

**MOTOR UNIT ACTIVITY AND
NEUROMUSCULAR FUNCTION AFTER
EXERCISE-INDUCED DAMAGE TO ELBOW
FLEXOR MUSCLES**

A thesis submitted for the Degree of

DOCTOR OF PHILOSOPHY



by

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Abstract

It has been known for some time that eccentric exercise produces significant muscle damage resulting in changes in muscle structure and function, leading to a fall in maximal force production, a rise in passive tension, as well as delayed-onset muscle soreness. The majority of studies to date have focussed on examining the structural changes in the muscle, however, little is known about how the nervous system responds to eccentric exercise-induced muscle damage. This thesis has investigated for the first time changes at the level of single motor unit activity following eccentric exercise, which provides specific information about the activity of spinal motor neurons that can reveal details of the nature of the neural adaptations to repeated eccentric contractions.

Muscle damage was induced in experiments in Chapters 2 and 3 by controlled lowering of a hand-held load, requiring eccentric contraction of the elbow flexor muscles, and in Chapter 4, by maximal voluntary eccentric contractions of the elbow flexors on an isokinetic dynamometer, to induce a 40% reduction in MVC force in all subjects. As well as an extended reduction in MVC force, I found consistent with results from previous studies a reduction in relaxed elbow joint angle (indicative of a rise in passive tension) up to 24-hrs after the exercise and delayed-onset muscle soreness a day later. An increase in sub-maximal biceps brachii EMG activity and increased force fluctuations for up to 24-hrs after the exercise was also found, along with increased antagonist activity from triceps brachii EMG immediately after eccentric exercise, confirming results from other studies.

Following a single bout of eccentric exercise, I found an increase in correlated motor unit activity (motor unit synchronization and coherence; Chapter 2) and a reduction in the force at which motor units were recruited (Chapter 3) that lasted for at least 24 hours after the

exercise. Minimum motor unit discharge rates were also influenced by eccentric exercise, but had recovered 24 hours later (Chapter 3). These findings indicate that eccentric exercise-induced muscle damage alters the correlated discharge behaviour and recruitment threshold of human motor units in elbow flexor muscles for ≤ 24 hrs. It was therefore hypothesised in Chapter 4 that a lasting adaptation in correlated motor unit activity and/or motor unit recruitment may contribute to the “repeated bout effect”, which results in reduced muscle damage from a subsequent bout of eccentric exercise.

In Chapter 4, a repeated bout of eccentric exercise performed 7 days after the initial bout resulted in reduced symptoms of muscle damage, including a faster recovery of muscle strength, and reduced development of muscle soreness. Motor unit activity measured 7 days after the initial bout of exercise (immediately before the repeated bout) showed elevated motor unit synchronization, but a recovery of motor unit recruitment threshold to pre-exercise levels. These findings are the first to demonstrate a long-term neural adaptation following eccentric exercise, and suggest a potential role for motor unit synchronization in reducing muscle damage after a repeated bout of eccentric exercise.

Declaration

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Dartnall, T.J., Nordstrom, M.A., & Semmler, J.G. (2008) Motor Unit Synchronization is Increased in Biceps Brachii after Exercise-Induced Damage to Elbow Flexor Muscles. *Journal of Neurophysiology* 99: 1008-1019.

Dartnall, T.J., Rogasch, N.C., Nordstrom, M.A., & Semmler, J.G. (2009) Eccentric Muscle Damage Has Variable Effects on Motor Unit Recruitment Thresholds and Discharge Patterns in Elbow Flexor Muscles. *Journal of Neurophysiology* 102: 413-423.

Dartnall, T.J., Nordstrom, M.A., & Semmler, J.G. Adaptations in human motor unit activity after repeated bouts of eccentric exercise in elbow flexor muscles. To be submitted to *Journal of Neurophysiology*.

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