Balance-Based Torso-Weighting Results in Fall Reduction during Sensory Organization Test for People with Multiple Sclerosis

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Falls and Multiple Sclerosis (MS)

- People with MS fall frequently
- Risk of hip fracture is > twice that predicted for general population (Bhattacharya et al. 2014)
  - Hip fractures occur at a younger age
- Fewer than 50% of fallers with MS don’t talk to or get information/recommendations from HCP (Cameron et al. 2013, Matsuda et al. 2011)
Fall Risk in MS

- Systematic review of fallers versus non-fallers (Gianni et al. 2014)
  - Included 15 studies
  - Found 30 - 63% of people with MS fall in 1 to 12 month time frames
- Accidental falls associated with
  - Higher disability scores
  - Use of assistive device
  - Progressive disease course
  - Poor performance on walking and balance tests

Sensory Organization Test

- Six conditions
- Three trials of in each condition
- Composite score (CS) is a average of trials in 6 conditions, trials 3-6 counted more heavily
- CS is reported as percentage points, higher is better
- Minimal detectable change is 8 CS percentage points (Wrisley 2007)

MS and SOT

- Nelson (1995) found abnormalities in the SOT in PwMS both the high and low functioning groups
- 53 people with MS tested using stabilometric assessment
  - Frequency of falls was greatest in conditions 5 & 6 (Cattaneo and Johsdottir 2009)
- Hebert et al. (2011) used SOT to measure change in balance before and after a 6 week intervention with three groups
  - 18.5 percentage point change in the SOT composite score (CS) with vestibular rehabilitation group
  - 5.2 change in CS exercise control group
  - 6.4 change in waitlist control group

Balance-Based Torso-Weighting™

- Examines directional balance loss
  - Brisk perturbations lateral and anterior-posterior, shoulder and pelvis
  - Resisted trunk rotation, shoulder and pelvis
- Strategic weighting to counteract balance loss
  - Light weights are strategically attached to light weight vest
- Found to improve gait velocity
  - (Widener et al. 2009, Crittendon et al. 2014) and Timed up and go test (Widener et al. 2009)
- Effects of torso weighting on balance using the SOT have not yet been studied
Purpose

Investigate the effects of BBTW on balance and fall frequency recorded by the sensory organization test (SOT) in people with multiple sclerosis (PwMS) and healthy age and sex matched control participants.

Protocol

• 64 people with MS self-identified gait or balance problems
  • 2 unable to complete testing; 2 eliminated because of equipment failure

• 10 healthy controls (HC) matched for age-group and sex

• All participants completed the same protocol

• Single session at Samuel Merritt University- Human Movement Lab
  • 3-5 hours for MS
  • 2-3 hours for HC
Protocol

- Testing
  - Sensory Organization Test
  - Motor Control Test
  - Clinical tests (randomized order)
    - Timed Up and Go
    - 25 Foot timed walk
    - Dynamic Gait Index
- Torso weighting using the BBTW protocol
  - Minimum 16 lateral and anterior/posture perturbations and 4 resisted rotations at the shoulders and pelvis
- Mandatory rest (15-30 minutes)
- Repeat testing

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Protocol

- **Testing**
  - Sensory Organization Test
  - Motor Control Test
  - Clinical tests (randomized order)
    - Timed Up and Go
    - 25 Foot timed walk
    - Dynamic Gait Index
- **Torso weighting using the BBTW protocol**
  - Minimum 16 lateral and anterior/posture perturbations and 4 resisted rotations at the shoulders and pelvis
- **Mandatory rest (15-30 minutes)**
- Repeat SOT and Clinical testing

Protocol

- Impairment testing followed clinical testing
  - Muscle strength lower extremities
  - Somatosensation feet
  - AROM knee and ankle joints
  - Muscle tone knees and ankles
- Rest breaks were given as needed/requested
# Results

## Participant Characteristics

<table>
<thead>
<tr>
<th></th>
<th>Mean Age years* (SD)</th>
<th>Years with MS Mean (SD)</th>
<th>Sex (% male)</th>
<th>Diseas steps (range)</th>
<th># Falls past 6 month Mean (SD)</th>
<th># Self-Report fallers past 6 months (%)</th>
<th>BBTW Average amount of weight pounds (% body wt) **</th>
</tr>
</thead>
<tbody>
<tr>
<td>MS</td>
<td>54.4 (11.1)</td>
<td>13.8 (8.4)</td>
<td>28 (17%)</td>
<td>2.6 (1-4)</td>
<td>1.8 (2.3)</td>
<td>39 (65%)</td>
<td>1.9 (1.3%)</td>
</tr>
<tr>
<td>n=60</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HC</td>
<td>53.7 (12.1)</td>
<td>--- (10%)</td>
<td>1 (10%)</td>
<td>--- (1%)</td>
<td>0.0 (0%)</td>
<td>1 (10%)</td>
<td>1.1 (0.8%)</td>
</tr>
<tr>
<td>n=10</td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>

* Independent t-test (p=0.43)

**Independent t-test (p=0.003), α=0.05
## Type of MS

<table>
<thead>
<tr>
<th>Type of MS</th>
<th>Relapsing remitting</th>
<th>Secondary progressive</th>
<th>Primary progressive</th>
<th>Unknown</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td>30 (50%)</td>
<td>16 (26%)</td>
<td>7 (12%)</td>
<td>7 (12%)</td>
</tr>
</tbody>
</table>

## SOT Composite Scores (CS): MS and HC

<table>
<thead>
<tr>
<th></th>
<th>CS NW Mean (SD)</th>
<th>CS WT Mean (SD)</th>
<th>Two-tailed P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>MS n=60</td>
<td>50.52 (14.63)</td>
<td>59.66 (14.51)</td>
<td>*&lt;0.001</td>
</tr>
<tr>
<td>HC n=10</td>
<td>73.9 (6.01)</td>
<td>75.2 (9.46)</td>
<td>0.626</td>
</tr>
</tbody>
</table>

Two-tailed P value

**<0.001  **0.001  ----

*Dependent t-test, α = .05; ** Independent t-test, α = .05
Composite Score Change: NW to WT

![Composite Score Change Graph]

Learning Effect – Average Equilibrium Scores MS

![Learning Effect Graphs]
Averaged Equilibrium Scores (ES)

Fall Frequency during SOT (trials 2,3 included)

<table>
<thead>
<tr>
<th></th>
<th>NW # falls (% total # trials)</th>
<th>WT # falls (% total # trials)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>MS</td>
<td>140 (19.4%)</td>
<td>91 (12.7%)</td>
<td>*&lt;0.001</td>
</tr>
<tr>
<td>n=60</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HC</td>
<td>3 (.03%)</td>
<td>2 (.02%)</td>
<td>**0.484</td>
</tr>
<tr>
<td>n=10</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

*Dependent t-test, α = .05; ** Mann Whitney U test, α = .05
Number of participants who did not fall during SOT (trials 2,3)

<table>
<thead>
<tr>
<th></th>
<th>NW (% total)</th>
<th>WT (% total)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MS</td>
<td>15 (25%)</td>
<td>25 (41.7%)</td>
</tr>
<tr>
<td>HC</td>
<td>7 (70%)</td>
<td>7 (70%)</td>
</tr>
</tbody>
</table>

Limitations

- Set order of testing
  - NW always preceded WT condition
  - Carryover of effects of BBTW
- Learning effects - SOT
  - Eliminated NW trial 1 for equilibrium score calculations
  - Eliminated trial one in both NW and WT conditions to reduce impact of learning on fall number
- Fatigue was an issue with the participants
  - Allowed people to rest as needed
Conclusions

• Composite scores were significantly improved for PwMS while weighted, over 50% changed 8 points or more
  • These improvements occurred even when participants were fatigued due to lengthy testing

• Number of falls for MS were significantly reduced with weighting during SOT; this did not happen in HC

• BBTW shows promise for fall reduction in PwMS
  • Need to investigate how weighting might impact falling in real world situation

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Research team:

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References