Protection of Skeletal Muscle Against Stimulation-Induced Damage

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We investigated the effect of low-frequency prestimulation on capillarization, force-generating capacity, and stimulation-induced damage in rabbit tibialis anterior (TA) muscle.

Methods. Muscles were stimulated at 2.5 Hz (a non-damaging pattern of stimulation) for 7, 10 or 14 days, either alone or followed by stimulation at 10 Hz (a potentially damaging pattern) for 9 days. Contractile characteristics, including maximum isometric force, were measured in a terminal experiment. Muscles were excised and transverse cryostat sections were stained with haematoxylin and eosin for morphological assessment and histochemically (myofibrillar ATPase with acid pre-incubation) to demonstrate capillaries. Percentage volume damage and capillary density were quantitated by point–counting morphometry.

Results. Muscles stimulated at 10 Hz for 9 days showed a significantly higher level of damage (7.9 ± 2.1%, mean ± SEM) than control unstimulated muscles (0.2 ± 0.09%, $P < 0.001$). The damage resulting from stimulation at 10 Hz was significantly lower in muscles that were first stimulated at 2.5 Hz for 7, 10 or 14 days (3.9 ± 0.3%, 4.4 ± 0.6%, 4.4 ± 0.6% respectively, $P < 0.05$). Capillary density was 360.4 ± 54.2, 420.4 ± 50.4, 408 ± 86 capillaries/mm^2 in muscles prestimulated at 2.5 Hz for 7, 10 or 14 days respectively; this was not significantly higher than controls (260.7 ± 45.57 capillaries/mm^2). There was a strong linear correlation between the decline of maximum isometric force and the incidence of histological damage.

Conclusions. Prestimulation has a significant protective effect on muscles subjected to a metabolically challenging pattern, but the data suggests that this is not attributable to capillary development alone. Force is affected by all forms of damage, some of which may be subtle and reversible, but histologically manifested damage appears to be a fixed proportion of the whole.

Acknowledgement. This study forms part of TMR Research Network ‘NEUROS’ (Contract Number: FMRX-CT96-0021).