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Ankle joint angle influences hamstring fine-wire and high-density electromyography activity in ramp isometric knee flexions

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Summary
This study aimed to examine whether fixing the ankle in dorsiflexion vs in plantarflexion affects knee flexion torque and hamstrings activity during ramp isometric contractions.

Ten pairs of fine wires were inserted into the four heads of the hamstrings and 15-channel high-density electromyography (EMG) arrays were attached over the biceps femoris long head (BFLH) and semitendinosus (ST) muscles of the right leg of 12 young males. Results suggest that higher hamstrings EMG activity is reached in BFLH, ST and BF short head when the ankle is plantar flexed vs dorsiflexed at 20° knee flexion (but not at 90° knee flexion). This suggests that plantar flexion should be applied when prescribing hamstring exercises requiring a near-extended knee.

Introduction
Hamstrings are highly vulnerable to strain injury. The hamstrings function as primary knee flexors. The fact that the gastrocnemius also contributes to knee flexion is often overlooked when prescribing hamstring exercises. Manipulating the length of the gastrocnemius may impact knee flexion torque and hamstrings activity, potentially influencing the efficacy of exercises targeting hamstrings muscles. Therefore, in this study we examined the impact of distinct ankle angles on knee flexion torque and hamstrings fine-wire (wEMG) and high-density surface electromyography (HD-EMG) activity.

Methods
So far, 12 young physically active males have participated in this ongoing study. Ramp isometric contractions of knee flexors (0-100% torque, 15 seconds pace) were performed at different knee and ankle angles, in a random order: A) knee 20° flexion and ankle 20° dorsiflexion, B) knee 90° and ankle 20° dorsiflexion, C) knee 20° and ankle 20° plantar flexion, D) knee 90° and ankle 20° plantar flexion. Contractions were performed lying prone in a dynamometer with trunk and hips fixed in a neutral position. HD-EMG activity was recorded with 15-channel arrays from the biceps femoris long head (BFLH) and semitendinosus (ST) muscles, and wEMG was recorded from the proximal, middle, and distal portions of the BFLH, ST, and semimembranosus (SM), as well as from the distal portion of the biceps femoris short head (BFSH, Figure 1). This setup aimed to capture intramuscular differences in knee flexion exercise [1]. Bipolar surface EMG and fascicle behaviour were recorded from the gastrocnemius medialis. Average EMG activities were calculated for intensity levels 0-25%, 25-50%, 50-75% and 75-100% relative to task-specific maximum torques. Data collection is still ongoing, therefore statistical analysis has not yet been performed.

Figure 1: Hamstrings fine-wire and high-density EMG setup.

Results and Discussion
Higher torque was reached in knee flexion with dorsiflexion vs with plantar flexion at 75-100% torque. This difference was small at 20° flexed knee (103±10 vs 97±13 Nm), and more pronounced at 90° flexed knee (56±10 vs 46±9 Nm).

Ankle angle mostly influenced EMG activity at 75-100% torque level. Differences in HD-EMG were more clear at 20° knee angle (higher in plantar flexion, Figure 2) than at 90° knee angle. BFSH showed similar trend unlike SM.

Conclusions
To increase hamstrings activity, ankle plantar flexion should be applied when performing knee flexion exercises at near-extended knee, e.g. in the terminal phase of the Nordic hamstring exercise.

References