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Surgical, medical and developmental outcomes in patients with Down syndrome and cataracts

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Abstract

Background: Individuals with Down syndrome have an increased risk for congenital cataracts, but descriptions of surgical, medical and developmental outcomes are sparse.

Materials and Methods: Retrospective review of medical charts of patients with Down syndrome with visits to Cincinnati Children's Hospital from 1988 to 2013 was performed. A case series of five patients with Down syndrome and cataracts is presented. A total of 47 patients with Down syndrome without cataracts were used as a developmental control. Developmental quotients were compared using an independent-sample, unequal variance t-test.

Results: Post-operative cataract complication rates ranged from 20% to 60%. Visual outcomes were varied; significant associations between complication rate and visual outcome were not found. Developmental quotients did not show an association with number of complications, but were lower for children with Down syndrome with cataracts requiring surgery compared to children with Down syndrome without cataracts.

Conclusion: In children with Down syndrome and congenital cataract, surgical intervention has risk for post-operative complications. Further investigation is needed to determine if there is an association between surgical complications and visual or developmental outcomes.

Keywords

Congenital cataracts, Down syndrome, development, trisomy 21, post-operative complication

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Introduction

As the most common chromosomal condition, 1/792 children are born with Down syndrome.[1] Individuals with Down syndrome have an associated array of medical and developmental issues including congenital heart defects, hypothyroidism, developmental delay and obstructive sleep apnea.[2] To guide management, current health supervision guidelines from the American Academy of Pediatrics provide guidance.[2] Congenital cataract requiring surgery during the neonatal period is increased from population rates of 1.71/10,000, affecting 1.7/100 of children with Down syndrome: a 100-fold increase.[3] Due to this increased risk, screening for cataracts with red reflex in infancy and referral to Ophthalmology at 6 months of age is recommended.[2]

The combination of Down syndrome and congenital cataracts is rare, affecting less than 1 in 40,000 live births.[1] Congenital cataracts may require surgical management but can also be mild and be managed expectantly. To date, few authors have reported surgical results or subsequent outcomes in this population of patients.[4] And available studies often lack information on medical and developmental outcomes.[4] As a child's medical home and important source of information for families, pediatricians should be aware of future outcomes in children with Down syndrome who

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require cataract surgery. Information about future outcomes including development may help pediatricians to guide referrals for therapy, need for developmental evaluation as well as the ability to provide reassurance to parents. We sought to describe patients with Down syndrome and congenital cataracts more comprehensively including medical, developmental and post-surgical complications to describe outcomes in patients with this rare combination of conditions.

Methods

This study was approved by the Institutional Review Board of Cincinnati Children's Hospital and conformed to the requirements of the United States Health Insurance Portability and Privacy Act. All patients with Down syndrome and a visit to Cincinnati Children's Hospital Medical Center from 1988 to 2013 were identified by query of the electronic medical record by the International Classification of Diseases (Ninth Revision; ICD-9) code for Down syndrome. Within this sample, a cohort of patients who underwent cataract surgery for congenital cataract within the first 2 months of life were identified by either the secondary ICD-9 code for cataracts or through the use of ophthalmologists' clinical databases. Medical records were reviewed for data including the presence of cataract, age at surgery, duration of follow-up and surgical complications. Patients with confounding ophthalmic diagnoses such as pre-operative uveitis, evidence of congenital infection and persistent fetal vasculature were excluded. None of the patients had intraocular lens implant (IOL) at the time of initial cataract removal surgery. Post-operative complications were defined as "severe" if subsequent surgical management was required. Frequencies of surgical complications were calculated. Medical diagnoses in the electronic medical record were recorded for each of the patients with Down syndrome and congenital cataract requiring surgery.

To evaluate global development, developmental assessments were retrospectively reviewed for all patients with Down syndrome (regardless of the presence of cataract). Any visits in the Division of Developmental and Behavioral Pediatrics at Cincinnati Children's Hospital Medical Center were reviewed; if completed, scores on standardized evaluations were recorded. The developmental evaluations for patients with Down syndrome with either congenital cataract requiring surgery or no cataract were included. Those with non-congenital (acquired) cataract or cataract which did not require surgery were excluded to minimize confounding factors as including patients with a mild, non-surgical cataract in the control could affect interpretation of results. All evaluations were performed by a developmental specialist or therapist. The developmental evaluation tools most frequently used were the Bayley-III and the Preschool Language Scales-3 (PLS-3). The Bayley-III and PLS-3 are standardized instruments that assess developmental function of infants and young children between 1 and 42 months of age.[5,6] Composite scores on the Bayley-III or PLS-3 in age-equivalent years were recorded. A developmental quotient was calculated by dividing the composite score in age-equivalent by chronological age allowing developmental comparisons of children of different ages. The global development quotient of the group of patients with Down syndrome and previous cataract surgery was compared to a control group of patients with Down syndrome without cataracts at our institution through the use of an independent-sample t-test with unequal variances.

Results

A total of 35 patients with Down syndrome and cataract were identified through query of medical records; of these, five patients had congenital cataract which required surgical intervention. These five patients with Down syndrome underwent cataract surgery by one of three pediatric ophthalmologists (Table 1). Surgical technique was similar for all patients and included primary lensectomy, posterior capsulotomy and partial anterior vitrectomy. Mean duration of follow-up was 4.6 years (range, 2–7 years); one patient was lost to follow-up at 3 years of age. Severe post-operative complications affected four of the five patients.

Systemic medical features associated with Down syndrome, including rates of congenital heart disease, hypothyroidism and additional surgeries, were reviewed (Table 1). All had hypotonia (not listed), three had congenital heart disease and two had frequent otitis media requiring pressure-equalizing tubes. One patient was diagnosed with acute myelogenous leukemia but was lost to follow-up. One patient had no medical diagnoses listed but routine follow-up and visits documented.

Of the four patients with visual outcome known, vision ranged from 20/80 OU to no light perception (Table 1). One patient with three severe complications had ability to fixate and follow/no light perception. The patient with the most preserved vision, 20/80 OU, had only one severe surgical complication. Frequency of surgical complication rates for the five patients with Down syndrome and congenital cataracts requiring surgery were calculated (Table 2). Complications rates range from 20% to 60%. Published complication rates in patients with Down syndrome and without Down syndrome were summarized.[4,7–9]

Of the charts of patients with Down syndrome reviewed, 58 had standardized developmental evaluations documented with the Bayley-III and PLS-3 used most frequently. After excluding patients with additional ophthalmologic diagnoses, 50 patients with Down syndrome had either the Bayley-III or PLS-3 documented: of which 3 had congenital cataract requiring surgery and 47 had no cataract (Table 3). Developmental quotients using the Bayley-III and PLS-3 did not show differences of statistical significance between patients with Down syndrome with cataracts and those with Down syndrome without cataracts (0.44 vs 0.58, $p = 0.333$).

Table 1. Ophthalmologic, medical and developmental outcomes in five patients with Down syndrome and congenital cataract.

Age, sex at the time of review	Age at surgery, laterality, decade	# of severe complications	Additional surgery	Severe complications	F/U duration (years)	Visual outcome	Medical diagnoses	Developmental outcome (scale, DQ)
12 years old, male	7 and 8 weeks, bilateral, 2000	0	0		3	Lost to follow-up at 3 years of age	Repaired CHD Acute myelogenous leukemia	No information
7 years old, female	4 and 5 weeks, bilateral, 2000	1	1	Endophthalmitis	7	20/80 20/80		Language impairment (PLS-3, 0.49)
5 years old, male	4 and 5 weeks, bilateral, 1990	1	2	MMG	5	F&F F&F	Frequent otitis media, requiring PE tubes Obstructive sleep apnea Resolved CHD	Autism, Developmental Delay
6 years old, male	7 weeks, unilateral, 2000	2	2	Aphakic glaucoma Capsulophimosis	6	F&F F&F	Conductive hearing loss Resolved CHD Dysphagia Frequent otitis media, requiring PE tubes	Language impairment (PLS-3, 0.60)
2 years old, male	4 and 5 weeks, bilateral, 2010	3	2	MMG, VH, Total RD	2	F&F NLP		Language impairment, dysarthria (Bayley-III, 0.21)

MMG: mixed mechanism glaucoma; VH: vitreous hemorrhage; F&F: fixates and follows; RD: retinal detachment; DQ: developmental quotient; PLS-3: Preschool Language Scales-3; CHD: congenital heart defect; PE: pressure-equalizing.

Table 2. Post-operative complications after congenital cataract repair; case series with comparison to literature.

	With Down syndrome		Without Down syndrome
	This study # of patients (%)	Published rates [a] # of patients (%)	Published rates # (%)
Glaucoma	3 (60)	3 (23)	24 eyes (6.1)[b] 5 patients (28)[c] 31 patients (31)[d]
Posterior capsular opacification	1 (20)	5 (38)	1 patient (8.3)[c]
Vitreous hemorrhage	1 (20)		
Retinal detachment	1 (20)	2 (15)	0 patients (0)[c] 6 eyes (1.5)[b]
Endophthalmitis	1 (20)		

[a]Gardiner et al.[4]
[b]Chrousos et al.[7]
[c]Watts et al.[8]
[d]Ruddle et al.[9]

Discussion

Although patients with Down syndrome are at increased risk for cataracts, limited reports correlating surgical outcomes, surgical complications, and developmental outcome have been made. Through retrospective chart review, we identified five patients with Down syndrome and congenital cataracts who required surgery. Describing their surgical, medical and developmental outcomes identified high rates of surgical complications but reassuring developmental outcomes.

Increased surgical complication rates may impact visual outcome. In five patients with Down syndrome and cataracts requiring surgery, high rates for specific surgical complications range from 20% to 60%. Published reports show similar rates of severe complications including capsular opacification and retinal detachment (Table 2).[4] Vitreous

Table 3. Developmental evaluations in 50 patients with Down syndrome, with congenital cataract requiring surgery and without cataract, at Cincinnati Children's Hospital Medical Center from 1988 to 2013.

		Down syndrome with congenital cataract requiring surgery	Down syndrome without cataract
	Mean age at evaluation (years)	2.3	3.7
Bayley-III	# evaluated	1	12
	Mean composite score (age equivalent in years)	0.21	0.96
	Mean DQ	**0.21**	**0.60**
PLS-3	# evaluated	2	36
	Mean composite score (age equivalent in years)	2.17	2.11
	Mean DQ	**0.55**	**0.57**
Total with either Bayley-III or PLS-3	# evaluated	3	47[a]
	Mean DQ	**0.44**	**0.58**

DQ: Developmental Quotient = Age Equivalent from Composite Score/Chronologic Age; PLS-3: Preschool Language Scales-3.
[a]One patient had both Bayley-III and PLS-3.

hemorrhage and endophthalmitis were each seen in 20% of our patients: both are previously unreported post-operative complications in patients with Down syndrome and congenital cataracts. Surgical complication rates, including glaucoma, posterior capsular opacification (PCO)/secondary membrane development and retinal detachment, appear to be higher than in the population without Down syndrome.[7–10] High rates of surgical complications mirror the increased morbidity following surgical interventions outside the field of ophthalmology.[11] Although varied, visual outcome showed trends of association with increased number of post-operative complications. The patient with least vision preservation had most severe surgical complications; the patient with most preserved vision had only one complication (Table 1).

Increased number of severe post-operative complications did not appear to reflect overall medical health. Children with Down syndrome have higher risk for medical issues which could affect post-operative course and healing; indeed, previous studies have shown that children with Down syndrome have more post-operative complications in non-ophthalmologic surgery than controls.[12] We hypothesized that children with more medical diagnoses might be more medically complex and prone to have a more difficult surgical course. Comprehensive review of medical history identified multiple medical diagnoses for patients with Down syndrome and cataract requiring surgery (Table 1). The number of severe post-operative complications in our five patients ranged from 0 to 3. Three of five patients had congenital heart disease; these included patients with zero, one or two severe complications. One patient with zero complications had acute myelogenous leukemia; one patient with three complications had no significant medical diagnoses. In this small sample, no clear patterns in comparison to the number of severe post-operative complications were shown.

Developmental outcomes did not differ based on the number of surgical complications or the presence of cataracts requiring surgery. Of the patients with Down syndrome and cataract requiring surgery, three had standardized developmental evaluations. Within these three patients, there were no clear developmental trends in association with number of surgical complications: the patient with the highest developmental quotient had two severe complications, followed by the patient with one severe complication and then the patient with three complications. All patients with developmental information available had developmental diagnoses of language impairment or developmental delay. The mean developmental quotient for these three patients was 0.44. From review of patients with Down syndrome and no cataracts, 47 had standardized developmental evaluations documented. The mean developmental quotient for the cohort without cataracts was 0.58. Comparing the developmental quotient for these groups did not reach statistical significance, but those without cataracts have a higher developmental quotient than those that have cataracts requiring surgery. Developmental delay due to visual impairments in otherwise healthy children has been widely reported.[13] It is reasonable to expect that visual impairment due to significant cataracts, even after surgical treatment, would compound the developmental delays of a child with Down syndrome.

Although Down syndrome is a relatively well-known genetic syndrome, the combination of cataracts in Down syndrome is rare. We identified five patients with Down syndrome and cataracts requiring surgery, of which three had developmental evaluations. This small sample size limited our power to draw conclusions of statistical significance when comparing patients with Down syndrome and surgical cataracts to patients with Down syndrome without cataracts. Our study was limited by additional factors, including: limitations of retrospective chart review including inability to control for multiple surgeons and inter-surgeon variability, reliance on previously completed developmental assessments and various formats of developmental evaluation used

by different therapists. Although these standardized measures are accurate indicators of overall developmental level, they may miss subtle differences in specific skills or learning deficits. Future studies could include prospective evaluation and monitoring of development in children with Down syndrome after congenital cataract is diagnosed—repetitive measures or more specific evaluations would allow us to determine if there are specific areas of development that should be monitored more closely following cataract surgery. Any possible association warrants further study with a larger sample size.

The combination of Down syndrome and cataracts is rare, but one for which pediatricians should screen.[2] Our cohort demonstrated high surgical complication rates that were not associated with significant difference in overall medical health or developmental outcomes, but may impact visual outcomes. The presence of cataracts requiring surgery in Down syndrome may impact development, but not to a significant degree. Pediatricians serve as the medical home for children with Down syndrome and should be aware of future outcomes in those children who require cataract surgery. Pediatricians should monitor the development of children with Down syndrome who have cataracts requiring surgery and refer for developmental evaluation. Although we saw differences in developmental outcome, they were not large enough to reach statistical significance due to our small sample of patients with cataracts; this may provide some reassurance that differences in developmental outcome as a result of cataract surgery may not be significant. Furthermore, minimal differences in developmental outcomes following high post-operative complication rates suggest that the benefit to global development justifies the often complex ophthalmic course in the treatment of congenital cataracts in this population.

Conclusion

Children with Down syndrome who have cataracts requiring surgery experience high surgical complication rates. An increased number of complications is associated with worse visual outcomes, but did not correlate with medical complexity. Developmental outcome may be impacted but not to a significant degree. These findings warrant further study with a larger sample size.

Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship and/or publication of this article.

Ethical approval

Ethical approval for this study was obtained from Cincinnati Children's Hospital Medical Center Institutional Review Board (Study ID 2013-5551).

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Informed consent

Informed consent was not sought for this study because waiver of consent was requested and approved by Institutional Review Board.

References

1. De Graaf G, Buckley F and Skotko BG. Estimates of the live births, natural losses, and elective terminations with Down syndrome in the United States. *Am J Med Genet A* 2015; 167: 756–767.
2. Bull MJ. Health supervision for children with Down syndrome. *Pediatrics* 2011; 128: 393–406.
3. Sheeladevi S, Lawrenson JG, Fielder AR, et al. Global prevalence of childhood cataract: a systematic review. *Eye* 2016; 30: 1160–1169.
4. Gardiner C, Lanigan B and O'Keefe M. Postcataract surgery outcome in a series of infants and children with Down syndrome. *Br J Ophthalmol* 2008; 92: 1112–1116.
5. Connolly BH, McClune NO and Gatlin R. Concurrent validity of the Bayley-III and the Peabody Developmental Motor Scale-2. *Pediatr Phys Ther* 2012; 24: 345–352.
6. Zimmerman IL and Castilleja NF. The role of a language scale for infant and preschool assessment. *Ment Retard Dev Disabil Res Rev* 2005; 11: 238–246.
7. Chrousos GA, Parks MM and O'Neill JF. Incidence of chronic glaucoma, retinal detachment and secondary membrane surgery in pediatric aphakic patients. *Ophthalmology* 1984; 91: 1238–1241.
8. Watts P, Abdolell M and Levin AV. Complications in infants undergoing surgery for congenital cataract in the first 12 weeks of life: is early surgery better? *J AAPOS* 2003; 7: 81–85.
9. Ruddle JB, Staffieri SE, Crowston JG, et al. Incidence and predictors of glaucoma following surgery for congenital cataract in the first year of life in Victoria, Australia. *Clin Exp Ophthalmol* 2013; 41: 653–661.
10. Trivedi RH, Wilson ME Jr and Golub RL. Incidence and risk factors for glaucoma after pediatric cataract surgery with and without intraocular lens implantation. *J AAPOS* 2006; 10: 117–123.
11. Castro-Rodriguez CO, Rodriguez-Hernandez L, Estrada-Loza MJ, et al. Prognostic factors associated with postoperative morbidity in children with isolated ventricular septal defect. *Rev Med Inst Mex Seguro Soc* 2015; 53 (Suppl. 3): S324–S335.
12. Goldstein NA, Armfield DR, Kingsley LA, et al. Postoperative complications after tonsillectomy and adenoidectomy in children with Down syndrome. *Arch Otolaryngol Head Neck Surg* 1998; 124: 171–176.
13. Salt A. Is my child's development normal? In: Taylor D and Hoyt CS (eds) *Pediatric ophthalmology and strabismus*. 3rd ed. London: Elsevier, 2005, pp. 1108–1112.