RESULTS FOLLOWING SECONDARY INTRAOCULAR LENS IMPLANTATION IN CHILDREN*

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ABSTRACT

Background: Placement of a secondary intraocular lens (IOL) in a child may be considered in children with congenital monocular cataracts who have had complete opacities removed early in life and who later become contact lens intolerant, in eyes that have received trauma which precluded placement of a primary IOL, and in young adults who have bilateral aphakia who become resistant to use of contact lenses or spectacles.

Methods: Clinical records of all children in our practice who received a secondary IOL between January 1988 and December 1994 were reviewed. Indications, biometry, type of procedures, preoperative and postoperative acuity, refractive error, binocular status, and complications were studied.

Results: During the 7-year period, 242 cataract operations were performed. Fifty-nine eyes received a lens implant, and 28 of these were secondary implants. There was a mean interval between the initial cataract operation and the procedure for the secondary implant of 77 months. The mean follow-up was 35 months (range, 3 to 71) for the 28 eyes that received a secondary implant. Two received anterior chamber implants. Eight eyes had insufficient capsular support for an IOL. Six implants were placed in the posterior chamber and required suture fixation to the sclera.

Twenty of 28 eyes had a measurable improvement in visual acuity. Only 1 eye had a decrease in visual acuity of 2 lines. Fifteen patients (54%) had a final refraction within 1.50 diopters of the fellow eye, and 75% were within 3.00 diopters. During the follow-up period, 2 eyes developed glaucoma. One had a transient pressure elevation, and the second has required 2 filtration procedures. Three patients required a Nd: YAG capsulotomy. Six patients demonstrated Worth fusion at distance and

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near, but only 3 patients demonstrated 200 seconds of arc or better stereo acuity.

Conclusion: Placement of contemporary-style, secondary intraocular lenses in children and young adults appears to provide a safe and effective alternative for correction of aphakia in children who become contact lens– or spectacle-intolerant.

INTRODUCTION

Primary implantation of an intraocular lens (IOL) has been successfully used to provide optical rehabilitation for children with acquired cataracts, traumatic cataracts, and partial congenital cataracts that progress and become visually significant later in childhood.[1-12] Over the past 2 decades, guidelines for use of the IOL in children have been evolving. Long-term safety remains a concern, but reports from many investigators show that there are few complications specifically related to placement of a posterior chamber IOL of modern design and finish in children. Currently, most surgeons are reluctant to place an IOL in an eye of a child with a monocular cataract who is younger than 1 year of age.[11] Primary implants are also not routinely used in children with bilateral cataracts who are less than 3 or 4 years of age.[9] Because of the age limitations, there will exist a population of children who are born with complete cataracts in whom placement of an intraocular lens at the time of cataract removal is not a consideration. These children are managed with lens aspiration and optical rehabilitation using a contact lens. Other infants with bilateral complete congenital cataracts are rehabilitated with either contact lenses or spectacles. As this population grows older, some of these children will become resistant to the use of their contact lenses or glasses. When this occurs, the family and the ophthalmologist must consider the alternative of secondary intraocular lens implantation or be confronted with a child who may be susceptible to development of amblyopia or will function with an uncorrected aphakic refractive error.

We report here a consecutive series of children and young adults who have received secondary intraocular lenses to correct their aphakic refractive errors. This retrospective study was conducted over a 7-year period using contemporary-design intraocular lenses and surgical techniques. The study focuses on surgical techniques and complications and reports the visual acuity and sensory results obtained in this population. The accuracy of calculation of lens power and selection of appropriate lenses is also examined.

PATIENTS AND METHODS

All children who had a secondary intraocular lens placed by 1 of the authors between January 1988 and December 1994 were included in this study. Parents and patients participated in an ongoing study protocol that has been approved by the institutional review board at Children's Hospital of Pittsburgh. Follow-up visits were conducted by the authors with the exception of 4 patients who, because of distance, continue to be followed by their referring ophthalmologists.

Prior to the secondary implant procedure, keratometry and axial length measurements of both eyes were obtained. In young or cooperative children, these studies were performed in the office. In uncooperative children, measurements were taken in the operating room with the patient under general anesthesia. The power of the intraocular lens was calculated using the SRK II or the Binkhorst formula. The choice of lens power was modified by the patient's age, the refractive error of the fellow eye, and, to a lesser extent, any familial tendency for high refractive error.[11] The goal of power selection was to achieve isometropia when the child reaches adulthood.

In children less than 4 years age, we decreased the power of the calculated lens power for emmetropia by 1.25 to 1.50 diopters to allow for growth of the eye. In older children, we calculated the power of the lens in an effort to achieve emmetropia. If a high degree of hyperopia or myopia was present in the fellow eye, attempts were made to approach a similar refractive error, but erring toward a plano refractive error. If the biometry and calculation of the IOL power suggested use of a stronger-than-expected lens power, one that could possibly produce a large power difference between the eye with the implant and an otherwise normal fellow eye, we decreased the lens power by reducing the power of the lens by 25% of the difference between the calculated lens power and +20.00 diopters in selecting the power of the IOL.

Procedures were performed with the patient under general anesthesia with endotracheal intubation. After induction of anesthesia, the intraocular pressure of each eye was measured. In some patients, intravenous mannitol, 200 mg/kg, was given to dehydrate and contract the vitreous. In patients with small amounts of residual lens capsule, or those with a pupil that dilated poorly, gonioscopy and or scleral indentation was performed to examine the space behind the iris to determine the extent of capsular remnants present and to assess their ability to provide support for the haptics of an intraocular lens.

The eye and surrounding adnexa were cleansed with a 5% povidone iodine (Betadine) solution. A 150° fornix-based conjunctival incision was

made at the limbus. A two-plane corneal-scleral incision at the anterior limbus was made in a plane parallel to the iris. If an iridectomy or iridotomy had not previously been performed, one was performed. Viscoelastic was introduced into the space between the iris and the remnants of the lens capsule. Adhesions between the lens capsule and the posterior iris were hydraulically dissected. Firmly adherent iridocapsular adhesions were severed using a Barraquer spatula, or they were cut with a discission knife or intraocular scissors. Care was taken to identify and break all adhesions so that there would not be any obstruction to placement of the lens haptics into the ciliary sulcus. In cases where the posterior capsule was intact but opacified, an Ocutome suction cutting instrument was used to create a 4- to 5-mm central circular opening in the capsule.

The corneal-scleral incision was enlarged with corneal scissors. After inspection for correct power, defects, and orientation, the IOL was irrigated and coated with viscoelastic. The lens haptics were placed in the ciliary sulcus, and the lens was rotated to position the haptics with a 3- and 9-o'clock (nasal-temporal) orientation. Viscoelastic was removed, and the wound was closed with either interrupted 9-0 polygalactin (Vicryl) sutures, which remain until absorption, or with interrupted 10-0 nylon sutures, which were removed 6 weeks postoperatively. Cefazolin (Kefzol), 50 mg, and dexamethasone (Decadron), 4 mg/mL, were injected at separate subconjunctival sites. A drop of atropine 1% and an antibiotic-steroid combination was instilled in the conjunctival sac. The eyes were shielded for 3 to 7 days. Patients were evaluated within 3 days of the procedure and again at 2 weeks, 4 weeks, 6 weeks, and at least semiannually thereafter. The frequency of use of atropine and antibiotic-steroid drops was adjusted according to the degree of inflammation within the eye. Systemic steroids were not given to any patients.

In patients with insufficient capsular support for sulcus fixation of the IOL haptics, the haptics of a posterior chamber lens were secured in the ciliary sulcus with sutures, or an anterior chamber IOL was used (Fig 1) The suture fixation technique has been described elsewhere in greater detail.[13] Small conjunctival incisions were made at the limbus at the 3- and 9-o'clock position. A partial-thickness, triangular scleral flap, hinged at the limbus, was created at each site. A double-armed 10-0 Prolene suture with a double-armed CIF-4 (Ethicon Co) needle was secured to each haptic. The needles were passed transcamerally, beneath the iris, and directed to exit through the base of the prepared scleral beds (Fig 1). The lens was inserted into the posterior chamber, and the haptics were positioned in the ciliary sulcus. The corneal scleral incision was closed, and the eye volume was reestablished with BSS solution. The Prolene sutures were

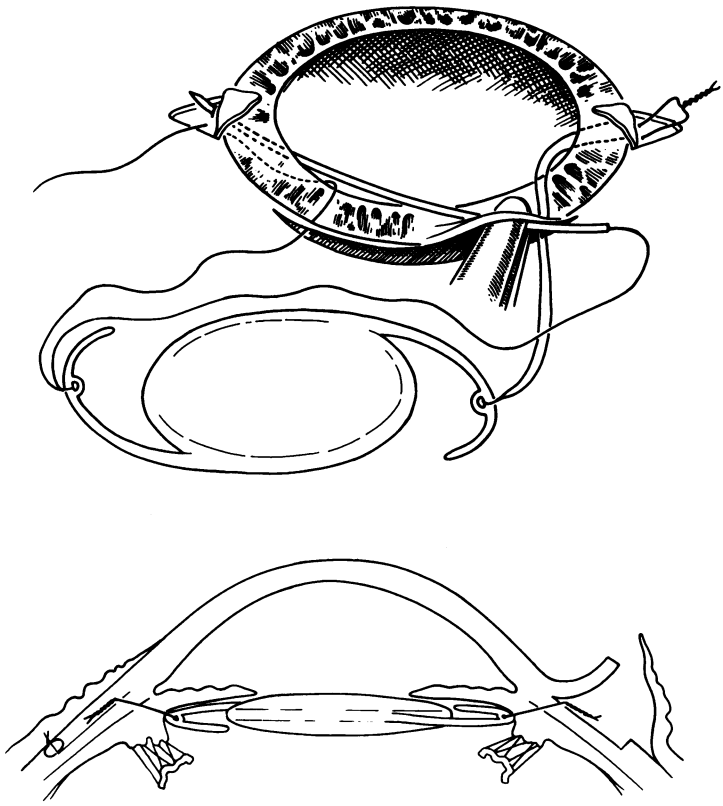

FIGURE 1
Placement of secondary intraocular lens. A 10-0 Prolene suture is secured to each lens haptic. A CIF-4 needle is passed beneath iris and exits sclera in the prepared scleral bed. The 10-0 Prolene suture is tied, and the scleral flap is secured with a 9-0 Vicryl suture.

tied when the lens was in satisfactory position and without a tilt. The scleral flaps were replaced over the cut ends of the Prolene suture and secured with a single interrupted 9-0 Vicryl suture. The conjunctiva was sealed with a coaptation forceps.

Eyes that had an anterior chamber IOL had gonioscopy performed preoperatively to establish the absence of angle abnormalities such as anterior synechiae or angle recession. Anterior chamber lens implantation was performed after the anterior chamber had been cleared of vitreous by anterior vitrectomy.

Information abstracted from the clinical records and operation reports included age at cataract diagnosis, type of cataract, age at initial

cataract removal, indication for the secondary IOL implantation, and the interval between the cataract removal and the secondary IOL implantation. The best-corrected acuity prior to the secondary lens implantation, best postoperative acuity, and most recent postoperative acuity were recorded. The axial lengths and keratometry of both eyes and the lens power that was used were tabulated. Intraoperative, early, and late postoperative complications were recorded, as were the refractive errors of both eyes at 6 months and the most recent refractive error. Results of sensory testing using the Worth four-dot test at 6 m and at 1/3 m and results of stereo acuity measurements using the Titmus stereo acuity test were also recorded.

RESULTS

During the 7-year study period, 28 secondary IOLs were implanted in 25 children or young adults (22 unilateral, 3 bilateral). The duration of follow-up was 3 to 71 months, with a mean of 35 months (Table I) At the time of initial cataract surgery, patient age ranged from 2 to 164 months (mean, 52.6 months). Age at the time of implant surgery ranged from 12 to 260 months (mean, 123.8 months). The interval between cataract surgery and IOL implantation ranged from 1 to 174 months (mean, 71 months).

Eight eyes had insufficient capsular remnants to support an IOL. Two of these received an anterior chamber intraocular lens, and 6 received a posterior chamber IOL with the haptics secured with sutures in the ciliary sulcus. With the exception of a single eye in which the lens capsule leaflets were able to be separated and the IOL placed within the capsular "bag," all remaining lenses were placed in the posterior chamber with the haptics of the lens resting in the ciliary sulcus.

Keratometry measurements, axial lengths, and power of the lens selected for use are listed in Table II. The mean power of the lens implant used in the 28 eyes was +20.82 diopters. Nine lenses were placed without calculations (+18.00 to +20.00 diopters, empirically chosen). An empiric power was selected when instrumentation was not available in the operating room to perform keratometry or axial length measurement in uncooperative patients or patients with nystagmus, or when patients had corneal scars that precluded keratometry.

The preoperative, best-achieved, and most recent visual acuity, refractive error, and degree of anisometropia at the most recent refraction are listed in Table III. Visual acuity improved in 20 of 28 patients, and only 1 patient lost 2 lines of vision. Nine of the 11 patients who had amblyopia and were in a treatable age range showed improvement in amblyopia fol-

TABLE I: TYPE OF CATARACT, AGE OF PATIENT AT DIAGNOSIS, AT INITIAL OPERATION, INDICATION FOR IOL, INTERVAL BETWEEN CATARACT SURGERY, AND SECONDARY IMPLANT PROCEDURE

Patient	Eye	Age At DX (MO)	Type of Cataract	Age At Cat Surg (MO)	Indication For IOL	Age At Implant (MO)	Interval Between Surg (MO)	MO of Follow-up After Implant (MO)
MS	OD	131	T, C	131	CL SCAR	228	97	34
BT	OS	70	T, C	82	CL SCAR	156	74	71
SW	OD	11	C	18	CL LOSS	43	25	22
AN	OS	41	C	41	Pt DESIRE	215	174	11
AN	OD	41	C	42	Pt DESIRE	216	174	10
PW	OS	51	T, C	150	CL SCAR	151	1	41
LR	OS	8	C	9	CL RESIST	65	56	54
SS	OS	14	P, N	30	CL INTOL	32	2	36
MB	OS	62	T, C	62	CL SCAR	143	81	23
JB	OD	60	N	62	PT DESIRE	188	126	52
JB	OS	60	N	62	PT DESIRE	192	130	48
SC	OD	36	P	36	CL AND GLASS	156	120	38
SC	OS	36	P	36	CL INTOL	157	121	37
CM	OD	36	T, C	36	CL RESIST	113	77	37
DK	OD	36	T, C	36	CL INTOL	38	2	18
NE	OS	1	C	2	CL INTOL	71	69	27
JF	OD	5	C	6	CL RESIST	12	6	50
GG	OS	65	T, C	65	REPLACE IOL	167	102	23
DG	OD	164	T, C	164	CL INTOL	260	96	3
EH	OS	61	P	61	REPLACE IOL	138	77	2
SH	OS	1	P	39	CL INTOL	148	109	51
DS	OD	63	T, C	64	CL INTOL	146	82	64
SW	OD	77	T, C	77	CL SCAR	176	99	3
KT	OS	24	PHPV	39	CL RESIST	42	3	16
TH	OS	50	P	48	CL INTOL	54	6	67
DC	OS	39	T, C	39	CL SCAR	60	21	56
EC	OS	1	C	1	EPI FAIL	57	56	55
KS	OD	30	P	36	CL FAIL	43	7	31
MEAN						123.8	71	35

DX = DIAGNOSIS
C = COMPLETE
P = PARTIAL
T = TRAUMATIC
N = NUCLEAR

CL INTOL = CONTACT LENS INTOLERANT
RESIST = RESISTANS INSERTION
INTOL = ABLE TO INSERT WITH GOOD FIT, BUT PATIENT WON'T USE
SCAR = UNABLE TO FIT CONTACT LENS DUE TO CORNEAL SCAR

PHPV = PERSISTENT HYPERPLASTIC PRIMARY VITREOUS
REPLACE IOL = PRIOR IOL DISLOCATED, REMOVED AND REPLACED
EPI FAIL = EPIKERATOPHAKIA GRAFT FAILURE REPLACED WITH IOL

TABLE II: BIOMETRY, LENS POWER USED, AND LOCATIONS OF IOL IN EYES RECEIVING SECONDARY IOL

		Keratometry		Axial Length			
Patient	Eye	Cataract Eye	Fellow Eye	Cataract Eye	Fellow Eye	lens Power	Location
MS	OD	DISTORTION	44.50/46.87	25.73	23.56	+17.00 C	PC, SF
BT	OS	DISTORTION		UNABLE		+20.00 E	PC
SW	OD	UNABLE		UNABLE		+19.00 E	PC, SF
AN	OS	42.25/46.00	46.00/42.25	23.09	23.3	+20.00 C	PC
AN	OD	46.00/42.25	42.25/46.00	23.3	23.09	+20.00 C	PC
PW	OS	UNABLE		UNABLE		+20.00 E	PC
LR	OS	UNABLE		UNABLE		+20.00 E	PC, SF
SS	OS	UNABLE		UNABLE		+18.00 E	PC
MB	OS	39.50/45.50	43.25/43.75	24.69	23.11	+18.00 C	PC, SF
JB	OD	42.00/44.50	41.12/44.25	21.16	21.39	+22.00 C	PC
JB	OS	41.12/44.25	42.00/44.50	21.39	21.16	+22.50 C	PC
SC	OD	42.75/45.50	43.00/44.50	23.40	23.69	+19.50 C	PC
SC	OS	43.00/44.50	42.75/45.50	23.69	23.46	+19.50 C	PC
CM	OD	41.25/42.37	41.87/43.37	22.54	22.25	+23.00 C	PC, SF
DK	OD	44.00/44.00		21.53	21.59	+27.00 C	PC
NE	OS	45.70/43.50		7.2	17.22	+18.00 E	PC
JF	OD	UNABLE	UNABLE	UNABLE	UNABLE	+20.00 E	PC, SF
GG	OS					+19.00 E	AC
DG	OD	40.50/42.75	43.75/43.25	23.8	23.0	+20.50 C	PC
EH	OS					+20.00 E	PC
SH	OS	40.25/42.00	42.50/44.00	27.32	23.02	+12.00 C	PC
DS	OD	42.50/45.50	42.25/46.00	23.32	23.09	+20.00 C	CAPS, "BAG"
SW	OD	44.25/46.00	45.00/41.00	25.70		+15.00 C	PC
KT	OS	47.00/45.75	45.00/46.00	21.9	21.3	+22.50 C	PC
TH	OS	46.00/46.00	46.25/46.25	20.55	20.55	+23.50 C	PC
DC	OS	43.40/43.00		22.00	22.00	+19.00 C	AC
EC	OS	50.00/56.00	62.00/58.00	21.60	22.70	+21.50 C	PC
KS	OD	46.75/45.75		20.50		+26.50 C	PC
MEAN						+20.82	

DISTORTION = UNABLE TO OBTAIN DUE TO CORNEAL SCAR OR NYSTAGMUS
UNABLE: UNABLE TO OBTAIN DUE TO LACK OF AVAILABILITY OR MALFUNCTION OF EQUIPMENT OR YOUNG AGE
AC = ANTERIOR CHAMBER C = POWER CALCULATED
PC = POSTERIOR CHAMBER E = EMPIRIC LENS POWER USED
SF = SUTURE FIXATION

TABLE III: VISUAL ACUITY PRIOR TO IMPLANT COMPARED WITH BEST OBTAINED SINCE IMPLANT, AND MOST RECENT VISUAL ACUITY. REFRACTIVE ERROR IN EYE WITH IOL IS COMPARED WITH FELLOW EYE

Patient	Eye	Preoperative Acuity (corrected) Cataract/ Fellow		Best Visual Acuity IOL Cataract/ Fellow		Last Visual Acuity IOL Cataract/ Fellow		Last Refraction Cataract Eye/Fellow Eye		Anisometropia
MS	OD	CF 2 FT	6/6	6/7.5	6/6	6/7.5	6/6	+6.00-5.50	-3.00-2.25	5.62
BT	OS	6/12	6/6	6/12	6/6	6/12	6/6	-3.00-2.75	-3.50-0.00	1.37
SW	OD	2/30*	15/30	CF 6 FT	6/6	CF 6 FT	6/6	-3.00-3.50	PLANO	4.75
AN	OS	6/9	6/7.5	6/7.5	6/7.5	6/7.5	6/7.5	+1.00	+1.00	0.00
AN	OD	6/7.5	6/7.5	6/7.5	6/7.5	6/7.5	6/7.5	+1.00	+1.00	0.00
PW	OS	6/21	6/6	6/12	6/6	6/30	6/6	PLANO-1.75	-2.25-0.50	1.50
LR	OS	LP	6/6	6/60	6/5	CF 5 FT	6/5	+1.00-2.50	+0.50-0.75	0.75
SS	OS	CSM	CSM	6/30*	18/30	CF 6 FT	6/18	+6.50-6.00	+1.50-0.75	2.50
MB	OS	6/60	6/6	6/9	6/6	6/12	6/6	+1.25-5.00	+0.25-0.50	1.25
JB	OD	6/9	6/7.5	6/6	6/6	6/6	6/6	+6.00-2.00	+4.50-3.00	1.00
JB	OS	6/7.5	6/9	6/6	6/6	6/6	6/6	+4.50-3.00	+6.00-2.00	1.00
SC	OD	6/9	6/6	6/7.5	6/9	6/7.5	6/9	+0.50-2.00	-1.00-1.25	1.12
SC	OS	6/6	6/9	6/9	6/7.5	6/9	6/7.5	-1.00-1.25	+0.50-2.00	1.12
CM	OD	6/24	6/5	6/7.5	6/6	6/7.5	6/6	+1.00-1.00	+1.75-0.50	1.00
DK	OD	CSM	20/30	6/6	6/9	6/6	6/9	-0.75-1.25	+1.25	2.37
NE	OD	6/60	6/7.5	6/60	6/7.5	6/60	6/7.5	-1.25-2.00	+1.00-1.25	2.37
JF	OD	ECC	CSM	ALLEN 8"	6/12	ALLEN 8"	6/12	+5.50	+0.75-1.25	5.37
GG	OS	6/120	6/6	6/60	6/6	6/60	6/6	+5.00	+1.50-0.50	4.25
DG	OD	6/15	6/6	6/6	6/6	6/6	6/6	+0.75-2.25	+1.75-1.00	1.62
EH	OS	6/120	6/6	6/120	6/6	6/120	6/6	+0.25-1.50	+0.50-0.25	0.87
SH	OS	6/60	6/6	CF 7 FT	6/6	CF 3 FT	6/6	+5.00-0.50	+0.50	4.75
DS	OD	HM	6/6	6/120	6/6	CF 3 FT	6/6	-2.75-3.00	+1.00-0.25	5.12
SW	OD	6/12	6/6	6/7.5	6/6	6/7.5	6/6	-2.50-3.25	-4.50-0.50	0.67
KT	OS	CF 1 FT	6/9	6/7.5	6/6	6/7.5	6/6	+0.75-1.50	+1.75-1.25	0.12
TH	OS	CF	6/7.5	6/7.5	6/6	6/7.5	6/6	PLANO-0.50	PLANO-0.50	0.00
DC	OS	NM	CSM	6/15	6/6	6/15	6/6	+2.75-1.75	-2.00-1.25	3.00
EC	OS	4/30*	3/30	6/60	6/60	6/60	6/60	-6.75 SPHERE	-4.25-1.75	1.67
KS	OD	4/30*	20/30	6/7.5	6/6	6/7.5	6/6	-0.75-2.50	+1.50	3.50

ECC = ECCENTRIC FIXATION
CSM = CENTRAL, STEADY, MAINTAINED
HM = HAND MOTION
CF = COUNTS FINGERS
* = MEASURED WITH ALLEN CARDS

lowing IOL. At 6 months, 12 eyes (42%) had an anisometropia of 1.50 diopters or less and 23 (82%) had an anisometropia of 3.00 diopters or less. At the most recent refraction, 15 eyes (54%) had an anisometropia of 1.50 diopters or less, and 21 (75%) had an anisometropia of 3.00 diopters or less.

The intraoperative and early postoperative complications related to the secondary implant procedure are listed in Table IV. Eight eyes had insufficient capsule remnants to support sulcus fixation of an IOL. Two eyes had extensive synechia between the residual lens capsule and the iris. Two eyes had an elevated intraocular pressure following the secondary implant. One was transient and was considered to be related to use of viscoelastic. The second eye had an intraocular pressure elevation after the initial cataract procedure. This lasted for 2 months. After an interval of 107 months of normal intraocular pressure, a secondary implant was placed in this eye. This was followed by persistent elevated intraocular pressure that has required 3 glaucoma procedures to control.

Table V lists other complications observed during the follow-up period. Some degree of strabismus was present in 10 patients before the implant procedure and was present in 11 patients over the follow-up period. One patient developed strabismus following the secondary implant procedure. No patients showed spontaneous resolution of the strabismus following the implant. Four patients have required strabismus surgery during the observation period. Sensory responses are listed in Table VI.

DISCUSSION

There will continue to be a need for secondary IOL procedures, because infants with complete monocular or binocular cataracts should have their cataract removed within the first 17 weeks of life.[5] Delay in removal of complete lens opacity beyond this critical period results in a poorer visual outcome. Children in this age range are considered by most ophthalmologists to be too young to have cataract surgery with a primary lens implant. This is because the response to surgical procedures is greater and because guidelines for accurate calculation and selection of a lens power that will be used for life do not exist. These children receive cataract surgery without IOL implantation and are usually rehabilitated with a rigid gas permeable or silicone contact lens.[14]

A difficult management problem occurs when a child with monocular aphakia is unable to wear a contact lens owing to corneal irregularity or a lid condition, or when a child has tolerated a contact lens but, with age, becomes resistent to insertion and removal of the lens. When this occurs during the first 8 years of life, amblyopia may occur, and the lack of com-

TABLE IV: INTRAOPERATIVE AND EARLY POSTOPERATIVE COMPLICATIONS FOLLOWING SECONDARY IOL IN CHILDREN

		Complications	
Patient	Eye	Intraoperative	Early Postoperative
MS	OD	NO CAPSULAR SUPPORT	ECCENTRIC PUPIL
BT	OS		IRITIS, MODERATE
SW	OD	NO CAPSULAR SUPPORT	LENS DECENTERED, TRAUMA
AN	OS		
AN	OD		
PW	OS	SYNECHIAE IRIS-LENS	
LR	OS	NO CAPSULAR SUPPORT	
SS	OS		
MB	OS	NO CAPSULAR SUPPORT	15° LENS TILT
JB	OD		
JB	OS		
SC	OD	PEAKED PUPIL	MONOCULAR DIPLOPIA, MCCANNEL SUTURE
SC	OS		
CM	OD	NO CAPSULAR SUPPORT	
DK	OS		
NE	OS	SYNECHIAE	
JF	OD	NO CAPSULAR SUPPORT, AC IOL	
GG	OS	IRIS FIXATION IOL REMOVED	
DG	OD	VISCOELEASTIC IOP ELEVATED 10 DAYS	
EH	OS	REMOVE PC IOL - REPLACE	ECCENTRIC PUPIL
SH	OS	RETAINED CORTEX, INFLAMMATION	GLAUCOMA, 3 PROCEDURES
DS	OD		
SW	OD		
KT	OS		
TH	OS		
DC	OS	NO CAPSULAR SUPPORT, AC IOL	
EC	OS		
KS	OD		

TABLE V: LATE COMPLICATIONS FOLLOWING IMPLANT OF A SECONDARY IOL IN CHILDREN

							Strabismus (In PD)	
Patient	Eye	Nd: YAG	Amblyopia	Glaucoma	Corneal Scar	Nystagmus Retina	Esotropia	Exotorpia
MS	OD	Y			Y			12 PD
BT	OS		Y				6 PD	
SW	OD		Y					20 PD
AN	OS							
AN	OD							
PW	OS							
LR	OS		Y				12 PD	
SS	OS	Y	Y					
MB	OS		Y					5 PD
JB	OD							
JB	OS							
SC	OD							
SC	OS							
CM	OD		Y					
DK	OD		Y		Y			
NE	OS		Y*		Y			
JF	OD		Y*			Y	ABSENT FOVEA	40 PD
GG	OS					RETINAL FOLD		
DG	OD							
EH	OS							
SH	OS		Y+				12 PD	
DS	OD		Y		Y		25 PD X	
SW	OD							
KT	OS						14 PD	
TH	OS							
DC	OS							
EC	OS				Y		25 PD X	
KS	OD						25 PD X	

X = STRABISMUS SURGERY PERFORMED
* = POOR COMPLIANCE OR NO COMPLIANCE WITH OCCLUSION THERAPY FOR AMBLYOPIA
+ = 3 GLAUCOMA PROCEDURES
PD = PRISM DIOPTERS

TABLE VI: RESULTS OF SENSORY TESTING FOLLOWING SECONDARY INTRAOCULAR LENS PLACEMENT

	Worth 4-Dot Test		Stereo Acuity, Titmus
Patient	6 Meter	1/3 Meter	(second of arc)
MS	SUPPRESS	SUPPRESS	ABSENT
BT	SUPPRESS	SUPPRESS	FLY
SW	SUPPRESS	SUPPRESS	FLY
AN	FUSE	FUSE	400
PW			
LR	SUPPRESS	SUPPRESS	ABSENT
SS	FUSE	FUSE	400
MB	SUPPRESS	FUSE	200
JB	ALTERNATE	FUSE	400
SC			
CM	FUSE	FUSE	400
DK	FUSE	FUSE	80
NE	SUPPRESS	SUPPRESS	0
JF			
GG	SUPPRESS	SUPPRESS	800
DG			
EH	SUPPRESS	SUPPRESS	0
SH	SUPPRESS	SUPPRESS	0
DS			
SW	FUSE	FUSE	400
KT	SUPPRESS	FUSE	800
TH	FUSE	FUSE	200
SC	SUPPRESS	SUPPRESS	800
EC	SUPPRESS	FUSE	0
KS	SUPPRESS	SUPPRESS	400

pliance with optical correction makes the amblyopia more difficult to treat. Opportunity to develop binocularity is also impeded. Alternatively, spectacles could be used. However, the unbalanced physical weight and thickness of glasses for correction of monocular aphakia precludes satisfactory use of glasses. Additionally, the aniseikonia produced by monocular aphakic spectacles interferes with the development of binocular function.

In the past, epikeratophakia grafts were used with limited success in this population. The delay in clearing of the graft and problems inherent in this procedure have prompted most ophthalmologists to seek other measures to rehabilitate these eyes.[15]

For the past 7 years, we have managed this group of children with implantation of a secondary IOL. All but 3 of the patients in our study had uncorrected monocular aphakia. The remaining 3 were older children who had bilateral aphakia and refused to wear glasses and contact lenses, and they, and/or their parents, requested an IOL. The indications for this procedure are not common. During this 7-year study period, the authors performed cataract surgery on 242 eyes. Of this group, 59 eyes (24%) received an IOL, and only 28 of the lenses were placed during a secondary procedure.

The relatively infrequent use of the IOL during this time interval represents our conservative philosophy toward use of IOLs. During the period of time over which this study was conducted, there was a continuous evolution of indications for use of an IOL, with a trend for use at younger ages and for a more liberal use of bilateral implants. During this study period, most children in our practice were fit with rigid, gas permeable contact lenses as their principal mode of optical rehabilitation. Our caution was based on the lack of complete knowledge and understanding of the long-term effect that an IOL would have on the development of a child's eye and its potential for damage to internal eye structures.

Most children in this series had difficulty wearing a contact lens either because of corneal scarring or because they became resistant to insertion and removal of the contact lens. We made a sincere effort to be sure that patients were not contact lens–intolerant because of poor fit or insufficient instruction. All patients were given thorough instruction and a trial with a contact lens by an experienced contact lens technician working with the authors. If a patient was referred to our practice for IOL implantation because of "contact lens failure," an attempt at refitting the contact lens was made in our office. If the patient rejected the lens, we proceeded with surgery.

The feasibility and technique of implanting a secondary IOL has

evolved. Implants were initially placed in the anterior chamber. Now most surgeons prefer to place the supporting haptics of the secondary implant in the ciliary sulcus. All but 2 of the IOLs in this series were placed in the ciliary sulcus. In 1988, the members of our group assessed the pros and cons of the lens styles and sizes available, and we standardized the lens style we were going to use during the upcoming 7-year period. We did this with an attempt to reduce the number of variables when assessing the results achieved with IOLs used in children. The lens selected and used was an all-PMMA lens with a 7-mm biconvex optic with UV coating, and haptics that had a 14-mm diameter. We preferred the larger-diameter optic because of the potential for decentration. We have since switched to a 6.5-mm optic lens. Children tend to produce greater amounts of secondary lens material that can displace a lens. We prefer placing the lens in the posterior chamber because of our concern and the concern of others over potential problems related to the anterior chamber–style implants.[16] The ideal location for an IOL is placement within the capsular "bag." However, placement of a secondary IOL within the capsular bag is technically difficult. In children, the capsular leaflets become firmly adherent and are difficult to separate. We attempted to place the lens within the capsular bag in a few children but were only successful in separating the leaflets in one eye. In this patient, the secondary IOL was successfully placed within the capsular bag.

Not all patients had sufficient capsular remnants to support sulcus fixation of the haptics. This was either because of the technique that was used to remove the cataract, or trauma that altered anterior chamber structures. Many children referred to our practice had had cataract surgery that used a pars plana or pars plicata approach with complete removal of the lens combined with a moderate anterior vitrectomy. This technique for cataract surgery became popular during the 1980s following development of the pars plana lensectomy technique. The lens was removed, leaving a 2-mm rim of lens capsule and performing an anterior vitrectomy. At that time, it was felt that the risk of developing amblyopia or interference with amblyopia treatment caused by regrowth of epithelial elements of the lens capsule was greater than the risk of developing cystoid macular edema following lensectomy and vitrectomy.[17,18] Because of this, some ophthalmologists extended this reasoning and removed as much of the lens as possible so that a secondary membrane would never occlude the visual axis. When patients who have had this surgery become contact lens intolerant, they present a difficult management problem. In 2 of these patients, an anterior chamber lens was used. In 6 other eyes, the haptics of a PC IOL were placed in the ciliary sulcus and were secured to

the sclera with a Prolene suture. This is technically a very difficult procedure and carries substantial risks of hemorrhage, tilting of the lens, erosion of the haptics into the ciliary body, breakage of the Prolene suture, and exposure of suture ends through the conjunctiva and a potential risk for endophthalmitis.[19] Nevertheless, these patients could or would not wear contact lenses and demonstrated poor vision due to lack of optical correction. Placement of a suture-fixated IOL was considered to be a reasonable alternative to leaving the patient without optical correction. To avoid this future potential dilemma, we routinely prepare all eyes that receive cataract surgery for the possibility of later placing a secondary implant.[15,20] This is accomplished by leaving sufficient anterior and posterior lens capsule leaflets, which will fuse and create a ringlike structure behind the iris (Fig 2). This will provide sufficient support for sulcus fixation of a secondary implant. We combine this with a limited anterior vitrectomy to prevent the anterior hyaloid face from acting as a scaffold for proliferating lens epithelium and secondary membrane formation.[21] With greater use of primary implants in children, this technique will be required less frequently. However, primary implants are still not recommended for all eyes because of age, and some of these children will undoubtedly develop resistance to wearing contact lenses. For these reasons, in the foreseeable future, there will continue to be a requirement for secondary implants.

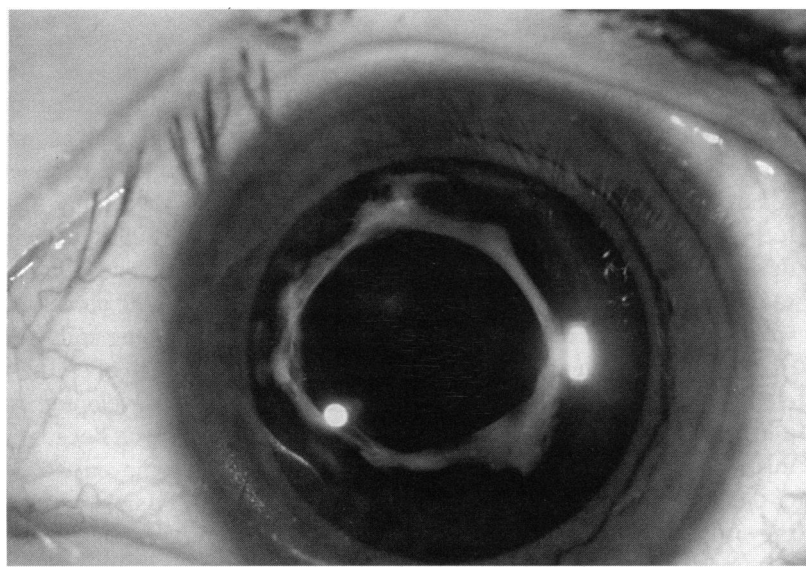

FIGURE 2

Eye with circular rim of residual lens cortex after cataract surgery, which will provide support for a posterior chamber IOL. Haptics can be placed in ciliary sulcus.

The safety of the secondary implant procedure was assessed. Operative complications resulting from placement of the secondary IOL were similar to those related to cataract surgery or as a result of preexisting ocular defects or trauma. The only complications specifically related to insertion of secondary IOLs were the following. One patient had a suture-fixated lens in the ciliary sulcus that developed a 15° tilt of the lens. The optical defect (astigmatism) created was corrected with spectacles. A second patient had cataract surgery 10 years prior to the secondary implant with a brief 2-month period of increased intraocular pressure immediately following the initial cataract operation. This patient was free from glaucoma for 9 years. When the secondary implant was placed, the patient had a recurrence of increased intraocular pressure. This has persisted over a 3-year period, and 2 glaucoma procedures have been necessary to control the intraocular pressure. A third patient, who had traumatic cataracts, received a suture-fixated posterior chamber lens. He was again struck in the eye by a seesaw. The lens haptic caused a radial tear in the iris. On exploration to reposition the iris and haptic, the iris was found to be torn and the haptic of the IOL still remained in the ciliary sulcus, amazingly, with the 10-0 Prolene suture still intact. From this experience, it would appear that the 10-0 Prolene suture is sufficiently strong, at least for the first few years, to withstand trauma of this degree. Prolene appears to resist biodegradation; however, the length of time it will remain structurally intact remains unknown.

The selection of an appropriate power for an IOL in a child's eye is difficult. This is further complicated by the difficulties in obtaining accurate measurements for calculation of the desired power of the implant. Frequently, children will not cooperate for accurate A-scan measurements, and nystagmus, poor fixation, or corneal scars may preclude accurate keratometry. In these situations, measurements were obtained on both eyes in the operating room, and lens powers were calculated at the time of the procedure. During the first 3 years of this study, an A-scan unit was not available in our operating room. Additionally, some patients had corneal scars that precluded accurate keratometry. In these situations, we used an empiric lens power based on the keratometry and refraction of the fellow eye. In these cases, an empiric lens power of +18.00 to +20.00 diopters was chosen.

Axial length determinations, performed under general anesthesia, may not measure the length of the eye along the visual axis. In spite of having the best equipment available for this purpose, we felt that the accuracy of keratometry and axial length determination was not as good as the measurements achieved in cooperative patients who have voluntary steady fixation.

Throughout the study, we have used a B&L keratometer, Terry keratometer, and Varidot surgical keratometer to determine the anterior corneal curvature. Comparison of readings of these 3 instruments as used under general anesthesia frequently produces slightly different values. These variations are largely due to obtaining measurements from directions other than along the central visual axis. These inconsistencies will influence the accuracy of IOL power calculation.

When calculating the power of the IOL, we attempted to select a power that would produce a relatively isometropic refractive error when the child reaches adulthood. Anisometropia is a risk factor for amblyopia. The guidelines on how we approach the power determination for an IOL have been previously reported.[11] We rely on keratometry and axial length measurements but modify the calculated power according to the refractive error of the fellow eye, the age of the child at the time of the procedure, and the refractive error of the parents. Throughout childhood, there is a progressive change in the axial length of the eye.[22] Concomitant with this, there is a flattening (reduction of power) of the curvature of the cornea. The largest changes in these parameters occur before the first year of life.[22] This is one of the reasons implants are not performed before 1 year of age. Using unadjusted calculated lens powers for eyes before the first year of life will result in lenses that will be too strong when the child matures. Although axial length and the curvature of the cornea continue to change throughout childhood, they do so at slower rates as the children age. We utilize our knowledge of these changes and have incorporated this information into the decision on selecting the power of the secondary implant.

To evaluate the accuracy of our lens power selection, we examined the spherical equivalent refractive error of both eyes at 6 months and again at the most recent refraction. We studied but did not tabulate data on the refractive error of both eyes 6 months following the implant. At 6 months, 42% of eyes had a difference of 1.50 diopters or less from the fellow eye, and 82% of eyes had a refractive error within 3.00 diopters of the fellow eye. At the most recent refraction, 54% had 1.50 diopters or less of anisometropia, and 75% were within 3.00 diopters of the fellow eye. The most recent refraction is probably our best indicator of the accuracy of power selection to achieve our goals at maturity. Discrepancies between the refractive errors between the eyes was compensated for by prescribing spectacles.

The improvement in visual acuity was dramatic. Twenty of 28 eyes showed an improvement in corrected visual acuity. Only 1 patient, for unexplainable reasons, lost 2 lines of vision (6/6 to 6/9). This may have been related to the accuracy of the single visual test in a young child prior

to surgery. It is possible that this child had an unresponsive amblyopia or developed a clinically undetectable cystoid macular edema. Because of age, a fluorescein angiogram was not performed.

Although there was dramatic improvement in visual acuity, the overall level of visual acuity was disappointing. This probably reflects the preponderance of children with monocular aphakia and the multiple preoperative problems in providing a consistent, effective optical correction and the concomitant difficulties that occur in treating amblyopia in this group of patients. When working with children, compliance of patients and the family unit is sometimes an insurmountable problem, and this group of patients, by our selection criteria, has an unusually high level of compliance problems. In many patients, the integrity of the family unit was not ideal. Our success in treating children depends in some way on the socioeconomic and educational background of the parents. For example, in 1 patient in this series, in spite of having cataract surgery with written and verbal instructions regarding which eye to place the contact lens in, the aphakic contact lens was repeatedly inserted into the incorrect (phakic) eye for a period of 2 months.

Several patients had a reduction in visual acuity on last follow-up from their best postoperative visual acuity. This was due either to development of secondary membranes or recividism following completion of amblyopia treatment. In spite of our attempts to clear the visual axis by removal of the posterior capsule at the time of the secondary implant, two patients required Nd:YAG capsulotomies and one patient will probably need treatment in the near future.

Ten of the 28 patients in this series have moderately severe amblyopia. In many cases, this existed prior to the placement of the implant. In 9 patients amblyopia improved following the secondary implant and occlusion therapy. In some of these patients, the improvement was from poor vision to excellent vision (Table III). Two patients who were compliant with amblyopia therapy had persistent poor vision 1 year following the implant. The fundus examination of 1 eye revealed an absent foveolar reflex, and the other patient had an eye that had an unrecognized preexisting epiretinal membrane.

Strabismus is common in children with cataracts.[23,24] This is probably a result of the extent and duration of visual deprivation and reduced or lack of stimulation of centers that control ocular alignment. Kodsi and associates[25] have been able to improve ocular alignment in children with cataracts using a contact lens. Benezra[26] had similar success using an intraocular lens in patients with acquired cataracts. In this series, 11 of 25 patients had strabismus. In 10 patients, the strabismus preexisted the

implant procedure. None had an improvement in their ocular alignment following the implant procedure. During this brief follow-up period, 4 children required strabismus surgery. The remainder had strabismus, but it was not of sufficient magnitude to require surgical correction. This population differs from the population of Kodsi[25] and Benezra.[26] In our series, there was a substantial time interval of noncompliance before use of optical correction. This may explain our high prevalence of strabismus and its failure to improve following optical correction of the aphakic refractive error.

One of the goals of early optical rehabilitation is to promote development of binocular function. In adults, aniseikonia and stereo acuity are measurably better when an IOL is used to rehabilitate eyes with cataracts.[27,28] In this study, only 6 patients developed a fusion response as measured with Worth four-dot testing at distance and at near. Only one patient had better than 100 seconds of stereo acuity. The development of binocular function is not as good in this series as it is in our unreported data on our primary implants, nor is it as good as seen in adults with cataract surgery followed by primary implant.[27] Development of binocular function is thought to occur before the age at which patients in this series became candidates for secondary implants. The poor binocular function present in this series probably reflects the visual deprivation caused by the cataract and the presence of a prolonged period of patients having an uncorrected aphakic refractive error during a period when fusion and binocular function develop.

Considering the expected life-span of children and the brief follow-up period of only 35 months, we cannot make any long-term statements regarding the safety of this procedure. We are reassured by the results of other contemporary series that indicate that children's eyes tolerate the placement of PMMA intraocular lens reasonably well. We remain, however, concerned regarding the long-term safety and effects the implant will have on the eye. We continue to follow the children in this study group to detect any long-term effect of the IOL on structures within the eye.

After analysis of our data, we feel that placement of a secondary intraocular lens in eyes of children who refuse or cannot tolerate a contact lens is an acceptable and safe method of rehabilitation in these eyes.

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DISCUSSION

DR MARSHALL M. PARKS. Dr Biglan and his coauthors assessed their results according to surgical complications, induced anisometropia, visual acuity outcome, and binocular vision outcome judged from both the motor and sensory status. I will focus only on vision outcomes, since I am most concerned whether secondary intraocular implants (SII) have a measureable therapeutic effect in either preventing or treating amblyopia.

Amblyopia is the major factor in causing poor visual outcomes in the management of cataracts during the amblyogenic period, which extends to 9 years of age. Other factors, in addition to optical methods selected to correct the aphakia, also have been identified as causing amblyopia in this patient population. For example, vision outcome was found to be related to the cataract type.[1] Despite the identical aggressive therapy, the median was quite different for the various cataract types, such as congenital nuclear cataracts, the acquired unilateral cataracts, whether it be a traumatic or posterior lentiglobus cataract, and the acquired bilateral lamellar cataracts. Other than traumatic cataracts, the type of cataracts in this cohort of patients was seldom identified. Instead, descriptive features of the cataract, such as partial or complete, were listed as the type of cataract. Finally, in assessing visual outcomes, the facts regarding the patient's compliance in accepting the aphakic optical correction and the occlusion therapy are often difficult to obtain.

The authors placed SII in 28 eyes of 25 patients ranging in age from 1 to 21-1/2 years. Nineteen were sulcus fixated, 6 were sutured in the sulcus, 2 were placed in the anterior chamber, and 1 was placed in the bag. In 22 patients the cataracts were unilateral, and in 3 patients they were bilaterally symmetric. The visual outcome is compared for the 4 SII placement techniques in the 28 eyes. The 19 eyes with the sulcus-fixated lenses had visual acuity ranging from 6/6 to counting fingers (median, 6/7.5). If the 6 bilateral cataract eyes are excluded, the 13 remaining unilateral cataract eyes have exactly the same range and median visual acuity. In the 6 eyes with sutured-in sulcus lenses, visual acuity ranged from 6/7.5 to 6/12 in 3 patients and counting fingers in the other 3. The 2 eyes with anterior chamber lenses had 6/15 and 6/60 vision. The "in the bag" SII placement in 1 eye resulted in counting fingers. Assessed by this method, we learn nothing about whether amblyopia is favorably affected by using the SII.

The 6 eyes with bilateral symmetric cataracts were described as having a complete cataract in 1 patient, partial cataract in another, and nuclear cataract in the third. All patients had bilateral cataract surgery between 3 and 5 years of age. An SII was placed in each eye between 13 and 18 years of age. All 6 eyes had either 6/6 or 6/7.5 visual acuity, no amblyopia, and

no strabismus; stereopsis was confirmed in the 2 patients who were tested. I presume that since neither unilateral nor bilateral amblyopia is associated with lamellar cataracts, despite late surgery, the cataracts in all 3 patients were probably lamellar. In evaluating the visual outcome in this study, it is important to set these 6 nonamblyopic eyes apart from the other 22 eyes with unilateral cataracts. The visual outcome for the 6 eyes in the bilateral cases was a median acuity of 6/6 compared with median acuity of 6/30 for the 22 eyes in the unilateral cases.

The visual outcome of the 22 unilateral cataractous eyes differed according to the cataract type. Eleven were traumatic, and 11 were some other, unspecified type. The visual outcome of the 11 eyes with traumatic cataract ranged from 6/6 to counting fingers, with a median of 6/12. The 11 other eyes had a visual outcome ranging from 6/7.5 to counting fingers, with a median of 6/60. This difference in outcome between the traumatic cataract and the other type of monocular cataract fits well with the prior visual outcome study that did not use SII.[1]

Also, consider the age of the 22 unilateral cataract patients when they received their SII. Eleven were between 1 and 6 years of age, the median being 3.5, and 11 were between 9-1/2 and 21-1/2 years of age, the median being 12. Within the younger group, the SII could have some influence on affecting the final visual acuity, but it certainly would have no influence on the 11 patients in the older group. In the 11 patients who received their SII between ages 1 and 6, only 2 patients had a traumatic cataract, and their final visual outcomes were 6/6 and 6/15. The 9 patients with an unspecified cataract type had a visual outcome ranging from 6/7.5 to counting fingers (median, 6/60) for the nontraumatic cataract patients.

From this report, I conclude that aside from the traumatic type of cataract, the SII probably offers little benefit in preventing or treating amblyopia in the aphakic child with a unilateral congenital or early-onset cataract, such as nuclear, persistent hyperplastic primary vitreous, or posterior lentiglobus.

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DAVID BERLER, MD. I would like to congratulate Dr. Biglan on his courage in presenting the paper which is interesting. I have one question. Are there significant anatomical differences at the limbus between the adult and very young eyes that are not only abnormal but that have had surgery. Particularly, how do you decide where to make your scleral entries for suture placement?

VERINDER NIRANKARI, MD. Again I want to congratulate Dr. Biglan for this very thought provoking paper. I have a question and a comment. I have been using suture fixation lenses for traumatic and adult secondary IOL placement for about seven to eight years and results have been very good. In adults we have done longitudinal endothelial cell studies and really have not seen any progressive endothelial cell loss after the first year. I wondered if Dr. Biglan has also or is currently doing similar longitudinal endothelial cells studies on these young patients. Because obviously we are concerned about a secondary IOL being in the eye for 50, or 70 years and whether he would share with us his results. Also has he seen any patients with secondary uveitis or glaucoma. In addition we used to see in the earlier studies when we do not make very thick scleral flaps, the prolene sutures had a tendency to get exposed. Has he seen that in his patients and how has he handled it?

The comment I have is that though he did not discuss in detail his technique of suture fixation, it looks like it is ab-interno where he goes from the limbus through the ciliary sulcus and then out under the scleral flap. My comment would be that we used to do that and I found that if you go ab-externo that is you go at 3:00 and 9:00 from the outside between 0.75 mm and 1.0 millimeter behind the limbus, which as you know from previous studies has shown that it is relatively safe. In our experience, we have experienced no complications such as hemorrhage, retinal detachment etc. in any of our patients.

MALCOM ING, MD. Al, I enjoyed your paper very much. I just had a few technical questions. How stable is the lens using sulcus fixation as related to time? In other words what were your tests to make sure that the lens was not rotating, tilting, etc. when you did not have a suture or some other fixation device added with the sulcus fixation? And would not a suture at least in one area be a stabilizing factor that you could use in addition to the sulcus fixation? That is the technical question.

Second, when you do the sclera flap fixation, it is my understanding that, even with the sclera flap, you do have erosion occasionally. You rarely have sutures coming loose and secondary endophthalmitis has been reported even with the use of a scleral flap. There are newer techniques or some techniques that have been reported where you use the suture as a fixation device but you rotate the knot in and this leaves nothing to erode through, at least not as much, because there are no knots there.

Then you also mentioned two patients with glaucoma. Was this a secondary type of glaucoma due to angle closure? Was it due to the fact that the lens rotated out of position? How did those patients develop glaucoma?

ROBERT DREWS, MD. Dr. Biglan mentioned "UV coating" of intraocular lenses. It may seem a minor point, but from the standpoint of long-term safety of lens implants especially in children, it is important to know that the UV absorbing material is not coated on the intraocular lens but is incorporated in the plastic.

ALBERT BIGLAN, MD. This may be longer than the presentation.

Dr. Parks I would like to thank you very much for your very important comments. The concerns about this pediatric population in the amblyopia age range are appropriate. When monocular aphakic children will not waer a contact lens, we try to refit them. Each child in this study was fit by my contact lens technician working directly with me or one of my associates, even if the child was referred from out of town. These children are true contact lens failures.

The time interval between the initial cataract surgery was a mean of seven years. The concern is, are we going to be successful in managing amblyopia? Perhaps we are waiting too long to do something for children who will not wear a contact lens. Amblyopia needs to be addressed. It is a very difficult decision. We normally make a sincere attempt at fitting a monocular aphakic child with a contact lens. We are usually successful in our attempts. As was reported earlier, of the 240 patients who had cataract surgery, only a few required secondary IOLs. We continue to be concerned about long-term safety, and we implant secondary IOLs with great caution. After looking at the inverval of seven years and the age of risk for amblyopia, perhaps we should be doing some of these sooner.

The second question that Dr. Parks addressed was the type of cataract. Many children were referred into our practice for this particular procedure, and we did not have records that provided us with an accurate description of the cataract prior to removal. We attempted to gather records, but the precise type of cataract that was present at the time of the initial cataract surgery is unknown in some patients. I agree with Dr. Parks that some of the cataracts were probably partial lens opacities, especially in the children with bilateral cataracts and good vision. I can recall one of the children with bilateral cataracts who was self-referred after doing cataract surgery on the sibling. The child had had extraction done elsewhere and requested secondary IOLs. I have no idea of the type of cataract this child had, but it is likely that Dr. Parks was correct and it was probable that the cataract that was removed was a partial cataract or a lamellar cataract. This procedure is really used to treat children with monocular cataracts who are "functionally aphakic". We feel the use of an IOL will provide some optical correction for the child who will not wear a

contact lens.

The high incidence of strabismus that we see is probably due to prolonged visual deprivation at a time when binocular function is developing.

Regarding Dr. Berler's comments on the technicalities of the procedure, Dr. Berler has reported to our group his technique. Actually, after listening to the description of his technique, we refined our procedure. To prevent erosion, the Prolene® suture is placed under a 3/4 thickness scleral flap. The suture exits the sclera about 1 to 1 1/2 millimeters from the limbus. We place the suture that secures the lens haptic at 3:00 and 9:00 o'clock. I tie about ten knots on the Prolene suture and trim the suture very short at the last knot. The scleral flap is replaced to cover the cut ends of the Prolene® suture. The flap is secured with a 0-0 Vicryl® suture and it is then covered with conjunctiva. In spite of these efforts, in one of my earlier cases, I have an eye in which I can see the Prolene® suture through the conjunctiva. It is not breaking through the conjunctiva, but it is visible and I am watching this patient's eye with concern.

Let me skip to Dr. Ing's question about the stability of the suture fixation. First let me emphasize the suture fixation is a technically difficult procedure in a child. I do not routinely suture lenses in. I only use this technique if there is insufficient capsular support. If there are sufficient capsular remnants, I feel secure with just placing the lens haptics behind the iris in the ciliary sulcus. Dave Apple, who is attending this meeting, has expressed some concern about the long-term safety of sulcus fixation. I share that concern, but I am left with the alternative of leaving an eye with uncorrected aphakia. I do not recommend routinely using suture fixation for the haptics. I reserve that for situations when there is lack of capsular support.

Regarding the question of glaucoma, two of the patients had glaucoma. One patient had a viscoelastic-related glaucoma that lasted for about two to three weeks. It disappeared without treatment. The second patient is notable. This is a child who had cataract surgery at age three. This patient had two months of elevated intraocular pressures which was treated with topical medications and it resolved. The patient was followed for about nine years without glaucoma following the initial cataract surgery. With the normal intraocular pressure history and failure to use a contact lens, I implanted a secondary IOL. The child then developed glaucoma. She has had two glaucoma procedures, and that eye is ready for its third glaucoma procedure.

Dr. Nirankari questions the endothelial counts. We did a series of endothelial counts in children with Dave Hiles, myself, Edward Fetherolf, and Miles Galin in 1982. Endothelial cell counts in children are very dif-

ficult to obtain. We had to use general anesthesia for many of these. Some of these patients are growing up and we get endothlial counts when we can. Our experience suggests that posterior chamber IOLs seem to do quite well. There does not seem to be progressive endothelial cell loss. Our experience, however, is limited.

As far as uveitis, we have not had any persistant uveitis as a result of the procedures.

Regarding the surgical technique, I have tried several approaches, and I feel most comfortable with the one I have described. Unlike the adult eye, it is the same as you have with an open globe with a penetrating keratoplasty. You have an open globe. Children's eyes have a very elastic sclera and the eyes tend to collapse and become distorted. If you look at the video tapes when you are placing the suture, you will be uncomfortable looking at the degree of globe distortion. The biggest risk that I worry about is when I have an open eye and I am passing the long-cutting edge needle through the sclera in the region of the sulcus. It is placed near the greater arterial circle of the iris. Hitting that vessel would cause uncontrollable bleeding. It is an uncontrollable complication. Knock on wood, I have not had that happen yet, but I am sure that it will happen with time.

Finally, I appreciate Dr. Drews comment regarding UV coating. It is true that the UV substance is throughout the PMMA. I might add that we have not used acrylic lenses or any of the other lenses. We feel that the PMMA has been relatively safe. I have followed some of the lenses that Dave Hiles and myself have put in since 1973. The eyes seem to do pretty well with the PMMA material.

I thank the discussants for their meaningful and constructive comments. I would like to especially thank Dr. Parks for his kind comments, and thank the audience for their attention.

Thank you.