Diagnosis and Treatment of Exotropia With a High Accommodation Convergence–Accommodation Ratio

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**Background:** Patients with exotropia often have a slow-to-dissipate fusional mechanism at near, which masks the true near deviation. Consequently, determination of the accommodation convergence–accommodation (AC/A) ratio in patients with exotropia must be based on near measurements obtained after prolonged monocular occlusion (typically 1 hour). When determined in that manner, the presence of a high AC/A ratio before surgery in an exotropic patient has been reported to be predictive of an esotropia at near after surgery.

**Objective:** To investigate the diagnosis and management of exotropia with a high AC/A ratio.

**Methods:** Three hundred four consecutive patients with exotropia were studied. In addition to the usual measurements, measurements were obtained at near after 1 hour of monocular occlusion, with and without additional +3.00-diopter lenses. Also, a gradient AC/A ratio was obtained by using additional minus lenses at distance fixation.

**Results:** One hundred fifty-four (50.7%) of 304 patients would have been thought to have a high AC/A ratio if that diagnosis was based on measurements obtained before prolonged monocular occlusion. In fact, only 22 patients (7.2%) actually had a high AC/A ratio; 132 patients (43.4%) had a pseudo–high AC/A ratio. Six of 22 patients with a high AC/A ratio underwent surgery to correct the exotropia. The presence of a high AC/A ratio before surgery had sensitivity, specificity, and positive and negative predictive values of 100% for predicting a postoperative esotropia at near associated with a high AC/A ratio. The remaining 16 patients with high AC/A ratios were treated with overcorrecting minus lens therapy (including a bifocal). Ten of them have been followed up to at least 18 years of age, by which time 9 have shown normalization of the AC/A ratio.

**Conclusions:** Near measurements used to calculate the AC/A ratio in exotropic patients must be made after prolonged monocular occlusion. Otherwise, many patients with a pseudo–high AC/A ratio will be thought to have a true high AC/A ratio. The presence of a high AC/A ratio is infrequent in patients with esotropia, but it is highly predictive of a postoperative esotropia at near fixation.

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ASSESSMENT of the ratio between accommodation and accommodative convergence (AC/A ratio) is important in treating patients with strabismus. Classically, the AC/A ratio can be measured in 1 of 2 manners. The gradient method involves measuring the change in angle of alignment, while the amount of accommodation is altered by the use of either minus lenses at distance fixation or plus lenses at near fixation. The heterophoria method involves comparing distance alignment to near alignment and factoring in the effect of interpupillary distance on the amount of convergence that is needed at near. For most esotropic patients, the difference between the distance and near deviation is a function of the AC/A ratio. For many patients with exotropia, there is another powerful factor that affects the difference between the distance and near deviation. In 1952, Scobee pointed out that many patients with exotropia have a slow-to-dissipate fusional mechanism at near that will mask the true deviation at 0.33 m. This mechanism has been labeled tenacious proximal fusion (TPF). Approximately 1 hour of monocular occlusion has been recommended to suspend TPF and to permit the full exotropic deviation at near to become manifest. It has been stated that TPF will contaminate the calculation of the AC/A ratio in patients with exotropia if the determination is made using any near measurements obtained before the suspension of TPF with 1 hour of monocular occlusion.

In most patients with intermittent exotropia, the distance deviation initially exceeds the near deviation. If one considers a hypothetical patient:

- Distance exotropia = 35 prism dipters (Δ)
- Near exotropia = 05' Δ
- Near exotropia after monocular occlusion = 35' Δ (was masked by TPF)

If the AC/A ratio in this patient is calculated by comparing the distance and near
PATIENTS AND METHODS

The routine I have used since 1982 for measuring cooperative patients with intermittent exotropia has been reported previously. In addition to prism and cover test measurements at 6.00 and 0.33 m, the following measurements and calculations are performed: (1) A gradient AC/A ratio is obtained by repeating the measurement at 6.00 m with an additional −1.50- or −2.00-D sphere added to each spectacle lens, or in a trial frame while fixation is maintained on a 20/40 Snellen optotype. The gradient AC/A ratio is then calculated by dividing the decrease in the exotropia by either 1.5 or 2, depending on which minus lens power was used. (2) An additional measurement at 0.33 m is made after 1 hour of monocular occlusion of the habitually deviating eye to determine if TPF is present. During the testing to obtain this measurement, the patient is not permitted to regain binocular fusion until measuring is completed, as has been described previously. The AC/A ratio using the heterophoria method is then calculated using the near measurement obtained after monocular occlusion using the standard formula:

\[ AC/A = \text{ipd} + \text{exotropia at } 6.00 \text{ m} - \text{exotropia at } 0.33 \text{ m}/3, \]

where ipd is the interpupillary distance in centimeters. (3) Another postocclusion measurement at 0.33 m is obtained with an additional +3.00-D sphere over each eye before allowing the patient to regain binocular fusion. The gradient AC/A ratio at 0.33 m is then calculated by dividing the difference between the near measurement obtained after monocular occlusion and that obtained with +3.00-D lenses at near after monocular occlusion by 3. In addition to the previously mentioned measurements, 1 was obtained at 0.33 m before monocular occlusion. As previously stated, I do not believe that this measurement is of any practical utility. It was obtained, however, as part of this clinical investigation to help understand the relationship between accommodation and convergence in patients with exotropia.

deviation before monocular occlusion (heterophoria method), the AC/A ratio will seem to be high by definition. This patient, however, may actually have a normal AC/A ratio because TPF is masking a near deviation that equals the distance deviation. Such a patient has been described as having a pseudo–high AC/A ratio by the heterophoria method. Many such patients will also manifest an increase in near deviation if they are tested with +3.00 lenses at near before monocular occlusion. If one again considers the hypothetical patient:

Distance exotropia = 35 Δ
Near exotropia = 0 Δ
Near exotropia with +3.00 dipoters (D) before monocular occlusion = 35’−40’ Δ
Near exotropia after monocular occlusion = 35’ Δ
(was masked by TPF)
Near exotropia after monocular occlusion and +3.00 D = 35’−40’ Δ

Even with a normal AC/A ratio, the addition of +3.00 lenses at near (before monocular occlusion) would be expected to add between 4 and 10 Δ to the true near angle of exotropia (35 Δ) because of a relaxation of normal accommodative convergence. This results in the near deviation exceeding the amount to which TPF has been accustomed to masking, and the entire deviation becomes manifest. When this patient is first measured at near after 1 hour of monocular occlusion, the true larger near deviation of 35’ Δ becomes manifest. When +3.00 lenses are subsequently used for obtaining a near measurement, the additional deviation is only 0 to 5 Δ, revealing an AC/A ratio that is low to normal. Similarly, a repeated measurement of the gradient AC/A ratio in the distance typically reveals that it is qualitatively unchanged after monocular occlusion. Also, in such patients, the AC/A ratio, calculated using the gradient method at distance and near (after monocular occlusion), is qualitatively the same. Such a patient is described as having a pseudo–high AC/A ratio by the gradient method. In addition, the presence of nonaccommodative proximal convergence can result in a near deviation that is smaller than the distance deviation. Proximal convergence will thus also result in a pseudo–high AC/A ratio if it is determined using the heterophoria method (even after prolonged monocular occlusion). The gradient method must be used to document that the AC/A ratio may in fact be normal in this circumstance.
It is important to identify exotropic patients who truly have high AC/A ratios for the following reason. In 1988, I reported⁴ that exotropic patients who show a high AC/A ratio when that diagnosis is made after 1 hour of monocular occlusion have a high likelihood of maintaining their high AC/A ratio after surgery. If their distance angle of strabismus is successfully eliminated with surgery, they predictably develop and maintain an esotropia at near associated with a high AC/A ratio. They need to use a bifocal after surgery to maintain good alignment at near. This is in contrast to most exotropic patients, who do not show a consecutive near esotropia even if their distance exotropia greatly exceeds their near exotropia before surgery.¹⁵ I have recommended that such patients be treated optically with overcorrecting minus lenses. Because of their high AC/A ratio, they experience a large decrease in deviation with a relatively small amount of overcorrecting minus lens power. Unlike most intermittent exotropes receiving overcorrecting minus lens therapy, however, these patients manifest a persistent esotropia at near when wearing overcorrecting minus lenses; they also need a bifocal.⁵,⁶,¹⁶

The purpose of this study is to report my experience with diagnosis and treatment of exotropic patients with a high AC/A ratio, to report the prevalence of that entity, and to present its long-term outcome with conservative management.

**RESULTS**

The Table gives descriptive variables of the 304 study patients. The presence of a pseudo–high AC/A ratio was a common finding in patients with intermittent exotropia. Forty-four percent of the 304 patients would be classified as having a high AC/A ratio using the heterophoria method, and 34% using the gradient method at near if those diagnoses were based on near measurements obtained before monocular occlusion. Only 22 (7.2%) of 304 patients actually had a high AC/A ratio. They all met the previously mentioned criteria of having a high AC/A ratio with the gradient method at distance fixation, the gradient method at near fixation after monocular occlusion, and the heterophoria method after monocular occlusion. In all patients, the AC/A ratio was qualitatively the same with all 3 methods of testing. No correlation was found between the size of the deviation at 6.00 m and the magnitude of the AC/A ratio. In addition, 18 patients had a near measurement of less than 10 Δ (before monocular occlusion), and 16 of those 18 patients showed an esophoria when tested at 0.17 or 0.08 m.

Of 304 patients reported in this series, 245 have undergone strabismus surgery. The surgery was based on the deviation at 6.00 m; the surgical dose and technique have been described previously.⁷ Six of 22 patients with a true high AC/A ratio exotropia were included in that surgical group. All 6 of these patients developed an esotropia at near associated with a high AC/A ratio after surgery. Five of them needed to wear a bifocal; the sixth patient was able to control a moderate-sized esotropia without a bifocal. These 6 were the only patients of the 245 undergoing surgery who developed an esotropia at near associated with a high AC/A ratio after surgery. Thus, in this series, the diagnostic criteria stated above had a sensitivity, specificity, positive predictive value, and negative predictive value of 100% for determining which patients would develop an esotropia at near associated with a high AC/A ratio after surgery for exotropia.

Of the 16 patients with a high AC/A ratio who did not undergo surgery, overcorrecting minus lens therapy was successful in all cases in controlling the distance deviation. The deviation at 6.00 m in these patients ranged from 15 to 35 Δ. Typically, myopic patients were given spectacles that incorporated 1 to 1.5 D more minus power than their cycloplegic refraction. Usually, hyperopic patients were given spectacles so that a spherical equivalent of the lens before the dominant eye was between –1 and –1.5 D. The power of the lens before the nondominant eye was chosen to make the amount of accommodation equal in the 2 eyes. Although using this amount of overcorrecting minus lens power would not be expected to reduce a substantial exotropia to orthotropia, it seems to decrease the deviation sufficiently to permit better control over an intermittent deviation. All 16 patients treated with overcorrecting minus lens therapy showed a persistent esotropia at near with the overcorrecting minus lenses in place, and needed a bifocal as part of their management. There were no obvious differences characterizing the 6 patients who underwent surgery from those who received optical management. Four of them were operated on before I was aware of the importance of a true high AC/A ratio before surgery in predicting a postoperative esotropia with a persistent high AC/A ratio. The other 2 patients were treated unsuccessfully with spectacles before surgery and elected to undergo surgery with the understanding that a bifocal would be needed afterward.
dertain approach.18

muscles, but I have no personal experience with that treat-
multaneous posterior fixation of the medial rectus
patients with bilateral lateral rectus recessions and si-
adolescence. I am aware of successful treatment of these
patients will outgrow the need for a bifocal by the end of
for control of a near esotropia. In many cases, the pa-
likelihood of providing good control over the misalign-
be based on the following considerations. Surgery can be
for calculating the AC/A ratios may be more practical if
it reveals a normal AC/A ratio.19 However, if the AC/A
ratio seems high with the heterophoria method after 1
hour of monocular occlusion, the possible effect of
proximal convergence must be ruled out by a gradient
method determination. Also, if results with either test
are equivocal, both should be used. The presence of an
esophoria at 0.17 or 0.08 m should alert the examiner
to the high likelihood of a high AC/A ratio being pre-
present; however, the absence of this finding does not rule
out that possibility. This is a helpful, but not essential,
diagnostic sign.

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