

# Fifteen-Year Outcome of Surgery for the Near Angle in Patients With Accommodative Esotropia and a High Accommodative Convergence to Accommodation Ratio

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**Objective:** To determine the 15-year outcome of patients with partly accommodative esotropia with a high accommodative convergence to accommodation (AC/A) ratio who underwent surgery based on the angle of esotropia at one-third meter while wearing full hyperopic correction.

**Methods:** A retrospective chart review to determine the 15-year outcome of 25 patients whose 6-month outcome had been previously reported as part of a prospective, randomized, masked clinical trial. All patients had partly accommodative esotropia with a high AC/A ratio and underwent surgery based on their esotropia at one-third meter while wearing full-distance optical correction.

**Results:** Fifteen years after surgery, 19 of the 22 patients for whom follow-up data are available had be-

tween 0 and less than 10 prism diopters of esotropia. Only 6 of the 19 needed to continue to wear optical correction to maintain satisfactory alignment; however, 8 more needed spectacles for visual purposes. Only 1 patient needed to use a bifocal add to have satisfactory alignment at one-third meter. All patients showed some degree of sensory fusion, with 4 obtaining 40 seconds of stereopsis and another 8 obtaining between 60 and 200 seconds of stereopsis.

**Conclusion:** Surgery for the near angle obtained with patients wearing their full hyperopic distance correction provides excellent motor and sensory results in patients with partly accommodative esotropia with a high AC/A ratio.

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**H**ISTORICALLY, the surgical management of partly accommodative esotropia has been to operate based on the angle of misalignment obtained at 6 m with the patient wearing his or her full cycloplegic refractive correction.<sup>1,2</sup> It has been known for many years, however, that if patients have a high accommodative convergence to accommodation (AC/A) ratio and if the near deviation exceeds the distance deviation by more than 10 prism diopters (PD), surgery based on the misalignment at 6 m will result in an unacceptably high number of surgical undercorrections.<sup>1,3-5</sup> For many years, Parks<sup>1</sup> has recommended adding 1 mm to the recession of each medial rectus if a high AC/A ratio is present. Even using this 1-mm augmentation as recommended by Parks, I experienced a high number of surgical undercorrections in this patient population and observed that a large number of these patients needed to continue wearing a bifocal to control their near deviation after surgery.<sup>4</sup> This led me and my colleagues to

conduct a prospective, randomized clinical trial of 2 alternative treatment modalities for the management of patients with accommodative esotropia with a high AC/A ratio, the results of which were published in 1987.<sup>4</sup> In that study, one treatment group received medial rectus recessions based on the angle of misalignment at 6 m while wearing their full cycloplegic spectacle correction. In addition, the recession was combined with posterior fixation of each medial rectus muscle 12- to 14-mm posterior to the insertion. The other group underwent bilateral medial rectus recessions based on a formula that was augmented to take into account the amount by which near deviation exceeded the distance deviation. The amount of bilateral medial rectus recession was determined using standard surgical tables based on the size of the deviation obtained at 6 m with the patient wearing full cycloplegic spectacle correction. That number was then augmented by adding 1 mm to each medial rectus recession if the near deviation exceeded the distance by 10 PD, 1.5 mm if the near deviation ex-

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## SUBJECTS AND METHODS

The subjects were patients in the augmented surgery group from the previously reported prospective randomized clinical trial.<sup>4</sup> Descriptive characteristics of the patients are available in detail in the previous report. All had undergone surgery for the nonaccommodative component of a partly accommodative esotropia associated with a high AC/A ratio as previously defined. This present study design consists of a retrospective chart review. The outcome determination date for each patient was the first examination obtained 15 years after surgery (range, 15-17½ years). For patients who were lost to follow-up, information obtained from their last examination was noted and analyzed separately. In several cases, patients were under the care of other pediatric ophthalmologists who provided me with the necessary data. Specific information obtained was the deviation at 6 and one-third meter, stereopsis (Titmus test), the need of spectacles for maintaining ocular alignment, the need of spectacles for visual clarity (eg, myopia), presence of simultaneous perception with the Bagolini lenses, recurrence of amblyopia (all patients had been free of amblyopia at the time of surgery), and fusion with the Worth 4-dot test. A satisfactory outcome was defined as less than 10 PD of esotropia as determined by the alternate prism and cover test; an exotropia of any size was considered unsatisfactory. In addition, any patient in whom hyperopic correction needed to be reduced for treating a consecutive exotropia was also considered to have an unsatisfactory outcome, because such patients have been shown to have poor long-term stability.<sup>11</sup> Finally, any patient undergoing a reoperation for esotropia or exotropia was considered to have an unsatisfactory outcome.

ceeded the distance by 15 PD, and 2 mm if the near deviation exceeded the distance by 20 PD. Because my standard surgical formula for medial rectus recessions increases in increments of 0.5 mm for each 5 PD of deviation, this augmented surgical formula for treating high-AC/A ratio esotropia turns out, in fact, to be exactly the same as operating on the near deviation (although I did not realize it at the time the study was conducted).

A satisfactory outcome in that study (described subsequently<sup>5</sup>) was defined as less than 10 PD of esotropia 6 months after surgery; any exotropia was considered unsatisfactory. I found that patients treated with the augmented surgical formula based on the near deviation had significantly better results than those treated with medial rectus recessions combined with posterior fixation. All 25 of the augmented recession group had satisfactory alignment compared with 17 (80%) of 21 of the patients undergoing posterior fixation surgery ( $P = .02$ ,  $\chi^2$  test) at the 6-month postsurgery outcome date. Also, 84% of the augmented recession group was able to discontinue the use of a bifocal add after surgery compared with 57% of those who received medial rectus recessions combined with posterior fixation ( $P = .04$ ,  $\chi^2$  test). That study

Surgical Results for 22 Patients 15 Years After Surgery

Outcome Category	No. (%)
Alignment	
Satisfactory category 1*	6 (27)
Satisfactory category 2†	8 (36)
Satisfactory category 3‡	5 (23)
Unsatisfactory	3 (14)
Stereopsis, s	
40	4 (18)
60-200	8 (36)
>200-800	6 (27)
None	4 (18)
Worth 4-dot fusion test, m	
1/3	21 (95)
6	20 (91)
Simultaneous perception with Bagolini lenses	21 (91)

\*Patients who had between 0 and less than 10 prism diopters (PD) of esotropia but needed to continue to wear hyperopic optical correction (spectacles or contact lenses) to maintain that alignment.

†Patients who did not need to wear optical correction for the purpose of maintaining alignment between 0 and less than 10 PD of esotropia. They did, however, need to continue wearing optical correction for visual purposes (to correct myopia, astigmatism, or anisometropia).

‡Patients whose vision was satisfactorily aligned and who were visually comfortable without optical correction.

was limited to patients who initially had more than 10 PD of manifest esotropia at 6 m while wearing their full cycloplegic spectacle correction and excluded patients who were amblyopic at the time of surgery. Although at the 6-month outcome determination date, 4 of the 25 patients in the augmented medial rectus recession group were still in need of a bifocal, most of them were able to tolerate a reduction in the strength of their bifocal add after surgery. I concluded that this augmented medial rectus recession surgical formula (in effect operating for the near deviation obtained with full hyperopic correction in place) was preferable to medial rectus recessions combined with posterior fixation. The purpose of this study is to give 15-year follow-up data for the patients who were included in my prior short-term outcome report and were treated with the augmented medial rectus recession formula. A 15-year follow-up outcome date was chosen because all 25 patients in that initial study group would be 16 years or older by 15 years after surgery. By this age, most of the loss of hyperopia or normalization of the AC/A ratio that occurs in childhood would have been completed.<sup>6-10</sup>

## RESULTS

Of the 25 patients who initially comprised the augmented surgery treatment group, 18 were still under my care for the 15-year outcome examination. An additional 4 patients were under the care of other pediatric ophthalmologists who provided me with the necessary data. Three patients were lost to follow-up. The 15-year outcome results of the 22 patients for whom data are available are presented in the Table. With respect to motor alignment, the outcome data are presented in several categories, depending on the patients' need of optical correction. The satisfactory category 1 group consisted of



patients who had satisfactory alignment but needed to continue to wear hyperopic optical correction (spectacles or contact lenses) to maintain that alignment. All but 1 of the 6 patients in that category had more than +2.50 diopters (D) of hyperopia before surgery. The satisfactory category 2 group consisted of patients who did not need to wear optical correction for maintaining satisfactory motor alignment. They did, however, need to continue wearing optical correction for visual purposes (to correct myopia, astigmatism, or anisometropia). Patients in the satisfactory category 3 group had satisfactory alignment and were visually comfortable without optical correction. Only 1 (5%) of the 22 patients still required a bifocal add of +1.25 D to maintain satisfactory ocular alignment at a near distance. An additional patient was found to have a reduced near point of accommodation and continued to wear a low plus bifocal add (+1.50 D) for visual clarity when reading; however, his ocular alignment was satisfactory at one-third meter without the bifocal. Of the 3 patients with unsatisfactory alignment, 1 had a recurrent esotropia and underwent additional horizontal surgery. This patient was previously described as having satisfactory alignment at the 6-month outcome date, but developed an esotropia several years after surgery.<sup>4</sup> Another patient had an 8-PD exotropia at 6 and one-third meter, which had been stable for more than 5 years. The third patient had 4 D of hyperopia before surgery. By the 6-month outcome date, she met the criteria for a satisfactory outcome; however, she needed to discontinue use of her hyperopic correction to have satisfactory alignment. In my initial report,<sup>4</sup> I indicated that this patient should not be considered a success because of concern she was at risk for a late consecutive exotropia.<sup>11</sup> In fact, she did show an increasing exotropia, which necessitated additional horizontal surgery. Another 3 patients have undergone additional surgery to treat inferior oblique overaction. Three other patients required resumption of amblyopia treatment some point after surgery; however, none of the patients were amblyopic by the time of their 15-year outcome evaluation.

The 3 patients who were lost to follow-up were last examined by me at 1½, 3, and 4 years after surgery, respectively. Two of them had satisfactory motor alignment when last examined. The third (last examined 4 years after surgery) had a 6-PD exotropia that had been stable for the previous 2 years.

#### COMMENT

The study shows that surgery based on the near angle (determined while wearing full hyperopic correction) is an effective treatment for partly accommodative esotropia associated with a high AC/A ratio. Although initially after surgery some patients may still need to continue wearing a bifocal add, the additional optical correction for near gaze can be gradually decreased during the subsequent years. Most patients will be able to discontinue the use of a bifocal add by the end of adolescence. These results are consistent with the reports<sup>3,12-14</sup> of others who have found success with surgery for the near angle in this population.

In preparing the protocol for my previously published clinical trial for treating this patient population, I conducted a retrospective chart review of patients I had operated on between 1974 and 1980. That review resulted in an interesting observation regarding the response to surgery in patients with partly accommodative esotropia associated with a high AC/A ratio.<sup>4</sup> It appeared that the response of the distance deviation of patients was inversely related to the size of the AC/A ratio. For example, if 2 hypothetical patients each had a 20-PD deviation at 6 m, but 1 had a 30-PD deviation at one-third meter and the other a 45-PD deviation, both would receive the same amount of surgery based on Park's recommendation (the protocol I had previously been following).<sup>1</sup> Surgery in these 2 hypothetical patients would consist of operating for the distance angle of 20 PD and adding 1 mm to each medial rectus recession because of the high AC/A ratio. During my chart review, I observed that the hypothetical patient with the 45-PD near deviation (and hence the higher AC/A ratio) would routinely experience a smaller reduction in the distance deviation of 20 PD than would the other patient with the near deviation of 30 PD. This led me to base my surgical approach on the size of the AC/A ratio, which is reflected in the near deviation.

Interestingly, in 6 of the patients in this series, one or both medial rectus muscles were recessed to a point greater than 10.5 mm from the limbus (11 mm in 2 patients, 11.5 mm in 3 patients, and 12 mm in 1 patient). None of these patients developed a consecutive exotropia.

For the present study, I did not use the common outcome criteria for success as  $\pm 10$  PD from orthotropia; any exotropia was considered unsuccessful in this series. I chose that more rigid criterion because that was the one I used in the short-term outcome report on this group of patients.<sup>4,5</sup> Also, it has been shown that a small-angle exotropia is not as stable an outcome for surgery for esotropia as a small-angle esotropia.<sup>15</sup>

It is noteworthy that none of the patients in my series underwent prism adaptation. Some comments about the role of prism adaptation in this patient population deserve mention. In a frequently cited study, Kutschke and coworkers<sup>16</sup> concluded that prism adaptation for the near angle in patients with high AC/A ratio esotropia would improve the surgical outcome. That study, however, compared prism adaptation of the near angle (and surgery based on that adapted angle in prism responders) with surgery based on the distance angle with no augmentation for the high AC/A ratio. My experience, and that of others, suggests that surgery based on the distance angle alone would be inadequate in treating this patient population.<sup>1,3-5</sup> Perhaps the improved results obtained by Kutschke and coworkers in their prism adaptation group were merely a result of the fact that they were operating for the near angle rather than the fact that they were using prism adaptation. On the other hand, there is something intuitively appealing about the concept of using prism adaptation for the near angle of misalignment in this patient population. A reasonable concern is that patients might be overcorrected at 6 m if surgery is based on the near angle, if the near angle substantially exceeds that of the distance angle. At first glance it seems

3 exotropias  
(10, 8, 12)  
4 25  
12%



logical that prism adaptation for the near angle might help predict which patients are at risk for developing a consecutive exotropia at distance viewing if surgery is performed for the near angle. Theoretically, if patients undergoing prism adaptation for the near angle do not adapt by overcoming the immediate exotropia that they typically manifest at distance viewing through the prisms, then they might not be expected to overcome an initial overcorrection at distance viewing if surgery is performed for the near angle.

As appealing as this concept is, however, some clinical experience contradicts its validity. Kutschke and co-workers<sup>16</sup> found that 20% of the patients who underwent prism adaptation for the near angle were "nonresponders" (they did not overcome the distance exotropia induced by the prism). These patients would be expected to have a surgical overcorrection at distance viewing when surgery is performed for the near angle if, in fact, the response to prism adaptation was predictive of a surgical overcorrection (based on the aforementioned hypothetical reasoning). Extrapolating from their data, one would expect a 20% overcorrection rate in this and other series of patients who received surgery for the near angle and did not undergo prism adaptation.<sup>3,12-14</sup> In fact, the overcorrection rates in these series were substantially smaller. Also, the reasoning outlined herein as theoretical justification for the role of prism adaptation would suggest that patients with high AC/A ratio esotropia would experience an initial surgical overcorrection at distance viewing if surgery were performed for the near angle, and then those with good fusion potential (presumably responders to prism adaptation) would compensate for it by ultimately controlling that distance exotropia. In fact, patients in this series routinely did not show an initial overcorrection at distance viewing even if evaluated immediately on emergence from anesthesia after the strabismus surgery. The role of prism adaptation for the near angle in patients with high AC/A ratio accommodative esotropia has yet to be determined.

This study needs to be viewed in light of its limitations. It is important to stress that all of the patients in this study met strictly defined inclusion criteria. Patients with amblyopia at the time of surgery, those who underwent simultaneous oblique muscle surgery, or those who received vertical transposition of the medial rectus muscles to treat an A or V pattern were excluded. Caution is urged in extrapolating results from this series to the patient population that was excluded. Also, all of my patients had a manifest deviation of at least 10 PD at 6 m while wearing their full hyperopic spectacle correction. This study did not include patients who had satisfactory ocular alignment at distance but needed a bifocal add for near alignment. One similarly cannot extrapolate results from this study to patients who have good ocular alignment with bifocals but want to stop using those bifocals. Also, none of the patients in this study who achieved satisfactory ocular alignment did so as a result of intentionally cutting their hyperopic correction to treat a surgical overcorrection. Past studies<sup>11</sup> have

shown that patients treated in this manner do not show a satisfactory long-term outcome. Finally, there were 3 patients (12%) in the study who were lost to follow-up. I believe this represents a relatively small amount of unavailable data for a study with a 15-year outcome date. Nevertheless, all patients who are lost to follow-up somewhat diminish the power of the conclusions of any study.

In conclusion, it appears that surgery for the near angle of patients with a partly accommodative esotropia (as determined while wearing full hyperopic spectacle correction) has a high likelihood of producing satisfactory ocular alignment with stability and the discontinuation of the need of a bifocal add.

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