RELATIONSHIP BETWEEN FASCICLE LENGTH AND SURFACE EMG RESPONSES OF THE GASTROCNEMIUS MUSCLE DURING MAXIMAL STATIC PLANTAR FLEXIONS

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Introduction
Surface EMG signals are affected by the muscle fiber length (1). Many studies have investigated the effects of muscle length on the amplitude and frequency content of EMG, but the findings are still in controversy. The disagreement in the previous findings may be, in part, due to the methodological concerns in those studies where changes in the muscle fiber length were only estimated from joint angles. The present study directly measured the fiber (fascicle) length of the medial gastrocnemius (MG) muscle during maximal static plantar flexions, to examine the relationship between the fascicle length and surface EMG responses.

Methods
Six healthy men performed maximal voluntary static plantar flexions in six positions with the knee fully extended and 90\(^\circ\) flexed, with the ankle 10\(^\circ\) dorsiflexed, 0\(^\circ\), and 30\(^\circ\) plantar flexed. The fascicle length of MG was determined using ultrasonography. Surface EMGs were recorded from the MG, lateral gastrocnemius, soleus and tibialis anterior muscles at a sampling frequency of 2 kHz. The mean amplitude (mEMG) and mean power frequency (MPF) of EMG were calculated during a 1.024 sec time period around the maximal torque.

Results & Discussion
As the knee joint was flexed and the ankle joint was plantar flexed, the maximal plantar flexion torque decreased. At the time the maximal torque was reached, the fascicle length of MG was shorter when the knee was flexed and the ankle was plantar flexed. The mEMG of MG decreased with knee flexion and ankle plantar flexion, while the MPF of MG increased. The mEMG and MPF were both linearly related (positively and negatively, respectively) with the fascicle length.

The decline in mEMG may be attributed to the impaired neuromuscular transmission in a shortened fascicle (2). The EMG power spectrum is known to be related to the muscle fiber conduction velocity (3), and the conduction velocity becomes higher as the fiber is shortened (4). Thus, the negative correlations observed between MPF and fascicle length would be due to the increased muscle fiber conduction velocity in shortened fascicles.

In conclusion, the present findings indicate that the fascicle length of MG is positively and negatively correlated with the amplitude and frequency of the surface EMG, respectively. These relations should be taken into consideration when the EMGs recorded at different joint angles or during dynamic movements are interpreted.

References

Keywords: Fascicle Length, Electromyography

\(^{12}\)th Annual Congress of the ECSS, 11–14 July 2007, Jyväskylä, Finland