INTER- AND EXTRAMUSCULAR CONNECTIONS DETERMINE MUSCLE PROPERTIES IN SPASTIC PATIENTS BY MYOFASCIAL FORCE TRANSMISSION

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INTRODUCTION

The purpose of this study was I. to determine whether intermuscular connections affect the behavior of the flexor carpi ulnaris muscle (FCU), and II. to show that FCU length-force relationship, measured in the distal tendon depends on the relative length of its surrounding muscles. It is hypothesized that the influence of the intermuscular connections depends on the stretch that is applied to it.

MATERIALS AND METHODS

I. Surgery was performed on the FCU with the goal to correct spastic flexion deformity of the wrist. FCU muscle length was measured before and after tetanic contraction in 10 patients: (a) after tenotomy, and (b) after subsequent surgical dissection of the muscle belly to approximately halfway the forearm.

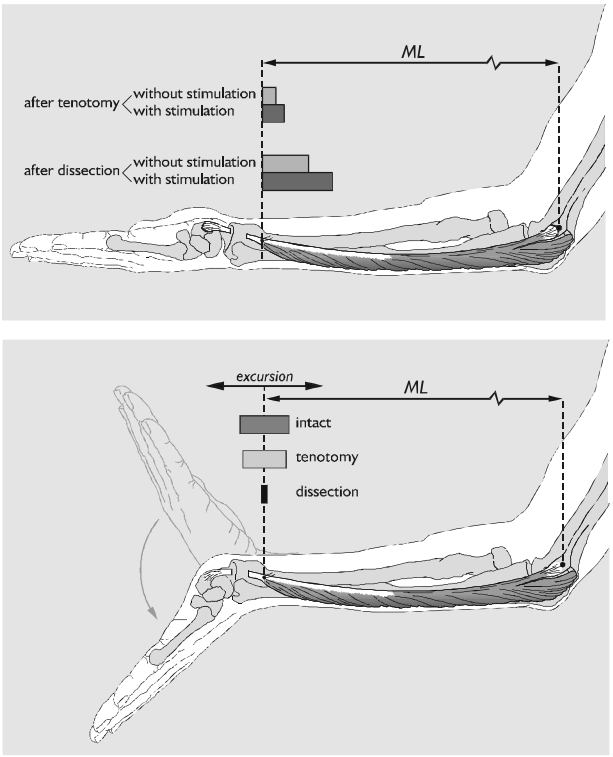

Fig 1: Mean muscle shortening in four different conditions; and mean FCU passive excursion, moving the wrist from flexion to extension in three conditions (Kreulen M et al, 2002, unpublished).

II. After tenotomy, active and passive isometric length-force curves of the spastic FCU in 5 patients with cerebral palsy were measured, using A method to measure length-force curves during transposition surgery, using a force transducer fixed to the humerus, transcutaneous, supra-maximal electrical stimulation and a data-acquisition system (Smeulders MJC et al, 2002, unpublished). Length-force curves were measured both with the wrist in extension and in flexion. In wrist extension, the flexor digitorum profundus (FDP) and sublimus (FDS) are at a high length relative to the FCU, and the intermuscular connections are supposedly stretched, while in flexed wrist position the FDP and FDS are allowed to be short, and the intermuscular connections are supposedly slack.

RESULTS AND DISCUSSION

I. (a) After tenotomy, tetanic activation caused only limited muscle shortening (8 mm ±2.8) (Fig 1). Passive wrist extension caused lengthening of FCU muscle, even though its distal tendon no longer crossed the wrist joint. (b) After surgical dissection, stimulation caused a significantly increased muscle shortening (mean increase= 26 mm.; SD= 5.1, $p < .001$). In contrast, the lengthening caused by passive extension of the wrist decreased dramatically to very low values.

II. In flexed position, the active force that was measured in the distal tendon was 20% to 40% higher than in the extended position over the entire range of FCU lengths (fig. 2). The passive force was not significantly different. This indicates the intermuscular connective tissue to influence active force exertion. The stretched intermuscular connections transmit 20% to 40% of the total force that is exerted by the FCU to the FDS and FDP, while in slack position, this force is transmitted to the distal tendon of the FCU.

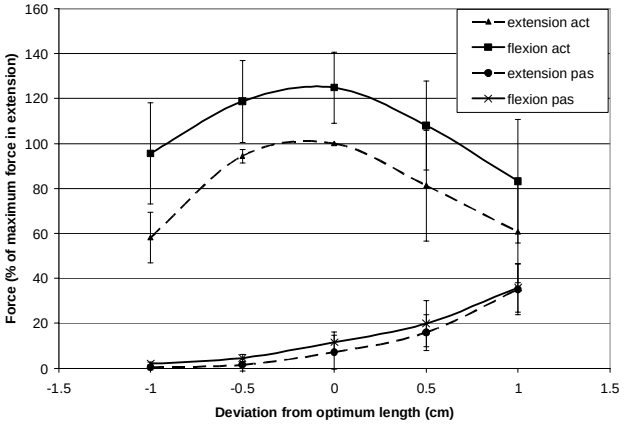

Fig 2: mean active and passive length force curves of 5 patients with flexed wrist and with extended wrist.

It is concluded that inter- and extramuscular connections of muscle are strong enough to withstand the exerted active muscle force and may be stretched to be stiff enough to actually transmit this force, and thus affect in vivo FCU behavior. The role of this myofascial force transmission has to be considered in transposition surgery.