INTRODUCTION
The importance of adjusting mechanical properties of an articulated ankle-foot orthosis (AFO) to optimize gait in individuals with stroke has been gradually recognized by researchers and clinicians. This paper presents the mechanical properties of a novel articulated AFO with independently adjustable plantarflexion resistance, dorsiflexion resistance and alignment, and their effect on ankle and knee joint angles, moments and power for a chronic stroke subject.

METHOD
Subject: The subject for this study was a 50-year-old female, 5.5 years post stroke with left hemiparesis. The subject presented with neuromuscular tone and +5° range of motion in dorsiflexion. The subject was unable to actively dorsiflex past 10° plantarflexion and walked in equinus in swing phase with excessive knee flexion in stance phase.

Apparatus: A custom polypropylene AFO was fabricated for the subject using Triple Action™ ankle joints. The sagittal resistance and alignment of the AFO were quantified under 12 different ankle joint adjustment settings using a motorized torque-angle tester comprised of an optical encoder and inline uniaxial torque sensor. Gait analysis was performed using a Vicon motion analysis system and Cleveland Clinic marker set with the subject walking on a Bertec split belt, instrumented treadmill at self-selected speed.

Procedures: The subject was fit with the AFO and the ankle joints were kinematically optimized using observational gait analysis. During motion trials, two of the three component settings were held at their optimum values while the ankle joint setting of interest was changed.

Data Analysis: Data were recorded and post-processed using Vicon Nexus and Visual3D software. Ankle and knee joint angles, moments and power were averaged and normalized to the gait cycle under each setting.

RESULTS
These results showed some systematic effects of ankle joint plantarflexion resistance settings on ankle angle at initial contact and moment from initial contact to loading response. The effects of changing AFO dorsiflexion resistance on ankle and knee joint kinematics and kinetics showed systematic effects on ankle angle at mid-stance and power at terminal stance. Changes in AFO alignment showed some systematic effects on ankle angle at initial contact and mid-stance and joint moments from initial contact to loading response.

DISCUSSION
The aim of this study was to investigate the mechanical properties and influence of a novel articulated AFO on ankle and knee joint angles, moments and power on stroke hemiparetic gait. The AFO showed systematic changes in mechanical characteristics with adjustment of the ankle joints. The subject’s ankle and knee joint kinematics and kinetics showed some systematic changes in response to changes in AFO mechanical properties during gait.

Improvement in heel rocker was demonstrated with a more normal dorsiflexor moment pattern when plantarflexion resistance was increased and ankle alignment was changed toward dorsiflexion. This study suggested that optimization of heel rocker during gait requires adjustment of both plantarflexion resistance and alignment.

Both knee and ankle moments were systematically responsive to dorsiflexion resistance and alignment changes of the AFO in mid to late stance.

CONCLUSION
This study suggests the advantages of using kinematic and kinetic data in addition to observational gait analysis for AFO optimization in stroke. It was also suggested however that patient preference and comfort need to be considered during the optimization process.

CLINICAL APPLICATIONS
The treatment of lower extremity biomechanical deficits resulting from stroke is an important area of orthotic practice. A better understanding of the factors that influence the process of AFO optimization has important implications for the quality of care of stroke patients.

REFERENCES