Relationship between dynamic postural control ability with voluntary and passive sway and lower limb muscle activity

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Background

- Proportion of elderly individuals in Japan: 26% (2015)
- Bedridden period → 8.9 years (men), 10.2 years (women)

Percent distribution of main causes for requiring care

<table>
<thead>
<tr>
<th>Cause</th>
<th>Proportion</th>
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<tbody>
<tr>
<td>Cerebrovascular diseases</td>
<td>30.7%</td>
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<tr>
<td>Dementia</td>
<td>21.5%</td>
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<tr>
<td>Asthenia due to a ripe age</td>
<td>15.3%</td>
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<tr>
<td>Arterial diseases</td>
<td>13.7%</td>
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<tr>
<td>Fracture and fall</td>
<td>10.9%</td>
</tr>
<tr>
<td>Other causes</td>
<td>10.2%</td>
</tr>
</tbody>
</table>

Methods

Subjects

<table>
<thead>
<tr>
<th></th>
<th>Old men</th>
<th>Young men</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>74.2 ± 8.2</td>
<td>22.2 ± 0.7</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>164.3 ± 3.9</td>
<td>173.8 ± 5.2</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>63.3 ± 5.4</td>
<td>72.8 ± 12.4</td>
</tr>
<tr>
<td>Foot length (cm)</td>
<td>23.7 ± 0.4</td>
<td>25.5 ± 1.0</td>
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</tbody>
</table>

Surface EMG: EMG is expressed in % RMS when setting RMS of the maximum voluntary contraction to 100%.

Target muscle

- VL: vastus lateralis
- BF: biceps femoris
- TA: tibialis anterior
- GAS: gastrocnemius

Measure of dynamic postural control ability

- We measure dynamic postural control ability with the center of pressure on the stabilometer or unstable tilt board.
- The unstable tilt board inclines front and back. It has a built-in sensor to measure direction and degree.

Protocol and Assessment

Test.1: Voluntary sway on the stabilometer

Test.2: Passive sway on the unstable tilt board

Results

Discussion

Section.1: Agonist (BF • GAS) • Antagonist (VL • TA)
- Front % COP is not different between younger and older adults, but muscle activity patterns are different.
- Younger: Reciprocal inhibition (Agonist ↑ • Antagonist ↓) ⇒ increase the degree of freedom of joint (mobility)
- Older: Co-contraction (Agonist ↑ • Antagonist ↑) ⇒ increase the stiffness of joint (stability)

Section.2: Agonist (VL • TA) • Antagonist (BF • GAS) / Section.3: Agonist (BF • GAS) • Antagonist (VL • TA)
- Back % COP and COP are better in younger adults than in older adults; older adults sway back with large amplitude.
- The typical standing posture of older adults has a center of gravity in the back.
- Older adults increased lower limb muscle activity more than younger adults and used a hip strategy. ⇒ Older adults got worked up.

Conclusion

Older adults compensate for the decline in dynamic postural control ability by increased lower limb muscle activity and a hip strategy.
- Voluntary sway to the front showed a trend of co-contraction. ⇒ increase of energy cost.
- Older adults used a hip strategy in unfamiliar conditions such as voluntary sway to the back and passive sway on an unstable surface. ⇒ increase of fall risk.

Exercise training should involve not only increasing muscle mass but also conditioning to relax the muscles for fall prevention; they should possibly shift from a hip strategy to an ankle strategy.