Prospective Cohort Study on the Effect of a Balance Training Program, Including Calf Muscle Strengthening, in Community-Dwelling Older Adults

By: Maritz, C and Karin Silbernagel, G.
Journal: Maritz, C and Karin Silbernagel, G.
Discussion lead by: Mariana Wingood, DPT PT GCS CEEAA
# Introduction - Anatomy

<table>
<thead>
<tr>
<th>Muscle</th>
<th>Origin</th>
<th>Insertion</th>
<th>Innervated</th>
<th>Action</th>
</tr>
</thead>
</table>
| Gastroc | Medial and Lateral epicondyles of Femur     | Calcaneal tuberosity via Achilles Tendon | Tibial Nerve (S1-2) | • Talocrural joint: plantar flexion  
                         |                                               |                    | • Knee Joint: flexion                         |
| Soleus  | Fibula (head and neck pos. surface) and tibia (soleal line via tendinous arch) |                                   |                    | Talocrural joint: plantar flexion         |
Introduction- Tricep Surae and its functional role

- Stability during standing
- Control and propulsion during walking
- During reactive stepping the ankle muscles are activated first before the hip and knee
- Improve Balance/Fall risk
  - Residents with a hx of falling had approximately 70% lower strength of the ankle muscles compared with a control group.
  - If insufficient the human body must rely on hip or stepping strategy
Hypothesis

- Ability to perform unilateral heel rise correlates to fall risk, functional performance tests such as Timed up and go (TUG), the 30 second Chair Rise (30-sCST), and balance.
- The addition of unilateral heel rise exercise to a general balance exercise program will cause improvements in calf muscle strength and endurance, function, balance, and balance confidence.
Method-Subjects

- Recruitment: Via Newsletter from Klein Jewish Community Center in Philadelphia, PA.

Participants
- n=28
- Inclusion:
  - Age: 60+
  - Independent with community mobility with/without AD
- Exclusion:
  - Unable to follow directions.
Procedure

- Pre-testing
  - static and dynamic balance
  - Calf muscle strength
  - Functional mobility
  - Fear of falling
- 10 session of 1:1 training and calf strengthening
- Post-testing: same as pre
Outcome Measures

- Zeno Electronic Walkway (formerly known as GAITRite)
  - Static standing with eyes open in normal stance for 30 seconds
  - Static standing with eyes closed in normal stance for 30 seconds
  - COP mean velocity (cm/s) - speed of sway

- Unilateral Heel Rise Test
  - Standing on a box with an incline of 10 degrees with hands on wall for balance
  - Minimum heel rise: 2 cm

- Timed up and go test (TUG)
  - 3 meters
  - Avg of 3 trials

- 30 second chair stand (30-sCST)
  - 17 inches

- Activity Balance Confidence Scale
Intervention- 1:1 Balance Training-Level I

- Static Standing Balance
  - Eyes open/closed progressively decreased BOS (30 secondsx3)
  - Marching in place progressively decreased BOS (10 reps x3)
  - Semi-tandem stance (30 secondsx3)
  - Rocking forwards and backwards initially with UE support (10 repsx3)

- Strengthening
  - Standing SLR -4 directions with UE support (10 reps- 1 set)
  - Heel Raises with UE support (unilateral if able or bilateral- 10 reps-2 sets)
  - Mini-Squats with UE support (10 reps-2 sets)

- Dynamic balance
  - Four Square Step Test (3 times)
  - Side, forward, and backwards stepping with UE support (10ftx10reps)
  - Walking in circles-clockwise and counterclockwise directions (5 times)
Intervention- 1:1 Balance Training-Level 2

Static Standing Balance
- Tandem Stance with UE support (15 seconds x3)
- Single Leg Stance with UE support (15 seconds x3)
- Eyes open/closed standing on foam pad - progressively decreasing BOS (30 seconds x3)
- Marching in Place standing on a foam pad progressively decreasing BOS (10 reps x3)
- Semi-tandem stance standing on foam pad (15 seconds x3)
- Rocking forwards and backwards standing on foam pad (10 reps x3)

Strengthening
- Standing SLR - 4 directions with UE support (10 reps - 2 set)
- Heel Raises with UE support - unilateral (15 reps - 2 sets)
- Mini-Squats with ball (10 reps - 2 sets)

Dynamic balance
- Four Square Step Test (5 times)
- Side, forward, and backwards stepping without UE support (10 ft x 10 reps)
- Modified Tai Chi Movement Pattern (parting wild horse’s mane)-series of weight shifting movements performed slowly and rhythmically (5 reps in each direction)
Intervention- 1:1 Balance Training-Level 3

- Static Standing Balance
  - Tandem Stance without UE support (15 seconds x3)
  - Single Leg Stance without UE support (15 seconds x3)
  - Eyes open/closed standing on foam pad - progressively decreasing BOS (30 seconds x5)
  - Marching in Place standing on a foam pad progressively decreasing BOS (15 reps x3)
  - Semi-tandem stance standing on foam pad (30 seconds x3)
  - Rocking forwards and backwards standing on foam pad (15 reps x3)

- Strengthening
  - Standing SLR - 4 directions with unilateral UE support (10 reps - 3 set)
  - Heel Raises with UE support - unilateral (15 reps - 3 sets)
  - Mini-Squats with ball (10 reps - 3 sets)

- Dynamic balance
  - Side, forward, and backwards stepping without UE support (15 ft x 10 reps)
  - Braiding with or without UE support (10 ft x 5 reps)
  - Modified Tai Chi Movement Pattern (parting wild horse’s mane)-series of weight shifting movements performed slowly and rhythmically (10 reps in each direction)
  - Balance Beam Walking forward and backwards (10 ft x 5 reps)
Intervention-Heel Raises

- In addition
  - ≤ 10 single heel raises → Bilateral heel raise intervention
  - > 10 single heel raises → unilateral heel raise intervention
  - progressively increased → goal of 3 sets of 10-15 reps
## Results: Static Balance

<table>
<thead>
<tr>
<th>Variable</th>
<th>Pretest Mean (SD)</th>
<th>Posttest Mean (SD)</th>
<th>Pre-Post Comparison</th>
</tr>
</thead>
<tbody>
<tr>
<td>EO-COP mean velocity</td>
<td>1.57 (0.47)</td>
<td>1.77 (0.76)</td>
<td>p=0.181</td>
</tr>
<tr>
<td>EO-COP mean velocity X</td>
<td>1.0 (0.34)</td>
<td>1.14 (0.46)</td>
<td>p=0.088</td>
</tr>
<tr>
<td>EO-COP mean velocity Y</td>
<td>1.02 (0.29)</td>
<td>1.13 (0.56)</td>
<td>p=0.358</td>
</tr>
<tr>
<td>EC-COP mean velocity</td>
<td>1.70 (0.87)</td>
<td>2.11 (1.07)</td>
<td>p=0.033</td>
</tr>
<tr>
<td>EC-COP mean velocity X</td>
<td>1.15 (0.62)</td>
<td>1.51 (0.77)</td>
<td>p=0.016</td>
</tr>
<tr>
<td>EC-COP mean velocity y</td>
<td>1.03 (0.51)</td>
<td>1.19 (0.65)</td>
<td>p=0.136</td>
</tr>
</tbody>
</table>

EO=eyes open, EC= eyes closed
COP=center of pressure
Y=side-side
X=forward-backwards
## Results: Post intervention

<table>
<thead>
<tr>
<th>Variables</th>
<th>Pretest Mean (SD)</th>
<th>Posttest Mean (SD)</th>
<th>Pre-Post Comparison</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heel Rise Right</td>
<td>9 (8.3)</td>
<td>16 (8.2)</td>
<td>p&lt;0.001</td>
</tr>
<tr>
<td>Heel Rise Left</td>
<td>9 (6.3)</td>
<td>17 (8.0)</td>
<td>p&lt;0.001</td>
</tr>
<tr>
<td>Timed up and Go</td>
<td>10.2 (2)</td>
<td>9.5 (1.8)</td>
<td>p=0.046</td>
</tr>
<tr>
<td>30 sec chair stand test</td>
<td>10 (3.2)</td>
<td>11.9 (3.4)</td>
<td>p=0.003</td>
</tr>
<tr>
<td>Activity Balance Confidence Scale</td>
<td>69 (16)</td>
<td>78 (12)</td>
<td>p=0.003</td>
</tr>
</tbody>
</table>
## Results: Heel Raise and Fall Risk

<table>
<thead>
<tr>
<th>Heel Rise</th>
<th>Timed Up and Go Pre/Post</th>
<th>30 sec Chair stand Pre/post</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right</td>
<td>p&lt;0.01/p&lt;0.05</td>
<td>p&lt;0.01/p&lt;0.01</td>
</tr>
<tr>
<td>Left</td>
<td>p&lt;0.01/p&lt;0.05</td>
<td>p&lt;0.01/p&lt;0.05</td>
</tr>
</tbody>
</table>
## Results: TUG and Single Heel Rise Ability

<table>
<thead>
<tr>
<th>Number of subjects in each group</th>
<th>Right Leg Heel Raise (n) ≤ 10 reps/&gt;10 reps</th>
<th>Left Leg Heel Raise (n) ≤ 10 reps/&gt;10 reps</th>
</tr>
</thead>
<tbody>
<tr>
<td>TUG high risk (≥ 12sec)</td>
<td>5/0</td>
<td>5/0</td>
</tr>
<tr>
<td>TUG low Risk (&lt;12sec)</td>
<td>12/10</td>
<td>11/11</td>
</tr>
<tr>
<td>TUG slower than age average (≥ 9.5 sec)</td>
<td>13/4</td>
<td>14/3</td>
</tr>
<tr>
<td>TUG slower than age average (&lt;9.5sec)</td>
<td>4/6</td>
<td>2/8</td>
</tr>
</tbody>
</table>
Discussion/Clinical Pearls

- Heel-Rise performance correlates moderately with TUG and 30-sCST.
- Balance Training program that includes calf muscle strengthening performed 2/week for 5 weeks resulted in significant improvement in calf muscle strength, functional performance and balance, as well as significantly improvement in balance confidence.
SIG Discussion

- What are you doing for National Fall Prevention Awareness Day?
  - Educational Booth?
  - Display’s?
  - Community Events?
  - Screenings?
  - Educating PCP about the STEADI
- Would it be helpful to have a data base of what everyone is doing?
Suggestions

- Do you think this was helpful?
- What is a good frequency?
- Did this time work for you?
- Was the topic helpful? Do you have suggestions for topics?
- Please e-mail me (mariana.Wingood@outlook.com).
Questions