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Four weeks of isometric strength training determine differential changes in muscle fibre conduction velocity in high- and low-threshold motor units

Casolo, A.1,2, Farina, D.2, Bazzucchi, I.1, Felici, F.1, Del Vecchio, A.1,2

1 Università degli Studi di Roma Foro Italico, Rome, Italy; 2 Imperial College, London, UK

INTRODUCTION:
Short-term strength training elicits adaptations in the central and peripheral properties of motor units. However, changes in the membrane properties of muscle fibres of individual motor units induced by short-term strength training are unknown. The average velocity of propagation of action potentials along the muscle fibres innervated by individual motor neurons, which we will refer to as motor unit conduction velocity (MUCV), reflects the electrophysiological properties of fibre membrane (1) and is associated to the fibre diameters (2). This study aimed at investigating MUCV adjustments after four weeks of strength training.
METHODS:
Twelve participants (INT) performed 4 weeks of strength training characterized by isometric ballistic (x40) and submaximal sustained (x30) contractions, while twelve acted as controls (CON). Measurement sessions involved recordings of maximal (MVF) and submaximal isometric muscle forces of ankle dorsiflexors during linearly increasing ramp contractions (35, 50, 70% MVF) while recording high-density surface EMG signals from the tibialis anterior muscle. EMG signals were decomposed into individual MU discharge timings (3) and the identified MUs were tracked across sessions (4). MUCV was estimated with a multi-channel maximum likelihood algorithm (5). Two-way RM ANOVAs and linear regressions between MUCV and recruitment threshold (RT) were performed.
RESULTS:
Maximal voluntary force (PRE: 284.3±64.0, POST: 324.4±61.5 N; P=0.003), normalized MU recruitment threshold (PRE: 32.2±18.1, POST: 27.4±15.7 %MVF; P=0.001), and average MUCV (PRE: 4.52±0.39, POST: 4.66±0.44 m/s; P=0.028) changed significantly in the INT group. MUCV of the tracked MUs was positively correlated with normalized RT in all conditions and groups (R2 =0.71±0.16; P<0.05). However, the slope of the regression line between MUCV and RT increased significantly only in the INT group (PRE: 0.019±0.007, POST: 0.025±0.011 m/s·%MVF; P=0.028), indicating a progressive greater increase in MUCV for higher threshold motor units. On the other hand, the initial value of MUCV did not change significantly. Similarly, average MU discharge rate at recruitment did not change significantly with training. None of the changes observed in the INT group were observed in the CON group.
CONCLUSION:
The increase in the rate of change in MUCV as a function of motor unit recruitment, but not the initial value of MUCV, suggests that short-term strength training elicits specific adaptations in the higher threshold motor units. Moreover, the increase in MUCV was not accompanied by changes in discharge rate. Our results provide the first evidence of specific adaptations in the electrophysiological properties of the muscle fibre membrane in high-threshold motor units.
REFERENCES:
1) Allen et al., Physiol Rev, 2007
2) Del Vecchio et al., JApplPhysiol, 2017
3) Holobar & Zazula, IEEE Trans signal Process, 2007
4) Del Vecchio et al., JPhysiol, 2019
5) Farina et al., Med Biol Eng Comput, 2001

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