FORCE-LENGTH RELATIONSHIPS OF HUMAN GASTROCNEMIUS AND SOLEUS MUSCLES IN VIVO

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INTRODUCTION: Synergistic muscle have different architecture, and therefore could have different force-length relationships for the same joint angle changes. Previous studies have failed to reveal the force-length relationships of synergistic muscles. The purpose of this study was to investigate the force-length relationships of the triceps surae muscles for humans in vivo.

METHODS: Five male subjects (25.2±2.5years; 170.1±5.8cm; 65.9±9.2kg; mean±SD) performed isometric plantar flexion, with the exerted torque from zero to voluntary maximum (MVC) at 30deg (plantar-flexed), 20deg, 10deg, 0deg (anatomical position), -10deg, -20deg (dorsiflexed). Simultaneously, fascicle length (FL) and pennation angle (PA) of the medial gastrocnemius (MG) and soleus (SOL) muscles were measured by using ultrasonography. The Fascicle forces(Ff) of MG and SOL were calculated by $Ff=Ft \cdot K/\cos\theta$, where Ft (tendon force)=TQ(Torque)/MA, K is the relative PCSA(Physiological cross sectional area) of MG=20% and SOL=59.6% (Fukunaga et al., 1992), θ is PA of MG and SOL, and MA is the moment arm lengths derived from Rugg et al (1990).

RESULTS & DISCUSSION: As the ankle was dorsiflexed, TQ and FL increased, while PA decreased. In both of MG and SOL, peak Ff was observed at -10deg and no further increase was shown at -20deg. The force-length curves of MG and SOL were similar, with no statistically significant differences.

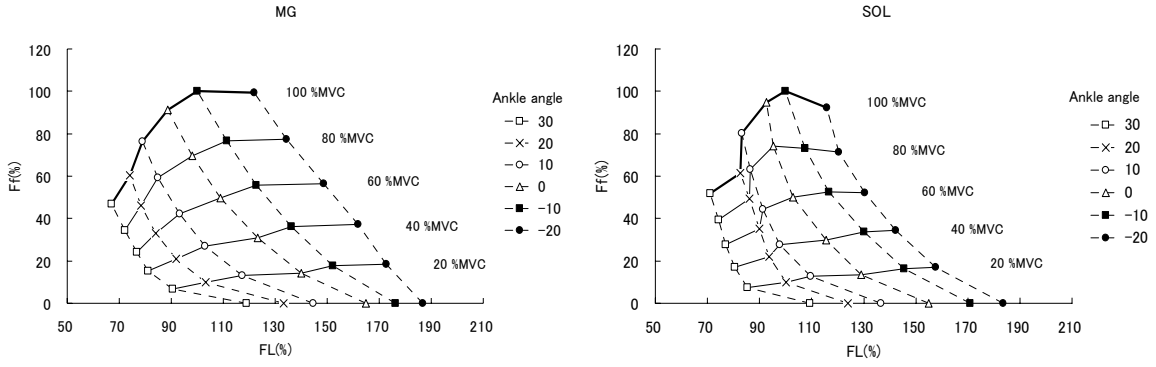

Figure1: Force-length curve of MG and SOL muscles

These results suggest that both MG and SOL fascicles are at their optimal length around -10 and -20 deg of ankle joint angle, and they operate on the ascending portion of the force-length curve.

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