Comparison of contractile responses of single motor units in the toe extensors during unloaded and loaded isotonic and isometric conditions

M. Leitch and V.G. Macefield, School of Medicine, University of Western Sydney, Penrith, NSW 2751, Australia.

Introduction: Much of the repertoire of muscle function performed in everyday life involves isotonic movements, either unloaded or with an additional load. Very rarely do we perform isometric contractions, yet most investigations of contractile properties of single motor units measure isometric forces. We recently measured the contractile properties of single motor units supplying the toe extensors, assessed by intraneural microstimulation of single human motor axons, in isotonic conditions (Leitch & Macefield, 2014), loaded isotonic and isometric conditions.

Methods: Highly selective tungsten microelectrodes were inserted into the common peroneal nerve and single motor axons (n=10) supplying the toe extensors were electrically stimulated through the microelectrode. The contractile responses were measured with either an angular displacement transducer for the unloaded and loaded (40 mN) isotonic conditions or a force transducer for the isometric conditions. Once a single motor axon was isolated the mean twitch profiles to 10 stimuli were measured at 1 Hz for all conditions. This was followed by trains of 10 pulses given at 2-30 Hz in 2 Hz increments, allowing us to measure the frequency-response curves in each condition.

Results: Twitch rise time, fall time and duration were shortest for the unloaded isotonic conditions and longest for the isometric conditions. Peak amplitude was lower in the loaded than unloaded isotonic conditions, and the frequency required to generate half of the maximal response in the unloaded condition was achieved earlier in the loaded isotonic condition.

Conclusions: We conclude that the contractile responses of single motor units supplying the toe extensors are influenced by how they are measured: twitches are much slower when measured in loaded than unloaded isotonic conditions, and slowest when measured in isometric conditions. One explanation for this is that, because of the slower twitches, fusion occurs earlier in the loaded isotonic and isometric conditions. This affects the capacity for motoneurones to translate changes in firing rate into a change in contraction amplitude, with lower frequencies being required to generate a given amplitude in loaded and, especially, isometric conditions.

Leitch M & Macefield VG. (2014) Comparison of the contractile responses to irregular and regular trains of stimuli during microstimulation of single human motor axons. *Journal of Neurophysiology* **111**: 1499-1506.