

Is There a Latent Period for the Surgical Treatment of Children With Dense Bilateral Congenital Cataracts?

Scott R. Lambert, MD,^a Michael J. Lynn, MS,^b Rachel Reeves, CO,^a David A. Plager, MD,^c Edward G. Buckley, MD,^d and M. Edward Wilson, MD^e

Background: It generally is accepted that cataract surgery during the first 6 weeks of life is associated with the best visual outcomes for children with dense unilateral congenital cataracts. The latent period for children with dense bilateral congenital cataracts has not been clearly defined. **Methods:** The best-corrected visual acuity (BCVA) at 4 to 6 years of age was collected retrospectively on a series of 43 children with dense bilateral congenital cataracts from 4 institutions. All of the children underwent a lensectomy, posterior capsulotomy, and anterior vitrectomy at 36 weeks of age or younger. **Results:** Cataract surgery was performed at a mean age of 11.5 weeks for the better-seeing eye. BCVA was assessed when the children were a mean of 5.3 years of age. The visual acuities of 26 (60%) were 20/40 or better, 12 (28%) were 20/50 to 20/80, and 5 (12%) were 20/100 or worse. There was a trend for worse BCVA with increasing age at the time of surgery ($r = 0.28$, $P = 0.07$). We noted that a BCVA of 20/100 or worse occurred only among eyes undergoing surgery when infants were older than 10 weeks (≤ 10 weeks: 0/21 = 0% vs. > 10 weeks: 5/22 = 23%, $P = 0.049$). Children with preoperative nystagmus had worse visual outcomes; only 38% of children with preoperative nystagmus achieved a BCVA of 20/40 or better compared with 74% of children without preoperative nystagmus ($P = 0.03$). **Conclusion:** Previous reports have proposed that cataract surgery during the first 5 to 8 weeks of life is associated with better visual outcomes in children with dense bilateral congenital cataracts. Our results would suggest that good visual outcomes can be achieved beyond this age, but the incidence of poor visual outcomes increases if cataract surgery is delayed beyond 10 weeks of age. The absence of preoperative nystagmus is a better predictor of a good visual outcome than the age at surgery. (J AAPOS 2006;10:30-36)

Many mammals are born with their eyes closed. For example, kittens do not open their eyes until 4 to 10 days after birth, and the opening of the left and right eyes may be separated by 3 to 7 days.¹ Although humans open their eyes shortly after birth, they spend all but a few hours of each day sleeping during the first few weeks of life. In addition, their visual system is quite immature, resulting in only rudimentary vision during the early neonatal period.² It has been proposed that vision during the neonatal period is mediated through

subcortical pathways.^{3,4} As a result, transient disturbances of ocular alignment during the neonatal period do not seem to have any lasting effect on a child's vision.⁵ The period of time after birth until visual deprivation begins to interfere with the maturation of the visual system has been referred to as the latent period. The latent period is followed by a sensitive period during which even minor disturbances in visual input can have a profound effect on the maturation of the visual pathways.^{6,7} The duration of the latent period for full-term infants with unilateral ocular disorders is believed to extend to approximately 6 weeks of age. On the basis of a review of a series of infants with dense unilateral congenital cataracts, Birch and Stager⁸ suggested that cataract surgery was equally effective at any point during the first 6 weeks of life. However, after the first 6 weeks of life, they noted that the likelihood of a good visual outcome declined rapidly. Although it has been proposed that a latent period also exists for children with dense bilateral congenital cataracts, its length has not been established.⁹

Bilateral visual deprivation has been shown to affect the striate cortex of kittens quite differently than unilateral visual deprivation. In a series of experiments in the 1960s,

From the ^aEmory Eye Center, Atlanta, Georgia; ^bDepartment of Biostatistics, Rollins School of Public Health of Emory University, Atlanta, Georgia; ^cDepartment of Ophthalmology, Indiana University, Indianapolis, Indiana; ^dDepartment of Ophthalmology, Duke University, Durham, North Carolina; ^eDepartment of Ophthalmology, Medical University of South Carolina, Charleston, South Carolina;

Supported in part by NIH Core Grant EY06360 and Research to Prevent Blindness, Inc. Submitted March 4, 2005.

Revised October 10, 2005.

Revision accepted October 10, 2005.

Reprint requests: Scott R. Lambert, MD, Emory Eye Center, 1365B Clifton Rd N.E., Atlanta, GA 30322.

Copyright © 2006 by the American Association for Pediatric Ophthalmology and Strabismus.

1091-8531/2006/\$35.00 + 0

doi:10.1016/j.jaapos.2005.10.002

Wiesel and Hubel¹⁰⁻¹² sutured one or both eyelids of newborn kittens closed for 2 to 3 months. In monocularly deprived kittens, they found that virtually all of the neurons in the striate cortex were only driven by the nondeprived eye, whereas in control animals 80% of the neurons were binocularly driven. Furthermore, this effect persisted even after the eyelids were reopened for up to 14 months. In contrast, in a kitten who had both eyes sutured closed for 3 months, one-third of the neurons continued to be binocularly driven, one-third were driven by only one eye, and the remaining neurons were unresponsive.¹¹ Fourteen months after reopening one eye, the percentage of neurons that were binocularly driven remained unchanged; however, most of the previously unresponsive neurons became responsive.¹² In infant monkeys, monocular visual deprivation results in the complete loss of binocularly driven neurons whereas bilateral visual deprivation results in ill-defined receptive field boundaries and a loss of visual responsiveness in more than one-half of the neurons in the visual cortex.¹³ On the basis of these animal studies, it is clear that bilateral visual deprivation affects the visual system differently than unilateral visual deprivation during the sensitive period. As a result, we hypothesized that the latent period would differ for children experiencing bilateral visual deprivation compared with children experiencing unilateral visual deprivation. To test this hypothesis, we analyzed the visual outcomes of a series of children with dense bilateral congenital cataracts who underwent cataract surgery during infancy.

METHODS

Eligibility Criteria and Data Collection

Data were collected retrospectively from medical records at the 4 participating institutions after obtaining approval from each institutional review board. Children were eligible if they met the following criteria: (1) they had dense bilateral cataracts believed to be congenital; (2) There was no red reflex with the pupil undilated in either eye; (3) Surgery was performed in both eyes before they reached 1 year of age; (4) they did not have developmental delay making them incapable of recognizing letters by age 5; and (5) they had a follow-up examination that included an optotype acuity on both eyes 4 to 6 years after surgery on the second eye. The examination closest to the child's fifth birthday was used for data analysis. A consecutive series of patients was obtained from each institution.

Case report forms were designed and provided to each of the institutions for recording data. The investigators selected the children at their institution that met the entry criteria, completed the case report forms, and faxed the forms to the data coordinating center at the Biostatistics Department at Emory University. The preoperative data included information related to the inclusion criteria as well as demographic data, date of diagnosis, ocular alignment, and the presence of manifest nystagmus. Intraoper-

ative data included the type of cataract, the date of the procedure for each eye, the intraocular pressure, corneal diameter, keratometry readings, indirect ophthalmology or B-scan ultrasonography findings, and axial lengths. Follow-up data included optotype best-corrected visual acuity (BCVA), refractive error, the type of optical correction being worn, and the date and the nature of all reoperations performed.

Statistical Methods

Analyses relating BCVA at 5 years of age to the age at surgery and nystagmus at the initial examination included only 1 eye from each child. We selected the eye with the better visual acuity; if the visual acuity was the same in both eyes, then we selected the eye that was operated on last. We decided to base the analysis on the acuity in the better eye for each child rather than all eyes to minimize the confounding variables of amblyopia and postoperative complications, which were often times more severe in 1 eye than the other. The relationship between BCVA at 5 years of age (in logMAR units) and age at surgery and nystagmus was assessed using linear regression. Statistical comparisons of 2 groups were made using the Fisher's exact test for percentages and the independent groups t test for means. A comparison of the mean BCVA at 5 years of age between the first and second eyes of a patient to undergo cataract surgery was done using a paired t test. All *P* values were calculated as 2-sided and values ≤ 0.05 were considered statistically significant.

RESULTS

Subjects

Forty-three children were included in the study from the 4 participating institutions. All of the children underwent a lensectomy, primary posterior capsulotomy, and anterior vitrectomy in both eyes. The surgeries were performed between March 1985 and December 1999. Three additional children who had primary intraocular lens implantation in both eyes were excluded from the analysis because their initial surgical treatment differed from the other children in the study.

Characteristics of the children at the initial examination are summarized in Table 1. Twenty-eight (65%) of the children had nuclear cataracts and 12 (28%) had total cataracts; the remaining 3 children (7%) had lamellar, central cortical, or persistent fetal vasculature cataracts. None of the children had visually significant abnormalities of the retina or optic nerve preoperatively. Sixteen (37%) of the children had manifest nystagmus at the time of their initial office examination. Twenty-three (53%) of the children were boys, and 36 (84%) were white.

The mean age at the time of the initial examination was 9.3 weeks, and the mean time from the initial examination to surgery on the first operated eye was 11.4 days. The mean age at the time of cataract surgery on the first

Table 1. Characteristics of the 43 subjects

Institution	
Duke	13 (30%)
Emory	6 (14%)
Indiana	20 (47%)
MUSC	4 (9%)
Type of cataract	
Nuclear	28 (65%)
Total	10 (23%)
Other	5 (12%)
Manifest nystagmus	
Present	16 (37%)
Gender	
Male	23 (53%)
Race	
White	36 (84%)
Black	4 (9%)
Other	3 (7%)
Age at the initial examination	9.3 ± 8.6 (0.3–34.9)
Weeks	
0.3–4.0	17 (40%)
4.1–8.0	4 (9%)
8.1–12.0	9 (21%)
12.1–20	10 (23%)
20.1–35	3 (7%)
Time between initial examination	11.4 ± 12.9 (0–48)
and first eye surgery	
Days	
0–3	13 (30%)
4–7	13 (30%)
8–14	6 (14%)
15–28	6 (14%)
29–48	5 (12%)
Age at first Eye surgery	10.9 ± 8.2 (0.7–35.1)
Weeks	
0.7–4.0	8 (19%)
4.1–8.0	9 (21%)
8.1–12.0	12 (28%)
12.1–20	9 (21%)
20.1–35.7	5 (12%)
Time between surgeries in	6.3 ± 6.5 (1–35)
child's 2 eyes	
Days	
1–2	19 (44%)
3–7	14 (33%)
8–17	9 (21%)
35	1 (2%)
Initial optical correction	
Contact lenses	31 (72%)
Spectacles	12 (28%)

Values in the table are n (%) or mean ± standard deviation (range)

operated eye was 10.9 weeks, with 67% of children 12 weeks of age or younger. The mean interval between cataract surgeries was 6.3 days, with 77% of the children having the 2 surgeries within 2 weeks of each other. None of the children underwent cataract surgery in both eyes on the same day. All cataract surgeries were performed before any child was 36 weeks of age. Thirty-one (72%) of the children initially were corrected with contact lenses and 12 (28%) with aphakic spectacles.

The children with nystagmus at presentation were, on average, older at the time of the initial office examination (mean, 15.8 vs. 5.4 weeks; $P < 0.0001$) and had the cataract surgery performed closer to the time of the initial office examination (mean, 5.8 days vs. 14.7 days; $P = 0.009$; Table 2).

Visual Outcome at 5 Years of Age

Results at the follow-up examination are summarized in Table 3. BCVA was assessed at a mean age of 5.3 years. At the time BCVA was assessed, 19 children (44%) were wearing only spectacles, 16 (37%) contact lenses and spectacles, 4 (9%) contact lenses only, and 4 (9%) IOLs and spectacles. BCVA is reported for 1 eye of each child (the better-seeing eye or the later-operated eye if both eyes had the same BCVA). The mean age at surgery for the eyes reported was 11.5 weeks (SD, 8.3; range, 0.9–35.7). BCVA was 20/40 or better for 26 children (60%), 20/50 to 20/80 for 12 children (28%), and 20/100 to 20/160 for 5 children (12%).

Vision and Age at Surgery. There was a trend for worse BCVA with increasing age at surgery (correlation = 0.28, $P = 0.07$, Figure 1). We noted that BCVA of 20/100 or worse occurred only among eyes in which the child's age at surgery was >10 weeks (≤ 10 weeks: 0/21 = 0% vs. >10 weeks: 5/22 = 23%, $P = 0.049$). However, BCVA of 20/40 or better occurred similarly in these 2 age groups (≤ 10 weeks: 14/21 = 67% vs. >10 weeks: 12/22 = 55%, $P = 0.54$). The mean ± SD for BCVA (logMAR) was 0.2737 ± 0.1707 (mean = 20/38) for children 10 weeks or younger at surgery and 0.394 ± 0.2406 (mean = 20/50) for children older than 10 weeks at surgery ($P = 0.067$).

Vision and Nystagmus. Children with nystagmus at the initial examination had worse visual outcomes (Table 2); a BCVA of 20/40 or better was achieved by 38% of children with preoperative nystagmus compared with 74% of children without preoperative nystagmus ($P = 0.03$). The mean BCVA in logMAR units was 0.2472 (20/35) for children without preoperative nystagmus and 0.4838 (20/61) for children with preoperative nystagmus ($P = 0.0002$).

Nystagmus and Age at Surgery. Given that children with preoperative nystagmus initially were examined at an older age (Table 2), there is a strong association between preoperative nystagmus and the age at surgery in the better-seeing eye (Figure 1). Mean age at the time of cataract surgery in the better-seeing eye was 17.6 weeks for children with preoperative nystagmus compared with 7.9 weeks for those without preoperative nystagmus ($P < 0.0001$). A multiple linear regression analysis relating BCVA to both preoperative nystagmus and age at surgery indicated that after accounting for preoperative nystagmus, age at surgery was not significantly associated with BCVA ($P = 0.81$). However, preoperative nystagmus was significantly associated with BCVA, even after accounting for age at surgery ($P = 0.001$). Thus, preoperative nystagmus is the better predictor of BCVA.

Table 2 Characteristics and visual outcome by nystagmus

Characteristic	Nystagmus at initial examination	
	No (n = 27)	Yes (n = 16)
Age at the initial examination	5.4 ± 6.0 (0.3–27.6)	15.8 ± 8.4 (3.3–34.9)
Weeks		
0.3–4.0	16 (59%)	1 (6%)
4.1–8.0	4 (15%)	0 (0%)
8.1–12.0	4 (15%)	5 (31%)
12.1–20	2 (7%)	8 (50%)
20.1–34.9	1 (4%)	2 (13%)
Time between initial examination and first eye surgery	14.7 ± 14.7 (0–48)	5.8 ± 6.1 (1–25)
Days		
0–3	7 (26%)	6 (38%)
4–7	5 (19%)	8 (50%)
8–14	6 (22%)	0 (0%)
15–28	4 (15%)	2 (12%)
29–48	5 (19%)	0 (0%)
BCVA in the better eye		
20/20	3 (11%)	0 (0%)
20/25–20/30	12 (44%)	1 (6%)
20/40	5 (19%)	5 (31%)
20/50–20/60	5 (19%)	3 (19%)
20/70–20/80	2 (7%)	2 (13%)
20/100–20/160	0 (0%)	5 (31%)
BCVA in the better eye (logMAR)	0.247 ± 0.164 (0–0.602)	0.484 ± 0.215 (0.176–0.903)

Values in the table are n (%) or mean ± standard deviation (range).

Table 3 Results at follow-up for the 43 subjects

Age at follow-up examination	5.3 ± 0.4 (4.3–6.6)
Year	
4.3–5.0	14 (33%)
5.1–5.5	20 (47%)
5.6–6.0	6 (14%)
6.1–6.6	3 (7%)
Optical correction at follow-up	
Contact lenses	4 (9%)
Spectacles	19 (44%)
Contacts and spectacles	16 (37%)
IOLs and spectacles	4 (9%)
BCVA in the better eye	
20/20	3 (7%)
20/25–20/30	13 (30%)
20/40	10 (23%)
20/50–20/60	8 (19%)
20/70–20/80	4 (9%)
20/100–20/160	5 (12%)
BCVA in the better eye (logMAR)	0.335 ± 0.212 (0.0–0.903)

Values in the table are n (%) or mean ± standard deviation (range).

First- Versus Second-Operated Eye. There was not a significant difference in the BCVA at 5 years of age between the first- and second-operated eyes of patients (Figure 2). The mean BCVA in logMAR units was 0.4257 (20/53) for the first operated eye and 0.4350 (20/54) for the second operated eye. The mean difference in BCVA in logMAR units between first and second eyes was -0.0093 (SD, 0.3199; range, -1.3010 to 0.9031 , $P = 0.85$).

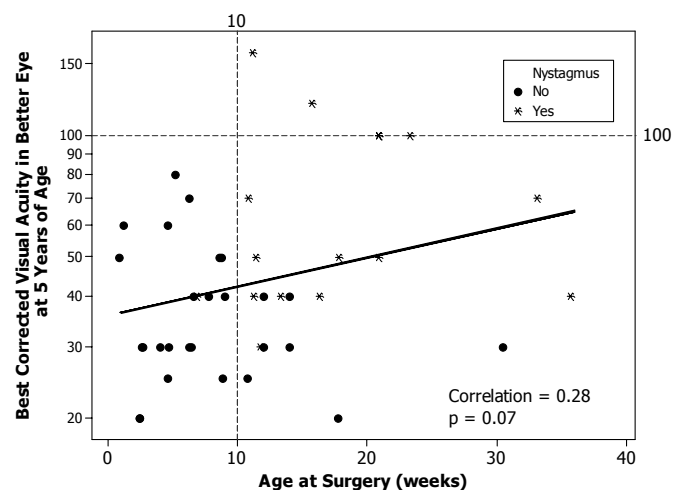


FIG 1. BCVA at 5 years of age in the better-seeing eye versus age at surgery. The equation of the regression line (solid line) is $(\text{LogMar BCVA}) = 0.2522 + 0.0072 \times \text{age}$. The 95% confidence interval of the coefficient for age is -0.007 to 0.0151 . Symbols indicate the status of nystagmus at the initial examination. Dotted lines indicate BCVA of 20/100 and age of 10 weeks.

Additional Surgery

Fifteen (35%) of the patients underwent a pupilloplasty, anterior vitrectomy, YAG laser capsulotomy, or cortical clean-up, including 4 of the patients who later developed glaucoma. One of these procedures had to be repeated in

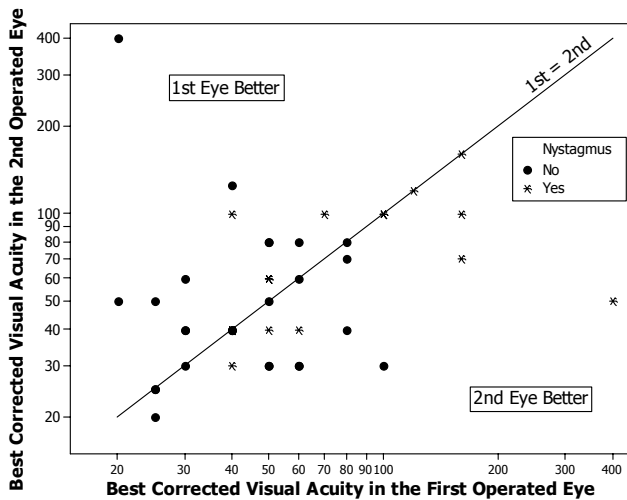


FIG 2. BCVA at 5 years of age for the first eye versus the second eye of a patient undergoing cataract surgery. The solid line of identity shows patients with the same BCVA in both eyes. Points above the line represent patients with better vision in the first operated eye, and points below the line represent patients with better vision in the second operated eye. Symbols denote the status of nystagmus at the initial examination.

2 patients. The first reoperation was performed a mean of 6.4 months (range, 0.5–24 months) after cataract surgery. The surgeries were unilateral in all but 1 patient. After excluding the patients who underwent glaucoma surgery and the patient who underwent bilateral reoperations, the acuity was worse in the eye undergoing reoperation in 5 patients, the same in 4 patients, and better in 2 patients. Five of these patients had an acuity of 20/100 or worse in the eye undergoing reoperation versus 3 of the fellow eyes.

Nine eyes (10% of eyes) in 7 patients underwent glaucoma surgery prior to the visual assessment. One eye developed acute angle closure glaucoma and underwent a peripheral iridectomy. The other 8 eyes developed open angle or chronic angle closure glaucoma and were treated with a variety of surgical procedures including: endoscopic cyclophotocoagulation, trabeculotomy, shunting with a Baerveldt implant and goniotomy (Table 4). Four of these eyes had risk factors for aphakic glaucoma (microphthalmos, $n = 3$; persistent fetal vasculature, $n = 1$). The visual acuity was the same or worse in the eye undergoing glaucoma surgery in the 5 patients who underwent unilateral glaucoma surgery. Three of these eyes had a visual outcome of 20/100 or worse.

Four patients underwent bilateral secondary IOL implantation before the visual assessment (mean, 4.5 years; range, 3.7–5.3 years). Eighteen patients (42%) did not undergo any additional intraocular surgeries after cataract surgery.

DISCUSSION

Several case series have noted a trend for better visual outcomes for children with bilateral congenital cataracts

treated during the first 6 to 8 weeks of life. However, some of these studies included children with dense and partial cataracts, children with other ocular and systemic abnormalities and children who had undergone outdated surgeries such as needling and aspiration procedures.¹⁴⁻¹⁷ Finally, grating acuities rather than optotype acuities were used to assess the visual outcome in some of these studies.^{18,19} Rogers and coworkers¹⁸ reported normal preferential looking acuities in 3 infants who underwent bilateral cataract surgery when 2 to 5 weeks of age, whereas 4 infants who underwent bilateral cataract surgery when 8 to 32 weeks of age had reduced preferential looking acuities. Gelbart and coworkers¹⁹ reported acuities of 20/80 or better using a combination of visual-evoked potential estimates and optotype acuities in 17 of 17 patients with bilateral congenital cataracts undergoing cataract surgery during the first 6 weeks of life versus only 1 of 7 patients undergoing cataract surgery after 6 weeks of age. Parks and coworkers¹⁵ noted a trend toward better visual acuity in 30 children with nuclear cataracts undergoing surgery at an earlier age, but the trend did not reach statistical significance. Lundvall and Kugelberg¹⁶ reported Snellen visual acuities of 20/50 or better in 9 children with dense bilateral congenital cataracts who underwent cataract surgery during the first 2 weeks of life but relatively poor visual acuities in 4 children who underwent cataract surgery when 6 weeks of age or older. In contrast, Bradford and coworkers¹⁴ did not find a correlation between the age of surgery and the visual outcome for 23 children with dense bilateral congenital cataracts.

We only included in our study children who had dense bilateral congenital cataracts who underwent cataract surgery during the first 36 weeks of life. Nearly two-thirds of the children had nuclear cataracts. All the children underwent lensectomies, posterior capsulotomies, and anterior vitrectomies and were corrected optically after surgery with spectacles or contact lenses. We also only used the optotype acuity obtained closest to the fifth birthday for the analysis. We found that all of the children undergoing cataract surgery when 10 weeks of age or younger had 20/80 or better visual acuity. Although many of the patients undergoing cataract surgery when older than 10 weeks of age also achieved 20/80 or better visual outcome, the visual results became less consistent and some of these children had a BCVA of 20/100 or worse. None of the patients in our study had a BCVA worse than 20/160 in their better-seeing eye.

We did not find an advantage to performing cataract surgery at any particular time before 10 weeks of age and, in fact, early surgery may predispose infantile eyes to more postoperative complications. Glaucoma is now one of the most vision-threatening complications that occurs after cataract surgery during infancy.²⁰⁻²³ It has been reported to occur in as many as 30% of eyes with nuclear cataracts.^{15,17} Lundvall and Kugelberg¹⁶ noted that glaucoma occurred more commonly in children undergoing surgery

Table 4 Outcome in eyes undergoing glaucoma surgery

Patient	Age at cataract surgery (weeks)	Visual acuity	Risk factor	Glaucoma surgery	Age when glaucoma surgery performed (years)
1	OS 3	20/400	—	Goniotomy	3.7,4.5
2	OD 4	20/25	—	Baerveldt implant	4.9
3	OS 4	20/25	—	Baerveldt implant	5.3
	OD 6	20/30	Microphthalmos	Endoscopic cyclophotocoagulation	5.0
4	OS 6	20/30	Micophthalmos	Endoscopic cyclophotocoagulation	1.2
				Endoscopic cyclophotocoagulation	4.0
5	OS 8	20/40	Persistent Fetal Vasculature	Endoscopic cyclophotocoagulation	4.0
6	OD 14	20/120	Microphthalmos	Trabeculotomy	0.5,0.7
7	OD 18	20/400	—	Endoscopic cyclophotocoagulation	3.0
7	OS 20	20/50	—	Peripheral iridectomy	0.5

during the first week of life. For this reason, there may be an advantage to waiting until a neonate is at least several weeks of age before performing cataract surgery.²⁴ Nine eyes in our study underwent glaucoma surgery. These eyes had some of the worse visual outcomes.

We found a strong correlation between the presence of preoperative nystagmus and the visual outcome. In fact, the correlation was stronger than the correlation between age at the time of surgery and visual outcome. However, age at the time of surgery and nystagmus are inextricably related to one another since visual deprivation during early childhood often causes nystagmus. Only 1 child who underwent cataract surgery before 10 weeks of age had preoperative nystagmus, whereas 14 of the 21 (67%) children who underwent cataract surgery after 10 weeks of age had preoperative nystagmus. It is possible that the cataracts were less dense in the 7 children without preoperative nystagmus who underwent cataract surgery after 10 weeks of age. Because of the retrospective nature of our study, we were not able to confirm the observation of Yagasaki and coworkers²⁵ that nystagmus commonly resolves if cataract surgery is performed within 4 weeks of its onset.

There was a mean interval of 6 days between the surgeries on the right and left eyes of the patients in our series. The first eye undergoing cataract surgery did not have a better visual outcome than the fellow eye. Some authors have recommended bilateral occlusion therapy until cataract surgery has been performed on both eyes.²⁶ Our findings would suggest that bilateral occlusion is not necessary if the 2 surgeries are performed in close proximity to each other. There is also a trend to perform bilateral simultaneous cataract surgery in infants with dense bilateral congenital cataracts with other medical problems,²⁷ which further minimizes the risk of one eye experiencing more visual deprivation than the other. Most of the differences between the acuities of the right and left eyes likely stemmed from differences in postoperative complications. For example, 5 patients in our series underwent glaucoma surgery. Three of these eyes had a visual outcome 4 lines or worse than their fellow eye.

Although there was a trend for the eyes requiring reoperations for secondary membranes and cortical reepithelialization to have worse vision than their fellow eyes, the interocular difference was smaller than for the eyes undergoing glaucoma surgery. Many surgeons also operate on the worst-seeing eye first, which may also partially explain why the visual acuity was not better in the eye undergoing cataract surgery first.

Our study had a number of limitations. It was a retrospective study and some charts were missing data. Visual acuity was tested in a nonstandardized manner. Some of the cataracts may have been denser than others, but we were unable to grade them because of the retrospective nature of the study. We also were lacking information regarding the date of onset of nystagmus and whether it resolved after cataract surgery. Finally, we had a relatively small number of patients, which reduced the statistical power of our findings.

We did not find a distinct latent period for children with dense bilateral congenital cataracts, as has been reported for children with dense unilateral congenital cataracts. Birch and Stager⁸ noted a bilinear relationship between the visual outcome and the age at surgery for infants with dense unilateral congenital cataracts with a break point at 5.6 weeks of age. In contrast, we noted a linear relationship between the visual outcome and the age at surgery for children with dense bilateral congenital cataracts, although the relationship did not reach statistical significance. Unfortunately, there are few animal data on the effects of visual deprivation during the neonatal period that would correspond to the latent period in human infants. Crawford and coworkers¹³ visually deprived both eyes of a monkey from 2 to 6 weeks of age; however, this would be equivalent to depriving a human infant from 2 to 6 months of age, which is beyond the latest period.²⁸

Although Wiesel and Hubel^{11,12} visually deprived kittens beginning at birth, they maintained the visual deprivation until the kittens were 3 months of age, which extended into the sensitive period. Perhaps, the most convincing evidence for a latent period was an observational

study by Blakemore and Cummings,¹ during which they noted that some kittens do not open their eyes until they are nearly 2 weeks of age, with no apparent deleterious effect on their visual outcome. Although there may be a latent period for human infants experiencing bilateral visual deprivation, we were unable to identify it in our study. However, we did find more children with visual outcomes of 20/100 or worse who underwent cataract surgery when 10 weeks of age or older. In particular, the presence of preoperative nystagmus was the best predictor of a poor visual outcome. Therefore, we recommend that infants with dense bilateral congenital cataracts undergo cataract surgery before the onset of nystagmus, which in most children occurs after the first 10 weeks of life.

References

- Blakemore C, Cummings RM. Eye-opening in kittens. *Vis Res* 1975;15:1417-8.
- Teller DY. First glances: the vision of infants. *Invest Ophthalmol Vis Sci* 1997;2183-203.
- Atkinson J. Human visual development over the first 6 months of life. A review and a hypothesis. *Hum Neurobiol* 1984;3:61-74.
- Dubowitz LM, Mushin J, De Vries L, Arden GB. Visual function in the newborn infant: is it cortically mediated? *Lancet* 1986;17:1139-41.
- Elston JS, Timms C. Clinical evidence for the onset of the sensitive period in infancy. *Br J Ophthalmol* 1992;76:327-8.
- von Noorden GK, Dowling JE, Ferguson DC. Experimental amblyopia in monkeys. I. Behavioral studies of stimulus deprivation amblyopia. *Arch Ophthalmol* 1970;84:206-14.
- von Noorden GK, Crawford, MLJ. The sensitive period. *Trans Ophthalm Soc UK* 1979;99:442-6.
- Birch EE, Stager DR. The critical period for surgical treatment of dense congenital unilateral cataract. *Invest Ophthalmol Vis Sci* 1996;37:1532-8.
- Vaegan TD. Critical period for deprivation amblyopia in children. *Trans Ophthalm Soc UK* 1979;99:432-9.
- Wiesel TN, Hubel DH. Single-cell responses in striate cortex of kittens deprived of vision in one eye. *J Neurophysiol* 1963;26:1003-17.
- Wiesel TN, Hubel DH. Comparison of the effects of unilateral and bilateral eye closure on cortical unit responses in kittens. *J Neurophysiol* 1965;28:1029-40.
- Wiesel TN, Hubel DH. Extent of recovery from the effects of visual deprivation in kittens. *J Neurophysiol* 1965;28:1060-72.
- Crawford, MLJ, Blake R, Cool SJ, et al. Physiological consequences of unilateral and bilateral eye closure in macaque monkeys: some further observations. *Brain Res* 1975;84:150-4.
- Bradford G, Keech RV, Scott WE. Factors affecting visual outcome after surgery for bilateral congenital cataracts. *Am J Ophthalmol* 1994;117:58-64.
- Parks MM, Johnson DA, Reed GW. Long-term visual results and complications in children with aphakia. A function of cataract type. *Ophthalmology* 1993;100:826-41.
- Lundvall A, Kugelberg U. Outcome after treatment of congenital bilateral cataract. *Acta Ophthalmol Scand* 2002;80:593-7.
- Robb TM, Petersen RA. Outcome of treatment for bilateral congenital cataracts. *Tr Am Ophth Soc* 1992;140:183-200.
- Rogers GL, Tishler CL, Tsou BH, Hertle RW, et al. Visual acuities in infants with congenital cataracts operated on prior to 6 months of age. *Arch Ophthalmol* 1981;99:999-1003.
- Gelbart SS, Hoyt CS, Jastrebski G, et al. Long-term visual results in bilateral congenital cataracts. *Am J Ophthalmol* 1982;93:615-21.
- Simon JW, Mehta N, Simmons ST, et al. Glaucoma after pediatric lensectomy/vitreotomy. *Ophthalmology* 1999;106:670-4.
- Rabiah PK. Frequency and predictors of glaucoma after pediatric cataract surgery. *Am J Ophthalmol* 2004;13:30-7.
- Mills MD, Robb RM. Glaucoma following childhood cataract surgery. *J Pediatr Ophthalmol Strabismus* 1994;31:355-60.
- Watts P, Abdolell M, Levin AV. Complications in infants undergoing surgery for congenital cataract in the first 12 weeks of life: is early surgery better? *J AAPOS* 2003;7:81-5.
- Lambert SR. Treatment of congenital cataract. *Br J Ophthalmol* 2004;88:854-5.
- Yagasaki T, Sato M, Awaya S, et al. Changes in nystagmus after simultaneous surgery for bilateral congenital cataracts. *Jpn J Ophthalmol* 1993;37:330-8.
- Wright KW. Lens abnormalities. In: Wright KW, Spiegel PH, editors. *Pediatric ophthalmology and strabismus*. New York: Springer-Verlag; 2003, p. 467-p. 468.
- Zwan J. Simultaneous surgery for bilateral pediatric cataracts. *Ophthalmic Surg Lasers* 1996;27:15-20.
- Boothe RG. Experimentally induced and naturally occurring monkey models of human amblyopia. In: Berkley MA, Stebbins WC, editors. *Comparative perception. Vol. I. Basic mechanisms*. New York: John Wiley & Sons; 1990. p. 465.