ALTERATIONS IN KINEMATICS AND MUSCLE ACTIVITY DURING LOCOMOTOR TRAINING.

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INTRODUCTION

Recently new approaches to facilitate locomotor recovery have been directed away from compensatory strategies and towards Locomotor Training (LT) using body weight support (BWS) that optimizes afferent sensory information and facilitates activity-dependent plasticity in the spinal cord to control movement (Harkema et al.). LT has been studied extensively as a therapeutic intervention for individuals after spinal cord injury (SCI) and stroke (Visintin, Barbeau). Preliminary studies have shown that LT following SCI can improve muscle activity during locomotion, where individuals are able to load more on the treadmill and improve their functional walking overground (Wernig, Muller). A potential limitation of the research related to LT is the lack of normative data to validate the kinematic and electromyography (EMG) data profiles that are generated from individuals with SCI. The objective of this preliminary study is to determine the effects of LT using BWS on kinematics, and muscle activation for able-bodied controls at different BWS, at different velocities, and the effect of the harness on kinematics and muscle activation. This data is highly relevant to the research being performed in our laboratory and an understanding of the effects of changing velocity, BWS and the influence of the harness to neural activation is necessary to the design of the new protocols or when analyzing the effects of LT.

METHODS

Four participants (3 males, 1 female, mean age: 31 ±11.03 years) walked at speeds: 0.71m/s, 0.89m/s, 1.16m/s for 60, 40, 0% BWS and without wearing a body weight support harness walked at .71m/s, .89m/s, and 1.16m/s. Each trial was collected for 20 seconds. Kinematic and EMG were collected bilaterally for each condition. A 6-camera Vicon system (sampled at 60Hz) was used to collect kinematic data. Spherical reflective markers were placed on right and left second and fifth metatarsal, calcaneous, tibial tuberosity, femoral epicondyle, greater trochanter, anterior inferior iliac spine, posterior inferior iliac spine. EMG was recorded using surface EMG for left and right medial gastrocnemius (L/R GA), tibialis anterior (L/R TA), rectus femoris (L/R RF) and bicep femoris (L/R BF). EMG were collected at a bandwidth of 10-600 Hz, and sampled at 1560 Hz. Raw EMG signals were filtered at a bandwidth of 30-150 Hz, full-wave rectified, and root mean squares (RMSs) were calculated over a 50ms window (Wilen et al.). Mean RMS EMGs were calculated as the sum of the RMS amplitudes from burst onset to burst offset divided by burst duration. Burst onset/offset was defined as time of onset/offset of EMG burst. Burst Duration (BD) was defined as time between the onset of EMG burst to the offset of EMG burst of each muscle within stance and swing phase of gait cycle (GT). EMG data was processed using MATLAB (MathWorks Inc., Version 6.1). Calculation of sagittal plane segment motion for the thigh, shank and foot was determined using MATLAB (MathWorks Inc., Version 6.1). Limb kinematics were calculated in the local moving plane. Orientation angles for each segment relative to the right horizontal. 3-8 gait cycles were analyzed per condition. Non parametric Wilcoxon signed rank test determined if there were significant differences between different levels of BWS or different speeds.

RESULTS AND DISCUSSION

Stance time (ST): Increased with decrease in BWS for all participants (.715m/s, 60%BWS: 53 ± 0.7% GT, versus .715m/s 0% BWS: 61%±. 4% GC). **Kinematics:** Increases in angular displacement (AD) at the hip and knee (Table 1) were not significant. There does appear to be a trend with an increase in hip and knee AD at 0% BWS. **Muscle Activation:** Not a significant increase in mean RMS LBF (Table 2). Figure 1 illustrated a trend: with a decrease in BWS there is an increase in amplitude. Similar results were shown for LGA and LTA at different BWS. Our results also indicated an increase in BD for an increase in load (Fig 1). There was also a trend to show an increase in mean RMS amplitude for LBF without harness (Table2, Fig 1). Similar results were shown for the right limb. The LRF RMS amplitudes were not significant at different BWS. BD for LRF occurred during early stance and pre swing for all individuals. Regardless of BWS LRF amplitudes were small (0.71m/s 60%, 40%, 0%, and without harness: 11.8 ±0.7, 10.9±0.8, 10.3±0.2, 7.8±3.9uV) In general, the BD for the LRF, LBF, LTA and LG increased with increasing load.

SUMMARY/CONCLUSIONS

At high BWS, ST was less and often heel strike was difficult to obtain. Altering BWS changes the kinematic and EMG activation patterns. The harness also seems to contribute to a change in kinematics and EMG. This study provided preliminary data relevant to able-bodied controls that we can use to compare individuals who have had a SCI and who have completed LT (Fig. 2). This preliminary data is limited by the small sample size but does show a trend. Further data needs to be collected to increase the n size.

Figure 1. For one participant: EMG Activity for LBF (uV) for different velocities, BWS and no harness.

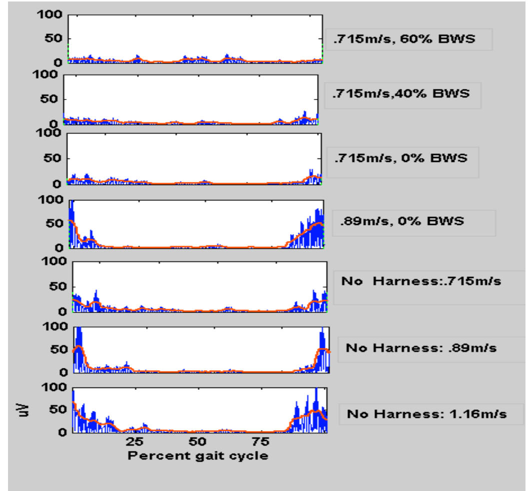

Figure 2. Individual with Chronic Motor Complete ASIA-B SCI. EMG data [LBF (uV)]

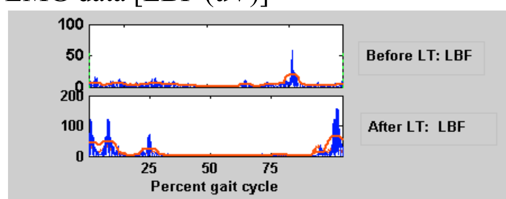

Table 2: Mean RMS LBF (uV): BWS (60,40,0%);

	60	40	0	NO Harness
0.71m/s	5.5±.4	10.7±1.8	10.1±2.6	20.7±8.0
0.89m/s	7.5	12.75.5±6.1	20.45.5±7.	25.5±3.2

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Table 1: Angular Displacement for knee and Hip for BWS (60,40,0%) and velocities (0.71m/s, 0.89m/s).

HIP					KNEE				
BWS	60	40	0	W/O Harness	BWS	60	40	0	NO Harness
0.71m/s	31.0±.12	33.0±.2.8	43.0±1.4	28.0±12.7	0.71m/s	56.9±2.8	57.4±3.5	65.6±1.9	68.2±10.3
0.89m/s	30.5±2.1	34.0±2.3	40.5±3.5	46.0±5.66	0.89m/s	60.5±.7	59.0±2.1	69.48±3.6	67.03±7.1