

BEHAVIOR OF THE TRICEPS SURAE MUSCLE IN HOPPING

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INTRODUCTION

Studies with ultrasonography (US) have revealed that muscle fascicle and tendon length changes may not follow the length changes of the whole muscle-tendon complex (MTC) in natural human movements [1]. In jumping, the gastrocnemius (Ga) muscle fascicles have been shown to shorten [2,3] during the ground contact, despite the lengthening-shortening action of the MTC. Fascicle behavior of the soleus (Sol) muscle in natural human movements has not yet been reported. However, modeling the triceps surae function in counter-movement jump indicates similar behavior of Ga and Sol muscle fibers [4]. The present study focused to explore fascicle behavior of the Ga and Sol muscles directly with US in natural stretch-shortening cycle (SSC) muscle action.

METHODS

Eight male subjects performed bilateral hopping at low (LOW), medium (MED) and maximum (MAX) intensity. Ground reaction forces (GRFs) were collected simultaneously with high-speed video (200 Hz) recordings and real-time US (96 Hz) of Sol and medial Ga (GaM). Achilles tendon force (ATF) and MTC lengths of Sol and GaM were calculated.

Ten jumps were selected and data was averaged from each subject for each hopping intensity excluding the US data, where two most representative jumps were chosen.

RESULTS AND DISCUSSION

Fig. 1 represents a typical example of ATF and length changes of MTC and fascicles of Sol and GaM, respectively. Lengthening of MTC increased both in Sol and GaM with increasing loading (ATF). Despite the lengthening of MTC, fascicles of GaM shortened at the beginning of the ground contact. This shortening is similar to the earlier findings regarding counter-movement jumps [2] and drop jumps [3]. It may contribute to the storage of elastic energy by stretching the AT [1,2] and improving energy transfer of the proximal muscles to the ankle joint due to increased muscle stiffness [5]. On the other hand, SOL fascicles showed a lengthening-shortening behavior similarly to the MTC. Similar fascicle behavior has also been observed in the vastus lateralis muscle in drop jumps [3]. It may also be worth noting that the initial shortening of GaM fascicles was followed by a rapid lengthening at MED and MAX, which may imply cross-bridge detachment due to high loading. Similar yielding of GaM fascicles was also observed in the drop jumps [3].

CONCLUSIONS

The novel finding of the present study was that Sol and GaM fascicles may behave differently in natural SSC muscle action. The Sol fascicles represented a lengthening-shortening behavior similarly to the MTC, whereas GaM mainly shortened during the contact phase in hopping. It is likely that

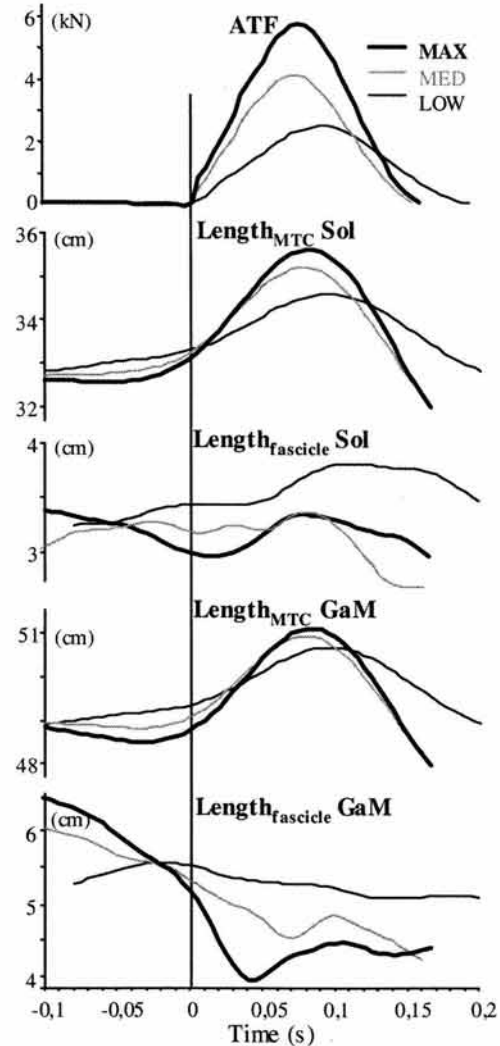


Figure 1: ATF and length-time curves of Sol and GaM MTCs and fascicles of one subject in hopping at different intensities. Vertical line denotes the onset of ground contact.

these differences in fascicle behavior between Sol and GaM are related to the suggested different roles of one- and two-joint muscles in human movements [5].

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