Medial Rectus Recession After Vertical Rectus Transposition in Patients With Esotropic Duane Syndrome

Stacy L. Pineles, MD; Arthur L. Rosenbaum, MD; Ramesh Kekunnaya, MD; Federico G. Velez, MD

Objective: To describe preoperative characteristics and postoperative results among patients with esotropic Duane syndrome who underwent vertical rectus transposition with vs without subsequent medial rectus recession (MRR).

Methods: Clinical records were compared of patients with esotropic Duane syndrome who underwent vertical rectus transposition (study group) vs without (control group) subsequent MRR.

Results: Twenty-three study group members and 26 control group members were identified. Preoperative characteristics that differed between groups were the mean (SD) primary position deviation (20 [7] prism diopters of esotropia [H9004/ET] for the study group vs 15 [9] H9004/ET for the control group, P = .002) and the mean (SD) adduction deviation (1.4 [4.0] H9004/ET for the study group vs 2.5 [4.0] H9004/exotropia for the control group, P = .04). Forcedduction testing (FDT) revealed greater restriction to abduction (17 [7]° for the study group vs 23 [6]° for the control group, P = .002). After vertical rectus transposition, study group members had significantly greater mean (SD) ET (16 [7] H9004/ET vs 0.4 [0.6] H9004/ET for the control group, P < .001) and torticollis (10 [4]° vs 1 [5]° for the control group, P < .001) and significantly less mean (SD) abduction (−3.0 [−0.6] vs −2.0 [−0.7] for the control group, P = .20). After MRR, no significant difference was observed between groups in primary position deviation, but the study group had significantly less mean (SD) abduction (−1.0 [−0.8] vs −0.4 [−0.6] for the control group, P < .003).

Conclusions: Risk factors for requiring MRR after vertical rectus transposition include greater ET in the primary position and in the adducting field of gaze, as well as greater restriction to abduction on intraoperative FDT. Postoperative results of patients who required MRR were similar to those of patients who did not require MRR.

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DUANE SYNDROME, A CONGENITAL INNERSERATIONAL DISORDER characterized by anomalous lateral rectus muscle innervation, commonly manifests as severely limited abduction, torticollis, esotropia (ET), and globe retraction in adduction. In typical cases of esotropic Duane syndrome, surgical intervention is indicated to reduce strabismic deviations, to decrease torticollis, to increase the diplopia-free binocular field, and to improve abduction. Vertical rectus transposition (VRT) surgery has been used effectively to treat Duane syndrome. First introduced in 1974 by Gobin,1 the procedure was further characterized and described for use in esotropic Duane syndrome by Molarte and Rosenbaum.2 In 1997, Foster3 added augmentation with posterior fixation sutures to the previously described procedure, and this version of the VRT was popularized for many years in the treatment of Duane syndrome.4 The usefulness of augmented VRT vs ipsilesional medial rectus recession (MRR) is debatable.4-7 The advantages of augmented VRT compared with ipsilesional MRR include increased abduction ability and diplopia-free visual field and decreased risk of creating a limitation to adduction.4-7 However, a subset of patients exists in whom the augmented VRT procedure does not adequately treat their associated ET or torticollis, such that subsequent MRR is required.48

The objectives of this study were to describe preoperative characteristics of patients who required MRR after augmented VRT for esotropic Duane syndrome and to identify risk factors that may predict the necessity of the subsequent procedure. Also, we evaluated surgical outcomes in this...
Table 1. Preoperative Characteristics of Patients Having Esotropic Duane Syndrome Who Underwent VRT With (Study Group) vs Without (Control Group) Subsequent MRR

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Study Group</th>
<th>Control Group</th>
<th>P Valuea</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age at surgery, y</td>
<td>6.1 (11.0)</td>
<td>4.3 (10.3)</td>
<td>.20</td>
</tr>
<tr>
<td>Deviation, △ET</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Primary position</td>
<td>20 (7)</td>
<td>15 (9)</td>
<td>.002</td>
</tr>
<tr>
<td>Adduction</td>
<td>1.4 (4.0)</td>
<td>2.5 (4.0)</td>
<td>.04</td>
</tr>
<tr>
<td>Abduction</td>
<td>38 (11)</td>
<td>42 (11)</td>
<td>.70</td>
</tr>
<tr>
<td>At near</td>
<td>15 (9)</td>
<td>11 (7)</td>
<td>.10</td>
</tr>
<tr>
<td>Torticollis, degrees</td>
<td>16 (6)</td>
<td>16 (6)</td>
<td>.90</td>
</tr>
<tr>
<td>Adduction</td>
<td>0.1 (0.2)</td>
<td>0.1 (0.2)</td>
<td>.50</td>
</tr>
<tr>
<td>Abduction</td>
<td>3.8 (0.4)</td>
<td>3.9 (0.3)</td>
<td>.80</td>
</tr>
<tr>
<td>Stereopsis, arc s</td>
<td>509 (890)</td>
<td>82 (78)</td>
<td>.10</td>
</tr>
<tr>
<td>Intraoperative forced duction testing, degreesc</td>
<td>17 (7)</td>
<td>23 (6)</td>
<td>.002</td>
</tr>
</tbody>
</table>

Abbreviations: △ET, prism diopters of esotropia; MRR, medial rectus recession; VRT, vertical rectus transposition.

a Two-tailed t test.

b Measured as prism diopters of exotropia.

c Testing of restriction to abduction during intraoperative forced duction testing, reported as degree in abduction at which initial restriction is appreciated.

This study was approved by the University of California, Los Angeles Institutional Review Board and it conformed to requirements of the US Health Insurance Portability and Accountability Act of 1996. The clinical records of all patients seen between January 1, 1998, and December 31, 2008, in the single-surgeon practice of one of us (A.L.R.) at the Jules Stein Eye Institute with the diagnosis of esotropic Duane syndrome were retrospectively reviewed. Included in the analysis were patients who had undergone full-tendon VRT with posterior fixation (augmented VRT) as their first surgical procedure and had at least 8 weeks of postoperative follow-up data. Our technique for performing VRT with posterior fixation has been described previously. Patients were excluded if they had a history of strabismus surgery or bilateral Duane syndrome. Also, they were excluded if they had any consecutive vertical deviations that required additional surgical treatments. Patients were categorized as those who had undergone subsequent ipsilateral MRR (the study group) and those who had required no additional surgical procedures (the control group) before their last follow-up visit.

The preoperative and postoperative characteristics recorded from the clinical records were age at onset, age at surgery, best-corrected visual acuity, cycloplegic refraction, near stereopsis, degree of torticollis, assessment of ocular ductions, and preoperative motor alignment at distance and near and in the cardinal positions of gaze. For patients who had undergone MRR after VRT, these characteristics also were recorded at the preoperative visit before the subsequent surgery. Surgical information recorded included the results of intraoperative forced duction testing (FDT) and all subsequent surgical procedures. Forced duction testing was graded on a 3-point scale as mild, moderate, or severe. Although FDT was estimated methodically by the same surgeon, it was not rigorously quantified using an objective instrument, such as a dynamometer. For the purpose of this study, these results were converted into numerical values, with mild representing restriction at 30° of abduction, moderate representing restriction at 20° of abduction, and severe representing restriction at 10° of abduction.

In general, visual acuity was assessed using projected age-appropriate optotypes after manifest or cycloplegic refraction. Near stereopsis was assessed using the Titmus test. Ocular alignment was evaluated using cover-uncover and alternate prism cover testing at distance (20 ft) in the cardinal gaze positions. Motor alignment at near was assessed at 14 in. All motor evaluations were performed using appropriate spectacle correction if indicated. Torticollis was estimated in degrees corresponding to the angle formed by the axial axes of the skull and an imaginary perpendicular line to the transverse axis of the body. It was qualitatively estimated by the same surgeon as the patient sat erect, fixing on a target at 20 ft. Ocular ductions were measured using a standard 9-point scale.

**STATISTICAL ANALYSIS**

Statistical analyses were performed using commercially available software (STATA; version 10.0; StataCorp LP, College Station, Texas; and Excel for Mac, version 2008; Microsoft Corporation, Redmond, Washington). To assess differences between patients who underwent MRR after VRT and those who did not, the t test was used to compare the mean characteristics of both groups. P < .05 was considered statistically significant.

Forty-nine patients met the inclusion criteria for the study. Five additional patients met the inclusion criteria but were excluded because of postoperative vertical deviations. Of the included patients, 23 had undergone MRR after VRT and 26 had undergone VRT only. No significant difference was observed in age between groups at the time of VRT. The mean (SD) interval between VRT and subsequent MRR was 11 (17) months in the study group. No significant difference was observed in the mean (SD) postoperative follow-up duration between groups (27 [30] months for the study group vs 33 [35] months for the control group, P = .50).

**PREOPERATIVE AND INTRAOPERATIVE FINDINGS**

Table 1 summarizes the preoperative findings in both groups. Before surgery, the study group had significantly greater primary position deviation than the control group. Before surgery, no significant differences were observed between groups in deviation at near, torticollis, adduction or abduction ability, or stereopsis. Intraoperative FDT results during VRT differed significantly between groups.

**POSTOPERATIVE FINDINGS**

After VRT and Before MRR

Table 2 summarizes the postoperative findings in both groups. Because a poorer surgical outcome was the rea-
son for subsequent MRR, the study group had significantly greater residual ET and torticollis after the first operation than the control group.

After MRR

After MRR, no significant differences were observed between groups in primary position deviation, adduction deviation, abduction deviation, or deviation at near (Table 2). The study group had significant reversal of the direction of torticollis and significantly less adduction. No significant difference was observed between groups in final postoperative abduction ability. For both groups, the deviation in all directions of gaze was significantly improved (P < .001 for both), and the mean (SD) abduction ability was significantly improved vs preoperative values (−3.8 [−0.4] vs −2.1 [−0.6] for the study group and −3.9 [−0.3] vs −2.0 [−0.7] for the control group, P < .001 for both).

Table 2. Postoperative Results of Patients Having Esotropic Duane Syndrome Who Underwent VRT With (Study Group) vs Without (Control Group) Subsequent MRR

<table>
<thead>
<tr>
<th>Variable</th>
<th>After VRT and Before MRR, Mean (SD)</th>
<th>After MRR, Mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Study Group (n=23)</td>
<td>Control Group (n=26)</td>
</tr>
<tr>
<td>Deviation, ΔET</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Primary position</td>
<td>15.9 (6.9)</td>
<td>0.4 (0.6)</td>
</tr>
<tr>
<td>Adduction</td>
<td>0.1 (5.0)</td>
<td>5.7 (6.9)c</td>
</tr>
<tr>
<td>Abduction</td>
<td>30 (7)</td>
<td>18 (11)</td>
</tr>
<tr>
<td>At near</td>
<td>9 (6)</td>
<td>0 (6)</td>
</tr>
<tr>
<td>Torticollis, degrees</td>
<td>10.3 (4.1)</td>
<td>1.2 (5.1)</td>
</tr>
<tr>
<td>Adduction</td>
<td>0.2 (0.3)</td>
<td>0.4 (0.6)</td>
</tr>
<tr>
<td>Abduction</td>
<td>−3.0 (−0.6)</td>
<td>−2.0 (−0.7)</td>
</tr>
</tbody>
</table>

Abbreviations: ΔET, prism diopters of esotropia; MRR, medial rectus recession; VRT, vertical rectus transposition.

a Two-tailed t test.
b P < .05.
c Measured as prism diopters of exotropia.

Patients with esotropic Duane syndrome undergoing augmented VRT who may need subsequent MRR usually can be predicted by preoperative characteristics. In our series, postoperative results of patients who required MRR were similar to those of patients who did not require MRR. Although the procedure of choice for esotropic Duane syndrome is debatable, with some authors favoring ipsilesional MRR,6,7 others believe that augmented VRT provides better postoperative abduction ability and a larger diplopia-free visual field than ipsilesional MRR only.4,7 The medial rectus (MR) length-tension curve in patients with esotropic Duane syndrome has increased stiffness in the ipsilateral MR muscle, which may explain why some patients with Duane syndrome do not respond to augmented VRT only and why some authors report improvement in ET after unilateral or bilateral MRR only.7,10 Given the increased ipsilesional MR stiffness in many patients with Duane syndrome, it is not surprising that a subset of patients exists in whom the augmented VRT procedure is insufficient to maximally treat ET or torticollis. Because the transposition procedure relies on relaxation of the antagonist muscle (ie, the MR) during attempted abduction to allow for an improvement in abduction and a decrease in ET, it follows that a tight MR often will create disappointing results after VRT.9

Our data reveal several characteristics of patients who require MRR after augmented VRT surgery. Specifically, patients who eventually underwent MRR were more likely to have larger-angle ET in the primary position and in adduction. This is logical because greater ET in adduction reflects increased stiffness in the MR before surgery (which is further corroborated by our finding of increased restriction of FDT in this group) and possibly less or absent cocontraction. Also, some patients who did not require MRR actually had exotropia in adduction before VRT, indicating greater cocontraction or less MR stiffness, which may have led to less likely undercorrection after surgery. Based on the results of augmented VRT in the study group only, one would conclude that augmented VRT is ineffective, underscoring the need for subsequent MRR. However, with the addition of subsequent MRR in this subgroup of patients, postoperative results were similar between groups in ET correction, direction of torticollis, and abduction ability. At the final postoperative visits, both groups had excellent surgical results, including equally significant improvement in abduction, which has not been described after other surgical procedures (including unilateral MRR).6,7

Some authors have argued for the use of unilateral or bilateral MRR to treat esotropic Duane syndrome, citing excellent results, a simpler procedure, and lower risk of postoperative complications, such as vertical deviations.6,7,10,11 However, despite its risks, VRT with or without subsequent MRR (depending on preoperative factors described herein) should be considered for patients in whom increased abduction and a larger diplopia-free field are desired outcomes, along with ET and torticollis correction. Furthermore, a theoretical risk of long-term failure exists after ipsilesional MRR only, owing to

**COMMENT**

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the lack of lateral rectus muscle tonus to maintain alignment stability. Finally, in patients with small deviations or preoperative exotropia in adduction, a risk of overcorrection exists with ipsilateral MR weakening procedures because of an enhancement of any lateral rectus cocontraction.12,13 Although postoperative overcorrection also is possible after augmented VRT, this result is more likely to be secondary to restriction created by the transposition; hypothetically, it may be more reversible than the enhanced cocontraction created by MR weakening.14 For these reasons, our preferred practice has been to treat most cases of esotropic Duane syndrome with augmented VRT and to perform subsequent MRR in those patients who demonstrate unacceptable residual deviations or torticollis. This study demonstrates that patients who require subsequent MRR can achieve the excellent results obtained by other patients after augmented VRT. In patients who are likely to require subsequent MRR, a single procedure incorporating augmented partial-tendon transposition with ipsilateral MRR may be considered. Although this procedure has been evaluated in patients with Duane syndrome,15,16 it has not been rigorously compared with full-tendon transposition and subsequent MRR in a stepwise approach, as was performed herein.

The results of our study should be understood within the context of its limitations. Our study was a retrospective clinical record review and is subject to the selection and follow-up bias inherent to all retrospective reviews. Also, we do not often perform primary MRR for esotropic Duane syndrome, we were unable to include this in our comparison of results, and we cannot comment on whether those patients who eventually underwent subsequent MRR would have benefited from MRR only. Finally, our practice mainly is composed of tertiary referrals and may not be representative of all patients with Duane syndrome.

Despite these limitations, our study represents the largest analysis to date, to our knowledge, of patients with esotropic Duane syndrome who require additional surgery for residual ET and torticollis. It reveals that these patients have much to gain from subsequent MRR. Patients with Duane syndrome who are undergoing augmented VRT should be informed of the possible need for subsequent procedures to obtain the best results, especially patients having greater ET or those found to have restriction on intraoperative FDT. A staged approach enables surgeons to titrate MRR after augmented VRT to further enhance accuracy.

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REFERENCES