THE EFFECT OF ACUTE FATIGUE ON NEUROMUSCULAR ACTIVATION PATTERN DURING SIDE-CUTTING IN FEMALE TEAM HANDBALL PLAYERS

[1] Mette K. Zebis, [3]Jesper Bencke, [1]Michael Kjær and [1,2]Per Aagaard
[1]Institute of Sports Medicine Copenhagen, Bispebjerg Hospital, Denmark
[2] University of Southern Denmark, [3] Gait Laboratory, Hvidovre University Hospital, Denmark
email: mkz01@bbh.hosp.dk

INTRODUCTION

Female handball players have a 2-8 fold higher incidence of non-contact injury to the anterior cruciate ligament (ACL) compared to their male counterparts (Myklebust G et al., 1998). Alternated motor control strategies have been identified as a potential risk factor (Malinzak RM et al., 2001). Furthermore it has been shown that fatigue may alter the movement strategy (Wojtys EM et al., 1996), and that the majority injuries occur in the late stage of a match (Gabett TJ, 2000; Pinto M et al., 1999).

The purpose of this study therefore was to investigate if muscle fatigue induced by a simulated handball match would result in altered leg muscle motor patterns during side-cutting movements in female elite team handball players. It was hypothesized that motor patterns would change following the simulated match in a way that could contribute to the increased risk of ACL injury.

METHODS

Neuromuscular activity (EMG; vastus lateralis and medialis, rectus femoris, biceps femoris, semitendinosus) was recorded (1 kHz) during a standardized side-cutting maneuver in fourteen female elite team handball players, pre and post a simulated handball match. Furthermore EMG was obtained during maximal isometric quadriceps and hamstring contraction (MVC) at a knee joint angle of 70° (0°=full extension). All EMG signals were highpass filtered (5 Hz cutoff) and smoothed by a moving RMS filter (30 ms time constant). EMG activity (mean average amplitude) during side-cutting was normalized to the peak EMG amplitude recorded during MVC. Median power frequency was determined by FFT analysis of the raw EMG signals subsequent to a Hanning window procedure.

The simulated handball match consisted of a series of intermittent exercises (side steps, cross over steps, jumps, high and low intensity running and sprinting) mimicking handball match activity (50 min).

RESULTS AND DISCUSSION

The simulated handball match protocol caused a marked decrease in quadriceps (-21%) and hamstring (-16%) MVC ($p<0.05$). During the ground contact phase (in time intervals 10, 50, 100 and 200 ms after toe-down) the neuromuscular activity of semitendinosus decreased by 47-55% (Fig.1). A tendency towards an increase in activity of biceps femoris was observed (50, 100 and 200ms after toe down, $p<0.10$) (Fig.1). Median power frequency (MPF) in biceps femoris increased after the simulated handball match from 109 ± 19 to 122 ± 32 Hz ($p<0.05$). In contrast, MPF remained unchanged in semitendinosus, 97 ± 25 vs 90 ± 14 Hz. EMG activity (RMS amplitude) and MPF remained unchanged in all other muscles examined.

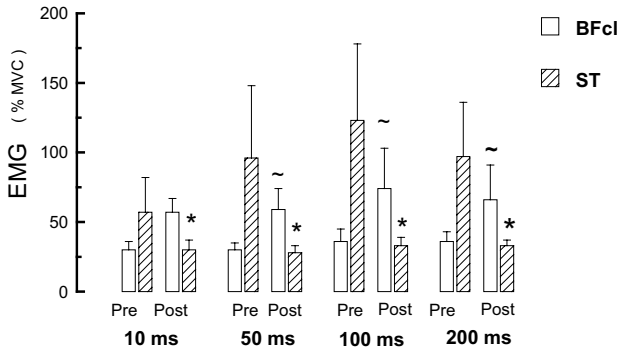

Figure 1: EMG activity of biceps femoris (BFcl) and semitendinosus (ST) during braking phase in a side-cutting maneuver. *denotes significant difference ($p<0.05$).~denotes a tendency towards a difference ($p<0.1$).

CONCLUSIONS

This study indicates that acute fatigue induced by handball match play, involving substantial eccentric and rotational forces, cause changes in the neuromuscular motor pattern during a standardized side-cutting maneuver.

The simulated handball match resulted in substantial decreases in maximal quadriceps and hamstring contraction strength. Likewise, alterations were observed in the neuromuscular activation pattern: Median power frequency increased in biceps femoris which could indicate recruitment of more type II motor units and/or a decrease in the amount of motor unit synchronization at the end of the simulated match. Furthermore, reduced EMG activity was found in the semi-tendinosus muscle in response to match-induced fatigue, which may potentially represent an elevated risk factor for ACL-injury. The typically female non-contact rupture of the anterior cruciate ligament (ACL) involves the knee in valgus, the foot fixed on the ground, and external rotation of the tibia. Since m. semitendinosus acts as an internal rotator of the tibia, the observed decrease in m. semitendinosus EMG activity may predispose for excessive external tibia rotation during side-cutting, thereby increasing the risk of ACL overloading.

REFERENCES

1. Gabbett TJ. *Br J Sports Med* 34: 98-103, 2000.
2. Pinto M, et al. *Clin J Sport Med* 9: 70-74, 1999.
3. Myklebust G. et al. *Scand J Med Sci Sports* 8:149-153, 1998
4. Wojtys EM, et al. *Am.J Sports Med* 24:615-21, 1996
5. Malinzak RA, et al. *Clin.Biomech* 16:438.-45, 2001