ADAPTATIONS AND AFTEREFFECTS OF MUSCLE ACTIVATION PATTERNS AND FOOT KINEMATICS FOLLOWING PASSIVE SWING PHASE ASSISTANCE

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INTRODUCTION

The purpose of the present study was to investigate alterations in lower extremity kinematics and muscle activity during and following application of anteriorly directed swing assistance during treadmill walking. A previous investigation showed that during applied swing phase assistance, muscle activity is altered (Gottschall and Kram, *J Appl Physiol*. 2005 99:23-30). Changing other types of environmental demands and task constraints produces adaptation in human locomotion (Reisman et al., *Brain*. 2007 Jul;130(Pt 7):1861-72). Similarly, preliminary data indicated that aftereffects and adaptations were also observed following removal of swing phase assistance.

METHODS AND PROCEDURES

Using a device similar to that described previously (Gottschall and Kram, *J Appl Physiol*. 2005 99:23-30), we applied a pulling force of 3-10% body weight (BW) at the foot during mid-stance to mid-swing phases of the gait cycle during treadmill walking in 10 able-bodied subjects. Electromyographic activity of six lower extremity muscles and hip and knee kinematics were collected from both legs during constant velocity treadmill walking using an accelerometer secured to the foot. Data were sampled at 1000 Hz and collected prior to, during, and following application of passive swing phase assistance.

RESULTS

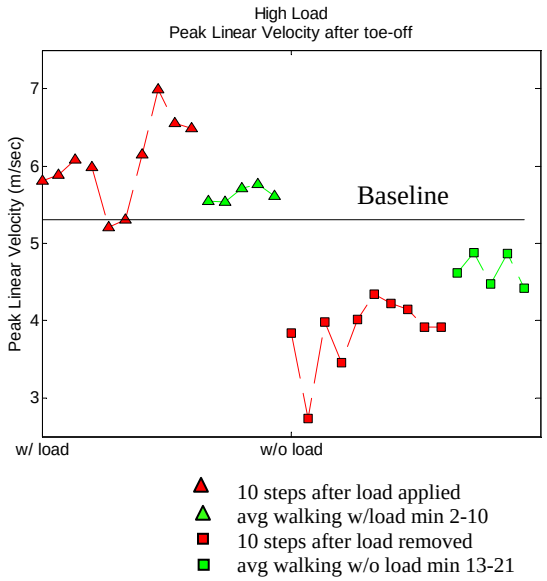

Figure 1: Peak linear velocity after toe-off for 10 minutes of treadmill walking with a high load (6-10% BW) swing phase assistance and 10 minutes following load removal. Data collected for the first 10 steps following load application (red triangles) revealed elevated foot linear velocity, which gradually decreased towards baseline during minutes 2-10 (green triangles, data averaged over 1 min every 2nd min). Upon removal of the assistance, data demonstrate a rapid decline in peak linear velocity for the first 10 steps (red square), which gradually increased back to baseline over 10 min (green square). Similar results were observed for low load (3-5%BW) conditions.

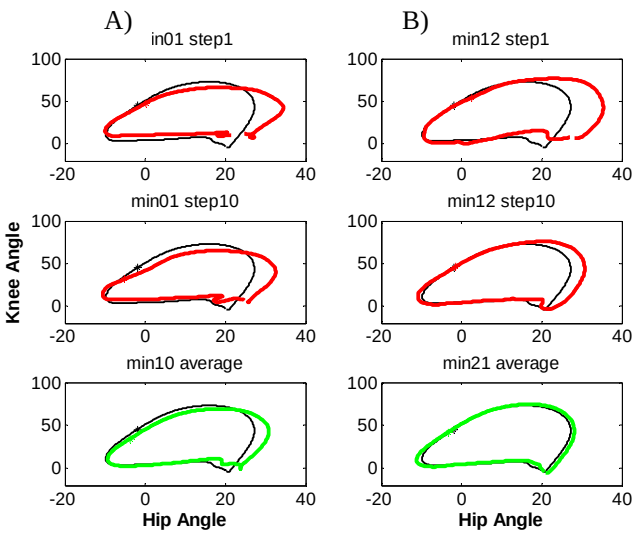

Figure 2. Hip and knee angle profiles during a) the 1st and 10th step following high load application (red traces), at 10 min following loading (green trace), and B) following assistance removal (1st, 10th steps, 10th min). Baseline walking is shown in gray. After load application, there is an increase in hip flexion and slight decrease of knee flexion. After 10 min of walking, the subject adapted their walking closer to baseline. Subjects flexed the hip to greater extent following removal of assistance. Walking profile returned to baseline by the 10th min.

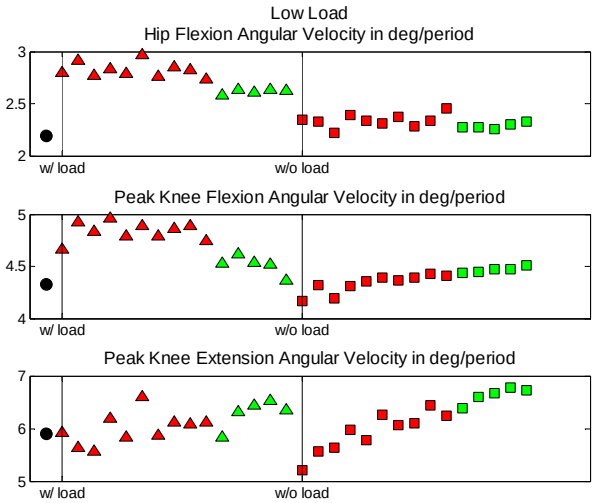

Figure 3. Angular velocity of hip flexion, knee flexion and knee extension with a low assistive load (3-5% BW). The black circle indicates average baseline data. Similar legends as in Figure 1. A large increase in hip and knee peak flexion velocity was observed following load application, with slight adaptation towards baseline following a 10 min stepping bout and little aftereffect following removal. In contrast, peak knee extension velocity demonstrated a substantial reduction following load removal. Elevation of medial hamstring activity during swing partially accounted for the reduced knee extension velocity.

DISCUSSION

The data presented demonstrated adaptation and after-effects in lower extremity kinematics in response to applied assistance loads. Subjects adapted to the perturbation (load applied) after a brief period of training, and demonstrated reduced end-point velocity, and altered joint kinematics and muscle activity following load removal. With the increasing use of therapist or robotic-assistance to facilitate treadmill stepping in individuals with neurological impairments, understanding the alterations in kinematics and muscle activity patterns following applied forces becomes paramount to optimizing perturbations to augment recovery.

REFERENCES

Gottschall and Kram, *J Appl Physiol*. 2005 99:23-30

Reisman et al., *Brain*. 2007 Jul;130(Pt 7):1861-72

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