

INCIDENTAL ACTIVITY INDUCES TIME-DEPENDENT CONDITIONING OF THE ACHILLES TENDON

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INTRODUCTION

It is well recognised that isolated human tendons display time-dependent conditioning properties when tested *in vitro* and exposed to prolonged or repeated loading. While such conditioning of tendon is routinely used in laboratory studies to reduce variability, little is known about this creep-related phenomenon under *in vivo* conditions. Although recent sonographic studies have noted an increase in axial tendon strain with repeated isometric muscle contraction [1], the duration of muscle activity (3–4 seconds) was prolonged relative to that of dynamic activities, such as walking (~0.6 sec). Whether the short yet repetitive loading associated with walking can induce time-dependent conditioning of the Achilles tendon remains to be established [1]. This research investigated the effect of incidental walking activity on Achilles tendon diametral strain.

METHODS

Eleven healthy male participants (age 25.9±4.9 years, mass 74.2±11.8 kg, height 177.9±6.5 cm) were required to refrain from physical activity in excess of the walking required to carry out necessary daily tasks, both 24 h prior to and during the 24 h study period. At commencement of the study (8am), participants were fitted with an activity monitor (Polar RS800sd) and unilateral sagittal sonograms of the Achilles tendon were acquired using a 12–5MHz linear array transducer. Subsequent images were acquired 12 (8pm) and 24 h post initial examination. Activity data was recorded continuously at 5 s intervals over the 24 h study period.

Sonographic images were post-processed using MATLAB software. Achilles tendon diameter and true diametral strain were determined 2 cm proximal to the calcaneal insertion [2]. Activity data was dichotomised as either present (1) or absent (0) for each 5 s interval. Total activity was subsequently estimated over two, 12 h periods (8am–8pm and 8pm–8am), by summing the activity values recorded within each period. Given the time-dependent recovery of Achilles tendon diametral strain following exercise [2,3], a linear weighting function was used to assess the temporal effect of walking activity relative to the time of tendon examination. The weighting function, $w(t)$, assumes activity performed greater than 12 h prior to examination has no effect on diametral strain [2,3] and is expressed as,

$$w(t) = \frac{1}{12}(t - t_m) \quad 0 \leq t \leq 12, \quad \text{eqn. 1}$$

where t is time in hours and t_m is an offset time denoted by the start of the each examination period (0 or 12 h). Weighted activity, $a_w(t)$, is defined as,

$$a_w(t) = w(t) \cdot a(t), \quad \text{eqn. 2}$$

where $a(t)$ is the activity time series 1 or 0. Total weighted activity for the two periods (8am–8pm and 8pm–8am) was estimated by summing the calculated weighted activity values. The relationship between diametral strain, total activity and total weighted activity were investigated using a

linear mixed model. Adequacy of model fit was given by Akaike's Information Criterion (AIC) in which smaller values represent a more adequate fit.

RESULTS AND DISCUSSION

A statistically significant negative relationship was evident between diametral strain and total activity ($p < 0.01$) (Figure 1). Consistent with viscoelastic theory, temporally weighting activity data improved the AIC from, 140 to 135 ($p < 0.01$) (Figure 2).

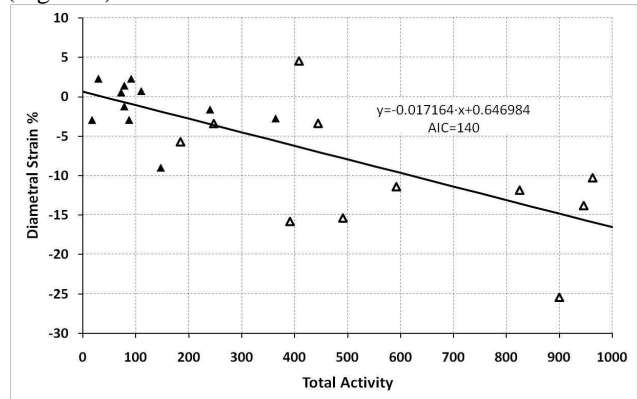


Figure 1: Individual diametral strain responses to total activity 8am–8pm (Δ) and 8pm–8am (▲).

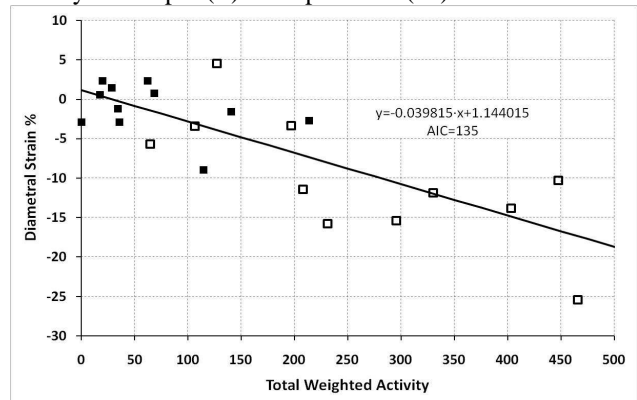


Figure 2: Individual diametral strain responses to total weighted activity 8am–8pm (□) and 8pm–8am (■).

The short yet repetitive loads generated during activities of daily living, such as walking, are sufficient to induce time-dependent conditioning of the Achilles tendon, as indicated by the correlation of diametral strain with activity. While similar changes in Achilles diametral strain (~15%) have also been reported following intense ankle strengthening exercise [3], in the current study, the effect was largely dependent on the duration and timing of activity. The findings highlight the importance of incidental activity history when examining Achilles tendon properties.

REFERENCES

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