

# SURGICAL TREATMENT FOR PARTIALLY ACCOMMODATIVE ESOTROPIA ASSOCIATED WITH A HIGH ACCOMMODATIVE CONVERGENCE/ACCOMMODATION RATIO

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## ABSTRACT

Partially accommodative esotropia, associated with a high accommodative convergence/accommodation (AC/A) ratio, is an acquired strabismus characterised by a manifest esotropia at distance with a larger constant esotropia at near when fixing on an accommodative target, which responds only partially to spectacle correction. The non-accommodative component of the strabismus is corrected surgically. A number of different surgical approaches have been described in patients with partially accommodative esotropia associated with a high AC/A ratio. These include standard or augmented recession, slanted recession, recession with posterior fixation suture or pulley fixation suture of the medial rectus muscle, or a combination of resection and recession of the MR muscle. In this review, the different surgical treatment modalities for partially accommodative esotropia associated with a high AC/A ratio are discussed.

**Keywords:** Partially accommodative esotropia, ophthalmologic surgical procedures, procedures, ophthalmological surgery.

## INTRODUCTION

A residual esotropia (>10 prism dioptres (PD)) at distance and near fixation that exists despite full correction of a hypermetropic refractive error or prescription of bifocal lenses or miotics or both, is called partially accommodative esotropia.<sup>1,2</sup> Partially accommodative esotropia, associated with a high accommodative convergence/accommodation (AC/A) ratio, can be characterised as having a high hyperopic refractive error (>2.0 dioptres (D)), a near deviation exceeding the distance deviation by 10 PD or more (high gradient AC/A ratio (>5 PD/D)), and an onset between the age of 6 months and 5 years of life.<sup>3-8</sup> The esotropic angle responds only partially to a reduction in accommodative effort through spectacle correction of the hyperopia, and the non-accommodative component is managed surgically.<sup>1,2</sup> A variety of surgical approaches have been proposed, including unilateral medial rectus (MR) recession,<sup>9</sup>

bilateral MR recession with<sup>4,7,10-14</sup> or without posterior fixation,<sup>3-5,7,15,16</sup> or by posterior fixation alone.<sup>17,18</sup> Some authors report using augmented formulae in an attempt to avoid undercorrections.<sup>3,4,19,20</sup> Others preferred slanted reattachment of the recessed MR muscles to the sclera.<sup>7,14,21,22</sup> In addition, some authors suggested that surgery be based on the full prism adapted angle.<sup>23-26</sup>

The objective of this review is to discuss the surgical management of patients with partially accommodative esotropia associated with a high AC/A ratio. The major surgical goal is to achieve ocular alignment and binocular function.

## SURGICAL TREATMENT

The surgical goal is to achieve alignment and fusion with full hypermetropic correction. Patients who have a cycloplegic refraction of +2.50 sphere or more with full hypermetropic correction will usually

require hypermetropic spectacles after surgery to maintain a stable result.<sup>1,2</sup>

## **a. MR Muscle Recession Operations**

### ***i) Unilateral MR muscle recession***

A large unilateral MR recession (6 mm) to treat esotropia with high AC/A ratio has been successfully applied by Zak.<sup>27</sup> Zak reported that stereopsis of 200 seconds or better was found in 75% of patients postoperatively. Then, Procyanoy and colleagues<sup>9</sup> reported that patients with high AC/A ratios and near esotropia of 15 to 35 PD were treated with a 6 to 8 mm unilateral MR recession, according to the near deviation. Of 25 patients, 96% had an alignment within 10 PD, with a follow-up ranging from 3 to 7 years.<sup>9</sup> The single MR recession has the advantage of operating on only one muscle (leading to less operating time, fewer potential complications, etc).<sup>9,27</sup>

### ***ii) Bilateral symmetric MR muscles recessions***

There are three methods for determining the target angle for partially accommodative esotropia. These include standard surgery, augmented surgery, and prism adaptation.<sup>2</sup>

## **THE STANDARD SURGERY**

The standard surgical strategy has been to operate for the residual esotropia, measured in the distance while wearing full hypermetropic correction.<sup>2</sup> In Wright and Bruce-Lee's study,<sup>20</sup> 22 (74%) of the 30 patients who had undergone standard surgery had postoperative deviations of 10 PD or less, with 8 (26%) showing a significant undercorrection. In West and Repka's study,<sup>5</sup> of 9 patients who underwent surgery for their distance deviation measured with full hyperopic correction, all had successful alignment ( $\leq 10$  PD) for both near and distance angles, and 8 of 9 (89%) had a fusion of the Worth 4-dot test at near and distance, or appreciation of the fly on stereo acuity test. In the literature, it has been shown that MR muscle recession alone, in conventional amounts targeting the distance deviation with full cycloplegic correction, produces a high rate of undercorrection.<sup>4,27</sup>

## **AUGMENTED SURGERY**

Various methods of augmenting the conventional amount of surgery have been advocated to reduce the number of undercorrections. These have included operating for the near deviation,<sup>3-5,19,28,29</sup>

the mean of the distance deviation with and without correction,<sup>30,31</sup> the mean of the near deviation with and without correction,<sup>20</sup> as well as a systematic adjustment of the surgical dosage table.<sup>32</sup>

In the study of Kushner et al.,<sup>4</sup> the amount of symmetric MR recession was determined by a modification of the basic formula, with an additional 1 mm to each medial rectus recession if the near-distance disparity was 10 PD, 1.5 mm for 15 PD, and 2 mm for 20 PD and more. They reported 96% of the 25 patients had less than 10 PD esotropia at 6 months follow-up.<sup>4</sup> Kushner et al.<sup>33</sup> later found that excellent sensory and motor outcomes persisted in 86% of 22 patients treated with near angle surgery who had received 15 years of follow-up. Other authors reported that, following augmented surgery on the near and/or distance angle, 56-98% of cases had postoperative deviations of 10 PD or less.<sup>5,7,14,20,28</sup> In the study of West and Repka,<sup>5</sup> 25 patients underwent surgery enhanced by 1.0 to 6.5 mm per eye over the dose of surgery for the distance angle (mean 3.1 mm); 20 of 25 (80%) were successful by alignment criteria ( $\leq 10$  PD) and 21 of 25 (84%) were successful by sensory criteria (a fusion of the Worth 4-dot test at near and distance or appreciation of the fly on stereo acuity test).<sup>5</sup> In Arnoldi and Thyssen's<sup>28</sup> study, 23 children were treated by recession of both medial rectus muscles for the full amount of esotropia measured at near fixation through the full distance hyperopic correction. They demonstrated that strabismus surgery was more effective than bifocals, both in reducing near deviation and in restoring normal stereopsis and binocular fusion.<sup>28</sup> The concern about this approach is that if the near alignment is fully corrected in surgery, an exotropia with distance fixation may result. Although a few exotropias are reported,<sup>5,19,20,30</sup> this is not a major problem in either the short term<sup>3,28,25,32</sup> or after many years of follow-up.<sup>33</sup>

## **THE PRISM ADAPTATION**

The rationale for prism adaptation is that prism neutralisation, done over a long period of time, will bring out the full latent deviation and reduce surgical undercorrection.<sup>2</sup> It can also help to determine if the patient has potential for fusion. Surgery is based on the full prism adapted angle.<sup>2,23-26</sup> Kutsche and Keech<sup>24</sup> used prism adaptation for the near angle in 65 patients with greater than 9 PD near-distance disparity (mean, 13.1 PD). Almost 90% had motor or sensory fusion with prisms (prism-response), whereas 31% were prism-builders. They found up to 86% of the prism responders achieving

target outcomes versus up to 50% of the non-responders.<sup>24</sup> Wygnanski-Jaffe and colleagues<sup>25</sup> also used near angle prism adaptation in 65 patients with convergence excess (mean, 15.1 PD), and found similar rates of prism-responders and prism-builders.

Excellent postoperative results (orthotropia  $\pm$  8 PD and Worth 4-dot near fusion) were more frequent for the prism-builders (72%) than for the non-responders (55%).<sup>25</sup> The preoperative use of prisms in acquired esotropia to determine the maximum angle of strabismus and to estimate fusional potential has been suggested by the Prism Adaptation Study Research Group. They reported that prism responders had better results with augmented surgery (89% of 61 patients) than with conventional surgery (79% of 67 patients).<sup>26</sup>

### **b. Bilateral Scleral Posterior Fixation Sutures with or without MR Recession**

A bilateral Faden operation on the MR muscles combined with or without recession has been advocated by some authors for the treatment of patients with partially accommodative esotropia that is associated with a high AC/A ratio.<sup>10-15,17,18,29,34-39</sup> Although the Faden procedure is technically difficult because the muscles are sutured posteriorly,<sup>7,13</sup> few global perforations after a Faden operation were reported.<sup>13</sup>

Some authors have reported that in cases with a preoperative angle of 50 PD (25° Hirschberg) or less, or in those with a large near esotropia and a very small or intermittent distance esotropia, treatment comprised of symmetric MR muscle Faden operations.<sup>13,18</sup> The posterior fixation suture is placed through the sclera, 12 mm to 14 mm posterior to the rectus muscle insertion, based on the angle of deviation (12 mm from the insertion for 20-30 PD of deviation angle, 13 mm for 40 PD, and 14 mm for 50 PD and more).<sup>13,38</sup> Some authors reported that 76-86% of patients with convergence excess were capable of maintaining satisfactory near ocular alignment with bilateral Faden operations of the MR muscles, at an average of 2-5 years of follow-up.<sup>18,34,39</sup> de Decker evaluated 235 patients who had a Faden procedure of the MR muscles, and he reported that 181 (76.5%) showed a satisfactory outcome after 2-3 years of follow-up.<sup>13</sup> The effects of posterior fixation on residual angles at near fixation were significantly higher than for angles measured at distance fixation.<sup>4</sup> Petersiem and Buckley<sup>18</sup> treated 18 patients who had a large near-distance disparity with the bilateral Faden procedure of MR muscles. They reported that the majority of patients maintained a collapse of near-distance disparity, and 70% of patients attained 400 arc-seconds of stereopsis postoperatively.<sup>18</sup> Akar et al.<sup>39</sup> determined a 77.6% reduction in near-distance disparity following a Faden procedure of

**A1**



**A2**



**B1**



**B2**



**Figure 1.**

**A1 and A2:** Preoperative photographs (with and without glasses) of a case with partially accommodative esotropia with a high AC/A ratio. Note: The patient is able to alternate fixation between his right and left eye so that at one moment the right eye fixates and the left eye turns inward (A1), and at the next the left eye fixates and the right turns inward (A2).

**B1 and B2:** Postoperative photographs (without and with glasses) showing primary position of the gaze, 6 months after bilateral medial rectus recession combined with Faden operations.

both MR muscles, which was stable during the entire follow-up period (mean 4.8 years). In the literature, the incidence of secondary exotropia occurring after a Faden operation of both MR muscles without recession has been reported to be 0–4.6%.<sup>18,34,39,40</sup> Some authors explained that the procedure's effect was lost over time.<sup>39–41</sup>

Some authors reported treatment that consisted of MR muscle recessions combined with a posterior fixation suture in cases where the preoperative esotropia was 50 PD (25° Hirshberg) or greater and where esotropia for distance fixation exceeded 10 PD, despite wearing his/her full cycloplegic correction glasses.<sup>7,13,42</sup> The actual amount of symmetric MR recessions performed in conjunction with posterior fixation is based on published surgical tables.<sup>4,43</sup> In the literature, some authors have reported that 70–88% of patients were able to maintain satisfactory ocular alignment (<10 PD) and 81–93% of these patients showed reduced near-distance disparity (<10 PD) from 5 months to 4.8 years of follow-up, after Faden operations of the MR muscles combined with recession for partially accommodative esotropia with a high AC/A ratio.<sup>7,11,12–14,39</sup> Some authors reported that 71–84% of patients attained a grade of binocularity after Faden operations of the MR muscles, combined with the recession of partially accommodative esotropia with a high AC/A ratio.<sup>11,12,39</sup> Kushner et al.<sup>4</sup> noted that 3 of 21 patients who underwent Faden operations of bilateral MR muscles with recession were overcorrected, whereas some were significantly undercorrected. In multiple studies,<sup>4,7,11,39</sup> the incidence of secondary exotropia occurring after Faden operations of MR muscles with recession has been reported as 0–14%, whereas the incidence of residual esotropia after these operations has been reported as 12–30%.

Preoperative and postoperative photographs of a case with partially accommodative esotropia with a high AC/A ratio are shown in Figure 1.

### **c. Bilateral Pulley Fixation Sutures with MR Recession**

Pulley sutures provide another useful surgical solution for convergence excess cases.<sup>8</sup> Standard MR recessions are combined with MR pulley posterior fixation without scleral sutures.<sup>6</sup> In this technique, the MR muscle belly is fixated directly to the pulley by a suture to produce a comparable mechanical restriction.<sup>6,8</sup> Clark and colleagues<sup>6</sup> first described the use of pulley fixation in 13 patients with accommodative or partially accommodative

esotropia associated with a near-distance disparity greater than 10 PD. They compared nine patients who had similar MR muscle recession doses but with scleral posterior fixation sutures. In this study, 92% of pulley suture patients and 89% of scleral posterior fixation suture patients had a final near and distance alignment of 0–10 PD with no overaction. Stereoacuity improved 67% of pulley suture patients and 86% of scleral posterior fixation suture patients.<sup>6</sup> Mitchell and colleagues<sup>8</sup> reported that 26 accommodative or partially accommodative esotropia patients with convergence excess were treated by the use of MR pulley posterior fixation sutures. They determined that of 29 patients, 16 (61.5%) were aligned between 0–9 PD at near and distance fixation and 7.7% of patients had an overaction (<10 PD) at final follow-up.<sup>8</sup> MR pulley posterior fixation augments MR recession with relatively greater effect at near.<sup>44</sup>

### **d. Bilateral Symmetric Slanted Recession of the MR Muscles**

Nemet and colleagues<sup>21</sup> introduced slanted suturing of the recessed rectus muscles insertion to the sclera for convergence excess esotropia. Slanted recession means the inferior pole of the muscle insertion is recessed more than the superior pole. In this technique, the amount of recession of the upper margin of the muscle is calculated to correct distance esotropia, and the amount of recession of the lower margin is calculated to correct near deviation. The amount of recession is based on conventional graduation.<sup>7</sup> Some authors<sup>7,14</sup> reported that satisfactory results ( $\leq 10$  PD esotropia at near and distance fixation) occurred in 70% of the patients who underwent slanted MR recession for the treatment of high AC/A ratio esotropia. These authors did not report sensorial outcomes.<sup>7,14</sup> Due to its good results and being an easy, non-invasive approach without any additional complications, the slanted recession has been recommended by some authors to treat partially accommodative esotropia with a high AC/A ratio.<sup>7,22</sup>

### **e. Bilateral Combined Resection and Recession of the MR Muscle**

Ramasamy and colleagues<sup>45</sup> reported that the use of this surgical technique produced full asymptomatic binocular control at near and distance fixation in four of the five patients with convergence excess, but one patient developed a consecutive exotropia.

Bradbury et al.<sup>46</sup> reported that the presence of binocular function stabilises the deviation. Table 1

**Table 1. Comparison between surgical results for patients with and without binocular function before surgery in various series.**

Pre-op, pre-operative; BF, binocular function; post-op, post-operative; mo, months; MR, medial rectus; op, operation.

**a.** Postoperative motor and sensorial success; motor success : deviation of  $\leq 10 \Delta$ , sensorial success: stereopsis  $\leq 400$  arc-seconds or better than 400 arc-seconds.

**b.** 7 of the 9 patients were able to co-operate with pre-operative and post-operative near stereoacuity measurements.

**c.** 12 of 13 patients were able to co-operate with pre-operative and post-operative near stereoacuity measurements.

Authors	No. of patients (n)	Surgical method	No. of patients with pre-op BF n (%)	Post-op success <sup>a</sup> n (%)	No. of patients without pre-op BF n (%)	Post-op success <sup>a</sup> n (%)	Follow-up (mo)
West and Repka <sup>5</sup>	9	Distance angle surgery	4 (44%)	4 (100%)	5 (56%)	4 (80%)	18
	25	Near angle surgery	15 (60%)	13 (87%)	10 (40%)	7 (70%)	30
Peterseim at al. <sup>18</sup>	16	Bilateral MR scleral Faden op	6 (38%)	4 (67%)	10 (62%)	7 (70%)	36
Clark at al. <sup>44</sup>	9 <sup>b</sup>	MR recession+scleral Faden op	4 (57%)	4 (100%)	3 (43%)	3 (100%)	22
	13 <sup>c</sup>	MR recession+pulley Faden op	7 (58%)	7 (100%)	5 (42%)	4 (80%)	10

provides an overall comparison between surgical results for patients with and without binocular function before surgery in the studies with various procedures for the treatment of partially accommodative esotropia associated with a high AC/A ratio.

## SUMMARY

Historically, surgical formulae for the management of partially accommodative esotropia with high AC/A ratio have been based on the residual deviation with full hypermetropic correction. The surgical management of patients with esotropia that is significantly greater at near than distance represents a challenging problem.

In response to the large number of undercorrections with standard surgery, the authors have devised formulae for augmenting the amount of rectus recession based on the average of the near deviation with and without correction, the mean of the distance deviation with and without correction, a systematic adjustment of the surgical dosage table, and prism-

adapted near angle surgery. Following augmented surgery, a few secondary exotropias were reported.

The effectiveness of bilateral Faden operations of the MR muscles combined with or without recession, for the treatment of partially accommodative esotropia with high AC/A ratio has been confirmed by many authors. Bilateral pulley fixation sutures with MR recession provide another useful surgical solution for these cases. The slanted recession of bilateral MR muscles and combined resection and recession of bilateral MR muscles has also been recommended by some authors.

In our clinic, we have preferred bilateral Faden operations of the MR muscles combined with or without recession for the treatment of partially accommodative esotropia with high AC/A ratio because these operations were advantageous in this patient population by reducing the near-distance disparity and the AC/A ratio, and by improving binocular function. Bilateral MR Faden operations is a good alternative in patients with a small distance deviation (to reduce the risk of overcorrection)

and those with large near esotropia and a very small or intermittent distance esotropia, because the patients with large near-distance disparity are particularly difficult to treat with traditional surgery. In the patients with large distance deviation and partially accommodative esotropia, we have preferred bilateral Faden operations of the MR muscles combined with recession. In these cases, we do not oppose an augmented MR muscle recession. In literature, it is not clear whether pulley

posterior fixation sutures reduced the near-distance incomitance more than augmented MR muscle recessions. In addition, the utility of adding pulley posterior fixation to MR muscle recessions was not proven. So, we have not preferred this technique for the surgical treatment of partially accommodative esotropia. We do not have any experience with bilateral symmetric slanted recession of the MR muscles for surgical treatment of partially accommodative esotropia.

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