Original Article

Long-term Results of Congenital Cataract Surgery with Primary Intraocular Lens Implantation: A Case–Control Study of Three Age Groups

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Abstract

Purpose: To analyze the results of ocular refraction at the age of 7 years in children after congenital cataract surgery with intraocular lens (IOL) implantation.

Methods: A study of ocular biometric data of 143 eyes who underwent lens aspiration with IOL implantation in unilateral (23 eyes) and bilateral (60 eyes) congenital cataracts was performed. All children were divided into groups according to the age categories at the time of surgery: Group A (0–12 months) - 43 eyes; Group B (12–36 months) - 45 eyes; and Group C (older than 36 months) - 55 eyes. An empirical reduction of the implanted IOL power was performed: an undercorrection of 20% in children aged 0 to 36 months and 10% less in children aged 36 to 60 months.

Results: By age 7 years, the mean elongation ± standard deviation (SD) in Group A was 3.93 ± 1.64 mm, 2.13 ± 0.94 mm in Group B, and 0.95 ± 0.76 mm in Group C (18.7%, 9.5%, and 4.1% of the baseline axial length, respectively). There was no significant difference in axial elongation between unilateral and bilateral congenital cataracts ($P = 0.32$). The mean absolute refraction error (MAE) at last examination was 3.99 ± 2.12 diopter (D), 2.46 ± 1.48 D, and 1.59 ± 1.31 D in Groups A, B, and C, respectively. In infants younger than 7 months of age, by age 7 years, the mean elongation ± SD was 3.27 ± 2.86 mm (25.5%) and MAE was 3.44 ± 2.1 D. The prevalence of preoperative corneal astigmatism of 1.0 D or more was 48.95%, 2.0 D or more was 27.27%, and 3.0 D or more was 5.6%. There was no significant difference in preoperative corneal astigmatism between unilateral (1.62 ± 0.77 D) and bilateral (1.78 ± 0.90 D) congenital cataracts ($P = 0.56$, 95% confidence interval = −0.50–0.28). Best-corrected visual acuity (BCVA) more than 20/40 was in 53.49%, 55.55%, and 74.54% in Groups A, B, and C, respectively.

Conclusions: Although IOL power was calculated in accordance with children's age, at the age of 7 years, there was a different degree of ametropia because of the biometric changes of the growing eye, and a higher rate of ametropia was observed more in the younger age group than in the elder age groups.

Keywords: Congenital cataract, Intraocular lens, Myopic shift

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Submitted: 06-Aug-2021; **Revised:** 14-Jan-2022; **Accepted:** 14-Jan-2022; **Published:** 30-Nov-2022

Introduction

Advances in surgical techniques, improvements in intraocular lens (IOL), and a better understanding of eye growth allowed performing congenital cataract surgery (CCS) with IOL implantation in infants and young children. Nevertheless, there are still many questions and uncertainties about how a child's eye grows after CCS.[1-8]

Access this article online

Quick Response Code:

Website: www.jcurrophthalmol.org

DOI: 10.4103/joco.joco_245_21

How to cite this article: Orazbekov L, Smagulova S, Ruslanuly K. Long-term results of congenital cataract surgery with primary intraocular lens implantation: A case–control study of three age groups. J Curr Ophthalmol 2022;34:290-6.

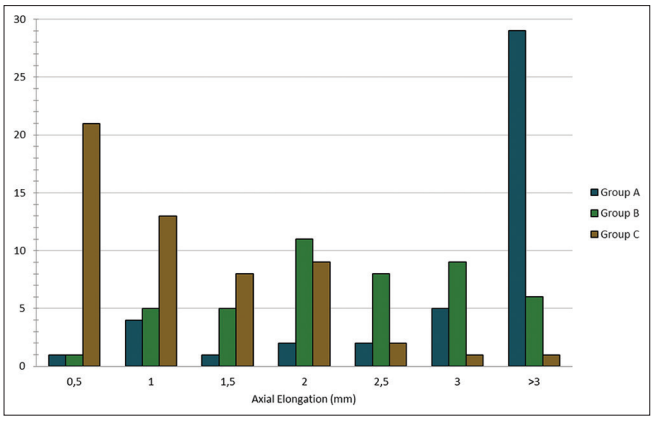

Figure 1: Bar graph shows the axial elongation of children at the age of 7 years from each age group after congenital cataract surgery with intraocular lens implantation. The axial elongation in millimeters are noted on the X axis and the number of cases on the Y axis

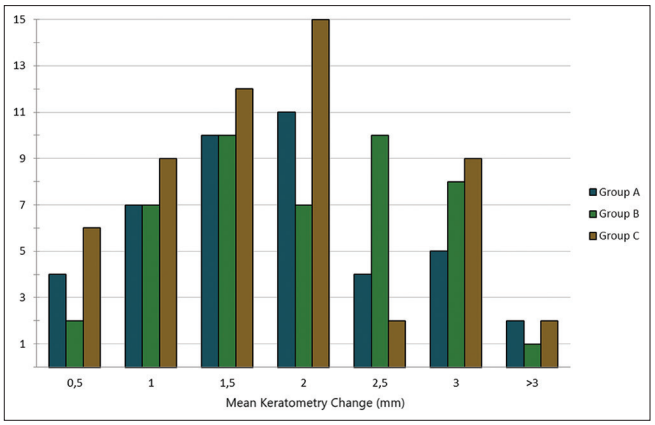

Figure 2: Bar graph shows the corneal curvature change of children at the age of 7 years from each age group after congenital cataract surgery with intraocular lens implantation. The corneal curvature in millimeters is noted on the X axis and the number of cases on the Y axis

The rapid growth of eyes occurs in the first 6 months, followed by slower growth until 10–18 years of age when it reaches an adult's eye size.[9] Similarly, there is a change in the corneal curvature: declining from 51.2 diopter (D) in newborns to 43.5 D at the age of 7 years.[10] In addition, many other variables may affect changes in ocular biometry and eye refraction: hereditary, axial length (AL) <18 mm, presence of coexisting pathology, laterality, IOL position, obtaining accurate baseline biometry, the accuracy of lens calculation formulae.[1-3] Any problems caused by the cataract will become more obvious as the demands on vision increase when a child becomes older.

Although the issue is not novel to ophthalmology, selecting IOL for implantation in children's eyes that are still growing is a challenge: difficulties in obtaining accurate refractive error and ocular biometrics due to lack of patient collaboration, the unpredictability of axial elongation. Still, there is no agreement on the optimal postoperative target refraction in infants and children.[1-6]

Certainly, primary IOL implantation in children younger than 7 months is controversial, and most surgeons recommend leaving children aphakic with further lens/spectacle correction.[1,3,5,6] However, we performed primary IOL implantation in 11 children who were under 6 months inclusive because of the inability to correct induced aphakia: lack of local eye specialists and/or remoteness from health services. Furthermore, uncorrected aphakia in infants is equal to unoperated congenital cataract in achieving normal visual acuity (VA) since in both cases, amblyopia develops rapidly.

The purpose of this report is to analyze the results of biometry changes of the children from 3 age categories at the age of 7 years after CCS with IOL implantation.

Methods

A case-control study was performed on 83 children (143 eyes) at the age of 7 years who underwent lens aspiration with IOL implantation in unilateral (23 children, 23 eyes) and bilateral (60 children, 120 eyes) congenital cataracts from September 2010 to February 2020. The Institutional Review Board approved the study. All required informed consent was obtained from the parents. The study followed the tenets of the Declaration of Helsinki. All children were divided into groups according to the age categories at the time of the surgical intervention, whether the cataracts were unilateral or bilateral: Group A (0–12 months), Group B (12–36 months), and Group C (older than 36 months).

Patients with corneal diameter <9 mm, scarring of the cornea, intraocular pressure of >25 mm, active uveitis, traumatic cataract, complicated cataract, primary persistent hyperplastic vitreous (anterior or posterior form), and history of intraocular surgery were excluded from the study.

The AL and the calculation of the IOL power included the following research methods: using A-Scan ultrasound biometer (EZ AB5500+ A-Scan/B-Scan, Sonomed Inc., Lake Success, NY, USA) in Groups A and B and a swept-source optical coherence tomography-based biometry (ZEISS IOLMaster 700, Carl Zeiss Meditec AG, Jena, Germany) in Group C.

In Groups A and B, Keratometry (K) measurements were taken with a hand-held keratometer (Nidek KM 500, Nidek Co., Ltd., Tokyo, Japan). In Group C, K was measured using a swept-source optical coherence tomography-based biometry (ZEISS IOLMaster 700, Carl Zeiss Meditec AG, Jena, Germany). The mean value of at least two K, within ±0.5 D of each other, were taken for accurate analysis.

VA was measured by different methods appropriate for age: in Group A by the central, steady, maintained method; in Group B by Kay pictures (Clement Clarke International Ltd., Harlow, UK); in Group C by the Snellen chart. For better numerical representations and convenience of analysis, VA was represented in the logMAR.

SRK/T formula was used for IOL power calculation.[1,11] We utilized an empirical reduction of the implanted IOL power

that was proposed by Dahan and Drusedau.[7] The following IOL power corrections were applied: an undercorrection of 20% in children aged 0–36 months and 10% less in children aged 36–60 months. IOL power undercorrection was not applied in children older than 60 months.

Postoperatively, all children were examined at the age of 7 years for best-corrected visual acuity (BCVA), AL, K, residual refraction. The refraction was measured with a dilated retinoscopy by a single examiner and was converted into a spherical equivalent (SE = sphere + ½ cylinder). The mean absolute refraction error (MAE = predicted SE– actual postoperative SE) was calculated postoperatively for analysis. Rate of AL growth was calculated using the following formula:

$$\frac{\text{Postoperative mean AL} - \text{Preoperative mean AL}}{\text{Preoperative mean AL}} \times 100$$

One surgeon (L.O.), according to the standard technique of CCS with IOL implantation performed all procedures. Paracentesis was performed at both upper quadrants; viscoelastic (Viscoat, Alcon) was injected into the anterior chamber. Then a 2.2 mm corneal tunnel incision was made at 11 o'clock. Circular continuous capsulorhexis was performed. Hydrodissection of the lens from the capsule was made. Phacoaspiration in irrigation-aspiration mode was provided. An IOL was implanted in the capsular bag. We implanted AcrySof IQ SN60WF (Alcon Laboratories Inc., Fort Worth, TX, USA), a folding hydrophobic acrylic IOL, in the capsular bag. After IOL implantation, pars plana 25G anterior vitrectomy and posterior capsulotomy were performed (Constellation, Alcon). The surgery was finished with corneal hydration.

In the postoperative period, all children received a combined antibacterial and anti-inflammatory eye drops for 1 month after surgery. An IOL exchange was not performed in any cases.

Statistical analysis

An independent statistician performed statistical analysis by GraphPad Prism 8 software program (GraphPad Software Inc., San Diego, CA, USA). All data were expressed as means ± standard deviation (SD), median, range. Nonparametric tests, the Wilcoxon signed-rank test, and the Mann–Whitney *U*-test were used to analyze continuous data. In all analyses, $P < 0.05$ was taken to indicate statistical significance.

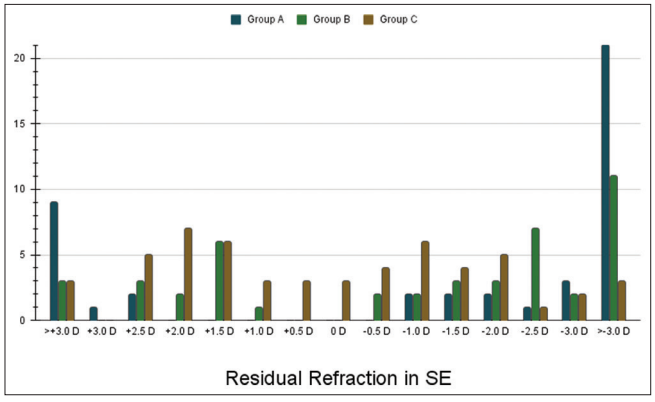

Figure 3: Bar graph shows the residual refraction of children at the age of 7 years from each age group after congenital cataract surgery with intraocular lens implantation. The residual refraction in spherical equivalent is noted on the X axis and the number of cases on the Y axis

Results

Eighty-three children (143 eyes) with a mean baseline age of 38.1 ± 23.8 months, ranging from 4 to 80 months, underwent CCS with IOL implantation [Table 1].

The first and last eye measurements in all groups are shown in Tables 2-4. The substantial axial elongation occurred in Group A, which included the youngest patients. By age 7 years, the mean elongation ± SD in Group A was 3.93 ± 1.64 mm, 2.13 ± 0.94 mm in Group B, and 0.95 ± 0.76 mm in Group C (18.7%, 9.5%, and 4.1% of the baseline AL, respectively) [Figure 1]. Across the three groups, a statistically significant difference in axial elongation was found ($P < 0.0001$). Regarding unilateral and bilateral congenital cataracts, there was no significant difference in axial elongation between them ($P = 0.32$).

The mean preoperative corneal astigmatism was 1.75 ± 0.88 D (range, 0.07–5.8 D). There was no significant difference in preoperative corneal astigmatism between unilateral (1.62 ± 0.77 D) and bilateral (1.78 ± 0.90 D) congenital cataracts ($P = 0.56$, 95% confidence interval = −0.50 to 0.28). The prevalence of preoperative corneal astigmatism of 1.0 D or more was 48.95%, 2.0 D or more was 27.27%, and 3.0 D or more was 5.6% [Figure 2].

In Group A, by age 7 years, myopia dominated in the structure of residual ametropia in 19 eyes (44.19%), hyperopia in 1 eye (2.32%), and mixed astigmatism (one principal meridian is nearsighted, and the other is farsighted: light rays come to two focal points, one is before the retina and the other is behind the retina) in 1 eye (2.32%). Myopic astigmatism (one or both principal meridians on the eye are nearsighted) was found in 11 eyes (25.58%), of which compound myopic astigmatism (light comes to two focal points, both are before the retina but at two different locations) in 10 eyes (23.26%), simple myopic astigmatism (light comes to two focal points: one before the retina, and one on the retina) in 1 eye (2.32%). Hyperopic astigmatism (one or both principal meridians on

Table 1: Preoperative parameters of children

Parameter	Group A	Group B	Group C
Children/eye	22/43	29/45	32/55
Gender: Male/female	14/8	19/10	22/10
Unilateral/bilateral cataracts	1/21	13/16	9/23
Mean age at the time of surgery±SD (months)	9.4±2.9	33.8±7.5	63.9±9.1
Follow-up duration±SD (months)	74.6±2.9	50.2±7.5	20.1±9.1

SD: Standard deviation

Table 2: Clinical characteristics of Group A patients (*n*=43)

Indicator	Before surgery			After surgery, at the age of 7 years			*P*
	Mean±SD	Median	Range	Mean±SD	Median	Range	
AL (mm)	21.01±1.84	20.62	17.0-25.3	24.94±1.91	25.3	20.01-29.04	<0.001†
K1 (D)	43.63±1.55	43.25	40.0-47.5	42.62±1.64	42.75	38.7-46.25	0.003†
K2 (D)	45.69±1.71	45.42	42.75-50.52	44.25±1.87	44.41	39.7-49.0	<0.001†
Km (D)	44.66±1.93	44.59	40.0-50.52	43.43±1.93	43.7	38.7-49.0	<0.001†
BCVA		1.6*		0.28±0.15	0.22	0.05-0.52	<0.001†
SE (D)		Not determined		−2.02±4.08	−2.98	−11.25 - +4.75	NA
MAE (D)		Not determined		3.99±2.12	3.5	0.5-11.25	NA

*All eyes had eccentric fixation and nystagmoid movements and were designated as uncentral, unsteady, and unmaintained (VA ≤5/200). †Wilcoxon signed-rank test. AL: Axial length, VA: Visual acuity, K: Keratometry measurements, BCVA: Best-corrected VA, SE: Spherical equivalent, MAE: Mean absolute refraction error, NA: Not available, D: Diopter, SD: Standard deviation

Table 3: Clinical characteristics of Group B patients (*n*=45)

Indicator	Before surgery			After surgery, at the age of 7 years			*P*
	Mean±SD	Median	Range	Mean±SD	Median	Range	
AL (mm)	22.52±1.64	22.02	19.16-26.18	24.65±1.62	24.75	22.0-27.8	<0.001*
K1 (D)	43.27±1.61	43.12	39.0-47.5	43.23±1.03	43.19	39.5-44.88	0.34*
K2 (D)	45.07±1.72	45.0	41.15-48.75	44.72±1.08	44.5	41.25-47.25	0.51*
Km (D)	44.17±1.89	44.12	39.0-48.75	43.97±1.29	44.05	39.5-47.25	0.29*
BCVA	1.67±0.43	1.69	1.02-3	0.24±0.15	0.22	0.0-0.52	<0.001*
SE (D)		Not determined		−1.08±2.69	−1.5	−6.0 - +4.63	NA
MAE (D)		Not determined		2.46±1.48	2.0	0-5.5	NA

*Wilcoxon signed-rank test. AL: Axial length, K: Keratometry measurements, BCVA: Best-corrected visual acuity, SE: Spherical equivalent, MAE: Mean absolute refraction error, NA: Not available, D: Diopter, SD: Standard deviation

Table 4: Clinical characteristics of Group C patients (*n*=55)

Indicator	Before surgery			After surgery, at the age of 7 years			*P*
	Mean±SD	Median	Range	Mean±SD	Median	Range	
AL (mm)	22.63±2.31	22.0	19.9-29.8	23.56±2.15	23.61	20.67-30.34	<0.001*
K1 (D)	42.85±1.85	42.35	39.0-47.14	43.37±1.64	43.35	40.12-46.87	0.02*
K2 (D)	44.5±1.79	44.25	41.41-48.3	45.01±1.98	44.75	42.25-50.5	0.29*
Km (D)	43.68±1.99	43.67	39.0-48.13	44.19±2.0	44.0	40.12-50.5	0.04*
BCVA	1.49±0.49	1.39	0.39-2.3	0.22±0.15	0.22	0.0-0.82	<0.001*
SE (D)		Not determined		0.15±2.06	0	−5.83 - +5.91	NA
MAE (D)		Not determined		1.59±1.31	1.5	0-6.0	NA

*Wilcoxon signed-rank test. AL: Axial length, K: Keratometry measurements, BCVA: Best-corrected visual acuity, SE: Spherical equivalent, MAE: Mean absolute refraction error, NA: Not available, D: Diopter, SD: Standard deviation

the eye are farsighted) was found in 11 eyes (25.58%), all of them were compound hyperopic astigmatism (light comes to focal points, both would be in a virtual location behind the retina but at different virtual locations).

In Group B, by age 7 years, emmetropia was achieved in 7 eyes (15.55%). Myopia, as well as in Group A, dominated in the structure of residual ametropia in 12 eyes (33.3%), hyperopia in 6 eyes (26.67%), and mixed astigmatism in 1 eye (2.22%). Myopic astigmatism was found in 11 eyes (24.44%), of which compound myopic astigmatism was in 10 eyes (22.22%) and simple myopic astigmatism in 1 eye (2.22%). Hyperopic astigmatism was found in 8 eyes (17.78%), of which compound hyperopic astigmatism was in 5 eyes (11.11%) and simple hyperopic astigmatism (light comes to two focal points, one on the retina and another focus point that would be a virtual point behind the retina) in 3 eyes (6.67%).

In Group C, by age 7 years, emmetropia was achieved in 25 eyes (45.45%). Myopia in 7 eyes (12.73%), hyperopia in 10 eyes (18.18%), and mixed astigmatism in 2 eyes (3.64%). Hyperopic astigmatism was found in 6 eyes (10.91%), of which compound hyperopic astigmatism in 1 eye (1.82%), simple hyperopic astigmatism in 5 eyes (9.09%). Myopic astigmatism was found in 5 eyes (9.09%), of which compound myopic astigmatism was in 1 eye (1.82%) and simple myopic astigmatism in 4 eyes (7.27%).

We separately analyzed data of children under the age of 6 months: 9 children (11 eyes) [Table 5]. The mean age

of the children was 5.27 ± 0.9 months, ranging from 4 to 6 months. By age 7 years, the mean elongation ± SD was 3.27 ± 2.86 mm (25.5%). One patient from this series was hyperopic at the final examination and had postoperative residual refraction in SE + 2.4 D and AL 20.01 mm (the mean elongation 1.01 mm; by 5.3%). Other 10 patients were myopic and had postoperative mean residual refraction −4.7 ± 1.19 D (SE ± SD) with range from −1.84 D to −5.79 D and mean AL ± SD was 25.35 ± 0.97 mm with range from 23.5 to 26.75 mm (the mean elongation 3.41 ± 2.89 mm; by 27.5%).

The later CCS was performed, the fewer refractive errors we noted [Table 6 and Figure 3]. There is no statistical significance in final mean refractive error between Groups A and B ($P = 0.17$), but statistically significant between Groups A and C ($P = 0.0019$) and Groups B and C ($P = 0.012$). There was no statistical significance in SE between the unilateral and bilateral cataracts ($P = 0.32$). BCVA more than 20/40 was in 53.49%, 55.55%, and 74.54% in Groups A, B, and C, respectively. There is no statistical significance in BCVA between Groups A and B ($P = 0.429$) and Groups B and C ($P = 0.201$), but a statistically significant difference was found between Groups A and C ($P = 0.017$).

The only postoperative complication was posterior capsular opacification (PCO) in 23 (16.1%) eyes: 11 (25.6%), 6 (13.3%), and 6 (10.9%) eyes in Groups A, B, and C, respectively.

Discussion

Predicting final AL and the refractive outcome in the growing eye remains a major issue in CCS with IOL implantation. The AL reaches from 16 mm at birth to 20 mm in the first 2 years of life, then elongates more slowly by the age of 7 years when it reaches approximate emmetropia.[7,10]

In our study, we observed AL elongation in all groups at final examination: Group A: 24.94 ± 1.91 mm ($P \leq 0.001$), Group B: 24.65 ± 1.62 mm ($P \leq 0.001$) and Group C: 23.56 ± 2.15 mm ($P \leq 0.001$).

According to the literature, younger children have steeper cornea and K that declines sharply in the first 6 months of life and at about the age of three corneal curvature reaches adult parameters (0.5 D per month up to 1 year, 0.05 D per month up to 3 years), declining from 51.2 D in newborns to 43.5 D at the age of 7 years.[10,12-14] Regarding rapid flattening of the corneal curvature, Gordon and Donzis reported that in newborn children, km declines from 51.2 D to 45.2 D at the age of 1 year, which is nearly consistent with our values of km (44.7 D) in children for the same age group.[10] Concerning the other two age groups, km in Group B was 44.2 D, which was lower than their km of 45.1 D, and km in Group C was 43.7 D, which was equal to 43.6 D in children from their study for the same age group.

Analysis of K showed that 78.32% of those studied had some degree (>1.0 D) of astigmatism, which persisted by the age of 7 years in 89.29% of children postoperatively. According to the literature, the percentage of corneal astigmatism more than 1 D in congenital cataract was 59.71%–79.0%.[15-17] Considering the high percentage of astigmatism in patients with congenital cataract, Vasavada *et al*. in their prospective case study implanted aspheric toric monofocal IOL after cataract surgery.[18] As a result, mean preoperative corneal astigmatism 1.56 ± 2.13 D after toric IOL implantation reduced postoperative refractive astigmatism to −0.55 ± 0.40 D, and children had good visual outcomes in 74%. Thus, in some cases, toric IOL is the best choice in treating CCS.

Today, there are three known methods of IOL strength undercorrection in children. Chen's method is based on undercorrection of the lens by 1.25 D less than SE of the fellow eye for children 2–4-year-old and for children older than 4 years equal to SE of the fellow eye.[19] Another approach recommended by Enyedi *et al*. the so-called "the rule of seven" where the sum of target refraction after the surgery and the children age is 7, and the target refraction is determined respectively: +6 D for a 1-year-old child, +5 D for a 2-year-old, +4 D for 3-year-old, +3 D for 4-year-old, +2 D for 5-year-old, +1 D for 6-year-old, plano for 7-year-olds and -1 D to -2 D for patients over 8-year-old.[3] Dahan and Drusedau proposed a percentage reduction from the calculated emmetropic IOL power according to age that we used in our study and mentioned in the material and methods

Table 5: Clinical characteristics of children under the age of 6 months (n=11)

Indicator	Before surgery			After surgery, at the age of 7 years			*P*
	Mean±SD	Median	Range	Mean±SD	Median	Range	
AL (mm)	19.81±0.71	19.67	18.9-20.87	24.87±1.86	25.7	20.01-26.75	0.001†
K1 (D)	43.71±1.04	43.75	42.1-45.5	43.18±1.17	43.66	41.0-44.75	0.051†
K2 (D)	45.78±1.98	45.0	44.0-50.5	44.19±0.91	44.25	43.0-45.58	0.01†
Km (D)	44.75±1.87	44.23	42.1-50.5	43.69±1.15	43.7	41.0-45.58	0.01†
BCVA		3.0*		0.38±0.14	0.39	0.22-0.52	<0.001†
SE (D)		Not determined		−4.06±2.42	−5.0	−5.79 - +2.39	NA
MAE (D)				3.44±2.1	4.75	0.25-5.5	NA

*VA "hand motion at 2 feet" - All patients were able to distinguish and fix their eyes on the examiner's moving hand from a maximum distance of 2 feet. †Wilcoxon signed-rank test. AL: Axial length, K: Keratometry measurements, BCVA: Best-corrected visual acuity, SE: Spherical equivalent, MAE: Mean absolute refraction error, NA: Not available, D: Diopter, VA: Visual acuity, SD: Standard deviation

Table 6: Residual refraction after congenital cataract surgery at the age of 7 years represented in spherical equivalent

SE (D)	Group A	Group B	Group C
>+3.0	9 (20.9)	3 (6.7)	3 (5.4)
+3.0	1 (2.3)	0	0
+2.5	2 (4.6)	3 (6.7)	5 (9.1)
+2.0	0	2 (4.4)	7 (12.7)
+1.5	0	6 (13.3)	6 (10.9)
+1.0	0	1 (2.2)	3 (5.4)
+0.5	0	0	3 (5.4)
0	0	0	3 (5.4)
−0.5	0	2 (4.4)	4 (7.3)
−1.0	2 (4.6)	2 (4.4)	6 (10.9)
−1.5	2 (4.6)	3 (6.7)	4 (7.3)
−2.0	2 (4.6)	3 (6.7)	5 (9.1)
−2.5	1 (2.3)	7 (15.5)	1 (1.8)
−3.0	3 (6.9)	2 (4.4)	2 (3.6)
>−3.0	21 (48.9)	11 (24.4)	3 (5.4)

Data are *n* (%) of total eyes from each group. SE: Spherical equivalent, D: Diopter

section.[7] The last two methods are widely used in ophthalmic practice.

Weakley *et al*. reported the greatest myopic shift in children younger than 1.5 years of age after IOL implantation followed by a slower axial elongation up to 5 years of age resulting in a high magnitude of postoperative refractive errors.[6] According to Vasavada *et al*. and Vanderveen *et al*., the greatest myopic shift was found in the 1st years of life, up to 3 years of age, and mostly in unilateral cataracts.[1,4] The mean myopic shift change per year in children who had surgery at the age of 1–3 was 0.81–0.93 D/year and gradually decreased in children who had surgery when they were older than 10 years 0.10–0.33 D per year.[2,14] With regard to myopic shift, our data is consistent with previous papers. Assuming that a 0.4 mm increase in AL corresponds to a 1.00 D change in refractive error, facile calculation showed that the greatest myopic shift in our series was in Group A (9.82 D), followed by Groups B (5.32 D) and C (2.37 D).[10-12] Unfortunately, the lack of data makes it impossible to accurately calculate the annual myopic shift change.

The degree of refractive error at final examination was higher as expected in children with pseudophakia who had surgery younger than 36 months of age (in Groups A and B), whose mean values in Group A, at the time of the survey, SE was equal to −2.02 ± 4.08 D, in Group B was equal to −1.08 ± 2.69 D, and mostly achieved the predicted emmetropic target refraction in Group C, at the time of the survey, is equal to 0.15 ± 2.06 D. Unfortunately, we had 1 patient from Group A with a large myopic shift. The child did not have glaucoma or any other ocular pathology. His eye refractions were −11.25 D in the right eye and −10.5 D in the left eye at the last examination; his AL elongated from 22.83 to 27.9 mm and from 23.48 to 29.04 mm and km changed from 44.81 to 47.12 D and from 44.72 to 47.5 D in the right and left eyes, respectively. Plager *et al*. reported a similar isolated case in their study.[2] A 3.5-year-old boy had postoperative refraction in both eyes of +3.00 D. However, by age 10, refraction was −7.25 D and −8.75 D in the right and left eyes, respectively. They suggested that such a large myopic shift was due to heredity since the child's parents had myopia. In our study, the child's mother's refraction was −8.0 D in both eyes and father's was −4.75 D in both eyes. We cannot make a definite suggestion as to whether it is hereditary or a sporadic case. In our opinion, the impossibility to predict the biometric changes of the growing eye in infants was the main cause of such a wide range of errors in postoperative refraction in all groups.

We found a similar issue with a myopic shift in the Infant Aphakia Treatment Study. The multicenter randomized clinical trial comparing IOL implantation and contact lens treatment after surgery in children chose as a target refraction +8.0 D in children between 4 and 6 weeks of age, and +6.0 D for children 6 weeks and older.[1] However, in 5 years, refractive errors ranged from +5.00 D to −19.00 D.[5]

Another factor contributing to postoperative refraction is AL measurement techniques. Usually, AL measurement errors occur when the cornea is compressed. Trivedi and Wilson reported that AL measured by the contact method in 84% were shorter (on average 0.27 mm) compared with the immersion method in pediatric eyes.[20] This difference in AL results in an IOL power difference of 1.06 ± 1.33 D. In other words, a lower AL value of the contact method results in the use of an average 1 D stronger IOL that induces myopia in the postoperative period.

The advantage of primary IOL implantation in children is reducing dependence on eyeglasses and/or contact lenses, providing conditions that are closest to natural for vision development in eyes prone to amblyopia.[21] However, concerns about primary IOL implantation relate to the higher refractive error rates, the choice of appropriate IOL power, and a variety of complications after implantation. The most commonly reported complications after CCS with IOL implantation are secondary glaucoma in 16% (compared with the aphakia group, 9%), PCO in 7.7% (in the aphakia group, 5.4%), and postoperative uveitis in 9.6% (in the aphakia group, 0.4%).[22-24] In our study, the sole complication we had was PCO, 16.1%.

Some studies have shown that delayed secondary implantation of IOL in children younger than 7 years of age is necessary, and it is recommended to leave the eye aphakic, followed by correction with contact lenses or glasses, thereby preventing higher rates of refractive errors, as well as a high incidence of intra and postoperative complications that require additional surgical procedures.[5,8]

The first and main limitation of our research is an absence of immediate postoperative data for detailed analysis. The second limitation of our work is the use of different methods to acquire biometric data from patients before and after surgery, which can, to some extent, affect the results of the study. The

third limitation of our study is that we have not evaluated the reliability of our findings by taking repeated measurements at same time by different observers or at different times using the same observer. The present findings may be attributed to the operational approach and methodology practiced at our center, which is another limitation of our research (considering that our research institute is the only organization that treats almost all cases of congenital cataracts in our state, our data may be representative of our region).

Although IOL power was calculated in accordance with children's age, at the age of 7 years, there was a different degree of ametropia because of the biometric changes of the growing eye and a higher rate of ametropia was observed more in the younger age group than in the elder age groups. Considering the high prevalence of corneal astigmatism preoperatively and the presence of astigmatism in residual refraction after CCS at the age of 7 years, a toric IOL implantation may be necessary. The greatest myopic shift and a wide range in postoperative refraction were mostly in the younger age group than in the elder age groups. The issue of appropriate age for IOL implantation remains open and may have to be decided on a case-by-case basis.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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