THERAPIST CONTROLLED POWERED LOWER LIMB ORTHOSES TO ASSIST LOCOMOTOR TRAINING

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INTRODUCTION

Locomotor training with manual assistance can greatly improve walking ability after neurological injury. However, manual assistance is labor intensive and variable from trainer to trainer. Robotic assistive devices are currently being developed to assist locomotor training, but no current device can assist ankle plantar flexion, the major source of work during normal walking. Therapist-controlled, powered lower limb orthoses for locomotor training could decrease therapist labor requirements, increase walking speed during training and lead to increased muscle activation and improved gait kinematics. However, because sensorimotor feedback contributes to muscle activation, plantar flexor assistance could decrease muscle activation of the triceps surae. The purpose of this study was to test therapist-controlled, powered ankle-foot orthoses (AFOs) to facilitate gait rehabilitation after spinal cord injury. We assessed the impact of localized powered assistance at the ankle on muscle activation patterns and joint kinematics during walking with partial bodyweight support in individuals with incomplete spinal cord injury.

METHODS

Four subjects (ASIA C or D) with chronic incomplete spinal cord injuries walked at 0.54 m/s under three different conditions: (1) without the AFOs, **WO;** (2) with passive bilateral AFOs, **PA;** and (3) with active bilateral AFOs under push-button control by a therapist, **TC**. Body weight support was provided at either 30% or 50% depending on the weight-bearing ability of the subject. When necessary, elastic cords provided lateral stability.

Figure 1: (a) Powered Ankle-Foot Orthosis (AFO). A lightweight carbon fiber orthosis (~1.5 kg) fit with an artificial pneumatic plantarflexor muscle. (b) **Therapist Control.** A therapist uses push-buttons to control the timing of active AFO assistance at the ankle as an ASIA D 24 yr. old male trains with partial body weight support.

RESULTS AND DISCUSSION

The passive condition and therapist control condition produced higher stance phase RMS EMG muscle activation in all three triceps surae muscles (SOL, MG, LG) than the without condition (Figure 2). The tibialis anterior demonstrated decreased stance phase activity in the passive condition and therapist control condition compared to the without condition.

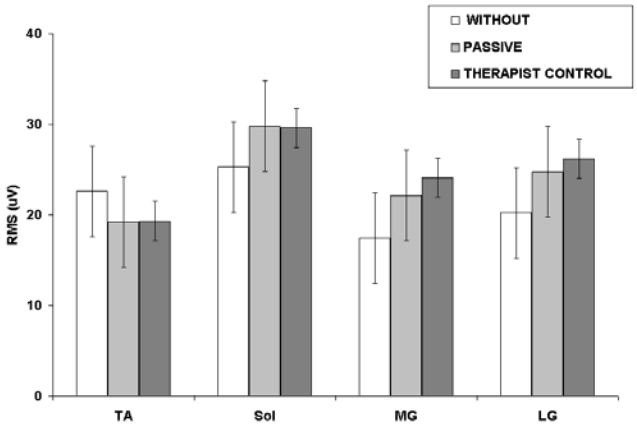

Figure 2: Stance phase averaged rectified RMS EMG for tibialis anterior (TA), soleus (Sol), medial gastrocnemius (MG) and lateral gastrocnemius (LG). Bars are mean and standard error of the mean.

CONCLUSIONS

These findings suggest that powered plantar flexion assistance does not decrease plantar flexor muscle recruitment during gait in incomplete spinal cord injury subjects. Thus powered lower limb orthoses may be a viable aid to assist therapist during locomotor training.

Our powered AFO comfortably delivered ~50% of normal ankle plantar flexor torque. Therapist labor intensity was reduced considerably, allowing the therapist to focus more on gait quality. Another possibility is that the push button control could come directly from the patient during gait rehabilitation.

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