The role of muscle related fascial tissues in length-history effects causing decreased active muscle force particularly at low lengths

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BACKGROUND: Length history dependence of isometric muscle force has been shown recently [1]. Our aim was to investigate determinants of such *history effects* with experiments designed in the context of epimuscular myofascial force transmission [2].
METHODS: Isometric forces of maximally active extensor digitorum longus (EDL) muscle, as well as tibialis anterior and extensor hallucis longus muscle complex (TA+EHL) of the rat were measured simultaneously. (1) Length-force (ℓ-*F* data were collected and (2) *control measurement*s were performed at i) EDL optimum length and ii) at lower length (muscle length attained at reference position i.e., with knee and ankle angles of 120° and 100° respectively). Between consecutive contractions, muscles were allowed to recover for 2 min. History effects were quantified as $F_{\ell\text{-}F}$- $F_{control}$ for the indicated lengths.
RESULTS: (1) History effects occurred only for muscle that has been active at lengths near optimum length. After being exposed to activity at high length, the effects on active force are found particularly at lower lengths: for lengthening of EDL exclusively (i) EDL distal force decreased by 5.18% at optimum length; but by 45.49% at lower length; whereas, (ii) force of TA+EHL restrained at constant length showed almost no change (even an increase by 2.36%). Such length dependence of these history effects is probably related to differences in l-F slopes at high and low lengths. (2) Time dependence of length-history effects indicate that viscoelastic intra- and extramuscular connective tissue properties are key determinants and that the time constant is high: a second control contraction after 15 min of recovery showed an even higher force decrease (e.g., at reference length, proximal EDL force drop increased from 41.53% to 55.69%). (3) Epimuscular myofascial force transmission appears to be an important co-determinant: (i) for lengthening of EDL and TA+EHL muscles simultaneously (a condition prevents changes of relative position of these muscles) the decrease in EDL distal force at reference length was much less pronounced (ΔF decreased by 42.14%). (ii) Interfering surgically with the connections of muscle with neighboring muscular and non-muscular structures (i.e., breaking epimuscular myofascial force transmission pathways) yielded reduced history effects: the decrease in EDL distal force was limited to 76.76% and 64.98% of that measured in the intact condition after blunt dissection (of collagenous connections between EDL and TA+EHL muscles) and after subsequent fasciotomy (of anterior crural compartmental fascia) respectively.
CONCLUSION: Length-history effects typically causing active force reductions should be considered as a fundamental phenomenon for muscle physiology and pathology. This may have important consequences: e.g. (1) for designing muscular mechanics experiments and (2) for effects of manual therapies. Although our results show that the presence of epimuscular myofascial force transmission may affect considerably the effect size, the primary condition causing such history effects, particularly at lower lengths, is previous activity at high muscle lengths.

REFERENCES

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