Effect of muscle force during stretch oneccentric contraction-induced muscle damage

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Introduction: Eccentric contraction-induced muscle damage (ECIMD) typically results in a deficit in force and increase in optimum muscle fibre length. These effects can be exaggerated by higher muscle force, larger muscle stretch amplitudes, and longer initial muscle lengths prior to stretch. However, in vivo, where muscle-tendon unit length is constrained, muscle fibres operate at shorter lengths when generating higher forces as a result of the stretch of elastic tendinous tissues. Accordingly, under conditions of increased loading, shorter relative muscle lengths at the initiation of stretch may partially offset the effect of higher muscle force during stretch on ECIMD. The aim of this study was to study the effect of muscle force during stretch on quantitative and qualitative indicators of ECIMD.

Methods: Participants (N= 12) performed single leg, straight knee eccentric heel drops with and without an additional mass equal to 30% of body mass until a target volume of body massnormalised negative mechanical work was achieved. Low and high force conditions were performed on separate legs, and were studied in distinct sessions separated by at least 7 days. Three-dimensional motion capture and ground reaction force data were collected during the task. B-mode ultrasound imaging was employed to measure medial gastrocnemius (MG) fascicle lengths. Measures of ECIMD were made pre-exercise, 2 h and 48 h after the damaging exercise. These measures included maximum voluntary plantar flexion torque, supramaximal tibial nerve stimulation torque, muscle soreness scores and serum creatine kinase activity.

Results: MG fascicle stretch amplitude was similar for low and high force conditions ($P > 0.71$). Therefore, work performed during stretch was greater in the high force condition. Minimum and maximum MG fascicle lengths were not statistically different between force conditions, however, there was a trend for MG fascicles to operate at shorter lengths during the high force condition ($P = 0.17$). Force during stretch was found to have no effect on the deficit in torque-generating capacity 2 h post-exercise ($P = 0.59–0.61$), or serum creatine kinase activity 48 h post-exercise ($P = 0.19$). Muscle soreness scores were also qualitatively similar post-exercise.

Discussion: These results suggest that the tendency for higher force and work during stretch to elicit greater ECIMD is largely negated by the fact that higher forces during stretch in vivo reduce fascicle operating lengths. In this regard, high series elasticity may provide protection against ECIMD by affording significant muscle fibre shortening against the stretch of the series elastic element prior to muscle fibre stretch.