Major Article

Surgical outcomes following rectus muscle plication versus resection combined with antagonist muscle recession for basic horizontal strabismus

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PURPOSE To evaluate change in ocular alignment and surgical success of rectus muscle plication versus resection when coupled with antagonist muscle recession for basic esodeviations and exodeviations.

METHODS The medical records of consecutive patients with basic horizontal strabismus who underwent a rectus muscle plication or resection combined with a known amount of antagonist muscle recession from January 2009-June 2016 by one surgeon were reviewed retrospectively. Changes in ocular alignment and surgical success at 4-16 weeks after surgery and reoperation rates for plication compared to resection were assessed. Success was defined as undercorrection of $\leq 10^{\Delta}$ and overcorrection of $\leq 4^{\Delta}$ at distance.

RESULTS A total of 162 patients with basic esotropia (88 lateral rectus muscle plications; 74 lateral rectus resections) and 60 patients with basic exotropia (31 medial rectus muscle plications; 29 medial rectus resections) were included. Success rates at 4-16 weeks after surgery were 95.5% for lateral rectus plication, 89.2% for lateral rectus resection, 77.4% for medial rectus plication, and 96.6% for medial rectus resection. No significant differences were found when analyzing the change in ocular alignment between the plication and resection groups for patients with either basic esotropia or basic exotropia. Reoperation rates were low for all groups (range, 3.2%-5.4%) during a follow-up period of 4 weeks to 72 months.

CONCLUSIONS Horizontal rectus muscle plication produced similar changes in ocular alignment and surgical success compared to rectus muscle resection at 4-16 weeks after surgery when coupled with comparable amounts of antagonist muscle recession. (J AAPOS 2017;■:1-5)

Muscle-to-sclera plication is an alternative procedure to resection for tightening of horizontal and vertical rectus extraocular muscles.[1,2] Potential advantages of plication over resection include simplicity, less surgical trauma, potential reversibility, shorter operating time, sparing of anterior ciliary vessels, and elimination of the risk of a lost muscle.[1-4]

Disagreement has arisen as to whether the dose–response effect of horizontal rectus muscle plication is equivalent to that of resection. Wright and Lanier reported that muscle-to-sclera plication was slightly less powerful than a standard resection, and recommended increasing the posterior placement of the suture 0.5 mm compared to a standard resection.[3] No clinical data to support this recommendation was published. Chaudhuri and Demer[2] concluded that horizontal rectus muscle plication produced an equivalent surgical effect to resection for the treatment of esotropia and exotropia. Alkharashi and Hunter[5] reported that 6-12 weeks postoperatively surgical success was significantly higher in the resection group (89%) compared to the plication group (58%). Chaudhuri and Demer[2] analyzed 22 consecutive patients who underwent bilateral horizontal rectus muscle plication or plication combined with antagonist recession, and Alkharashi and Hunter[5] reviewed a total of 24 plication procedures. Therefore, these two prior studies examined only a small number of patients who underwent plication and included patients with a history of prior muscle surgery on the antagonist muscle and complex strabismus. This retrospective study evaluated the change in ocular alignment and surgical success of horizontal rectus muscle plication versus resection when coupled with antagonist muscle recession for basic esodeviations and exodeviations.

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Subjects and Methods

This study was approved by the IntegReview Institutional Review Board and conformed to the requirements of the US Health Insurance Portability and Accountability Act of 1996. All patients with basic horizontal strabismus who underwent a rectus muscle plication or resection combined with a known amount of antagonist muscle recession from January 2009 to June 2016 by a single surgeon were retrospectively reviewed. This surgeon's preferred routine horizontal rectus muscle strengthening or tightening procedure was resection from 1987 through 2012 and then changed to plication from 2013 to the present.

Inclusion criteria for this study were basic esotropia or exotropia (distance and near measurements varying by $<15^{\Delta}$), with the following procedures permitted: simultaneous muscle surgery on a vertical rectus muscle or an inferior oblique muscle, vertical transposition of the horizontal rectus muscles of ≤3 mm in the same direction, and an adjustable suture for the recessed antagonist horizontal rectus muscle only if no adjustment was made in the position of this muscle postoperatively. Exclusion criteria for this study were as follows: oculomotor or abducens nerve paresis, prior eye muscle surgery on the involved horizontal rectus muscles, simultaneous superior oblique surgery, abnormal eye muscles (eg, thyroid eye disease, Duane syndrome, CPEO, prior scleral buckle surgery), and vertical transposition of the horizontal rectus muscles in opposite directions to address an A or V pattern.

All patients had a comprehensive baseline eye and ocular motility evaluation. Distance and near heterotropias were measured by prism and alternate cover testing at 6 m and 1/3 m, wearing optimal optical correction as needed. We assessed changes in ocular alignment and surgical success at 4-16 weeks after surgery, analyzing the last available measurements during that 3-month time period. Ocular alignment measurements listed in Tables 1 and 2 represent the average of the distance and near ocular alignment in primary gaze. Follow-up intervals and reoperation rates were calculated for plication compared to resection patients. Success was defined as distance ocular alignment of $\leq 10^{\Delta}$ of undercorrection and $\leq 4^{\Delta}$ of overcorrection.

Surgical doses for plication and resection were based on the distance measurement for esotropia and near measurement for exotropia. Surgical doses for recession were based on the near measurement for esotropia and distance measurement for exotropia. The quantity of surgery performed followed the recommendations of Parks but reduced the medial rectus resection or plication by 1 mm from these recommendations.[6,7] The surgeon assumed an equivalent effect for plication and resection procedures.

Sex, age, type of recession (fixed conventional vs adjustable converted to hang-back), surgical approach (fornix vs limbal incision), and anesthesia type (general vs local with sedation) were analyzed. The presence of amblyopia was calculated for all four cohorts. Amblyopia was defined for this study as an interocular difference of best-corrected visual acuity of ≥2 lines, with no other anatomic explanation, or the inability to hold fixation to a blink in a preverbal child.

Most operations were performed under general anesthesia using a fornix conjunctival incision for patients <65 years of age and a limbal conjunctival incision for patients ≥65 years of age. A double-armed polyglactin 910 suture was placed through the muscle margin at the distance from the scleral insertion based on the planned plication or resection amount. Adjacent anterior ciliary vessels were avoided for plications when possible. For plication, the two suture needles were passed through partial thickness scleral tunnels located about 2 mm anterior to and parallel to the muscle insertion, avoiding anterior ciliary vessels, as described by Wright and Hong.[1] The suture ends were tied securely forming a triple surgeon's knot. The surgeon's plication technique is shown in Video 1 (available at jaapos.org). For resections, a straight hemostat compressed rectus muscle adjacent to the previously placed suture and muscle anterior to the clamp was cut along the clamp and severed from the sclera using curved tenotomy scissors. Resected muscle was sewn to the globe at the insertion site and tied with a triple knot.

Statistical Analysis

Independent *t* tests were conducted to detect significant differences in the change in ocular alignment between the plication and resection treatment groups of the esotropia and exotropia cohorts. One requirement to perform independent *t* tests is that the differences in the dependent variable between the two related groups should be normally distributed. To test this, skewness and kurtosis statistics were calculated and confirmed by visual inspection of Q-Q plots. Outliers were assessed by converting prism diopter change in ocular alignment to *z* scores. A *z* score of >3 was deemed an outlier. The effect size, Cohen's *d*, was computed for the group differences between the plication and resection treatment groups for esotropia and exotropia patients. The effect size on this group difference can be classified as a small (0.1 to <0.5), medium (0.5 to <0.8), or large (≥0.8) based on the arbitrary, broadly applied thresholds proposed by Cohen.[8] Due do the small sample sizes of the exotropia cohort (n = 60) and unequal sample sizes for the plication and resection groups, the nonparametric Mann-Whitney-Wilcoxon test was also used to detect possible significant differences between the plication and resection groups for the esotropia and exotropia cohorts. An a priori power analysis was calculated to determine the minimum sample size required for statistical significance of our results. Sample size estimates for each treatment was based on 80% power and two-sided α of 0.025 (overall $\alpha = 0.05$). For Independent *t* tests we calculated a total sample size of 128 (64 in group 1; 64 in group 2). Our basic esotropia cohort met this threshold; our basic exotropia cohort did not.

Results

A total of 222 patients met inclusion and exclusion criteria. For basic esotropia, 88 patients (mean age, 23 years; 50% female) underwent lateral rectus muscle plication and medial rectus muscle recession, and 74 patients (mean age, 10 years; 45% female) underwent lateral rectus resection with medial rectus recession. For basic exotropia, 31 patients (mean age, 34 years; 48% female) underwent medial rectus plication and lateral rectus recession, and 29 patients (mean age, 23 years; 48% female) underwent medial rectus resection and lateral rectus recession.