Distance/Near Differences in Intermittent Exotropia

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Background: Burian’s classification of exotropia based on the difference between the distance deviation and near deviation (distance/near differences) leaves some questions unanswered. Controversy exists concerning whether the divergence excess pattern is caused by an excess of divergence or by excessive accommodative convergence. Much of the literature on this subject has been confusing because investigators did not eliminate tenacious proximal fusion as an artifact in calculating the ratio of accommodative convergence to accommodation (AC/A ratio). Previously, one of us (B.J.K.) proposed a classification system that respected this artifact and subdivided the classification system proposed by Burian.

Methods: A total of 202 consecutive patients with an exotropia underwent a series of measurements to determine the respective role of accommodative convergence and tenacious proximal fusion as a cause for their distance/near differences. In addition, the value obtained by a rapid prism adaptation test as a possible substitute for 1 hour of monocular occlusion was studied.

Results: In 98 patients, the initial distance deviation exceeded the near deviation. In 10 patients, the distance/near differences were caused by a high AC/A ratio, which would have been mislabeled by Burian’s classification system. Brown’s recommendation of using +3.00-diopter lenses at near to diagnose simulated divergence excess would have led to the misdiagnosis of a high AC/A ratio in 61 of these patients. In 26 patients, the near deviation exceeded the distance deviation. Burian’s classification would have incorrectly labeled 2 patients as having convergence insufficiency when, in fact, they had pseudo-convergence insufficiency. The new proposed classification system proved 100% sensitive and 100% specific (15 of 15 patients for both parameters) for identifying preoperatively exotropic patients who postoperatively developed an esotropia at near with a high AC/A ratio. Rapid prism adaptation tests at near proved useful for identifying the presence of tenacious proximal fusion, but were not accurate in its quantification.

Conclusions: The validity and utility of the new classification system was confirmed. Identification of exotropic patients with a high AC/A ratio and consideration of nonsurgical treatment is important. The rapid prism adaptation test is qualitatively, but not quantitatively, the same as 1 hour of monocular occlusion.

SUBJECTS AND METHODS

Consecutive patients seen by the senior author (B.J.K.) between 1986 and 1996 with intermittent exotropia were included in this series subject to the following exclusion criteria: untreated amblyopia, previous strabismus surgery, or insufficient cooperation for the rigorous measurement protocol described below. We also excluded patients with small exophorias at near and decreased fusional convergence amplitudes (fusional convergence insufficiency) if they did not have a tropia that was at least intermittently manifest at distance or near. Patients who had underlying neurologic or severe systemic disease and patients with a paralysis of convergence and accommodation also were excluded. We considered patients to have an intermittent exotropia if the deviation was intermittently manifest at either distance or near. Consequently, patients who had a constant exotropia at distance but an intermittent exotropia at near were included. There were no arbitrary age limits for participation, pending the ability to permit the required diagnostic tests. Patients in this study underwent the following series of measurements pending age and cooperation. In addition to the usual prism and cover-test measurements at 6 m and 0.3 m, a gradient AC/A ratio was determined by repeating the measurement at 6 m with an additional –1.50-D sphere or –2.00-D sphere added to each spectacle lens or in a trial frame, while fixation was maintained on a 20/40 Snellen optotype. The gradient AC/A ratio was then calculated by dividing the decrease in the exotropia by either 1.5 or 2, depending on which power of minus lenses was used (gradient method for calculating the AC/A ratio in the distance). An additional near measurement was obtained after 1 hour of monocular occlusion of the habitually deviating eye to determine the presence of TPF. Another postocclusion near measurement was obtained with an additional +3.00-D sphere over each eye prior to allowing the patient to regain binocular fusion. The AC/A ratio was 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 (gradient method for calculating the AC/A ratio at near). We considered the AC/A ratio to be normal using the gradient method at either distance or near if it was between 2.5:1 and 6:1. Finally, the AC/A ratio was determined using the heterophoria method by dividing the difference between the distance and near deviations (obtained after monocular occlusion) by 3 and adding the result to the interpupillary distance (IPD) measured in centimeters. To simplify measurements, in most cases we assumed an IPD of 5 cm for children younger than 5 years, 5.5 cm for children between 5 and 10 years, and 6 cm for patients older than 10 years. If a given patient was obviously hypertelor or hyperteleoric, the IPD was measured. We considered the normal range of the AC/A ratio to be the IPD with an SD of 3. Thus, for a younger child, the range would be 2 to 1 to 8 to 1; for an older patient, it would be 3 to 1 to 9 to 1. We chose these numbers because they represent the upper and lower limits of the AC/A ratio that would still result in distance and near deviations within 10Δ for a given patient. It has previously been reported that the AC/A ratio for most individuals is not identical if calculated both by the gradient and heterophoria methods; this is consistent with the aforementioned assumptions. In addition, a near measurement with +3.00-D lenses was also obtained prior to monocular occlusion for most patients. However, for reasons outlined below, we feel this measurement is of no meaningful clinical utility; we obtained it mainly for investigational reasons.

If patients had a high AC/A ratio based on the near measurement prior to monocular occlusion, but had a normal AC/A ratio if the near measurement after monocular occlusion was used, we described them as having a pseudohigh AC/A ratio. This was in keeping with previous suggestions that the near measurements are contaminated in exotropic patients if TPF is not suspended. For the purpose of classification, we considered the near deviation to equal the distance deviation if they were within 10Δ. For determining if a patient met Burian’s simulated divergence excess category, we relied on the near measurement after monocular occlusion and not the response of the near deviation to +3.00-D lenses. (See “Comment” section for significance of the +3.00-D lens measurement at near.) If a patient met the criteria of having a simulated divergence excess pattern based solely on Brown’s criteria (the response to +3.00-D lenses at near) and did not show an increase in the deviation at near with monocular occlusion, we refer to them in the data analysis as having a simulated divergence excess pattern—Brown’s modification. Patients who would be classified as having a basic exotropia according to Burian represent a group of patients with a normal AC/A ratio and without TPF. In keeping with commonly used terminology, we also describe these patients as having a basic pattern.

Previously, a form of rapid PAT at near was suggested as an alternative method to determine the presence of TPF, and the senior author (B.J.K.) hypothesized that it might reveal a near measurement equivalent to that obtained after monocular occlusion. The rapid PAT is performed by first obtaining distance and near measurements in the usual manner with the prism-and-cover test. Next, base-in plastic prisms equaling the distance measurement are placed in trial clips or a trial frame, and the patient is instructed to read a near-vision card for approximately 30 seconds. The prism-and-cover test is then repeated with the additional prisms in place, and the net deviation calculated. For example, if the patient measured 10Δ of esotropia at near while wearing a total of 25Δ of base-in plastic prisms, the net esotropia would be 15Δ. This rapid PAT measurement was obtained prior to the aforementioned monocular occlusion measurement in patients in whom the initial distance deviation exceeded the near deviation.

Also, as part of a separately conducted clinical trial, we also measured the angle of exotropia of many of these patients while they looked through a window at an outdoor target 0.4 km away and as they looked at targets 6 m away after 1 hour of monocular occlusion to test for vergence aftereffects. Those results are reported elsewhere. This study was conducted prospectively according to protocol set up after the prior report on this topic.
occlusion for the determination of any near measurements.

In 1897, Duane classified exotropic deviations based on distance/near differences. Subsequently, in a classic series of articles, Burian modified Duane’s classification and developed the system that is considered the accepted standard. Burian categorized patients in whom the distance exotropia exceeded the near deviation by more than 10Δ as having an excess of divergence. Patients in whom the distance and near exotropia were within 10Δ of equal were said to have a basic pattern. Patients in whom the near deviation exceeded the distance deviation by 10Δ were said to have convergence insufficiency, although Burian did not specify the type of convergence that was insufficient (eg, accommodative or fusional). In addition, patients in whom the initial distance deviation exceeded the near deviation by 10Δ, but in whom the 2 measurements were within 10Δ of equal after 1 hour of monocular occlusion (indicating a presence of TPF), were said to have a simulated divergence excess pattern. Whether the distance/near differences are in reality caused by an active excess of divergence as Burian suggested is unproven and has been questioned.

Historically, there has been considerable confusion and controversy regarding the proper way to distinguish a patient with true divergence excess from one with simulated divergence excess exotropia. Burian initially based the differentiation on the results of the near measurement after prolonged monocular occlusion. Brown later observed that these same patients could be identified if they showed an increase in the near deviation if measured through +2.50-diopter (D) or +3.00-D spherical lenses. Helveston correctly pointed out that prolonged monocular occlusion and the use of plus lenses at near affect different convergence mechanisms and should not be interchangeable. Monocular occlusion suspends fusional convergence and plus lenses relax accommodative convergence; patients who show a large increase in the angle of exotropia at near with +3.00-D lenses should be considered as having a high AC/A ratio. In spite of this obvious difference between these 2 diagnostic tests, Burian and Franceschetti reported that approximately one third of patients will have the same response with either method, ie, an increase in their near angle of exotropia. On this basis, Brown argued the 2 tests could be used interchangeably to diagnose simulated divergence excess, although he recognized the tests measure different convergence mechanisms. This apparent paradox can be understood in light of the comments of Cooper and coworkers. They pointed out the need to eliminate TPF with monocular occlusion before obtaining a near measurement for the purpose of calculating the AC/A ratio. We have also found that most patients who show an increase in their near angle of exotropia with both monocular occlusion and +3.00-D lenses will appear to have a normal AC/A ratio if the +3.00D lens test at near is performed after monocular occlusion has eliminated TPF.

We refer to such patients as having a pseudohigh AC/A ratio (see “Comment” section for further explanation). If Cooper and coworkers are correct that TPF will contaminate the determination of the AC/A ratio using near measurements in patients with intermittent exotropia, then any study investigating the nature of distance/near differences in intermittent exotropia must include near measurements made after monocular occlusion.

Proper understanding of the cause of distance/near differences in intermittent exotropia is important for several reasons. Although the distance deviation exceeds the near deviation in most patients with intermittent exotropia, the patients do not maintain that distance-to-near difference after undergoing lateral rectus resections. If they did maintain the difference, a postoperative esotropia at near distance would become manifest. However, some such patients infrequently do develop an esotropia at near associated with a high AC/A ratio after surgery. They manifest crossing at near despite orthophoria in the distance measurement. Raab indicated that such an outcome could not be predicted using standard testing. However, it was subsequently suggested that, with appropriate investigation of the AC/A ratio in exotropic patients, such patients could be identified before surgery. We observed that although these patients respond very well to minus lens therapy to control their distance deviation (because of their high AC/A ratio), they typically manifest a maintained high–AC/A-ratio esotropia at near for which they need bifocal lenses. Because these patients have such a frequent incidence of developing and maintaining an esotropia at near associated with a high AC/A ratio if they undergo surgery for the distance deviation, we have advised against surgery for most patients in this group. Instead, we have recommended optical management consisting of minus lens correction for distance and bifocal lenses for near. A more thorough understanding of distance/near differences in intermittent exotropia might possibly identify before surgery those patients who are destined to develop a consecutive high–AC/A-ratio esotropia, permitting appropriate forewarning or alternative treatment recommendations. Also, clarification of distance/near differences might help our understanding of the appropriateness of different surgical procedures for treating intermittent exotropia.

In the 18th Annual Richard G. Scobee Memorial Lecture, one of us (B.J.K.) presented some preliminary investigations on this subject. One of us (B.J.K.) proposed that distance/near differences in patients with intermittent exotropia be viewed differently than the manner proposed by Burian. Table 1 indicates how the senior author’s (B.J.K.) proposed classification system subdivides Burian’s system. The main difference is that the proposed classification subdivides Burian’s divergence excess category into 2 subsets, one with a true high AC/A ratio and the other with strong proximal convergence. In addition, the convergence insufficiency category is subdivided into 3 subsets. Finally, the simulated divergence excess category, classified according to Brown’s criteria (an increase in exotropia with +3.00-D lenses at near), is subdivided into high–AC/A-ratio and TPF categories. Instead of considering patients in whom the distance deviation exceeded the near deviation as having an excess of divergence as suggested by Burian, the senior author (B.J.K.) considered them to have an esotropia at distance focus with an excess of convergence at near focus—either accommodative convergence or proximal conver-
gence. In the senior author’s (B.J.K.) original report on this subject, he considered that patients who met Burian’s criteria for divergence excess, and who did not have a true high AC/A ratio, might in fact have an excess of divergence. For reasons outlined later in this article, the senior author (B.J.K) now believes it is more appropriate to consider these patients to have an excess of proximal convergence. Tenacious proximal fusion differs from proximal convergence. The former is a slow-to-dissipate fusional vergence that can be suspended with prolonged occlusion or prism adaptation and is probably related to awareness of near (see “Comment” section on proximal convergence). The patient Burian described as having a simulated divergence excess pattern based on the 1-hour occlusion measurement was one the senior author (B.J.K.) conceptualized as having an exotropia with TPF. The patient who had a simulated divergence excess pattern, as determined by the use of +3.00-D lenses at near (prior to monocular occlusion [Brown’s method]), might have either an exotropia with a high AC/A ratio or an exotropia with TPF, according to our classification system. The measurement would need to be repeated with +3.00-D lenses at near following prolonged monocular occlusion to differentiate these 2 mechanisms. One of us (B.J.K.) considered Burian’s basic exotropia to have a normal AC/A ratio without either TPF or strong proximal convergence. Patients with a convergence insufficiency pattern might have insufficient fusional convergence or a low AC/A ratio; further testing is necessary to determine the responsible mechanism. In addition, a small percentage of patients with an apparent convergence insufficiency pattern may show an increase in the distance deviation after monocular occlusion, so that distance deviation then equals the near deviation. These patients have been described as having a pseudo-convergence insufficiency.

Previously, one of us (B.J.K.) suggested that a form of rapid prism adaptation test (PAT’) at near might produce interchangeable results with the 1-hour patch test to determine the presence of TPF. In that same report, one of us (B.J.K.) suggested the postoperative occurrence of a high AC/A–ratio esotropia after surgery for exotropia might be predictable if the presence of a high AC/A ratio is assessed properly before surgery. The purpose of this article is to present the results of our continued investigations of the subject of distance/near differences in patients with intermittent exotropia, compare the results of the rapid PAT’ with monocular occlusion for diagnosing TPF, and report our further experience with high AC/A ratios in patients with exotropia.

### RESULTS

This series includes the results of measurements of 202 patients who were between the ages of 4 years and 64 years; 127 were female and 75 were male. The majority, however, were younger than 20 years. The patients older than 20 years primarily had exotropia of the convergence insufficiency type. Table 2 presents the distribu

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<th>Table 1. Comparison of Categories of Proposed Classification With Those of Burian and Brown*</th>
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<td><strong>Burian’s Classification</strong></td>
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*AC/A indicates accommodative convergence to accommodation; TPF, tenacious proximal fusion.
‡Diagnosis made based on increase of near deviation after monocular occlusion.
§This is a subset of divergence excess according to Burian’s classification.
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<td><strong>Author’s Classification</strong></td>
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*XT indicates exotropia at 6 m; XT° exotropia at 1⁄3 m; CI, convergence insufficiency; NA, not applicable; AC/A, accommodative convergence to accommodation; and TPF, tenacious proximal fusion.
‡These patients are a subset of those included under Burian’s classification.
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As found in our prior report, the largest single group (N=80) were patients in whom the initial distance measurement exceeded the near deviation measurement. However, this difference disappeared after TPF was suspended with monocular occlusion (Burian’s pseudo-divergence excess). Although they all had a normal AC/A ratio by the 3 testing methods employed (heterophoria method, gradient method at distance, and gradient method at near), 61 patients had a pseudohigh AC/A ratio. This means that the near deviation increased substantially with +3.00-D lenses. However, if the increase in exotropia at near with +3.00-D lenses was tested after monocular occlusion, a normal AC/A ratio was revealed.

A total of 18 patients had distance deviations that exceeded the near and did not increase at near after monocular occlusion. All 18 patients would be categorized by Burian as having a true divergence excess. By the proposed classification, 8 of the 18 patients had a normal AC/A ratio, but had strong proximal convergence. Of the 18 patients, 10 had high AC/A ratios both when tested with the +3.00-D lenses at near after monocular occlusion and with minus lenses at distance. These 10 patients did not manifest an increase in their exotropia at near after prolonged monocular occlusion because they did not have TPF. Although they would have been considered to have a true divergence excess by Burian, who relied on monocular occlusion to bring out the near deviation, they would have been categorized as having a simulated divergence excess type exotropia by Brown, who felt that the +3.00-D lens test at near was diagnostic. (See “Comment” section concerning high AC/A ratio exotropia below.)

A total of 41 patients in whom the initial distance deviation exceeded the near deviation and in whom TPF was present (ie, they did not have a high AC/A ratio) underwent a rapid PAT at near. The initial near measurement, near measurement after occlusion, and near measurement with PAT are represented in Figure 1. The mean near deviation prior to occlusion was $7.3\Delta \pm 5.8\Delta$ (range, 0-16\Delta). The mean near deviation after occlusion was $22\Delta \pm 5.5\Delta$ (range, 10\Delta-30\Delta), as compared with the mean near deviation with PAT’ of $17.9\Delta \pm 4.4\Delta$ (range, 10\Delta-25\Delta). This difference was significant ($P<.001$, t test), indicating that the 2 measurements were not equivalent. In all 41 patients, the near deviation increased at least 5\Delta with the PAT’ and, in 30 patients (73%), it increased by at least 10\Delta. In only 14 patients (34%), however, was the measurement with PAT’ equal to the measurement after monocular occlusion. In addition, the rapid PAT’ was performed on 10 patients who did not have TPF, but in whom the distance deviation exceeded the near deviation. Of these patients, 6 patients had a high AC/A ratio and 4 patients had proximal convergence as causes of the distance/near differences. None of the 10 patients showed an increase in the near measurement with PAT’ of greater than 5\Delta. Thus, although the rapid PAT’ does not produce measurements identical to monocular occlusion, it does appear that an increase in the near measurement of 10\Delta or more with the PAT’ is strongly suggestive of TPF. The presence of TPF has been shown to be a good prognostic sign in patients with intermittent exotropia and allows the surgeon flexibility in choosing between different surgical options.

Because we now try to manage intermittent exotropia with a high AC/A ratio with nonsurgical treatment, only 2 of the 18 patients of that type in this series underwent surgery. Both were patients who did not have satisfactory control of their deviation with optical management and were informed about the probable need for bifocal lenses after surgery. This proved to be a valid forewarning; both developed a consecutive esotropia at near. Since 1982 when we began testing the AC/A ratio in intermittent exotropia in the manner which we have outlined here, the senior author (B.J.K.) has operated on a total of 6 patients with a high AC/A ratio (2 patients in this series and 4 previously). Immediately after surgery, all 6 developed an esotropia at near associated with a high

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Figure 1. Scattergram depicting the near deviation measurement in 41 patients prior to monocular occlusion, after monocular occlusion, and after rapid prism adaptation test at near.
AC/A ratio; 5 patients needed bifocal lenses to control the near deviation. During the same period, these 6 were the only patients to develop an esotropia at near associated with a high AC/A ratio after undergoing surgery for the first time for an intermittent exotropia. Thus, the criteria described herein for diagnosing a high AC/A ratio were 100% specific and 100% sensitive in predicting a high AC/A ratio esotropia after surgery.

Our approach to the optical management for patients with intermittent exotropia is to give them the least amount of additional minus lens correction necessary to permit adequate control of the deviation in the distance. Because of the high AC/A ratio, a substantial decrease in the distance deviation is seen with a relatively small amount of minus lens therapy. Typically, this result is our prescribing between −1.00- to −2.00-D lenses for patients who are hyperopic and an additional myopic correction of −1.00 to −2.00 D for patients with myopia. Similarly, the bifocal correction prescribed is the lowest amount necessary to control the esotropia at near. Because these patients are frequently orthophoric at near prior to receiving additional minus lens correction for distance, the bifocal power needed is frequently just enough to offset the additional minus lens correction for distance. To date, there are 9 patients with intermittent exotropia with a high AC/A ratio whom we have treated with minus lenses and bifocals and have continued to follow up until at least 18 years of age. All 9 patients have shown a normalization of their AC/A ratio and no longer need bifocal lenses. In addition, they have shown increased control over their distance deviation, and none require additional minus lens correction. Two patients require a small amount of base-in prism in their spectacles, and 1 patient successfully underwent surgery after the AC/A ratio had normalized.

Of the 26 patients in whom the near deviation exceeded the distance deviation, 23 had low AC/A ratios in keeping with our previous observations. In some cases, the AC/A ratio was approximately 0. These patients showed no measurable increase of the near deviation after monocular occlusion with +3.00-D lenses, and, even for those who were not presbyopic, there was essentially no decrease in the distance deviation with −2.00-D lenses. This occurred despite their having normal near points of accommodation for their respective ages.

**COMMENT**

Although Duane and Burian and colleagues attributed a larger distance exotropia to an excess of divergence, others have questioned whether an active divergence mechanism is responsible. Substantial reason exists to believe that patients with a larger exotropia at distance have, in fact, an excess of some type of convergence at near to account for the distance/near difference. As reported by Jampolsky, Duane only used the term divergence excess descriptively. Of the 98 patients in this series in whom the distance deviation initially exceeded the near deviation, 80 patients had TPF, masking the near deviation. For another 10 patients, accommodative convergence caused the decrease in the near deviation. For the remaining 8 patients, the mechanism is unclear. We have attributed the distance/near difference to proximal convergence. The 8 patients may have an excess of divergence causing their motility pattern; however, they may not. Perhaps a period of monocular occlusion longer than 1 hour, as has been advocated by some, would have revealed an underlying larger near deviation. A longer period of prism adaptation as advocated by several authors might accomplish that same goal. Certain clinical observations suggest that patients such as these 8 do not in fact have an excess of divergence. Two separate series have reported that exotropic patients are approximately 30Δ more exotropic when deeply anesthetized than they are in the awake state. This is consistent with the observations that we have seen since 1977 on patients in this series in whom the distance deviation exceeded the near deviation. We found this to be true for all 3 subsets of patients listed in Table 1 in whom the distance deviation exceeded the initial near deviation. It is difficult to explain how an excess of active divergence can cause an esotropia if the deviation increases when neuromuscular control is relaxed by anesthesia.

Although many investigators have attributed most distance/near differences in intermittent exotropia to accommodative convergence, the literature is confusing for several reasons. As previously stated, all near measurements in patients with intermittent exotropia are contaminated by TPF, which must be suspended first with monocular occlusion. Most investigators did not eliminate this source of error. Second, the investigators made the assumption that if accommodation occurred at near fixation and there was a relative convergence at near, the two were causally linked. Our investigation shows that, although accommodation and convergence occur at near distance in patients with intermittent exotropia, the convergence typically is not caused by the accommodation. Convergence and accommodation are coincidentally, not causally, linked. Finally, there is a difference between a stimulus AC/A ratio and a response AC/A ratio. The former assumes that the amount of accommodation that occurs is appropriate for the visual stimulus, while the latter relies on special instrumentation to determine how much accommodation actually occurs. Most clinical investigations (including this study) are based on stimulus AC/A ratios. Cooper and coworkers studied response AC/A ratios in patients with divergence excess and simulated divergence excess exotropia before and after monocular occlusion. They found normal gradient AC/A ratios that were not altered by monocular occlusion. In such patients, the AC/A ratio would be incorrectly considered high if the distance/near differences were solely relied on prior to occlusion. This confirms the concept that monocular occlusion must be performed prior to determining a near measurement for this purpose.

Other clinical observations suggest that excessive accommodative convergence is not the cause of most divergence excess or simulated divergence excess patterns. Typically, if both lateral recti are recessed, based on the distance deviation, the patient does not develop an esotropia at near after surgery. If the distance/near differences preoperatively were caused by a true high AC/A ratio, one would be left with the conclusion that
recessing both lateral recti decreased the AC/A ratio; that would be illogical. Also, the use of minus lens therapy in these patients does not result in a marked or lasting esotropia at near as would be expected if the distance/near difference was caused by a high AC/A ratio. Both of these observations are consistent with the hypothesis that these patients have a larger deviation at near that is masked by TPF.

ON THE OTHER HAND, the relatively uncommon esotropic patient who has a true high AC/A has unique identifying characteristics. These patients frequently manifest a high AC/A ratio when tested in the manner advised here. In addition, those patients who initially are orthophoric at the usual 0.3 m near testing distance will frequently show a small esophoria if tested at closer distance (eg, 0.2 or 0.1 m). This is different than other patients for whom such a near testing distance is closer than their near point of convergence and who will typically break fusion to manifest an exotropia. Also, when treated with minus lens therapy for the distance deviation, the exotropic patient with a high AC/A ratio will typically develop and maintain an esophoria or esotropia at near, unlike most patients with intermittent exotropia. A total of 8 of the 10 patients in this series who had a high AC/A ratio were orthophoric at 0.3 m. Six of the 8 patients manifested an esophoria when tested at a distance of 0.2 or 0.1 m. Because 2 of the patients did not show an esophoria at the very near testing distance, we do not feel the absence of an esophoria at a very close distance is diagnostic of TPF. A high AC/A ratio may still be present.

Burian’s observation that one third of patients will have the same response to +3.00-D lenses at near and monocular occlusion, despite the fact these 2 tests work on different mechanisms, needs clarification. It is understandable in light of our understanding of TPF. Consider a hypothetical patient with a 30 Δ exotropia at distance and orthophoria at near. If that patient has TPF, he would be masking a 30 Δ exotropia at near that could be made manifest by monocular occlusion. If one assumes the patient to have a normal AC/A ratio, the addition of +3.00-D lenses would cause the near latent deviation to increase by approximately 15Δ to 18Δ due to relaxation of accommodative convergence. The tenuous proximal fusional mechanism is not accustomed to compensating for such a large deviation, and the fusion lock is broken. This results in the entire deviation of 30Δ to 48Δ becoming manifest. If the entire increase in the near deviation was incorrectly attributed to the 3-D change in accommodative effort, the AC/A ratio would be thought erroneously high. Thus, we refer to these patients as having a pseudohigh AC/A ratio. This is a very common type of patient. In this study, we found 61 of the 202 patients had these characteristics. Shipman and coworkers also identified this type of patient. However, because they routinely used the +3.00-D–lens test at near to diagnose the pseudo–divergence excess exotropia, they referred to these patients as having a pseudosimulated divergence excess pattern. We believe that, because they were describing patients who appeared to have, but did not have, a high AC/A ratio, the term we have suggested is preferable.

In 8 of our patients in whom the distance exceeded the near deviation, we attributed the distance/near difference to excessive proximal convergence. We feel this is a somewhat inadequate explanation because of ambiguities associated with that term. Proximal convergence has been defined as the mechanism that describes the difference between an AC/A ratio determined by the gradient method and by the heterophoria method. Consequently, saying that the distance/near difference is owing to proximal convergence is an incomplete statement because it does not explain the mechanism at work. With accommodation controlled during testing, it should not be a function of accommodative convergence. What factors specifically influence proximal convergence is not clear. It is, however, probably a stronger mechanism than TPF. Lenses of +3.00 D at near will frequently cause TPF to dissipate, but do not alter the alignment in patients with the proximal convergence.

Of the 26 patients in this series with a convergence insufficiency pattern, 23 patients had low AC/A ratios but normal fusional convergence. In some cases, the AC/A ratio was 0 with all modes of testing. In assessing fusional convergence in these patients, it is important that the calculations use the fusion-free position as the starting point, as has been pointed out by Jampolsky. For example, if a patient has a 15Δ intermittent exotropia in the distance, a 30Δ intermittent exotropia at near, and convergence amplitudes to overcome an additional base-out prism of 8Δ to 10Δ at near, the patient has normal fusional convergence. If one begins calculating from the fusion-free position of 30Δ of exotropia, the total fusional convergence amplitude at near is 38Δ to 40Δ. Because patients with this type of exotropia have very deficient accommodative convergence, it is not surprising they do poorly with surgery. They typically do not achieve good alignment at both distance and near after surgery. This goal may seem impossible if there is no accommodative convergence. The term convergence insufficiency has been used in the literature to describe 2 different entities. The patient who has a minimal esophoria at near and decreased convergence amplitudes typically has a normal AC/A ratio and a deficiency of fusional convergence. Such patients have asthenopia at near, do well with orthoptic exercises, and, as stated, were not described in this article. Conversely, the patient with a measurable exotropia at distance and a greater exotropia at near is the patient with a low AC/A ratio.

The rapid PAT’ at near is not identical to, but is qualitatively similar to, prolonged monocular occlusion. Early in our experience with this test, we observed that in patients with TPF the near deviation increased during the rapid PAT’, but the distance deviation did not change. Consequently, the distance/near difference lessened. In exotropic patients with a true high AC/A ratio, the near deviation does not increase with the rapid PAT. Therefore, the distance/near distance does not change. This is in sharp contrast to the response of esotropic patients with high AC/A ratio undergoing prolonged PAT for the near
difference and a normalization of the AC/A ratio. They tend to show a decrease in the distance/near angle. They may function as a decision between rapid and prolonged PAT. This study needs to be viewed in the light of several limitations. It was limited to stimulus AC/A ratios, which are not as meaningful as the response AC/A ratios. Although this may affect the data quantitatively somewhat, it would have little impact on our qualitative conclusions. Also, entry in the study was determined by certain inclusion and exclusion criteria. Patients with amblyopia, a history of previous surgery, or a constant deviation at distance and near were excluded. Results of this study cannot be extrapolated with confidence to the patients who were excluded.

Based on data reported herein, the following recommendations seem appropriate: All patients with intermittent exotropia in whom the distance deviation exceeds the near should have the mechanism of the distance/near difference clarified. This includes a near measurement after 1 hour of monocular occlusion to determine if TPF is present. Based on a recent report, patients with TPF can be treated with either bilateral lateral rectus recessions or a unilateral recess-resect procedure, according to the surgeon's preference. If TPF is not present, one must determine if the distance/near difference is caused by a high AC/A ratio. This determination is an important difference between this classification and that of Burian. This testing can be performed by any or all of the 3 methods described herein, provided that any near measurements are made after an hour of monocular occlusion and prior to allowing the patient to bifoveal. Minus lens therapy could be considered if a high AC/A ratio is present, and the patient should expect to need a bifocal lens. If surgery is performed, there is a high likelihood of a high-AC/A-ratio esotropia developing after surgery. For patients with a basic pattern in whom the AC/A ratio can be assumed to be normal, no special testing is necessary to investigate the AC/A ratio. For patients with an apparent convergence insufficiency pattern, a distance measurement should be obtained after 1 hour of monocular occlusion to rule out a pseudo convergence insufficiency pattern secondary to strong vergence effects at the distance. If that pattern is found, the patient can be treated as having basic exotropia. In addition to the aforementioned investigations of the distance/near difference, all patients with intermittent exotropia should have their deviation measured while looking at a distant outdoor target and at a target 6 m away after an hour of monocular occlusion. Based on the findings of a separate report, patients for whom the distance deviation is equal to or exceeds the initial near deviation should undergo surgery for the largest deviation measured.

Figure 2 is a decision tree that outlines the diagnostic and therapeutic approaches described herein.

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REFERENCES


A look at the past...

JACQUES DAVIEL, 1693-1762, called the father of modern cataract surgery, was the first ophthalmologist to remove a cataract through a corneal incision. A medal was issued in 1962 to commemorate the bicentennial of Daviel's death. It was engraved by Aleth Guzman and struck in bronze at the “Monnaie de Paris” (Paris Mint) in France. Figure 1 depicts the obverse, and Figure 2 the reverse.

Figure 1.

Figure 2.