BINOCULAR FUNCTION IN PSEUDOPHAKIC CHILDREN

BY **Malcolm R. Ing MD***

ABSTRACT

Purpose: There have been few reports on the binocular vision results in bilateral pseudophakic children. The author reports on the results of visual and binocular tests personally performed on patients who had the primary insertion of intraocular lenses following the removal of cataracts in their childhood.

Methods: The author visited 4 different medical centers to perform monocular and binocular tests on 21 patients using the same equipment for sensory testing for binocularity on all patients before the history was abstracted from the clinical records. These patients were selected from a consecutive series and followed up for a minimum of 5 years by their ocular surgeons.

Results: The mean patient age at surgery performed on the first eye was 6 years 4 months. The mean age at the date of the author's examination was 16 years 5 months, and the mean length of follow-up was 10 years 4 months. All but 2 patients had motor alignment within 8 prism diopters of orthotropia at near. Fusion and some stereopsis were found to be present in 15 patients, but only 4 of these patients demonstrated fine (60 seconds of arc or better) stereoacuity. Patients with fine vs gross stereoacuity were compared and found to be similar in type of cataract, age at first surgery, interval between surgeries, and length of follow-up and refraction, but to differ in the quality of best-corrected visual acuity.

Conclusion: Although satisfactory motor alignment, fusion, and some stereopsis are present in the majority of patients, fine stereoacuity is uncommon in pseudophakic children.

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INTRODUCTION

Bilateral intraocular lens implantation following cataract extraction in children has been utilized successfully by ophthalmic surgeons for the past two decades.[1-8] Although several investigators report satisfactory pseudophakic monocular visual acuity results in their series, binocular vision studies in bilateral pseudophakic children are scarce. Zubcov and associates[9] reported stereopsis in 3 of 7 patients with bilateral pseudophakia after treatment for developmental cataracts. According to these investigators, there had been no previous reports in the literature with reference to binocular function in bilateral pseudophakic children. Lesueur and associates[4] reported that binocular vision was more likely in children who received intraocular lenses rather than aphakic spectacles or contact lenses. Indeed, they reported 53% of their patients, when tested with Wirt and Lang stereopsis tests, demonstrated binocularity, and this binocularity was more frequently found in these pseudophakic patients when compared to their patients who were treated with spectacles and contact lenses.

However, previous to the present study, there have been no studies dedicated to determination of motility and presence of fusion and stereopsis in pseudophakic children.

METHODS

The author obtained permission from 4 different ocular surgeons to visit their medical centers to personally examine patients who had the insertion of bilateral intraocular lenses following bilateral cataract extraction by the age of 15 years. To minimize the chance of selecting only those with satisfactory results, the surgeons were instructed to select their patients from a consecutive series.

The author visited the respective medical centers to personally perform all the tests. These consisted of refraction for best visual acuity, slit-lamp examination, tonometry, when possible, and funduscopic examination with direct and indirect ophthalmoscope. The binocular examination included prism cover tests for motor alignment. Sensory tests for binocularity, as advocated by Parks[10] in his seminal work on the monofixation syndrome, included fusion determination with Worth 4 dots presented at 16 inches and stereopsis testing with the Polaroid Titmus vectographic stereotest. To minimize bias, these tests were performed before abstracting the chart record for the type of cataract, management of the posterior capsule, and scrutiny of previous motility examinations and treatment. These patients were examined in compliance with institutional review board regulations.

RESULTS

Forty-two eyes of 21 patients were examined. All patients had received a primary posterior lens implant following cataract surgery. These data are displayed in Table 1. The mean patient age at initial surgery was 6 years, 4 months (range, 0.75 months to 11 years 2 months) for the group as a whole. The mean age at the time of the examination by this author was 16 years, 5 months (range, 8 years 6 months to 25 years 8 months). The length of follow-up for the group as a whole was calculated to have a mean of 10 years, 4 months (range, 5 years 2 months to 16 years 3 months).

The records of the patients were examined to determine the type of cataract present at the time of surgery. The types of cataracts described were as follows: 20 lamellar, 12 posterior pole, and 8 nuclear. In one patient (number 21), the type of cataracts encountered was not described by the surgeon.

Fine stereoacuity was defined as 60 seconds of arc or better. For the purpose of comparison with respect to binocular function, the

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Bold type indicates AOS member.

TABLE 1. COMPLETE DATA FOR PATIENTS IN THIS STUDY

PATIENT NO.	DOB		SURGERY DATE	CATARACT TYPE	POST CAPSULE	AGE AT SURGERY (yr:mo)	EXAM DATE	AGE AT EXAM (yr:mo)	FOLLOW-UP (yr:mo)	REFRACTION	VA	MOTOR ALIGNMENT	FUSION	STEREOACUITY (sec of arc)	COMMENTS
1	12/13/1988	OD	8/30/1995	Lam	YAG	6:04	10/19/2000	11:02	5:02	-3.25	20/25	Ex=0	+	140	
		OS	8/24/1995	Lam	YAG	6:04	10/19/2000	11:02	5:02	-.50/-.50´50	20/30	Ex'=0			
2	12/22/1986	OD	5/20/1995	Nuc	YAG	8:07	10/19/2000	13:02	5:05	+3.00/-1.75´110	20/20	Ex=0	+	40	
		OS	6/17/1995	Nuc	YAG	8:06	10/19/2000	13:02	5:04	+2.00/-2.50´160	20/20	X'=12			
3	5/31/1982	OD	6/28/1990	Lam	YAG	8:01	6/23/2004	22:11	14:00	-.50/-1.50´130	20/15	Ex=0	+	40	
		OS	2/17/1989	Lam	YAG	6:03	6/23/2004	22:11	15:04	-.25/-2.50´105	20/15	X'=12			
4	1/29/1981	OD	3/17/1988	Nuc	Vit	7:02	6/23/2004	23:07	16:03	+.75/-1.00´150	20/70	ET=15, RHT 6	0	0	Bilateral amblyopia
		OS	5/11/1990	Nuc	Vit	9:04	6/23/2004	23:07	14:01	+.50/-1.50´55	20/50	ET'=4, RHT' 6			
5	2/11/1982	OD	9/23/1988	Post	YAG	6:07	6/23/2004	22:08	16:03	-6.00/-2.00´170	20/30	X=4	+	50	
		OS	8/9/1989	Post	YAG	7:06	6/23/2004	22:08	15:02	-2.25/-1.75´170	20/25	Ex'=0			
6	2/18/1979	OD	4/6/1990	Lam	YAG	11:02	6/23/2004	25:08:00	14:02	+1.00/-2.75´170	20/30	Ex=0	+	100	
		OS	6/22/1989	Lam	YAG	10:04	6/23/2004	25:08:00	15:00	+1.00/-3.25´175	20/30	Ex'=0			
7	7/9/1982	OD	5/19/1988	Lam	YAG	5:02	6/23/2004	21:01	16:01	+1.25/-1.25´20	20/25	ET=4	+	400	
		OS	4/6/1990	Lam	YAG	7:03	6/23/2004	21:01	14:02	-.25/-1.00´120	20/100	EX'=0			
8	2/17/1990	OD	12/31/1998	Post	YAG	8:10	3/26/2005	15:11	7:09	+1.25/-1.00´10	20/25	XT=14	0	0	
		OS	10/8/1998	Post	YAG	8:08	3/26/2005	15:11	7:07	+1.00/-2.00´10	20/30	XT'=35			
9	12/11/1988	OD	9/24/1992	Nuc	YAG	3:03	5/26/2005	16:07	13:04	-3	20/40	Ex=0	+	140	
		OS	1/7/1993	Nuc	YAG	4:11	5/26/2005	16:07	12:04	-3	20/40	Ex'=0			
10	1/20/1984	OD	7/8/1993	Post	YAG	9:06	5/26/2005	21:08	12:02	-.50/-1.50´15	20/20	ET=10	+	140	
		OS	2/4/1993	Post	YAG	9:01	5/26/2005	21:08	12:03	-.50/-1.75´175	20/25	Ex'=0			
11	8/13/1988	OD	8/11/1994	Lam	YAG	6:00	5/26/2005	16:03	11:03	plano/-.25´100	20/20	Ex=0	+	100	
		OS	5/12/1994	Lam	YAG	5:03	5/26/2005	16:03	11:00	-1.50/-.50´10	20/20	Ex'=0			
12	10/19/1987	OD	5/14/1998	Post	YAG	10:05	5/26/2005	17:05	7:00	-.75/-1.00´15	20/50	XT=12	-	3000	Mild optic atrophy (OD)
		OS	4/30/1998	Post	clear	10:06	5/26/2005	17:05	7:01	plano/-1.00´180	20/20	X(T)'=6			
13	11/3/1997	OD	8/3/2000	Lam	Vit	2:03	11/10/2008	11:00	8:03	-2.00/-1.00´155	gcm	Ex=0	?	?	Down syndrome
		OS	8/10/2000	Lam	Vit	2:03	11/10/2008	11:00	8:03	-2.00/-1.50´30	gcm	Ex'=0			
14	3/12/1991	OD	6/10/1999	Post	Clear	8:03	11/10/2008	17:04	9:05	-.50/-1.00´150	20/20	Ex=0	+	100	Glaucoma
		OS	3/23/2000	Post	Fibrosis	9:00	11/10/2008	17:04	8:08	-.50/-.50´30	20/25	Ex'=0			(OS)
15	2/11/1994	OD	2/24/2000	Lam	Vit	6:00	11/10/2008	14:03	8:09	-4.5	gcm	XT=10	?	?	Cerebral palsy
		OS	4/1/1999	Lam	Vit	5:02	11/10/2008	14:03	9:07	-3.50/-1.00´180	gcnm	XT'=15			
															Nystagmus
16	6/17/1996	OD	2/7/1999	Post	Vit	2:09	11/10/2008	12:07	9:09	+3.00/-.50´180	gcm	Ex=0	?	?	Down syndrome
		OS	10/12/1998	Post	Vit	2:04	11/10/2008	12:07	10:01	+3.00/-1.50´90	gcm	Ex'=0			
17	11/19/1998	OD	7/25/2002	Lam	Vit	3:08	11/10/2008	10:00	6:04	3	20/20	Ex=0	+	60	
		OS	7/18/2002	Lam	Vit	3:08	11/10/2008	10:00	6:04	2.5	20/20	Ex'=0			
18	4/11/1996	OD	7/25/2002	Lam	Vit	6:03	11/10/2008	12:05	6:04	-1.75/-1.75´180	20/25	Ex=0	+	100	
		OS	8/1/2002	Lam	Vit	6:04	11/10/2008	12:05	6:03	-2.00/-2.00´180	20/20	Ex'=0			
19	6/1/1999	OD	7/26/2001	Lam	Vit	2:01	11/10/2008	9:07	7:04	0.5	gcm	Ex=0	?	?	Down syndrome
		OS	7/12/2001	Lam	Vit	2:01	11/10/2008	9:07	7:04	0.5	gcm	Ex'=0			
															Wound revision
20	5/4/2000	OD	5/25/2000	Nuc	Vit	00:00.5	11/10/2008	8:06	8:06	+.50/-.50´40	20/25	ET (OS)=12	+	0	Glaucoma
		OS	6/1/2000	Nuc	Vit	0:01	11/10/2008	8:06	8:05	+2.50/-1.00x180	20/25	RHT'=6			(OD)
21	4/15/1995	OD	10/17/1996	?	Vit	1:06	11/10/2008	13:05	12:01	-1.25/-.50´105	20/20	Ex=0	+	100	
		OS	11/1/1996	?	Vit	1:07	11/10/2008	13:05	12:00	-2	20/20	Ex'=0			
			MEAN			6 yr:4 mo		16 yr:5 mo	10 yr:4 mo						

DOB, date of birth; ET. esotropia at distance; ET´, esotropia at near; Ex, orthophoria at distance; Ex´, orthophoria at near; gcm, good central fixation maintained; gcnm, good central fixation not maintained; Lam, lamellar; Nuc, nuclear; Post, posterior pole; RHT, right hypertropia at distance; RHT´, right hypertropia at near; Vit, post capsulotomy and vitrectomy; YAG, YAG laser; VA, visual acuity; X, exophoria at distance; X¢, exophoria at near; XT, exotropia at distance; XT´, exotropia at near; X(T), intermittent exotropia at distance; X(T)´, intermittent exotropia at near; +, fusion of Worth 4 dot.

group was divided into 3 subgroups. Subgroup A consisted of 4 patients who demonstrated motor alignment without a tropia at distance and near and who had both fusion and fine stereoacuity. Subgroup B consisted of 11 patients with motor alignment that was within 8 prism diopters (Δ) of orthotropia at near point with prism cover test who also demonstrated fusion or gross stereopsis or both. There were 3 patients with Down syndrome and 1 patient with cerebral palsy, and the sensory data for binocular function could not be obtained in these 4 patients. In addition, there were 2 patients (numbers 8 and 15) assigned to subgroup C, whose motor misalignment exceeded 8Δ of tropia at the near point. One of these patients (number 8) had manifest strabismus before cataract extraction and implantation of an intraocular lens. One patient not assigned to any subgroup (number 4), whose near measurement was less than 10Δ of misalignment at near, was diagnosed as having bilateral amblyopia, and this patient was unable to demonstrate sensory evidence for binocular function.

The calculated mean patient age at initial surgery for patients in subgroup A was: 6 years, 3 months. The mean age at initial surgery in subgroup B was 6 years, 1 month. The interval between the surgery for the first and second eye was calculated, and these data are displayed for subgroups A and B in Tables 2 and 3. The mean interval between the surgeries between each eye for subgroup A was 2.75 months and for subgroup B, 4.32 months. The mean interval for subgroup C was 6 months.

The mean length of follow-up was similar for subgroup A (10.5 years) and subgroup B (11.3 years). The mean follow-up for subgroup C was 8 years, 6 months.

TABLE 2. INTERVAL BETWEEN EYE SURGERIES FOR PATIENTS IN GROUP A (FINE STEREOACUITY)

	DATE OF SURGERY		
PATIENT NO.	**OD**	**OS**	**INTERVAL (MO)**
2	5/20/95	6/17/95	1
3	6/28/90	2/17/89	16
5	9/23/88	8/9/89	13
17	7/25/02	7/18/02	0.23
		Mean	2.75

TABLE 3. INTERVAL BETWEEN EYE SURGERIES FOR PATIENTS IN GROUP B (MONOFIXATION

	DATE OF SURGERY		
PATIENT NO.	**OD**	**OS**	**INTERVAL (mo)**
1	8/30/95	8/24/95	0.19
6	4/6/90	6/22/89	2
7	5/19/88	4/6/90	23
9	9/24/92	1/7/93	3.45
10	7/8/93	2/4/93	5.13
11	8/11/94	5/12/94	3
12	5/14/98	4/30/98	0.48
14	6/10/99	3/23/00	9.42
18	7/25/02	8/1/02	0.19
20	5/25/00	6/1/00	0.19
21	10/17/96	11/1/96	0.48
		Mean	4.32

The refractive errors in spherical equivalents for patients in subgroup A are displayed in Table 4. The mean refractive error at the time of the examination in subgroup A for each eye was −0.78 for the right eye and −0.35 for the left eye with a mean interocular difference of 1.50 diopters. The refraction in spherical equivalents for each eye and the interocular differences for patients in subgroup B demonstrated similar findings with a mean of −1.16 for the right eye and −0.93 for the left and a 0.86 mean interocular difference (Table 5).

TABLE 4. REFRACTIVE ERROR FOR PATIENTS IN GROUP A (FINE STEREOACUITY)

PATIENT NO.	OD	OS	DIOPTER DIFFERENCE
2	2.12	0.75	1.37
3	−1.25	−1.50	0.25
5	−7.00	−3.13	3.87
17	3.00	2.50	0.50
Range	+3.00 to −7.00	+2.50 to −3.13	
Mean	−0.78	−0.35	1.50

TABLE 5. REFRACTIVE ERROR FOR PATIENTS IN GROUP B (MONOFIXATION)

PATIENT NO.	OD	OS	DIOPTER DIFFERENCE
1	−3.25	−0.75	2.50
6	0.38	0.63	0.25
7	0.62	−0.75	1.37
9	−3.00	−3.00	0.00
10	−1.25	−1.38	0.13
11	−0.13	−1.75	1.62
12	−1.25	0.50	0.75
14	−1.00	−0.75	0.25
18	−2.63	−3.00	0.37
20	0.25	2.00	1.75
21	−1.50	−2.00	0.50
Range	+0.62 to −3.25	+0.63 to −3.00	
Mean	−1.16	−0.93	0.86

Visual acuity results are displayed in Tables 6 and 7. The visual acuity scores for patients in subgroup A (mean, 20/20) exceeded those found in subgroup B (mean, 20/27). Amblyopia, as defined by best-corrected visual acuity of less than 20/30 and/or a difference of 2 or more lines between the eyes of the same patient, was found in 4 eyes in subgroup B. Amblyopia was not found in any of the patients in subgroup A.

Management of the posterior capsule varied for the patients in the group as a whole. By the time of this author's examination, there was a clear pupillary space in all eyes except for one eye with a mild fibrosis of the posterior capsule (patient 14). A YAG laser capsulotomy had been performed for 21 eyes, and a primary capsulectomy with a limited anterior vitrectomy had been performed at the time of cataract extraction in 18 eyes. Three patients in subgroup A had received a YAG capsulotomy by the time of the examination, and 1 patient of this subgroup was treated by primary capsulectomy and limited anterior vitrectomy. In subgroup B, 19 eyes had received a YAG capsulotomy and 6 had received a primary capsulectomy.

TABLE 6. VISUAL ACUITY FOR PATIENTS IN GROUP A (FINE STEREOACUITY)

PATIENT NO.	OD	OS
2	20/20	20/20
3	20/15	20/15
5	20/30	20/25
17	20/20	20/20
Range	20/15 to 20/30	20/15 to 20/25
Mean	20/21	20/20

TABLE 7. VISUAL ACUITY FOR PATIENTS IN GROUP B (MONOFIXATION)

PATIENT NO.	OD	OS
1	20/25	20/30
6	20/30	20/30
7	20/25	20/100
9	20/40	20/40
10	20/20	20/25
11	20/20	20/20
12	20/50	20/20
14	20/20	20/25
18	20/25	20/20
20	20/25	20/25
21	20/20	20/20
Range	20/20 to 20/50	20/20 to 20/100
Mean	20/26	20/28

DISCUSSION

The binocular motor alignment of the patients was found to be within 8Δ of orthotropia at near point for all but 2 patients (8 and 15). If no previous manifest strabismus was present before the cataract surgery was performed, there was usually a presence of satisfactory alignment suggesting that some form of binocularity survived the onset and treatment of cataracts in both eyes. This existence of satisfactory alignment after cataract surgery prevailed despite the fact that in some of the patients, the onset of cataracts occurred at different times. Both subgroups A and B were found to have motor alignment within 8Δ of orthotropia, as well as a similarity in age at first surgery, type of cataract, length of follow-up, interval between surgery for the first and second eye, and difference in refraction between the 2 eyes. The finding of a motor angle of 8Δ or less at near point, with fusion and gross (more than 60 seconds of arc) stereoacuity, in subgroup B is basically a monofixation syndrome result.

It was notable that the monocular visual acuity achieved a level of 20/30 or better in 26 of 34 eyes (76%) in patients who could be tested subjectively. Nevertheless, the monocular visual acuity scores in the patients who demonstrated fine stereoacuity were superior to the visual acuity scores by those with a lesser quality of binocularity. There was a greater incidence of amblyopia (4 of 22 eyes) in subgroup B, resulting in the lower mean corrected visual acuity score compared to those with fine stereoacuity. It is generally recognized that excellent visual acuity is a prerequisite for fine stereoacuity.

One might ask why fine stereoacuity was an uncommon finding in patients who received an intraocular lens in childhood following cataract extraction. Is the finding of a slight disparity in the best-corrected visual acuity between subgroup A and subgroup B enough of a difference to explain the different result in stereopsis testing? Several investigators[11-13] have shown that anisometropia that leads to amblyopia results in the loss of binocularity in immature humans. In general, there was no significant anisometropia for patients in subgroup A or B. However, it is possible that during the clinical management in the past, the optical corrections were too disparate, not given early enough, or not changed often enough for patients in subgroup B to achieve maximum monocular visual

acuity and prevent the disruption of the stereoacuity system in these patients. As recognized by Jampolsky many years ago,[14] unequal input in the monocular visual system can severely disrupt the binocular visual system. In addition, as described by Pavlovic,[15] children's eyes with cataracts severe enough to require cataract extraction usually have some degree of amblyopia already present prior to surgery. Jeffrey and associates[16] report that early visual experience improves the binocular sensory outcomes in children after surgery for congenital unilateral cataracts, and this experience is likely to be operative in binocular cases as well. Excellent monocular visual acuity is generally recognized as a prerequisite of fine stereoacuity.

Fawcett and associates[17] demonstrated that there is reduced stereoacuity and an absence of foveal fusion with long-standing surgical monovision in adults, suggesting a continued susceptibility of the binocular visual system to an anomalous binocular experience. It is presumed that the 4 patients with fine stereoacuity had developed this binocular function before the onset of a cataract that was severe enough to disturb monocular and binocular vision. Apparently, the surgical removal of the cataract and vision provided by the intraocular lenses and correcting spectacles were timely enough to preserve this function in these 4 patients who demonstrated fine stereoacuity. It should be acknowledged, however, that there is no definite proof that this was actually the case for these patients, because there were no records of stereopsis testing before the surgeries were performed.

It is acknowledged that the visual acuity and sensory binocular test results could not be obtained in 4 patients because these patients did not have the mental capacity to cooperate for this type of testing. The overall analysis may have been slightly different if the subjective data from these patients had been obtained.

An obvious limitation of the present study is the sample size. Nevertheless, despite the difficulty in obtaining the cooperation of patients to return to the various medical centers, sometimes from distant locations, to participate in this long-term independent study by an ophthalmologist other than the patient's own surgeon, the author believes valuable data were obtained.

In summary, the major findings of the present report are that fine stereoacuity was an uncommon result in bilateral pseudophakia in children and that the majority of patients, if they maintained straight eyes, demonstrated a binocular result that was within the confines of a monofixation syndrome. Considering the many hurdles to developing monocular and binocular vision in children with cataracts, these findings should be no real surprise. The findings in this study should remind ocular surgeons of the importance of achieving the maximum monocular visual acuity, whenever possible, as soon as possible, and to not neglect the role of follow-up refraction if they desire to help their patients achieve the highest quality of binocular outcome.

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PEER DISCUSSION

DR. LAWRENCE TYCHSEN: Malcolm Ing has done several travelogue studies, usually devoted to outcomes of infantile esotropia surgery. His work showcases the storied history of the AOS. Malcolm was Marshall Parks's 7th fellow, and has steadfastly carried on the Parksian tradition of pediatric ophthalmology research and publication in private practice.

The case series presented here addresses fusion and stereopsis in an observational study of 21 children gathered from his travels to 4 locations: he flew from Hawaii to Dallas, to Charleston SC, to Atlanta and to Calgary Alberta. He arbitrarily set entrance criteria that: a) required bilateral IOLs implanted at the time of lensectomy and b) had a minimum 5 yrs follow-up (the average was 10 years). Half of the children had primary posterior capsulectomy and vitrectomy at the time of implantation, and the other half subsequent YAG laser capsulotomies. It is safe to conclude, since these were implanted a decade ago, that these were all monofocal lenses, some PMMA and some acrylic.

The mean age at surgery was 6 years and the mean acuity better than 20/30, implying strongly that this is a select group of children with mild developmental cataracts, not dense congenital cataracts. Only one of the 21 children had surgery in infancy, at age 1 month. Only one other child had surgery before age 2 years. Mean psuedophakic refractive error was -1 D and mean anisometropia about 1 D.

Malcolm's chief outcome interest was binocularity. Summarizing, ~20% were orthophoric with high-grade stereopsis. The bulk (~50%) was microtropic monofixators with gross stereopsis. The remaining ~30% had macrotropia or, owing to neurobehavioral disorders, were unsuitable for sensorial fusion testing. Every child who had good visual acuity in each eye and absence of a heterotropia had stereopsis. Every child who had poor visual acuity and a heterotropia was stereoblind or markedly stereo-deficient.

So the important factor is not whether a child has IOLs, it is whether the child has amblyopia and strabismus. Malcolm's data reinforces the point that to build binocular fusion, the ocular dominance columns of the visual cortex need sharp images from each eye and correlated binocular input, and we can use any optical device available to achieve that goal.

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REFERENCES

DR.DOUGLAS D. KOCH: Consult for Alcon and AMO. Malcolm, this is great information. It seems to me that it would be relevant and important to know the magnitude and duration of the cataracts in these children, the level of binocularity, and amount of strabismus, if any, before their procedures. These data are important to help us evaluate the role of preoperative factors in determining the surgical outcome. They may be more determinative than perioperative factors.

DR. KENNETH W. WRIGHT: No conflict of interest. Malcolm in the late 1970s and early 80s there were a few articles written on acquired traumatic cataracts in adults. These were patients with monocular traumatic cataracts and loss of binocularity and fusion. I believe that it was reported in the *British Journal of Orthoptics*. They demonstrated that the longer the duration of the traumatic cataract, the higher the incidence of developing strabismus and losing fusion. It was interesting that in your Group C there was six month interval between eyes and in Group A and Group B time was much shorter. Have you specifically evaluated the interval between the first eye and the second eye? The input between the two eyes would be very unequal.

DR. M. EDWARD WILSON: No conflict of interest. Malcolm, this is a very nice paper. When I look at it, based on the way you selected them, I wonder why more of these patients did not have fine stereopsis. Perhaps some of the reasons that have already been stated are important. How long the cataract has been there and whether the deprivation from the cataracts created some loss of binocularity before the surgery. We also have to remember that even in acquired cataracts without microphthalmia, we are not sure if the cataract in these kids is just a lens disorder or more of a panocular condition. We know that in congenital cataracts with microphthalmia, more than just the lens is involved. Perhaps more study needs to be done with acquired cataracts. We assume that the outcome is dependent on when and what we do, but perhaps there are other defects in the eyes as well and that has not been completely investigated.

DR. MALCOLM R. ING: Thank you for the review, Larry. I appreciate your comments. There was a limitation in that there were not many really young children that were in this series. We are dealing with mostly a group of children who have acquired cataracts which brings us back to this: the decision to operate was made by the surgeon based on what he saw with the ophthalmoscope, and not so much with what he measured with visual acuity, especially if he was operating on somebody rather young. We do not have a real

handle on what separated the patients in the superb result Group A versus those in the less than superb, but still very good groups. In fact, it is interesting, but no real surprise because there were so many hurtles to monocular visual acuity, much less binocular function.

Doug Koch mentioned about the magnitude of how long the cataracts had been present, and I just discussed that situation. We used what was contained in the clinical record. The operating surgeon made his decision to operate based on blockage of the visual axis was present basically in many of the young children, but in the older children they could calculate a vision. Dr. Wright mentioned that if binocularity is interrupted for a long time, even as an adult, that there could be a loss of stereo acuity. Interestingly, as I was developing this series I realized that many of the problems we face with the binocular cataract patients are the same ones that we face with the monocular cataract patients. That is, once you make one eye really good you have again set up a scenario for amblyopia, unless you get to that second eye in time. Perhaps the time between procedures is very critical. As Dr. Wilson mentioned, the only retinal examination I performed was with the ophthalmoscope. There were no functional studies. There may be other abnormalities that children have behind the lens that are undetectable. Maybe some of the new technology will give us a better way to assess that possibility. I want to thank all the discussants for discussing my paper. I believe that I have some new ideas. Thank you very much.