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## THE EFFECT OF ANTERIOR CYCLIC LOADING APPLIED TO THE KNEE ON NEUROMUSCULAR CO-ACTIVATION DURING JUMP LANDING

<sup>1</sup> André Luiz Almeida Pizzolatti, <sup>1</sup> Ari Digiacoimo Ocampo Moré, <sup>1</sup> Carlos Rodrigo de Mello Roesler, <sup>2</sup> Gilmar Moraes Santos

<sup>1</sup>Biomechanical Engineering Laboratory of Hospital of Santa Catarina Federal University.

<sup>2</sup>Laboratory of Biomechanics of Santa Catarina State University

email: alpizzolatti@terra.com.br, web: [www.lebm.ufsc.br](http://www.lebm.ufsc.br)

### SUMMARY

**PURPOSE:** The aim of this study is evaluates the effect of anterior cyclic loading applied to the knee on the neuromuscular co-activation during jump landing. **METHOD:** Muscle electrical activity were recorded in seven women while performing five single leg jumps from 30 cm of height before and after anterior cyclic loading applied to the knee. The load applied passively pulls the tibia forward with the knee in a 30° flexion for 90 cycles at 0.1 Hz, with maximal loads of 40% of the body weight. The co-activation index was obtained by biceps femoris and vastus laterals (CI BF), and semitendinosus and vastus medialis (CI ST). The co-activation was analyzed in three jump phases: 100-0 ms pre-landing, 0-100 ms post-landing and 100-200 ms post-landing. The vertical ground reaction force (VGRF) was also determined. **RESULTS:** The CI BF after cyclic loading was similar to that observed before loading in the three phases of jump. Before landing, the pre-loading co-activation represents 92.9% of post-loading. After landing, the co-activation was 91.6% and 87.3% for 0-100 ms and 100-200 ms post-landing, respectively. The CI ST after cyclic loading were lower than those values observed before cyclic loading in all phases of jump. The percentage of the co-activation was 81.2%, 77.9% and 80.5% for 100 ms pre-landing, 0-100 ms and 100-200 ms post-landing, respectively. The VGRF was similar than that observed after cyclic loading. **CONCLUSION:** The method purposed in this study shows that the anterior cyclic loading applied in the knee may alter the co-activation for muscles medialis of thigh.

**Key-words:** knee, muscle co-activation, jump landing

### INTRODUCTION

Injuries in the anterior cruciate ligament (ACL) for non-contact frequently occur during the deceleration phase of jump landing executed in sports movements [1,2]. At this moment, the knee is generally in an excessive valgus position with internal rotation and near full extension. This position applies high forces to the ACL [3,4]. In order to absorb these forces and stabilize the knee, the co-activation of hamstring muscles is critically important [5,6]. However, has been shown that women have poor co-activation, which may results in high incidence of ACL lesion in this population [7]. Moreover,

during exercise, the co-activation may be impaired, increasing the risk of lesion. Therefore, the purpose of this study is evaluates if the anterior cyclic loading applied to the knee of women may change the neuromuscular co-activation.

### METHODS

Seven healthy and physically active women volunteers participated in this study (Age: 24 ±2; Height: 1,65 m ±0,05; Weight: 60,2 kg ±7,3). None of the subjects had a history of articular or muscle injury in the lower extremities 6 months before this study.

The preparation for the recording of EMG data on vastus medialis (VM), vastus lateralis (VL), semitendinosus (ST) and biceps femoris (BF) followed the guidelines proposed by SENIAM. The EMG was recorded using a data acquisition system (EMG System do Brasil®, São Paulo, Brazil), which has eight analogical channels for electromyography and four for dynamometry acquisition.

For the application of cyclic loading to the knee, the subject was seated in a chair with the knee at a flexion of 30°. This position was chosen to mimic the Lachman test and because the hamstring vector is not totally opposite the vector of the load. The distal portion of the thigh and the shank were fixed in the chair. A belt of polypropylene was fixed immediately bellow the tuberosity of the tibia. This belt was fastened in a steel cable, which was fixed in the material testing machine (Brasvalvulas®, São Paulo - Brasil) (Figure 1). The cyclic loading applied to the tibia ranged from a minimum of 47 N to a maximum of 40% of the body weight. The mean peak load range was 247.4 N ±5.63. Ninety cycles were applied at 0.1 Hz. The total time of cyclic loading was 15 min.

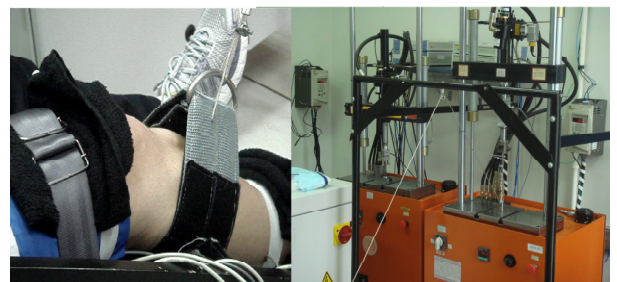


Figure 1. Method for cyclic loading application.

Five jump landings were realized before and five immediately after to the cyclic loading application. In order to standardize this task, the subjects were instructed to put their hands across the chest, stand on their dominant leg with the contralateral knee flexed 90 degrees and jump 25 cm forward to land in the middle of the force plate (customized in the biomechanical laboratory) fixed on the floor. The jumps were executed from 30 cm high platform.

The VGRF was filtered with a first-order Butterworth filter (cut-off frequency of 220 Hz). The VGRF was normalized with respect to the body weight.

The raw EMG data were full-wave rectified and filtered with first-order Butterworth filter (cut-off frequency of 10 Hz), yielding the linear envelopes of each muscle EMG in each trial. The EMG was normalized to the MVIC peak. The area of normalized EMG (IEMG) was obtained. The co-activation index (CI) was calculated to define the flexor muscle activation related to the sum of flexor and extensor muscle activation of the thigh, taking into consideration that the flexor muscle function is to protect the ACL and stabilize the knee. The CI was divided into the CI BF, which are the VL and BF, and the CI ST, consisting of the VM and ST. the averages values for the CI were computed during each of the following times frame: 1) 100 ms before foot contact with the ground, 2) 100 ms immediately after contact with the ground, 3) and 100 ms to 200 ms after contact with the ground.

## RESULTS AND DISCUSSION

The CI BF after cyclic loading was similar to that observed before cyclic loading in the three phases of jump (Figure 2). In the pre-landing phase, the value of CI BF after loading represents 92.9% of the value of CI showed before loading. After landing, the values of CI after loading were 91.6% and 87.3% for 0-100 ms post landing and 100-200 ms post landing, respectively.

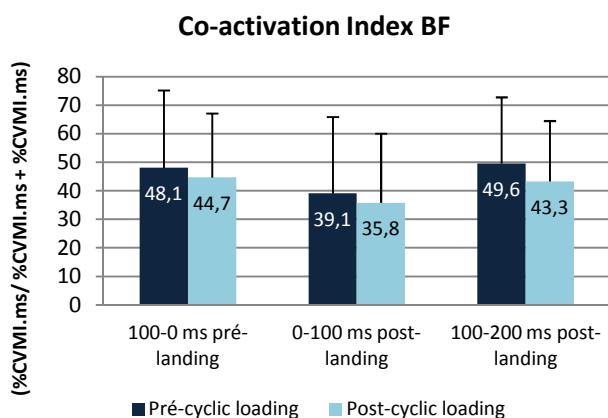


Figure 2. Co-activation index of BF.

The CI ST values after cyclic loading were lower than before cyclic loading in all phase of jump (Figure 2). The value of CI after loading in the pre landing phase was 81.2% of CI observed before loading. After landing phase, the values of CI after loading were 77.9% and 80.5% for 0-100 ms post landing and 100-200 ms post landing, respectively. The VGRF was similar to that observed after cyclic loading, representing 96.8% of value before cyclic loading.

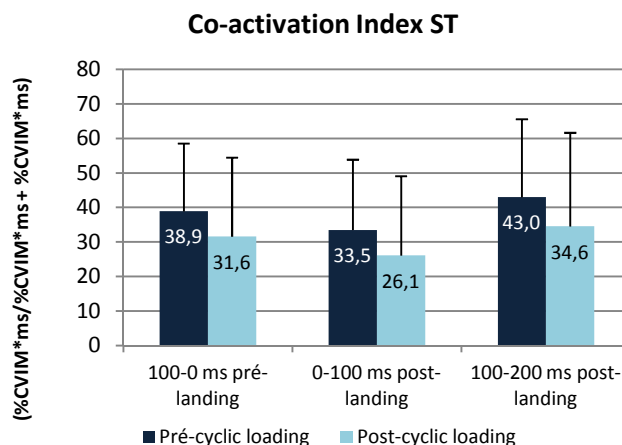


Figure 3. Co-activation index of ST.

## CONCLUSIONS

The decrease of neuromuscular co-activation of semitendinosus suggests that the anterior cyclic loading applied to the knee may alter the co-activation, according to the method of this study.

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