Bimedial faden recession versus augmented medial rectus recession in the treatment of high ac/a ratio partially accommodative esotropia with large distant near disparity
Mohammed F. Farid, Ahmed M. Saeed

Department of Ophthalmology, Benha University, Benha, Egypt
Correspondence to Ahmed M. Saeed, MD, 33rd El-Horreya Street, El-Sherif Tower, El-Kanater El Khairaeya 13621, Egypt
Tel: +20 122 746 8426/+20 242 197 773; fax: +20 222 794 1538; e-mail: a_saeed775@yahoo.com
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Purpose
The purpose of this study was to compare the results of medial rectus (MR) Faden recession (FR) with MR augmented recession (AR) in the management of large distant–near disparity (DND), in convergence excess, partially accommodative esotropia (ET) associated with a high accommodative convergence/accommodation (AC/A) ratio.

Patients and methods
This is a prospective interventional study of 31 patients with convergence excess partially accommodative ET associated with a high AC/A ratio. Patients were divided into two groups. Group FR, which contains 15 patients who were treated by bimedial FR, and group AR, which contains 16 patients who underwent augmented MR recession based on the angle of near deviation. Surgical success was defined as distant and near ET ≤10 prism diopter with shrinkage of high AC/A ratio and high DND.

Results
Surgical success was achieved in 93.3% of cases in the FR group and in 81.2% of cases in the AR group. In the FR group, mean DND decreased from 33.3±11.5 to 3.06±2.08 prism diopter. For the AR group, mean DND decreased from 25.3±7.1 prism diopter preoperatively to 5.3±2.5 prism diopter postoperatively. The difference between both groups regarding reduction of DND was statistically significant (P<0.05). The mean AC/A ratio decreased from 8.6±2.5 to 2.3±1.3 prism diopter/diopter and from 7.3±1.9 to 2.1±0.9 prism diopter/diopter in the FR and AR groups, respectively, with no statistically significant difference between both groups. Two cases in the AR group with large DND (40 and 50 prism diopter) developed consecutive exotropia.

Conclusion
Faden recession achieves marginal superior control of DND and high AC/A ratio in convergence excess partially accommodative ET. Augmented recession also works well with the possible development of consecutive exotropia in cases with extremely high DND. This study recommends Augmented recession for cases with mild to moderate DND and Faden recession for cases with extremely large DND.

Keywords:
augmented recession, faden, high ac/a ratio, large distant–near disparity, partially accommodative esotropia

Introduction
Partially accommodative convergence (AC) excess esotropia (ET), by definition, is a convergent squint, which is outside the fusional range at distant fixation ‘≥10 prism diopter’ and is more than 10 prism diopter greater for near fixation after full hypermetropic correction. In many patients, the accommodative convergence/accommodation (AC/A) ratio is high. However, in some patients, the AC/A ratio is normal or even low ‘nonaccommodative and hypoaccommodative convergence excess ET, respectively’ [1].

Management of convergence excess partially accommodative ET is highly controversial, and the results were often disappointing. Some authors recommended bimedial rectus recession with the target angle; whether it is based on distant deviation, near deviation, or an average of both is also debatable. Others advocate adding posterior fixation suture to the medial rectus (MR) recession for controlling convergence excess ET. Other procedures such as marginal myotomy and slanted recession are less popular [2].

Despite repeated recommendations in the literature, limited number of prospective randomized studies comparing the different treatments for high AC/A ratio partially accommodative ET.
ratio partially accommodative ET with large distant–near disparity (DND) were found [2]. It is the role of this trial to provide prospective comparison between MR recession combined with posterior fixation suture [Faden recession (FR)] on one hand and augmented recession (AR) in the treatment of such entity of ET on the other.

**Patients and methods**

The study was approved by the Ethics Committee of Benha Faculty of Medicine and it conformed to the principles of the Declaration of Helsinki. Patients having partially accommodative acquired ET associated with a high AC/A ratio were included in the study under the following criteria: acquired ET exceeding 15 prism diopter at distant fixation despite full cycloplegic refractive correction, near ET \(\geq10\) prism diopter than distant ET ‘DND \(\geq10\) prism diopter’, and high AC/A ratio ‘AC/A >5 prism diopter/diopter’. Exclusion criteria included fully accommodative ET, pure convergence excess ‘ET \(\leq10\) prism diopter ET at distant fixation’, partially accommodative ET with low DND, cases with normal or low AC/A ratio, accommodative ET successfully treated with bifocal glasses ‘bifocal responders’, alphabet pattern that needs concurrent horizontal tendon transposition or oblique muscle surgery, other forms of ET (infantile, sensory), paralytic or restrictive muscle disorders, and previous horizontal muscle surgery. In either group, patients who developed consecutive exotropia (XT), which did not respond to the reduction of hypermetropic prescription, were excluded from the final data analysis.

Preoperatively, all patients underwent full ophthalmic and orthoptic examination including cycloplegic refraction and best-corrected visual acuity measurement with full cycloplegic prescription. If amblyopia was detected, patients were postponed until their amblyopia recovered. The angle of deviation was measured with full correction in place for both distant and near fixation, using prism cover test. Sensory fusion was assessed – whenever possible – by Worth’s four-dot test. Measurement of stereopsis was recorded using the Titmus fly test. The AC/A ratio was measured by gradient method, and values more than 5 prism diopter/diopter were considered high.

Thirty-one patients met the inclusion criteria. They were randomly divided into two groups. Group FR included 15 patients who were treated by bilateral symmetrical MR recession combined with posterior fixation suture. The amount of recession was obtained from surgical tables, and it was based on distant deviation while the patient is fully corrected. Placement of posterior fixation suture was performed according to the recommended guidelines based on the magnitude of DND: 12 mm from muscle insertion in DND 20–30 prism diopter, 13 mm for DND 30–50 prism diopter, and 14 mm for DND \(\geq50\) prism diopter [3,4]. The other group, group AR, included 16 patients who underwent augmented bilateral symmetrical MR recession. The target angle was the angle of near deviation with full correction in place, and the surgical dose was obtained from published surgical tables [1].

All surgeries were performed by a single surgeon (F.M. F.) under general anesthesia using the standard limbal approach. Follow-up was at 1 week and 1, 3, 6 months to 1 year. Postoperative measurements were taken by an assistant, who was masked to the procedure. Measurements at the last postoperative visit were recorded and compared with baseline measurements. Descriptive statistics using mean and SDs were calculated and analyzed, and significance was tested using the paired \(t\)-test and the Wilcoxon test, with a \(P\) value less than 0.05 considered statistically significant.

**Results**

The mean age of patients at the time of surgery was 4.5 ±1.3 years in group AR and 4.9±1.4 years in group FR. Male to female ratio was 9 : 7 in the first group and 7 : 8 in the second group. The mean follow-up time was 9.4 ±3.3 and 10.2±2.4 months, respectively.

In all patients, visual acuity varied from 1.0 to 0.7. Two patients from group AR were successfully treated for amblyopia before being enrolled into the study. The mean preoperative hypermetropic correction was 5.1 ±1.3 diopter for group AR and 4.9±1.2 diopter for group FR.

In group FR, the difference between preoperative and postoperative values for distant deviation, near deviation, DND, and AC/A ratio was statistically significant (\(P\leq0.001\) for each) (Table 1). The mean operative correction of distant deviation and near deviation was 25.6±9.7 and 55.8±18.8 prism diopter, respectively (Figure 1).

In group AR, the difference between preoperative and postoperative values for distant deviation, near deviation, DND, and AC/A ratio was statistically significant as well (\(P\leq0.001\) for each) (Table 1). The mean correction of distant deviation and near deviation
was 23.7±9.2 and 45.5±9.4 prism diopter, respectively (Figure 2). However, the difference between the mean correction of distant and near deviations in both groups was not statistically significant (P>0.05) (Figure 3).

Patients in group AR achieved more correction of their distant deviation (93.6%) compared with group FR (91.4%), whereas for correction of near deviation the FR group scored better results (91.1%) than the AR group (86.5%). DND was collapsed more in the FR group (90.8%) compared with the AR group (79%). The average reduction of DND was 30.2±5.8 and 20±5.8 prism diopter in the FR and AR groups, respectively, with a statistically significant difference when comparing both groups (P<0.05). Mean reduction of high AC/A ratio was 6.3±2.2 and 5.25±1.3 prism diopter/diopter for group FR and AR, respectively, whereas the difference was not statistically significant (P>0.05). Sensory data could be obtained from 19 patients in both groups. All patients showed no changes in their sensory status after surgery. Preoperatively, four patients (21%) had no fusion on Worth’s four-dot test, and 15 patients (79%) had different grades of stereopsis (one patient achieved 40–60 s of arc, three achieved 80–140 s, and 11 achieved 200–800 s of stereoacuity).

The mean operation time showed a significant difference when compared between both groups. The average time in the AR group was 14.5±4.8 and 19.6±5.5 min per muscle in the FR group (P<0.001).

No intraoperative complications were reported in either group. At 1 month postoperatively, five cases developed consecutive XT in the AR group (mean; distant: 25.8±5.1 prism diopter, near: 17.4±2.7 prism diopter). Initially, those patients were treated optically by reducing their hyperopic prescription. The average reduction was 1.3±0.48 diopter sphere. Three cases were corrected (distant: 8.1±1.6 prism diopter, near:

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<th>Table 1 Comparison between preoperative and postoperative average values and percentage of reduction for distant ET, near ET, DND, and AC/A ratio in both groups</th>
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<td>Preoperative (mean±SD) (minimum–maximum)</td>
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<tr>
<td><strong>Group A (N=14)</strong></td>
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<tr>
<td>Distant angle (prism diopter)</td>
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Table 1 shows the comparison between preoperative and postoperative average values and percentage of reduction for distant ET, near ET, DND, and AC/A ratio in both groups.

Figure 1

Figure 2

Graphic representation of preoperative and postoperative values in the FR group. AC/A, accommodative convergence/accommodation ratio; DND, distant–near disparity; ET, distant esotropia; ET', near esotropia; FR, Faden recession.

Graphic representation of preoperative and postoperative values in the AR group. AC/A, accommodative convergence/accommodation ratio; DND, distant–near disparity; ET, distant esotropia; ET', near esotropia; FR, Faden recession.
2.6±3.2 prism diopter) and two cases required secondary operative intervention (bilateral MR advancement in one case and bilateral lateral rectus recession in the other). These cases had very large DND preoperatively (40 and 50 prism diopter) and were excluded from the final results of group AR; in other words, they were calculated for 14 patients instead of 16. In the FR group, three cases developed residual ET at near fixation (average 17.3±3.1 prism diopter). These patients, as they were aligned for distant fixation, were treated with bifocal glasses (mean near addition: 2.8±0.2 diopter) that succeeded to keep them within fusional range at both distant and near fixation.

Discussion

Much of the controversies in the treatment of accommodative ET are actually because of nonuniform definitions. Therefore, different disorders - although related - were grouped together, which makes the comparison of outcomes and concluding a clear management strategy difficult. This trial focused on a definite subentity of accommodative ET: those patients who have residual distant ET outside the fusional range despite full hypermetropic correction, and with a near deviation that exceeds the distance one by 10 prism diopter or more, as well as a high AC/A ratio. This group of patients, as their distant deviation is beyond the fusional range, are not candidates for bifocals and have no options other than surgery [5].

As surgery based on distant deviation frequently resulted in undercorrection [6], augmenting or increasing the amount of MR recession was introduced in 1970 [7]. Since then, the concept of augmentation was widely accepted and several formulas had been adopted such as operating for the near deviation [6–9], the mean of the distance deviation with and without correction [10,11], the mean of the near deviation with and without correction [12], as well as a systematic adjustment of the surgical dosage table [13]. West and Repka [9] compared the results of MR recession based on near and distant deviations in patients with DND and showed that both methods yielded satisfactory outcomes. They reported that using the distance angle increased the possibility of undercorrections, whereas using the near angle reduced the need for continuous spectacle wear but with an increased risk of overcorrections.

Kushner et al. [6] prospectively compared bimedial FR with 1–2 mm augmented bimedial recession in 46 patients with a distant ET ≥10 prism diopter and with large DND. At 6 months postoperatively, they reported that rates of overcorrections and undercorrections were more variable in the Faden group (21 patients) compared with the augmentation group (25 patients), although overall numbers were low. Kushner and colleagues concluded that ARs result in at least equal, if not better, results with an easier surgical procedure for this particular group of accommodative ET. In addition, 22 out of the 25 patients of the augmented group maintained long-term follow-up for 15 years, and 19 of them achieved <10 prism diopter of ET at near [14]. However, one of the success criteria of the Kushner study was discontinuation of bifocals after surgery, which they reported to occur more frequently after augmented compared with FRs. In the current series, bifocal responders were excluded, as they were aligned within the fusional range for both distant and near fixation. The Arnoldi and Tychsen [15] study included 23 patients with accommodative ET associated with large DND and high AC/A who were treated by augmented bimedial rectus recession based on the near deviation. The distance deviation decreased in 87% of cases, with 13% of cases developing consecutive XT. However, their group of patients was not homogeneous, as some patients had no measurable distant deviation, whereas others had up to 50 prism diopter.

Bilateral MR Faden surgery with or without recession has been recommended for the treatment of patients with partially accommodative ET associated with a high AC/A ratio [16–19]. The amount of MR recession was determined by distant deviation, whereas the placement of posterior fixation suture was usually done at 12 mm.
posterior to muscle insertion or could be graded according to the degree of DND. Trials that studied the effect of bimedial FR in the treatment of partially accommodative ET with high AC/A ratio had reported that 70–88% of patients achieved ≤10 prism diopter ET, 81–93% had their DND collapsed to ≤10 prism diopter, and 71–84% of patients attained a grade of binocularity [19–22]. In the FR group of the current study, 93.3% of cases achieved less than 10 prism diopter ET at distant and near fixation, whereas the amount of DND collapse was 90.8%. In the literature, the rate of consecutive XT has been reported to range between 0 and 14%, whereas the incidence of residual ET has been estimated to be from 12 to 30% [20–23]. Kushner et al. [6] reported 14% overcorrections (three of 21 patients) and some significant undercorrections following bimedial FR for partially accommodative ET with high AC/A ratio. In the study by Akar et al. [19], 7.9 and 13.7% of cases developed consecutive XT and residual ET, respectively, secondary to MR FR. In the current series, the incidence of post-Faden consecutive XT was 12.5%, whereas 20% of cases developed residual ET but were successfully managed with bifocals.

Two studies shared the current series theme in comparing augmented MR recession with FR in the treatment of large distant–near disparity ET. Gharabaghi and Zanjani [20] compared the previously mentioned techniques with slanted MR recession in the treatment of high AC/A ratio ET with DND ≥10 prism diopter. In their 28 patients’ study, it was not well clarified whether ET was partially accommodative or pure convergence excess. However, DND was collapsed nonsignificantly by 54.2% secondary to bimedial AR, and significantly by 80.7% secondary to bimedial FR. Patients who achieved postoperative satisfactory outcome (≤10 prism diopter ET at distant and near) were 55.6 and 77.8%, respectively, with two cases developing consecutive XT in the augmented group. The other study was that of Khalifa [22], which also compared AR and FR with slanted recession of MR in the treatment of partially accommodative, convergence excess (≥10 prism diopter DND) ET, but with a normal AC/A ratio in a group of 29 patients. Significant collapse of DND by 69.6 and 76.9% was achieved in the augmented and Faden groups, respectively. Postoperative satisfactory results ‘with bifocal correction’ were obtained in 72 and 100% in the augmented and Faden groups, respectively. In total, 22.2% of cases in the augmented group developed residual near ET and 11.1% developed consecutive XT, whereas 30% of cases of Faden group were postoperatively undercorrected.

Comparatively, our study had clearer definitions for patient selection, which included patients with partially accommodative ET who showed ≥10 prism diopter deviation at near compared with their distant one and were associated with a high AC/A ratio. DND was significantly reduced by 90.8 and 79% in the Faden and augmented groups, respectively, with significant difference in favor of the Faden group. Surgical success, as defined by ≤10 prism diopter ET at distant and near fixation, was achieved in 93.3% of cases in the Faden group and in 81.2% of cases in the augmented group. In total, 12.5% of cases in the augmented group developed consecutive XT that mandated secondary surgical interventions, whereas 20% of cases in the Faden group developed residual near ET that was successfully treated with bifocal glasses.

In conclusion, this trial was concerned with a unique entity of ET in both diagnosis and management. Overall, both AR and FR procedures were significantly effective in controlling large DND and high AC/A ratio. Although FR was surgically more difficult and lengthy, it achieved a more significant reduction of DND. Both procedures had their own drawbacks; more undercorrections occurred with Faden, which may be managed optically, and more overcorrections occurred with AR, which may need a secondary procedure. It is worth mentioning that consecutive XT that complicated AR occurred in cases with extremely large DND (>40 prism diopter). Therefore, this study recommends AR for cases with mild to moderate DND and FR for cases with extremely large DND.

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Nil.

Conflicts of interest
There are no conflicts of interest.

References