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The prevalence of secondary glaucoma after congenital cataract surgery and associated risk factors in a Tertiary Center in Iraq

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ABSTRACT

BACKGROUND: The objective of this study was to find out the prevalence of glaucoma and its associated risk factors in children who underwent congenital cataract surgery.

MATERIAL AND METHODS: A cross-sectional study was conducted at Ibn Al-Haitham Teaching Eye Hospital targeting children who had undergone congenital cataract surgery between January 2014 and March 2020, with a minimum follow-up of 1 year. The required information was obtained from clinical records of 422 patients operated by the same surgeon, and after exclusion criteria, the total sample was 375 patients and 512 eyes.

RESULTS: The prevalence of secondary glaucoma was 4.69% of the total 512 eyes. The factors that significantly increased the risk of developing secondary glaucoma were female gender and surgery before the age of 9 months.

CONCLUSION: The prevalence of secondary glaucoma after congenital cataract surgery in a sample of Iraqi children was in the low range compared to other international studies, mainly attributed to more late presentation and relatively older age at surgery. The possible risk factors for developing secondary glaucoma included female gender and surgery before the age of 9 months. A close follow-up is needed for each patient after the congenital cataract study, especially for those for whom the surgery was performed before the age of 9 months, which carries a higher risk of secondary glaucoma.

KEY WORDS: congenital cataract; secondary glaucoma; pseudophakia; intraocular pressure

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INTRODUCTION

A pediatric cataract is one of the leading causes of treatable blindness in children, affecting about 1 to 15 children per 10,000 children worldwide [1]. The incidence is even higher in Arab countries owing to the high degree of consanguinity among parents. The prevalence of childhood cataracts in Saudi Arabia was estimated to be 14.7 per 10,000 children, which by far is considered the highest international global incidence [2]. Despite being quite rare compared to adult cataracts, pediatric cataract affects the quality of a child's vision as it is encoun-

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tered during the most sensitive phase of the visual system development that might result in irreversible impairment [3].

Optimal timing for surgery is difficult to establish due to the association of aphakic glaucoma with very early surgery. Some have suggested that early intraocular lens (IOL) implantation may protect against this complication [4]. IOL implantation has been advocated in children two years [5] and above due to problems arising due to IOL power, size, availability, material, refraction change, and long term IOL safety [6].

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. [6]. Currently, the age of the patient at the time of surgery is a known risk factor for developing glaucoma after cataract surgery [7–13]. Primary IOL implantation is currently used in children older than two years of age, and IOL implantation in newborns and infants has gradually gained popularity among surgeons [14]. A recent meta-analysis that reported lower glaucoma risk in childhood pseudophakia was based on primary research limited by selection bias and failure to deal with confounding factors due to age at surgery [11].

The aim of the current study is to report the prevalence of glaucoma and its associated risk factors in children who all underwent congenital cataract surgery at different ages by the same surgeon using a modern surgical technique with follow-up care provided by a pediatric ophthalmologist and a glaucoma specialist.

MATERIAL AND METHODS

Study design

This is a cross-sectional study conducted at Ibn Al-Haitham Teaching Eye Hospital, a tertiary center in Baghdad that is regarded as the main ophthalmological center in Iraq, on a sample of Iraqi patients who underwent surgery for congenital cataract.

Study approval

The necessary official approvals were obtained before the initiation of data collection. These included the approval for conducting this study from The Iraqi Board of Health Specializations and the approval of Ibn Al-Haitham Teaching Eye Hospital, from which data was collected.

Study population

Five hundred twelve eyes from 375 patients were included in this study. Patients were identified by reviewing the surgical logs of the surgeon who operated on all these cases and the medical records of the patients who underwent pediatric cataract surgery in the main tertiary eye center in Iraq (Ibn Al-Haitham Teaching Eye Hospital) between January 2014 and March 2020. Figure 1 illustrates the enrollment procedure.

Inclusion criteria

Patients undergoing unilateral or bilateral surgery for congenital cataract with a minimum follow-up of 1 year were included in this study.

Exclusion criteria

Exclusion criteria were: Traumatic cataract, cataract secondary to infection or uveitis, steroid-induced cataract, congenital glaucoma, retinopathy of prematurity, microcornea, megalo-cornea, and any cataract associated with anterior segment dysgenesis.

Data collection

The following data were ascertained from the clinical records of each subject included in the study: age of the patient in months at the time of surgery, gender, unilateral or bilateral cataract surgery, whether an IOL had been implanted, follow-up period in years, development of secondary glaucoma and time of glaucoma presentation in the postoperative follow-up period.

Ocular parameters

The following information regarding his method of management was taken from the surgeon who operated on the cases in this study:

Intraocular pressure (IOP) measurements were done:

- using air puff tonometer or Goldman applanation tonometer in cooperative patients;
- in uncooperative patients with any suspected symptoms or signs of increasing IOP like tearing, blepharospasm, photosensitivity, buphthalmos, large corneal size, and Haab striae IOP measurement was performed with Perkins's tonometer during examination under anesthesia (EUA) in 1-month postoperative visit under **GA** at the same time of sutures removal to decrease the risks of GA.

B-scan ultrasonography was performed:

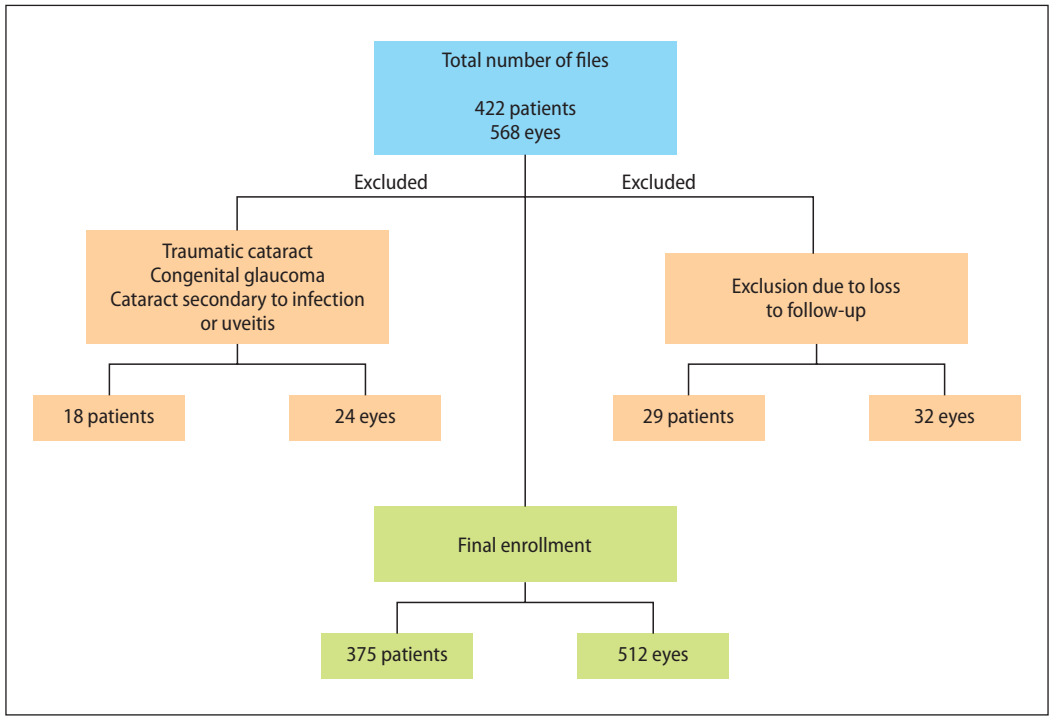

FIGURE 1. Flowchart of sample enrollment procedure

- in those with dense cataracts precluding direct fundus examination. All uncooperative patients were examined under EUA.

Diagnosis of glaucoma

Glaucoma was defined as the presence of IOP ≥26 mm Hg. All patients diagnosed with glaucoma or suspected glaucoma were treated by a glaucoma specialist.

Statistical analysis

Data tabulation, input, and handling were done using IBM SPSS version 22. Comparisons between categorical variables were made using the Chi-Square test. Multivariate Cox's regression model to estimate proportional hazards ratio of secondary glaucoma. p-value < 0.05 was considered significant, and < 0.001 was considered highly significant throughout the study.

RESULTS

The number of children enrolled in the study was 375; 209 (55.7%) were males and 166 (44.3%) — females. There were 137 (36.5%) patients with bilateral cataract surgeries, and 15 (4%) patients developed glaucoma (Tab. 1). The mean age of diagnosing glaucoma was 22.48 months following cataract surgery, ranging from 15 days to 6 years. The mean duration of follow-up was 3.4 years, ranging from 2 to 7 years.

Table 1. Basic characteristics of the study population

Variables	Mean	Min–Max
Age at surgery	44.4 months	2 months–276 months
Gender	Number	Percent
Male	209	55.7
Female	166	44.3
Laterality of surgery		
Unilateral	238	63.5
Bilateral	137	36.5
Glaucoma		
No	360	96.0
Yes	15	4.0
Total	375	100.0

There were 162 (43.2%) cases operated within the first year of life, including (18.7%) within three months of life, 31 (8.27%) between 1–2 years, 19 (5.07%) between 2–3 years, and 163 (43.46%) after the age of three years (Fig. 2).

Twenty-four (4.69%) eyes from the total 512 eyes developed glaucoma (Fig. 3).

There was a statistically significant association between gender and the development of glaucoma,

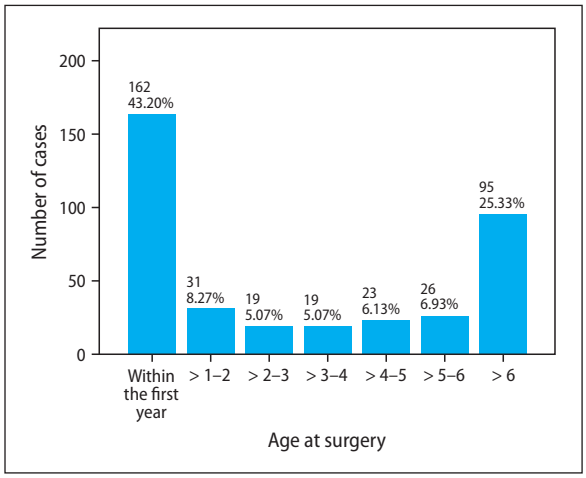

FIGURE 2. Distribution of the study sample according to the age of surgery (number = 375)

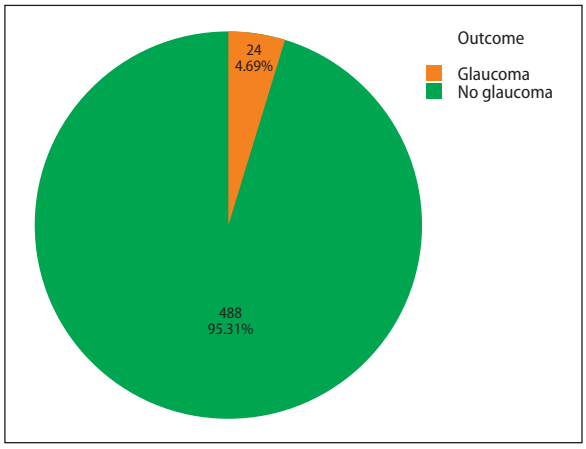

FIGURE 3. Distribution of eyes according to the development of glaucoma (n = 512)

Table 2. Distribution of patients with glaucomatous eyes according to gender

Variables	Glaucoma	No glaucoma	Total	p-value
	No. (%)	No. (%)	No. (%)	
Gender				
Male	7 (2.5)	272 (97.5)	279 (100)	0.019*
Female	17 (7.3)	216 (92.7)	233 (100)	
Total	24 (4.7)	488 (95.3)	512 (100)	–

*significant association; Chi-square test with continuity correction

Table 3. Distribution of eyes according to intraocular lens (IOL) insertion and the development of glaucoma

Variables	Glaucoma	No glaucoma	Total	p-value
	No. (%)	No. (%)	No. (%)	
IOL				
Aphakia	22 (8.5)	236 (91.5)	258 (100)	< 0.001*
Pseudophakia	2 (0.8)	252 (99.2)	254 (100)	
Total	24 (4.69)	488 (95.3)	512 (100)	–

*highly significant association. Chi-square test with continuity correction

as there were seven (2.5 %) eyes of males, compared to 17 (7.3%) eyes of females that developed glaucoma (Tab. 2).

There was a statistically significant association between IOL insertion and the development of glaucoma, as 8.5% of aphakic eyes developed glaucoma, while only two (0.8%) eyes were pseudophakic and developed glaucoma (Tab. 3).

There was a statistically significant association between the age of surgery and the development of glaucoma, as there were 20 (10.4%) of eyes operated on before the age of 9 months that developed glaucoma, while four (1.3%) of eyes operated on after the age of 9 months developed glaucoma (Tab. 4).

There was no significant association between the laterality of surgery and the development of glaucoma, as there were 6 (2.5%) cases operated unilaterally that developed glaucoma, and 9 (6.6%) bilateral surgery cases developed glaucoma (Tab. 5).

Female gender, earlier age of surgery, and aphakia increased the risk of developing secondary glaucoma by 2.6, 10.9, and 14.1 times, respectively (Tab. 6). Figure 4 shows that majority of cases were diagnosed early after cataract surgery

Table 4. Distribution of eyes according to the age of surgery and the development of glaucoma

Variables	Glaucoma	No glaucoma	Total	p-value
	No. (%)	No. (%)	No. (%)	
Age at surgery				
< 9 months	20 (10.4)	173 (89.6)	193 (100)	< 0.001*
≥ 9 months	4 (1.3)	315 (98.7)	319 (100)	
Total	24 (4.69)	488 (95.3)	512 (100)	–

*highly significant association. Chi-square test with continuity correction

Table 5. Distribution of patients according to laterality of surgery and the development of glaucoma (n = 375)

Variables	Glaucoma	No glaucoma	Total	p-value
	No. (%)	No. (%)	No. (%)	
Laterality of surgery				
Unilateral	6 (2.5)	232 (97.5)	238 (100)	0.054
Bilateral	9 (6.6)	128 (93.4)	137 (100)	
Total	15 (4)	360 (96)	375 (100)	–

Table 6. Risk stratification for development of glaucoma using univariate Cox proportional hazards ratio

Variables	Hazard ratio		p-value
	Mean	95% CI	
Female gender	2.6	1.1–6.3	0.032*
Age of surgery <9 months	10.9	3.7–31.9	< 0.001**
Aphakia	14.1	3.3–60.1	< 0.001**

*significant; **highly significant; CI — confidence interval

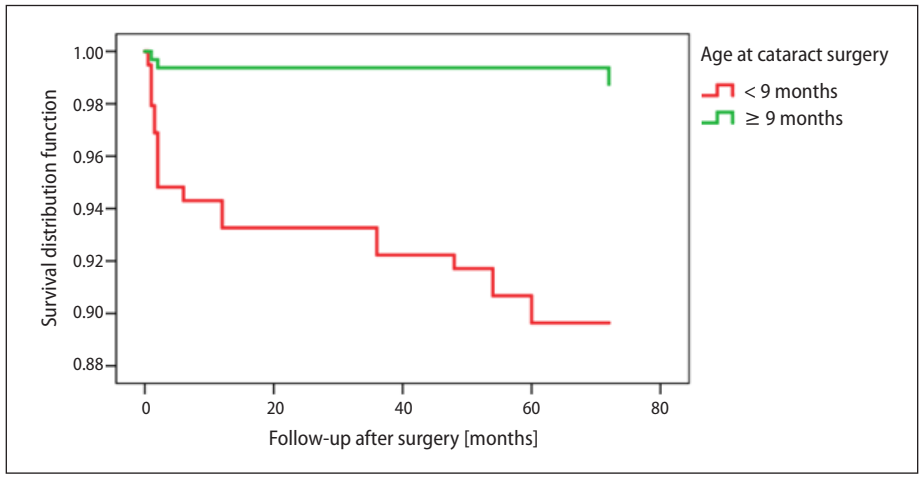

FIGURE 4. Survival curve relating between ages of cataract surgery and the developing glaucoma

DISCUSSION

Secondary glaucoma is the most frequent complication that threatens vision after congenital cataract surgeries. About 20% of children might have glaucoma after cataract surgeries [15]. Open-angle glaucoma could occur months to years following the operation. The most significantly associated risk factors for developing secondary glaucoma after cat-

Table 7. Comparison of glaucoma prevalence between different studies

Author/country	Number of cases/eyes	Eyes with glaucoma	Follow-up
Tatham et al. [20]/United Kingdom	74/104	2%	Median 4.9 years
Kirwan et al. [9]/Ireland	110/144	Aphakia: 33% Pseudo.: 10%	Aphakia: 9.4 years Pseudo.: 4.7 years
Comer et al. [21]/Canada	64/75	24%	Mean 6.5 years
Lim et al. [22/United States	778/1122	Aphakia: 12% Pseudo.: 1%	Aphakia: 4.3 years Pseudo.: 2.25 years
Sahin et al/ [23]/Turkey	148/249	Aphakia: 4.8% Pseudo.: 0%	Aphakia: 5.1 years Pseudo.: 5.2 years
Ruddle et al. [10]/Australia	101/147	32.0%	Median 9.9 years
Mataftsi et al. [11]/Greece	470/659	17%	Median 4.3 years
Freedman et al. [15]/United States	113/113	17%	Mean 4.8 years
Balekudaru et al. [13]/India	101/101	7.9%	Mean 6.4 to 7.64 years
Nyström et al. [24]/Sweden	207/288	23.7%	Mean 3.31 years
The current study/Iraq	375/512	Aphakia: 4.3% Pseudo.: 0.4%	Aphakia: 6 years Pseudo.: 5.7years

Pseudo. — pseudoaphakia

aract removal are the young age of surgery and leaving the patient's aphakia [16].

In the current study, the mean age at surgery was 3.7 years, and 43% of patients were operated on within the first year, 55.7% of cases with congenital cataracts were males, and 63.5% undergone surgery for one eye. Gender distribution was very close to the results of Kareem et al. (2020) in Iraq, who reported that 64.9% of the cases with congenital cataracts presented within the first year (20% within the first three months), 56.14% were males [17]. The gender distribution was comparable to the results of Kamath et al. (2018) in India, who reported that 61.4% of their study sample were males. However, they reported higher age at presentation, and only 12.7% of cases were presented before three years of age, and 20.63% of their cases with congenital cataracts were unilateral [18]. Both, age and gender distribution, seem to be related to socio-economic factors intrinsic to developing countries, with later presentation and male preference. This concept is supported by Katibeh et al. (2013) from Iran, who reported a 10% male preference in male preference and 3.2 years for the mean age of presentation [19], while in the United Kingdom, Tatham et al. (2010) reported that 16.9% of cases were operated before or at 50 days of age, 23.9% were operated from 51 days to one year of age, and 59.2% between 1-14 years (20). The difference in laterality between the current study and the aforementioned studies is that we reported the surgery laterality rate rather than the actual congenital cataract laterality.

The prevalence of secondary glaucoma differs widely between the aforementioned studies. It can be seen that the main factors that influenced these differences included the target population (aphakia, pseudophakia, laterality, type of cataract), the follow-up period, and variation in glaucoma diagnostic criteria. In the current study, secondary glaucoma was defined by an IOP ≥ 26 mm Hg with a prevalence of secondary glaucoma close to other studies like Sahin et al. [23], Swamy et al. [25] and Tatham et al. [20] that defined secondary glaucoma as any corrected IOP ≥ 26 mm Hg. At the same time, showed lower prevalence of secondary glaucoma in comparison to Nyström et al., which defined it as any elevated IOP that required glaucoma surgery secondary to cataract surgery [24].

In the current study, the female gender, earlier age of surgery, and aphakia increased the risk of developing secondary glaucoma. The most frequently reported risk factor included early surgery within the first year of life (7–13), except for Nyström et al., who reported that very early surgery within the first month reduces secondary glaucoma risk [24]. Several factors have been proposed to link aphakia with glaucoma, such as retained lens material or the anterior vitreous that might interact/damage the immature trabecular meshwork component [8]. Also, another set of factors include barotrauma during surgery, inflammation, and steroid-induced

ocular hypertension as children appear to be more susceptible to steroids [26], leaving a critical issue of controlling the increased inflammation after peadiatric cataract removal, requiring close monitoring [7]. Female sex was reported to have a higher rate of secondary glaucoma by Bazaz et al. (2014) in Iran, however, it was not identified as a risk factor [27], and our finding could be caused by bias in sex presentation, as it was found that females with congenital cataract had lower access to surgery [19, 28].

LIMITATIONS OF THE STUDY

Loss to follow-up of children was a problem encountered in the current study.

The data were collected retrospectively, so the incidence (new cases per year) could not be calculated.

Glaucoma diagnostic criteria differ widely between studies, and additionally, we did not measure IOP in each visit pre- or post-operative due to EUA difficulties.

Sine secondary glaucoma can happen many years after cataract surgery. A longer follow-up period is needed for all patients.

CONCLUSIONS

The prevalence of secondary glaucoma after congenital cataract surgery in a sample of Iraqi children was 4.69%, and it was in the low range compared to other international studies, mainly attributed to more late presentation and age of surgery.

The possible risk factors for developing secondary glaucoma included female gender, surgery before the age of 9 months, and a close follow-up is needed for each patient after the congenital cataract study and especially for those for whom the surgery was performed before the age of 9 months which is carrying a higher risk of secondary glaucoma.

RECOMMENDATIONS OF THE STUDY

1. A Close follow-up is needed for each patient after the congenital cataract study and especially for those for whom the surgery was performed before the age of 9 months which is carrying a higher risk of secondary glaucoma
2. The follow-up period of patients with congenital cataract surgery should be for life if possible since secondary glaucoma may occur many years post-operative.
3. Further studies are needed regarding the age of IOL implantation after congenital cataract surgery and the rule of implanted IOL in the development or protection from secondary glaucoma.

Financial resources

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This study has not received any external funding.

Conflict of interest

The authors declare no conflict of interest.

Informed consent

Written informed consent was obtained from all participants' caretakers included in the study. Additional informed consent was obtained from all individual participants for whom identifying information is included in this manuscript.

Ethical approval for humans

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards (Code: 2019/C081).

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