Effects of a Passive Dynamic Lower-Leg Exoskeleton during Walking

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INTRODUCTION

• The ankle produces 60% of the lower-body positive mechanical work during the stance phase of gait.1-2
• If ankle muscles are weak, there are reductions in the ability to generate appropriate torques and powers during walking
• This leads to slower preferred walking speeds (PWS), which correlate with poor physical function, more disabilities, increased hospitalization visits and costs, and even mortality.3-4
• Due to this, many orthotic and exoskeletal devices are being created to restore proper ankle function by promoting ankle plantar flexion.5,6
• Purpose: Build a passive dynamic lower-leg exoskeleton to assist ankle plantar flexion, and assess its effects during walking
• Hypothesis 1: Wearing the exoskeleton will reduce the biological ankle torque contribution during stance
• Hypothesis 2: Wearing the exoskeleton will insignificantly affect ankle angle throughout gait
• Hypothesis 3: Wearing the exoskeleton will decrease the metabolic cost of walking

MATERIALS / METHODS

• Ten young, healthy participants between the ages of 19 and 35 years will walk on a level treadmill, at 10% faster than their PWS, for a variety of exoskeleton conditions (Table 1)

Table 1. Exoskeleton conditions during level treadmill walking.

|-------------------------------|--------------------|--------|----------------------------------------|------|-----------------------------------|------|--------------------------------------|------|

• All walking trials will be five minutes long and followed by a three minute rest
• Subjects will begin the study with a habituation period on the treadmill, involving three walking trials wearing the device with constant assistance actuators (CA Condition)
• 3D motion capture (Vicon Nexus) will measure hip, knee, and ankle motion in the sagittal plane
• An instrumented treadmill (Bertec) will measure ground reaction forces
• Using inverse dynamics, lower-body joint torques and powers will be calculated from motion and force data during walking trials

EXOSKELETON

• The lower-leg exoskeleton consists of four major components
(1) Calf Cuff
(2) Passive Clutch
(3) Extension Spring (Elastic Actuator)
(4) Foot Bracket


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