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DOI

[10.1136/bjo.2009.160192](https://doi.org/10.1136/bjo.2009.160192)

Publication date

2010

Document Version

Final published version

Published in

British journal of ophthalmology

[Link to publication](#)

Citation for published version (APA):

Sminia, M. L., de Faber, J. T. H. N., Doelwijt, D. J., Wubbels, R., & Tjon-Fo-Sang, M. (2010). Axial eye length growth and final refractive outcome after unilateral paediatric cataract surgery. *British journal of ophthalmology*, 94(5), 547-550.
<https://doi.org/10.1136/bjo.2009.160192>

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Axial eye length growth and final refractive outcome after unilateral paediatric cataract surgery

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See Editorial, p 529

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Accepted 6 July 2009

Published Online First

18 August 2009

ABSTRACT

Aim To compare the axial eye length growth of the two fellow eyes within one patient after unilateral paediatric cataract surgery and to assess changes in refraction and keratometry.

Patients/methods A retrospective study in 90 eyes of 45 patients was performed. The 45 patients were divided into group 1 (patients younger than 18 months at the time of surgery, n=25) and group 2 (patients 18 months or older at the time of surgery, n=20). The axial eye length, spherical equivalent refraction and keratometry were measured during surgery and at follow-up. All outcome data in the operated eyes were compared with the outcome data of the fellow non-operated eyes. The Student t test was used for statistical analysis. Values of p<0.05 were considered statistically significant.

Results In group 1 the absolute growth (mm) of the operated eyes was borderline statistically significantly less than in the fellow non-operated eyes (p=0.049). No statistically significant difference in the rate of axial growth between the two eyes was found (p=0.25). A larger myopic shift (p=3.85×10⁻⁵) and a larger change in keratometry (p=0.02) were found in the operated eyes. In group 2 no statistically significant differences were found between the two eyes.

Conclusion We did not find a statistically significant difference in axial length growth between the operated eyes and fellow non-operated eyes in our unilateral paediatric cataract patients.

non-affected eyes within the same patient, as presented in this study, are rather limited.^{4 6 8 10 13 14} To our knowledge this is the largest group ever presented.

METHODS

Patients

All consecutive patients under the age of 8 years old that had a unilateral cataract operation in our hospital between 1996 and 2006, with a minimum follow-up of 1 year, were included in this study. All congenital and developmental cataracts, without comorbidity (trauma, glaucoma, persistent fetal vasculature, retinal or optic nerve anomalies) and without microphthalmus were included. During this time period 91 children underwent unilateral cataract extraction, with or without primary implantation of an IOL. Forty-six patients were excluded from analysis; one patient died during follow-up from a cause not related to a syndrome or the eye disease, one patient suffered from endophthalmitis and one patient developed glaucoma. In 25 patients the available data were incomplete and 18 patients were lost to follow-up, mainly because they moved and the current address was unknown.

Complete data were available in 45 patients (90 eyes). These 45 patients were divided into two groups according to the age at the time of the surgery: group 1 (patients younger than 18 months at the time of the surgery, n=25) and group 2 (patients 18 months or older at the time of the surgery, n=20).

Methods

The primary data collected were the axial length at the time of the surgery, the date at the time of the surgery, the patient's age at the time of the surgery, laterality, the type of the cataract and the IOL characteristics. The secondary data collected were spherical equivalent (SE) refraction at 4 weeks and keratometry at the time of the surgery.

For this study the included patients were recruited again for a recent axial length measurement, a measurement of SE refraction and keratometry. These measurements were made at the last follow-up visit. The follow-up time was the time between this recent last follow-up visit and the day of the cataract surgery. In case of primary aphakia with a secondary IOL implant, the second axial length measurement, SE refraction and keratometry were measured at the time of this second surgery. The follow-up time in these patients was also at least 1 year. None of the patients included developed secondary glaucoma during follow-up.

INTRODUCTION

Paediatric cataract surgeons often have to deal with a wide range of (long-term) postoperative refractive outcomes. We tried to answer the question of whether this is a result of altered growth in eyes that underwent cataract surgery. Several studies have looked at the axial growth of eyes after paediatric cataract surgery.¹⁻¹³ Some studies report growth as axial growth,^{1-8 10-13} whereas others reported growth as refractive growth⁹ (reflecting not only axial changes but also changes in corneal curvature and intraocular lens (IOL)-related factors). Some studies report on axial growth as an absolute value^{2-8 10-12} (axial length in mm), whereas others report it relative to the initial axial length (ie, rate of growth).¹³ Moreover, due to differences in inclusion and exclusion criteria (type of cataract, age of children, laterality, aphakia, pseudophakia), these studies are difficult to compare and interpret.

The number of studies in which the axial eye growth of operated eyes is compared with the fellow

The preoperative axial length was measured using applanation A scan at time of surgery. The second axial length measurement was performed with the IOL Master (Carl Zeiss AG, Oberkochen, Germany) in the outpatient clinic or with applanation A scan in case of a secondary IOL implant. Methodological consistency would have been optimal if the applanation A scan measurements were repeated, but for ethical reasons (minimal discomfort for the patients) the second measurement was performed using a non-contact technique.

All surgery was performed by two surgeons (JTHNdeF/MT-F-S). The IOL power was calculated using the SRK-T formula. Polymethylacrylate (PMMA) was used. The target postoperative refraction ranged from +1.0 to +4.0 depending on patient's age and refractive status of the fellow eye.

We calculated the absolute axial eye growth in mm by subtracting the axial length at the time of the surgery from the axial length at the last follow-up visit.

We also calculated the rate of axial growth (RAG; introduced by Vasavada *et al* in 2004¹³). The RAG was calculated by first dividing the axial growth in mm by the preoperative (initial) axial length in mm and then multiplying this number with 100 (axial growth in mm/initial axial length in mm $\times$ 100%).

We calculated the myopic shift as the SE refraction at the last follow-up visit minus the SE refraction at 4 weeks after surgery in dioptres (D).

The changes in keratometry values were calculated as the mean corneal curvature (K) at the last follow-up visit minus the mean corneal curvature at the time of the surgery in dioptres (D).

All outcome data in the operated eyes were compared with the outcome data of the fellow non-operated eyes.

The Student *t* test was used for statistical analysis. Values of $p < 0.05$ were considered statistically significant.

RESULTS

Patient characteristics

Details on the age, laterality, IOL, type of cataract and follow-up time are presented in table 1.

Change in axial length

At the time of the surgery the axial length of the affected eyes (18.3 ± 1.6 mm) was significantly ($p = 0.0003$) shorter than in the fellow non-affected eyes (19.0 ± 1.2 mm) in group 1. The abso-

lute change in mm axial length in the operated eyes (2.65 ± 1.6 mm) was (borderline) significantly ($p = 0.049$) smaller than the growth of the fellow non-operated eyes (2.92 ± 1.21 mm). Due to the small number of eyes implanted with an IOL in this age group, the influence of the IOL implantation on the axial elongation could not be ascertained (table 2).

In group 2 the preoperative axial length of the affected eyes (22.4 ± 1.9 mm) was not statistically significantly ($p = 0.33$) different from that in the healthy fellow eyes (22.0 ± 0.9 mm). The absolute change in axial length in the operated eyes (0.66 ± 0.86 mm) was not statistically significantly ($p = 0.12$) different from that in the fellow non-operated eyes (0.96 ± 0.69 mm).

RAG

The RAG of the operated eyes was not statistically significant different from that in the fellow non-operated eye in any group ($p = 0.25$ for group 1, $p = 0.10$ for group 2) (table 2).

Refractive outcome

In group 1 the mean myopic shift was statistically significantly ($p = 3.85 \times 10^{-5}$) larger in the operated eyes (6.0 ± 4.4 D) than in the fellow non-operated eyes (1.7 ± 1.3 D) (table 3).

In group 2 the mean myopic shift was not statistically significant different ($p = 0.86$) between the operated (1.0 ± 1.46 D) and fellow non-operated eyes (1.1 ± 0.96 D).

Keratometry

In group 1 the mean change in corneal curvature (K) was statistically significantly ($p = 0.02$) larger in the operated eyes (2.97 ± 6.68 D) compared with the fellow non-operated eyes (-0.18 ± 1.27 D) (table 4).

In group 2 the mean change in K in the operated eyes (-0.07 ± 0.83 D) was not statistically significantly ($p = 0.14$) different from that in the fellow non-operated eyes (0.83 ± 2.46 D).

DISCUSSION

Predicting the refractive outcome is one of the main remaining challenges for the long-term care of children after cataract surgery. We did not find a difference in growth in paediatric eyes operated on for unilateral cataract compared with the healthy fellow eyes within the same patient that would explain the wide range of refractive outcome.

A number of other studies compared the axial length growth of the operated eyes with the axial length growth of the fellow non-operated eyes within the same patient.

Leiba *et al*⁸ found a tendency towards greater axial lengthening in operated eyes after unilateral congenital cataract extraction in nine children, age 0 to 9 years old at the time of the

Table 1 Patient characteristics

Characteristics	Value	
	Group 1 (n=25)	Group 2 (n=20)
Age at surgery	4.8 ± 4.0 months	4.1 ± 1.5 years
Range	0.8–17.0 months	2.2–8.0 years
Follow-up time (years)	4.3 ± 3.2	4.8 ± 2.6
Range (years)	1.0–11.9	1.8–11.1
Operated eye, n (%)		
Right	17 (68)	9 (45.0)
Left	8 (32)	11 (55.0)
Primary IOL implanted, n (%)		
Yes	6 (24)	20 (100)
No	19 (76)	0 (0)
Type of cataract, n (%)		
Posterior	18 (72)	14 (70.0)
Nuclear	5 (20)	3 (15.0)
Lamellar	0 (0)	0 (0)
Other	2 (8)	3 (15.0)

Values are mean $\pm$ SD unless stated otherwise.
IOL, intraocular lens.

Table 2 Axial growth

	Operated eye	Fellow eye	p Value
Group 1 (<18 months, n=25)			
Preoperative AL (mm)	18.3 ± 1.6	19.0 ± 1.2	0.0003
AL growth (mm)	2.65 ± 1.6	$2.92 \pm .21$	0.049
RAG (mm)	14.8 ± 9.0	15.6 ± 6.8	0.25
Group 2 (>18 months, n=20)			
Preoperative AL (mm)	22.4 ± 1.9	22.0 ± 0.9	0.33
AL growth (mm)	0.66 ± 0.86	0.96 ± 0.69	0.12
RAG (mm)	2.95 ± 3.55	4.4 ± 3.1	0.10

Values are mean $\pm$ SD. AL, axial length; RAG, rate of axial growth.

Table 3 Refractive outcome

	Operated eye	Fellow eye	p Value
Group 1 (<18 months, n=25)			
SE 4 weeks postoperative (D)	22.0±11.1	1.8±1.1	3.85×10 ⁻⁵
SE at follow-up (D)	16.0±11.1	0.2±0.8	
Myopic shift (D)	6.0±4.4	1.7±1.3	
Group 2 (>18 months, n=20)			
SE 4 weeks postoperative (D)	1.15±1.27	1.0±0.73	0.86
SE at follow-up (D)	0.13±2.22	-0.09±1.06	
Myopic shift (D)	1.0±1.46	1.1±0.96	

Values are mean±SD. SE, spherical equivalent.

surgery, compared with their non-operated eyes ($p=0.055$). Rasooly and BenEzra¹⁰ in their study suggested that unilateral aphakia after congenital or traumatic cataract is associated with excessive eye elongation of the operated eyes and that this might be related to amblyopia and poor vision.

Inatomi *et al*⁶ compared the two eyes within 15 children (5–15 years) after congenital or traumatic unilateral cataract surgery with implantation of an IOL. They found no difference in axial length elongation between the operated and fellow non-operated eyes ($p>0.5$). In accordance with this Kora *et al*¹⁴ found no significant difference between the postoperative increase in axial length in the operated eyes compared with the fellow non-operated eyes in their patient group of 16 children.

Griener *et al*⁴ studied the axial length growth of both eyes of 11 infants between 2 and 4 months old operated and implanted with an IOL for unilateral congenital cataract. They suggested that there may be a reduction of axial growth in infantile eyes after cataract extraction and IOL implantation, based on their findings that in the majority (7/11) of their patients the mean axial growth in the operated eyes was less than in the fellow non-operated eyes. We calculated the RAG of these seven eyes and found (with the paired Student *t* test) that the RAG was not significantly different between their operated eyes and the fellow non-operated eyes ($p=0.7$). The axial length of these seven affected eyes at the time of surgery was shorter than the axial length of the fellow eyes, as in our study.

In our younger patients the absolute axial length growth in the operated eyes is (borderline) statistically significantly less than the growth in the fellow non-operated eyes. This implies a restricted growth of the operated eye in these young patients. Yet the RAG of the operated eyes was not significantly different from the fellow non-operated eyes. The smaller absolute growth (mm) can probably be explained by the fact that an eye that starts off smaller and has the same rate of growth does grow less when measured in millimetres, as also seen in the study by Griener *et al*. Vasavada *et al*¹³ introduced RAG in 2004. According to Vasavada *et al*, changes in axial growth are better expressed as percentage differences rather than as absolute differences in millimetres, especially when the base values (preoperative axial length) vary.¹³ We feel that this is true for our study population where, preoperatively, the affected eyes in the younger age group

Table 4 Keratometry values

	Operated eye	Fellow eye	p Value
Group 1 (<18 months, complete data n=17/25)			
Mean change in K (D)	2.97±6.68	-1.18±1.27	0.02
Group 2 (>18 months, complete data n=19/20)			
Mean change in K (D)	-0.07±0.83	0.83±2.46	0.14

Values are mean±SD. K, mean corneal curvature.

were smaller than their fellow non-affected. A shorter preoperative axial length in the affected eyes in infants was reported earlier by Kugelberg *et al* and Trivedi *et al*.^{15 16}

Although we did not find a different growth in paediatric eyes operated on unilateral cataract, we did find a large, statistically significant difference in myopic shift between the operated and non-operated eyes and a wide range of refractive outcome in children that were operated before the age of 18 months (group 1). Furthermore we found a statistically significant difference in change of mean corneal curvature in these young children.

Refractive changes in normal phakic eyes are influenced by changes in axial length, corneal curvature and lens growth. In a study by Mutti *et al*¹⁷ modulation in the amount of axial growth in relation to initial refractive error appeared to be the most influential factor in emmetropisation of SE refractive error in normal paediatric eyes. In their study the cornea and crystalline lens lost substantial amounts of dioptric power, but neither appeared to play a significant role in emmetropisation.

The myopic shifts in pseudophakic eyes are expected to be greater than those observed in normal eyes even if the axial growth follows the normal pattern. This increased myopic shift probably occurs because in the developing phakic eye progressive flattening of the crystalline lens reduces the refractive consequences of the axial elongation.¹⁸ Flitcroft *et al*³ reported that, with regard to the ocular growth patterns of the two ocular-metric variables affecting the choice of IOL power (keratometry and axial length), the change in axial length appears to outweigh the progressive corneal flattening in eyes with paediatric cataract. They state that for operations as early as 4 weeks, using preoperative keratometry readings is likely to contribute an underestimate of the appropriate power for later life of only 2 D or so. We cannot confirm these findings.

CONCLUSION

We did not find a statistically significant difference in axial length growth between the operated eyes and fellow non-operated eyes in our unilateral paediatric cataract patients. Yet significant larger myopic shifts and changes in the mean corneal curvature were found in the operated eyes of children younger than 18 months at the time of the surgery. An improved knowledge of development of axial length, keratometry and lens changes in infants younger than 18 months may contribute to better IOL power calculation and prediction of postoperative refraction in this age group.

Competing interests None.

Ethics approval This study was conducted with the approval of the Ethics Committee, Erasmus MC, Rotterdam, The Netherlands.

Patient consent Obtained.

Provenance and peer review Not commissioned; externally peer reviewed.

REFERENCES

1. Dahan E, Drusedau MU. Choice of lens and dioptric power in pediatric pseudophakia. *J Cataract Refract Surg* 1997;**23**(Suppl 1):618–23.
2. Fan DS, Rao SK, Yu CB, *et al*. Changes in refraction and ocular dimensions after cataract surgery and primary intraocular lens implantation in infants. *J Cataract Refract Surg* 2006;**32**:1104–8.
3. Flitcroft DI, Knight-Nanan D, Bowell R, *et al*. Intraocular lenses in children: changes in axial length, corneal curvature, and refraction. *Br J Ophthalmol* 1999;**83**:265–9.
4. Griener ED, Dahan E, Lambert SR. Effect of age at time of cataract surgery on subsequent axial length growth in infant eyes. *J Cataract Refract Surg* 1999;**25**:1209–13.
5. Hutchinson AK, Wilson ME, Saunders RA. Outcomes and ocular growth rates after intraocular lens implantation in the first 2 years of life. *J Cataract Refract Surg* 1998;**24**:846–52.

Clinical science

6. **Inatomi M**, Kora Y, Kinohira Y, *et al*. Long-term follow-up of eye growth in pediatric patients after unilateral cataract surgery with intraocular lens implantation. *J AAPOS* 2004;**8**:50–5.
7. **Lal G**, Trivedi RH, Wilson ME Jr, *et al*. Interocular axial length difference in eyes with pediatric cataracts. *J AAPOS* 2005;**9**:358–62.
8. **Leiba H**, Springer A, Pollack A. Ocular axial length changes in pseudophakic children after traumatic and congenital cataract surgery. *J AAPOS* 2006;**10**:460–3.
9. **McClatchey SK**, Dahan E, Maselli E, *et al*. A comparison of the rate of refractive growth in pediatric aphakic and pseudophakic eyes. *Ophthalmology* 2000;**107**:118–22.
10. **Rasooly R**, BenEzra D. Congenital and traumatic cataract. The effect on ocular axial length. *Arch Ophthalmol* 1988;**106**:1066–8.
11. **Sorkin JA**, Lambert SR. Longitudinal changes in axial length in pseudophakic children. *J Cataract Refract Surg* 1997;**23**(Suppl 1):624–8.
12. **Trivedi RH**, Wilson ME Jr. Changes in interocular axial length after pediatric cataract surgery. *J AAPOS* 2007;**11**:225–9.
13. **Vasavada AR**, Raj SM, Nihalani B. Rate of axial growth after congenital cataract surgery. *Am J Ophthalmol* 2004;**138**:915–24.
14. **Kora Y**, Shimizu K, Inatomi M, *et al*. Eye growth after cataract extraction and intraocular lens implantation in children. *Ophthalmic Surg* 1993;**24**:467–75.
15. **Kugelberg U**, Zetterstrom C, Syren-Nordqvist S. Ocular axial length in children with unilateral congenital cataract. *Acta Ophthalmol Scand* 1996;**74**:220–3.
16. **Trivedi RH**, Wilson ME. Biometry data from Caucasian and African-American cataractous pediatric eyes. *Invest Ophthalmol Vis Sci* 2007;**48**:4671–8.
17. **Mutti DO**, Mitchell GL, Jones LA, *et al*. Axial growth and changes in lenticular and corneal power during emmetropization in infants. *Invest Ophthalmol Vis Sci* 2005;**46**:3074–80.
18. **Gordon RA**, Donzis PB. Refractive development of the human eye. *Arch Ophthalmol* 1985;**103**:785–9.

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Br J Ophthalmol 2010 94: 547-550 originally published online August 18, 2009

doi: 10.1136/bjo.2009.160192

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