Lower Extremity EMG Activity during AlterG Treadmill Walking

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Spring Research Conference 2016
Introduction

Normal human gait is defined as walking from one plane to another in order to complete every day actions such as walking, stair climbing, and standing up from the seated position (Winter, 1995). The sole purpose of walking is to transport the body safely and efficiently (Winter, 1995). Gait is comprised of a set of complex body movements through a dynamic interaction of the internal and external forces (Sacco and Amadio, 2000).

LeVeau and Bernhardt (1984) reported that during normal walking the major joints of the lower extremity are exposed to considerable loads with increased joint reaction forces. Running is known to cause forces between 2-3 times actual body weight (Munro, Miller, & Fuglevand, 1987). The AlterG is an anti-gravity treadmill that provides an uplifting force, allowing people to run or walk at a fraction of their body weight. (Hunter, Seeley, Hopkins, Carr, & Franson, 2014). The AlterG has many different uses: rehabilitation for recovering from lower-extremity injury, endurance training to help prevent stress injuries, and for special populations such as obese or elderly. The AlterG has gained popularity due to its ability to decrease the impact during gait via reduced ground reaction forces while maintaining proper gait mechanics. Therefore, using the AlterG may be an extremely beneficial tool for rehabilitation.

While the reduction of impact forces during gait in the AlterG has been studied extensively (Grabowski, 2010), the relationship between reduced gravity and muscle activation still remains unclear. Previous research has associated increased EMG activity with an increased risk of injury during gait (Souza & Powers, 2009). Yet, very few studies have analyzed EMG activity during gait in a reduced gravity setting (Hunter et al.,
The study by Hunter et al. (2014) found that during running at 4.47 m/s, most lower extremity muscles, except for the hip adductors and hamstrings, demonstrated lower EMG amplitudes as more body weight was supported. These results suggest the AlterG is an effective rehabilitation tool for most lower extremity muscle injuries due to the decreased ground reaction forces and muscle activity during running. However, to the authors’ knowledge, no previous study has analyzed EMG activity changes while walking in an AlterG.

Treadmill walking with body weight support can decrease weight bearing on the lower extremities and is a routine treatment used for patients with neurological and musculoskeletal injuries. This warrants investigation into the effectiveness of the AlterG as a rehabilitation tool due to a shortage of research concerning muscle activation patterns while walking in an AlterG treadmill. Therefore, the purpose of this study is to examine the changes in muscle activation related to the amount of body weight that is supported by the Alter G. Participants will walk at two different speeds self-selected and 1.4m/s each at 40, 60, 80 and 100% of body weight support for 2 minutes respectively.

Methods

For this study healthy recreationally active participants will be recruited to participate. Retroreflective markers will be placed on the lateral side of the right leg. Kinematic data of the stance and swing phase will be collected using 5 Motion Analysis Cameras (Motion Analysis Corp, Santa Rosa, CA) at a sampling rate of 200Hz. Foot strike and toe-off will be identified using vertical velocity changes in the heel and toe markers, respectively. Cortex 5.5 software (Motion Analysis Corporation, Santa Rosa,
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CA, USA) will be used to collect and track the data, while C-Motion Visual 3D software (C-Motion, Inc., Germantown, MD, USA) will be used to filter and analyze the data.

**EMG Protocol**

To analyze muscle activity, electrodes will be placed at an estimated point midway between the muscle insertion and innervation zone, along the longitudinal axis of the hip abductors, vastus medialis, vastus lateralis, peroneus longus, medial gastrocnemius, and the anterior tibialis muscles, as described by SENIAM guidelines(). Muscle activity will be detected with DE-2.1 single differential surface EMG sensors and amplified by a Bagnoli™ 16-channel system (Delsys Inc., Boston, Massachusetts). The electrodes have a bipolar Ag surface (Delsys Inc., Boston, MA, USA) with a fixed inter-electrode distance of 10 mm and are 10 x 1 mm. Electrodes will be applied to participants using double-sided tape. EMG data will be collected for the final 5 gait cycles of all body weight support conditions. All EMG amplitudes will be normalized to the 100% condition. This will be done by dividing the average EMG amplitude of each condition by the peak EMG amplitude found during the full gait cycle of the 100% condition. Root mean square (RMS) amplitudes using a 50 ms window will be calculated during the swing and stance phase of the gait cycle.

**Procedures**

All testing will take place in the Human Performance Laboratory at the University of Kentucky. Upon arrival to the lab, the procedures for this study will be explained to participants and they will give informed consent to participate. Participants will then be fitted for Alter G compression shorts. The Alter G shorts zip the participant into the anti-gravity treadmill. Participants will then be given a familiarization warm up period in the
AlterG treadmill. They will be instructed to walk at a self-selected walking speed at 100% of their body weight as a 3 minutes warmup prior to testing. Participants walked at a self-selected speed and a speed of 1.4 m/s at 40%, 60%, 80% and 100% of body weight support for 2 minutes at each condition. The order of the trials will be randomized. Data will be captured for the last 15-seconds of each trial.

**Data Analysis**

Two one-way repeated-measures ANOVAs and descriptive statistics (SPSS, v 22, Chicago, IL) will be used to analyze the variables during the stance and swing phases of the gait cycle. Significance level will be set at p < .05. The independent variable are the body weight supports ranging from 40-100% of body weight support. Dependent variables included RMS amplitudes of the hip abductors, vastus medialis, vastus lateralis, peroneus longus, medial gastrocnemius, and the anterior tibialis muscles. All trials were normalized to a peak value found during the full gait cycle of the 100% body weight trial.

**Discussion**

In this study, kinematic and electromyography data will be collected while walking at a self-selected speed and 1.4 m/s on an AlterG treadmill at 40%, 60%, 80% and 100% body weight support. It is hypothesized that there will be a significant decrease in muscle amplitudes of the: gastrocnemius, anterior tibialis, peroneus longus, vastus medialis, vastus lateralis and the hip abductors. The results within this study are expected to be similar to the ones found by Hunter et al. (2014). Mentioned formerly, Hunter et al. collected electromyography activity during positive-pressure treadmill running at 60-100% of bodyweight.
References


Grabowski, A. M. (2010). Metabolic and biomechanical effects of velocity and weight support using a lower-body positive pressure device during walking. *Archives of physical medicine and rehabilitation, 91*(6), 951-957.


