ADAPTIVE CHANGES IN LOWER LIMB COORDINATION IN RESPONSE TO UNILATERAL LOADING DURING TREADMILL LOCOMOTION

Jeremy W. Noble and Stephen D. Prentice
Gait and Posture Lab, Department of Kinesiology, University of Waterloo, Waterloo, ON, Canada.
email: jwnoble@uwaterloo.ca

INTRODUCTION

In order for the Central Nervous System (CNS) to effectively control the movement of the limbs during locomotion it must have sufficient knowledge of the mechanical properties of the lower limb. With this knowledge the CNS is able to coordinate actions at the three major joints of the lower limb to provide safe and effective locomotion. Previous studies have manipulated limb mechanics by placing an additional mass on the lower limb and reported the changes in limb kinematics and kinetics [1,2]. However none of these studies have examined the resulting disruptions in interjoint coordination in the lower limb when the mechanical properties of the limb were altered. The goal of this study was to determine how interjoint coordination is affected during the adaptation to addition of mass to the limb, and its subsequent removal.

METHODS

Participants (n=8) were instructed to walk on a treadmill moving at 1.56 m/s for three 5 minute trials (PRE, WEIGHT, POST). During the WEIGHT condition a 2 kg mass was placed at the centre of mass of the leg segment of the left lower limb. Bilateral limb and trunk kinematics were obtained from an OPTOTRAK system (Northern Digital Inc., Waterloo ON) and infrared emitting diodes placed on anatomical landmarks defining a seven segment representation of the limbs and trunk.

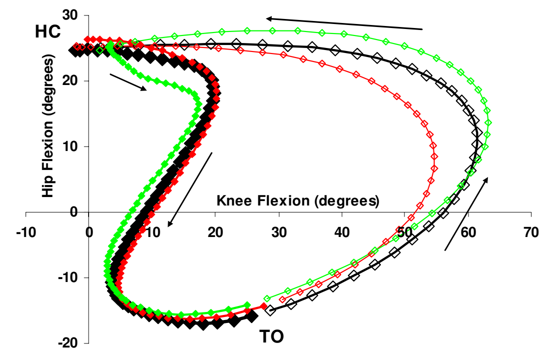
Segment and joint kinematic time histories were determined using the conventions described by Winter [3] and net joint moments the sagital plane were calculated at the ankle, knee and hip joints during the swing phase using standard inverse dynamics [3]. Time series data from the WEIGHT and POST conditions was then averaged into bins of five consecutive strides so that the time course of the adaptation to the mass could be analyzed. In order to investigate interjoint coordination between the hip and knee joints knee vs. hip angle plots were determined for each stride.

RESULTS AND DISCUSSION

During the PRE condition the Hip vs. Knee angle graphs were similar to those previously reported [4]. With the added mass, there was decrease in knee flexion during the swing phase of the first bin of 5 strides although the range of hip motion was similar to the PRE condition. Once accustomed to the mass the swing phase of the angle-angle plot approached that which was observed in the PRE condition however knee flexion never fully returned to that observed in the PRE condition.

When the mass was removed the peak angles observed at both the hip and knee joints during the swing phase were greater than the PRE condition. There was also a period of additional hip extension during early stance. This extra hip extension during weight acceptance diminished over the first 25 strides of the POST condition.

A



B

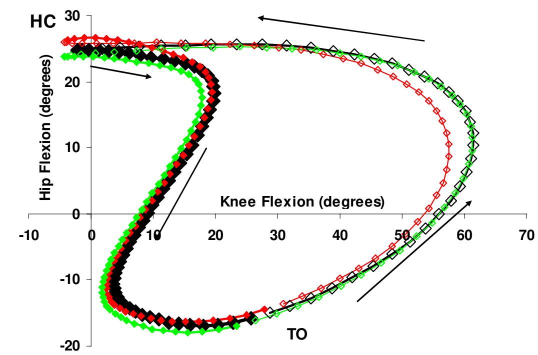


Figure 1: Hip vs. Knee Angle Plots comparing the first (A) and 25th (B) bins of the WEIGHT (Red) and POST (Green) to the mean of the PRE (Black) condition.

CONCLUSIONS

Adaptive changes in knee-hip coordination were observed primarily during the swing phase when the mass would have the greatest effect. Early exposure to the weight (or its removal) brought a disruption to the normal coordination between the knee and hip which returned close to PRE coordination within 25 strides. Additional changes in the coupling between the knee and hip during weight acceptance following the removal of the mass would indicate the influence of swing limb mechanics upon the actions of weight acceptance.

REFERENCES

1. Martin PE et al (2000) IV WCB Calgary AB.
2. Reid MJ & Prentice SD (2001) *Neurosci Res Com* **29:**79-87.
3. Winter DA (1991) The Biomechanics and Control of Human Gait. Waterloo, Waterloo Biomechanics.
4. Hershler C & Milner M (1980) *Am J Phys Med* **59**:109-25.

ACKNOWLEDGEMENTS

Financial support for this project was provided by NSERC