THE ORIGIN OF MECHANICAL INTERACTIONS BETWEEN ADJACENT SYNERGISTS IN RAT

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INTRODUCTION

It has been shown that adjacent synergistic muscles do not function as independent units with regard to force transmission. Length changes as well as position changes of a single muscle-tendon complex in rat do not only result in force changes of the muscle that is manipulated, but also in force changes measured at the tendons of adjacent synergists [1, 2]. The underlying mechanism for such mechanical interaction between muscles is force transmission to bone via pathways other than the muscular origin and insertion, i.e. epimuscular myofascial force transmission [3]. Two separate pathways for such force transmission exist: (a) connective tissue at the interface between muscle bellies (intermuscular) and (b) extramuscular connective tissues. As both myofascial pathways are possibly involved, the **purpose** of the present study is to investigate the origin of mechanical interactions between synergistic muscles.

METHODS

In male Wistar rats (n = 8), the proximal and distal tendons of extensor digitorum longus (EDL) muscle as well as the tied distal tendons of tibialis anterior and extensor hallucis longus (TA+EHL) muscles were transected and connected to force transducers. Connective tissues at the muscle bellies of the anterior crural compartment were left intact. Supramaximal stimulation (100 Hz) of the common peroneal nerve excited all muscles maximally and simultaneously. Length–isometric force characteristics of distal TA+EHL were assessed. Simultaneously, forces exerted at the proximal and distal tendons of EDL, kept at constant muscle-tendon complex length and relative position, were measured. Intermuscular interaction was tested in two conditions: (a) after full longitudinal compartmental fasciotomy, and (b) after blunt dissection of the intermuscular connective tissue linkages between EDL and TA. Note that in the latter condition, intermuscular myofascial pathways were eliminated.

RESULTS AND DISCUSSION

Distal length changes of TA+EHL altered proximal as well as distal EDL force, despite the fact that EDL muscle-tendon complex length was kept constant (Figure 1). Blunt dissection caused no changes of the TA+EHL length effects on *proximal* EDL force. This indicates that effects of TA+EHL lengthening on proximal EDL force are mediated predominantly by extramuscular myofascial force transmission. In contrast, the amplitude of change in the *distal* EDL force curve decreased significantly (by ≈40%) subsequent to blunt dissection. Therefore, part of the change of *distal* EDL force is mediated by intermuscular myofascial force transmission.

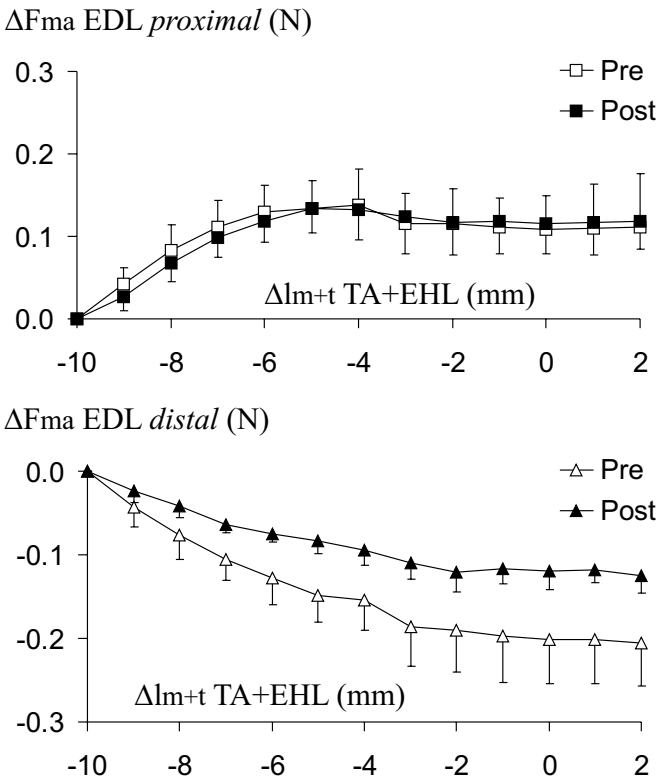

Figure 1: Changes of distal and proximal EDL active forces (F_{ma}) as a function of TA+EHL muscle-tendon complex length. F_{ma} is expressed as the deviation from the initial value (Δl_{m+t} TA+EHL = −10 mm): EDL *distal* $F_{ma,\ pre}$ = 1.74 N (0.10) and $F_{ma,\ post}$ = 1.67 N (0.14); EDL *proximal* $F_{ma,\ pre}$ = 1.45 N (0.14) and $F_{ma,\ post}$ = 1.42 N (0.17). Mean (SD), n = 8.

CONCLUSION

It is concluded that mechanical interaction between synergists originates from both intermuscular as well as extramuscular connective tissues. The highest contribution, however, should be ascribed to the latter pathway.

REFERENCES

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