Center of Mass Acceleration as a Surrogate for Force Production After Spinal Cord Injury - Effects of Inclined Treadmill Walking

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Traditional Walking Outcomes

WHAT DO THESE TELL US ABOUT THE FACTORS THAT CONTRIBUTE TO IMPAIRED WALKING?
Advanced Measurement Tools

EMG for analyses of muscle activation

Motion capture to determine body positioning and movement (kinematics) and force requirements (kinetics)
Force Production

Mild Hemiparesis
Propulsion $P_{paretic} = 52.8\%$
Gait Velocity - 1.20 m/s

Moderate Hemiparesis
Propulsion $P_{paretic} = 34.2\%$
Gait Velocity - 0.60 m/s

Severe Hemiparesis
Propulsion $P_{paretic} = 8.9\%$
Gait Velocity - 0.44 m/s

Bowden, et al, 2006
Longitudinal assessment of propulsion. Notice the steady improvement in leg performance from Session 1 to session 13, reflecting an improvement in weaker leg contribution to propulsion from 3.8% to 32.9%.
Utilize the framework that has been developed from previous experiences studying walking in people with stroke in order to:

1. Understand the mechanisms by which walking is impaired in those individuals with incomplete spinal cord injury

2. Develop interventions to address those mechanisms specifically in improve walking ability (and performance).
Plots of summed ground reactions forces (GRFs) and COM acceleration. Calculated COMa measures are very similar to data collected directly from force plates on an instrumented treadmill, implying that COMa is a valid surrogate for laboratory-collected ground reaction forces. The ability for measures to equate to theoretically identical outcomes is critical to link laboratory measures to portable measurement tools.
Pre- and post-training accelerations of individuals participating in a locomotor training intervention. While COMa increases, it does not approach normative values, particularly in the critical phase 3 and 4 period of the gait cycle, implying specific therapies need to target specific mechanistic elements of the walking pattern.
Can COMa be Trained?
COMa before (blue line) and 2 minutes after (red line) incline training. A brief (5 minute) period of adaptation training yielded a 48% increase in both peak COMa and the time integral of the COMa curve in phase 3 and 4. The x-axis represents percentage of the gait cycle.

**Hip Extension Angle:** Peak hip extension increased by 1.8 degrees in the weaker leg and by 2.1 degrees in the stronger leg. These increases were maintained at the end of 2-minutes (increases over baseline were 1.8 degrees in the weaker leg and 1.7 degrees in the stronger leg).

**Propulsive (Anterior) GRF:** The peak GRF increased in the weaker leg by 12.3% (36.1N/kg to 40.6 N/kg) and did not change in the stronger leg (48.1 to 47.9 N/kg). The increase in the weaker leg persisted at the end of two minutes (41.3 N/kg). Propulsive impulse (area under the positive portion of the anterior/posterior GRF curve) responded similarly: the weaker leg increased by 10.5% and the stronger leg had a minor decrease of 3.8%.
Final Enrollment

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Manuscripts


• Bowden MB, Embry AE, Gregory CM. COM acceleration as a surrogate for force production after incomplete SCI: impact of incline training. (in progress).
Conference Presentations


• Bowden MG, Gregory C and Kautz S. Center of mass acceleration as a surrogate for force production after neurological Injury: Effects of inclined treadmill walking. Poster presentation at the Society for Neuroscience Annual Meeting. October, 2012; New Orleans, LA.

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