ANALYSIS OF THE MUSCULAR INTERVENTION IN A BALLISTIC STRECHING EXERCISE BASED ON THE ANGULAR ACCELERATION AND EMG DATA.

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INTRODUCTION: The aim of stretching exercises is to increase muscle-tendon flexibility which depends on neurogenic (stretch reflex), myogenic (viscoelasticity of the musculo-tendinous structures) and joint constraints (Taylor *et al.* 1990; 1997). Among the other common techniques (passive, static and PNF) ballistic stretching is using the momentum of a moving body or a limb to force it beyond its normal range of motion. However, in spite of the exciting concerns of stretching neuromechanics, as well as, the overestimation of the role of connective tissue and the underestimation of the resistance of the muscles to stretch (Hutton, 1992), there is a lack of studies concerning the muscular activity in ballistic stretching. The main purpose of this study was to determine the intervention of the muscles *quadriceps femoris* (*rectus femoris - vastus medialis*) and *biceps femoris* and its relationship with the kinematics of the hip joint during a common ballistic stretching exercise.

METHODS: Six normal subjects were required to perform three ballistic stretches consisting of a flexion–extension of the hip joint. On this movement a sequence of four phases were determined, namely, *flexion acceleration - flexion deceleration – extension acceleration and extension deceleration.* Kinematic data of the hip joint and EMGraphic data of the muscles *quadriceps femoris* (*rectus femoris - vastus medialis*) and *biceps femoris* were recorded by a measurement chain (Zipp, 1982) which consists of an EMG synchronized with an ELGoniometric system. Surface electrodes were used and myoelectric signals were transmitted to the amplifier (input impedance 100 Mohm, CMRR 90 dB and frequency response 10-2000 Hz), using gain 2000 and band-pass filter 10–1000 Hz. The sampling rate was 2.4 KHz and the resulting EMG signal was recorded in a PC using a 12-bit acquisition card (DI-200/PGH). Goniometers accuracy was 1.5° over 90° from neutral position, precision was better than 1.0° and the analogue output sensitivity was 1.0V/90°. Angular position–time data, concerning the estimated hip joint angle, were treated using the package "Generalized Cross-Validatory Spline" (Woltring, 1986) according to the true predicted mean-squared error developed in MATLAB 5.3.

RESULTS AND DISCUSSION: The conducted study yielded information concerning the sequence of muscular activation and the history of the angular velocity and acceleration of the hip joint during the defined phases of acceleration and deceleration of the flexion–extension movements. The mean values of the angular velocity of the hip joint (rad/s) during the four phases are (.64±.27), (1.23±.55), (.96±.53) and (.58±.22) respectively. The mean values of the angular acceleration of the hip joint (rad/s^2) are (2.55±1.25), (10.38±8.96), (8.63±7.07) and (1.45±.84). The RMS_{EMG} mean values for *vastus medialis* are (.06±.05), (.15±.13), (.12±.11), (.06±.05), for *rectus femoris* (.03±.01), (.08±.04), (.05±.02), (.03±.01) and for *biceps femoris* (.04±.01), (.07±.02), (.12±.04), (.06±.02). Finally, the obtained results confirmed statistically significant (p<.000-p<.05) linear correlations (.902-.504) between the kinematic and temporal and spectral parameters of the EMG data.

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