STRETCHING AND WARM-UP: ARE THEY IMPORTANT FOR ACHILLES TENDON INJURY REDUCTION?

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INTRODUCTION

Achilles tendon rupture is among the most frequent musculoskeletal injury, with over 1 million cases annualy in the United States alone [1]. Calf stretches and warm-up are routinely used by professional and recreational athletes as an injury prevention measure. Both londitudinal stretch training studies and accute calf stretching have shown to decrease tendon stiffness [2,3], representing a possible mechanism for reducing the incidence of tendon rupture. However, these studies use stretching protocols that are impractical and of much greater intensity compared to those commonly used by 'typical' middle-aged indiviulas, who are most at risk of tendon injury. Moreover, no studies have addressed the effect of warm-up on Achilles tendon mechanical properties. Concequently, whether or not commonly adopted stretching and warm-up routines used by recreational athletes confer any accute adaptive response to the Achiles tendon remails unclear.

Here we explore the effect of a standard standing static calf stretch and a 5-minute warm-up routine on the material properties of the Achilles tendon.

METHODS

Subjects (5 Male, 5 Female) were tested for tendon material properties in a custom-built dynamometer. We measured the net ankle joint moment during static plantar flexion trials (at 80% of the maximum voluntary contraction) using the reaction force (Omega Instruments) and its orientation relative to the ankle joint as determined by an 8-camera motion capture system (Vicon). Tendon force was computed by using the subject-specific moment arm of the Achilles tendon using OpenSim software. B-mode ultrasound (60 Hz) was used to simultaneously track the muscle tendon junction of the medial gastrocnemius, which was used to compute the stretch of the free tendon. Ultrasound images were digitized using a custom MATLAB program [4]. We corrected for displacement of the tendon due to changes in ankle joint angle throughout the plantar-flexion trial; the contribution of ankle joint movement was minimal. Tendon stress was computed by dividing the tendon force by its cross-sectional area (determined by ultraound) and tendon modulus was computed from the linear portion of the stress-strain curve. Tendon hysteresis was also computed.

Trials were performed during an initial "cold" condition and re-tested immidiately after 5 minutes of moderate-speed jogging (3 m/s). In a seperate session, tendon stiffness was measured prior to stretching, immediately after a calf stretching routine consisting of 3 sets of 30 second calf dorsiflexion at 30°, and again immediately after 5 minutes of moderate-speed jogging.

RESULTS AND DISCUSSION

Both the tendon modulus of elasticity and the hysteresis remained unchanged after the 5-minute warm-up routine (Fig. 1a and 1b, respectively). Likewise, no change in material properties was found following the static calf stretching routine, nor the subsequent 5-minute warm-up (Fig. 1a and 1b). A commonly adopted stretching and warm-up routine used by recreational athletes was thus found to have little affect on Achilles tendon material properties.

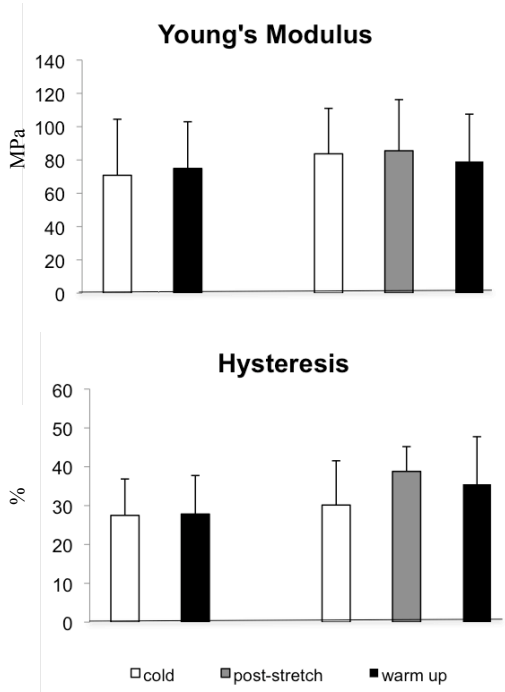

Figure 1: (**a**) the Achilles modulus of elasticity and (**b**) hysteresis, during the "cold" condition, post warm-up and following both stretching and warm-up (± SD).

CONCLUSIONS

Our experiments indicate that a typical stretching and warm-up routine used by recreational athletes has no significant effect on tendon material properties. For stretching to be useful for altering tendon properties a considerably longer stretching protocol is likely required [3].

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