Original Research Paper

Volume - 10 | Issue - 6 | June - 2020 | PRINT ISSN No. 2249 - 555X | DOI : 10.36106/ijar

Ophthalmology

CENTRAL CORNEAL THICKNESS AND INTRAOCULAR PRESSURE CHANGES AFTER CONGENITAL CATARACT SURGERY – A PROSPECTIVE STUDY

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ABSTRACT

PURPOSE: To evaluate the changes in central corneal thickness and intraocular pressure in infants and children aged 3 months to 12 years who had undergone congenital or developmental cataract extraction surgery.

METHODS: Institution based prospective longitudinal study was carried out among patients with congenital or developmental cataract undergoing phacoaspiration and anterior vitrectomy. Eyes had IOL implantation (pseudophakic group) or remained aphakic (aphakic group). The CCT and IOP were measured in all cases preoperatively and at 1 month, 6months, and 12 months postoperatively.

RESULTS: The study evaluated 50 eyes (50 patients). The mean pre-operative CCT was 553±29.29 microns and the mean preoperative IOP was 11.88±1.75 mm Hg. At 12 months postoperative follow-up, mean CCT was 580±35.84 microns and mean IOP was 16.24±3.24 mm Hg, the difference which is statistically significant ($p<0.0001$).Also in patients kept aphakic, the mean CCT at post-operative 12 months was greater (608±12.43 microns) than in pseudophakia (567±35 microns) and IOP was 19±3.8 mm Hg and 14.9±1.74mm Hg respectively.

CONCLUSION: Central corneal thickness increased in patients after 12 months of congenital or developmental cataract extraction with a significant increase in intraocular pressure.

KEYWORDS : CCT, IOP, congenital cataract, aphakia, pseudophakia

INTRODUCTION

Congenital cataracts are responsible for 5-20% of blindness in children worldwide.[1,2]

In the majority of bilateral congenital cataracts or infantile cataracts, genetic mutation is likely the most common cause.[3]; such as CRYGD, CRYAA, CRYGC, CRYG4, CRYAB, CRYA2, CRYBA1, CRYB1, CRYBB2, CRYB2, CCP, PCC, CTPP2, MIP (54), AQP0, GJA3, CX46, CZP3, CAE3, GJA8, among others.

Systemic associations include metabolic disorders such as Galactosemia[4,5,6], Wilsons disease, Hypocalcemia[7], Diabetes insipidus, intrauterine infections including rubella[8], herpes simplex[9], toxoplasmosis, varicella, and syphilis.[9,10]

In contrast, most unilateral cataracts are usually the result of local dysgenesis and may be associated with ocular dysgenesis such as persistent fetal vasculature[11], posterior lenticonus, lentiglobus[12], trauma.

It is now well established that critical period of surgery for visually significant unilateral cataracts is from birth to 6 weeks of age,[14] while in bilateral dense cataracts, permanent sensory deprivation can occur if the surgery is delayed beyond 3-4 months of age.[15,16]

The prevalence of increased intraocular pressure after congenital cataract surgery varies from 1% to 32%[17]. Central corneal thickness influences IOP measurement – an important predictive factor for the development of primary open-angle glaucoma in the Ocular Hypertension Treatment Study[18].The average central corneal thickness in children without glaucoma is 540-560 micron.

MATERIALS AND METHODS

METHODS

1. **STUDY AREA:** Regional Institute of Ophthalmology, Kolkata and Department of Medicine, Medical College, Kolkata.
2. **STUDY POPULATION:** Patients with congenital and developmental cataract presenting at OPD at RIO, Kolkata
3. **STUDY PERIOD:** 18 months(1st January 2018 – 1st June 2019)
4. **SAMPLE SIZE:**50
5. **STUDY TECHNIQUE AND DATA COLLECTION:**
   A. History taking
   B. Clinical examination and local eye examination
   C. Relevant investigations
D. CCT and IOP measurement before and following congenital cataract extraction surgery
E. Follow-up based on clinical finding, pachymetry, and tonometry

6. STUDY TOOLS:

A. Torch
B. Snellen chart (if visual acuity can be measured)
C. Slit-lamp biomicroscope (to exclude any anterior segment pathology if possible)
D. Direct or indirect ophthalmoscope (to exclude any retinal pathology)
E. Pediatric speculum
F. Anaesthetic eye drop
G. General anaesthesia equipment if required
H. Perkins tonometer or Goldmann Applanation Tonometer
I. Ultrasonic pachymeter

7. **INVESTIGATIONS:**

A. Slit-lamp biomicroscopy
B. Indirect ophthalmoscopy using 20D lens or direct ophthalmoscopy
C. Ultrasonic pachymetry
D. Tonometry (Perkins or Goldmann)
E. B-scan USG

8. **TYPE OF STUDY:**

Institution based prospective longitudinal study.

9. Inclusion Criterion:

A. Patients aged 3 months to 12 years with unilateral or bilateral congenital or developmental cataracts significantly blocking the visual axis.
B. Patients who had undergone congenital cataract extraction surgery with unilateral or bilateral aphakia or pseudophakia.
C. Their parents or legal guardians signed the informed consent to receive examinations or co-operative with clinicians.

10. Exclusion Criterion:

A. Patients with cataracts other than congenital cataract, like traumatic cataract.
B. Patients with ocular pathology which can alter CCT and IOP like microphthalmos, corneal opacity, congenital glaucoma, anterior segment dysgenesis, iris coloboma, aniridia, accompanying uveitis.
C. Patients with systemic syndromes like Down syndrome, Marfan syndrome, Sphingolipidosis which can alter CCT.
D. Non-cooperative parents or legal guardians.
E. Patients who were lost to follow-up.

RESULTS AND ANALYSIS STATISTICAL ANALYSIS

For statistical analysis, data were entered into a Microsoft Excel spreadsheet and then analyzed by SPSS (version 25.0; SPSS Inc., Chicago, IL, USA) and GraphPad Prism version 5. Data had been summarized as mean and standard deviation for numerical variables and count and percentages for categorical variables.

Table 1: Distribution of MEAN CCT in Micron

		Number	Mean	SD	Minimum	Maximum	Median	p-value
CCT in Micron	Pre.Op	50	553.5600	29.2973	512.0000	637.0000	552.5000	0.0001
	At1 Month	50	556.8800	28.5168	512.0000	639.0000	560.5000	
	At6 Month	50	569.3000	34.0469	520.0000	651.0000	564.0000	
	At12 Month	50	580.3600	35.8414	522.0000	641.0000	584.0000	

In pre-op, the mean CCT in Micron (mean± s.d.) of patients was 553.5600 ± 29.2973. In at 1 month, the mean CCT in Micron (mean± s.d.) of patients was 556.8800 ± 28.5168. In at 6 months, the mean CCT in Micron (mean± s.d.) of patients was 569.3000 ± 34.0469. In at 12 month, the mean CCT in Micron (mean± s.d.) of patients was 580.3600 ± 35.8414. The difference of mean CCT in Micron vs. follow up was statistically significant (p=0.0001).

Table 2: Distribution of mean IOP

		Number	Mean	SD	Minimum	Maximum	Median	p-value
IOP	Pre.Op	50	12.3800	2.0493	10.0000	19.0000	12.0000	<0.0001
	At1 Month	50	11.8800	1.7571	10.0000	18.0000	12.0000	
	At6 Month	50	15.1200	2.3702	11.0000	22.0000	14.0000	
	At12 Month	50	16.2400	3.2423	11.0000	25.0000	16.0000	

In pre-op, the mean IOP (mean± s.d.) of patients was 12.3800 ± 2.0493. In at 1 month, the mean CCT in Micron (mean± s.d.) of patients was 11.8800 ± 1.7571. In at 6 month, the mean IOP (mean± s.d.) of patients was 15.1200 ± 2.3702. In at 12 month, the mean IOP (mean± s.d.) of patients was 16.2400 ± 3.2423. The difference in mean IOP vs. follow up was statistically significant (p<0.0001).

Table 3: Distribution of mean IOP 12 month Post-op vs Age group

		Number	Mean	SD	Minimum	Maximum	Median	p-value
IOP at 12 month Post	≤20	16	19.0625	3.8896	12.0000	25.0000	18.5000	0.0001
	21 to 30	17	15.0588	2.0147	11.0000	18.0000	16.0000	
	31 to 40	12	14.6667	1.5570	12.0000	17.0000	14.0000	
	>41	5	15.0000	1.4142	13.0000	16.0000	16.0000	

In age ≤20 months, the mean IOP at 12 month Post (mean± s.d.) of patients was 19.0625 ± 3.8896.

In age, 21 to 30 months, the mean IOP at 12 month Post (mean± s.d.) of patients was 15.0588 ± 2.0147. In age, 31 to 40 months, the mean IOP at 12 month Post (mean± s.d.) of patients was 14.6667 ± 1.5570. In age, 41 to 50 months, the mean IOP at 12 month Post (mean± s.d.) of atients was 15.0000 ± 1.4142. The difference of mean IOP at 12 month Post vs. age group was statistically significant (p=0.0001)

Table 4: Distribution of mean CCT in Micron at 12 month Post-op vs Age group

		Number	Mean	SD	Minimum	Maximum	Median	p-value
CCT in Micron at 12 month Post op	≤20	16	608.0000	12.4365	586.0000	624.0000	612.0000	0.0001
	21 to 30	17	578.0000	40.3965	522.0000	641.0000	572.0000	
	31 to 40	12	561.4167	27.6157	524.0000	591.0000	570.5000	
	>41	5	545.4000	29.1170	522.0000	590.0000	528.0000	

In age ≤20 months, the mean CCT in Micron at 12 month Post-op (mean± s.d.) of patients was 608.0000 ± 12.4365. In age, 21 to 30 months, the mean CCT in Micron at 12 month Post-op (mean± s.d.) of patients was 578.0000 ± 40.3965. In age, 31 to 40 months, the mean CCT in Micron at 12 months Post-op (mean± s.d.) of patients was 561.4167 ± 27.6157. In age, 41 to 50 months, the mean CCT in Micron at 12 month Post-op (mean± s.d.) of patients was 545.4000 ± 29.1170. The difference of mean CCT in Micron at 12 month Post-op vs. age group was statistically significant (p=0.0001).

Table 5- Association between Post-op status & CCT at 12 months

In aphakia, the mean CCT at post-operative 12 months was 608 ± 12.43 & in pseudophakia, the mean CCT at postoperative 12 month was 567 ± 35 microns

Post-op status	Mean	SD
Aphakia	608	12.43
Pseudophakia	567	35.95

Table no.-6 Association between post-op status & IOP

Post-op status	Mean	SD
Aphakia	19.06	3.88
Pseudophakia	14.91	1.74

In aphakia at postoperative 12 months mean IOP was 19.06±3.8 mm of Hg. & in pseudophakia, it was 14.91±1.74 mm of Hg.

DISCUSSION

Prevention of childhood blindness secondary to congenital cataracts is one of the WHO programs to eliminate preventable blindness in the world, the Vision Programme 2020[19]. The prevalence of congenital cataract is lower in industrialized countries, ranging from 1:10,000 to 6:10,000 children, reaching 5:10,000 to 15:10.000 children in developing countries[20-24]. All congenital amblyopic cataracts should be surgically treated.

Several cross-sectional studies have been shown that children undergoing cataract extraction have corneal thickening, which may artificially increase the value of IOP measured with GAT[25]. Thus IOP is the information of paramount importance in monitoring and decision making in glaucoma in children as the main modifiable risk factor. So central pachymetry also plays an important role in the evaluation of children with cataracts.

In this study, the mean CCT in 50 patients was 553.56±29.29 ranging from 512 microns to 637 microns (Table no 1). In 2004, Amino[26] et al published the average CCT of patients undergoing surgery was significantly higher than in normal patients (592±47 micron and 524±43 micron respectively, p<0.001).

In 2005, Simon[27] et al found in his study that means CCT of aphakic (665 microns, n=36) and pseudophakic (631 microns,n=6) groups were similar (p=0.13). However, the CCT in the pseudophakic group is higher than found in our study which is 608±12.43 micron(Table no 5), probably due to the average age of surgery, which is much lower in this study(51±36 months).In our study, patients aged <24 months were kept aphakic and >24 months underwent primary IOL implantation.

In 2006, Simsek[28] et al found a difference in CCT between aphakic and pseudophakic patients undergoing primary IOL implantation. This was not observed when IOL implantation was performed secondarily. (n=5,p=0.835). In our study, we found that mean CCT at post-operative 12 months is 608±12.43 who has been operated at age less than 20 months whereas mean CCT at post-operative 12 months is 545±29.11 (Table no 4).

Thus we found a negative correlation between CCT and age in the

group of patients operated for congenital cataract, suggesting that lower age at the time of surgery is an important risk factor for increased CCT.

Muir[29] et al conducted a study analysis of patients with or without a diagnosis of glaucoma. Aphakic glaucoma patients had a mean CCT (685±94 micron,n=32) higher than an aphakic patient without glaucoma (620±56 micron,n=25, $p < 0.001$). Among aphakic patients without glaucoma, the longest time after cataract surgery was correlated with higher CCT which suggests that follow-up time may influence the detection of increased CCT. However Muir et al did not describe age when surgery was performed, so we cannot analyze whether CCT increase was due to cataract surgery or it was or present earlier before surgery.

Our study is one of the first longitudinal studies in the literature and presents a longer follow-up (12 months) of children who underwent surgery for congenital cataract treatment. Similar to studies previously discussed[28,29], we observed an increase in CCT in aphakic children after cataract (from 563±10.14 to 608±12.43µm) when compared with pseudophakic eyes (from 543±31 to 567±35µm)(Table no 5).

Two mechanisms may justify this finding: the absence of the lens may be corneal development, and surgery performed at an earlier age[30] significant corneal alterations[31,32,33,34,35]. Probably, studies that showed no difference in CCT between aphakic and pseudophakic patients had early surgery in both groups[27], but at the time of surgery, it was not always clearly demonstrated in the previous studies[28,29,36].

Our study suggests that congenital cataract surgeries performed more often earlier result in greater increases in CCT measurement (Table no 3). The fact of earlier operated pseudophakic patients shows a tendency towards CCT increase, while later-operated aphakic patients did not present presenting an increase in CCT confirms this hypothesis.

Finally, Lim et al found an increase in CCT in patients who developed glaucoma after cataract surgery when compared to patients without glaucoma, suggesting that glaucoma may accentuate the increased CCT.[37-39].

The definitions of ocular hypertension and glaucoma are quite different. depending on the study evaluated. Simon et al defined ocular hypertension as IOP 22 to 35 mmHg with no optic nerve changes or nerve fiber layer injury and no documented visual field loss. Glaucoma was defined as greater or equal IOP at 22 mmHg, with damage to the optic nerve or nerve fiber layer or progression and / or confirmed visual field loss or IOP greater than 35mmHg. According to these definitions, ocular hypertension was found in 60% of the eyes (25/42 eyes) and glaucoma in 21% of the eyes (9/42 eyes). This may be due, among other factors, to the postoperative follow-up time for the measurement which is significantly higher in the study by Simon et al (107.82 months x 36 months)[40].

Simsek et al[28] also analyzed postoperative IOP. The median of the operated group was 23 mmHg, while that of the control group was 14.5 mmHg. We must point out that patients with glaucoma were included, contrary to our study. Positive correlation was found between CCT and IOP in the operated groups ($r = 0.643$; $p < 0.001$) and control ($r = 0.59$; $p < 0001$). In our study, we observed the same behavior in the aphakic group ($r=0.54$;$p=0.04$) but not in the pseudophakic group ($r=0.02$;$p=0.68$) (Table no 5 and 6). The definition of glaucoma, used by Simsek et al, considered glaucoma as the presence of nerve changes associated with IOP greater than 22mmHg. However, optic nerve changes needed to classify the eye as glaucomatous have not been clearly described.

CONCLUSION

CCT increased in patients after 12 months of congenital or developmental cataract extraction. Especially, congenital cataract surgery performed at an earlier age resulted in a greater increase of CCT.

Significant increase in IOP in patients undergoing congenital cataract surgery. This increase was significant after 12 months. An increase in IOP was more significant in patients undergoing surgery at an earlier age. This may be associated with increased CCT in these patients.

Negative correlation was found between age at the time of surgery and CCT variation in all patients, strengthening the hypothesis that early cataract removal surgery can evolve with a greater increase in CCT.

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