

# Strabismus Surgery for Elimination of Bifocals in Accommodative Esotropia

GREGG T. LUEDER, MD, AND ALAN A. NORMAN, MD

- **PURPOSE:** This study reports the outcomes of strabismus surgery to eliminate bifocals in patients with accommodative esotropia with a high accommodative convergence to accommodation (AC:A) ratio.
- **DESIGN:** Retrospective interventional case series.
- **METHODS:** Sixteen patients who wore bifocals for treatment of accommodative esotropia with a high AC:A ratio underwent strabismus surgery following prism adaptation testing (PAT) for the near angle of esotropia without bifocals. Outcomes were considered successful if patients had microtropias and maintained fusion without bifocals.
- **RESULTS:** All patients had successful outcomes after one or two surgeries. Three of 13 (23%) patients with positive PATs required two surgeries. Two of three (67%) patients with negative PATs required two surgeries. Binocularity remained the same in 13 patients and improved in three patients. Glasses were eliminated entirely in eight of 16 (50%) patients.
- **CONCLUSIONS:** Strabismus surgery may eliminate the need for bifocal glasses in patients with accommodative esotropia with a high AC:A ratio, with many patients able to discontinue glasses entirely. Preoperative PAT may help predict the risk of requiring more than one surgery. (Am J Ophthalmol 2006;142:632–635. © 2006 by Elsevier Inc. All rights reserved.)

**T**HE GOAL OF TREATMENT FOR PATIENTS WITH ESOTROPIA is to restore normal ocular alignment and binocularity. If patients have hyperopia that is greater than normal for age, they are usually treated initially with their full cycloplegic refraction in spectacles. If the angle of esotropia is greater when fixating on near objects, and the deviation normalizes when viewing through additional +3.0

diopter lenses at near (that is, high accommodative convergence:accommodation (AC:A) ratio esotropia) bifocals are often added in an attempt to control the near deviation.

Another option for patients with high AC:A ratio esotropia is strabismus surgery. This may be considered in an attempt to eliminate glasses entirely if the amount of hyperopia is not large (for example, <2 diopters). In patients with larger amounts of hyperopia and deviations that are greater at near, surgery for the near angle may be considered in an attempt to eliminate bifocals. This study reviewed the results of such surgery. Using a MEDLINE search, we were unable to identify any previous study that evaluated this approach in a group of patients who had all been wearing bifocals before surgery and who underwent preoperative prism adaptation testing.

## METHODS

THIS WAS A RETROSPECTIVE MEDICAL RECORD REVIEW OF all patients with accommodative esotropia who had been wearing bifocal spectacles at the time of their initial evaluation at the Children's Eye Center and who underwent strabismus surgery in an attempt to eliminate the need for bifocals. Patients were candidates for surgery if a trial of decreased bifocal strength resulted in esotropia at near, or if the family did not wish to attempt weaning of the bifocals. The Washington University School of Medicine Human Studies Committee approved the study. The alternatives of surgery vs continued bifocal wear were discussed with the patients' caregivers, and informed consent for the procedures was obtained.

All of the patients had esotropias that were greater at near angle and that were controlled with bifocal spectacles. All demonstrated evidence of fusion by either Worth-4-Dot or Titmus stereoacuity testing. Before surgery, prism adaptation testing (PAT) was performed for the near angle by occluding the bifocals with opaque tape and correcting the near angle with Fresnel prisms through the top portion of the spectacles. If the esotropia increased, the prism was increased to reflect the larger angle. PAT was considered positive if patients were microtropic at near and distance,

Accepted for publication May 25, 2006.

From the Departments of Ophthalmology and Visual Sciences and Pediatrics, St Louis Children's Hospital, Washington University School of Medicine, St Louis, Missouri (G.T.L.), and Pediatric Eye Specialists, Fort Worth, Texas (A.A.N.).

Presented at the American Association for Pediatric Ophthalmology and Strabismus annual meeting, Keystone, Colorado, March 15 to 18, 2006.

Inquiries to Gregg T. Lueder, MD, St Louis Children's Hospital (Room 2s89), Washington University School of Medicine, One Children's Place, St Louis, MO 63110; e-mail: lueder@vision.wustl.edu

**TABLE.** Individual Data for Patients With Accommodative Esotropia who had Surgery to Eliminate Bifocals

Patient	Age Began Bifocals (years)	Bifocal Duration (years)	Average Rx (diopters)	Preoperative Angle (N-cc)	Preoperative Angle (D-cc)	PAT Angle (N-diopters)	Surgery Age (years)	Procedure	Second Surgery (Age)	Follow-up (months)	Glasses	Outcome
<b>Positive PAT</b>												
1	3.1	3.7	3.25	25	6	28	10	BMRc 4.5	LLRc 7 (10.4 years)	60	Y	Good (2 surgeries)
2	6.1	0.6	2.25	20	6	32	6.9	BMRc 5	BLRs 4.5 (7.5 years)	46	N	Good (2 surgeries)
3	6.5	0.6	5.25	20	2	30	7.4	BMRc 4.5		49	Y	Good
4	3.5	4.5	2	20	4	35	8.25	BMRc 5.5		48	N	Good
5	8.5	1	1.25	35	0	50	10.1	BMRc 6		34	N	Good
6	4.7	7	3	16	0	45	12.25	BMRc 6		9	N	Good
7	4	0.75	3.75	25	0	45	6.6	BMRc 6		22	Y	Good
8	7.8	0.1	3.75	20	2	30	8.2	BMRc 4.5	LLRc 7 (14.6 years)	6	N	Good (2 surgeries)
9	2.5	6.5	3.25	16	2	22	13.9	RMRc 6.5		12	Y	Good
10	0.75	3.3	5.75	35	6	35	4.4	BMRc 5.0		22	Y	Good
11	9	3	6.25	16	3	15	12.5	LMRc 6.5		10	Y	Good
12	5	0.4	3.5	25	12	40	5.5	BMRc 5.0		19	Y	Good
13	8	2.5	-0.5	25	2	44	11	BMRc 5.0		3	N	Good
<b>Negative PAT</b>												
14	2.5	4	2.25	40		40	6.5	BMRc 6		92	N	Good
15	3	0.2	2	35		35	3.4	BMRc 4	Re-rc RMR 2.0 (5.2 years)	28	N	Good (2 surgeries)
16	2	3	2.25	25		25	5.5	BMRc 4.5	BLRc 7.0 (5.8 years)	12	Y	Good (2 surgeries)

PAT = prism adaptation testing; d = distance; n = near; cc = with correction; b = bilateral; l = left; r = right; MRc = medial rectus recession; LRs = lateral rectus resection; Re-rc = re-recession; y = yes; n = no.

and was considered negative if patients developed an exotropia at distance. Surgery was performed based on the prism-adapted near angle.

Outcomes were considered successful if the patients had microtropias at distance and near and maintained or improved fusion without bifocals after strabismus surgery.

---

## RESULTS

SIXTEEN PATIENTS (AGE RANGE THREE TO 16 YEARS) UNDERWENT SURGERY (Table). The duration of bifocal wear before surgery ranged from one month to seven years (average 2.6 years). The spherical equivalent hyperopic correction through the top portion of the spectacles ranged from +1.25 to +5.75 (average +3.0). All patients had subjective fusion preoperatively at near, either by Worth-4-Dot or Titmus stereoacuity testing.

Surgery consisted of medial rectus recessions (bilateral in 14 patients and unilateral in two patients). Of the 13 patients who had positive PATs, 10 (77%) had good outcomes after a single surgery. Three patients required a second procedure, two for consecutive exotropia and one for recurrent esotropia. All had good outcomes following the second surgery. Of the three patients who had negative PATs, one had a good outcome, one had a consecutive exotropia, and one had a recurrent esotropia. The latter two did well after a second surgery.

Overall, 11 of 16 patients (69%) had good outcomes after a single surgery, and all patients had good alignment after one or two surgeries. Follow-up after the last surgery ranged from three to 92 months (average 30 months). Binocularity remained the same in 13 patients and improved in three patients. Eight patients were able to eliminate spectacles entirely.

---

## DISCUSSION

VARIOUS TREATMENT OPTIONS ARE AVAILABLE FOR CHILDREN WITH ESOTROPIA WHO HAVE NEAR DEVIATIONS THAT ARE GREATER THAN DISTANCE. The standard treatment for children who have hyperopia that is greater than normal for age is full cycloplegic correction of their hyperopia, with bifocal lenses if needed to control the near deviation. The primary benefits of bifocals are that they rapidly restore binocularity at near and eliminate the expense and potential risks of surgery. Pharmacologic methods, such as phospholine iodide, have been employed to decrease accommodative effort, and therefore lessen the esotropic drive. This also avoids the need for surgery, but the use of medication has generally fallen out of disfavor because of systemic and ocular side effects. Observation without bifocals has also been reported,<sup>1</sup> but this does not allow patients to fuse at near.

An alternative treatment for children with high AC:A ratio esotropia is surgery. The specific goal of surgery in this

study was to eliminate the need for bifocals in these patients. There are several potential advantages to strabismus surgery in such patients. First, many patients dislike the social stigma of wearing bifocals, which are unusual in school-age children. Second, primate evidence suggests that spectacle correction of hyperopia may affect the normal emmetropization process.<sup>2</sup> There are few data regarding the natural history of emmetropization in children with high hyperopia. Atkinson and associates found that incomplete correction of the refractive error in hyperopic infants did not decrease emmetropization, but the rate of reduction was related to the initial level of hyperopia.<sup>3</sup> Lambert and associates found that children with greater than three diopters of hyperopia who were fully corrected were much less likely to be successfully weaned from spectacles than children with smaller refractive errors.<sup>4</sup> Although not conclusive, these findings suggest that spectacle correction may affect emmetropization in children with higher levels of hyperopia. Third, there is some evidence to suggest that wearing bifocals may decrease accommodative ability. Von Noorden and associates reported a group of teenagers who had worn bifocals and who had decreased amplitudes of accommodation compared with a control group.<sup>5</sup> Although this suggests that the use of bifocals may lead to decreased accommodation, it is also possible that these patients had decreased accommodation as a primary problem. Similarly, Albert and associates also found that bifocals did not change the course of this disorder.<sup>6</sup> Fourth, Parks has shown that surgery is effective in restoring a normal AC:A ratio, whereas bifocals usually are not.<sup>7</sup> This allows the patient to be aligned at all distances, whereas the use of bifocals provides alignment at distance (through the top segment) and a fixed near point (through the bottom segment), but not at fixation distances between the upper and lower segments nor closer than the bifocal near point. Finally, many children who are prescribed bifocals may not actually use them as intended. They may look over the top portion of the spectacles, even when viewing near objects.<sup>8</sup>

Several studies have evaluated the outcome of strabismus surgery in patients with convergence excess esotropia, with generally good results and a low incidence of consecutive exotropia.<sup>9-13</sup> Most of these studies, however, did not include patients who wore bifocals. It is possible that prior use of bifocals could affect the outcome of surgery in this group of patients, particularly if their prolonged use causes a reduction in accommodative ability. We identified four studies of surgical treatment that included some patients who wore bifocals, but the outcomes of surgery in patients with and without bifocals were not analyzed separately,<sup>14-16</sup> or information regarding the duration of bifocal wear was not included.<sup>17</sup>

The use of preoperative prism adaptation has been shown in a multicenter randomized trial to have a beneficial effect on surgical outcomes of patients with acquired esotropia.<sup>18</sup> Prism adaptation has also been used in patients

with convergence excess esotropia, with the best results found in patients prism adapted for the near angle.<sup>16,19,20</sup> The beneficial effect of prism adaptation has not been definitively established in such patients,<sup>21</sup> but the testing does seem to identify patients with a better prognosis for surgery. In this study, the parents of patients with negative PATs were informed that there was a greater likelihood that their children would require additional surgery. Although the study is limited by its retrospective nature and small sample size, with only three patients in the group that had negative PATs, two (66%) of them required a second surgery, compared with three of 13 (23%) in the positive PAT group.

The overall success rate of surgery in eliminating bifocals in this study was excellent, although five patients (31%) required two surgeries (three for consecutive exotropia and two for persistent esotropia). Except for the PAT results, no preoperative findings were found that differentiated those patients who required two surgeries. None of the patients had a decrease in binocularity. The primary benefit of surgery was the elimination of bifocals, for the reasons described previously. Of particular note is that eight (50%) of the patients were able to eliminate glasses entirely, which is a remarkable benefit that has also been reported by others.<sup>14,17</sup> In conclusion, this study demonstrates that strabismus surgery may be used effectively to eliminate bifocals in patients with high AC:A ratio esotropia.

## REFERENCES

1. Pratt-Johnson JA, Tillson G. Sensory outcome with nonsurgical management of esotropia with convergence excess (a high accommodative convergence/accommodation ratio). *Can J Ophthalmol* 1984;19:220–223.
2. Hung L-F, Crawford MLJ, Smith EL. Spectacle lenses alter eye growth and the refractive status of young monkeys. *Nat Med* 1995;1:761–765.
3. Atkinson J, Anker S, Bobier W, et al. Normal emmetropization in infants with spectacle correction for hyperopia. *Invest Ophthalmol Vis Sci* 2000;41:3726–3731.
4. Lambert SR, Lynn M, Sramek J, Hutcheson KA. Clinical features predictive of successfully weaning from spectacles those children with accommodative esotropia. *J AAPOS* 2003;7:7–13.
5. Von Noorden GK, Jenkins RH. Accommodative amplitude in children wearing bifocals. In: Lennerstrand G, editor. Update on strabismus and pediatric ophthalmology. Boca Raton, Florida: CRC Press, 1994:201–204.
6. Albert DG, Lederman ME. Abnormal distance—near esotropia. *Doc Ophthalmol* 1973;34:27–36.
7. Parks MM. Abnormal accommodative convergence in squint. *Arch Ophthalmol* 1950;59:364–380.
8. Knapp P. The clinical management of accommodative esotropia. *Am Orthopt J* 1971;16:8–13.
9. Kushner BJ. Fifteen-year outcome of surgery for the near angle in patients with accommodative esotropia and a high accommodative convergence to accommodation ratio. *Arch Ophthalmol* 2001;119:1150–1153.
10. Wright KW, Bruce-Lyle L. Augmented surgery for esotropia associated with high hypermetropia. *J Pediatr Ophthalmol Strabismus* 1993;30:167–170.
11. Damanakis AG, Arvanitis PG, Kalitsis A, Ladas ID. Bilateral medial rectus recession in convergence excess esotropia, with and without distance orthophoria. *Eur J Ophthalmol* 1999;9:297–301.
12. Rosenbaum AL, Jampolsky A, Scott AB. Bimedial recession in high AC/A esotropia. *Arch Ophthalmol* 1974;91:251–243.
13. Greenwald MJ, Eagle JR, Peters C, Haldi BA. Treatment of acquired esotropia: for augmented surgery. *Am Orthopt J* 1998;48:16–20.
14. O'Hara MA, Calhoun JH. Surgical correction of excess esotropia at near. *J Pediatr Ophthalmol Strabismus* 1990;27:120–123.
15. Arnoldi KA, Tychsen L. Surgery for esotropia with a high accommodative convergence/accommodation ratio: effects on accommodative vergence and binocularity. *Ophthalmic Surg Lasers* 1996;27:342–348.
16. Kutschke PJ, Scott WE, Stewart SA. Prism adaptation for esotropia with a distance-near disparity. *J Pediatr Ophthalmol Strabismus* 1992;29:12–15.
17. West CE, Repka MX. A comparison of surgical techniques for the treatment of acquired esotropia with increased accommodative convergence/accommodation ratio. *J Pediatr Ophthalmol Strabismus* 1994;31:232–237.
18. Prism Adaptation Study Research Group. Efficacy of prism adaptation in the surgical management of acquired esotropia. *Arch Ophthalmol* 1990;108:1248–1256.
19. Kutschke PJ, Keech RV. Surgical outcome after prism adaptation for esotropia with a distance-near disparity. *J AAPOS* 2001;5:189–192.
20. Wagnanski-Jaffe T, Trotter J, Watts P, et al. Preoperative prism adaptation in acquired esotropia with convergence excess. *J AAPOS* 2003;7:28–33.
21. Kushner BJ. Surgical outcome after prism adaptation for esotropia with a distance-near disparity. *J AAPOS* 2002;6:59–60.