PASSIVE STRETCH-INDUCED FASCICLE BEHAVIOUR IN THE HUMAN SOLEUS MUSCLE

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Previous studies investigating passive muscle properties have primarily focused on clinical populations and have thus neglected the influence of the stretch reflex (SR) on passive tension. Therefore, very little is known about the mechanical behaviour of skeletal muscle in response to passive stretch, particularly at fast stretch velocities where a SR is elicited. The purpose of this study was to investigate fascicle behaviour in the human soleus (SOL) muscle in response to fast passive stretches eliciting a SR. This information was used to discuss the mechanisms responsible for the contraction state-dependent responses of skeletal muscle to stretch (Nicol & Komi, 1999).

Double stretches (0.06 rad; 2.09 rad/s) with varying inter-stretch intervals were induced in 8 subjects using a custom-made ankle ergometer, and ultrasonography was used to record fascicle behaviour. The first stretch always caused a stretch reflex in SOL. When the 2nd stretch occurred shortly after reflex activation, the muscle exhibited a high resistance to the stretch. This resulted in clear force enhancement and minimal fascicle lengthening. When the 2nd stretch occurred later, i.e. when the muscle was relaxing, the fascicles exhibited a more compliant response and there was a clear decline in force gain.

Stretch reflex activation results in a brief increase in muscle stiffness. Therefore, when a stretch occurs shortly after reflex activation, the muscle exhibits a high resistance to the stretch, as indicated by the minimal fascicle extension in the present study. When the 2nd stretch occurs whilst the muscle is relaxing, fewer actin-myosin cross-bridges are likely to be attached, so the stretch-resisting capability of the muscle is decreased. This was evidenced by the greater increase in fascicle length in response to the 2nd stretch. When the 2nd stretch occurred significantly later than the 1st (800ms), a reflex response was also evident after the 2nd stretch in some subjects. This was again associated with a stiff fascicle response and a clear increase in force gain compared to subjects where a 2nd reflex was not observed.

The fascicle length change patterns exhibited a clear relationship with the force responses in the SOL muscle. The findings support the idea that force enhancement during stretch is proportional to the number and strength of attached cross-bridges (Edman, 1999), and highlight the importance of a muscle’s contraction-relaxation state to the stretch response (Nicol & Komi, 1999). These findings may have significant implications for motor control, as passive muscle properties affect the ability of the neuromuscular system to accurately control movement.


Keywords: Reflex, Muscle, Fascicle Length