SUBSTANTIAL INTER-ANTAGONISTIC EPIMUSCULAR MYOFASCIAL FORCE TRANSMISSION OCCURS WITHIN THE ENTIRE LOWER LEG OF THE RAT

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INTRODUCTION

Due to *epimuscular myofascial force transmission* i.e., substantial fractions of muscle force transmitted via (1) the direct collagenous connections between neighboring muscles via shared epimysia and (2) the extracellular matrix of a muscle to surrounding non-muscular elements of a compartment and bone, adjacent synergistic muscles have been shown not to function independently [e.g., 1]. Moreover, such mechanical interaction and hence functional dependency was recently shown to be important also for antagonistic muscles within different compartments [e.g., 2] including anterior crural, peroneal and triceps surae muscles of the rat. The goal of the present study was to test the hypothesis that due to inter-antagonistic epimuscular myofascial force transmission, length changes also of deep flexors affect substantially the mechanics of anterior crural and peroneal muscles. Confirmation would allow concluding that such force transmission occurs within the entire lower leg of the rat for these experimental conditions.

METHODS

Anterior crural muscles (i.e., extensor digitorum longus (EDL), as well as tibialis anterior and extensor hallucis longus muscle complex (TA+EHL)) and peroneal (PER) muscles were kept at constant length, whereas, distal length changes were imposed on deep flexor (DF) muscles before performing isometric contractions. Distal forces of all muscle-tendon complexes were measured simultaneously, in addition to EDL proximal force. Force differences were considered significant (n=6) at $p<0.05$ for ANOVA as well as Bonferroni post–hoc tests.

RESULTS AND DISCUSSION

Distal lengthening of DF caused substantial and significant effects on its antagonistic muscles (Figure 1): (1) increase in proximal EDL total force (maximally 19.2 %), (2) decrease in distal EDL total (maximally 8.4 %) and passive (maximally 49 %) forces, (3) variable proximo-distal total force differences indicating net proximally directed epimuscular myofascial loads acting on EDL at lower DF lengths and net distally directed loads at higher DF lengths, (4) decrease in TA+EHL total (maximally 50%) and passive (maximally 66.5 %) forces and (5) decrease in PER total force (maximally 51.3 %). Such effects are explained by epimuscular myofascial loads (a resultant of several load components of different magnitude, as well as direction) acting on the restrained muscle (group). Due to the continuity of intra- and epimuscular connective tissues, such loads are expected locally to take part in the balance of forces at the sarcomere, therefore co-determining its length at equilibrium.

Maas and Sandercock [3] argued that for the cat, knee angle induced changes in relative position of its synergist muscles does not affect the force of m. soleus. In contrast, our recent human *in vivo* MRI data, in agreement with our present results show changing knee angles causing sizable strains not only in m. gastrocnemius but also in m. soleus and other muscles within the entire lower leg, not crossing the knee.

CONCLUSIONS

Substantial inter-antagonistic epimuscular myofascial force transmission does occur in rat between deep flexor, anterior crural and peroneal muscles. Therefore, we conclude that epimuscular myofascial force transmission is capable of causing major effects within the entire lower leg. Implications should be studied also for human muscle in both health and disease.

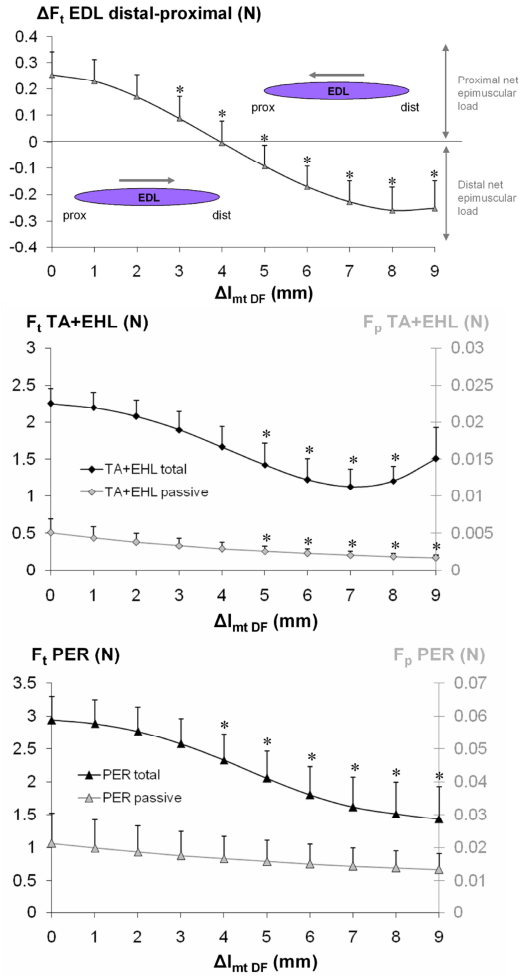

Figure 1: Effects of DF length on proximo-distal EDL total force differences, TA+EHL and PER forces (* indicates significant differences).

REFERENCES

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