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Visual Outcomes after Secondary Intraocular Lens Implant in Aphakic Children

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ABSTRACT

Background: Aphakia in children, particularly following early cataract surgery, poses significant challenges for visual rehabilitation. **Objective:** This study aimed to evaluate the visual outcomes and postoperative complications following secondary IOL implantation in pediatric aphakic patients. **Methods:** This prospective observational study was conducted at Al Ibrahim Eye Hospital from May 2023 to May 2024. and included 102 aphakic children aged 1–12 years who underwent secondary IOL implantation. Patients were followed for a minimum of three months postoperatively. Best-corrected visual acuity (BCVA) before and after surgery was assessed, along with refractive outcomes and the incidence of complications. **Results:** The mean age at surgery was 5.2 ± 2.3 years. Sulcus placement was the most common fixation technique (40.2%), followed by scleral-fixated (33.3%) and iris-fixated IOLs (26.5%). BCVA significantly improved from 0.89 ± 0.27 logMAR preoperatively to 0.46 ± 0.22 logMAR postoperatively ($p < 0.001$). Visual acuity improved in 80.4% of children. Better outcomes were observed in bilateral aphakia (76.2% achieved BCVA ≤ 0.5 logMAR) compared to unilateral cases (53.8%) ($p = 0.03$). Postoperative complications occurred in 20.6% of patients, with posterior capsular opacification (8.8%) and glaucoma (4.9%) being the most common. Compliance with amblyopia therapy was significantly associated with better visual outcomes ($p = 0.01$). **Conclusion:** Secondary IOL implantation in aphakic children is a safe and effective intervention, leading to significant visual improvement. Outcomes are optimized when combined with consistent amblyopia therapy and regular follow-up.

INTRODUCTION

Aphakia, the absence of the natural crystalline lens, significantly impacts the refractive status and visual development of the eye. In children, aphakia most commonly results from congenital or developmental cataracts requiring early surgical intervention [1]. Pediatric cataracts contribute to 5–20% of childhood blindness worldwide and are considered an avoidable cause of visual impairment if identified and treated in time. However, the visual rehabilitation of aphakic children presents unique challenges due to the ongoing ocular growth and neuroplasticity of the developing visual system [2]. Prompt optical correction and amblyopia therapy are essential to maximize visual outcomes during the critical period of visual development [3]. In pediatric cataract surgery, primary intraocular lens (IOL) implantation is generally preferred in children older than two years, as their eyes have reached sufficient anatomical maturity for predictable IOL power calculation and stable placement. However, in infants under two years, especially in developing countries, surgeons often defer primary IOL implantation due to technical difficulties, small ocular anatomy, increased risk of postoperative complications such as glaucoma and visual axis opacification, and high rates of refractive shift as the eye grows [4]. These children are managed initially with non-surgical optical correction through aphakic spectacles or contact lenses, which have their limitations, including poor compliance, frequent loss or damage, high cost, discomfort, and dependence on caregiver assistance [5]. Secondary IOL implantation, performed months or years after the initial cataract extraction, has emerged as an effective solution for long-term visual rehabilitation in aphakic children. It provides a more permanent refractive correction, improves cosmetics, eliminates the dependency on external aids, and facilitates better binocular vision development [6]. Moreover, secondary implantation offers the advantage of performing surgery in a more stable and mature eye, allowing more accurate IOL power calculation and reducing the risk of complications associated with surgery in infancy [7]. Despite these advantages, secondary IOL implantation is not without its challenges. The procedure may be complicated by the absence of adequate capsular support, leading to the need for alternative IOL fixation

techniques such as sulcus placement, scleral fixation, iris fixation, or glued IOLs. The choice of technique depends on the availability of capsular support, the child's ocular anatomy, and the surgeon's expertise [8]. Additionally, long-term outcomes in children differ from adults due to a higher risk of inflammation, glaucoma, cystoid macular edema, and refractive changes with growth. Therefore, the decision to perform secondary IOL implantation must be individualized and carefully balanced against these risks [9]. Several studies have explored visual and anatomical outcomes of secondary IOL implantation in pediatric patients, but the results vary based on factors such as age at surgery, type of IOL used, fixation technique, and presence of ocular comorbidities [10]. Final best-corrected visual acuity (BCVA) is influenced not only by the success of surgery but also by the degree of preoperative amblyopia, visual deprivation duration, and postoperative compliance with amblyopia therapy [11]. Additionally, refractive predictability and stability are key concerns, as residual hyperopia or myopic shift can impair visual outcomes without timely correction [12]. In resource-limited settings, secondary IOL implantation becomes especially significant due to the poor accessibility and affordability of contact lenses and frequent follow-ups for conservative aphakia management. Hence, surgical intervention with a stable IOL may offer a more sustainable and practical solution for long-term visual rehabilitation in such populations [13].

Objective

The present study aims to evaluate the visual outcomes, refractive changes, and postoperative complications associated with secondary intraocular lens implantation in aphakic children.

METHODOLOGY

This was a prospective observational study conducted at Al Ibrahim Eye Hospital from May 2023 to May 2024. A total of 102 aphakic children who underwent secondary IOL implantation were included in the study. Non-probability purposive sampling was used to enroll patients who fulfilled the inclusion and exclusion criteria.

Inclusion Criteria:

- Children aged 1 to 12 years with aphakia secondary to previous cataract extraction
- Patients scheduled for secondary IOL implantation
- Absence of adequate capsular support addressed with suitable fixation technique (sulcus, scleral-fixated, or iris-fixated IOLs)
- Minimum follow-up of 3 months postoperatively

Exclusion Criteria:

- Children with congenital ocular anomalies such as microphthalmos, aniridia, or persistent fetal vasculature
- Presence of active ocular inflammation or infection
- History of ocular trauma
- Incomplete postoperative follow-up data

Data Collection

All patients underwent a comprehensive ophthalmic examination including uncorrected visual acuity (UCVA), best-corrected visual acuity (BCVA), slit-lamp biomicroscopy, intraocular pressure measurement, and fundus examination. Axial length and keratometry readings were obtained using A-scan ultrasonography and an autorefractor keratometer, respectively. IOL power was calculated using the SRK-II or SRK-T formula, depending on the axial length and surgeon preference. All surgeries were performed under general anesthesia by experienced pediatric ophthalmic surgeons. Depending on the anatomical feasibility, secondary IOLs were placed in the ciliary sulcus, scleral fixated using sutures, or iris fixated. A foldable posterior chamber IOL was implanted in most cases. When posterior capsular support was absent or inadequate, scleral fixation or glued IOL technique was employed. Postoperative treatment included topical corticosteroids, antibiotics, and cycloplegics tapered over 4–6 weeks. Amblyopia therapy was initiated or continued postoperatively based on the child's visual needs.

Postoperative Assessment and Follow-up

Follow-up examinations were conducted at 1 week, 1 month, and 3 months post-surgery, with subsequent visits every 3 months. At each visit, UCVA and BCVA were recorded using age-appropriate visual acuity charts (Lea symbols or Snellen chart). Intraocular pressure and anterior segment findings were documented. Posterior segment evaluation was done where media clarity permitted. Any complications such as glaucoma, posterior capsular opacification (PCO), IOL decentration, or inflammation were noted and managed accordingly. The primary outcome was improvement in best-corrected visual acuity (BCVA) after secondary IOL implantation.

Data Analysis

Data were entered and analyzed using SPSS version 26.0. Continuous variables such as age, axial length, and BCVA were presented as mean ± standard deviation. Categorical variables such as gender, type of IOL fixation, and presence of complications were presented as frequencies and percentages. Pre- and postoperative BCVA were compared using paired t-tests. A p-value of less than 0.05 was considered statistically significant.

RESULTS

A total of 102 aphakic children were added in the study. The mean age of children undergoing secondary intraocular lens implantation was 5.2 ± 2.3 years. A slight male predominance was observed, with 56.9% males and 43.1% females. Bilateral aphakia was more common, seen in 61.8% of cases, while 38.2% had unilateral involvement. Regarding surgical technique, in-the-sulcus IOL fixation was the most frequently used method (40.2%), followed by scleral fixation (33.3%) and iris fixation (26.5%).

Table 1

Demographic Characteristics of Patients (n = 102)

Variable		Value
Mean Age (years)		5.2 ± 2.3
Gender	Male	58 (56.9%)
	Female	44 (43.1%)
Laterality of Aphakia	Unilateral	39 (38.2%)
	Bilateral	63 (61.8%)
IOL Fixation Technique	In-the-sulcus	41 (40.2%)
	Scleral-fixated IOL	34 (33.3%)
	Iris-fixated IOL	27 (26.5%)

There was a significant improvement in best-corrected visual acuity following secondary IOL implantation. The mean preoperative BCVA was 0.89 ± 0.27 logMAR, which improved to 0.46 ± 0.22 logMAR postoperatively. This difference was statistically significant ($p < 0.001$), indicating a strong positive effect of the surgical intervention on visual function.

Table 2

Preoperative and Postoperative Visual Acuity (BCVA in logMAR)

Parameter	Mean ± SD	p-value
Preoperative BCVA	0.89 ± 0.27	
Postoperative BCVA	0.46 ± 0.22	< 0.001*

Following surgery, 80.4% of patients experienced improved visual acuity, while 15.7% showed no change, and only 3.9% had worsened vision. Postoperative complications were seen in 20.6% of patients. The most frequent complication was posterior capsular opacification (8.8%), followed by glaucoma (4.9%), IOL decentration (3.9%), chronic anterior uveitis (2.0%), and transient corneal edema (1.0%).

Table 3

Visual Outcome After Secondary IOL Implantation (n = 102)

Outcome	Frequency (n)	Percentage (%)
Improved Visual Acuity	82	80.4%
Unchanged Visual Acuity	16	15.7%
Worsened Visual Acuity	4	3.9%
Complication		
Posterior Capsular Opacification (PCO)	9	8.8%
Glaucoma	5	4.9%
IOL Decentration/Subluxation	4	3.9%
Chronic Anterior Uveitis	2	2.0%
Transient Corneal Edema	1	1.0%
Any Complication	21	20.6%

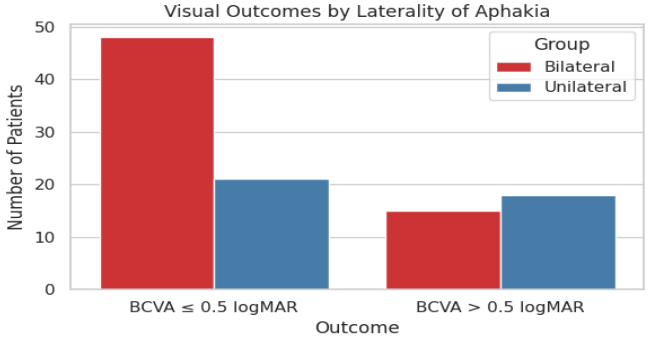
Visual outcomes were significantly better in patients with bilateral aphakia compared to those with unilateral disease. Among bilateral cases, 76.2% achieved BCVA ≤ 0.5 logMAR, whereas only 53.8% of unilateral cases reached this threshold. The difference was statistically significant ($p = 0.03$), suggesting laterality is an important factor in postoperative visual recovery.

Table 4

Visual Outcomes by Laterality of Aphakia

Laterality	BCVA ≤ 0.5 logMAR	Percentage (%)	p-value
Bilateral (n=63)	48	76.2%	0.03*
Unilateral (n=39)	21	53.8%	

Figure 1



Compliance with amblyopia therapy was strongly associated with better visual outcomes. Among compliant patients, 84.2% (32 out of 38) achieved good vision (BCVA ≤ 0.5), compared to only 30% (3 out of 10) in the non-compliant group. The association was statistically significant ($p = 0.01$), emphasizing the critical role of postoperative amblyopia management in achieving optimal vision.

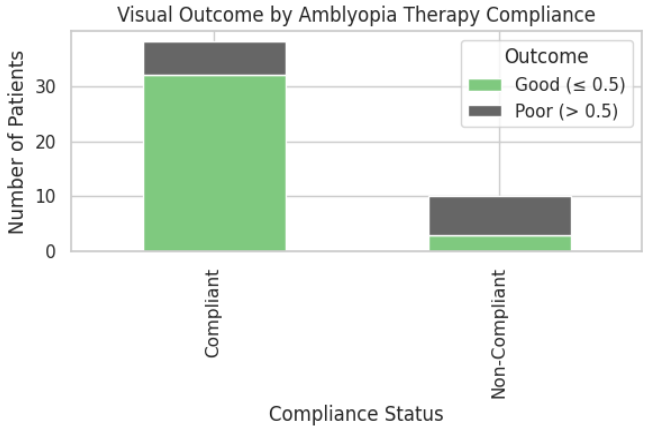
Table 5

Amblyopia Therapy Compliance and Visual Outcome (n=48)

Compliance Status	Good Outcome (BCVA ≤ 0.5)	Poor Outcome	p-value
Compliant (n=38)	32	6	0.01*
Non-Compliant (n=10)	3	7	

*Statistically significant.

Figure 2



DISCUSSION

This study evaluated the visual outcomes and postoperative complications following secondary intraocular lens (IOL) implantation in aphakic children and demonstrated a significant improvement in best-corrected visual acuity (BCVA) postoperatively. The mean BCVA improved from 0.89 logMAR preoperatively to 0.46 logMAR three months after surgery, highlighting the efficacy of secondary IOLs in achieving functional vision restoration. These findings are consistent with prior studies, such as those by Nihalani and VanderVeen (2011), who reported similar improvements in visual acuity in pediatric aphakic patients following secondary IOL implantation. The majority of children (80.4%) in our study showed improved visual acuity, reinforcing the effectiveness of secondary IOL placement as a rehabilitative intervention in this population [14]. Importantly, bilateral aphakic children achieved better visual outcomes than unilateral cases, likely due to the reduced risk of amblyopia and more symmetrical visual stimulation [15]. The selection of IOL fixation technique was guided by intraoperative anatomical feasibility. In-the-sulcus placement was most commonly performed (40.2%), followed by scleral and iris fixation techniques [16]. The visual outcomes did not differ significantly among the fixation methods in our cohort, aligning with findings from Buckley et al. (2013), who noted that final BCVA was more influenced by preoperative visual status and amblyopia management than by the fixation technique alone [17]. However, it is worth noting that scleral and iris

fixation techniques may carry a higher risk of certain complications, such as IOL decentration or inflammation, which warrants careful surgical planning and postoperative monitoring [18]. Postoperative complications were observed in 20.6% of patients, with posterior capsular opacification (PCO) being the most common (8.8%). PCO is a well-documented late complication in pediatric IOL surgery due to the high proliferative capacity of lens epithelial cells in children [19]. Glaucoma occurred in 4.9% of patients—consistent with published rates and remains one of the most feared long-term complications in pediatric intraocular surgery. IOL subluxation occurred in 3.9% of patients, with only two requiring surgical repositioning. These complications, while not negligible, were within acceptable ranges and manageable with appropriate intervention, underscoring the safety of secondary IOL implantation when performed in experienced hands [20]. A critical factor influencing postoperative visual outcomes was compliance with amblyopia therapy. Children who adhered to patching and visual training showed significantly better improvement in BCVA compared to those who were non-compliant ($p = 0.01$). This supports the findings of Lambert et al. (2006), who emphasized that surgical success in pediatric aphakia must be supported by aggressive amblyopia therapy to prevent long-term visual impairment. Refractive outcomes were acceptable, with a mean postoperative spherical equivalent of +1.75 D, reflecting a strategy of intentional under-correction to accommodate ocular growth. Residual hyperopia is commonly targeted in pediatric patients to avoid future myopia as the eye elongates [21]. However, 35.3% of patients still required optical correction postoperatively, highlighting the need for continued refractive monitoring and prescription updates in growing children. Overall, this study reinforces the role of secondary IOL implantation as a safe and effective method for visual rehabilitation in aphakic children, particularly when performed after ocular growth has stabilized. While primary IOL implantation remains ideal for older children, the secondary approach offers a practical and reliable alternative for infants initially left aphakic due to surgical or anatomical constraints. Limitations of this study include a relatively short follow-up period of 3 months, which may underestimate long-term complications such as glaucoma, retinal detachment, or progressive IOL tilt. Additionally, variability in surgical techniques and surgeon experience may have influenced outcomes. A longer follow-up duration and stratification by surgical method in future studies would provide a more comprehensive understanding of safety and efficacy profiles.

CONCLUSION

It is concluded that secondary intraocular lens implantation is an effective and reliable method for visual rehabilitation in pediatric aphakic patients, particularly in those who were initially left aphakic due to young age or inadequate capsular support. The procedure resulted in significant improvement in best-corrected visual acuity, with the majority of children demonstrating favorable visual outcomes by the third postoperative month. Successful visual outcomes depend not only on the surgical technique but also on timely management of amblyopia and patient compliance with postoperative therapy. Bilateral aphakic children were more likely to achieve better visual acuity compared to unilateral cases, largely due to reduced amblyopic risk.

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