Can a motorized ankle-foot orthosis be developed to maintain natural gait for rehabilitation?

Abstract
The objective of this project was to optimize a rigid, motorized ankle-foot orthosis (afo) to assist in the rehabilitation process for people suffering from neuromuscular conditions. An Active Ankle-Foot Orthosis, “AAFO”, with a mass of 1.00 kg was re-designed from a previous model of 2.13 kg, “LiTREAD”, and incorporated into walking studies with minimal inhibition of a person’s normal gait.

Introduction
Over 2.3 million people worldwide suffer from multiple sclerosis and two-thirds of the 7 million stroke survivors in the United States suffer from mobility disabilities. This research aims to develop a lightweight ankle-foot orthosis (afo) to be used in conjunction with a variable damping controller to assist those suffering from neuromuscular conditions.

Methods
The “AAFO” was designed in SOLIDWORKS and printed with ABS. Measuring ankle kinematics was conducted without and with the “AAFO” for 1 minute walking trials on a force-sensing treadmill. A goniometer was attached to the ankle and an EMG placed on the tibialis anterior. The data was captured and processed with MATLAB/Simulink.

Results
The new “AAFO” has a mass of 1.00 kg compared to the old afo, “LiTREAD”, which had a mass of 2.13 kg. After initial heel strike, Figure 3 below shows the subject’s ankle angle deviating 1 degree when the toes make contact with the ground, followed by a 3 degree deviation when the heel leaves the ground, and a 13 degree deviation when the toes leave the ground. Figure 4 below shows the subject’s tibialis anterior had a maximum deviation of 7% wearing the “AAFO”.

Discussion & Conclusion
This AAFO has minimal impact on a person’s natural gait. The same walking pattern and similar muscle activation is exhibited while wearing the robot with slight deviation. This provides researchers the ability to integrate a variable damping controller and adjust appropriate damping values to assist in ankle-foot mobility. Given a robust variable damping controller, entrainment studies may be conducted in the future for people suffering from neuromuscular conditions to achieve a normal gait cycle.

References

Acknowledgements
Omik Save, Andrew Cook, John Atkins, Carly Thalman, Hyunglae Lee, lab members of NMCHR