Post-Operative Refractive Changes After Cataract Surgery in Children Less Than 4 Years of Age

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ABSTRACT

Aim: To observe the changes in refraction after Cataract surgery in children less than 4 years of age using Dahans formula.

Methods: The retrospective evaluation of the records of children with congenital and developmental cataracts who underwent cataract operations with intraocular lens implantation was conducted. The patients' ages ranged from 6 months to 4 years. All the sutures of cornea were removed after 1 month of surgery. IOL power was calculated using Dahan's formula based on axial length. Refraction was performed after 1, 3, 6, and 12 months.

Results: About 40 eyes of 20 children with bilateral congenital & developmental cataract (11 males and 9 females) were included. The age range was 6 months to 4 years & mean was 28.8±1.38 months. Significant myopic shift was observed in all the children and maximum myopic shift was observed in children below 2 (0-24 months) years of age.

Conclusion: Significant myopic shift has been observed in children. So, under corrected IOL implantation is safe to achieve target refraction.

Keywords: Refraction, Dahans formula, Myopic Shift

INTRODUCTION

Even though significant advancements in surgical techniques, instrumentation, and IOL design have been accomplished, achieving the predicted ultimate post-operative refraction remains challenging. Axial Length (AL) increases rapidly in the first two years of life due to eye growth, then tapers off and stabilizes between the ages of 7and 10 years. Other main causes of the refractive changes brought on by eye growth that make the eye more myopic include flattening of the cornea and a decrease in lens power. This procedure is called emmetropization[1,2]. Dahan et al (1997)[3] shows IOL power was found to be under corrected by 80% for patient younger than two years old and by 90% for those older than two years. In a different study, Enyadi et al (1998)[2] corrected by given hypermetropia correction and myopic shift was assessed during serial follow up. One of the main causes of the myopic shift in pediatric pseudophakic eyes is axial length elongation[4, 5]. Although the degree of this shift drastically diminishes after two years of age, most children's eyes continue to undergo some degree of axial elongation throughout childhood [6, 7]. Because of this, some doctors choose to implant an IOL that first corrects emmetropia in young children because they are worried that the child won't wear an over refraction after surgery, which could lead to the development of or exacerbation of amblyopia[8,9]. Furthermore, they have observed that some of these eyes only experience a slight myopic shift and they think it is impossible to forecast with any degree of accuracy how much the refractive error will change over time in these eyes. Some surgeons advocate for first treating these children for undercorrection and then using spectacles to correct any remaining refractive error[10–13]. They claim that since the majority of these kids would experience a fair amount of myopia in their pseudophakic eyes, under correcting them at first will result in a less refractive error in these eyes as they get older [3,14]. Consequently, these individuals might require fewer glasses or contact lenses for refraction in the future. Furthermore, these children's decreased Anisometropia as their pseudophakic eye elongates and approaches emmetropia may enhance their stereopsis and lessen aniseikonia in the future[15, 16].

PATIENTS AND METHODS

This retrospective observational study was conducted in 20 children aged between 6 months to 4 years who were previously diagnosed as congenital and developmental cataract and surgeries were performed in Chittagong Eye Infirmary & Training Complex (CEITC), Chattogram between June 2022 and June 2023. Preoperative axial length reading, postoperative refraction, age at surgery, sex, and other data were included. Ocular anomalies, mental and systemic disorders, children older than four, and follow-up periods shorter than a year were the exclusion criteria. Only a single pediatric ophthalmologist conducted all of the procedures. Informed consent were taken from parents or legal guardians.

The preoperative examination comprised B-scan ultrasonography, direct and indirect ophthalmoscopy following complete dilatation, slit lamp biomicroscopy, and visual assessment using the CSM method. Calculations of intraocular lens (IOL) power were performed using the axial length (Ocuscan machine) that suggested by Dahan et al[3]. Moreover, patients younger than two years old had 20% under correction, whereas children older than two years old had 10% under correction[3].

Table1: Axial length & IOL power calculation proposed by Dahan et al[3]

Axial Length(mm)	IOL power (D)
17	28.00
18	27.00
19	26.00
20	24.00
21	22.00

All patient underwent cataract surgeries under general anesthesia with spontaneous ventilation and aseptic precaution. The Micro Vitreoretinal (MVR) blade was used to create corneal tunnels at the 11 and 2 o'clock positions. To dilate the pupil, adrenaline was injected into the anterior chamber. To stain the anterior capsule of the lens, trypan blue was utilized. Using 25G Inner Limiting Membrane (ILM) forceps, continuous curvilinear capsulorrhexis (CCC) was performed. Irrigation and Aspiration (I/A) were done in every cases by using an automated I/A hand piece with Optikon R-Evo smart machine. Soft foldable hydrophobic acrylic lenses (Alcon, MBI) were placed in bag in all cases. Primary posterior Capsulectomy (PPC) and anterior vitrectomy (AVT) were done with automated vitrectomy machine. Corneal tunnels were closed by 10-0 nylon. All patients received a sub-conjunctival injection of Gentamycin (5mg) and dexamethasone (2mg).The eye remain padded until the

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first post-operative follow up.

All the patients were discharged after one day of surgery and were reviewed after one week, one month, three months and at six months of interval. Antibiotic eye drop was continued up to one month. Steroid eye drop was reduced slowly over the following 8 weeks. All the sutures from cornea were removed after 1 month of surgery by total intravenous anesthesia with ketamine. Refraction and spectacles prescription were given after removal of corneal sutures.

All data were entered in SPSS (version 16.0 for windows; SPSS Inc, Chicago, IL, USA). Statistical analysis was performed by SPSS software version 16.0. Normality of data was estimated from P-value<0.05 was regarded as statistically significant. Analyses were conducted by Descriptive analysis, Paired sample t test and the Friedman (k dependent) test.

RESULT

A total of 20 children with bilateral cataract (11 males and 9 females, 40 eyes) met the inclusion criteria. Mean age at the time of surgery was 28.8±1.38 months (range 7–46 months). (Table 2)

Table 2: Demographic data and clinical characteristics of study children

Characteristics	**Amount (N=40 eyes)**	**Minimum**	**Maximum**
Age at presentation	26.45±1.37 months (0-24 months) = 12 eyes (25-48 months) =28 eyes	07 months	46 months
Age at surgery	28.80±1.38 months	09 months	48 months
Sex	Males =11 Females =09	-	-
Types of cataract	Developmental Cataract=14 Congenital Cataract=06	-	-
Axial length	21.08±2.02 mm	12mm	23.55mm
IOL power implanted	18.75±2.27D	15D	23.5D

About 5% were myopic, 55% were hyperopic and 40% had only astigmatism at the end of 1 year follow up. (Figure 1).

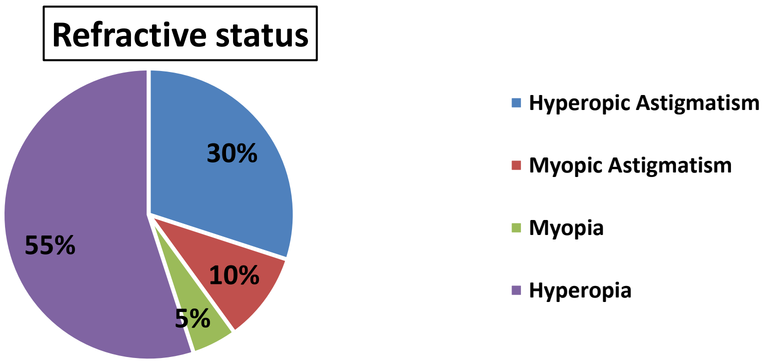

Figure 1: Distribution of the final refractive status

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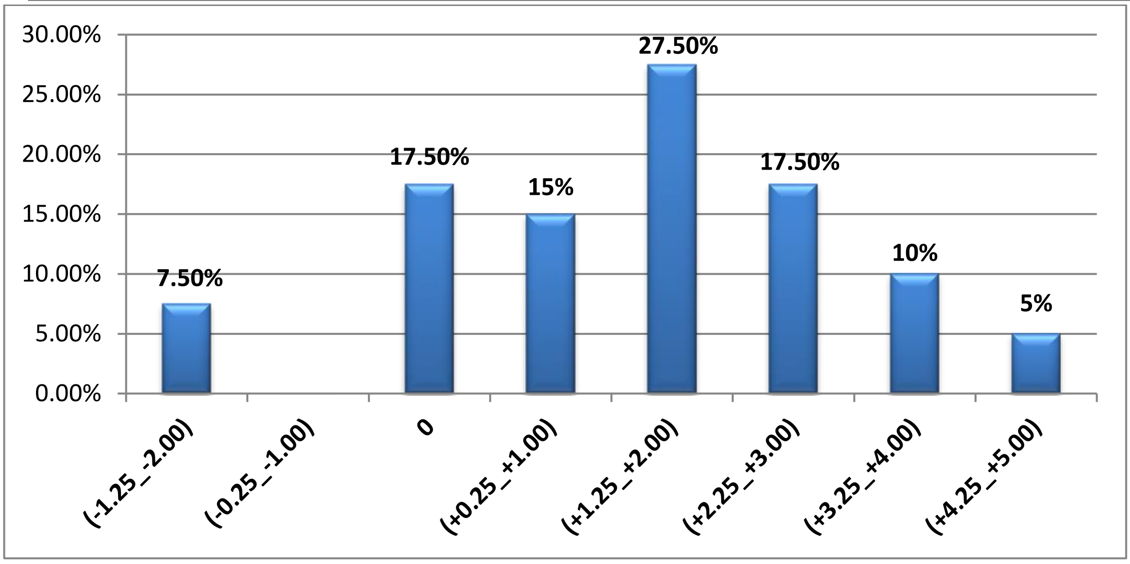

Figure 2: Distribution of the final refractive power (Spherical equivalent) in children who underwent cataract surgery with intended under correction of IOL power

Figure 3 shows the myopic shift observed in all the children and across 2 groups at different follow up visits since the time of the surgery. As expected, the maximum myopic shift was observed in children between 0-24 months of age which was statistically significant according to Friedman K (X^2=32.942, p<0.0001). All patients had with the rule astigmatism & in final postoperative follow up at 1year mean astigmatism was 0.89±1.75 DC.

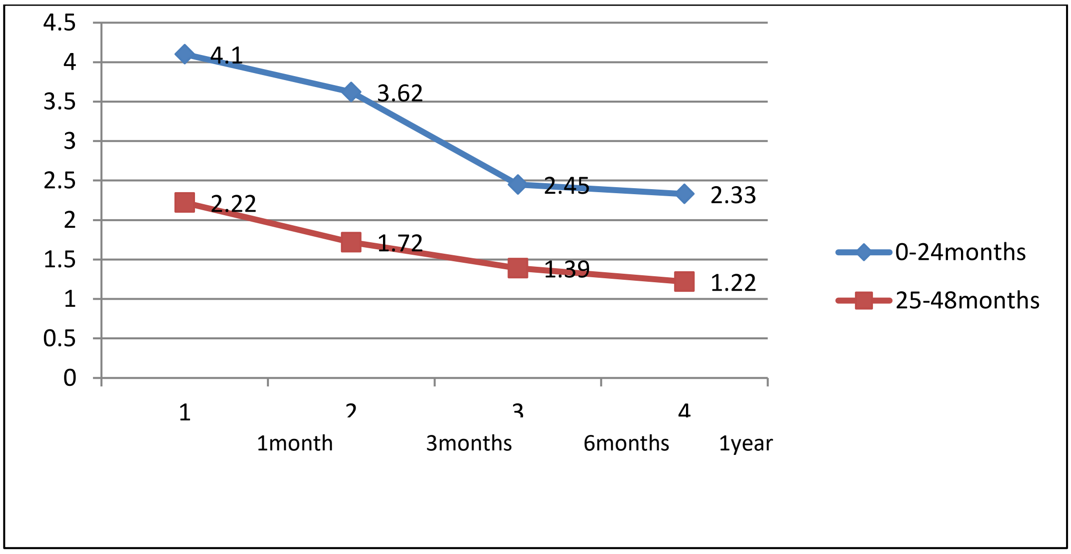

Figure 3: Distribution of the myopic shift (mean refractive error at different follow-up visits) in between 2 groups during validation of under correction guidelines.

Paired sample t test shows that there was statistically significant difference (0.66±1.63D) between the target refraction & initial refraction which reflects the accuracy of IOL power calculation using Dahans formula.

Table 3: Mean differences of target refraction and initial refractive findings of children.

	Mean Standard Deviation	**Mean Differences**	**P values**
Target Refraction	3.45±1.21	0.66±1.63	t=2.547
Initial Refraction	2.79±1.84		p<0.01

DISCUSSION

The majority of ophthalmologists advise an undercorrected IOL power in children to make an initial hypermetropia because to the quick myopic shift, which produces refractive alterations. On the contrary, the amount of myopic shift varies in different children and is not entirely predictable[17]. There is a rising tendency toward intraocular lens (IOL) implantation, which results in a refractive change in children whose eyes are still growing rapidly[12]. Because eye growth influences axial length (AL) and Keratometry readings (KR) and can eventually result in an unexpected refractive error, choosing an appropriate IOL power is not an easy option[12]. Achieving the desired final post-operative refraction is a major difficulty in juvenile cataract surgery, despite great advancements in surgical techniques, equipment, and IOL design.[13].

A large body of studies has indicated that the mean myopic shift in the first year post cataract surgery in children <1–2 years of age was 5.43 to 5.49 D [18,19]. Ganesh *et al.*[5] reported a mean myopic shift as −0.78 ± 1.2D in the first 6 months, −1.66 ± 1.7D in the first year, and −0.75 ± 1.06D in the second year. They reported a mean total myopic shift of −2.35 ± 2.15D in 2 years post operation follow-up. In our study, the highest myopic shift was recorded in the first year of post-operative period between 0-24 months of age which are statistically significant (X^2=32.942, p<0.0001). Our findings are in agreement with most relevant studies that described a long lasting myopic shift until early adolescence after cataract surgery [20]. The youngest age group experienced the most myopic shift, and the variable rate of refraction varied with age. According to Plager et al.[7] children's myopic shift gets less severe as they get older. When Muppidi et al.[8] examined the median myopic shift of children undergoing cataract surgery, ages 2 to 18, they found that the younger group had the most myopic shift and the older group had the least. As expected, our study shows that maximum myopic shift happens in children ≤1 year of age. During follow-up, it was observed that as the age increases, the myopic shift decreases. Mean postoperative refractive astigmatism at 1 year after surgery 0.89±1.75DC. Several study documented that a high degree of astigmatism in neonates and infants that is even higher in preterm newborns and has an inverse association with postconceptional age and birthweight [20]. The linear reduction of the astigmatism to lower values with age is apparently a part of normal eye maturation and emmetropization. It has been suggested that the high astigmatism in early life induces and activates accommodation[20]. Over time, our patients also experienced a shift toward WTR astigmatism. According to earlier research, astigmatism is caused by corneal flattening along the incisional meridian [15, 16], which is consistent with the findings of this study.

Gordon and Donzis[1] aimed for more under correction than the guidelines suggested by Enyedi et al[2] and Dahan et al[3]. Their justification for selecting the guidelines was that Asian children are more likely to develop myopia later in life than other populations. In our study we used Dahans recommendation for under correction of IOL power to achieve target refraction.

The mean difference between target refraction and Initial refraction after surgery is 0.66±1.63D, which is statistically significant according to Freedman K test. Although the evolution of surgical technique has made primary implantation quite popular and possible in pediatric population below 2 years of age, the post operative target refraction accuracy and emmetropization of refractive error are still the two debatable issues[17].In children less than 2 years of age, axial length and keratometry change rapidly as compared to more than 2 years of age. Therefore it has been found practical to rely on axial length alone when IOL power is to be chosen for infants. The majority of change in axial length occurs in the first 2 years of life making the IOL implantation more challenging as there is a myopic shift expected as the child grows, so these children should be under corrected substantially to aim for emmetropia or mild myopia in adults life[17].It is also impossible to accurately predict how much the refractive error will change over time in these eyes. The high residual hypermetropia plus the near add makes it difficult for the infants to wear glasses hence making it a risk factor for amblyopia. So the under correction done was modified according to age at surgery, laterality of cataract, refractive status and axial length of the other eye.

On the contrary, the results of pediatric cataract surgery are not similar as those obtained in adult cataract surgery because pediatric eye differs from the adult eye in terms of low sclero-corneal rigidity and unstable growth of axial length.

Limitations

Recording of AL was not possible in the post-operative follow-up visit, and sample size was small due to irregular follow-up.

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