FEASIBILITY OF AN EXOSKELETON POWERED BY ECCENTRIC JOINT WORK FOR REDUCING WALKING METABOLIC COST.

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INTRODUCTION

Walking is a self-resistive movement that requires substantial metabolic energy. Different groups are **developing walking exoskeletons** in attempt to increase the metabolic economy. The main practical **problem is limited power source autonomy**. The proposed **ideal solution** would be to **power** the exoskeleton **by recycling eccentric joint work** that naturally occurs during walking (1).

In previous experiments our group developed a pneumatically powered ankle foot exoskeleton that could reduce metabolic cost (2).

=>**Current goal**: Measure inverse dynamics with the exoskeleton in order to **find out if sufficient eccentric joint power is available** to power the exoskeleton with, instead of powering the exoskeleton with compressed air.

METHODS

9 subjects (height: 1m68 +/- 0.055, mass= 59.88kg +/- 3.87) walked over an **instrumented walkway** wearing a plantarflexion assisting exoskeleton that was tethered to an air compressor and a steering unit on a trolley (figure 1).

Measurements:

- Ground reaction forces (Kistler& AMTI, 1000hz)
- Full body kinematics (Qualisys, 200hz)
- Joint kinetics (Visual3D)

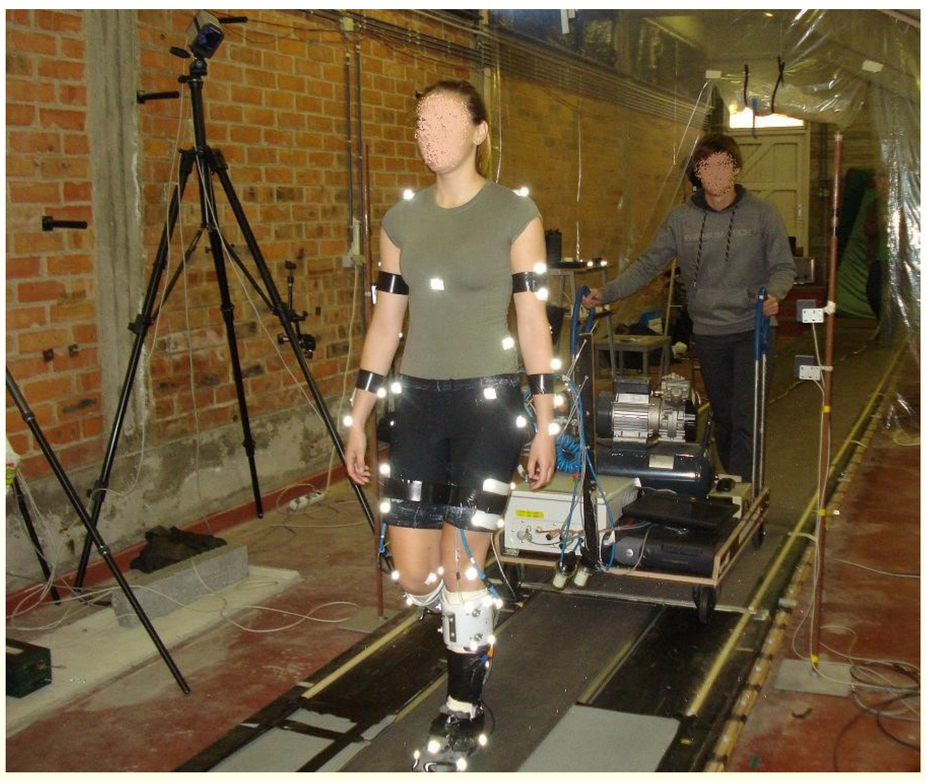

Figure 1: Experimental setup

RESULTS AND DISCUSSION

Results of one subject show clear eccentric power phases in the **knee** and hip **joint** (figure 2). The summation of te eccentric power phases **indicates that sufficient eccentric joint power is available** to reproduce the concentric power of the pneumatic exoskeleton.

One **concern** is that the eccentric joint power will have to be **transferred** over different joints and/or **stored and released** at a later time which will cause some **energy loss**. Another concern is that a recycling exoskeleton will probably **affect** the **gait** pattern and consequently eccentric joint power. On the other hand **humans could** adapt their gait to optimally **exploit** a recycling exoskeleton just like they adapted to use anatomical features such as bi-articular muscles.

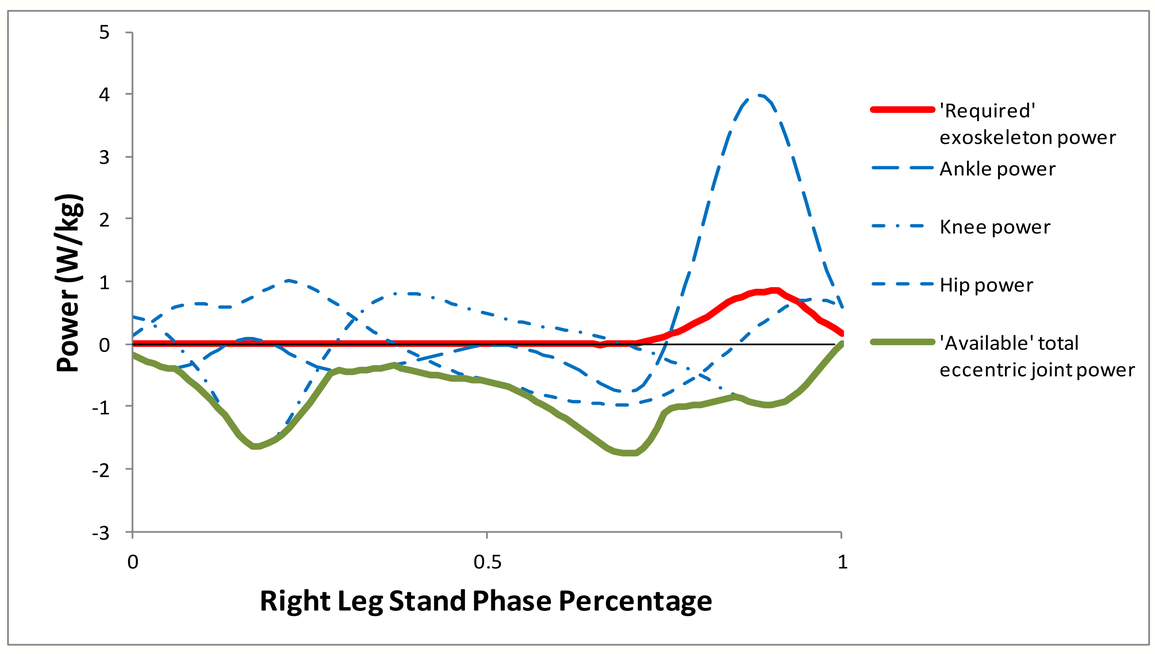

Figure 2: Exoskeleton, ankle, knee, hip and total eccentric joint power during stance phase. The 'available' total eccentric joint work is 6.33 higher than the 'required' exoskeleton work.

CONCLUSION

Preliminary results show that a plantarflexion assisting **exoskeleton** that was previously shown to reduce metabolic cost **could in theory be powered by recycling eccentric joint power** during walking. If practical obstacles can be overcome such a recycling exoskeleton **can benefit** to clinical **populations** as well as able bodied (e.g. rescue workers).

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