Published in final edited form as:
Strabismus. 2013 March ; 21(1): 23–28. doi:10.3109/09273972.2012.762533.

Postoperative Drift in Patients with Thyroid Ophthalmopathy Undergoing Unilateral Inferior Rectus Muscle Recession

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Abstract

Background—Extraocular muscles of patients with thyroid ophthalmopathy (TO) may respond differently to strabismus surgery than those of other strabismic patients. This study reports postoperative alignment changes in patients with TO compared with patients with non-restrictive strabismus following unilateral inferior rectus muscle recession (IRR).

Methods—We reviewed records of patients with and without TO who underwent unilateral IRR. Group A had adjustable muscle sutures, while Group B had permanent or semi-adjustable sutures. Controls were patients undergoing adjustable unilateral IRR for other indications.

Results—Mean preoperative hypotropias were 17 ± 9, 21 ± 7, and 11 ± 4 PD for groups A (n = 13), B (n = 14), and controls (n = 19), respectively. Postoperative day one (POD1) measurements after adjustment were 1.2 ± 2.5, 3.7 ± 4.9, and 0.3 ± 2.4 PD, respectively, representing overall undercorrections in all cases (the preoperative deviation was given a positive (+) value and overcorrections were deemed negative (−) deviations). Dose response from linear regression analysis of thyroid patients compared with control patients for IRR was 3.26 PD/mm (SE 0.18) vs 2.38 PD/mm (SE 0.18) (p = 0.001). Mean final measurements were −0.7 ± 5.6 (overcorrection), 2.7 ± 5.7, and 1.7 ± 5.7 PD of hypotropia, respectively. Final overcorrections occurred in 23%, 14%, and 16% of patients, for adjustables, permanent sutures, and control subjects, respectively. Drifts from POD1 measurements after adjustment to final measurements were −1.9 ± 4.3, −1.0 ± ; 4.6, and 1.4 ± 5.9 PD respectively (p = 0.05 for comparison between Group A and controls).

Conclusions—TO patients with adjustable sutures drift toward postoperative overcorrection.

Keywords

Adjustable; drift; Graves disease; overcorrection; restriction

INTRODUCTION

Thyroid ophthalmopathy (TO) is a well-known autoimmune inflammatory disease entity that leads to many ophthalmic problems, including restrictive strabismus. Infiltration of the extraocular muscles by lymphocytes, hyaluronic acid, and glycosaminoglycans leads to eventual fibrosis and incomitant strabismus, surgical correction of which is further complicated by the altered physical properties of the extraocular muscle (Bothun et al.,

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Material presented as a poster at the 2012 AAPOS meeting.

2009; Fells et al., 1994; Kazim et al., 2002; Metz 1999). These intrinsic changes to the muscle may lead to different responses to standard dose surgery. In an attempt to address the less predictable nature of these extraocular muscles, adjustable sutures are frequently used (Nihalani & Hunter 2011; Tripathi et al., 2003). Using adjustable sutures may allow for more precise alignment of the eyes in the immediate postoperative period, and allows the surgeon to adjust for unpredictable outcomes in the immediate postoperative period. However, the use of adjustable sutures in patients with TO is controversial and previous studies have evaluated the efficacy of adjustable sutures in TO to prevent immediate postoperative misalignment (Gardner & Kennerdell 1990; Kraus & Bullock 1993; Sharma & Reinecke 2003; Sprunger & Helveston 1993). Additionally, semiadjustable procedures have been proposed for use to prevent late muscle slippage, including patients with TO (Kushner 2004).

Because the inferior rectus muscle is most commonly involved in TO, we chose to examine patients who underwent unilateral inferior rectus recession (IRR) for hypotropia, both with and without adjustable sutures, to evaluate differences in postoperative outcomes when these patients were compared to control cases with non-restrictive strabismus. Because previous studies have revealed a higher likelihood of overcorrections in patients with TO, we sought to evaluate the outcome differences in patients who underwent adjustable vs semi-adjustable procedures, compare the likelihood of overcorrection to control subjects undergoing a similar procedure for a non-TO indication, and quantify postoperative alignment changes (Hudson & Feldon 1992; Sprunger & Helveston 1993; Wright 1996). Our goal was to further characterize postoperative outcomes in patients with TO to aid in surgical planning.

METHODS

This study was approved by the University of California, Los Angeles, Institutional Review Board and conformed to the requirements of the U.S. Health Insurance Portability and Accountability Act. The clinical records of patients in tertiary care strabismus practices at the Jules Stein Eye Institute between 1997 and 2011 with the diagnosis of TO and vertical strabismus were retrospectively reviewed. Those patients undergoing unilateral IRR for the vertical component of their strabismus as their first surgery were selected from these patients. No patient included had any prior strabismus surgery. Data from subjects were included until the subject's last recorded follow-up visit. Patients were divided into two groups, those who underwent adjustable suture surgery (Group A) and those who underwent permanent or semiadjustable suture fixation as previously described (Group B) (Kushner 2004). For the most part, patients with thyroid ophthalmopathy who consented to adjustable suture procedures underwent standard adjustable sutures until 2004 when the semi-adjustable procedure was introduced by Kushner (2004). After that time, patients more typically underwent semi-adjustable procedures. Patients were excluded if they had previous strabismus surgery or surgery on vertical (but not horizontal) extraocular muscles other than the inferior rectus muscle during the procedure. Control patients who underwent unilateral IRR were selected and matched based on the amount of recession performed. All control cases underwent recession with adjustable suture. Patients were matched as closely as possible for the amount of inferior rectus muscle recession performed in order to match based on the postoperative position of the inferior rectus. If the number of controls needed for a certain amount of recession was fewer than the number of controls available for selection, the control patients were selected consecutively alphabetically from a list of patients with that amount of recession.

The following pre- and postoperative characteristics were recorded from the patients' medical records: age at presentation to clinic, age at first surgery, preoperative heterotropia at distance and near in the cardinal positions of gaze, amount of surgical recession performed, initial postoperative deviation (POD1) (before and after adjustment, if performed), final deviation determined at last visit or immediately prior to a second operation. Measurements included in this study were always performed by the surgeon, were primary deviations, and were performed in primary position at distance. Surgical information was retrieved from operative reports. Surgical dosages were determined by angle of strabismus in combination with the surgeon's interpretation of intraoperative forced duction testing. In our general clinical practice, contralateral inferior rectus recession is typically performed in cases where the contralateral eye has a limitation to supraduction greater than 50% of normal. Subjects in whom the contralateral inferior rectus required recession were excluded from the analysis. Adjustment was performed either on the day of surgery or on POD1. No further suture adjustment was performed after POD1.

Best corrected visual acuity was measured in each eye using Snellen optotypes after manifest refraction. Heterotropia with spectacle correction was assessed using alternate cover testing at distance (3–4 m) in the cardinal gaze positions. Motor alignment was also assessed in primary position at near (14 inches). In cases of paralytic strabismus the prism was placed over the paralytic eye for all measurements.

Statistical analyses were performed with JMP version 9.0 (Cary, NC) and Microsoft Excel® (Microsoft Corp, Redmond, Washington). To assess differences between groups, a *t* test was used to directly compare the mean characteristics. A Fischer exact test was used to assess the association between overcorrection on postoperative day one and overcorrection at final visit for patients within Group A. Linear regression models were created for each subject group in order to determine dose-response behaviors. Slopes from linear regression analysis were compared using an F-test. A p value of <0.05 was considered to be statistically significant.

RESULTS

During the study period, 13 patients with TO underwent unilateral IRR with adjustable sutures (Group A), 14 patients with TO underwent unilateral IRR with permanent sutures (Group B), and 19 control patients underwent unilateral IRR with adjustable sutures who met the study inclusion criteria. Causes of strabismus in the control group included trochlear nerve palsy (11), diplopia after corneal surgery (2), diplopia after cataract surgery without retrobulbar injection (1), partial oculomotor palsy (1), inferior oblique paresis (1), and idiopathic (3). Ten of the 14 patients in Group B had a semiadjustable procedure. Demographics and baseline patient information are presented in Table 1. There was no significant difference in patient ages amongst groups. One control patient was significantly overcorrected on POD1, and could not be adjusted satisfactorily; he was operated on the following week (follow-up time 6 days prior to second surgery). All other patients had a minimum of 28 days of follow-up. Although the groups were matched to recession amount, the preoperative vertical deviation in the control group was significantly lower that of Group A ($p = 0.04$) and Group B ($p < 0.001$).

Postoperative results of surgery on all patients are presented in Table 2. Total postoperative drift of the vertical deviation was −1.9 ± 4.3 prism diopters (PD), −1.0 ± 4.6 PD, and +1.4 ± 4.9 PD for Group A, Group B, and controls, respectively ($p = 0.59$ for Group A vs B, $p = 0.05$ for Group A vs controls, $p = 0.16$ for Group B vs controls). Postoperative drift for all thyroid patients in Groups A and B combined was −1.44 ± 4.38 PD ($p = 0.049$ for Groups A and B vs controls). For the purposes of analysis and comparison, the preoperative deviation was given a positive (+) value and overcorrections were deemed negative (−) deviations. A negative drift is a drift towards overcorrection, and positive drift is a shift toward the original deviation. Three patients (23%) in Group A, two patients (14%) in Group B, and three patients (16%) in the control group were overcorrected at their final visit.

Patients in Group A were analyzed by subgroup by the presence or absence of final postoperative overcorrection (Table 3). There was no significant association between final overcorrection and amount of recession, age, or preoperative deviation. However, there was a significantly higher amount of overcorrection on postoperative day one in those patients who were overcorrected at the final visit (mean postoperative day one deviation −0.3 ± 0.6 PD) compared to those who were eventually orthotropic or undercorrected (mean deviation +1.7 ± 2.7 PD, p 0.047).

Analysis of the amount of vertical deviation corrected per millimeter of recession for each group prior to adjustment was determined. Dose responses were calculated from measurements of deviation prior to adjustment. Linear regression forced through zero was performed. Group A experienced a dose response of 2.97 PD/mm (SE 0.26, $r^2 = 0.72$), Group B a dose response of 3.62 PD/mm (SE 0.22, $r^2 = 0.23$), and controls a dose response of 2.38 PD/mm (SE 0.18, $r^2 = 0.55$) (Comparison of slopes using F-test: $p = 0.04$ for A vs control, $p = 0.05$ for A vs B, $p = 0.0002$ for B vs control). Dose response of all thyroid patients combined compared to control patients for recession was 3.26 PD/mm (SE 0.20, $r^2 = 0.42$) vs 2.38 PD/mm (SE 0.18) ($p = 0.0014$).

DISCUSSION

The most commonly involved muscle leading to restrictive strabismus in TO is the inferior rectus muscle (Dyer 1977). Kraus & Bullock had previously found that patients with TO undergoing unilateral inferior rectus muscle recessions trended toward a benefit from undergoing adjustable suture techniques (Kraus & Bullock 1993). However, the use of adjustable sutures has been associated with late muscle slippage in patients with restrictive strabismus (Metz 1999). Sprunger & Helveston found a post-operative progressive overcorrection occurred in 50% of TO patients undergoing inferior rectus recession with adjustable sutures (Sprunger & Helveston 1993). They found a mean deviation of 8 PD in those patients who had progressive overcorrection, however these results combined all etiologies of strabismus, not only TO (Sprunger & Helveston 1993). Surgeons may intentionally undercorrect patients to prevent late overcorrections (which lead to reversal of hypotropias), but these overcorrections can be unpredictable (Flanders & Hastings 1997; Scott & Thalaker 1981). Forced duction testing and intraoperative relaxed muscle positioning may aid in determining how much recession to perform (Nguyen et al., 2002; Nicholson et al., 2011). The use of adjustable sutures for these patients allows for more accurate ocular alignment and single binocular vision outcomes for these difficult cases (Gardner & Kennerdell 1990; Lueder et al., 1992). In this study, we evaluated the effects of IRR in patients with TO on either adjustable or permanent sutures in comparison to control patients with adjustable sutures with the intention of quantifying postoperative drift and dose-response behaviors in TO patients compared to control subjects. In comparison to previous studies, our study is the first to use a non-restrictive strabismus control group, and is the first to quantify specifically at the amount of postoperative drift from POD1 postadjustment measurements (Hudson & Feldon 1992; Kraus & Bullock 1993; Sprunger & Helveston 1993a,b; Wright 1996). The results suggest that anticipation of a drift towards overcorrection may aid in preoperative planning, especially for patients undergoing recessions on adjustable sutures, which may therefore aid in preventing overcorrection of vertical deviations.

In our series, patients undergoing IRR for TO on adjustable sutures responded differently to recessions than controls. Patients with TO had a larger dose response per millimeter of recession compared to controls, whether on adjustable or permanent sutures. Postoperative drift for patients with thyroid ophthalmopathy was also statistically different compared to controls (−1.44 ± 4.38 PD vs + 1.42 ± 4.91 PD, $p = 0.049$). Kraus & Bullock found that for TO operated using nonadjustable sutures, there was 3.9 PD/mm deviation correction, which is similar to the current finding of 3.6 PD/mm for Group B at the final visit (Kraus & Bullock 1993). However, their study did not compare to control patients without TO. Although follow-up time was not statistically significant between groups, follow-up time was nearly twice as long in Group A compared to Group B and to controls. This should be considered in light of the larger amount of drift in Group A compared with Group B.

These results suggest that extraocular muscles affected by TO have different properties than control muscles. The majority of IR muscles affected by TO are tight and restricted, which could lead toward a tendency for the muscles to pull and distort their new attachments to the globe, further recessing the muscle. In addition, the Bells phenomenon may contribute to further posterior displacement of the inferior rectus muscle. Postoperative scarring associated with the unique anatomical relationship of the inferior rectus muscle to Lockwood’s ligament and the capsulopalpebral head has been suggested as a mechanism for progressive weakening of the inferior rectus muscle, resulting in reversal of hypotropia (Wright 1996). Surgical planning should take postoperative drift and surgical dose response into account, and the amount of recession performed should be adjusted accordingly. Based on our results, we suggest adjustment of patients with TO undergoing IR recession to undercorrection of at least 2 PD to account for postoperative drift. Some surgeons determine the amount of recession preoperatively based on angle of deviations; others modify those amounts by testing intraoperative forced ductions. Intraoperative relaxed muscle positioning has been proposed as an adjunctive test to influence surgical amounts (Nguyen et al., 2002; Nicholson et al., 2011; Thomas & Cruz 2007).

We found that those patients who underwent IRR on adjustable suture did not appear to have a significantly different final outcome compared to patients who underwent surgery with permanent suture. Although the mean amount of postoperative drift was higher in the adjustable suture group (−1.9 vs −1.0 PD), there was no significant difference between groups. This finding is interesting in light of reports that hang-back adjustable sutures are more likely to slip (Kushner 2004). This finding may reflect a certain amount of bias related to the selection of patients for adjustable sutures vs fixed scleral sutures. Patients who had comparatively tighter muscles on intraoperative examination may have been selected to undergo fixed scleral sutures rather than adjustable sutures.

The results of this study must be considered with the study’s limitations. This study was limited by a relatively small sample size, limiting the power of our observations. A limited number of patients with thyroid ophthalmopathy, no previous strabismus surgery, who only needed one vertical rectus muscle recession, and who had adjustable sutures placed, were found. In spite of this, our study presents the largest number possible from our patient base. These patients may have undergone horizontal rectus muscle surgery at the same time, introducing possible error by not having solely inferior rectus involvement. As well, this study was retrospective, and does not control for possible deviations in surgical procedure performed by each surgeon. Preoperatively patients undergoing IRR without TO had significantly smaller amounts of vertical deviation per amount of recession performed compared to all patients in the study with thyroid ophthalmopathy. However, the control group was selected to evaluate for differences in postoperative drift after a given amount of recession, not to compare preoperative or postoperative deviations. This may have been the result of surgeon bias towards attempting to undercorrect thyroid patients due to past experience and reports. As such, surgeons were aware that these patients had thyroid ophthalmopathy, and therefore may have been biased to alter their surgical plan to aim for undercorrection. Also, the amount of further recession or advancement in patients with adjustable sutures was not determined in this study. In patients with thyroid ophthalmopathy, the extent of proptosis and orbital involvement was not analyzed. These factors may influence final postoperative alignment. In control patients with diplopia after cataract or corneal surgery only the use of retrobulbar anesthesia was documented, and it is possible that peribulbar anesthesia was used, inducing a fibrotic response. A prospective study comparing adjustable to non-adjustable sutures in TO would be ideal. Thus far there are no randomized controlled trials comparing adjustable and non-adjustable suture strabismus surgery (Engel 2012; Haridas & Sundaram 2005)

Despite these limitations, this study demonstrates the necessity for proper preoperative planning for IRR in TO patients. Dose response to recession is greater in patients with TO and therefore recession amount should be changed accordingly. Postoperative drift in TO patients who undergo adjustable suture techniques is significantly greater than in control patients. Our average amount of drift was 2 PD compared to an undercorrecting drift in non-thyroid control patients. Increased drift in TO patients could be due to altered biomechanical properties of the inferior rectus muscles themselves. Adjustable sutures may be of significant benefit in these patients, allowing for precise undercorrection to 2 PD on POD1 to account for postoperative drift.

Acknowledgments

We would like to thank Dr. Arthur L. Rosenbaum for his dedication to his patients included in this study, and for years of thoughtful discussion that led to the inception and implementation of this study.

DECLARATIONS OF INTEREST

Funding/Support: Grant support: NIH/NEI K23EY021762 (SLP), EY08313 (JLD), Knights Templar Eye Foundation (SLP), Oppenheimer Family Foundation (SLP), Leonard Apt Fellowship (JHP), Adelaide Stein Fellowship (JHP)

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TABLE 1

Comparison of characteristics of all patients undergoing inferior rectus recessions (mean ± SD).

	Group A (n = 13)	Group B (n = 14)	Controls (n = 21)	p value* A vs B	p value* A vs controls
Age (years)	65 ± 13	59 ± 12	62 ± 15	0.25	0.59
Vertical deviation (PD)	17.0 ± 9.2	21.3 ± 7.5	11.2 ± 4.5	0.20	0.04
Recession amount (mm)	5.4 ± 1.5	4.6 ± 1.1	4.5 ± 1.3	0.14	0.11
Postoperative follow-up (months)	14.3 ± 32.4	7.6 ± 9.4	7.3 ± 8.7	0.48	0.46

Group A: Adjustable suture patients, Group B: Permanent suture patients.

*Student's t-test, $p < 0.05$ considered statistically significant.

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TABLE 2

Comparison of postoperative results of all patients undergoing inferior rectus recession (mean ± SD).

	Group A (n = 13)	**Group B (n = 14)**	**Controls (n = 21)**	***p* value* A vs B**	***p* value* A vs controls**
Deviation on POD1 after adjustment (PD)	1.2 ± 2.5	3.7 ± 4.9	0.3 ± 2.4	0.11	0.29
Drift after surgery (PD)	−1.9 ± 4.3	−1.0 ± 4.6	1.4 ± 4.9	0.59	0.05
Deviation at last visit (PD)	−0.7 ± 5.6	2.7 ± 5.7	1.7 ± 5.7	0.13	0.26

Group A: Adjustable suture patients, Group B: Permanent suture patients.

*Student's *t*-test, $p < 0.05$ considered statistically significant.

TABLE 3

Risk factors for overcorrection in patients undergoing inferior rectus recession with adjustable suture surgery for thyroid ophthalmopathy.

	Overcorrected	Orthotropia/ undercorrected	*p* value*
Amt of Recession (mm)	6 ± 1	5.2 ± 1.6	0.31
Age at surgery (years)	68 ± 18	64 ± 12	0.73
Preop Deviation (PD)	14 ± 9	18 ± 10	0.6
POD1 deviation after adjustment (PD)	−0.3 ± 0.6	1.7 ± 2.7	0.047
Overcorrected on POD1 after adjustment	1/3 (33%)	1/10 (10%)	0.42†
Undercorrected on POD1 after adjustment	0/3	6/10 (60%)	0.19†

*Student's *t*-test, $p < 0.05$ considered statistically significant.

†Fisher exact test, $P < 0.05$ considered statistically significant.