

# **Vertical muscle transposition with augmentation for treatment of exotropia caused by iatrogenic lost medial rectus muscle**

Authors: Elkamshoushy AA, El Sayed DA, Sprunger DT.

## **Abstract**

**Purpose:** To evaluate the results of vertical muscle transposition with augmentation in cases of exotropia caused by iatrogenic lost medial rectus muscle.

**Methods:** This is a retrospective review of 5 cases of lost medial rectus with exotropia and marked limitation of adduction that underwent surgery. All cases had a history of strabismus surgery on the medial rectus and failed attempt at retrieval of the lost muscle.

**Results:** Five patients fulfilled the criteria. Full tendon vertical muscle transposition with augmentation sutures was done for all cases. Surgery led to a significant reduction of the

angle of exotropia  $25.8 \pm 13.6$  prism diopters ( $p= 0.027$ ) and improvement in adduction of  $7.5 \pm 3.8$  degrees ( $p=0.034$ ). There were no complications.

Conclusions: Isolated vertical muscle transposition with augmentation is a useful option to improve the exotropia and adduction deficit in patients with iatrogenic lost medial rectus muscle.

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## **INTRODUCTION**

A lost muscle is one of the most devastating complications that a strabismus surgeon can face in the intra operative period. A lost muscle can also occur as a complication of retinal surgery. A similar clinical picture has been reported after endoscopic sinus surgery as a result of inadvertent trauma to an extraocular muscle.( Flynn et al, 1979; Mark & Kennerdell, 1979) However, a slipped muscle is a distinct entity from a lost muscle. A slipped muscle retains a portion of the muscle and/or capsule attached to the sclera. A lost muscle has no attachment to the globe. Plager & Parks (1990) reported that 67% of lost superior, inferior, and lateral rectus muscles were retrievable while only 10% of lost medial rectus muscles were retrievable. MacEwen et al (1992) found that medial rectus muscles that were cut and lost during strabismus surgery are seldom located, but snapped or traumatically severed muscles are frequently located.

A variety of transposition procedures, with and without augmentation sutures,

have been described to treat ocular deviation created by a dysfunctional rectus muscle. (Helveston et al, 1980; Struck, 2009) Several variations of vertical transposition procedures for limitation of abduction have been described (Bansal et al, 2006; Couser et al, 2012; Flanders et al, 2001) with few reports specifically regarding transposition for limitation of adduction. (Aoki et al, 2003; Cho et al, 2008; Park et al, 2015) The majority of cases with limited adduction are associated with vertical rectus muscle paresis due to third nerve affection, thus limiting the utility of vertical muscle transposition in these cases. In cases of marked limitation of adduction with fully functional vertical recti, transposition of those muscles may be superior in achieving better motility. Loss of MR due to endoscopic sinus surgery causes a large exotropia with no adduction, and usually spares the vertical recti. Several authors described transposition for this condition with or without concomitant lateral rectus (LR) weakening by recession or botulinum toxin, (Cho et al, 2008; Lee et al, 2002; Olitsky & Brooks, 2001; Thacker et al, 2004), reporting variable outcome. In cases of combined transposition and lateral rectus recession, the risk of anterior segment ischemia was reduced by vessel sparing procedures in most cases. (Cho et al, 2008) Our series focuses on the results of the transposition without concomitant LR weakening.

## **METHODS**

This is a retrospective review of 5 cases that underwent surgery for a large exotropia and a marked limitation of adduction after surgical loss of the medial rectus muscle. After obtaining IRB approval from University of Alexandria, patient records were searched for cases that underwent vertical muscle transposition from January 2007

until June 2015. Inclusion criteria included preoperative limitation of adduction and a documented history of lost medial rectus muscle. Exclusion criteria included marked restriction of adduction (determined by positive intra-op forced duction test). All patients had full pre and post operative measurements and follow up of at least 3 months.

The pre-operative variables recorded were age, gender, details of previous surgical or medical treatment, as well as all measures of motility and deviation. The strabismus angle was measured in all directions of gaze for near and far and recorded in prism diopters ( $\Delta$ D). Krismky method was used to measure the angle for near. Prism and cover testing was not possible due to the marked limitation of adduction. Distance angle was measured by placing prisms over the fixing eye and observing the corneal reflex. The extent of horizontal motility was measured in degrees of abduction and adduction beyond the imaginary midline bisecting the palpebral fissure. We use preset wall markings to measure the degree of horizontal ductions while the patient placing head on chin rest. The same surgeon (AE) performed all 5 cases. Surgical procedure was as follows: First, forced duction test was performed to ensure either full or almost full adduction. A nasal, 180 degree limbal incision was utilized to expose medial, superior and inferior recti. A retrieval attempt was made in every case by a good exposure, following the Tenon posteriorly and attempting to find the muscle exit into posterior orbit. Any bradycardia was noticed while pulling on tissues. No orbitotomies were done. If the muscle was not found the retrieval attempt was deemed unsuccessful and we proceeded to transposition. The two vertical recti were cleared of Tenon's capsule and surrounding sheath up to 17 mm posterior to insertion. 6-0 absorbable suture was used to secure the vertical rectus muscles prior to complete dis-insertion and transposition to the original insertion site of

the medial rectus. The muscles were reattached at a position that preserved the spiral of Tillaux. Two non-absorbable sutures (Foster augmentation-like) were placed fixing the borders of the transposed muscles to the sclera 5 and 11 mm behind the new insertion. The anterior sutures are taken first to facilitate the pull of the muscles together at the posterior level. Special care was taken to prevent asymmetric transposition to avoid any induced vertical or torsional deviation. The lateral rectus muscle of the operated eye was left intact. Three months post-operative measurements were recorded and the data analyzed.

## **RESULTS**

Five patients fulfilled the criteria of the study. Table (1) provides demographic information. The mean age of the patients was  $20.4 \pm 7.45$  years ranging from 9 years to 30 years. Three months post-operative results showed a significant improvement of the exotropia angle in the majority of cases. Table (2) shows the post-operative results. The strabismus angle for near was equal or within 5 prism diopters from the angle for distance. The reported angles in the tables are the angles of deviation for distance. Patient #4, being bilateral, deserved special attention in the statistical analysis. The improvement in adduction in each eye was considered separately. So as far as improvement in adduction is concerned, the results can be viewed as those of six eyes of five patients. The angle on the other hand represented a different situation as surgery on each eye augments the other. Our surgical mean aimed at evaluating the amount of angle improvement expected from the transposition procedure (on one eye), hence, the improvement in angle was divided by 2 before the mean was calculated so as to have to

the mean representative of the improvement in angle caused by a unilateral transposition procedure.

Surgery reduced the angle of exotropia in primary position  $25.8 \pm 13.6$  prism diopters (mean of  $46.7 \pm 9.9$  to  $20.8 \pm 13.4$  prism diopters). Maximum improvement was 45 prism diopters, and minimum was 5 prism diopters with a median of 27.5 prism diopters. The change was statistically significant by Wilcoxon signed ranks test ( $p = 0.027$ ). Surgery did not induce a vertical deviation in any of the patients. Torsion was estimated during fundus examination and there was no fundus torsion reported.

The mean improvement in adduction averaged  $7.5 \pm 3.8$  degrees. Maximum improvement in adduction was 10 degrees and minimum was nil. Again, this change was found to be statistically significant by Wilcoxon signed ranks test ( $p = 0.034$ ). Figure one shows the pre and post operative pictures of patient #4.

None of the patients in our series complained of diplopia at the time of presentation. Binocularity was tested and all patients were negative on Bagolini and Worth four dot tests with no stereoacuity. In the three months post operative examination this did not change.

There were no intra-operative or post-operative complications.

## Discussion

Several surgical options are available after surgical loss of a medial rectus muscle. An isolated LR recession has a significant possibility of considerable under-correction of the typical large-angle exotropia associated with this challenging complication of strabismus surgery. Combined vertical transposition to medial rectus and lateral rectus recession (with or without ciliary vessel sparing) increases the risk of anterior segment ischemia. (Cho & Won, 1995; Elsas & Witherspoon, 1987; France et al, 1986) Various techniques including half-tendon transposition, preservation of the anterior ciliary artery and a botulinum toxin injection into the antagonist LR, are useful tools for reducing the risk of anterior segment ischemia.(Brooks et al, 2000; McKeown, 1992; Olitsky & Brooks, 2001) However, since cases of lost medial rectus muscles with significantly limited adduction are notorious for under-correction, the strongest possible transposition procedure may be a wise choice for the first procedure.

We performed full tendon vertical rectus muscle transposition with augmentation as the initial procedure and evaluated for improvement in exotropia and adduction. Most previously described cases have been for significant medial rectus trauma due to endoscopic sinus surgery.(Cho et al, 2008; Lee et al, 2002; Olitsky & Brooks, 2001; Park et al, 2015; Thacker et al, 2004;) In this series, none of the cases was caused by endoscopic sinus surgery and all were lost medial rectus muscles from strabismus surgery..

Cho et al (2008) treated 4 patients with exotropia and limited adduction following sinus surgery with an X-type of transposition in which each half-tendon is pulled and crossed through the undersurface of the severed MR to the other end of the MR insertion.

Two of 4 patients underwent concurrent LR recession depending on the result of the forced duction test. Two patients that did not have tight LR were operated only 3 months after the sinus surgery. The 2 patients in whom LR recession was not done achieved orthophoria. In the two cases in which LR recession was done, one of them was orthophoric and the other had a residual XT of 70 prisms and adduction deficit that the authors attributed to adhesions around the LR. Timing of previous surgery as well as forced duction test results were suggested by the authors to be utilized to determine the need of doing a concomitant LR recession (with vessel sparing). Only 1 patient in this series of 4 appeared to benefit from LR recession. Although the technique of transposition is different from the one we used, however, the good results obtained without LR weakening confirms our findings that LR recession is not pivotal in correction of the XT when doing a transposition. Other authors combined LR weakening with transposition and used variable methods to avoid anterior segment ischemia. The combination of both procedures does not allow the value of each to be assessed independently. Olitsky et al (2001), reported on a single patient with medial rectus injury after sinus surgery, in which botulinum toxin was injected into the LR combined with a modified Hmmelsheim procedure employing 7 mm resections of the transposed muscles. Orthophoria in the primary position was achieved. Surgery was done only 2 weeks after the sinus surgery. Early surgery decreases the chance of developing LR contracture. Thacker et al (2004) described a variety of cases of strabismus and limited motility after sinus surgery and in more than half of cases, more than one extra-ocular muscle was injured. Three cases in this series underwent transposition with Botulinum toxin injection to the lateral rectus muscle. Transposition technique involved a 4 mm

resection of the fully transposed muscles. Improvement in the exotropia ranged between 40 and 60  $\Delta$ D. A 4 mm resection of the vertical recti was added as an augmentation to the full tendon transposition. The difference in transposition techniques and LR weakening methods may contribute to the variable results.

While most authors did combined surgeries, or transposition alone, Lee et al (2002) described a single case of a transected medial rectus after endoscopic sinus surgery with 65 $\Delta$  of exotropia in primary position with marked limitation of adduction in which a 12 mm recession of lateral rectus muscle in the affected eye caused a 40 $\Delta$  improvement in the angle of exotropia in primary position. Subsequent Hmmelsheim operation caused small improvement in the angle of deviation leaving the patient with 20 prism diopters of exotropia, which was corrected by prisms. In this single case report the response to LR recession was bigger than what is usually expected in a patient with complete MR palsy. We believe that such a response can occur in cases where the exotropia is caused mainly by a tight LR. Forced duction test may be useful in predicting such cases. In our cases forced duction test did not show any restriction in the LR in any of the patients. Park et al (2015) described 3 cases of MR palsy post sinus surgery for which they did a muscle union using single sutures without splitting to spare the ciliary vessels. The XT was reduced 62 $\pm$ 9  $\Delta$ D. It was not mentioned if any of those three patients underwent a concurrent LR recession. This muscle union procedure is similar to the augmentation sutures without disinserting the muscles. This may explain the similarity in improvement in their cases to our series. Aoki et al (2003) did a transposition with lateral rectus recession for five cases of MR palsy caused by sinus surgery and reported an improvement of 26.2 degrees in the exotropia. Combination of

both procedures gives the strongest effect but exposes the eye to risk of anterior segment ischemia and does not allow assessment of the result of each procedure alone. In our series, good success rate was obtained without having to expose the eye to further risk of anterior segment ischemia.

Anterior segment ischemia is an uncommon complication with a reported incidence of 1 in 13300 cases. (France & Simon, 1986) This risk increases with old age and other vascular and blood diseases. (Saunders et al, 1994; Wan & Hunter, 2014). Most reported cases involve operating on 3 or 4 rectus muscles, even if the surgery is staged. (Saunders & Phillips, 1988; Wan & Hunter, 2014). In cases of post strabismus surgery lost MR risk of anterior segment ischemia may be higher due to an already detached muscle. A transposition procedure then will interrupt 4 of the 5 remaining anterior ciliary vessels. Adding a lateral rectus recession will interrupt all remaining 5 vessels and hence the importance of trying to avoid this procedure.

To our knowledge, there is no report of use of an augmented, full tendon transposition for lost medial rectus muscle from eye muscle surgery. In this clinical setting we found significant improvement in both alignment and ability to adduct the affected eye. There were no complications using this technique. The improvement in exotropia is all attributed to the effect of full muscle transposition with augmentation. This procedure also allows for consideration of a subsequent procedure on the ipsilateral LR if required. We believe that results of this procedure will be similar in cases of iatrogenic or traumatic MR palsy as long as SR and IR are functioning normally. The need for concurrent LR weakening by recession or toxin injection was not proven to be essential in the studies that used strong transposition for post sinus surgery MR palsy.

Furthermore, the one study (Cho et al, 2008) that utilized transposition without LR weakening in two cases of post sinus surgery MR palsy reported significant improvement. This is in accordance with our findings. Direct comparison of the results of the aforementioned studies to ours may not be accurate because of the difference in the technique of transposition from one article to another.

In conclusion, if there is no restriction on forced duction test, transposition with augmentation may be enough to treat patients with iatrogenic lost MR, without the need of a LR recession. Transposition with resection (Olitsky & Brooks, 2001; Thacker et al, 2004) or X-transposition (Cho et al, 2008) may yield similar results. In cases where the LR is tight on forced duction test, consideration may be given to adding a LR weakening procedure.

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