·Clinical Research·

Surgical results of the slipped medial rectus muscle after hang back recession surgery

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Abstract

• **AIM: To analyze the surgical results of a slipped medial rectus muscle (MRM) after hang back recession surgery for esotropia.**

• **METHODS: Twenty-one patients who underwent re-exploration for diagnosed slipped muscle after hang back recession surgery were included in this retrospective study. Dynamic magnetic resonance imaging was performed to identify the location of the slipped muscle. Ocular motility was evaluated with assessment with prism and cover test in gaze at cardinal positions. The operations were performed by the same consultant. Intraoperative forced duction test was performed under general anesthesia. The empty sheath of the slipped MRM was resected and the muscle was advanced to the original insertion site in all patients.**

• **RESULTS: The average age of 21 patients who had consecutive exotropia with a slipped MRM at the time of presentation was 17.4±5.4y (5-50y). The average duration between the first operation and the diagnosis of the slipped muscle was 25mo (12 to 36mo). The mean follow up after the corrective surgery was 28mo. The mean preoperative adduction limitation in the field of action of the slipped muscle was -2.26 (ranging from -1 to -4). All patients had full adduction postoperatively.**

• **CONCLUSION: The diagnosis of the slipped muscle should be confirmed during the strabismus surgery. The slipped muscle may be caused due to insufficient suture and excessive rubbing of the eye. When divergent strabismus is observed after the recession of the MRM, a slipped muscle should be considered in the differential diagnosis.**

• **KEYWORDS:** esotropia; empty sheath; hang back recession; re-exploration; slipped muscle
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INTRODUCTION

A slipped muscle is defined as the rectus muscle disinsertion that has retracted posteriorly within the capsule after attempted reattachment to the globe [1-4]. The slipped muscle is one of the most serious potential complications of strabismus surgery [5]. It should be considered in the differential diagnosis of a patient who presents with a limitation of duction and when there is an early or late unexpected postoperative overcorrection with a large angle of deviation. The most challenging differential diagnosis is lost extraocular muscle that is the retraction of the entire muscle with its capsule towards the orbital cone[6-8]. The limitation of duction is mild to moderate in slipped muscle, whereas a lost muscle is generally associated with a severe limitation of duction[9,10]. On the other hand, it is easier to distinguish these two entities intraoperatively [1]. Other differential diagnosis of a slipped muscle includes excessive muscle recession, hemorrhage and edema around the muscle and postoperative pain causing splinting of the extraocular muscle movement, a severed nerve to an extraocular muscle, neuropraxia, a crushed or entrapped muscle and muscle fibrosis or contracture[11,12].

Medial rectus muscle (MRM) arises from the annulus of Zinn and inserts the sclera at about 5.5 mm distance from the limbus[13]. Among the extraocular rectus muscles, MRM is the one that is most frequently observed to slip [1,2,4]. One of the reasons is that MRM has no fascial attachments to the oblique muscles [6,7]. There are other reasons as well. MRM is the most frequent extraocular muscle to be operated on [14]. Additionally, MRM is the closest to the limbus and it is at risk for traumatic detachment[15].

As a challenging and unpredictable problem, each case is required critical observation and experienced surgery. In this study, we introduce the results of the surgical treatment to correct the slipped MRM after hang back recession surgery for esotropia.

SUBJECTS AND METHODS

The records of patients who underwent re-exploration surgery for suspected slipped MRM between June 2007 and December 2012 by a single consultant (Duranoglu Y) in Akdeniz University Medicine School Department of Ophthalmology were included in this retrospective study.

The examination of each patient including the best corrected visual acuity, versions and ductions, prism and alternate cover measurements in cardinal gaze positions at near and far distance, forced ductions, active force generation, gaze-dependent clinical tests (squint magnitude, eye movement range, palpebral fissure widening, proptosis, intraocular pressure change) were recorded. Dynamic MRI was performed to identify the slipped MRM.

The function of the MRM was evaluated through the Kestenbaum limbus test of motility. The test is performed by holding a transparent millimeter ruler horizontally in front of the cornea [16]. The difference of the temporal limbus point in primary position and in maximum adduction were noted on the ruler. Established normal value for adduction is 10 mm. Motility limitations were recorded in a grading scale between -1 and -4. (Grading with 0 for full excursion, -1 for excursion more than 7 mm, -2 for excursion between 5 and 7 mm, -3 for excursion between 3 and 5, -4 for motility less than 3 mm. Horizontal deviations were measured in patient with -3 or -4 adduction deficiency by Krimsky test.

Patients with a vertical strabismus, suspected or confirmed diagnosis of neuromuscular disease, history of previous ocular trauma, or surgery due to other causes than strabismus were excluded.

The data analysis was performed using the statistical package for the social sciences 10.0 software. The pre- and postoperative score of the MRM underaction and the horizontal deviation were evaluated through Student's t-test. The correlation test was performed in order to determine the relationship between two groups. Statistical significance was based on a value of $P<0.05$.

After a detailed explanation of the procedure, informed consent forms were obtained from all the patients. All the procedures were conducted in accordance with the principles of the Declaration of Helsinki.

Surgical Technique All operations were performed under general anesthesia by the same ophthalmologist (Duranoglu Y). The slipped muscle was located using the conjunctival approach. The diagnostic translucent empty capsule was identified following the careful dissection of the fibrous tissue surrounding the capsule. To differentiate an empty muscle capsule from the muscle or a tendon, a hook was placed under the tissue and was visible through the thin empty sheath (Figure 1). The empty capsule was then followed posteriorly until the muscle fibers were located, usually around the penetration site of the tenon capsule. After the length of the empty muscle sheath was measured, the muscle was imbricated with a non-absorbable synthetic suture and securely reattached to the insertion where only empty sheath was inserted. The segment of the empty sheath of the slipped MRM in front of the suture was resected. The total muscle advancement was calculated in mm based on the total amount of resected sheath and advanced muscle.

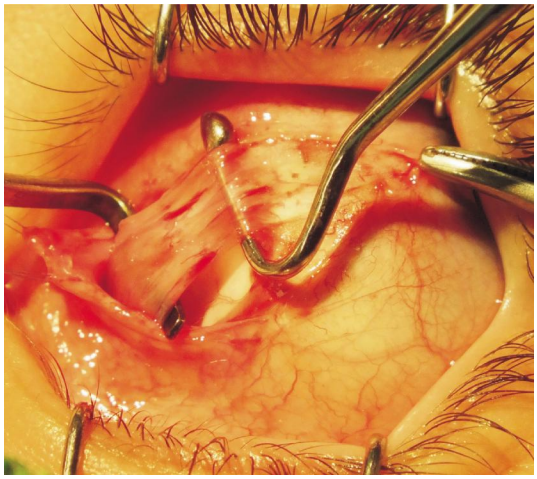

Figure 1 Peroperative view of the slipped MRM.

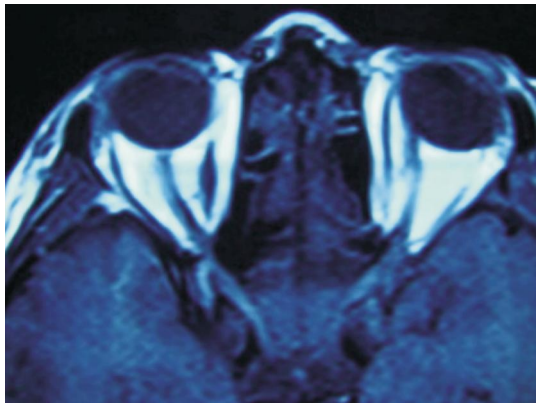

Figure 2 The loss of apposition of the MRM tendon is seen in right eye (axial section MRI).

RESULTS

A total of 21 patients (12 females, 9 males) with a right/left split of 7/14, who underwent surgery to correct the slipped muscle were enrolled in this study. The mean age was 17.4± 5.4y (ranging, 5-50y).

The average duration between the first operation and the diagnosis of the slipped muscle was 25mo (min: 12mo, max: 36mo). The average follow-up period after the corrective surgery was 28mo.

Of all 21 patients widening of the lid fissure on adduction and mild exophthalmos were observed in the patients' preoperative pictures.

The MRI showed the place of the slipped muscle in 6 patients (Figure 2). However, it was not reliable to show the exact diagnosis and the place of the slipped muscle insertion for all of the patients from MRI.

Preoperatively, the mean horizontal deviation was -30.8±1.75 prism diopter (PD) (ranging from 15 to 50 PD) of exotropia. This value was found as +4 PD (ranging from orthophoria to +10 PD) in the primary position during the last assessment. This result pointed out a statistically significant difference between the two periods ($P=0.0024$).

The mean length of the empty muscle sheath was measured 6.3 mm (min: 5 mm, max: 9 mm). The length of muscle sheath was found to be correlated with the preoperative horizontal deviation ($P<0.001$, $r=0.88$).

The resected part of the slipped muscle was histopathologically examined. Fibrovascular connective tissue with no muscle fibers was found in all the specimens.

Forced duction test demonstrated no limited rotation towards the field of action of the slipped muscle preoperatively.

The average score of the preoperative MRM underaction was -2.26 (ranging, -1 to -4). No adduction deficiency was observed in any of the patients postoperatively. This result showed a statistically significant difference between the two periods (P<0.001).

The mean change of deviation in all the cases was found as 3.20 PD for each 1 mm of muscle advancement.

After this second procedure, the large widening in the palpebral fissure and the mild exophthalmos were resolved.

DISCUSSION

Our study based on the results of corrective surgery of the patients who had slipped MRM. The magnitude of the problem is presently unknown because of the lack of published statistics on the incidence and prevalence of the condition. All of the patients in our study had hang-back recession surgery previously that pointed out probable main problem in suturing technique of the first surgery. Chen *et al* [17] observed that 10.6% of the patients who underwent corrective surgery due to an unsatisfactory surgical outcome were patients with a slipped muscle. In their study, the slipped muscle was detected through direct intraoperative inspection.

As expected, MRM had the greatest incidence of slippage, since it does not have fascial attachments to the oblique muscles. If the suture is passed only through the thin capsule before disinsertion, it retracts itself posteriorly within the capsule after the reattachment to the sclera, leaving the empty sheath attached to the recession site on the sclera. If the whole width of the muscle tendon is not included in the sutures before disinsertion, it may result in a partial recession of the muscle tendon[6].

Chatzistefanou *et al* [18] have obtained multipositional high-resolution MRI of the patients with thyroid-associated eye disease on the day after the rectus muscle recession using a suspension technique. The arc of contact and the distance between the insertion and the point of tangency of each of the extraocular muscles to the globe were measured in the primary position as well as in the cardinal fields. The data confirm that the small wraparound effect of the inferior and MRM may explain one of the mechanisms accounting for the increased incidence of slipped muscles encountered after the recession of these muscles. In this study, dynamic MRI was used to identify the slipped MRM. The method is regarded as the investigation of choice to determine the exact position of a slipped muscle and the presence of its attachment to the eye. MRI enables the viewing of the extraocular muscles while maintaining various gaze positions [18]. It was also shown that MRM was located more distant in slipped muscle cases than normally recessed ones in MRI in another study[19]. In present study, we found MRI was limited to show slippage of MRM, though, we showed shifted insertions posteriorly in few images.

Murray [20] and MacEwan *et al* [21] reported on a series of patients with a slipped MRM. Also in our study including 21 slipped muscles, all the patients had solely slipped MRM, all of which were successfully relocated with a single surgical procedure.

Murray pointed out that the management of the slipped muscle or a muscle that is detached after the surgery must be carried out at an early stage and after a careful exploration[20]. Contracture of the ipsilateral antagonist can occur as early as 2wk after the initial surgery. If explored early, the muscle should be found 5 to 6 mm away from the intended insertion, although it retracts further in time. Chen *et al* [17] have observed that the length of the empty muscle sheath is 5-10 mm. Though, our patients were referred in late postoperative period. It might influenced the grading the limitation of adduction as well as the degree of the deviation. Interestingly, we didn't find any scarring and contracture.

The widening of the palpebral fissure (greater than 1 mm) on attempted eye movement to the side of action of the slipped muscle supports the diagnosis. In such cases, the antagonist muscle relaxes whereas the disinserted agonist does not pull effectively on the globe. Reduced saccadic velocity measurements, the active forced generation test which reveals diminished pull from the inserted muscle, and the different intraocular pressure measurements support the diagnosis; although they are inconclusive[21].

The definitive diagnosis of the condition is made intraoperatively. The hallmark in the diagnosis of a slipped muscle is the empty muscle capsule attached to the sclera[11]. The thin and less vascular capsule must be distinguished from the bulkier and more solid tendon and its highly vascular capsule. During the surgery, great care must be taken to prevent any further damage to the empty friable muscle capsule, which is translucent. Occasionally, the empty capsule appears thicker due to the fibrous tissue around it and may be mistakenly identified as a tendon [3]. The 'tendon step test' were found helpful to assist the intraoperative diagnosis of a slipped muscle[22,23].

The proper surgical techniques that can help minimize the incidence of a slipped muscle include obtaining a full thickness locking bite at the edge of the muscle as well as a full-thickness suture loop placed through the central third of the muscle or tendon and secured with a surgeon's knot. The anterior tendon's capsule overlying the muscle tendon should be carefully removed so that the surgeon can clearly visualize the full-thickness tendon and ensure that the tendon and not just the overlying tendon capsule is secured. The majority of the posterior intermuscular septum and check ligaments should be left intact. There is no need to dissect posteriorly

and clean these important fascial connections. Visualization through the operation microscope offers enhanced control, particularly during the placement of the sutures. Due to the unpredictable outcomes of the slipped muscle surgery routine microscopic control during strabismus surgery has been suggested by several authors [20,22]. Additionally, the securing of firm locking sutures and reattachment to the sclera should be carried out carefully [3]. Adjustable suture surgery were advised to the surgeons in cooperative patients [2,19]. Some authors recommend absorbable sutures, though the others advocate permanent sutures for reattaching the slipped muscle to the globe [6]. In our study, we preferred to use non-absorbable synthetic suture.

According to Chen *et al* [17], the problem of muscle slippage, with its potential to unnecessarily increase the strabismus reoperation ratios, clearly requires further attention. Further studies of this kind conducted on patients with recently slipped muscles and also measuring saccade parameters before and shortly after first strabismus surgery may be helpful in increasing our insight into the outcome of strabismus surgery.

The several limitations of the study are the fact that it is retrospective and non-randomised in nature. Furthermore, the examination of the patients before the first surgery was unknown. Finally, to the best of our knowledge, our study is the first that gives the results of the slipped muscle after hang-back surgical technique and one of the few studies about the complications of the strabismus surgery.

A surgical nomogram for the surgery on slipped muscles, proposed by Sebastian and Marsh [22], is pointed out a 3 PD change in the angle of deviation for every 1 mm of muscle advancement. In this study, it was found 3.2 PD. That slight difference might be because the surgeon modified the technique through his experience for very large and very small deviations. The total amount of muscle advancement was a summation of the total amount of empty sheath resected and muscle advanced.

In conclusion, our study showed that the length of the empty muscle sheath was highly correlated with the exodeviation degree. Secondly, the limitation of the MRM was disappeared postoperatively. Therewithal, the change in the deviation for every 1 mm was found 3.2 PD that was similar to the literature.

Although re-operation of a slipped muscle is challenging field in strabismology, the result of a cautious corrective surgery is satisfactory.

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