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Journal Title: Journal of AAPOS
Volume: Volume 20, Number 6
Publisher: Elsevier | 2016-12-01, Pages 501-505
Type of Work: Article | Post-print: After Peer Review
Publisher DOI: 10.1016/j.jaapos.2016.09.014
Permanent URL: https://pid.emory.edu/ark:/25593/s6psf

Final published version: http://dx.doi.org/10.1016/j.jaapos.2016.09.014

HHS Public Access
Author manuscript
J AAPOS. Author manuscript; available in PMC 2017 December 01.

Published in final edited form as:
J AAPOS. 2016 December ; 20(6): 501–505. doi:10.1016/j.jaapos.2016.09.014.

Strabismus surgery outcomes in the Infant Aphakia Treatment Study (IATS)

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Abstract

Purpose—To report strabismus surgery frequency and outcomes after monocular infantile cataract surgery with or without IOL implantation.

Methods—The Infant Aphakia Treatment Study (IATS) is a randomized, multicenter clinical trial comparing treatment of aphakia with a primary IOL or contact lens in 114 infants with a unilateral congenital cataract. This report is a secondary outcome analysis of ocular motor data from IATS patients who underwent strabismus surgery prior to age 5 years.

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This data used in this study was presented as a poster at the Annual Meeting of the American Academy of Ophthalmology, November 14–15, 2015.

Results—Strabismus surgery was performed in 45 (39%) patients (contact lens group [CL], 37%; IOL group, 42% [$P = 0.70$]). The indications for strabismus surgery were esotropia (62%), exotropia (33%), and hypertropia (4%). Infants who underwent cataract surgery at a younger age were less likely to undergo strabismus surgery (28–48 days, 12/50 [24%]; 49–210 days, 33/64 [52%]; $P = 0.0037$). Of the 42 patients who underwent strabismus surgery, 14 (33%) had a postoperative distance alignment within 8^{Δ} of orthotropia at age 5 years. The 5-year visual acuity of children with strabismus was the same whether or not strabismus surgery had been performed (1.10 logMAR with surgery vs 1.00 without [$P = 0.71$]).

Conclusions—In this study cohort, cataract surgery performed in the first 6 weeks of life was associated with a reduced frequency of strabismus surgery. Strabismus surgery outcomes in this population are guarded. Surgical improvement of strabismus does not appear to influence long-term visual acuity.

Although strabismus is a common in infants with unilateral congenital cataract, with a reported frequency ranging from 27% to 100%,[1–10] there are few reports, and no prospective studies, on strabismus surgery outcomes in this population.[9,11,12] In the prospective Infant Aphakia Treatment Study (IATS), strabismus was detected in 81% of infants by age 5.[13] The present study evaluates the pre- and postoperative characteristics of children who underwent strabismus surgery up to 5 years postoperatively.

Subjects and Methods

The Infant Aphakia Treatment Study (IATS) is a randomized, multicenter, longitudinal study that evaluated the clinical outcomes of 2 treatments (contact lens [CL] vs intraocular lens [IOL]) for aphakia after early surgery for unilateral infantile cataract.[14] The randomization was stratified according to the category of the age of the infant at surgery (28–48 vs 49–210 days). The primary outcomes at 5 years of age, including visual acuity, adverse events, and strabismus have been previously described.[13–15,16] The IATS was approved by the institutional review boards of all the participating institutions and complied with the US Health Insurance Portability and Accountability Act of 1996. The off-label research use of the AcrySof SN60AT and MA60AC IOLs (Alcon Laboratories, Fort Worth, TX) was covered by US Food and Drug Administration investigational device exemption #G020021. Written informed consent was obtained from all parents/guardians.

Examination and Surgery

Ocular alignment at distance and near was assessed at each follow-up examination and immediately prior to strabismus surgery by an IATS-certified investigator until patients were 5 years of age. Strabismus was measured in prism diopters using the simultaneous prism cover test followed by the prism-alternate cover test or Krimsky light reflex testing when fixation was poor. Monocular optotype HOTV visual acuity was measured at age 4.5 years by a masked traveling tester. Strabismus surgery was performed, timed, and dosed at investigator discretion.

Analysis

The percentage of children with strabismus surgery was compared between aphakia treatment groups and between the age groups at cataract surgery (28–48 days vs 49–210 days) using the Fisher exact test. The median visual acuity was compared between groups of children with and without strabismus surgery using the Wilcoxon rank-sum test, and the percentage of children with visual acuity of 20/200 or worse was compared between groups using the Fisher exact test. These same methods were used for children having strabismus surgery to compare visual acuity of those with strabismus of $\leq 8^{\Delta}$ at age 5 years and those with strabismus of $>8^{\Delta}$. The Fisher exact test was used to compare the percentage of children with strabismus of $\leq 8^{\Delta}$ at age 5 years between age groups at cataract surgery and between those who underwent strabismus surgery at <1 year of age or ≥1 year of age. All statistical tests were two-sided. A P value of <0.05 was deemed statistically significant.

Results

A total of 114 infants were enrolled in the study, with 57 randomized to each treatment group. Of these, 113 completed a clinical examination at age 5 years (mean, 5.0 years; range, 4.7-5-4 years). Strabismus surgery was performed in 45 children (39%) and did not differ in frequency between treatment groups (CL group, 21 [37%]; IOL group, 24 [42%]; $P = 0.70$). Infants who underwent cataract surgery at a younger age were less likely to undergo strabismus surgery (28–48 days, 12/50 [24%]; 49–210 days, 33/64 [52%]; $P = 0.0037$). The median time between cataract surgery and strabismus surgery was 18.3 months (interquartile range [IQR], 9.7–30.6 months; range, 2.8–53.8 months).

Median visual acuity at age 4.5 years was 1.10 logMAR (IQR, 0.40–1.82 logMAR) among 45 children with prior strabismus surgery versus 0.70 logMAR (IQR, 0.30–1.30 logMAR) among 67 children without ($P = 0.097$). Poor visual acuity (20/200 or worse) was present in 26 of 45 children (58%) who had undergone strabismus surgery compared to 29 of 67 (43%) who had not ($P = 0.18$). Among children with strabismus at age 5, the median visual acuity of the 40 children with previous strabismus surgery was 1.10 logMAR (IQR, 0.40–2.08 logMAR), not significantly different from the median visual acuity of 1.00 logMAR (IQR, 0.40–1.92 logMAR) among 45 children without strabismus surgery ($P = 0.71$). Among children with strabismus at age 5, poor visual acuity (20/200 or worse) was present in 23 of 40 children (58%) who had undergone strabismus surgery compared to 24 of 45 (53%) of those who had not ($P = 0.83$). Of children with strabismus $>8^{\Delta}$ at age 5, the median visual acuity was 1.10 logMAR (IQR, 0.40–2.12 logMAR) in 28 children with prior strabismus surgery and 1.20 logMAR (0.50–2.17 logMAR) in 32 children without ($P = 0.78$) Among children with strabismus $>8^{\Delta}$ at age 5, poor visual acuity (20/200 or worse) was present in 16 of 28 children (57%) who had undergone strabismus surgery compared to 20 of 32 (63%) of those who had not ($P = 0.79$).

The surgery was performed on the cataractous eye only in 33 (73%) patients (CL, 15 [71%]; IOL, 18 [75%]), bilaterally in 11 (24%) patients (CL, 6 [29%]; IOL, 5 [21%]), and on the fellow eye in 1 (2%) patient (IOL group). 23 involved the right eye only and 11 involved the left eye only. Horizontal rectus muscle strabismus surgery only was performed in 38 of the 45 patients (84%). The medial rectus muscle was involved in 80% of cases (Table 1).

Esotropic patients who underwent strabismus surgery typically had constant deviations (96%), with a mean preoperative deviation of 29^{Δ} (range, 5^{Δ}–60^{Δ}). Exodeviations leading to surgery (mean, 35^{Δ}; range, 16^{Δ}–50^{Δ}) were commonly intermittent (40%) (Table 2). Seven children underwent two strabismus surgical procedures.

Orthophoria was detected in 5 of the strabismus surgery patients at age 5 years (11%). Fourteen of the strabismus surgery patients (33%) had a postoperative distance alignment within 8^{Δ} of orthotropia at age 5. The visual acuity of those 14 children was 1.20 logMAR (IQR, 0.60–1.60 logMAR) compared to 1.10 logMAR (IQR, 0.40–2.12 logMAR; $P = 0.89$) for the 28 children with previous strabismus surgery having larger residual strabismus angles. Visual acuity of 20/200 or worse was found in 57% of both alignment outcome groups ($P = 0.99$). Alignment within 10^{Δ} at age 5 years was present in 5 of 12 of children (42%) who underwent cataract surgery between 28–48 days of age compared to 9 of 30 children (30%) who underwent cataract surgery between 49 and 210 days of age ($P = 0.49$). Eleven of the 42 children underwent strabismus surgery prior to 1 year of age; of these, 2 (18%) achieved an ocular alignment $\leq 8^{\Delta}$ or orthophoria at age 5 compared to 12 of 31 (39%) who had strabismus surgery after 1 year of age ($P = 0.28$).

Postoperative exotropia (range, 4^{Δ}–30^{Δ}) was more common (42%) than esotropia (range, 3^{Δ}–25^{Δ}; 31%) at age 5 years (Table 3). Vertical deviations were identified in 29% of patients. These strabismus surgery results may be compared to the results of motility examinations at age 5 years for the 67 children who did not undergo strabismus surgery (Table 4).

Discussion

This secondary analysis for the IATS randomized controlled trial did not find a statistically significant difference in the frequency of strabismus surgery based on aphakia management. Strabismus surgery was performed in approximately 50% of patients with strabismus by 5 years of age, consistent with our prior description of strabismus patterns in this population; esotropia surgery was twice as common exotropia surgery.[13] It follows that horizontal rectus muscle strabismus surgery was performed more than 80% of the time.

Several retrospective studies document strabismus surgery success in children with cataract. Weisberg and colleauges,[11] Hiles and Sheridan,[9] and Merino and colleagues[12] reported success rates between 75% and 83.3% in older children with cataract. At 1 year of age, a small number of IATS children had undergone strabismus surgery, with an initial success rate of 53% of children within 8^{Δ}.[17] Unfortunately, this early good alignment was not maintained in most patients: strabismus surgery at any point in the first 4.5 years of follow-up resulted in a postoperative distance alignment of $<10^{\Delta}$ of orthotropia at age 5 years in only 33% of children. At that same examination only 11% of children were orthophoric. Visual acuity did not appear to be associated with an alignment within 10^{Δ} after strabismus surgery. The poor ocular motility outcome in this series compared to prior reports in older children likely correlates to the poor fusion and the dense recalcitrant amblyopia associated with this infantile cataract cohort (50% of children had a visual acuity of ≤20/200 in the affected eye).[15] Such sensory results may have influenced investigators to be more conservative with strabismus reoperations, performed in only 6% of patients.

Although esotropia was more common preoperatively, exotropia was more common after strabismus surgery at age 5. Conservative surgical dosing may be indicated to avoid consecutive deviations in these children. Despite a paucity of vertical muscle surgery, vertical deviations were identified in 29% of children at age 5. This parallels an increase in vertical deviations, hypertropias, and dissociated vertical deviations in patients who did not undergo strabismus surgery.

Despite the majority of IATS infants developing strabismus in the first year of life, only 13% underwent strabismus surgery by that time.[17] The mean time between infant cataract surgery and strabismus surgery was 18 months. The timing of strabismus surgery may depend on the age when patching becomes more difficult and both eyes are consistently viewed by caregivers, when strabismus cover testing measurement becomes feasible, or when deviations are felt to be stable; timing may also be influenced by the presence of other indications for examination under anesthesia. Although the sample size is small and statistical significance was not achieved between groups, it does not appear that strabismus surgery prior to 1 year of age was more beneficial than delayed surgery. The trend in fact suggested that surgery *after* 1 year of age might be advantageous.

Strabismus surgery was less common in the group of infants who had undergone surgery before 49 days of age. This is not surprising as a prior report showed orthotropia at age 5 was more common in children who had infantile cataract surgery before 49 days of age, although this difference did not reach statistical significance.[13] Although the sample size is small, the timing of cataract surgery did not affect the result of later strabismus surgery.

We previously reported that at 5 years of age, children without strabismus more commonly had better visual acuity than those with strabismus.[13] It has not been known whether better acuity in the treated eye is protective for the development of strabismus or whether straighter alignment improves amblyopia treatment after cataract surgery. In the present study visual acuity was better in children who did not undergo strabismus surgery than in those who did (0.70/1.10 logMAR, $P = 0.097$). One might suspect that eyes with worse visual acuity had more constant motility deviations or that surgeons were more prone to operate on poor-seeing eyes. However, it is noteworthy that the visual acuity at age 4.5 years did not differ between the groups of strabismus children that had prior strabismus surgery and those children who had not. Strabismus surgery had a positive (albeit guarded) effect on alignment, suggesting that prior strabismus surgery had no impact on the visual acuity result. One can infer both that in the IATS cohort better visual acuity in the treated cataract eye is protective for the development of strabismus and that amblyopia treatment is not augmented by early strabismus repair. As early correction of primarily horizontal strabismus did not affect visual acuity outcome or subsequent vertical strabismus, delayed strabismus surgery may be reasonable to minimize sedation in infants after cataract surgery.

The present study is chiefly limited by the fact that the timing and dosing of strabismus surgery was not part of the IATS protocol. This secondary outcome is influenced by factors that were at the discretion of the investigator and the family, albeit representing the real-world practice of strabismus management in these children.

In conclusion, strabismus surgery was common in both treatment arms of the IATS. Infants who had cataract surgery at a younger age were less likely to undergo strabismus surgery. Strabismus surgery outcomes in this population are guarded. Surgical improvement of strabismus does not appear to influence long-term visual acuity.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

Supported by National Institutes of Health Grants U10 EY13272 and U10 EY013287 and in part by NIH Departmental Core Grant EY06360 and Research to Prevent Blindness Inc, New York, New York. This study is registered with ClinicalTrials.gov (NCT00212134).

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Table 1

Extraocular muscles operated on (muscles tallied in combination)

Muscles	No. patients (% of 45)
MR	15 (33)
MR + LR	19 (42)
MR + SR	1 (2.2)
MR + SO	1 (2.2)
LR	4 (9)
LR + IO	2 (4.4)
SR	1 (2.2)
IO	2 (4.4)
Total	45

MR, medial rectus muscle; *LR*, lateral rectus muscle; *SR*, superior rectus muscle; *SO*, superior oblique muscle; *IO*, inferior oblique muscle.

Table 2

Types of deviation, frequency, and prism diopters at distance[a] in 45 patients measured preoperatively at first strabismus surgery procedure

Deviation type	n (%)[b]	Frequency n (%)[c]			Measurable deviation	
		Total n	Intermittent	Constant	No. patients	Mean value ± SD (range)[d]
Esotropia	28 (62)	27	1 (4)	26 (96)	21	28.8 ± 10.7 (5–60)
Exotropia	15 (33)	15	6 (40)	9 (60)	14	35.1 ± 9.2 (16–50)
Pure HT	2 (4)	2	2 (100)	0	2	18.0 ± 2.8 (16–20)
Mixed HT	6 (13)	6	1 (17)	5 (83)	6	11.5 ± 4.5 (6–18)

HT, hypertropia; *PD*, prism diopter; *SD*, standard deviation.

[a]Of 45 patients, 43 had the same strabismus pattern at distance and near.

[b]Percent based on total of 45 patients.

[c]Percent based on number of patients with frequency data for each deviation ("Total n").

[d]Percent based on number of patients with prism diopter quantification for each deviation ("Total n").

Table 3

Types of deviation, frequency, and prism diopters at distance[a] at age 5 in 45 patients who underwent prior strabismus surgery

Deviation type	n (%)[b]	Frequency n (%)[c]				Measurable deviation	
						No. patients	Mean value ± SD (range)
Orthophoria	5 (11)						
		Total n	Phoria	Intermittent	Constant		
Esotropia	14 (31)	14	0	3 (21)	11 (79)	14	12.6 ± 7.4 (3–25)
Exotropia	19 (42)	18	0	4 (22)	14 (78)	18	15.6 ± 6.7 (4–30)
Pure HT	7 (16)	5	0	2 (40)	3 (60)	5	7.8 ± 3.3 (2–10)
Mixed HT	8 (13)	7	0	1 (14)	6 (86)	7	9.6 ± 6.1 (2–20)

HT, hypertropia; *PD*, prism diopter; *SD*, standard deviation.

[a]Of the 45 patients, 37 (82%) had the same strabismus pattern at both distance and near.

[b]Percent based on total of 45 patients.

[c]Percent based on number of patients with frequency data for each deviation (“Total n”).

Table 4

Strabismus measurements at age 5 examination for the 67 patients without prior strabismus surgery

Deviation type	n (%)	Frequency n (%)[b]			Deviation PD, mean ± SD (range)
Orthophoria	21 (31%)				
		Phoria	Intermittent	Constant	
Esotropia	28 (42%)	0	4 (14%)	24 (86%)	16.5 ± 14.2 (2–70)
Exotropia	15 (22%)	2 (13%)	4 (27%)	9 (60%)	17.1 ± 11.3 (3–45)
Hypertropia	10 (15%)	0	2 (20%)	8 (80%)	6.1 ± 4.4 (2–14)
		Manifest	Latent		
DHD	2 (3%)	1 (50%)	1 (50%)		
DVD	10 (15%)	4 (40%)	6 (60%)		

DHD, Dissociated Horizontal Deviation; *DVD*, Dissociated Vertical Deviation; *PD*, prism diopter.

[a]Percent based on the total number of patients (67).

[b]Percent based on the number of patients with the specified deviation.