Corticomuscular Coherences in Individuals with Anterior Cruciate Ligament Rupture

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Introduction

Anterior cruciate ligament (ACL) rupture is the most common athletic knee injury [1]. Overall, only 65% of patients return to their pre-injury sports level after surgical ACL reconstruction (ACLR), with 55% returning to competitive sports [2]. A technique for coupling EEG and EMG rythms is known as corticomuscular coherences (CMC), a well-established and widely employed method for evaluating the synchronization between neural signals and muscles. The aim of this study was to investigate the relationship between beta and gamma CMC in control subjects and those with ACLR and to see if they differ.

Materials and Methods

The study is based on data collected by the Bern Movement Lab. In this thesis, two measurements of subjects with ACLR were analysed, 5-8 weeks (M1) and six months after surgery (M3). 14 Healthy subjects were matched as closely as possible to injured patients with ACLR. They performed a joint position sense (JPS) test from 90° flexion to 50° flexion while seated and without visual aids. To assess EMG, electrodes were placed on the skin in proximity to the muscles vastus lateralis (VL), vastus medialis (VM) and rectus femuris (RF). The EEG data sets were grouped into 4 brain areas: prefrontal, frontal, parietal, and centra. A MATLAB script was developed to find the correct event latencies at which the JPS tests begin ("S") and end ("M1"). The time between "S" and "M1" is referred to as an epoch. Between 30 and 60 epochs occurred within one measurement. The EEG and EMG data were pre-processed, processed, aligned and cut into epochs which were run through a developed algorithm to calculate the CMC.

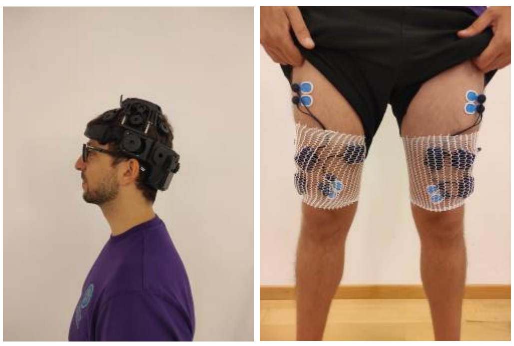

Fig. 1 Left: EEG Headset. Right: Set-up in lower limbs.

Results

To investigate whether CMC differs between healthy controls and individuals with ACLR during knee extension. For this purpose, multiple linear regression models were developed and compared between healthy controls and individuals with ACLR and their contralateral (CL) leg. The difference between controls and individuals with ACLR and their CL leg was not statistically significant. Beta CMC for the M1.CL group compared to the M1.ACLR group shows a (p= 0.00121). The results indicate that the central area of the M1.CL group has increased Beta CMC values compared to the M1.ACLR group, showing statistical significance.

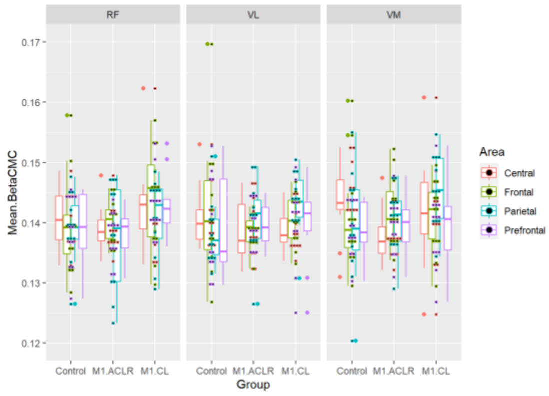

Fig. 2 Control vs. M1.ACLR vs. M1.CL

Discussion

Beta CMC appears to be very similar to other studies. Why the ACLR and CL legs differ needs to be investigated in the future. However, this is not the case for gamma CMC, which is higher in other studies, including tasks that involve force steadiness. The complexity of CMC patterns suggests distinctive neural adaptations and interlimb interactions in individuals who have received ACLR surgery. This is especially evident among specific groups and limb combinations.

References

[1] Alexander W. Brinlee, Scott B. Dickenson, Airelle Hunter-Giordano, and Lynn Snyder-Mackler. Acl reconstruction rehabilitation: Clinical data, biologic healing, and criterion-based milestones to inform a return-to-sport guideline. Sports Health, 14(5):770–779, 2022. PMID: 34903114.

[2] Clare L Ardern, Nicholas F Taylor, Julian A Feller, and Kate E Webster. Fifty-five per cent return to competitive sport following anterior cruciate ligament reconstruction surgery: an updated systematic review and meta-analysis including aspects of physical functioning and contextual factors. British Journal of Sports Medicine, 48(21):1543– 1552, 2014.