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ORIGINAL PAPER

Glaucoma following childhood cataract surgery: the South India experience

Ifeoma Ezegwui · Meenakshi Ravindran · Neelam Pawar · Fathima Allapitchai · Ramakrishnan Rengappa · R. Ramalakshmi Raman

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Abstract

Purpose To determine the characteristics and risk factors for the development of glaucoma after cataract surgery in children seen at a major referral tertiary eye centre in South India.

Methods This is a retrospective review of the medical records of consecutive patients seen at the glaucoma/paediatric eye clinic of the centre, with a diagnosis of glaucoma secondary to aphakia/pseudophakia over a 5-year period.

Results There were 21 eyes of 14 children that developed glaucoma and 23 eyes of 12 children were selected as control. The mean age (standard deviation SD) at the time of cataract surgery for the glaucoma group was 7.4 (± 10.1) months and 39.13 (± 41.2) months for the control. The mean follow-up (SD) period was 114.29 (± 61.9) months and 97.61 (± 43.5) months for the glaucoma and control, respectively. The mean duration from cataract surgery to onset of glaucoma was 81.19 (± 52.4) months (median 66 months, range 21–172 months). Multivariate analysis detected age at surgery younger than 12 months (OR 10.45, 95%CI 1.76–62.03, $p = 0.010$) and ocular anomalies mainly microcornea (OR 7.11, 95%CI 1.14–44.46, $p = 0.036$) as risk factors for development of glaucoma after paediatric cataract surgery.

Conclusion Glaucoma can develop several years after childhood cataract surgery. Surgery in the first year of life and microcornea are risk factors for the development of glaucoma post-surgery. Signs of glaucoma should specifically be looked for during follow-up visits.

Keywords Paediatric cataract surgery · Glaucoma in aphakia/pseudophakia · Risk factors for glaucoma in aphakia/pseudophakia · South India

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I. Ezegwui · M. Ravindran · N. Pawar · F. Allapitchai
Paediatric Ophthalmology and Adult Strabismus Services, Aravind Eye Hospital, Tirunelveli, India

I. Ezegwui (✉)
Paediatric Ophthalmology and Strabismus Unit, Department of Ophthalmology, College of Medicine, University of Nigeria, Enugu Campus, Enugu, Nigeria
e-mail: ifeoma.ezegwui@unn.edu.ng

R. Rengappa
Glaucoma Services, Aravind Eye Hospital, Tirunelveli, India

R. R. Raman
Aravind Eye Hospital, Tirunelveli, India

Introduction

Glaucoma is esteemed to be the commonest long-term complication of paediatric cataract surgery [1]. The

documented incidence following isolated childhood cataract surgery varies from 1.6 to 45% [2–7]. Higher incidence rates are reported in studies with longer follow-up periods [8]. The glaucoma risk is lifelong [9].

Cataract surgery in children has undergone many evolutions from the time of needling to modern surgery techniques involving extracapsular cataract procedures, primary posterior capsulorhexis, anterior vitrectomy and intraocular lens implantation [10]. The modern techniques, however, do not eliminate the glaucoma risk [6]. The risk factors associated with the development of glaucoma after childhood cataract surgery include microcornea, younger age at surgery, chronic inflammation, retained lens matter and persistent foetal vasculature [1, 3, 5, 6].

Regular follow-up/clinical examination is needed to aid diagnosis of paediatric cataract surgery related glaucoma. This study aims to determine the characteristics and risk factors for the development of glaucoma following surgery for isolated cataract in children seen at a major referral tertiary eye centre in South India.

Methods

This is a retrospective review of the medical records of consecutive patients seen at the paediatric eye clinic/glaucoma clinic of Aravind Eye Hospital Tirunelveli, a tertiary referral eye centre, with a diagnosis of glaucoma secondary to aphakia/pseudophakia over a 5-year period (2010–2015). Patients who had traumatic or uveitic cataract were excluded. Data extracted include age at the time of cataract surgery, duration from surgery to development of glaucoma, associated ocular or systemic anomalies, cataract surgery techniques, primary or secondary intraocular lens (IOL) placement, any secondary surgeries (e.g. membranectomy) performed, type of glaucoma intervention and length of follow-up. Regarding ocular anomalies, microcornea was defined as corneal diameter < 10 mm or < 9.5 mm in the first month of life. The case notes in which there was no measurement of corneal diameter but the cornea was clinically judged as microcornea were excluded as microcornea. The control group was randomly selected from consecutive patients who had undergone childhood cataract surgery in our centre, had been followed up for a minimum of 4 years, did not develop glaucoma and presented to the clinic within the study period.

Glaucoma diagnosis was made by the glaucoma unit of the hospital based on sustained rise in intraocular pressure (IOP) above 21 mmHg in combination with one or more signs of glaucoma such as progressive cupping of the optic nerve head, increase in corneal diameter or clouding of the cornea. IOP was measured with either non-contact tonometer (Pulsair, Keeler) or Perkins hand held tonometer (Clement Clarke, London) or Tonopen (Reichert Technology) or Goldmann tonometer (Haag Streit USA).

Data entry was done with Microsoft Office Excel 2007 and analysis performed with STATA 11.1. Means and frequencies were derived. Two sample t test was used to find the mean difference between case and control. Logistic regression analysis was used to determine the risk factors for the development of glaucoma. Eye was used as the unit for all analysis. Statistical calculations were done at significance of $p < 0.05$.

Results

A total of 22 eyes of 15 children that developed glaucoma following cataract surgery were seen in our centre during the study period; the occurrence was bilateral in 7 children. One child had the cataract surgery in another hospital and referred to our centre only after the glaucoma surgery done in the referral hospital was not successful. This patient was excluded from further analysis as details of the cataract surgery and onset of glaucoma were not available. Twenty-three eyes of 12 children constituted the control group. All the children in the study are Indians. None of the patients in the 2 groups had pre-existing glaucoma or family history of glaucoma.

The characteristics of the study subjects are shown in Table 1. Eleven eyes (52.4%) had microcornea in the glaucoma group. Additional four eyes were noted clinically to have microcornea but since there was no actual documentation of their corneal diameters, they were not recorded as microcornea for the purpose of analysis. The mean age (standard deviation SD) at the time of cataract surgery for the glaucoma group was 7.4 ($\pm$ 10.1) months (median 4 months, range 1.5–48 months) and 39.13 ($\pm$ 41.2) months (median 24 months, range 1.5–126) for the control. Majority of

Table 1 Descriptive characteristic of study subjects

Characteristic	Glaucoma *n* (%)	Control *n* (%)
Sex		
Male	8 (57.1)	6 (50.0)
Female	6 (42.9)	6 (50.0)
Laterality of cataract		
Unilateral	7 (50.0)	1 (8.3)
Bilateral	7 (50.0)	11 (91.7)
Ocular anomalies		
None	9 (42.9)	21 (91.3)
Microcornea	11 (52.4)	1 (4.3)
Microcornea + PHPV	1 (4.7)	0
PHPV	0	1 (4.3)

PHPV Primary hyperplastic primary vitreous (persistent foetal vasculature)

the cataract surgeries, 81% (17/21), were performed in the first 6 months of life (90.5%, 19/21 in the first 12 months of life) for the glaucoma group. The mean follow-up (SD) period was 114.29 (± 61.9) months (median 114 months, range 41–201 months) and 97.61 (± 43.5) months (median 72 months, range 48–168 months) for the glaucoma and control, respectively.

All the eyes in the glaucoma group had primary posterior capsulorhexis with anterior vitrectomy while 2/23 eyes did not have posterior capsulorhexis or anterior vitrectomy among the control. Primary intraocular lens (IOL) was implanted in one eye; 4 eyes had secondary IOL placement while the rest were left aphakic for the glaucoma group. For the control, 14 eyes (60.9%) had primary IOL placement; 7 eyes (30.4%) had secondary IOL placement while 2 eyes (8.7%) were left aphakic. Five eyes, 23.8%, (all from glaucoma group) had secondary surgeries mainly membranectomy to clear the visual axis.

The mean duration from cataract surgery to onset of glaucoma was 81.19 (± 52.4) months (median 66 months, range 21–172 months). Eighteen eyes (85.7%) received only medical treatment for glaucoma while 3 eyes (14.3%) underwent surgery—combined trabeculotomy and trabeculectomy. The mean intraocular pressure (IOP) at the time of glaucoma diagnosis was 31.43 (± 5.4) mmHg (median 31 mmHg, range 24–42 mmHg). The average central corneal thickness (CCT) was 640.06 (± 67.2) µm (median 649 µm, range 450–714 µm). The CCT was not documented in 2 children with bilateral involvement and in one child with unilateral occurrence. Among the unilateral cases, the mean CCT in the non-glaucoma eye was 604.17 (± 38.8) µm (median 621 µm, range 534–633 µm). Logistic regression analysis detected age at surgery younger than 12 months and ocular anomalies mainly microcornea as risk factors for development of glaucoma after paediatric cataract surgery (Table 2).

Discussion

Almost all the children who developed glaucoma following childhood cataract surgery in this series had their surgery in infancy. Whereas it is universally accepted that early age at cataract surgery predisposes to secondary glaucoma, there is no consensus on the threshold age for surgery when this occurs. Young age at cataract surgery has been variously defined by different studies in the range of 4 weeks–12 months [3, 6, 7, 11–14]. Over three-quarters of eyes that developed glaucoma in the current study were operated on when the children were within 6 months of age.

Microcornea was more common (57.1%) among the glaucoma group than the control (4.3%). Logistic regression analysis in univariate and multivariate models identified microcornea and younger age at surgery as significant risk factors in the development of secondary glaucoma. This agrees with other reports [6, 7, 13]. Although the glaucoma group had a longer follow-up duration than the control, this did not reach statistical significance ($p = 0.304$) so was not included in the regression analysis.

The median time to the development of glaucoma in this study was 66 months. This is longer than 8 months [2] or 3.6 years [7] previously reported. Bimodal peak in onset of glaucoma after cataract surgery is often noted [8, 14–16]. The early peak is usually of the angle closure type while the late peak is of the open angle type. Early onset glaucoma was not observed in this series; the earliest time from surgery to glaucoma being 21 months. This may be because peripheral iridectomy was performed on most of the eyes.

All the eyes in this study (both glaucoma group and control) except two (among the control) had primary

Table 2 Regression analysis of factors associated with secondary glaucoma

Variable	Onset of glaucoma		Unadjusted		Adjusted	
	Yes	No	OR (95% CI)	*p* value	OR (95% CI)	*p* value
Age						
> 12 months	2 (9.5)	15 (65.2)	1	–	1	–
≤ 12 months	19 (90.5)	8 (34.8)	10.45 (1.76–62.03)	0.010	10.45 (1.76–62.03)	0.010
Ocular anomalies						
None	9 (42.9)	21 (91.3)	1	–	1	–
Micro cornea/PHPV	12 (57.1)	2 (8.7)	7.11 (1.14 –44.46)	0.036	7.11 (1.14–44.46)	0.036

posterior capsulorhexis and anterior vitrectomy. This may suggest that posterior capsulorhexis/anterior vitrectomy does not increase the risk of secondary glaucoma. The precise mechanism of glaucoma following childhood cataract surgery is not known. One of the chemical theory proposed is that lens particles or proteins and vitreous derived factors are toxic to the trabecular meshwork [8]. Swamy et al. [7] found primary posterior capsulotomy/anterior vitrectomy significant predictor of glaucoma in the univariate model but not in the multivariate analysis. Michaelides et al. [13] inferred that leaving the posterior capsule intact may mitigate the risk of glaucoma secondary to aphakia. Although 21/23 eyes in the control group had primary IOL placement, the absence of glaucoma in these eyes may likely be due to older age at the time of cataract surgery. The supposed protective effect of IOL from glaucoma was not sustained by recent studies [3, 6].

In conclusion, surgery in the first 12 months of life and microcornea are risk factors for secondary glaucoma following childhood cataract surgery in this South Indian population. Lifelong follow-up of these patients is mandatory to protect them from visual loss from glaucoma; as some of them developed glaucoma several years after the cataract surgery. During the follow-up visits, signs of glaucoma should specifically be looked for.

Compliance with ethical standards

Conflict of interest The authors declared that they have no conflict of interest.

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