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Research Article

Ocular Axial Length Growth of Cataractous and Fellow Eyes in Paediatric Patients after Unilateral Cataract Surgery

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ABSTRACT

Background: To assess the preoperative and postoperative axial length growth of the cataractous and unaffected eyes in children who had unilateral cataract surgery.

Materials and methods: This was a retrospective study involving 38 eyes from 19 children who had unilateral cataract extraction due to unilateral congenital or developmental cataract. Preoperatively, at the time of surgery or a few days before surgery, and postoperatively, at the final follow-up appointment, the axial lengths of the cataractous and unaffected eyes were measured. Three of the 19 patients had no postoperative axial length measurements, thus they were excluded from the postoperative portion of the study. The measurements of axial length in the cataractous and unaffected eyes were compared.

Results: The axial length of the cataractous eyes was significantly ($P<0.001$) shorter than that of the non-affected eyes prior to surgery. The operated eyes had significantly higher postoperative axial length growth ($p=0.007$) than the fellow eyes, however there was no statistically significant difference ($p=0.5$) in postoperative axial length measured at the last follow up examination between the operated and fellow eyes.

Conclusion: At the time of surgery, we discovered that the cataractous eyes were significantly shorter than the unaffected eyes. The axial length growth of the operated eyes was significantly greater than that of the fellow eyes after surgery, and there was no statistically significant difference between the axial lengths of the operated eyes and fellow eyes at the last follow-up visit.

Keywords: Ocular axial length; Cataractous; Cataract surgery; Eyes

INTRODUCTION

Results from animal studies of refractive development provide convincing evidence for an active emmetropization process that can detect and compensate for imposed focusing errors. Compensatory eye growth responses to focusing errors represent the most compelling evidence for active emmetropizatio [1]. In humans, evidence of active emmetropization was found, similar to that shown in animal experiments. The alteration of axial elongation in response to initial refractive error and its correlation with change in refractive error both demonstrated an active role. Despite considerable variations in the power of the cornea and crystalline lens, these changes were not large enough to prevent emmetropization, and they didn't make any passive influences on emmetropization [2]. Studies of identical twins proved that visual deprivation, as that caused by a cataract, causes elongation of the axial length [3,4]. Accurate prediction of axial length growth is of paramount importance when considering the implantation of intraocular lens in paediatric patients. Numerous studies have looked into axial length change after paediatric cataract surgery, although the results have been inconsistent. Some of these studies found enhanced axial growth in the operated eyes when compared to non-operated fellow eyes [5-7], while others found reduced axial length growth in the operated eyes when compared to fellow eyes [8,9] and yet others found no significant difference in axial length growth between the operated and fellow eyes [10-14].

The preoperative axial length and postoperative axial length growth of the cataractous and unaffected eyes in children who received unilateral cataract surgery are compared in this study.

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MATERIALS AND METHODS

This is a retrospective analysis of 38 eyes from 19 patients who had unilateral cataract surgery (with or without IOL insertion) between May 1995 and October 2005 at Alder Hey Hospital in Liverpool, United Kingdom. The study only included eyes with unilateral congenital or developmental cataract. Applanation A scan was used to collect all axial length measures, both preoperatively and postoperatively. When required, patients were sedated. The study excluded eyes with aniridia, microphthalmos, persistent foetal vasculature, glaucoma, a history of trauma, and retinal or optic nerve defects. Under general anaesthesia, all procedures were performed by a single surgeon using a conventional approach (corneal tunnel, anterior capsulorhexis, hydro dissection, lens matter aspiration, closure of the main incision and the side port with 10-0 vicryl). In children aged 5 years and under, posterior capsulorhexis and anterior vitrectomy were performed, while IOL's were implanted in those aged 1 year and up. Appropriate postoperative visual rehabilitation was implemented and patching treatment was used when needed. The influence of cataract on ocular axial growth was investigated by comparing preoperative axial lengths (measured at the time of surgery or a few days before surgery) in cataractous and non-cataractous eyes. The axial length growth in the operated and non-operated eyes was compared postoperatively during the postoperative follow-up period. The following formula was used to compute axial length growth: Axial length growth in mm=axial length at last follow-up-preoperative axial length.

Postoperative axial length measurements of 3 out of 19 patients were not available and these patients were excluded from the postoperative part of the study. Statistical Package of Social Services, version 25 (SPSS) was used to enter and analyse the obtained data (IBM, 2017). The Shapiro-Wilk test was used to examine the variance homogeneity and distribution properties of variables. The data was presented in the form of a mean and standard deviation. The Mann Whitney test and the Student's t test were employed to analyse quantitative independent variables, where appropriate. To analyse quantitative paired variables, the paired t test and the Sign test were used as appropriate. A P value of ≤ 0.05 was considered significant in all tests.

RESULTS

Patient characteristics: Patient's age, operated eye, optical management and follow-up period

Table 1 indicates the age of the 19 patients at the time of surgery, the operated eye, optical treatment, and follow-up duration. The patients' ages varied from 0.85 months to 209.4 months at the time of surgery, with a mean of 28.0 months +/-55.6 months (SD). 15 of the 19 patients were under the age of 18 months, and 12 were under one year old. The right eye was operated on in 12 individuals, whereas the left eye was operated on 7. IOL was inserted in 12 patients, while in the remaining seven patients who were left aphakic, contact lenses were utilized. The mean postoperative follow-up duration was 27.2 months +/-15.0 (SD). 3 out of 19 participants were excluded from the postoperative part of the study as their Postoperative axial length measurements were not available.

Table 1: Patient's age, operated eye, optical management and follow-up period.

Patient	Age (Months)	Operated eye	Optical management	Follow-up period (Months)
1	2.43	R	CL	5.88
2	2.31	R	CL	35.67
3	1.87	R	CL	3.95
4	2.63	R	IOL	9.44
5	2.92	R	IOL	51.78
6	6.9	R	IOL	25.64
7	7.1	R	CL	41.92
8	11.97	R	CL	34.13
9	15.68	R	IOL	8.52
10	34.65	R	IOL	31.73
11	0.85	L	IOL	35.44
12	1.38	L	CL	42.58
13	4.5	L	IOL	15.19
14	5.75	L	IOL	24.85
15	13.35	L	CL	23.45
16	17.56	L	IOL	44.88
17	209.36	L	IOL	-
18	40.47	R	IOL	-
19	151.17	R	IOL	-

Preoperative axial length

The preoperative axial length values in cataractous and normal eyes are shown in Table 2. The preoperative axial length measurements were collected on the day of surgery or a few days before surgery. The cataractous eyes' preoperative axial length (19.2 ± 2.1) was significantly ($P<0.001$) shorter than that of the unaffected eyes (19.8 ± 1.9).

Table 2: The preoperative axial length between the cataractous eyes and fellow unaffected eyes.

Patient	AL (Cat. eye)	AL (Fellow eye)
1	17.87	18.61
2	15.44	16.3
3	17.7	18.89
4	17.46	18.64
5	18.03	19.73
6	18.53	17.79
7	19.64	19.08
8	19.32	20.26
9	19.2	19.46
10	20.99	21.95
11	17.91	17.59
12	16.1	18.36
13	18.85	20.04
14	18.93	20.11
15	20.07	20.7

16	21.83	21.63
17	22.95	22.96
18	21.62	20.37
19	23.04	23.86
Mean ± SD	19.2 ± 2.1	19.8 ± 1.9

Postoperative axial length

Table 3 illustrates the postoperative axial length values at the final follow-up and the axial length growth over the follow-up period in the operated eyes and unaffected eyes. The postoperative axial length measures were collected at the last follow-up visit. The postoperative axial length of the operated eyes (21.5 ± 1.3) and the fellow eyes (21.3 ± 0.8) did not differ significantly (p=0.5).

Table 3: Postoperative axial length values at the last follow-up and axial length growth during the follow-up period in the operated eyes and fellow eyes.

Patient	AL(Operated eye)	AL(Fellow eye)	Change in AL(Operated eye)	Change in AL(Fellow eye)
1	19.33	21.04	1.46	2.43
2	21.26	20.23	5.82	3.93
3	21.86	20.09	4.16	1.2
4	20.3	20.7	2.84	2.06
5	20.25	21.64	2.22	1.91
6	21.84	21.41	3.31	3.62
7	22.55	20.76	2.91	1.68
8	21.44	21.5	2.12	1.24
9	19.64	19.96	0.44	0.5
10	22.24	22.5	1.25	0.55
11	24.26	21.47	6.35	3.88
12	22.36	21.88	6.26	3.52
13	21.5	21.5	2.65	1.46
14	20.45	22.47	1.52	2.36
15	21.82	21.22	1.75	0.52
16	23.23	22.53	1.4	0.9
Mean ± SD	21.5 ± 1.3	21.3 ± 0.8	2.9 ± 1.8	2.0 ± 1.2

Postoperative axial length growth

During the follow-up period, axial length growth in the operated eyes (2.9 ± 0.8) was significantly greater (p=0.007) than in the fellow eyes (2.0 ± 1.2).

Our findings are summarised in Table 4 below. It demonstrates that the cataractous eyes were significantly shorter than the unaffected eyes at the time of cataract surgery. However, the operated eyes grew significantly greater than the fellow eyes after cataract surgery (during the follow-up period), therefore there was no statistically significant difference between the axial lengths of the operated eyes and fellow eyes at the last follow-up appointment.

Table 4: Summary of preoperative and postoperative findings.

Variables	Cataract eye	Fellow eye	P
Preoperative axial length (mm): Mean ± SD	19.2 ± 2.1	19.8 ± 1.9	<0.001
Postoperative axial length (mm): Mean ± SD	21.5 ± 1.3	21.3 ± 0.8	0.5
Axial length growth (mm): Mean ± SD	2.9 ± 1.8	2.0 ± 1.2	0.007

DISCUSSION

When an intraocular lens (IOL) is placed into a paediatric eye, accurately predicting axial length progression after cataract surgery is critical. After unilateral cataract surgery, several studies evaluated the axial length change in cataractous and normal eyes. Some of these studies supported our findings, reporting more axial length progression in the treated eyes as compared to non-operated eyes. Leiba et al. [5] studied 20 children under the age of ten who had surgery for traumatic (5 eyes) or congenital cataract (9 unilateral and 6 bilateral patients) and found that pseudophakic eyes had a tendency toward greater axial lengthening after unilateral cataract surgery when compared to their fellow eyes. (Traumatic cataract: p=0.06; unilateral congenital cataract, p=0.055). Axial length growth was significantly more in patients under 5 years old at the time of surgery than in those older than 5 (p=0.025). Rasooly and Benezra, et al. [6] assessed the axial length in paediatric patients with unilateral aphakia (15 patients with congenital cataract and 27 with traumatic cataract) and in patients with bilateral congenital cataract (operated on in 14 cases and not operated on in 8 cases). They found that in all patients with unilateral aphakia, the aphakic eye was always longer than the normal fellow eye. Vasavada et al. [7] proposed the rate of axial growth (RAG) in 2004, which was determined by dividing axial growth in mm by preoperative axial length in mm and multiplying this value by 100 (axial growth in mm/initial axial length in mm × 100). They found that the RAG in pseudophakic eyes of children 1 year old or below (25.53%) was significantly (p=0.06) greater than that in the fellow eye (16.32%), whereas the rate of axial growth was 4.16% and 4.37% (p=0.88) in children operated after 1 year.

Other research, on the other hand, found that the operated eyes had slower axial elongation than their normal fellow eyes. Griener et al. [8] looked at 11 infants who had unilateral cataract surgery between the ages of 2 and 4 months and found that in 7 of them, the mean axial growth in the pseudophakic eye was less than in the other eye. They concluded that there may be a slowing in axial growth in infantile eyes after cataract extraction and IOL implantation. Sminia et al. [9] evaluated axial length progression in 90 eyes of 45 patients after unilateral cataract surgery and concluded that the absolute change in mm axial length of the operated eyes (2.65 ± 1.6 mm) was borderline statistically significantly (p=0.049) smaller than the growth in the fellow normal eyes (2.92 ± 1.21) in the patients younger than 18 months (25 patients) while they couldn't find any significant difference between both eyes eyes in patients aged 18 months or older at the time of surgery (20 patients). They also found that in the patients younger than 18 months, the preoperative axial length of the affected eyes (18.3 ± 1.6 mm) was significantly (p=0.0003) less than in the normal fellow eyes (19.0 ± 1.2 mm) while no significant difference was seen between the two eyes in patients aged 18 months and older (22.4 ± 1.9 *vs.* 22.0 ± 0.9 mm, p=0.33).

Other findings have revealed no significant difference in axial progression between eyes that have been operated on and the fellow normal eyes. Kora et al. [10] investigated the effect of cataract extraction and IOL implantation on axial elongation in 16 children (14 unilateral and 2 bilateral) divided into two groups: trauma group (8 patients aged 7-14 years) and congenital group (8 patients aged 7-15 years) and found no significant difference in postoperative axial length growth in the operated and fellow eyes in the two groups. Serial axial length assessments in 11 patients who underwent cataract extraction under 2 years with a mean follow-up of 20 months found no significant difference in axial length growth in the operated *vs.* the fellow eye, according to Hutchinson et al. [11]. After unilateral congenital or traumatic cataract surgery, Inatomi et al. [12] reported no significant difference in axial length progression between the operated and fellow eyes of 15 patients (aged 5 to 15 years). Although the mean axial length growth in the operated eyes of the 18 patients who had unilateral surgery for congenital cataract was more than the axial length growth in the other eyes, Hussain and Markham, et al. [13] found that the difference was not statistically significant (mean age at surgery was 10.4 ± 10.2 months and mean follow-up time was 116 ± 48.0 months). Wilson et al. [14] evaluated how axial length changed over time from the time of unilateral cataract surgery at age 1 to 7 months to the age of 5 years (70 patients were eligible, axial length data of both eyes were available for 64 patients at baseline and 69 patients at 5 years). They found no significant difference in axial length growth between the operated and fellow eyes (3.3 *vs.* 3.5 mm, P=0.31), and that the operated eyes' axial length was significantly less than the fellow eyes both before surgery (18.1 *vs.* 18.7 mm, P<0.0001) and at the last follow-up (21.4 *vs.* 22.1 mm, P=0.0004).

In our study, we studied the preoperative axial length and postoperative axial length growth in the cataractous and fellow eyes of children who had unilateral surgery for congenital or developmental cataract. Most of our patients were under the age of 18 months (15 out of 19). Twelve patients were under the age of one year.

At the time of surgery, the axial length of the cataractous eyes was significantly shorter than that of the fellow normal eyes (p<0.001).

Postoperatively, the axial length growth in the operated eyes was significantly greater than that of the fellow eyes (p=0.007).

At the last follow-up visit, there was no significant differences between the axial length of the cataractous eyes and the fellow eyes (p=0.5).

We think that this inconsistency in the findings may be related to differences between studies in the number of patients, type of cataract, age of the patients, duration of follow up and the method of calculating axial length growth. Many factors, including the type and density of the cataract, visual acuity, age at the time of surgery, and compliance with amblyopia therapy, might influence eye development. Values from a single sample may not always generalize to all children, as a general restriction.

CONCLUSION

In our study we found that at the time of surgery, the cataractous eyes were significantly shorter than the fellow normal eyes. After cataract surgery, the operated eyes grew significantly more the fellow normal eyes so that at the last follow-up visit, there was no statistically significant difference between the axial lengths of the operated eyes and fellow eyes.

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