EFFECTS OF FATIGUE ON MUSCLE FUNCTION DURING DOWNHILL RAMP WALKING

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Introduction

Downhill walking is a daily activity which poses a greater risk of falling when compared to level walking [Redfern, 1997]. We postulate that with fatigue, this task may become more hazardous and thus a better understanding of how neuromuscular control is affected during ramp walking is warranted.

The purpose of this study is to determine the effects of fatigue on the neuromuscular and biomechanical determinants of downhill gait. It is hypothesized that muscle activation levels will increase post-fatigue in order to compensate for the force-output deficit and preserve the biomechanical parameters pre- and post-fatigue.

Methods

To date, five healthy active young adults (2 females, 3 males; 25 ± 2.4 years of age) have been evaluated. Electrodes were placed over 8 muscles crossing the knee. Reflective markers affixed to the subjects and used to reconstruct the kinematics of the upper and lower segments [Beaulieu, 2010]. Participants performed a 5 minute warm-up followed by maximum voluntary isometric contractions recorded on an isokinetic dynamometer. Participants were then asked to walk up and down an instrumented ramp containing two force platforms and inclined to 9° until three successful trials were completed.

To fatigue the participants, they were then asked to perform squats (35 per minute) until they could no longer keep up with the metronome or could no longer continue. Three additional successful down-ramp walking trials were recorded as quickly as possible following the fatigue protocol.

Electromyography (EMG) was normalised to MVC and integrated over the foot-contact phases (iEMG). Ankle, knee and hip kinematics, moments and powers were calculated. Pre- and post-fatigue for each dependant variable was compared using a two-way Paired samples T-tests ($\alpha = 0.05$).

Results

Peak knee power, hip power and extension moment were significantly greater post-fatigue (Figure 1), while all gait parameters, range of motions, anterior shear forces, and remaining moments for all three joints were found to be insignificant. Hip range of motion (ROM) trended towards a significant increase (pre: 32.8 ± 1.9° & post: 36.0 ± 4.8° $p = .096$). An F test revealed significantly greater variance in hip range of motion post fatigue. iEMG of rectus femoris, vastus lateralis, biceps femoris, semitendinosus, and medial gastrocnemius, were significantly greater post-fatigue.

Discussion

Preliminary results support the hypothesis that the increase in muscle activation post- fatigue was proficient in maintaining the biomechanical parameters of the knee and ankle. However, trending increases in hip ROM, and significant increases in peak power and extension moment were observed. The increased hip ROM in the fatigued state lends support to the literature [Qu, 2011] and when compounded with the greater variability in this measure when fatigued, it is evident that the participant is using a less controlled movement strategy. This lack of kinematic control in the fatigued state could enhance the risk of falling, especially in populations such as older adults, where other large variances in gait without fatigue already exist [Hollman, 2011].

References

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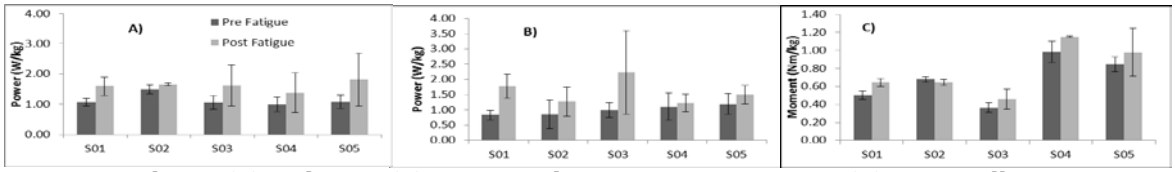

Figure 1. Peak Hip (A) and Knee (B) Power and Hip Extension Moment (C) across all participants.