【国際セッション】

Decreased motor unit firing rate and force control in older men

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Introduction

Ageing is related to muscle atrophy that leads to decreases in muscle force. The largest changes are found in fast muscle fibres and fast force production, reducing the capability to recover from sudden balance disturbances. Also ageing-related decrease in force control has been found, as indicated by an increase in force fluctuations and motor unit (MU) firing variability (Galganski et al. 1993). Possibly due to differences in measurement protocols and muscles, the results concerning the effects of ageing on motor unit firing rate are, however, somewhat contradictory (for review, see Roos et al. 1997). The purpose of the present study was to investigate the age-related changes in the firing properties of the Soleus muscle, which has an important role in locomotion and balance.

Methods

8 YOUNG (27.1±3.2yr, 177.1±7.8cm 71.7±4.7kg) and 9 OLD (70.2±4.1yr, 176.3±4.5cm 84.9±10.7kg) physically active males served as subjects in the study. The subjects performed plantar flexions while seated in an ergometer. The trials consisted of isometric ramp contractions at a very slow rate (1%MVC/s) and level contractions at 10 and 20%MVC. EMG activity of Soleus (SOL) was measured with a bipolar surface electrode. For motor unit (MU) identification four novel bipolar fine-wire electrodes were inserted into SOL. Signal decomposition, motor unit identification and data analysis were performed with a special Daisy -software (Olsen et al. 2001). From the motor unit data, firing rates (FR) were calculated at recruitment threshold (TH; see Fig. 1.) and at two submaximal EMG activity levels (L10 & L20%MVC-max). For analysis, motor units were divided into two groups (TH10% and TH20%) according to the activation level. The variabilities in FR and force were determined by coefficient of variation (FR CV%: SD of instantaneous FR/mean FR and F CV%: SD of force curve/mean force, respectively).

Results

The maximal voluntary plantarflexion force was 21.4% lower in OLD as compared to YOUNG ($p=0.03$). Also FR was significantly lower in OLD at TH10%, TH20% and L10%. The difference at L20% did not reach statistical difference (Fig.2). In OLD force fluctuation was larger at L10%, which was accompanied with a slight increase [n.s.] in FR variation (Fig.3).

Discussion/Conclusion

FR was lower in OLD at recruitment threshold and in L10%, which is in line with earlier findings in other distal muscles, e.g. Tibialis Anterior (Connelly et al. 1999) and Adductor Digiti Minimi (Nelson et al. 1984). Also the larger F CV% in OLD at L10% was in line with previous studies with smaller hand muscles (Galganski et al. 1993). These findings suggest that the age-related changes in motor unit control do exist and they can be measured also in large leg extensors that play an important role in human locomotion and balance control.

Fig. 1. Identification of three motor units. Inset: For MU identification, raw data (bottom) and two different filtered signals were used

Fig. 2: Firing rates ($\pm$ SD) of YOUNG (black) and OLD (gray) at threshold (TH) and in level contractions (L).

References

Roos et al. (1997) *Muscle Nerve* Vol 22: 1094-1103
 Galganski et al. (1993) *J Neurophys.* Vol 69: 2108-15
 Connelly et al. (1999) *J.App. Physiol* Vol 87: 843-852

Fig. 3: Coefficient of variation ($\pm$ SD) of firing rate (FR) and force (F) in level contractions.

Nelson et al. (1984) *Phys Ther* Vol 64: 29-34
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