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Review article

Restrictive problems related to strabismus surgery

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ABSTRACT

Strabismus surgery may be responsible for some restrictions in ocular motility that may cause new problems after surgery. Most of the time these restrictions present as a complex motility problem after surgery that requires further treatment. There may be various reasons that cause motility restriction following strabismus surgery. Those are excessive shortening or inadvertent capture of extraocular muscles, transposition procedures and, the most challenging problem, postoperative scar tissue-adhesion formation. In this review the potential reasons for postoperative restrictive problems, preventive measures and finally the treatment options for such problems are overviewed.

1. Introduction

The aim of strabismus surgery is primarily to correct ocular misalignment and to keep both eyes aligned in nine positions of gaze with free ocular movements. However, in some patients that goal may not be achieved by surgical intervention and strabismus surgery itself may be the reason for ocular misalignment and restrictive ocular motility problems.

The tissue that causes a restriction may limit the rotation of the eye both in the opposite and in the same direction which is called as “leash” and “reverse leash” effect by Jampolsky [1]. Figure 1 demonstrates the schematic representation of “leash” and “reverse leash” effect.

The tissue that causes a restriction of ocular movements may be the extraocular muscle, conjunctiva, soft tissues around the extraocular muscles and orbital adhesions that possibly affect the extraocular muscle pulleys.

2. Diagnosis

When a postoperative limitation of ocular movement is observed, the surgeon first needs to know whether it is due to a restriction or due to weakness of an extraocular muscle. For differential diagnosis, forced duction test, forced generation test, intraocular pressure change on side gazes and saccadic velocity measurements can be used. Slit lamp examination may also give clues about excessive conjunctival scarring and the presence of orbital fat tissue under the conjunctiva at the early postoperative stage.

The forced duction test is a simple test that can be performed at the examination room with topical anesthesia in adults. Use of the forced duction test during surgery provides very important additional information if it is repeated at different stages of surgery. In order to find out which tissue is responsible for the restricted ocular movement, the forced duction test must be repeated before and after dissection of conjunctiva, Tenon’s capsule and extraocular muscles. That will allow to determine the tissue that causes the restriction. Sometimes the forced duction test may still be positive after disinsertion of the extraocular muscle, which indicates the presence of orbital fibrosis.

The forced generation test is useful to rule out a lost muscle problem after surgery. Intraocular pressure change at gaze positions also gives an idea about the presence of a restriction and any change exceeding 4 mmHg is suggestive of a restrictive motility problem. Saccadic velocity measurement gives reliable information but it is not as easy as the other methods to perform and requires some equipment which is not available in most clinics.

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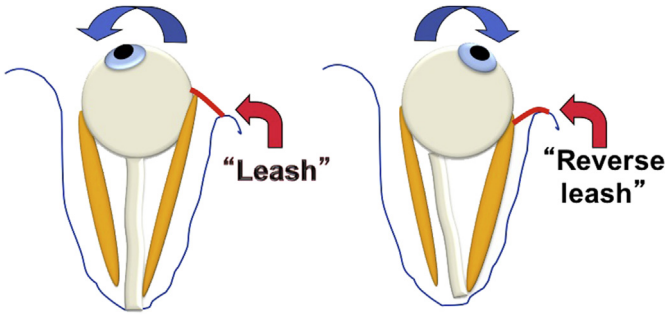

Figure 1. The schematic representation of "leash" and "reverse leash" effect. The tissue that causes a restriction may limit the rotation both in the opposite and the same direction [1].

3. Etiology — preventive measures

The problem that causes restricted ocular movement may be at the extraocular muscles, conjunctiva, Tenon' capsule, soft tissues surrounding the extraocular muscles and at the orbital structures.

Etiology of restricted ocular movements may be summarized in four groups:

1. restrictions related to excessive shortening of an extraocular muscle;
2. restrictions related to inadvertent capture of a neighboring muscle;
3. restrictions related to transposition surgery; and
4. restrictions related to postoperative scar tissue — adhesions.

3.1. Restrictions due to excessive shortening of an extraocular muscle

Excessive shortening of an extraocular muscle may develop either due to excessive resection or excessive tucking-plication of an extraocular muscle. Excessive shortening of an extraocular muscle causes a restriction towards the opposite side of the functional area of the shortened extraocular muscle. In order to avoid that complication, the amount of resection must be carefully determined. In surgical tables the conventional maximum amounts of resections show some variability. The surgeon needs to consider that the elasticity of an individual muscle may have some variability and in some certain conditions even the conventional amounts of resection may cause some restrictive motility problems in concomitant strabismus. In all resections, performing forced duction test must be a routine procedure. In dysinnervational problems such as Duane syndrome and congenital fibrosis of extraocular muscles, resections should be avoided as a golden rule. There may be only rare exceptions to perform resections in Duane syndrome which should be regarded with great caution [2]. Thyroid-associated eye disease is another condition in which resections should be avoided. In cases with cerebral palsy the abnormal muscle tone may cause unpredictable postoperative restrictions.

One of the problems that troubles the strabismus surgeon is reoperation. There are no reliable surgical tables for secondary operations. It is the surgeon's subjective decision how much resection to perform in a previously resected muscle. In some cases the information on the amount of the previous resection may not be obtained. In such a situation the surgeon has to decide the amount of re-resection based on the elasticity of the muscle. A forced duction test might be a good guide before closure to decide whether the new positions of the extraocular muscles will cause any restriction or not. The use of adjustable sutures is a very useful preventive measure to avoid restrictions related to primary or secondary resection surgery.

Tucking or plication is mostly used for the superior oblique tendon in cases with superior oblique palsy. A complication of excessive tuck surgery is the development of secondary Brown syndrome. Because of the high risk of iatrogenic Brown syndrome, tuck surgery is advised to be performed in congenital cases with abnormally lax tendons. The amount of tucking must be determined depending upon the laxity of the superior oblique tendon. Before closure, the surgeon must repeat the forced duction test and if it is positive the amount of tucking must be reduced. A slight limitation in elevation on adduction is usually well tolerated and demonstrates a decrease in time.

3.2. Restrictions related to inadvertent capture of a neighboring muscle

This problem may occur during superior and lateral rectus muscle surgery by inadvertent capture of superior oblique in the former and inferior oblique in the latter. The preventive measure is to hook the lateral rectus muscle from the superior site and to hook the superior rectus muscle from the temporal site. The hook must not engage the muscle far behind the insertion with blind fishing.

3.3. Restrictions related to transposition surgery

Transposition of rectus muscles may cause a restriction towards the eye movement in the opposite direction with the transposition. As an example, transposition of vertical recti laterally in an abducens palsy may cause a limitation on adduction. In order to avoid that complication, the forced duction test should be performed and if any restriction is felt, transposition should be performed with a small recession of the transposed muscle [3]. The risk for a restriction increases with Foster augmentation sutures and a small restriction usually does not cause any problem in an abducens nerve palsy. However if it occurs in Duane syndrome where there is some limitation of adduction preoperatively, the restriction may cause significant problems. If there is a restriction in the preoperative forced duction test, the augmentation sutures may be placed more anteriorly, enough to allow a free forced duction test.

Transposition of oblique muscles may also cause some restrictions. Anterior transposition of the inferior oblique muscle may cause a limitation of elevation–antielevation syndrome — if it is placed too anteriorly or the posterior fibers are spread too temporally. In order to reduce that risk, the posterior fibers are recommended to be sutured in a bunched up fashion and the placement of sutures should not be placed anterior to the inferior rectus insertion.

3.4. Restrictions related to postoperative scar tissue — adhesions

One of the major problems in strabismus surgery is the development of postoperative adhesions, particularly in patients who require multiple strabismus surgeries. The adhesions may develop in the conjunctiva, Tenon's capsule, intermuscular membrane, orbital fat, sclera or extraocular muscle. Such adhesions may cause limitation of ocular motility despite an appropriate amount of extraocular muscle surgery.

Adherence syndrome is described by Parks [4] and he used this term specifically for the motility disturbance secondary to hemorrhage and prolapse of orbital fat tissue following inferior oblique surgery. Later on he suggested that the fat is not directly involved and the loss of elasticity of the septae in the extraconal space that