3. What is the most common cause of additional surgical interventions in children submitted to lens surgery?

a. Retained cortex
b. Visual axis opacification
c. Ocular hypertension
d. Retinal detachment

4. About retinal detachment following pediatric lens surgery:

a. Occurs most commonly in the first postoperative year.
b. Occurs less frequently than in adults.
c. Mostly caused by severe ocular inflammation.
d. Mostly related to myopia.

5. When examining a 4-year-old child who underwent lens surgery at the age of 2, you notice no red reflex. What is the most probable complication this patient might have?

a. Posterior capsule opacity
b. Dislocated IOL
c. Posterior capsule rupture
d. Retinal detachment

Answers

1. (**B**) Although hyphema, and posterior capsule rupture are common intraoperative complications of pediatric lens surgery, iris prolapse is the most frequently intra-operative complication reported in the IATS and BICCIG studies.

2. (**C**) Postoperative chronic open angle glaucoma is considered the most common complication following pediatric lens surgery and can develop many years after surgery.

3. (**B**) Studies have shown that visual axis opacification caused by capsular opacity, lens re-proliferation, and pupillary membranes is the major complication that leads pediatric patients to additional surgical interventions.

4. (**D**) Retinal detachment secondary to lens surgery occurs most frequently in pediatric population and tend to have a late onset. The risk factors associated with retinal detachment in the pediatric population submitted to lens surgery include myopia, aphakia refraction, and wound dehiscence. Retinal detachment in these cases is related to vitreoretinal traction that is a precursor of retinal breaks.

5. (**A**) Although retinal detachment may also course with red reflex loss, this complication usually has a late onset in the pediatric population. Posterior capsule opacity, on the other hand, develops due to the proliferation of residual lens epithelial cells on the posterior capsule and has an earlier onset. To avoid this complication, posterior capsulotomy and anterior vitrectomy should be performed as part of the initial surgical intervention.

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