EFFECTS OF BODY WEIGHT UNLOADING ON MUSCLE ACTIVITY, KINETICS AND CENTER OF PRESSURE DURING OVERGROUND GAIT

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Introduction
Gait training with body weight unloading (BWU) is a common therapeutic intervention. Manipulation of the levels of BWU allows to decrease the biomechanical gait restrictions, to ease the pain that limits range of motion of the lower extremities and thus enable clinical patients to produce the force required for forward propulsion during daily walking [1,2]. Studies on the effects of BWU on gait kinetics, kinematics and muscle activation patterns have been confounded by the walking modalities (treadmill vs. overground) and variability of walking speed [2,3]. Research shows that BWU during treadmill walking and/or variable walking speed does not replicate daily walking [4]. By designing the proper apparatus to maintain a constant speed during overground walking this study allows to sort out the unique effects of BWU on the hip, knee and ankle biomechanical parameters under conditions that replicate daily walking.

Methods
Sample and Procedure: Fifteen healthy male subjects with no prior gait impairment, included in the sample, walked overground under various levels of body weight reduction performed with a Biodex BWU system. An electric winch pulled the system at a constant speed of 4km/h. The procedure included overground walking under a control (No vest), and three 0%, 15%, and 30% BWU experimental conditions.

Measures: The Electromyographic (EMG) measures included the peak EMG activity and impulse of the EMG signal for each of the muscles examined, the tibialis anterior (TA), lateral gastrocnemius (Lat GC), vastus lateralis (VL) and Rectus Femoris (RF).

Kinetic measures included the peak moments and impulses in the sagittal and frontal planes of the hip, knee and ankle. The foot center of pressure (COP) was calculated by using the force plate and marker data. Kinetic and EMG data were simultaneously recorded with a Vicon Nexus motion tracking system (Oxford Metrics Ltd).

Results
Findings show that healthy subjects overground gait under 0%, 15%, and 30% BWU levels resulted in a significant decrease of peak moments and impulses in the sagittal and frontal planes (Table 1). The hip 1st peak adduction moment was reduced by 9% when comparing 0% vs. 15% BWU and by 17% when comparing 15% vs. 30% BWU. The knee 1st peak adduction moment was reduced by 11% when comparing 0% vs. 15% BWU and by 19% when comparing 15% vs. 30% BWU. Additionally, paired comparisons of kinetic trajectories under three BWU levels show high correlations between trajectories (r>0.95; p<0.001). A significant inverse relationship was observed between BWU levels and EMG activity (Fig. 1a). Additionally, Increasing the BWU level resulted in a lateral shift of the foot COP in the frontal plane (Fig. 1b).

Figure 1: (a) EMG signal of the Vastus Lateralis and (b) Average trajectories of the COP during stance under three 0% 15% and 30% BWU conditions.

Conclusions
The observed reduction in joint moments, the lateral shift in COP and reduction in EMG activity resulting from BWU have wide implications in gait rehabilitation suggesting that BWU may safely be applied with clinical patients undergoing rehabilitation in situ, i.e., under conditions that replicate daily walking. As lower joints regain their functional activity with respect to range of motion and locomotor patterns, patients’ body weight may be gradually increased until they resume normal daily walking without any BWU.

References