ALTERATIONS IN ENERGY COST OF WALKING IN HEALTHY AND HEMIPARETIC GAIT USING FORCES APPLIED TO THE CENTER OF MASS

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Introduction

- Walking recovery post-stroke results in:
  - Slow, asymmetric gait[1]
  - Greater energy cost during walking[2]
- Higher energy cost of walking
  - Reduced paretic propulsion decreases the body's center of mass (COM) anterior movement[3]
    - During the latter half of stance phase
  - Compensation at other joints may drive up energy cost[4]
- Manipulating the anterior-posterior forces on the COM should influence energy cost of walking

Objective

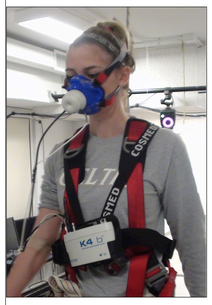
This study aimed to determine if imposing anterior or posterior forces on the COM during paretic propulsion will alter the energy cost of walking.

Methods

- **Subjects**:
  - 7 subjects with chronic (> 6 months) stroke
  - 10 unimpaired subjects

Group	Gender	Age (years)	Time Post-Stroke (months)	Over-ground Speed (m/s)	Treadmill Speed (m/s)	Fugl-Meyer
Stroke	6 F, 2 M	53.12 ± 11.89	102.29 ± 137.24	0.64 ± 0.27	0.54 ± 0.27	25.5 ± 4.47
Control	6 F, 4 M	25.4 ± 2.8		1.39 ± 0.15	1.35 ± 0.12	

- **Protocol**:
  - Single-session of walking on treadmill (Bertec Corp, Worthington, OH)
  - Began testing with 5 minutes of quiet sitting for baseline O2 cost
  - Three randomly-ordered conditions (each lasted 4 minutes)
    - Comfortable walking (control)
    - Walking with an anterior pull at the COM (anterior)
    - Walking with a posterior pull at the COM (posterior)
  - A novel device consisting of theratubing was utilized to apply an anterior or posterior force at the COM that coincided with paretic propulsion.
  - Each participant received a maximum force pull equivalent to ~10% of their body weight (~5% for two in stroke group)
    - Suggested to be an energetic minimum[5]
  - Subjects wore a non-restricting safety harness that attached overhead. No BWS was provided



- **Data Collection**:
  - Overground self-selected walking speed (20' Zeno pressure mat)
  - Gas exchange (inspired VO2/expired VCO2) (Cosmed metabolic cart)
    - Breath-by-breath
  - Anterior-Posterior pulling force (Transducer Techniques)
    - Sampled at 1200Hz
- **Statistical Analysis**:
  - Repeated-measures ANOVA: average VO2 during the final minute of walking was compared between conditions
  - Post-hoc tests: paired samples t-tests, as necessary
  - Significance set at α = 0.05

Results

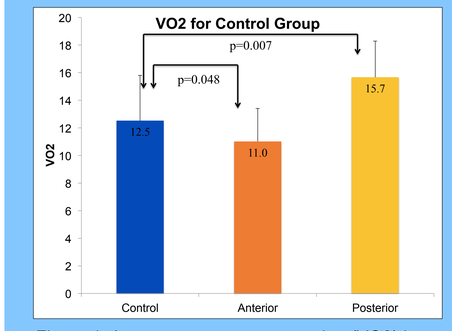


Figure 1. Average oxygen consumption (VO2) in last minute of each condition for Control group. ($p<0.001$; $\eta_p^2 = 0.675$)

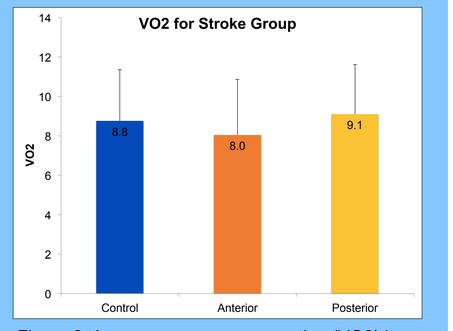


Figure 2. Average oxygen consumption (VO2) in last minute of each condition for Stroke group. ($p=0.099$; $\eta_p^2 = 0.320$)

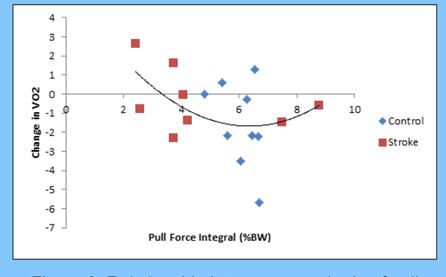
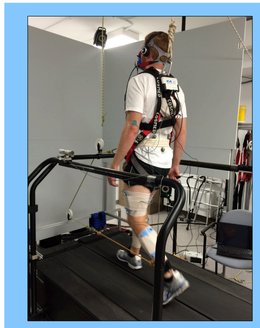
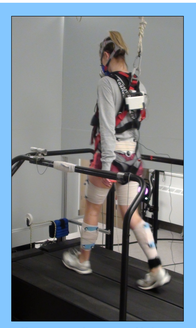


Figure 3. Relationship between magnitude of pull force and energy cost change between anterior and control conditions



Anterior condition



Control condition

Posterior condition

Discussion

- These data partially support our hypothesis
- In healthy controls, metabolic cost:
  - Decreased during the anterior condition
  - Increased for the posterior condition
- These changes were not as robust in our stroke group possibly due to:
  - Slower walking speeds
  - Small sample size
- Excessive or insufficient pull force at the COM can result in increased energy cost or no change at all
- Interventions facilitating anterior translation of the COM merits further investigation with a larger sample size
- Addressing COM mechanics may be a feasible approach for decreasing the metabolic cost of walking for individuals post-stroke.

References

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