DISINSERTED EXTRAOCULAR MUSCLES

Alan B. Scott, M.D.
San Francisco, California

Marked limitation of eye movement after strabismus, retinal, or orbital surgery may mean that the muscle is detached from the globe. Techniques to find or identify the lost muscle insertion include visual identification at surgery, palpation of the muscle against the orbit wall, feeling the tug on the forceps as the alert patient under local anesthesia activates the muscle by gaze, frozen sections of a biopsy specimen, and change in cardiac rate with traction on the suspected muscle.

The inadequacy of these techniques, several of which are not applicable with children, has stimulated me to develop a simple and effective apparatus.

A constant-current muscle stimulator was developed to produce 1 msec pulses. A stimulation frequency of 25 Hz produces a vibration sensation if the stimulated muscle is pulling against a forceps held by the surgeon. This is detectable at a lower force level than stimuli of higher frequency (that produce tetany), or lower frequency where the pull of the muscle may be missed. The current is variable from 0 to 10 mA. The stimulator (Figure) works by passing a constant current between its two poles. Muscle between these poles will contract when the current has reached a certain level (about 6 mA); this can then be seen or felt as a retraction of the tissue. One pole of the stimulator is attached to a rod that is thrust into the orbit near the suspected site of the muscle. The second pole clips to a forceps that holds the suspected muscle or tissue possibly connected to the muscle. A foot switch is used to activate the unit. Our model is battery operated to prevent any possible accident from line voltage. Any variable output stimulator can be utilized as long as it has the approximate characteristics described above. Medically approved cardiac pacemakers are among the devices capable of such modifications.

Case reports

Case 1—A 12-month-old girl underwent resection of the left medial rectus and left lateral rectus muscles. She had esotropia of the left eye

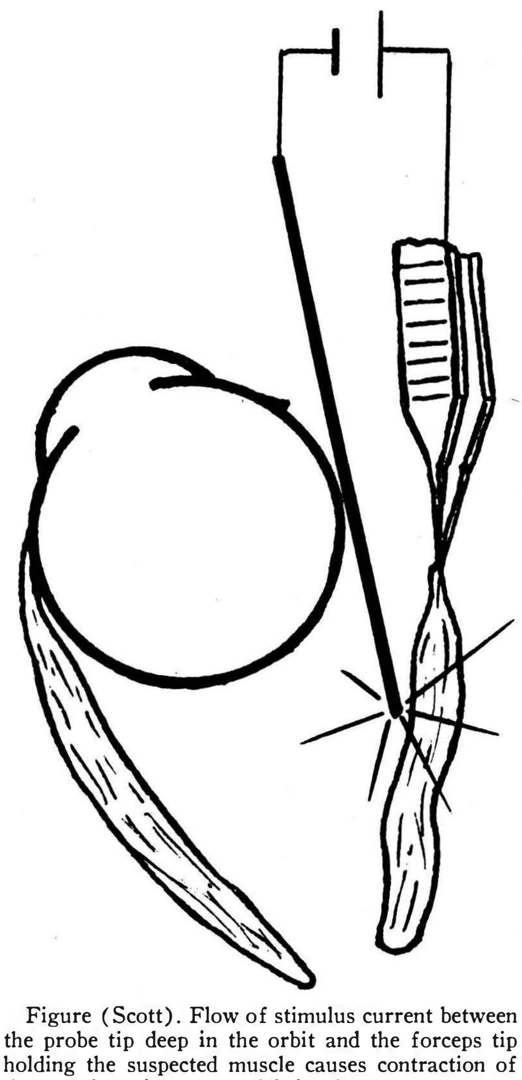

Figure (Scott). Flow of stimulus current between the probe tip deep in the orbit and the forceps tip holding the suspected muscle causes contraction of the muscle to be seen or felt by the surgeon.

From the Smith-Kettlewell Institute of Visual Sciences, San Francisco, California. This study was supported in part by a grant from the Smith-Kettlewell Eye Research Foundation, by Public Health Service research program project grant EY 00299, and Visual Sciences Center grant EY 01186.

of 70 prism diopters. On examination two months later, she had exotropia of the left eye of 60 prism diopters in the primary position, with failure of adduction. The velocity of saccadic movements to adduction was diminished by an estimated 50%, and there was 1 to 2 mm of exophthalmos of the left eye. At reoperation there was a restriction to passive adduction of the left eye; resession of the previously resected left lateral rectus muscle to a position 7 mm behind the insertion allowed free adduction. The area of the left medial rectus muscle was explored without finding the muscle. The stimulator was employed, using maximum current (10 mA) with no response. It was then determined that succinylcholine had been given to the patient when anesthesia was administered. The muscle responded to stimulation 45 minutes after the original injection of succinylcholine. There was no contraction of the muscle until the probe had been placed 18 mm posterior to the caruncle, when the typical vibrating pull against the forceps was felt. This increased as the probe was placed more posteriorly, identifying the anterior position of the muscle at about the level of the posterior pole of the globe. The muscle itself was never visible. Sutures placed through the fibrous tissue extending back to the muscle were attached to the globe about 7 mm from the corneoscleral limbus. At this point there was resistance to abduction, as the muscle was quite tight and contracted. Both conjunctival incisions were closed. Stay sutures of 4-0 silk were placed through the conjunctiva and superficial sclera near the corneoscleral limbus and then through the medial and lateral canthal ligaments where they were placed through a silicone rubber bolster and left loose, to be adjusted as necessary postoperatively. On the first postoperative day, 10 prism diopters of esotropia were present, and abduction was limited. Therefore, the medial stay suture was cut and removed. The lateral stay suture was tightened by holding the eye into 20 degrees of abduction. The suture was removed three days later. There was 5 to 6 prism diopters of esotropia remaining three months after surgery.

Case 2—A 9-year-old boy had intermittent exotropia beginning at age 3. After surgery on the left eye at age 6, the exotropia worsened. Two months later, exploration of the left eye was done with no improvement in alignment. Two years later, the eye showed exotropia of 30 diopters in the primary position, with absent abduction. The left eye was about 2 mm exophthalmic, and this increased with abduction. At surgery the medial area of the left eye was explored 24 mm posterior to the corneoscleral limbus and the muscle was not encountered. In the area near the muscle, the Tenon's capsule was grasped with a forceps attached to one pole of the stimulator, and a probe was placed behind the globe posteriorly. Electrical stimulation was increased to 8 mA with no effect. With movement of the probe deeper into the orbit and then downward, there was a slight twitch of the tissue seen 6 mm inferior to the forceps. By holding various portions of Tenon's capsule while stimulating, the strands connected posteriorly to the muscle were found. The muscle was unattached to the globe at a distance of about 20 mm from the corneoscleral limbus. Sutures placed through the muscle led up through the original insertion where they were tied. It took five minutes to find the muscle with this technique, and the muscle was located by the stimulator in an area that was unexplored during visually guided surgery.

Discussion

Reduced rotation amplitude, reduced saccadic velocity, reduced active force, and exophthalmos are clues to a posteriorly slipped muscle. Exophthalmos, with increase on gaze into the direction of limited motility, is due to absence of the agonist muscle contracting as the antagonist relaxes. A restriction restrains relaxation of the antagonist, and enophthalmos is produced by gaze in the direction of limited motility.

Sometimes the disinserted muscle is easily found a few millimeters posterior to its appropriate position. However, as shown in Case 1, the muscle, because of prior resection or because of marked shortening back into the orbit, could never really be identified except by its contraction effect. Knowing that it was attached through fibrous tissue to the globe ensured successful surgery. In Case 2, the muscle was found in another area. The stimulus of 6 to 8 mA is uncomfortable in an awake patient, and general anesthesia is desirable. The anesthesiologist must be forewarned that the avoidance of any muscle relaxant is absolutely essential. Injection of local anesthetics will abolish the effect of muscle contraction to stimulation. If general anesthesia is not acceptable, topically administered tetracaine is the preferred technique in a cooperative adult, if the patient is to activate the muscle himself.

In my experience, no confusion has occurred in locating horizontal extraocular muscles. However, the close proximity of the inferior rectus and the inferior oblique muscles sometimes leads to stimulation of both when only one is sought, or to movement of both because of their attachment. Therefore, careful visual identification is required after finding the tissue by stimulation.

Summary

In two patients, a muscle that slipped from the globe posteriorly created the clinical pattern of reduced rotation amplitude, reduced saccadic velocity, reduced active force, and increasing exophthalmos with gaze into the field of action of the muscle. The muscle was surgically identified by an electronic stimulator that caused the muscle to contract, thus allowing the surgeon to feel its pull on the forceps or see its traction on adjacent tissues.

Acknowledgment

Bert L. Tate helped design and assemble the original stimulator. This instrument is available from L. T. Instruments, Box 36221, Houston, TX 77036.

Ophthalmic miniature

Something or other must have occupied that place in the animal's head; must have filled up, we will say, that socket. But that it should have been an eye, knowing as we do what an eye comprehends,—viz. that it should have consisted first, of a series of transparent lenses (very different, by-the-bye, even in their substance, from the opaque materials of which the rest of the body is, in general at least, composed): secondly, of a black cloth or canvas (the only membrane of the body which is black) spread out behind these lenses, so as to receive the image formed by pencils of light transmitted through them; and placed at the precise geometrical distance, at which, and at which alone, a distinct image could be formed; thirdly, of a large nerve communicating between this membrane and the brain; without which, the action of light upon the membrane would be lost to the purposes of sensation;—that all this should be thought to be accounted for, by the short answer, "that whatever was there must have had some form or other," is too absurd to be made more so by any augmentation.

William Paley, D.D.
Natural Theology, London, 1826