DOES PRE-EXERCISE STRETCHING AFFECT MUSCLE TENDON UNIT COMPLIANCE?

M. Polly McGuigan, Dominic J. Farris, Michael J. Wood, Amro Abbas, and Grant Trewartha

School for Health, University of Bath, UK

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INTRODUCTION: Pre-exercise stretching is carried out by the majority of recreational and professional athletes, yet there is conflicting evidence with regard to the benefits of such programmes to either performance or injury risk reduction. It is unclear whether pre-exercise stretching can affect compliance, and at what level of the muscle-tendon unit (MTU) this effect may occur. Therefore the aim of this study was to determine whether an active pre-exercise stretching protocol increased the compliance of the triceps surae muscle-tendon complex and whether changes in compliance occurred in the muscle body or free tendon.

METHOD: The hypotheses were addressed using a cross over design in which each subject acted as their own control. To date seven female subjects have been recruited to the study which was approved by the University Ethics committee. The compliance of the MTU and the Achilles tendon were determined during six single leg hops before and after an active pre-exercise stretching protocol. The stretching protocol consisted of a concentric contraction of the gastrocnemius and soleus muscles for 5s followed by passive stretching of the triceps surae complex for 25s. This was repeated four times, twice with the knee extended and twice with the knee slightly flexed, to differentially stretch the gastrocnemius and soleus muscles respectively. A combination of ultrasound, forceplate and 3D motion analysis were used to determine the length of the MTUs (Hawkins & Hull, 1990), the length of the Achilles tendon (Lichtwark & Wilson, 2005) and Achilles tendon force. The stiffness of the Achilles tendon and the gastrocnemius and soleus MTUs were defined as the gradient of a linear regression fitted to the force-length relationships of the tendon and the two MTUs during the loading phase of each hop. Paired t tests were used to identify differences in MTU and Achilles tendon stiffness before and after the stretching protocol, with a significance level of $p \leq 0.05$.

RESULTS & DISCUSSION: Results to date show that the stiffness of the gastrocnemius MTU was reduced after the stretching protocol (147 ± 44 Nmm^{-1} (mean ± sd) pre stretch vs 128 ± 36 Nmm^{-1} post stretch, $p = 0.02$). However, the stiffness of the Achilles tendon was not significantly affected by the stretching (188 ± 118 Nmm^{-1} pre stretch vs 203 ± 109 Nmm^{-1} post stretch). This suggests that an active pre-exercise stretching protocol increases the compliance of the MTU, but the alteration in the mechanical properties occurs at the level of the muscle body rather than the free tendon. It is not clear whether this change in muscle compliance is due to changes in the connective tissue element of the muscle, or changes in the contractile machinery, and this question requires further investigation.

CONCLUSION: This study has identified that pre-exercise stretching does not significantly increase the compliance of the Achilles tendon, but does increase the compliance of the muscle body. This suggests that pre-exercise stretching may alter the strain characteristics of the muscle fascicles without affecting the force transmission through the tendon. This has implications for both athletic performance and injury prevention.

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