

# PERSISTING ACCOMMODATIVE ESOTROPIA\*

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## INTRODUCTION

ACCOMMODATIVE ESOTROPIA IS CONSIDERED ONE OF THE MORE STRAIGHT-FORWARD strabismus entities, marked by a typical postinfancy age of onset<sup>1</sup> and two major and etiologically distinct classes.<sup>1,2</sup> Recent scrutiny has disclosed prominent exceptions to this profile, particularly a common and early-appearing accommodative esotropia in the congenital esotropia patient, and the association of deterioration with both normal and abnormally high AC/A ratios, rather than predominantly with the latter.<sup>2</sup>

Deterioration to nonaccommodative esotropia is a recognized complication of this condition, but generally it is felt that management of most cases after age 8 years is largely a matter of presiding over an easily-achieved favorable outcome after only a limited additional time period, with most cases having subsided by ages 10 to 12 years.<sup>1,3</sup> Although cited as an unusual occurrence,<sup>4</sup> my personal experience has indicated that many cases of accommodative esotropia persist, with or without deterioration, well beyond this expected time of disappearance. This paper examines this troublesome feature of management and in particular whether there are findings that might predict if an individual case will subside at all, and if so, whether timely or delayed.

## SUBJECTS AND METHODS

A group of neurologically normal accommodative esotropia patients from my personal practice, most of whose members had been the subjects of an earlier inquiry,<sup>2</sup> was utilized to examine the additional questions posed in this study. Onset of the deviation was after age 6 months in all cases, and the esotropia was controllable originally to within 8 prism diopters of orthotropia with the appropriate glasses (bifocals when necessary) and anticholinesterase miotic agents applied topically. The latter were employed infrequently. Methodologic details of case selection, of examina-

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tion and treatment, and of scrutinizing refraction data have been described.<sup>2</sup> Patient records were reviewed again and information from visits beyond the previous compilation were incorporated to maximize follow-up duration. Of the 286 patients included in this study, 84 were examined on only one occasion. Their data have been used only in considering questions not dependent on longitudinal observation.

Accommodative esotropia was considered to be subsided if the deviation decreased to within the 8 prism diopter limit without the necessity for optical or chemical control of accommodative innervation. Cases showing deterioration to a nonaccommodative esotropia of 10 or more prism diopters were grouped with persisting cases. For convenience, age intervals were divided into 2-year segments. The age of subsiding or of deteriorating was estimated arbitrarily to be midway between the age at which such an outcome was determined and that of the prior examination. For the calculation of age-specific improvement rates of accommodative esotropia, patients whose first examination had already occurred but whose last-recorded visit had not, and whose deviation neither already had resolved nor deteriorated, were considered "under observation" for the age interval in question. The mean follow-up duration (either to deterioration, subsidence, or to the last visit for persisting cases) was 4.1 years. Of 152 persisting or deteriorating cases, 101 were followed at least 2 years.

## RESULTS

Accommodative esotropia subsided in 49 (24.4%) of the 202 serially-followed patients, at an age of  $10.2 \pm 3.3$  years (mean and standard deviation [SD]) (range, 4.2 to 17.3 years). Although the data essentially are normally distributed, there is no discrete modal age of improvement. Twenty-six cases (53.1%) persisted beyond age 10 years, and 14 (28.6%) beyond age 12 years (Table I).

Since follow-up intervals and times of entry into and departure from the study varied widely among these patients, age-specific improvement rates were determined. While there was a peak age interval (12 to 14 years) at which disappearance of accommodative esotropia occurred, only approximately half (52.6%) of patients examined in this interval achieved that goal (Table II). When the determination was limited to cases with at least a 2-year follow-up, the results were similar (Table III).

Because a high AC/A ratio has been considered an adverse influence on the outcome of accommodative esotropia,<sup>3</sup> the contribution of this factor was examined. Excluding single-visit cases, of 200 for whom this informa-

TABLE I: DISTRIBUTION OF AGES AT DISAPPEARANCE OF ACCOMMODATIVE ESOTROPIA

AGE (YR)	NO. OF CASES
≤ 6	4 (8.2%)
6-8	7 (14.3%)
8-10	12 (24.5%)
10-12	12 (24.5%)
12-14	10 (20.4%)
14-16	3 (6.1%)
16-18	1 (2.0%)
Total	49 (100%)

TABLE II: AGE-SPECIFIC RATES OF IMPROVEMENT IN ACCOMMODATIVE ESOTROPIA

AGE (YR)	OBSERVED CASES	NO. IMPROVED
≤ 2	22	0 (0.0%)
2-4	76	0 (0.0%)
4-6	109	4 (3.7%)
6-8	84	7 (8.3%)
8-10	55	12 (21.8%)
10-12	36	12 (33.3%)
12-14	19	10 (52.6%)
14-16	8	3 (37.5%)
16-18	2	1 (50.0%)
18-20	0	0 (0.0%)
> 20	2	0 (0.0%)

TABLE III: AGE-SPECIFIC RATES OF IMPROVEMENT IN ACCOMMODATIVE ESOTROPIA (FOLLOW-UP 2 YEARS OR LONGER)

AGE (YR)	OBSERVED CASES	NO. IMPROVED
≤ 2	19	0 (0.0%)
2-4	66	0 (0.0%)
4-6	95	4 (4.2%)
6-8	81	7 (8.6%)
8-10	53	12 (22.6%)
10-12	35	12 (34.3%)
12-14	19	10 (52.6%)
14-16	8	3 (37.5%)
16-18	2	1 (50.0%)
18-20	0	0 (0.0%)
> 20	2	0 (0.0%)

TABLE IV: INFLUENCE OF THE AC/A ON THE COURSE OF ACCOMMODATIVE ESOTROPIA

AC/A	TOTAL CASES	NO. SUBSIDED
High	92	18 (19.6%)
Normal	108	31 (28.7%)

\* $P > 0.05$ .

TABLE V: ACCOMMODATIVE ESOTROPIA CASES SUBSIDED FOR VARIOUS THRESHOLDS OF INITIALLY DETERMINED HYPERMETROPIA

HYPERMETROPIA THRESHOLD (D)	TOTAL CASES*	NO. SUBSIDED†
≤ +2.00	61	12 (19.7%)
≥ +2.12	138	37 (22.0%)
≤ +3.00	103	26 (25.2%)
≥ +3.12	96	23 (24.0%)
≤ +4.00	137	33 (24.1%)
≥ +4.12	62	16 (25.8%)
≤ +5.00	163	40 (24.5%)
≥ +5.12	36	9 (25.0%)
≤ +6.00	183	45 (24.6%)
≥ +6.12	16	4 (25.0%)
≤ +7.00	192	48 (25.0%)
≥ +7.12	7	1 (14.3%)

\*Multiple visit cases only.

†Results same when limited to persisting cases with at least a 2-year follow-up. Differences are not significant ( $P > 0.05$ ) above and below each threshold.

TABLE VI: CHANGE IN HYPERMETROPIA PRIOR TO AGE 7 YEARS

ACCOMMODATIVE ESOTROPIA	NO. OF CASES	ANNUAL CHANGE (D)*
Subsided	19	+0.01 (-0.31-+0.28)
Persisted	65	+0.20 (-0.76-+1.03)

$P < 0.01$ .

\*Spherical equivalent of preferred eye.

TABLE VII: CHANGE IN HYPERMETROPIA AFTER AGE 7 YEARS

ACCOMMODATIVE ESOTROPIA	NO. OF CASES	ANNUAL CHANGE (D)*
Subsided	39	-0.29 (-0.79-+0.08)
Persisted	39	-0.16 (-0.93-+0.44)

$P < 0.05$ .

\*Spherical equivalent of preferred eye.

tion was available (using the less exact distance-near comparison), 18 (19.6%) of 92 "high" and 31 (28.7%) of 108 "normal" AC/A cases showed disappearance (Table IV). This difference is not significant (chi-square,  $P > 0.05$ ). When nonsubsiding cases with less than 2 years follow-up were excluded, the same result was obtained (not tabulated).

Since excessive hypermetropia plays a causative role in at least half of all cases of accommodative esotropia,<sup>2,5</sup> it was necessary to consider whether initially determined hypermetropia and its subsequent changes might predict whether the deviation would improve. Excluding myopic subjects from this analysis, proportions of subsiding and persisting cases above and below various threshold levels of hypermetropia of the preferred eye from +2.00 to +7.00 D are indicated in Table V. The difference for each is not significant ( $P > 0.05$ ).

Subsequent changes in hypermetropia were observed in individual subjects as described in a previous report,<sup>2</sup> with a minimum interval of 2 years between refractions (thus reducing the number of available determinations). Accommodative esotropia cases that subsided showed a mean annual increase in hypermetropia prior to age 7 years of +0.01 D (range, -0.31 to +0.28 D), while for persisting cases the increment was +0.20 D (range, -0.76 to +1.03 D) (Table VI). This difference is significant ( $t$ -test for unpaired samples,  $P < 0.01$ ). After age 7 years, the annual decrease in hypermetropia was -0.29 D (range, -0.79 to +0.08 D) and -0.16 D (range, -0.93 to +0.44 D), respectively (Table VII), also a statistically significant difference ( $P < 0.05$ ).

The occurrences of several frequently associated parameters of childhood strabismus were ascertained for their possible importance as indicators of the natural course of accommodative esotropia. Although a family history of strabismus (Table VIII), inferior oblique overaction (Table IX), and dissociated vertical deviation (DVD) (Table X) appear to operate against disappearance of the deviation, in all instances the difference is not significant (chi-square,  $P > 0.05$ ).

In addition to observing features of patients whose accommodative deviations did and did not resolve, comparison was made between those who improved by age 10 years ("early") and those whose improvement occurred at an older age ("late"). Initial hypermetropia was higher in the

TABLE VIII: FAMILY HISTORY OF STRABISMUS IN ACCOMMODATIVE ESOTROPIA

FAMILY HISTORY	TOTAL CASES	NO. SUBSIDED
Positive	77	14 (18.2%)
Negative	113	31 (27.4%)

$P > 0.05$ .

TABLE IX: INFERIOR OBLIQUE OVERACTION IN ACCOMMODATIVE ESOTROPIA

OVERACTION	INFERIOR OBLIQUE TOTAL CASES	NO. SUBSIDED
Positive	36	5 (13.9%)
Negative	165	44 (26.7%)

$P > 0.05$ .

TABLE X: DISSOCIATED VERTICAL DEVIATION IN ACCOMMODATIVE ESOTROPIA

DVD	TOTAL CASES	NO. SUBSIDED
Positive	8	0 (0.0%)
Negative	193	49 (25.4%)

$P > 0.05$ .

TABLE XI: COMPARISON OF ASSOCIATED PARAMETERS IN "EARLY" AND "LATE" SUBSIDING ACCOMMODATIVE ESOTROPIA

ASSOCIATED FEATURE	SUBSIDED	
	< 10 YEARS	> 10 YEARS
Initial hypermetropia	+ 2.87 D	+ 3.58 D
Change in hypermetropia to age 7 years	- 0.04 D	+ 0.09 D
Change in hypermetropia after age 7 years	- 0.23 D	- 0.26 D
High AC/A ratio*	8/23	10/26
Family history of strabismus*	7/21†	7/24†
Inferior oblique overaction*	1/23	4/26
Dissociated vertical deviation*	0/23	0/26

\* $P > 0.05$ .

†No information for four patients.

latter group by a modest and statistically insignificant amount. Changes in hypermetropia before age 7 years were in opposing directions but clinically inconsequential, while both groups showed the same decrease<sup>2</sup> afterward. The prevalences of a high AC/A ratio, a family history positive for strabismus, inferior oblique overaction, and DVD were statistically the same (Table XI).

#### DISCUSSION

The proportion of patients undergoing resolution of accommodative esotropia cannot be determined accurately from these results, since this was not a constant representative cohort. In a referral practice, these subjects probably represent a group selected for more than average severity. Nonetheless, the findings underscore the possibility of a prolonged course to a supposedly age-restricted anomaly.

These results indicate that resolution of accommodative esotropia does not occur in most cases within a highly circumscribed time frame, and in particular, approximately a third of resolving cases persist into the teen years and occasionally later. In this series, two patients were examined originally by the author as adults with every attribute of childhood accommodative esotropia; they have shown no tendency to subside even after several additional years of observation.

The AC/A ratio, contrary to popular doctrine, appears to play no definitive part in persistence of accommodative esotropia and, as previously demonstrated,<sup>2</sup> the natural course of hypermetropia in this entity is similar to that of a normal childhood population.

There were no striking differences in the occurrence of several commonly encountered accompanying features in these cases which would tend to predict whether or not resolution would occur, although a statistically significantly smaller increase in hypermetropia before age 7 years, and greater decrease later, in subsided than in persisting cases was observed. Likewise, this additional information did not indicate whether improvement will be timely or delayed. It is possible that other unexamined parameters might yield such information.

The stimulus for this inquiry has been the anxiety and disappointment expressed by accommodative esotropia patients and their families, when the rapid improvement at the close of childhood of which they had been assured has not materialized. For most, the original occurrence of the problem, the constant need for glasses or "drops" over many years, and the prompt reappearance of the deviation when these measures are relaxed are prominent negative morale factors not at all diminished

by the ophthalmologist's satisfaction that all is well. These observations indicate that for the present, our efforts should be directed to more cautious and realistic, although unfortunately not more encouraging, advice to affected individuals.

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#### DISCUSSION

DR HENRY S. METZ. Doctor Raab has posed some very interesting questions about accommodative esotropia.

As clinicians, many of us have seen patients with accommodative esotropia who have initially responded well to spectacle correction. With time, some of these individuals have "deteriorated" with the development of esotropia not responsive to full refractive correction. Others have remained straight or settled at a very small angle esotropia. A group of these patients can maintain good alignment without glasses or drops, while some continue to require optical correction or the esotropia reappears. By providing long-term follow-up on his patients, Doctor Raab has provided us with information of prognostic importance.

It is interesting that 75% of this group of patients could not discontinue treatment of the accommodative component. We often advise parents that there is a good chance of removing the glasses during the teen years.

The teaching litany has suggested that a high AC/A ratio may be responsible for deterioration of accommodative esotropia. One would think this factor would also lead to the prolonged need for spectacle correction to maintain a parallel eye position. Surprisingly, this factor made little difference in the percentage of patients whose accommodative esotropia spontaneously subsided over time. A similar unexpected result was noted when patients with different amounts of hyperopic refractive error were analyzed. Larger amounts of hyperopia did not lead to an increased number of persisting accommodative esotropes. Although the tendency for hyperopia to decrease after age 7 years was slightly greater in the subsiding group, the difference between the two groups appears small and unconvincing as a clinically important factor.

Doctor Raab's patients serve to remind us that some old clinical "truisms" may

not be correct. Careful follow-up of a group of patients by an astute clinician can provide a wealth of information. I am sometimes tempted to say "Don't confuse us with the facts," but instead will commend Doctor Raab for bringing this information to our attention so we can have a better idea of what to expect over time in accommodative esotropes.

It is interesting to speculate whether older teenage and adult persistent accommodative esotropes, who do not wish to wear spectacles or contact lenses, might not be surgical candidates. The concern about diminishing hyperopia leading to eventual exotropia probably does not apply in this group of patients. I have followed a few individuals in this age group treated with surgery and they seemed to do quite well. In addition, they are extremely grateful patients.

One might think all the information is known about accommodative esotropia. Doctor Raab has reminded us that there remain things to learn and in some cases, our traditional approach to therapy may usefully be altered.

DR SUZANNE VÉRONNEAU-TROUTMAN. I would like to ask Doctor Raab if the sensory state of these patients was taken into account? Only if it was, could it be said that no factor could be found helpful in predicting who will be able to discard his or her glasses.

Doctor Metz has already partially answered my second question. If 20% of esotropes with accommodative strabismus spontaneously recover, without any clues as to who will do so, is it justifiable to consider surgery just to discard glasses, risking consecutive exotropia in a large number of cases?

DR JOHN T. FLYNN. I, too, would like to commend Doctor Raab for bringing to our attention a tough problem. My experience over the years has led me to adopt a strategy in talking, early on, with the parents about their child's accommodative esotropia: they are in for a long-term problem that may last years and years into the teenage area. If they get better, I look like a good doctor, and if they don't, I look like a prophet. There is one aspect which I don't think has been addressed but I think is important in accommodative esotropia and that is compliance with therapy. Occasionally, in the children who do not improve, I really think it is very difficult information to get. It is probably the most difficult historical information that we as physicians try to elicit from our patients. But the outcome of treatment can depend upon noncompliance with the wearing of glasses. It all depends on how we ask the question. If we ask the parents and sound judgmental about it, very often they will lie to us. I think the wearing of glasses is essential to the control of the deviation and it is a critical issue in the management of these children. That is the question I would like to ask Doctor Raab, has he evaluated compliance versus noncompliance in this group of patients.

DR ARTHUR KEENEY. This is a fascinating continuation of a problem with multiple factor etiology. In 1957 I published a study of the "Bony Orbital Walls in Horizontal Strabismus." Careful submentovertex x-rays were made on 66 patients (age 8 months to 25 years) with horizontal nonaccommodative and nonparalytic strabis-



mus. Sixty-eight orthophoric patients (age 3 to 33 years) seen in the general eye clinic served as controls. Three orbital angles were measured: (1) lateral to medial wall, (2) lateral wall to saggital plane, and (3) right to left lateral walls. All angles tended to be somewhat greater in males than in females. Angles (3) tended to be greater above age 12 or in blacks. Medial orbital walls were generally parallel or converged or diverged by only a few degrees.

Strabismic patients were further divided by race into 33 esotropic whites, 11 exotropic whites, 12 esotropic blacks, and 10 exotropic blacks. In monocular exotropia, angles (1) are generally larger on the side of the deviating eye (up to 7° in whites, 11° in blacks). In monocular esotropia, angles (1) are generally smaller on the side of the deviating eye. In alternating esotropia, angles (1) generally fall within the same range as in the control group. Medial orbital walls showed no significant variation from the control group to the strabismic group.

In 25% of monocular esotropic patients angle (1) is significantly smaller on the deviating side and in 33% of monocular exotropic patients angle (1) is significantly larger on the deviating side. When this structural irregularity exists, monocular surgery may be indicated rather than symmetrical surgery.

DR ROBERT DREWS. I am usually a little careful about statistical interpretations. Some of the data seems to show a factor which might affect outcome, but the statistical analysis showed a probability greater than 0.05. The conclusion reached was that, therefore, this was not a factor, but you have to remember that the conclusion might equally well mean that the size of the sample wasn't big enough.

DR EDWARD L. RAAB. I wish to thank all of the discussants, in particular Doctor Metz for serving as the primary discussant. Regarding his query about surgery—yes, I am getting into that area as well. My initial results are promising. I wouldn't offer that in early childhood but certainly it seems to work well in older cases and gets some patients out of bifocals and into contact lenses, and makes management easier. With regard to Doctor Véronneau-Troutman's question about the binocular status, you must recall and hopefully accept my definition of improvement for this study. I was really looking at the natural history of accommodative innervation. If the patient's deviation is higher than the threshold amount I postulated, even if kept latent by fusion, I didn't regard that as a subsided case. Compensation by fusional divergence is very useful and occurs often but it was not an element of this inquiry. One might not like that definition, however. As to Doctor Flynn's comment, although my abstract promises to report the response to treatment, I found that I could not isolate this feature retrospectively so that I simply did not consider it. Doctor Keeney's observations about orbital anatomy are interesting to me and I cannot say I considered this factor, nor do I see immediately how to approach this question. Finally, Doctor Drews is quite correct. So far all I am able to point out is that these are questions in which I cannot reject the "null hypothesis." Perhaps I and hopefully others will be able to approach these issues in a planned prospective fashion.