

# Glaucoma after Congenital Cataract Surgery

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## Abstract

**Purpose:** To determine the incidence and risk factors associated with glaucoma following congenital cataract surgery (CCS) in children under age of 15

**Methods:** This prospective cohort (since 2006) consisted of children less than 15 years of age who underwent cataract surgery with or without intraocular lens (IOL) implantation. The role of the following factors on the development of glaucoma after CCS including age at surgery, gender, laterality of the cataract, IOL implantation, congenital ocular anomalies, intra- and postoperative complications, length of follow-up, central corneal thickness (CCT) as well as the effect of the age of onset, time to development of glaucoma, and response to treatment were evaluated.

**Results:** Overall, 161 eyes of 96 patients were included in this study of which 28 eyes developed glaucoma. Incidence of glaucoma was 17.4%. Mean±SD age at surgery was 9.3±6.9 (range, 1-24) months in glaucomatous and 40.4±41.1 (range, 1 m-13.6 year) months in non-glaucomatous group ( $p<0.001$ ). All glaucoma patients had the operation under two years of age. In group 1, 9 (60%) and in group 2, 24 (30%) patients were female ( $p=0.001$ ). In group 1, 17 eyes (60.7%) and in the group 2, 41 eyes (30.8%) were aphakic ( $p=0.001$ ). Mean time to diagnosis of glaucoma was 111.2 days (range 30-1200 days). Mean follow-up time was 3.1 years (range, 1-6 years). In 22 (78.6%) eyes glaucoma was diagnosed within six months after surgery. Glaucoma was controlled with medications in 23 eyes (82%) and with surgery in five eyes.

**Conclusion:** In this study the incidence of glaucoma after CCS was 17.4% over a follow-up period of six years. Younger age at the time of lensectomy increases the risk of secondary glaucoma. IOL implantation may protect against glaucoma. Female gender was affected more than male.

**Keywords:** Secondary Glaucoma, Congenital Cataract, Cataract Surgery

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## Introduction

Glaucoma is one of the most important complications of congenital cataract surgery (CCS). It may present as angle closure glaucoma shortly after the surgery or later as an open angle type.<sup>1</sup> Although different pathogenetic mechanisms have been proposed, the exact mechanism remains unknown.<sup>1</sup> The reported incidence for this varies from 6% to 58.7% based on the length of follow-up.<sup>2-6</sup> Glaucoma in these eyes has a slow and progressive course. It may occur years after surgery and the diagnosis is often difficult.<sup>1</sup> Therefore, children who undergo lensectomy remain at risk of developing glaucoma throughout their lives.<sup>3</sup>

Studies have shown that ocular anomalies like microphthalmia,<sup>7</sup> microcornea and persistent fetal vasculature (PFV) may be associated with glaucoma after surgery.<sup>2,4,8</sup>

Currently, the age of the patient at the time of surgery is a known risk factor for developing glaucoma after the cataract surgery.<sup>4,6,7,9-13</sup> Primary intraocular lens (IOL) implantation is currently used in children older than two years of age<sup>14</sup> and IOL implantation in newborns and infants has gradually gained popularity among the surgeons.<sup>15,16</sup> There is growing evidence that the incidence of glaucoma is significantly lower in pseudophakic eyes compared to aphakic eyes<sup>17</sup> leading to the hypothesis of the possible protective role of IOL.<sup>18</sup>

Treatment of aphakic glaucoma is difficult and controversial. In contrast to primary congenital glaucoma, medication is the mainstay of treatment with limited role and surgical procedures have poor prognosis.<sup>11,19</sup>

Since secondary glaucoma following the cataract surgery is the leading cause of visual loss years after the surgery, better understanding the pathogenesis and potential risk factors are of paramount importance.

In this study, we evaluated the incidence and risk factors associated with glaucoma after surgery for congenital or developmental cataract.

## Methods

This prospective cohort has been underway since 2006. The study was approved by the ethics committee of Ahvaz Jundishapur University of Medical Sciences, Ahvaz, Iran

and adheres to the tenets of Declaration of Helsinki.

The study included all children younger than 15 years of age who underwent lensectomy and anterior vitrectomy with or without IOL implantation for congenital or developmental cataract with a minimum follow-up of one year. Exclusion criteria included patients with a history of ocular trauma, those with ocular or systemic diseases, concomitant glaucoma and cataract, and follow-up period less than one year.

The eligible eyes were divided into two groups; group 1 including the eyes that developed glaucoma during the study (glaucomatous group), and group 2 including the eyes without glaucoma during the study (non-glaucomatous group).

All patients underwent complete eye examination before and after the surgery including visual acuity, slit-lamp examination, tonometry and fundoscopy, IOP measurements were done using Goldman applanation tonometer (GAT BQ 900, Haag-Streit, Konitz, Switzerland) in cooperative patients, and Perkins tonometer (Clement Clarke international Ltd, Harlow, UK) in uncooperative patients under anesthesia.

B-scan ultrasonography (Tomey UD 1000 B-scan, Tomey, Nagoya, Japan) was performed in those with severe hazy media precluding direct fundus examination. All uncooperative patients had examination under anesthesia (EUA) before and one week after the operation. If there was no complication after the surgery, next EUA was performed after one month. Thereafter, regular examination or EUA was done every three to four months or earlier if needed. Central corneal thickness (CCT) was measured using ultrasonic pachymetry (Pachymeter SP 3000, Tomey, Nagoya, Japan).

Glaucoma was defined as the presence of intraocular pressure (IOP) >25 mmHg, or cup progression greater than 0.2, or cup asymmetry more than 0.2 on two different examinations, or a combination of both.

Factors that may potentially affect the development of glaucoma including age at the time of surgery, gender, laterality of cataract, IOL implantation, congenital ocular anomalies, intra- and postoperative complications and their correlation with age at onset of

glaucoma, time interval between lensectomy and diagnosis of glaucoma, corneal thickness, and response to glaucoma therapy were evaluated.

All patients were operated under general anesthesia and the same surgical technique, i.e. clear cornea incision, anterior capsulotomy, lensectomy, posterior capsulotomy and anterior vitrectomy. The decision to implant IOL or not was made based on the age of the patient, ocular and systemic conditions and the surgeon's preference. All IOL's were foldable hydrophobic acrylic and were inserted in the capsular bag.

Statistical analysis was done by SPSS 15 software (version 15, Chicago, IL, USA) using *t*-test,  $\chi^2$  and Fisher test. Logistic regression model was used to determine which factors predict development of glaucoma. *p*-values less than 0.05% were considered significant.

## Results

Overall, 161 eyes of 96 patients that underwent lensectomy with anterior vitrectomy with or without IOL insertion were followed for a mean period of 3.1 years (range, 1-6 years). Congenital cataract was the cause of surgery in all cases. Glaucomatous group consisted of 28 eyes and non-glaucomatous group included 133 eyes. The incidence of secondary glaucoma was 17.4% over this period. Demographic data and the patients' characteristics are summarized in table 1.

At the time of surgery, there was no significant difference between the two groups in terms of study parameters except for age. Glaucomatous group was younger at the time of the cataract surgery compared to nonglaucomatous group ( $p < 0.001$ ). In group 1, 15 eyes (53.6%) had surgery between three to five months of age. No patient operated between seven to 10 months of age developed glaucoma.

Mean time to glaucoma diagnosis was 111.2 days (range, 30-1,200 days) after surgery.

The age of the patients at the time of diagnosis of glaucoma was less than one year for 18 eyes (64.2%) and greater than one year for 10 eyes (35.8%) (Table 2). None of the patients operated after two years of age developed glaucoma during follow-up.

In 22 (78.6%) eyes glaucoma was diagnosed within six months after surgery. The highest peak incidence was two months postoperatively (8 eyes, 28.6%), followed by one month (5 eyes, 17.9%) and two weeks postoperatively (4 eyes, 14.3%).

Age at the time of surgery had no statistically significant correlation with response to glaucoma treatment (0.685) and time to glaucoma diagnosis (0.392).

No significant correlation was found between uni- or bilaterality of cataract and development of glaucoma ( $p = 0.09$ ) (Table 3).

Postoperative complications were noted in nine eyes including uveitis in three eyes (two in glaucomatous and one in non-glaucomatous group), iridocorneal adhesion (one in each group), choroidal effusion (one in non-glaucomatous group), retinal tear (one in non-glaucomatous group), iris incarceration (one in non-glaucomatous group) and capsular phimosis (one in glaucomatous and two in non-glaucomatous group). These complications occurred in three eyes in group 1 and six eyes in group 2 ( $p = 0.579$ ) (Table 3).

Overall, 23 glaucomatous eyes were controlled with medications and five needed surgery of which four eyes underwent combined trabeculotomy and trabeculectomy and one eye ended up with Ahmed glaucoma valve (AGV) implantation. Overall, 26 eyes were controlled with  $2.1 \pm 0.8$  medications. One patient with bilateral cataract surgery developed unilateral glaucoma unresponsive to medical therapy needing AGV implantation. Logistic regression model showed that age at surgery (Odds ratio; OR=4.2) and aphakia (OR=2.45) are major predictors of developing glaucoma.

**Table 1.** Characteristics of glaucomatous and non-glaucomatous groups following surgery for congenital or developmental cataract

Group	Number of eyes / patients	Gender F(%)	Age at surgery (months)	CCT (µm)	
glaucomatous	28/15 (17.4%)*	9 (60)	9.3 (6.9)	626±94	17 (60.7)
Non-glaucomatous	133/81	24 (30)	40.4 (41.1)	627±73	41 (30.9)
p		0.19	<0.001	0.946	0.001

F: Female, CCT: Central corneal thickness, \*: Incidence of glaucoma

**Table 2.** Age distribution of the patients with (group 1) and without (group 2) glaucoma at the time of cataract surgery and glaucoma diagnosis

Age distribution	Group	<1 year	>1 year
at the time of cataract surgery	1	24 eyes (85.7%)	4 eyes (14.3%)
	2	47 eyes (35.3%)	86 eyes (64.7%)
at the time of glaucoma diagnosis	1	18 eyes (64.2%)	10 eyes (35.8%)

Group 1: Eyes with glaucoma, Group 2: Eyes without glaucoma

**Table 3.** Potential risk factors for development of glaucoma

Risk factor	Glaucomatous Group	Non-glaucomatous Group	p	Odds Ratio
Gender (F)	9 (60%)	24 (30)	0.19	1.2
Age at surgery (months)	9.3±6.9	40.4±41.1	<0.001	4.22
Aphakia	17 (60.8%)	41 (30.9%)	0.001	2.45
Postsurgical complications	3 (10%)	6 (4%)	0.579	1.53
Bilateral cataract	13 patients (92.9%)	52 patients (64.2%)	0.09	1.53

## Discussion

Glaucoma after the congenital or developmental cataract surgery is a major cause of visual loss in these patients. In our study, the incidence of this complication was

17.4% for a mean follow-up period of 3.1 years. In the other studies, the reported incidence has been 6- 58.7% (Table 4).

**Table 4.** Review of studies reporting incidence of glaucoma and potential risk factors after pediatric cataract surgery

Study	Year	Incidence of glaucoma (%)	Mean follow-up (years)	Age	Other risk factors
Chrousos et al <sup>2</sup>	1984	6.1	5.5		coexisting ocular anomalies, retained lens cortex, secondary membrane surgery
Keech et al <sup>23</sup>	1989	11	3.6	<8 w	
Simon et al <sup>3</sup>	1991	24	6.8		f/u time
Mills and Robb <sup>4</sup>	1994	15.8	7.4	<1 y	congenital rubella syndrome, poor pupillary dilation, microcornea
Magnusson et al <sup>7</sup>	2000	12	9.6	<10 d	Microphthalmos
Miyahara et al <sup>5</sup>	2002	26	9.7		Microcornea, microphthalmos
Rabiah <sup>20</sup>	2004	21	9	<9 m	secondary membrane surgery, primary posterior capsulotomy/ anterior vitrectomy, microcornea
Chen et al <sup>6</sup>	2006	58.7	124 m (10.3)	1 y	cataract type, Postoperative cycloplegic use, microcornea
Swamy et al <sup>11</sup>	2007	15.4	6.3	<9 m	f/u time, microcornea
Haargaard <sup>13</sup>	2008	31.9	10	<9 m	
Current study	2013	17.4	3.1	<1 y	Aphakia

Several studies have reported the age of the patients at the time of the cataract surgery an independent risk factor for developing glaucoma.<sup>4,6,7,11,13,20.</sup>

In our study, the mean age at the time cataract surgery was 9.3 months for group 1 and 40.4 months for group 2. In a study by Chen et al,<sup>6</sup> the mean age of the patients who developed glaucoma after the cataract surgery was 8.2 months compared to 37.7 months for those without glaucoma. This study also included patients up to 15 years of age with similar results compared to our study.

In a study on 210 eyes that underwent lensectomy without IOL insertion before 10 months of age, Khan et al found that the greatest risk of glaucoma in aphakic eyes was at one month and six months of age whereas the least risk of glaucoma was between three to five months of age.<sup>21</sup>

In the current study, glaucoma was diagnosed before one year of age in 18 eyes and after one year in 10 eyes. In contrast to Khan et al study, the greatest risk of glaucoma was for cataract surgery between three to five months and lowest risk for cataract surgery between seven to 10 months of age.

The surgical technique has been reported as a risk factor for developing glaucoma. In a study by Chak et al, the greatest incidence of glaucoma was in patients operated by lens aspiration and anterior vitrectomy technique in comparison to the other surgical techniques.<sup>22</sup> Michaelides et al found that all patients with aphakic glaucoma had posterior capsulotomies compared to 61% in patients without glaucoma.<sup>12</sup> Moreover, 53% of glaucomatous patients and 35% of non-glaucomatous patients had anterior vitrectomy. In this study all glaucoma patients were aphakic, however, among patients without glaucoma, 57% were pseudophakic. In Asrani et al study, the incidence of the glaucoma was 0.27% in pseudophakic and 11.3% in aphakic patients.<sup>18</sup>

The protective role of IOL for prevention of glaucoma has been evaluated in several studies.

Rabiah showed that posterior capsulotomy and anterior vitrectomy might be associated with a higher risk of glaucoma,<sup>20</sup> however, such an appraisal was not possible in our study due to using the same technique for all

patients (i.e. anterior lensectomy, posterior capsulotomy and anterior vitrectomy).

Ocular anomalies such as PFV, microcornea and microphthalmia have been shown to be associated with a higher risk of glaucoma.<sup>4,6,7,8,11,20</sup> The presence of these anomalies, however, may result in earlier diagnosis and surgery for cataract. In Mills et al study, microphthalmia was more frequent in patients undergoing cataract surgery at a younger age.<sup>4</sup>

Although some studies revealed clinically significant relationship between younger age at the time of surgery and the incidence of uveitis,<sup>1,6</sup> the role of uveitis in postoperative glaucoma is still unknown. In our study, postoperative uveitis was not found to be related to glaucoma, ( $p=0.579$ ) which may be due to other factors. Chak et al did not find such a relationship neither.<sup>22</sup>

In Chen et al study, sex had no influence on the development of glaucoma.<sup>6</sup> We observed no statistically significant difference between the two groups in terms of gender ( $p=0.19$ ).

Time to diagnosis of glaucoma after cataract surgery in aphakic eyes has been reported between 1 to 157 months in Khan et al study,<sup>21</sup> and one to 60 months in Michaelides et al study.<sup>12</sup> A retrospective study by Kirwan et al following patients for 23 years revealed that the incidence of glaucoma after the cataract surgery for both aphakic and pseudophakic eyes is highest within the first year after the cataract surgery.<sup>24</sup> They also showed that no new case of the glaucoma was identified in pseudophakic eyes beyond three years after the surgery, although new cases of glaucoma were diagnosed in aphakic eyes up to 18 years after surgery. Moreover, the incidence of glaucoma decreased dramatically one year after the surgery.<sup>24</sup>

In our study, the mean time of diagnosis of the glaucoma was 111 days after surgery. Additionally, we did not find any correlation between the age of the patients at the time of surgery and the time of development of glaucoma.

In Michaelides et al study, 7 eyes (47%) of the total 15 glaucomatous eyes needed surgical intervention for IOP control.<sup>12</sup> In Kirwan et al study, all seven pseudophakic eyes as well as 18 eyes of 25 aphakic eyes with the glaucoma underwent surgery for

control of glaucoma with AGV being the first choice in all patients.<sup>24</sup> In our study, five out of 28 glaucomatous eyes needed surgery, of which four underwent trabeculotomy and trabeculectomy and one AGV implantation. No correlation was found between age at the time of surgery and time to glaucoma diagnosis and response to treatment.

A major shortcoming to this study was the relative short follow-up time and with longer follow-up probably more glaucoma cases could be diagnosed. Although all surgeries were not done by a single surgeon, the technique was the same. Age can be considered as a confounding factor for IOL implantation.

### Conclusion

This study revealed younger age at the time of surgery, aphakia as the major risk factors for development of glaucoma. However, surgery should not be delayed due to the risk of profound amblyopia. Most glaucoma cases are diagnosed within one year after cataract surgery. In most patients glaucoma was managed with medications.

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