USE OF MAGNETIC RESONANCE IMAGING FOR EVALUATING PATIENTS WITH STRABISMUS

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ABSTRACT
Background: Dynamic magnetic resonance imaging (MRI) describes sets of static MRI images acquired with the eyes in different gaze position.
Material and methods: 15 patients were referred to us with suspicions of slipped or “lost” medial rectus (MR), 14 after strabismus surgery and 1 after trauma. All the patients had absent adduction past the midline and 7 underwent dynamic MRI examination. One patient had “A” pattern exotropia, 3 prior surgeries, over depression in adduction.
Results: The dynamic MRI showed the MR retracted posterior from the normal insertion and a contractile thickening on attempted adduction. All patients underwent surgery, according to deviation, length of the pseudo-tendon, stiffness of the MR, lateral rectus (LR) contracture: All the slipped muscles were found and re-attach to the globe. In the “A” pattern exotropia MRI showed superior displacement of the LR pulleys, corrected by bilateral MR resection with up-shift.
Conclusions: MRI is an index of functional muscle contractility and precise muscle location. It should be considered in complex cases of strabismus for the predictability of the results.

Key words: dynamic MRI, slipped or “lost” muscle, heterotropic pulleys, cross-sectional area, muscle contractility.

1. INTRODUCTION
MRI demonstrates that extra ocular muscles (EOMs) do not follow the direct paths from orbital apex to scleral insertion, they pass through pulleys, described by Prof. J.L. Demer [1].

Pulleys are connective tissue rings, located between the equator and posterior pole, coupled to the orbital wall and acting as functional mechanical origins of the EOMs[2].

MRI dynamic can show the changes over the gaze shifts: pulleys move slightly with changing gaze and only the anterior muscles segments between the pulleys and insertions move with the eye[3].

Posterior segments are stable over the gaze shifts because of the pulley stiffness.

In contraction, the muscle cross-sectional area increases and the point of maximum cross section shifts posterior, toward the origin of the muscle, in the opposite gaze (relaxation) the cross-sectional area decreases[4].

2. SUBJECTS AND METHODS
Fifteen patients were referred to us with suspicions of slipped or “lost” medial rectus (MR), 14 after strabismus surgery (1-8 previous procedure) and 1 after trauma. Age range was 5-14 years, exotropia range was 40-65 PD. The onset of the consecutive deviation was between 6 months and 6 years after the last surgery, all “late” slipped muscles, 1-3 years between the onset of exotropia and our surgery. All the patients had absent adduction past the midline in primary position.

Seven patients with very weak adduction and weak generated force in adduction underwent dynamic MRI in order to examine the muscle attachments to the globe and muscle changes over gaze shifts.

3. RESULTS
The dynamic MRI showed the MR retracted posterior from the normal insertion (7-13mm) and the muscle belly showed contractile thickening on attempted adduction.

In the operation room we found the medial rectus muscles slipped back within a capsule that was attach to the globe: a thin, translucent empty capsule or a thick and fibrotic scar.

8 14 patients underwent surgery, according to deviation, length of the pseudo-tendon, stiffness of the medial rectus (MR), lateral rectus (LR) contracture.

The medial rectus was sutured with a full-thickness locking bites through the muscle fibers.

8 13 patients: Resection of the MR pseudo-tendon (7-10mm) with re-insertion (5,5 – 9,5 mm from the limbus) + recession of the LR (4-10 mm) on adjustable sutures in 4 cases.

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2 patients: only resection of the MR pseudo-tendon (10-13mm) with re-insertion

2 patients underwent a second procedure for residual exotropia.

All the muscles slipped after previous surgeries were found and re-attached to the globe.

8 Heterotypic pulleys – 1 case. The pulling direction of a muscle is determined by the relationship between its pulley and its scleral insertion. Heterotypic pulleys can cause A or V-pattern strabismus. Superior displacement of the LR relative to the medial rectus can cause A-pattern. Inferior displacement of the LR or nasal displacement of the IR can cause V-pattern

8 Post-trauma lost MR – 1 case: medial orbital wall fractures, MR cut in the belly and prolapsed into the ethmoid sinus.

Case 1: Consecutive exotropia after surgical correction of esotropia. Right lost medial rectus (Fig 1, 2, 3, 4, 5, 6, 7)

After surgery: OS Resection of the medial rectus pseudo-tendon 12 mm, re-inserted at 6 mm from the limbus. Recession of the lateral rectus 7 mm. (Fig 8, 9, 10)

Case 2: A patient with had “A” pattern exotropia with a history of 2 prior surgeries. (Fig 11, 12, 13, 14)

This heterotropic pulley displacement needs recession of the lateral recti with down-shift for exotropia and “A” pattern correction.

Case 3: One case had left eye contusion with post-trauma...
matic lost left medial rectus. MRI shows: medial orbital wall fracture, medial rectus and orbital fat prolapsed into the ethmoid sinus, Medial rectus cut in the belly behind pulleys and retracted into the orbit. (Fig 15)

In this case, the medial rectus has no indication of finding and re-attaching.

4. CONCLUSIONS

8 In complex cases if strabismus, clinical motility examination is not enough for a correct diagnosis and treatment plan.

8 MRI examination of the orbits permits 3 D reconstruction and correlation with in vivo MRI.

8 MRI shows the precise muscle location and attachment to the globe.

8 Muscle cross section in the primary position is an index of functional EOM contractility.

An increase in the maximum cross section of an EOM in attempt duction involving the muscle, demonstrates the retained contractility of the muscle. A reduction of it is an index of contractile impairment or atrophy[5].

8 MRI is useful to diagnose congenital anomalies, traumatic injuries, slipped or lost muscles, to distinguish heterotropic pulleys from oblique muscle dysfunction.

8 A slipped or “lost” muscle requires determination of its contractile potential.

The medial rectus is the most commonly slipped or lost muscle after surgery. An immediate re-intervention is necessary if the muscle is “lost” intra-operatively or immediately after surgery.

A normal contractile muscle that was partial or total dis-inserted should be repaired by re-insertion.

“Lost” muscles retract into their pulleys, where they can generally be found and re-attached to the globe.

8 If the muscle has no contractility, or it is totally lost and cannot be retrieved, other EOMs should be transposed.

A Modified Hummelsheim procedure is indicated with shift of the “neighboring” half rectus muscle to the insertion of the LM[6].