Efficacy of Arm Sling for Improvement of Balance Control and Gait Performance in Hemiparesis Patients after Stroke: A Randomized, Crossover Study

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Hemiplegic Gait Pattern and FALL

• In HK, there are around **21,000 episodes of stroke** every year
• Altered body mechanics and balance causing higher risk of fall after stroke
  • 40% of chronic stroke people had fall history
  • 1.9x risk of single fall
  • 3.4x risk of recurrent fall

(Belgen et al, 2006; Jørgensen et al, 2002; Sze et al, 2001)

• **Old days**: arms play no obvious role in ambulation

• **New evidences**: arm swing in walk cycle improves gait stability, energy efficiency, & maintenance of dynamic postural equilibrium

• **Conventionally**: arm slings are used for the management of shoulder subluxation in stroke patients

(Ada et al, 2005; Foongchomcheay et al, 2005)

• **Recent evidences**: suggests that arm sling may also have positive influences on balance control and gait performance when the paretic arm was supported during walking ↑ gait efficiency and ↑ balance performance


However, there is a lack of research done on comparing the effects of different types of arm slings on gait performance and balance control in stroke survivors
Objectives

To investigate the effects of different types of arm slings, with straight or bent elbow, vs. not using arm sling on:

1) **Balance control** in patients presented with hemiparesis after stroke

2) **Gait parameters** including velocity, step length, stride length, cadence, percentage of duration of single limb support in gait cycle, and;
   - A randomized, crossover, repeated measures design
   - Stroke patients with hemiparesis that affects the walking performance
   - 30 subjects underwent 3 testing conditions. The order of testing conditions was randomized and divided into 6 different testing sequences

- Written consent: ✓
- Ethics approval: ✓ (KC/KE-16-0171/ER-2)
Results (1): Balance Control

Berg Balance Scale (BBS)

- No arm sling: 42.7
- Straight arm sling: 44.5
- Elbow bent arm sling: 44.3

*\( p = 0.029 \)
*\( p = 0.015 \)
\( p = 0.151 \)

Timed Up and Go Test (TUG) (sec)

- No arm sling: 29.6
- Straight arm sling: 27.3
- Elbow bent arm sling: 26.7

*\( p = 0.004 \)
*\( p = 0.001 \)
\( p = 0.198 \)

BBS score was **sig. higher and close to/touching the cutoff score (45 for risk of fall)** under the testing conditions of using arm slings, either straight arm or elbow bent type, as compared with no arm sling.

TUG was **sig. lower** under the testing conditions of using arm slings, either straight arm or elbow bent type as compared with no arm sling.

However, no sig. difference was found between the two arm slings conditions.
## Results (2): Spatiotemporal Gait Parameters

<table>
<thead>
<tr>
<th>Gait Parameters</th>
<th>No arm sling</th>
<th>Straight arm sling</th>
<th>Elbow bent arm sling</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step length (cm)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>affected side</td>
<td>40.3±13.1</td>
<td>42.1±12.0</td>
<td>42.9±12.9</td>
<td>0.820</td>
</tr>
<tr>
<td>unaffected side</td>
<td>32.7±16.34</td>
<td>36.1±21.2</td>
<td>37.1±22.1</td>
<td>0.284</td>
</tr>
<tr>
<td>symmetry</td>
<td>1.23±0.30</td>
<td>1.20±0.28</td>
<td>1.17±0.25</td>
<td>0.548</td>
</tr>
<tr>
<td><strong>Stride length (cm)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>affected side</td>
<td>75.2±25.9</td>
<td>75.4±27.3</td>
<td>77.9±28.2</td>
<td>0.336</td>
</tr>
<tr>
<td>unaffected side</td>
<td>75.1±25.8</td>
<td>75.7±27.4</td>
<td>77.8±28.4</td>
<td>0.409</td>
</tr>
<tr>
<td><strong>Duration of single limb support in % of gait cycle (% gait cycle)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>affected side</td>
<td>25.5±7.0</td>
<td>24.5±8.0</td>
<td>25.3±7.7</td>
<td>0.390</td>
</tr>
<tr>
<td>unaffected side</td>
<td>32.4±7.4</td>
<td>32.7±7.7</td>
<td>32.4±7.4</td>
<td>0.855</td>
</tr>
<tr>
<td><strong>Cadence (per minutes)</strong></td>
<td>-</td>
<td>75.7±18.4</td>
<td>76.6±20.1</td>
<td>0.053</td>
</tr>
<tr>
<td></td>
<td></td>
<td>78.5±20.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Velocity (cm/s)</strong></td>
<td>-</td>
<td>49.1±26.4</td>
<td>50.3±28.4</td>
<td>0.058</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>53.7±29.4</td>
<td></td>
</tr>
</tbody>
</table>

Greater trend of improvement in step length, walking speed, cadence and gait symmetry when using arm slings as compared with no arm sling. **No statistically sig. differences** in gait parameters was found between the 3 testing conditions.
Discussion & Conclusion

• Our study demonstrated that the application of arm slings
  1. Improves balance performance
  2. Improves step & stride length and gait symmetry
  3. Improves walking speed

• Echo previous studies, arm slings can improve balance & gait by:
  • Enhancing postural awareness of paretic arm and trunk
  • Inhibiting the abnormal patterns of arm-trunk and CG interactions
  • Improving postural stability during walking (Acar and Karatas, 2010; Yavuzer and Ergin, 2002)

• Restoration of normal movements in gait patterns, ↑ walking speed, and ↑ weight bearing on the hemiparetic leg are the most important rehab. goals of gait training in stroke survivors

• Arm slings application → Optimize baseline capacity of chronic stroke patients for further patients’ specific balance training and gait rehabilitation, and reduce the fall risk