

Factors associated with strabismus after cataract extraction and primary intraocular lens implantation in congenital cataracts

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Abstract

- **AIM:** To evaluate factors associated with the development of strabismus after cataract extraction and primary intraocular lens implantation.

- **METHODS:** The medical records of 122 patients, aged 1.5mo to 9y, who had undergone cataract extraction with primary intraocular lens implantation between January 1993 and August 2011 were reviewed. Fourteen patients (17 eyes) with strabismus before cataract surgery were excluded. Patients were divided into those with congenital bilateral cataracts (64 patients, 128 eyes) and those with unilateral cataracts (44 patients, 44 eyes). The associations between the development of strabismus and age at cataract surgery, pre- and post-cataract extraction corrected distance visual acuity (CDVA), interocular CDVA difference, nystagmus, surgical method, and secondary cataract were evaluated.

- **RESULTS:** Factors significantly associated with the development of strabismus included age at cataract surgery ($\leq 1y$), preoperative mean CDVA $\leq 20/100$, presence of nystagmus in the bilateral cataract group and postoperative interocular CDVA difference $>20/70$ in the unilateral group. Postoperative CDVA $\leq 20/100$ and preservation of posterior capsule, and presence of secondary cataract were significant factors in both groups.

- **CONCLUSION:** Children with congenital cataracts should be monitored carefully after cataract surgery for the development of strabismus, especially when they underwent surgery at age $\leq 1y$, and they have nystagmus, large postoperative interocular CDVA difference, poor preoperative and postoperative CDVA, preservation of the posterior capsule, or secondary cataract.

- **KEYWORDS:** strabismus; congenital cataract; nystagmus

INTRODUCTION

Congenital cataract is a condition observed in 2.2-3 of 10 000 newborn infants and is responsible for the loss of sight in 10% of children worldwide who become blind^[1-3]. Unlike cataracts in adults, early detection, method and time of operation, time of intraocular lens (IOL) implantation, proper IOL power, and optical treatment for amblyopia after surgery are important for visual outcomes in children with congenital cataracts^[4]. Excessive inflammatory reaction, secondary cataract, glaucoma, and strabismus can occur after surgery. Especially, the rate of strabismus associated with congenital cataract has been reported to range from 20.5%-86% before and after cataract surgery^[5-8]. Strabismus occurs more frequently in patients with unilateral than bilateral cataracts^[7,8].

A study of patients who underwent primary IOL implantation for congenital cataract found that corrected distance visual acuity (CDVA) before and after operation, the form of strabismus and the presence or absence of amblyopia after surgery were associated with the occurrence of strabismus^[7]. Factors related to the onset of postoperative strabismus in aphakic or pseudophakic patients after surgery for congenital cataract included older age at surgery, development of secondary cataracts, poor visual rehabilitation after surgery, and unilateral cataract^[8]. To our knowledge, however, no study has assessed factors associated with newly developed strabismus after primary IOL implantation except the cases with strabismus which already existed preoperatively. We therefore analyzed the factors associated with the onset of strabismus after cataract removal and primary IOL implantation in patients with unilateral and bilateral congenital cataracts.

SUBJECTS AND METHODS

Subjects This retrospective analysis included 189 eyes of 122 patients who underwent cataract removal and primary IOL implantation for congenital cataract by one surgeon at

Table 1 Characteristics of patients with congenital cataracts

Variables	Bilateral cataract (n=64)			Unilateral cataract (n=44)		
	Postop. orthotropia (n=53)	Postop. strabismus (n=11)	P	Postop. orthotropia (n=31)	Postop. strabismus (n=13)	P
M:F	26:27	7:4		20:11	6:7	
Mean age at surgery (a)	3.7±2.5 (0.2-9)	2.4±1.7 (0.1-5)	0.074	3.1±2.1 (0.5-6)	1.2±0.6 (0.7-2)	0.119
Follow-up period (a)	4.8±2.5 (2-12)	4.9±2.2 (2.8-8)	0.624	4.1±3.8 (2-16)	4.3±2.0 (2-9)	0.671

Table 2 Associations between age at surgery and postoperative onset of strabismus

Variables	Bilateral cataract (n=64)			Unilateral cataract (n=44)		
	Postop. orthotropia (n=53)	Postop. strabismus (n=11)	P	Postop. orthotropia (n=31)	Postop. strabismus (n=13)	P
Age at surgery (a)						
≤1	10	6 (37.5%)	0.013	2	3 (60.0%)	0.113
>1	43	5 (10.4%)		29	10 (25.6%)	

Maryknoll hospital from January 1993 to August 2011. The patients with accompanying abnormality of the eyes were excluded. Angle of deviation was measured before and after operation, and all included patients were followed-up for at least 2y. Seventeen eyes of 14 patients (6 eyes of 3 patients with bilateral cataracts and 11 eyes of 11 patients with unilateral cataracts) who had strabismus before surgery were excluded. The remaining 108 patients were divided into 2 groups: 128 eyes of 64 patients with bilateral cataracts and 44 eyes of 44 patients with unilateral cataracts, with each group further subdivided into those with preoperative orthotropia and postoperative strabismus and those with pre- and post-operative orthotropia. Diagnostic criteria for congenital cataract included patients with cataract observed within 1y after birth, patients with a family history of congenital cataract, and patients with systemic disease or cataract shape suspected of being congenital (e.g. anterior polar, nuclear, lamellar, and sutural cataract)^[9-12].

Methods Factors assessed for their correlation with postoperative onset of strabismus included age at cataract surgery, CDVA before and after surgery, interocular CDVA difference before and after surgery, nystagmus before and after surgery, surgical methods, and secondary cataract. CDVA was measured with a Snellen chart, or, with evaluation of central, steady, and maintained (CSM) visual behavior in non-verbal children. Surgical method was dichotomized by preservation of the posterior capsule (PC; yes vs no). In patients with bilateral cataracts, PC removal was defined as removal from both eyes. Patients with bilateral cataracts who had unilateral PC removal were regarded as the group of intact PC. Of the 172 eyes, 131 underwent posterior continuous curvilinear capsulorhexis (PCCC), with 107 undergoing optic capture of the IOL and 24 eyes undergoing IOL implantation in the bag after anterior vitrectomy using a vitreous cutter. Of the 41 eyes not undergoing PCCC, 16 had lens decentration, with scleral

fixation of the IOL performed after cataract removal. In patients with bilateral cataracts, it was regarded as the presence of secondary cataract if one of the both eyes had secondary cataract.

Statistical Analysis All statistical analyses were performed using SPSS version 12.0. Pearson's Chi-square test was employed to compare discrete variables between groups. A two-sample *t* test was employed to compare continuous variables such as age at surgery between the two groups. A *P*-value less than 0.05 was considered significant. Ethical approval was obtained by the Institutional Review Board of Maryknoll Hospital, and the study conducted adhered to the Declaration of Helsinki.

RESULTS

We found that 11 (17.2%) of 64 patients with bilateral cataracts and 13 (29.5%) of 44 patients with unilateral cataracts had postoperative onset of strabismus (*P*=0.100) (Tables 1, 2).

Preoperative CDVA was defined as the mean CDVA of both eyes in patients with bilateral cataracts. Patients in whom CDVA could be measured only by CSM or in whom measurement was impossible were excluded from evaluation of the association between preoperative CDVA and postoperative strabismus. CDVA was measured in 45 patients with bilateral cataracts and 23 with unilateral cataracts (Tables 3, 4).

Postoperative CDVA at last follow-up in patients with bilateral cataracts was measured as the average for both eyes in 63 patients (Table 5). When the association between strabismus and postoperative interocular CDVA difference at last follow-up was assessed in patients with bilateral cataracts (Table 6).

None of the patients with unilateral cataracts had nystagmus before or after surgery. One patient with bilateral cataracts showed the disappearance of nystagmus after surgery and one newly developed nystagmus after surgery (Table 7).

Table 3 Associations between preoperative visual acuity and postoperative onset of strabismus

Variables	Bilateral cataract (n=64)			Unilateral cataract (n=44)		
	Postop. orthotropia (n=53)	Postop. strabismus (n=11)	P	Postop. orthotropia (n=31)	Postop. strabismus (n=13)	P
-20/100	13	4		11	4	
20/80-20/40	19	1		7	1	
20/32-20/25	8	0		0	0	
≤20/100	13	4 (23.5%)	0.039	11	4 (26.7%)	0.433
>20/100	27	1 (3.6%)		7	1 (12.5%)	
CSM (-)	2	3		12	7	
CSM (+)	6	1		1	1	
CSM(-), CSM (+)	5	2				

CSM: Central, steady, maintained.

Table 4 Associations between preoperative visual acuity difference between eyes and postoperative onset of strabismus

Variables	Bilateral cataract (n=64)			Unilateral cataract (n=44)		
	Postop. orthotropia (n=53)	Postop. strabismus (n=11)	P	Postop. orthotropia (n=31)	Postop. strabismus (n=13)	P
-20/70	36	4		5	1	
20/63-20/40	3	1		5	4	
20/32-20/25	1	0		3	1	
20/20-	0	0		4	0	
≤20/70	36	4 (10.0%)	0.461	5	1 (16.7%)	0.541
>20/70	4	1 (20.0%)		12	5 (29.4%)	
Unable to measure	13	6		14	7	

Table 5 Associations between postoperative visual acuity and postoperative onset of strabismus

Variables	Bilateral cataract (n=64)			Unilateral cataract (n=44)		
	Postop. orthotropia (n=53)	Postop. strabismus (n=11)	P	Postop. orthotropia (n=31)	Postop. strabismus (n=13)	P
-20/100	3	5		2	9	
20/80-20/40	9	3		14	3	
20/32-20/25	24	3		14	1	
20/20	16	0		0	0	
≤20/100	3	5 (62.5%)	0.003	2	9 (81.8%)	0.000
>20/100	49	6 (10.9%)		28	4 (12.5%)	
CSM (+)	1	0		1	0	

The mean age at surgery of patients with bilateral cataracts was similar in those with intact and removed PC [2.8±1.8y (range 0.1-6y) vs 3.5±2.1y (range 0.2-9y), P=0.421], as was the mean age of patients with unilateral cataracts with intact and removed PC [1.5±0.4y (range 0.6-2y) vs 2.2±1.4y (range 0.5-6y), P=0.132].

Secondary cataracts developed in all 26 patients who underwent IOL implantation with preservation of the PC. Of patients with PCCC, six in the patients with bilateral

cataracts and three with unilateral cataracts, respectively, developed secondary cataracts. The preservation of PC affected the prevalence of secondary cataracts (P=0.000 and P=0.000, respectively). All 35 patients in whom secondary cataracts developed, underwent clearance of the visual axis at 2.4 ±1.9y (range 2mo to 6y) after cataract surgery. Thirteen (37.1%) underwent Nd:YAG laser posterior capsulotomy and 22 (62.9%) secondary optic capture after PCCC (Table 8).

Table 6 Associations between postoperative visual acuity difference between eyes and postoperative onset of strabismus

Variables	Bilateral cataract (n=64)			Unilateral cataract (n=44)		
	Postop. orthotropia (n=53)	Postop. strabismus (n=11)	P	Postop. orthotropia (n=31)	Postop. strabismus (n=13)	P
-20/200	35	3		0	0	
20/160-20/70	13	6		8	0	
20/63-20/40	4	2		7	3	
20/32-20/25	0	0		13	6	
20/20-	0	0		2	4	
≤20/70	48	9 (15.8%)	0.282	8	0 (0%)	0.039
>20/70	4	2 (33.3%)		22	13 (37.1%)	
Unable to measure	1	0		1	0	

Table 7 Associations between nystagmus and postoperative onset of strabismus in patients with bilateral cataracts

Variables	Postop. orthotropia (n=53)	Postop. strabismus (n=11)	P
Nystagmus (+)	4	8 (66.7%)	0.000
Nystagmus (-)	49	3 (5.8%)	

Table 8 Associations between posterior capsule removal, other ocular diseases, and secondary cataract and postoperative onset of strabismus

Variables	Bilateral cataract (n=64)			Unilateral cataract (n=44)		
	Postop. orthotropia (n=53)	Postop. strabismus (n=11)	P	Postop. orthotropia (n=31)	Postop. strabismus (n=13)	P
Intact PC	8	7 (46.7%)	0.002	3	8 (72.7%)	0.000
Removed PC	45	4 (8.2%)		28	5 (15.2%)	
Secondary cataract (+)	13	8 (38.1%)	0.002	7	7 (50.0%)	0.042
Secondary cataract (-)	40	3 (7.0%)		24	6 (20.0%)	

PC: Posterior capsule.

DISCUSSION

The visual prognosis of patients with congenital cataracts has been improved by early operation, advanced operative skill, and active visual rehabilitation. Anterior vitrectomy after PCCC or optic capture of IOL has been found to reduce the occurrence of secondary cataract, the most frequent complication after surgery for congenital cataract [5,6,12-14]. However, the frequency of strabismus is higher in these patients than in the normal population (1.3%-4.5%) [15-17]. For example, the frequency of strabismus was reported to be 70.6% after surgery for unilateral cataracts and 39% in children who underwent primary IOL implantation [7,18]. Another study reported that the frequency of strabismus was 34% before surgery and 65% at final follow-up [8]. We found that the frequency of strabismus was 17.2% in children with bilateral and 29.5% in those with unilateral congenital cataracts, similar to frequencies of 22% and 50%, respectively, and 20.5% and 34.8%, respectively [5,8]. The

higher frequency of strabismus in patients with unilateral than bilateral cataracts is thought to be the result from the higher degree of hypoplasia in cells of the lateral geniculate body on the affected side compared to the opposite side in patients with unilateral cataracts, a difference that may damage the visual cortex and lateral geniculate body. The greater difficulty in fusion results in a higher frequency of amblyopia by competition between the two eyes, with lower compliance with occlusive treatment causing secondary strabismus more frequently [19-21].

We assessed the relationship between several factors and onset of strabismus, including age at cataract surgery, preoperative and postoperative CDVA, preoperative and postoperative interocular CDVA difference, nystagmus before and after surgery, operative method (preserved vs removed PC), and secondary cataract.

We found that age at the time of surgery (≤ 1 vs > 1 y) was related to onset of strabismus in bilateral cataracts, but was

not related in unilateral cataracts. Although one previous study found no association between age at surgery and development of strabismus, another reported that strabismus occurred in 8% of children undergoing surgery at age <3y and in 32% of those aged >3y^[7,8].

However, in our study, the patients with earlier surgical timing had higher rate of postoperative onset of strabismus in bilateral cataracts. The reason for this opposite result is thought the existence of nystagmus enabled earlier diagnosis for congenital cataracts. In under developed countries, congenital cataract cannot be noticed until a later time, leading to delay of surgery or aggressive management for amblyopia. Nystagmus had a strong relationship with development of strabismus like other study^[22]. Of the patients who underwent bilateral cataract surgery at age ≤1y, nystagmus was observed in 5 of 6 patients with postoperative strabismus, compared with 3 of 10 patients without strabismus ($P=0.039$).

In terms of unilateral cataracts without nystagmus, the optimal time of surgery for congenital cataracts is age 6-8wk, a period essential for the development of visual acuity^[6,23]. However, the age at cataract surgery in our present study was over 8wk in all the cases; age at surgery thus likely had little impact on development of strabismus in the patients with unilateral cataracts.

There was significant relationships between mean preoperative CDVA (≤20/100) and strabismus in bilateral cataracts. Nystagmus was noted in 4 of 17 patients (23.5%) with poor preoperative CDVA ≤20/100, and in no patient with CDVA >20/100.

We observed no significant relationships between preoperative interocular CDVA difference (≤20/70 *vs* >20/70) and strabismus, both in patients with bilateral and unilateral cataracts.

Strabismus, however, was significantly more frequent in patients with postoperative CDVA ≤20/100 than in those with postoperative CDVA >20/100, both in patients with unilateral and bilateral cataracts. Moreover, strabismus was significantly more frequent in unilateral cataract patients with postoperative interocular CDVA difference >20/70 than ≤20/70. Strabismus has been reported more frequent when good CDVA after operation was not achieved. Improper postoperative treatment of amblyopia in patients with unilateral cataracts has been reported to increase interocular CDVA difference, leading to strabismus^[7,8].

None of our patients with unilateral cataracts had nystagmus, compared with 18.8% of patients with bilateral cataracts pre- or postoperatively, similar to the rate of 24% observed in a previous study^[6]. Another study reported that 8 of 139

patients had preoperative nystagmus, with this condition disappearing in 1 patient but developing in 5^[5].

We found that the frequency of strabismus was significantly lower in patients who did than did not undergo PCCC, both in patients with unilateral and bilateral cataracts. The incidence of strabismus was significantly higher in patients with than without secondary cataract.

PCCC has been associated with a lower rate of secondary cataract and a higher rate of optic capture of IOL. Secondary cataracts prevent the maintenance of the clear visual axis, and can cause amblyopia. Amblyopia is reported to be a predisposing factor for the development of strabismus^[7,8].

In our cases, secondary cataracts occurred in all patients in whom the PC was preserved. 8 of 35 patients with secondary cataracts had not been followed-up continuously, thus management for secondary cataracts was delayed. Even after ND:YAG posterior capsulotomy or secondary optic capture for secondary cataract, a significant relationship was evident between secondary cataracts and the development of strabismus. Therefore, either optic capture or anterior vitrectomy after PCCC during cataract removal may help prevent onset of the postoperative strabismus by minimizing the risk of development of secondary cataracts.

In conclusion, the prevalence of strabismus after surgery for bilateral congenital cataracts was significantly higher when surgery was performed at age ≤1y, when preoperative CDVA was lower, and nystagmus developed before or after surgery. The prevalence of strabismus was higher in patients with unilateral cataracts with a larger postoperative interocular CDVA difference. The occurrence of strabismus was significantly higher in both sets of patients when postoperative CDVA was lower, when PCCC was not performed, and when secondary cataract developed.

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