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NEUROMUSCULAR EFFICIENCY OF VASTUS LATERALIS AND BICEPS FEMORIS MUSCLES AFTER ANTERIOR CRUCIATE LIGMENT RECONSTRUCTION

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SUMMARY

Aim: Analyse the neuromuscular efficiency (NME) of the vastus lateralis (VL) and biceps femoris (BF) in subjects with ACL injuries in two phases: 1) preoperative phase and 2) the postoperative phase (2 months), in order to compare the injured limb at both times mentioned, using the uninjured limb as control. **Methods:** EMG and muscle strength of BF and VL were collected during three MIVC's in flexion and extension movements of the knee. The protocol was conducted in two stages to obtain the NME before and after the surgery. **Results:** For NME, there was an increase in muscle BF of the nonsurgical limb in the comparison of the 2 moments. The NME of the VL muscle was not different between both time periods studied. **Conclusions:** The nonsurgical limb showed greater NME of BF muscle in the postoperative phase compared to their preoperative phase, while no significant differences were found in NME of VL between both moments.

INTRODUCTION

The anterior cruciate ligament (ACL) is one of the most important structures for stabilization of the knee joint and one of the most frequently injured ligament during sports activities [1], resulting in great incapacity for the limb and long term problems, like osteoarthritis [2]. Even after a surgical reconstruction, and the rehabilitation, significant deficits may remain concerning the muscular strength of the knee extensors and flexors muscles [3]. These muscle imbalances frequently hamper the rehabilitation, therefore, identify and revert the causes of persistent muscular weakness after an ACL injury and rehabilitation helps to improve patient's condition [4].

The neural factor, which is related to the effectiveness of motor units activation during a muscular contraction is among the causes of muscular weakness. Biomechanically, the neuromuscular efficiency is calculated by the relation between the amount of neural stimulation and the muscle's ability to generate strength [5], which can be described by the ratio [Strength/IEMG], at 50% of maximal contraction [6].

Understanding the basis of physiological and biomechanical that determines the strength recovery of muscles related to knee joint is of utmost importance for the development of effective rehabilitation programs in patients undergoing surgical reconstruction of the ACL.

Thus, the aim of this study was to analyse the neuromuscular efficiency of the vastus lateralis (VL) and biceps femoris (BF), in subjects with ACL injuries in two phases: 1) in preoperative phase and 2) the postoperative phase, two months after the procedure, in order to compare the injured limb at both times mentioned, using the uninjured limb as control.

METHODS

The study was composed of 12 male subjects (29,27±6,90 years) who presented unilateral ACL injury, with no previous injuries, in the contralateral knee, which underwent a surgical procedure for ACL reconstruction and physical therapy, just after the preoperative evaluation.

The evaluation protocols were performed bilaterally in the preoperative phase and two months after the surgical procedure. The strength assessment occurred in a structure where the subject was positioned sitting on a high standard table with the hip at 90° of flexion. Once positioned, a load cell of 100 kgf coupled to the wall of the laboratory was set and adjusted to the ankle so that the force vector was carried out always at 0° to the load cell axis. Then, the subjects were instructed to perform a series of maximal isometric voluntary contractions (MIVC's), in knee extension and flexion. The joint was positioned always at 60° of flexion, with 0° corresponding to the full extension of the knee. The joint angle was positioned with a goniometer and controlled with a video camera using a light synchronism. Three 5-sec. MIVC's, with 120 sec. intervals were then performed in each movement direction (flexion and extension).

Data regarding EMG and strength were obtained with a 12-channel biological system (BioEMG 1100, Lynx, Brazil). The surface electrodes were placed in the BF and VL muscles belly in a bipolar arrangement, following the SENIAM recommendations for placement of electrodes and data analysis of electromyography.

The EMG data were cutted (0.25 ms interval) before and after the peak strength. They were then rectified and filtered (bandpass 10-500 Hz, 3rd order Butterworth) to obtain the integral of EMG signal (IEMG). The signal processing was performed in MatLab® environment (Mathworks, USA).

The data from muscular strength were normalized so that one could get a more accurate mathematical projection of the force exerted by VL and BF muscles individually, hence the criterion of contribution percentage equivalent to those

muscles, in relation to the total physiological cross sectional area (PCSA) of their respective muscle groups was used. The ratio of 36% for VL and 40% for BF was adopted, taking as basis the entire knee muscle extensors and flexors group as 100%, respectively. Subsequently the muscular strength was divided by two in order to obtain 50% MVIC.

The independent Student t test was used to identify the differences of strength, IEMG and NME, between the injured and uninjured limbs and the paired Student t test was used to compare the variables between the pre-and postoperatively moments. All tests were performed with SPSS® v.17, adopting $\alpha \leq 0,05$.

RESULTS AND DISCUSSION

Both pre and post-operative decrease in strength was found in the BF of the surgical limb. For the VL muscle, a decreased muscle strength in the surgical limb in both time periods studied were also found.

After surgery the subjects have a tendency to keep the limb immobilized, this result in muscle weakness and atrophy of the extensor muscles as much of the flexor muscles of the thigh. Gerber et al. [8] observed atrophy and decreased muscle strength of the quadriceps and biceps femoris of 20% and 30%, respectively, three months after ACL reconstruction, although patients were performing rehabilitation.

The neuromuscular efficiency is related to the activation of muscle fibers and force production, generated by a specific muscle. Therefore, it is considered more efficient that subject capable of producing greater muscle strength with the lowest magnitude of muscle fibers activation [7].

There was an increase of the NME in BF of the nonsurgical limb comparing the pre and post moments. The NME of the VL muscle was not different between both time periods (Figure 1).

Moreover, an increase of NME in the BF muscle of the non-surgical limb compared to the surgical limb in the post-operative moment was observed. While, for the VL, no difference was found (Figure 1).

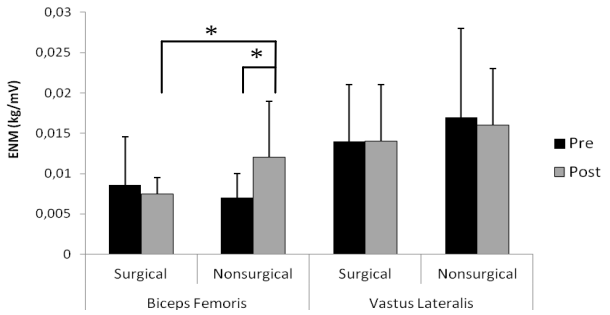

FIGURE 1 – Mean (SD) of NME of BF e VL muscles in Pre and Post-operative moments (*p<0.05).

CONCLUSIONS

It was concluded that: (1) the nonsurgical limb showed greater NME of BF muscle in the postoperative phase compared to their preoperative phase, (2) no significant differences were found in NME of VL between preoperative and postoperative. The NME result demonstrates that the knee joint muscles persist unrecovered 2 months after the ACL reconstruction surgery.

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