BASIC SCIENCE

ELECTROMECHANICAL DELAY OF THE KNEE FLEXORS MUSCLES AFTER ANTERIOR CRUCIATE LIGAMENTS RECONSTRUCTION USING SEMITENDINOSUS TENDON. PRELIMINARY STUDY.

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Received September 23, 2013 – Accepted October 10, 2013

Increasing in electromechanical delay has been found in patients after ACL reconstruction using both semitendinosus and gracilis tendons. Using only one tendon may improve electromechanical delay results in patients after ACL reconstruction surgery. The purpose of the study is to evaluate electromechanical delay in ACL reconstruction patients after one tendon surgery technique. In particular, in this study, patients undergone the reconstruction surgery using the semitendinosus tendon will be evaluated. An isokinetic dynamometer will be used for the test. After warming up, patients will be ask to perform a maximally explosive isometric. Torques will be measured by the dynamometer while the electrical activity of the semitendinosus and gracilis muscles will be detected using surface EMG. Results of the study will evaluate if one tendons technique may increase electromechanical outcomes for ACL reconstruction patients.

Basic Science Study

One of the greater issue for the anterior cruciate ligament (ACL) reconstruction is the selection of the graft type to be used (1-2). Several research used electromyographic (EMG) data to evaluate how muscular function is altered after this kind of surgery (3). Mechanical response of a muscle data can be combined with muscular activation to evaluate delay between contraction and development of the force/torque of a joint, showing how muscle can provide mechanical response and protection during everyday activities. This delay time is known as electromechanical delay (EMD) (4-6).

Different studies showed that the EMD time is related to mechanical properties of the muscle, shape, size and fiber type and presence of fatigue (7-9). These studies suggested that alteration in EMD should be expected after substantial changes in the muscle structure. In particular after an ACL reconstruction surgery, muscle tendons are harvested and a scar tissue is developed (10). There are contrasting results about different tendons: reconstruction performed with the medial third of the patellar tendon did not alter EMD of the extensors muscles (11), while EMD for the flexor muscles was found altered when semitendinosus (ST) and gracilis tendons were used as graft (12).

In this study EMD for flexor muscles is being investigated after ACL reconstruction surgery using one tendon surgery technique (semitendinosus tendon). The muscle investigates are the superficial

Key words: ACL reconstruction, Electromechanical delay, Semitendinosus tendon.
muscles of the hamstring group, ST and biceps femoris (BF). Even if BF was not involved in the surgery, it was included in the study because previous research (12) demonstrated that surgery on the other hamstring muscles affected also the BF. It is hypothesized that one tendon technique may improve EMD outcome in patients after ACL reconstruction.

MATERIALS AND METHODS

Participants: 2 male patients with ACL reconstructed using only semitendinosus tendon (mean age, 30±1.5 years; mean body mass 73±9; mean height 1.75±0.07 m) ; 2 healthy males (mean age, 32±1.5 years; mean body mass 75±8; mean height 1.74±0.06 m) with no history of ACL surgery and pain, matching for age, weight, height and level of physical activity. Exclusion criteria for all participants: neurological disorders, symptomatic knee pain, history of knee flexor muscles injuries. KT-1000 arthrometer test for anterior knee instability was performed and participants with a side-to-side differences > 3 mm at the manual maximum test were excluded.

Other patients’ requirements were same surgery technique (harvesting only one ST tendon), same surgeon (G.C.).

Experimental protocol

A isokinetic dynamometer was used for the test. All participants sat on the testing chair of the dynamometer and secured with body straps. Knee was flexed at 30° and hip joint at 90° (Fig. 1). After warming up, The dynamometer generated a specific sound that was used as a start and then participants performed a maximally explosive isometric contraction and maintained the contraction for at least 3 seconds. The participants was asked to repeat the maximal contraction 4 times. Participants were asked to relax completely before each contraction.

EMD measurement

Torques was measured and recorded by the dynamometer. Electrical activity of the muscles were detected using wireless surface EMG (BTS freemg 300) and acquired with a sampling rate of 1000 Hz. A dedicated software was used for data collection and visualization. EMG probes were placed bilaterally on the BF and ST muscles. Electrodes were placed parallel to the muscle fibers and over the dorsomedial muscle bulge at two thirds of the proximodistal thigh length for the ST, and at the dorsolateral side of the thigh at one half of the proximodistal thigh length for the BF (12). A “zero offset” function was performed to establish a zero baseline for all muscles.

The raw EMG signals were firstly band-pass filtered (20-500 Hz) with a Butterworth filter to remove movement artifacts and high frequency noises, full-wave rectified, band and smoothed with a 100-millisecond RMS algorithm.

According with Ristaninis et al.(12) EMD was calculated as the time differences between onset of muscular contraction and onset of torque development. The threshold was defined as 3.6 Nm above the baseline level for torque development and 15 µV deviations from baseline level for EMG signal (Fig. 2)

Paired t-test was used to compare left and right side in healthy subjects and not significant differences were found so, as consequence, right side was chosen as representative for control group. Paired t-test between was used to compared reconstructed leg with intact leg within ACL reconstructed group and to compare control group with reconstructed group.
**RESULTS**

Preliminary results of a total of 4 participants are shown in Fig. 3. Significant increasing in EMD (p.< 0.05) was found for both ST and BF when comparing the intact leg with the reconstructed leg in the patients group. Similar results were found when reconstructed leg was compared with control group. No significant differences were for both muscles were found when intact leg of the reconstructed group was compared with control group. All results are summarised in Fig. 3.

**DISCUSSION**

The results of the study seemed to be in contrast with our hypothesis, in particular the EMD seems to be affected by the reconstruction surgery even
if only ST tendons is used. Harvesting only one tendon don’t seem to improve outcome for ACL reconstruction patients. Possible explanation for the ST muscle results is that the development of the scar tissue changed the material properties of the harvested muscle resulting in EMD alterations. The alteration in the EMD of the BF may be explained as a sort neuromuscular adaptation: in normal condition ST and BF work synergistically during knee flexion, the delay in the BF muscles may be seen as a strategy to maintain this condition (12).

It is needed to be highlighted that this article reports only preliminary results with 4 participants and the statistical relevance of the study is questionable. There are other limitations of the study as the absence of a specific method for EMD calculation. However results EMD values of this study seems to be similar to values of similar studies present in the literature (6,12).

CONCLUSION

One tendon technique, using only ST tendon, don’t seem to improve EMD outcome for ST and BF muscles in patient after ACL reconstruction. However, further participants are needed to give a statistical relevance to the results.

REFERENCES