Quadriceps performance under activation of foot dorsal extension in healthy volunteers

The muscle (m.) quadriceps femoris on the front of the thigh stretches the leg in the knee joint and is the strongest muscle in the human body. It is important in activities of daily living as walking and getting up from a chair, in sports, and for the independence of elderly people. In medicine, especially in neurology, muscle performance is measured by electric activity of the nerves that control the activity of the muscle, quantified by the so-called electro-myogram (EMG). In medical literature, two older studies showed increased EMG activity of the quadriceps muscle when the probands lifted up the foot (toes towards the knee), i.e. performed the so-called foot dorsal extension. The aim of this study was to repeat this finding by EMG (physiological replication) and to test whether dorsal foot extension increases single leg hop distance (functional verification).

Table: Mean EMG activity data and single leg hop distances of 35 subjects

	Knee flexion	Without dorsal foot extension	With dorsal foot extension	SRM	Statistical significance*
EMG of m. vastus medialis	45°	32.4μV	53.7μV	1.39	high
	90°	124.9μV	152.8μV	1.08	high
EMG of m. rectus femoris	45°	9.4μV	18.9μV	0.71	high
	90°	77.8μV	135.3μV	0.89	high
Single leg hop distance	-	169.8cm	178.9cm	1.09	high

* Statistical significance of the difference with minus without dorsal foot extension.

EMG activity was measured on the leg press at 45° and 90° knee flexion at the isometric weight load, i.e. the probands had to hold the weight in the same position, not to move it. The weight load was a determined according to pre-defined standards for each individual and was, on average, 79.7kg. EMG activity was quantified by micro volts, mV. Single leg hop distance was measured between the tests. Intra-individual changes between with and without dorsal foot extension were quantified and compared by so-called standardized response means (SRM). An SRM is the standardized difference between two measurements (with minus without and dorsal foot extension) and reflects high effects if it exceeds 0.80.

Thirty-five healthy subjects between 21 and 57 years were included in the trial. All following results are means of all subjects (see in the Table). The m. vastus medialis, one of four parts of the quadriceps muscle, was activated to an EMG level 32.4mV without and 53.7mV with dorsal foot

extension at 45° knee flexion (Table). The difference of 21.3mV reflects a SRM=1.39, i.e., a high effect, which is highly statistically significant. The table shows the corresponding results at 90° knee flexion for the same muscle and those for the m. rectus femoris, another part of the quadriceps.

This study proved that pre-activation of the muscles, which extend the foot (dorsal foot extensors), significantly increased muscle activity of the m. quadriceps (as measured by the differences on the EMG) and performance of the quadriceps (as quantified by the increase in single leg hop distance). Pre-activation of the dorsal foot extensors can therefore be used to improve functional muscle performance of the m. quadriceps femoris in training and rehabilitation. As a result of the higher training effect, better knee joint stability and more safety in walking and sporty activities can be expected.

Publication

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