Orthopaedics & Traumatology: Surgery & Research 101 (2015) S149–S157

Available online at
ScienceDirect
www.sciencedirect.com

Elsevier Masson France
EM|consulte
www.em-consulte.com/en

Review article

Tendon lengthening and transfer

F. Fitoussi*, M. Bachy

Hôpital Trousseau, Service de Chirurgie Orthopédique et Réparatrice de l'Enfant, Université Pierre-et-Marie-Curie, 26, rue du Dr-Arnold-Netter, 75012 Paris, France

ARTICLE INFO

Article history:
Accepted 1st July 2014

Keywords:
Tendon transfer
Paralysis
Tendon suture
Musculotendinous lengthening

ABSTRACT

Tendon lengthening and transfer are usually indicated for certain neuromuscular disorders, peripheral or central nerve injury, congenital disorder or direct traumatic or degenerative musculotendinous lesion. In musculotendinous lengthening, technique depends on muscle anatomy, degree of correction required, and the need to avoid excessive loss of force. Lengthening within the muscle or aponeurosis is stable. In the tendon, however, it may provide greater gain but is not stable and requires postoperative immobilization to avoid excessive lengthening. Tendon transfer consists in displacing a muscle's tendon insertion in order to restore function. The muscle to be transferred is chosen according to strength, architecture and course, contraction timing, intended direction, synergy and the joint moment arm to be restored. Functions to be restored have to be prioritized, and alternatives to transfer should be identified. The principles of tendon transfer require preoperative assessment of the quality of the tissue through which the transfer is to pass and of the suppleness of the joints concerned. During the procedure, transfer tension should be optimized and the neurovascular bundle should be protected. The method of fixation, whether tendon-to-bone or tendon-to-tendon suture, should be planned according to local conditions and the surgeon's experience.

1. Introduction

Tendon lengthening and transfer made a considerable contribution to the treatment of neuromuscular conditions, and poliomyelitis in particular. The techniques have become less widely known, but are still employed in a variety of indications. The present article will deal successively with lengthening and with transfer, setting out the guiding principles and presenting a few of the many techniques.

2. Tendon lengthening

2.1. General considerations

Tenotomy is defined as surgical sectioning of a tendon. It can be used to treat contracture or harmful muscle action, but impairs force and joint moment arm [1]. *Musculotendinous lengthening* serves to restore a more physiological course while conserving function.

Both are usually indicated for musculotendinous retraction complicating a neuromuscular condition, whether congenital (such as club-foot) or degenerative/traumatic. Several techniques have been described and differ both technically and in the anatomic level of the musculotendinous unit involved. The technique is chosen according to various criteria: location, muscle anatomy (tendon and muscle body length, aponeurosis), degree of correction required and avoidance of excessive loss of force. Lengthening within the aponeurosis or muscle is stable, with or without postoperative immobilization, whereas pure tendon lengthening requires immobilization to avoid excessive lengthening or recurrence of contracture. Certain studies have, however, shown that overcorrection may be due not only to the lengthening technique but also to certain biomechanical consequences of lengthening as such [2].

2.2. Percutaneous techniques

Percutaneous techniques have several advantages: less scarring, possible out-patient treatment, and low rates of complication. They can, however, only be used on superficial tendons, as sectioning is performed blindly.

2.2.1. Total tenotomy

Total tenotomy in the lower limbs should be indicated only with caution in patients able to walk. The tendon is palpated and gripped between thumb and forefinger. A minimal incision is made on one

* Corresponding author. Tel.: +33 1 44 73 66 13; fax: +33 1 44 73 63 24.
E-mail address: franck.fitoussi@trs.aphp.fr (F. Fitoussi).

http://dx.doi.org/10.1016/j.otsr.2014.07.033
1877-0568/

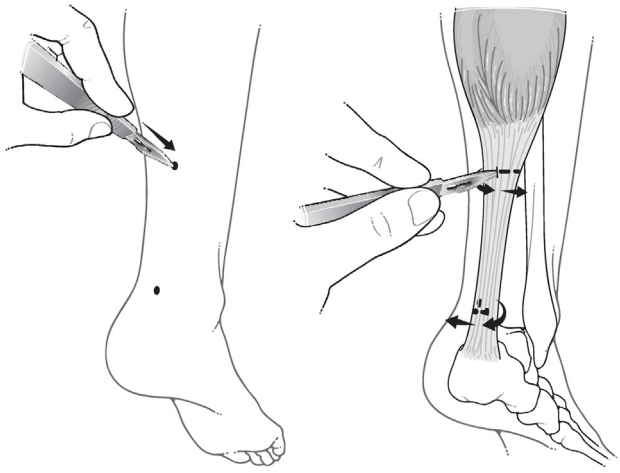

Fig. 1. Alternating 2-level hemi-tenotomy.

edge; the tendon may then be held with forceps and pulled out through the incision. Complete sectioning is performed using a cold blade. The main indication is Achilles tenotomy for varus equinus club-foot on the Ponseti method. Healing is in 6 steps, with a normal tendon structure aspect on ultrasound achieved by 6 months [3]. The adductor longus and gracilis can also be lengthened in this way. Tenotomy of the long part of the brachial biceps in rotator cuff tendinopathy may be performed arthroscopically, allowing resection of the intra-articular part.

2.2.2. Alternating and sliding hemi-tenotomy

Lengthening is achieved by sliding within the sheath in the full tendon body. This technique is especially indicated for the Achilles tendon (Figs. 1 and 2). The length of the tendon is palpated and 2 or 3 small incisions are made, using a cold blade, at various levels, medially and laterally, along the edges of the tendon. The knife needs careful handling, as hemisectioning is performed blindly. A No. 11 blade is recommended, with a blunted proximal part to avoid accidental skin lesions or excessive tendon sectioning. At each level, the blade is introduced into the middle of the tendon parallel to the

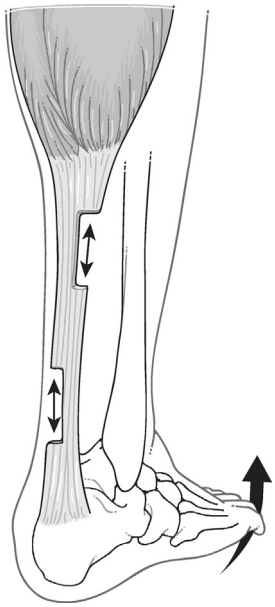

Fig. 2. Sliding with resulting lengthening.

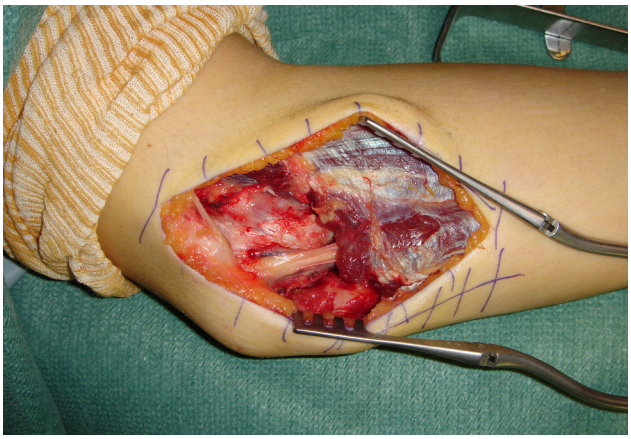

Fig. 3. Medial side of elbow after release of the medial epicondyle flexor-pronator unit for spastic retraction. The ulnar nerve is left in the epicondyle-olecranial groove.

long axis, then turned 90° to enable hemisectioning forward and backward. In the Achilles tendon, low internal transverse hemisectioning is performed just above the calcaneal insertion, followed by high external transverse hemisectioning. A third hemisection can be performed in the same direction as the first, at a higher level. A forced joint movement along the stretching plane of the muscle enables lengthening by sliding of the tendon fibers. If sliding is not achieved, the procedure has to be carefully repeated until sectioning is complete. Closure is by simple skin suture, followed by 6 weeks' cast immobilization.

2.3. Open surgery techniques

Open surgery techniques may be presented according to anatomic level. The more distal the lengthening, the greater the gain, but at the cost of instability, as demonstrated on biomechanical tests [4].

2.3.1. Proximal release

The proximal insertion of the muscle or muscle group is exposed between two Farabeuf retractors and sectioned by cold blade at the aponeurotic fascia. The technique is used for hamstring and gastrocnemius tendons (Silverskiöld procedure), sometimes associated to partial neurotomy [5]. In the upper limbs, the Page-Scaglietti-Gosset procedure consists in releasing all of the flexor/pronator muscles of the medial epicondyle (Fig. 3). In sequelae of obstetric paralysis of the brachial plexus, the subscapularis muscle may also be released from the scapula in case of retraction in internal rotation of the glenoid joint.

2.3.2. Intramuscular lengthening

In intramuscular lengthening, the musculotendinous junction should be sectioned several centimeters above the end of the last muscle fibers, to avoid any muscle tear on stretching [6]. Several options are available, depending on muscle anatomy and the required gain.

2.3.2.1. Transverse sectioning of the musculotendinous junction. The aponeurotic sheath at the origin of the tendon is exposed then sectioned transversally. This procedure can be applied in certain thigh muscles (gracilis and semitendinosus) and in the flexor muscles of the wrist or digits in case of spastic retraction (Fig. 4). The technique may be high or low and at 1 or 2 levels; a cadaver study of the tibialis posterior muscle showed that correction is greater in low tenotomy, but with a greater risk of tear [7].