

## Change in Pattern of Strabismus in Pediatric Cataract Before and After Cataract Surgery

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### Abstract

**Background:** Pediatric cataract is a significant cause of childhood visual impairment. The presence of strabismus may further compromise the development of normal binocular vision.

**Objective:** To evaluate changes in the pattern and degree of strabismus in pediatric cataract patients before and after cataract surgery.

**Methods:** A quasi-experimental study was conducted over three months on 62 eyes of 31 pediatric cataract patients with  $\geq 10$  prism diopters of strabismus, presenting to the Orthoptic Clinic, Mayo Hospital, Lahore. Pre- and postoperative assessments included best-corrected visual acuity

(BCVA) using the LogMAR chart, deviation measurement with the Alternate Prism Cover Test (APCT), and cycloplegic refraction using 1% cyclopentolate.

**Results:** Of the 31 patients (54.83% male), the mean age was  $7.47 \pm 2.60$  years for males and 6.71

$\pm 2.05$  years for females. Mean BCVA improved significantly from  $0.89 \pm 0.09$  preoperatively to  $0.21 \pm 0.06$  postoperatively. The mean squint angle decreased from  $37.58 \pm 7.40$  to  $28.48 \pm 10.00$  prism diopters. Postoperatively, 61.29% showed improvement (relieved), 22.58% remained unchanged, 9.68% worsened, and 6.45% developed consecutive deviations.

**Conclusion:** Cataract surgery with intraocular lens (IOL) implantation significantly improves visual acuity and reduces ocular misalignment in pediatric patients. Early surgical intervention can restore vision and enhance binocular coordination.

**Keywords:** Strabismus, Pediatric cataract, Intraocular lens, LogMAR, Orthoptic assessment

### Introduction

Cataract, the opacification of the eye's natural lens, is the leading global cause of reversible blindness and visual impairment, responsible for more cases than glaucoma, age-related macular degeneration, and diabetic retinopathy combined<sup>1</sup>. In children, pediatric cataracts pose a unique challenge, as they can severely impair visual development and lead to amblyopia and

secondary strabismus if not addressed early <sup>2</sup>. Approximately one-third of pediatric cataracts are hereditary in origin <sup>3</sup>.

Early diagnosis and treatment during the critical period of visual development are crucial to prevent irreversible visual loss and structural changes such as atrophy of the lateral geniculate body. Disruption of a clear visual axis during early visual maturation can impair the development of binocular vision, leading to misalignment of the eyes. While cataract surgery can restore optical clarity, postoperative binocular function does not always return to normal. Strabismus after surgery may resolve, persist, or newly develop, depending on factors such as age at intervention, laterality, and the quality of amblyopia management. Research indicates that strabismus is commonly observed both before and after pediatric cataract surgery <sup>4</sup>.

In the Infant Aphakia Treatment Study, 88% of children with unilateral infantile cataract developed some form of strabismus by age 10.5 years, often shifting from early esotropia to exotropia <sup>5</sup>. Large-scale analyses have found that 9–10% of children undergo strabismus surgery within five years following cataract extraction, particularly those who are younger at the time of surgery, have unilateral disease, or present with pre-existing binocular vision abnormalities <sup>6</sup>. Some evidence suggests that intraocular lens (IOL) implantation may lower this risk in selected cases <sup>7</sup>.

Studies from tertiary eye care centers report that one-third to one-half of children develop newonset strabismus after cataract surgery <sup>8</sup>. Conversely, some children with preoperative misalignment achieve postoperative ocular alignment, especially when visual deprivation is mild and postoperative acuity is good <sup>9</sup>. Typically, unilateral cataracts present with constant esotropia in early childhood that may evolve into exotropia over time, while bilateral dense cataracts are more likely to result in nystagmus and impaired binocularity than large-angle deviations <sup>10-11</sup>.

The success of ocular alignment post-surgery is strongly influenced by early surgical timing, accurate diagnosis, and effective amblyopia treatment, including optical correction and occlusion therapy <sup>12</sup>. In low-resource settings, delayed presentation and inconsistent follow-up are significant barriers to successful outcomes <sup>13</sup>. Recent systematic reviews have emphasized the need for standardized definitions and consistent outcome measures, as considerable variation exists across studies <sup>14</sup>. Disparities in access to care between high- and low-income regions further contribute to unequal outcomes <sup>15</sup>.

Overall, the trajectory of strabismus following pediatric cataract surgery is dynamic, shaped by both clinical and social factors <sup>16</sup>. Identifying predictors of postoperative alignment can inform surgical planning, enhance postoperative care, and improve long-term binocular visual outcomes<sup>17</sup>.

## Materials and Methods

A quasi-experimental study was conducted over four months at the Orthoptic Clinic, Mayo Hospital, Lahore. Thirty-one pediatric patients were enrolled using non-probability convenience sampling. Sample size was calculated with 5% significance and 90% power, based on an expected improvement in ocular alignment from 24.2% to 60% post-surgery.

### Inclusion / Exclusion criteria:

Inclusion criteria included children aged between 3 and 12 years with either congenital or acquired cataracts, and the presence of strabismus measuring 10 prism diopters or more. Exclusion criteria were children with mental retardation, media opacity, pupil abnormalities, glaucoma, or those outside the specified age range.

Assessments included BCVA (Log MAR), cycloplegic refraction (1% cyclopentolate), and APCT. All patients underwent cataract surgery with IOL implantation. Follow-up was conducted at three months. SPSS-26- was used for analysis. Paired t-tests compared pre- and postoperative data ( $p \leq$

0.05 considered significant).

## Results

### Descriptive Statistics

| GENDER |        | N         | Minimum   | Maximum   | Mean      |            | Std. Deviation |
|--------|--------|-----------|-----------|-----------|-----------|------------|----------------|
|        |        | Statistic | Statistic | Statistic | Statistic | Std. Error | Statistic      |
| Age    | Female | 14        | 4         | 10        | 6.71      | .549       | 2.054          |
|        | Male   | 17        | 3         | 12        | 7.47      | .631       | 2.601          |

A total of 31 pediatric patients were included: 14 females (45.16%) and 17 males (54.83%). The mean age was  $6.71 \pm 2.05$  years for females and  $7.47 \pm 2.60$  years for males.

### Tests of Normality

|                           | Kolmogorov-Smirnov <sup>a</sup> |    |      | Shapiro-Wilk |    |      |
|---------------------------|---------------------------------|----|------|--------------|----|------|
|                           | Statistic                       | df | Sig. | Statistic    | df | Sig. |
| Age                       | .160                            | 31 | .042 | .957         | 31 | .242 |
| Visual Acuity Before Surg | .230                            | 31 | .000 | .836         | 31 | .000 |
| Visual Acuity After Surg  | .339                            | 31 | .000 | .760         | 31 | .000 |
| Amount of Squint Before   | .165                            | 31 | .032 | .939         | 31 | .078 |
| Amount of Squint After    | .214                            | 31 | .001 | .922         | 31 | .026 |

Shapiro-Wilk test indicated that visual acuity (pre- and post-surgery) and squint angle after surgery were not normally distributed ( $p < 0.05$ ). Only the squint angle before surgery followed a normal distribution. Mean preoperative BCVA was  $0.89 \pm 0.09$ , improving significantly to  $0.21 \pm 0.06$  postoperatively. The average squint angle decreased from  $37.58 \pm 7.40$  to  $28.48 \pm 10.00$  prism diopters.

**Type of Squint**

|                               |     | Type of Squint After Surgery |       | Total  | P value           |
|-------------------------------|-----|------------------------------|-------|--------|-------------------|
|                               |     | ESO                          | EXO   |        |                   |
| Type of Squint Before Surgery | ESO | 16                           | 1     | 17     | 1.00 <sup>c</sup> |
|                               |     | 94.1%                        | 5.9%  | 100.0% |                   |
|                               | EXO | 1                            | 13    | 14     |                   |
|                               |     | 7.1%                         | 92.9% | 100.0% |                   |
| Total                         |     | 17                           | 14    | 31     |                   |
|                               |     | 54.8%                        | 45.2% | 100.0% |                   |

<sup>c</sup>Binomial Distribution is used

Esotropia was more prevalent preoperatively (54.84%). Postoperatively, 94.1% of esotropic and 92.9% of exotropic cases retained their deviation type.

**Outcome**

|              | Frequency | Percent |
|--------------|-----------|---------|
| Consecutive  | 2         | 6.5     |
| Not Relieved | 7         | 22.6    |
| Relieved     | 19        | 61.3    |
| Worsened     | 3         | 9.7     |
| Total        | 31        | 100.0   |

Regarding postoperative outcomes: 61.29% showed improvement (relieved), 22.58% were unchanged (non-relieved), 9.68% worsened, and 6.45% developed consecutive strabismus. This suggests that early cataract surgery improves both visual acuity and ocular alignment.

**Discussion**

Pediatric cataract remains a leading cause of preventable childhood blindness. If left untreated, cataract-induced visual deprivation during the critical period of visual development can result in amblyopia and sensory strabismus. However, visual impairment in these cases is potentially reversible if recognized and managed promptly. Early diagnosis and timely surgical intervention are crucial to ensure optimal visual and binocular outcomes. Dense cataracts that obscure the red reflex or cause poor visual behavior necessitate early surgical management to prevent deprivation amblyopia, while partial or non-visually significant cataracts may be monitored. The timing of surgery is especially critical in bilateral cases—intervention before six weeks of age yields the best outcomes in visual acuity and binocular function.

Our study aimed to evaluate short-term changes in ocular alignment following cataract surgery and visual rehabilitation. Postoperatively, patients were followed up for three months to assess changes in ocular alignment. We observed a significant reduction in the mean angle of deviation from  $37.58 \pm 7.40$  to  $28.48 \pm 10.00$  prism diopters ( $p < 0.05$ ), indicating that restored visual input following cataract removal can positively influence ocular alignment. This supports previous studies suggesting that visual rehabilitation may promote realignment by enhancing sensory input and fusion potential.

Strabismus outcomes in our cohort were categorized as relieved (decrease in deviation), nonrelieved (no change), worsened (increase in deviation), and consecutive (change in deviation type). Notably, 61.29% of patients showed improvement in alignment, while a small percentage (6.45%) developed consecutive strabismus—most commonly exotropia following esotropia or vice versa. These findings are consistent with previous literature, which has reported variable strabismus outcomes following pediatric cataract surgery, often influenced by factors such as patient age, cataract laterality, duration of visual deprivation, and timing of intervention.

Our results align with existing literature, which reports that approximately 25% of children achieve orthotropia following cataract surgery, representing a relieved outcome marked by a decrease in ocular deviation and improvement in motor alignment<sup>19</sup>. Similarly, Park et al. noted a significant reduction in strabismus angles after secondary intraocular lens (IOL) implantation in aphakic children, reinforcing the potential for improved alignment with enhanced visual input and sensory fusion — another example of a relieved outcome<sup>20</sup>.

In contrast, other studies have reported non-relieved or worsened outcomes. For instance, 47.5% of children developed new-onset strabismus following surgery, while another study documented a rise in strabismus prevalence from 34% to 65%, suggesting either a lack of improvement (nonrelieved) or a worsening of deviation over time (worsened)<sup>21</sup>.

The occurrence of consecutive strabismus has also been documented. The Infant Aphakia Treatment Study (IATS) reported that a substantial number of children initially presenting with esotropia developed exotropia between the 5- and 10-year follow-ups, illustrating a change in deviation type, characteristic of a consecutive outcome<sup>22</sup>.

These variations in postoperative ocular alignment have been attributed to a range of risk factors. Prior studies highlight early surgery (especially before 6 months of age), unilateral cataracts, poor visual acuity, nystagmus, posterior capsule preservation, and development of secondary cataract as significant predictors of persistent misalignment or progression of strabismus<sup>23</sup>.

While our study supports early cataract surgery and visual rehabilitation for improving ocular alignment. Postoperative care is vital. Early optical correction (within one week for aphakia, four weeks for pseudophakia), regular follow-up including refraction and IOP checks, and adherence to amblyopia therapy are key to visual success. Parental education—through clear, simple communication—greatly enhances compliance. Treatment involves topical antibiotics, corticosteroids, and atropine as needed. Systemic antibiotics are rarely necessary. Follow-up is initiated on day one and adjusted based on recovery.

In conclusion, early intervention can lead to meaningful alignment improvement, but variability in outcomes—especially non-relieved and consecutive strabismus—underscores the need for individualized monitoring and consistent postoperative management.

## Conclusion

This study demonstrated a significant change in strabismus patterns three months post cataract surgery in pediatric patients. Early screening and intervention are vital for effective amblyopia and strabismus management. Routine pediatric ophthalmic screening at ages one, three, and

five is recommended, alongside community education. Cycloplegic refraction should be mandatory in early childhood. Future genetic studies on strabismus are warranted.

### Limitations

The study's findings are limited to children aged 3–12 years and may not apply to other age groups. Accuracy depended on child cooperation, and reliance on a single visual acuity chart (Log MAR) may have introduced bias.

### Future Directions

Improved refractive planning and IOL selection are essential to optimizing visual and alignment outcomes in pediatric cataract patients. Advances in IOL power calculation—including refined biometry, age-specific refractive targets, and newer formulas enhanced by machine learning—have reduced postoperative refractive error and better accounted for ocular growth. Emerging technologies such as adjustable IOLs and advanced power-prediction algorithms are promising avenues to achieve more stable long-term refractive outcomes in children<sup>18</sup>.

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