

CORTICAL ACTIVITY DURING FORCE REPRODUCTION AFTER ACL RECONSTRUCTION

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INTRODUCTION

Due to a reconstruction of the anterior cruciate ligament (ACL) afferent proprioceptive information from the knee joint may be altered which could result in changes of cortical activity. A recent study (Baumeister et al. 2008) has shown differences between ACL reconstructed patients and controls in performance, neuromuscular and cortical activity during a joint position sense (JPS) reproduction task. The results demonstrated differences in EEG frontal Theta (related to attention) and parietal Alpha-2 (related to somatosensory information processing) spectral power values which were consistently described in cognitive and sensorimotor tasks in conjunction with the load of the working memory (Sauseng et al. 2005). The aim of this study is to look whether performance (accuracy), neuromuscular activity (EMG) and cortical activation measured by EEG is influenced by an ACL-reconstruction when performing a force reproduction task.

METHODS

Nine patients 12.0±4.7 months after ACL reconstruction (25±5 years; 76.8±12.2 kg; 182±10cm) and nine healthy controls (24±3 years; 73.0±10.2 kg; 181±9cm) participated in the study. The force control task consists of an active knee extension force reproduction where subjects were asked to reproduce 50% of their individual maximal voluntary contraction (isometric MVC) reproduction without visual feedback in a sitting position. The participants have had the possibility to practice with visual feedback before each trial. The task was analyzed in a 2 (ACL vs. controls) x 4 (trials per 3 min) design for both extremities (M1-M4=uninvolved vs. control; M5-M8=involved vs. control).

During task performance the error in reproduction accuracy was calculated over each trial. Neuromuscular (EMG) activity was obtained from RF, VL and VM. At cortical level EEG activity was recorded at 17 electrode positions using international EEG standards (10:20 System), transformed (FFT) and calculated with the CATEEM system (MediSyst, Linden, Germany). The power spectra were divided into different frequencies: Theta (4.75-6.75 Hz), Alpha 1 (7.0-9.5 Hz), Alpha 2 (9.75-12.5 Hz) and Beta 1 (12.75-18.5 Hz). Average power spectra were log-transformed and calculated across all trials for each subject.

RESULTS AND DISCUSSION

The performance data demonstrate no significant differences in reproduction accuracy (aberrations from the target force) and no significant differences in EMG activity at RF, VL and VM in the ACL reconstructed patients compared to the controls.

EEG power spectra demonstrate differences during the force control task between ACL patients and controls in the Theta, but not in the Alpha-2 frequency band. The ACL patients exhibited significantly more power at frontal Theta than controls during the task performance at F3 (uninvolved vs. control: $F_{1,16}=4.763$, $p=.044$, partial $\eta^2\leq.229$; involved vs.

control: $F_{1,16}=4.645$, $p=.047$, partial $\eta^2\leq.225$) and F4 (Fig. 1; uninvolved vs. control: $F_{1,16}=6.341$, $p=.023$, partial $\eta^2\leq.284$; involved vs. control: $F_{1,16}=7.094$, $p=.017$, partial $\eta^2\leq.317$).

The accuracy in force reproduction performance and the neuromuscular activity were not affected by an ACL reconstruction.

On the other hand we found significant differences due to the ACL reconstruction in cortical activity. The ACL patients performed with increased frontal Theta power (Fig.1) compared to the healthy control group which might reflect a higher state of focussed attention during the performance in connection with a reconstructed ACL. This finding was supported by numerous cognitive and visuomotor studies which describe frontal Theta power as an indicator of focussed attention which is thought to be generated in the anterior cingulate cortex (ACC), an important part of the human attentional system (Smith et al. 1999).

Opposite to the results Baumeister et al. (2008) found in a joint position sense task the quantity of somatosensory information processing in the parietal cortex areas which is inversely related to Alpha-2 spectral power values was not influenced by the ACL reconstruction during force reproduction.

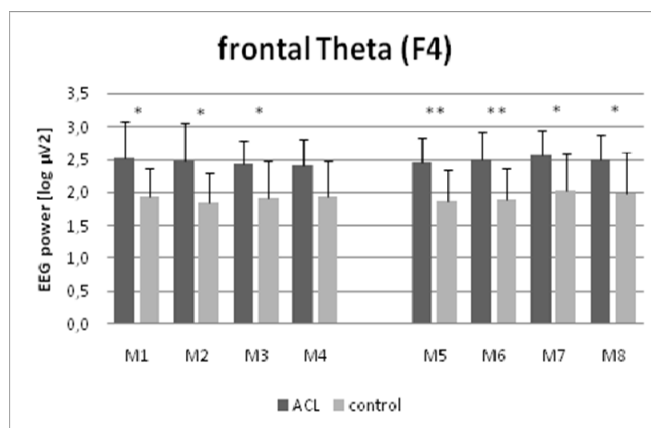


Figure 1: Frontal Theta spectral power during the force reproduction in ACL patients and controls

CONCLUSIONS

Whereas the performance and the neuromuscular activity were not affected in a force reproduction task the EEG was able to measure the influence of ACL reconstruction at cortical level. According to the increased frontal theta power the patients seemed to perform with a higher amount of focussed attention.

REFERENCES

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