THE EFFECT OF FATIGUE ON FORCE SENSE OF THE KNEE

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INTRODUCTION: Knee injuries commonly occur in the later stages of competition indicating that fatigue may influence dynamic knee stability. Proprioception and neuromuscular control of the quadriceps and hamstrings are important contributors to knee joint stability and the prevention of injury. Force sense (FS) is a submodality of proprioception and under the influence of the muscle mechanoreceptors. If FS is affected by fatigue, this could lead to less effective neuromuscular control and increased risk for injury. The purpose of this study is to measure the effects of peripheral fatigue of the quadriceps and hamstring on FS at the knee. It is hypothesized that fatigue will increase FS error for both the quadriceps and hamstrings.

METHODS: A total of twenty healthy and physically active females and males (age: 23.4±2.7yrs, mass: 69.5±10.9kg, height: 169.7±9.4cm) participated. FS of the dominant leg, was assessed isometrically prior to and following a fatigue protocol, using the Biodex System 3 Multi-Joint Testing and Rehabilitation System (Biodex Medical Inc., Shirley, NY). Subjects were instructed to produce and hold a target force with visual feedback (5s) and after a rest interval reproduce the target force without visual feedback (5s). Five repetitions were performed at 45° of knee flexion. FS of the quadriceps and hamstrings muscles was tested on two separate days. Fatigue was induced by performing three bouts of isokinetic knee joint extension (day 1) and flexion (day 2) at an angular velocity of 180°/s, with a 30s rest interval between each bout. During the fatigue protocol, electromyographic (EMG) activity of the vastus medialis (VM), vastus lateralis (VL), medial hamstring (MH) and lateral hamstring (LH) were collected. Fatigue was verified based on median frequency analysis of the EMG signals during the fatigue protocol. Separate dependent t-tests were performed to determine significant differences in median frequency between the average of the first 3 repetitions and the average of the last 3 repetitions of the fatigue protocol. Separate dependent t-tests were also conducted for each dependent variable to compare the absolute differences between force production and reproduction within pre- and post-fatigue conditions. An alpha level of 0.05 was set a priori to determine significant differences.

RESULTS AND DISCUSSION: There was a significant decrease in the median frequency for all muscles when comparing the average of the first 3 repetitions and the average of the last 3 repetitions of the fatigue protocol ($p < .001$). This indicates that the fatigue protocol was successful in inducing peripheral fatigue as measured by median frequency. No significant difference in FS error was demonstrated pre versus post fatigue protocol; for the quadriceps, the pre FS error was 0.28±2.69 and post 0.21±1.78 ($p = .44$). For the hamstrings, the pre FS error was 0.54±2.28 and post 0.47±1.62 ($p = .45$). One potential reason for the lack of a fatigue effect on FS is the time elapsed between the end of the fatigue protocol and the initiation of the FS protocol (2 minutes). Despite out best efforts to reduce this time period, recovery may have occurred. It may also be possible that the FS methodology utilized in this study does not target the appropriate mechanisms by which fatigue may affect neuromuscular control. Our previous research has demonstrated that threshold to detect passive motion (TTDPM) is negatively affected by the same fatigue protocol as used in this study[1]. A decrease in TTDPM may be indicative of impaired mechanoreceptors. It therefore may have a negative effect on muscle spindle sensitivity and the subsequent muscle and joint stiffness. Future research should try to find other research methodologies to target the muscle spindle sensitivity.

1. Rozzi, S.L., Lephart, S.M., Fu, F.F. J Athl Train, 1999;34(2): 106-114