NEGATIVE STRAIN IN THE SOLEUS POSTERIOR APONEUROSIS DURING HUMAN VOLUNTARY ISOMETRIC CONTRACTION

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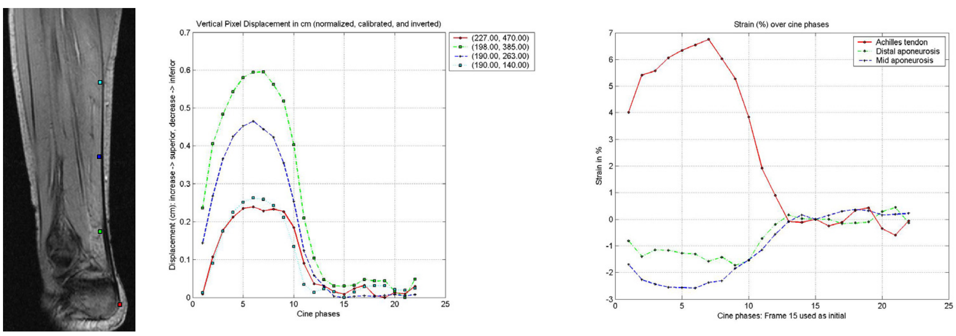
INTRODUCTION: Aponeurosis in a pennate muscle has been modelled as an *in-series* structure (3) with homogeneous *elasticity* along the length of the muscle. Therefore, one can readily assume that muscle and aponeurosis sustain forces in the same proportion and thus, aponeurosis strain (L/L_0) is homogeneous. This study aimed to investigate force-elongation (strain) characteristics of aponeurosis in *in-vivo* human soleus during voluntary contraction.

METHOD: Experiment was performed for human triceps surae muscle (n = 4) during voluntary isometric plantarflexion contractions at submaximal (20% MVC) activation level. During the contraction we acquired cine velocity-encoded, phase-contrast magnetic resonance image (VE-PC MRI) of the lower leg, which consisted of two sets of 22 still images, one containing morphological information and the other containing tissue velocity information encoded in the superior-inferior direction(1). Assuring the soleus activation using EMG prior to MRI acquisition, we selected 4 regions of interest (ROI) on the soleus along the length of the leg (Fig. 1a) and tracked their trajectories throughout the 22 images using the velocity information and the time elapsed between them. This procedure produced kinematics (velocity and displacement (Fig. 1b) over time) of the ROIs and enabled us to estimate the regional strain of the soleus aponeurosis during the contraction-relaxation cycle.

RESULTS & DISCUSSION: Strains of two regions (distal and mid) of the soleus aponeurosis were quantitatively different over the contraction-relaxation cycle (Fig. 1c). Moreover, the strain experienced by these regions of the soleus aponeurosis was negative (shortening) during the contraction phase. Possible causes of the observed negative strain in the posterior aponeurosis are the directions of the applied muscle forces, including the soleus itself and the gastrocnemius muscles, and "not *in-series*" structural arrangement of aponeurosis with the soleus muscle (2). The observations of this study indicate that the oversimplified geometric muscle models that are commonly used in many studies need further improvements for more accurate description of the mechanics of in-vivo muscle-tendon complex.



A B C

Figure 1. Morphological image of the lower leg with the locations of 4 ROI, A. Displacement of the ROI, B; Regional strain of the soleus aponeurosis, C.

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TRAINING INDUCED GAINS IN MECHANICAL MUSCLE FUNCTION IN ELDERLY AFTER HIP-SURGERY: CORRELATIONS TO FUNCTIONAL PERFORMANCE

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INTRODUCTION: The ability to rapidly produce contractile force (0-200 ms) is known to have important functional consequences for elite athletes. Interestingly, increasing evidence also underline the importance of these parameters for elderly individuals in many types of daily life actions. Therefore, the present study examined the effect of various training regimes following hip-replacement surgery on explosive muscle force characteristics (Rate of Force Development: RFD and contractile impulse) and the correlations to functional performance.

METHODS: Thirty elderly subjects (60-86yrs) were randomized to a 12 wk rehabilitation program consisting of either; **1)** RT, resistance training (3/wk), **2)** ES, electrical muscle stimulation (1h/day) or **3)** SR, standard rehabilitation (1h/day). The non-operated side served as a within-subject control. Maximal walking speed (10m), maximal stair climbing performance, maximal isometric strength (MVC), RFD and contractile impulse (∫Force dt) was measured in the quadriceps muscle at baseline, after 5wks and 12wks of training.

RESULTS: Increases were observed in MVC (24 %, $p<0.05$), RFD (26-45 %, $p<0.05$) and impulse (27-32%, $p<0.001$) after 12 wks of RT. These gains were accompanied by increases in maximal gait-speed (30%, $p<0.001$) and stair climbing (28%, $p<0.001$). Walking speed (19%,) and stair climbing (21%) also increased with ES, however, RFD and impulse remained unchanged in both ES and SR. The observed gains in walking speed and stair climbing performance was correlated to the increase in RFD in the very early part (30-50 ms) of the contraction ($r=0.70$-0.79, $p=0.001$) and in contractile impulse in the early (30-50-100-200 ms) phase of muscle contraction ($r=0.66$-0.86, $p=0.001$). In contrast, the change in maximal walking speed and stair climbing performance did not correlate to the change in MVC.

DISCUSSION: The present study demonstrates that explosive muscle force capacity of the neuromuscular system remains trainable with progressive RT even in frail elderly recovering from hip-surgery. Furthermore, the correlations between gains in explosive muscle force characteristics and functional performance parameters underlines the importance of implementing progressive RT in future rehabilitation programs.