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Functional walking capacity of subjects with paralyzed knee extensors while walking with an SCO in locked vs unlocked mode

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**Products**

**E-MAG Active**

**Major Findings**

With E-MAG Active in unlocked mode (vs locked mode):

- Significantly increased walking speed (0.06 m/s; p < 0.05)
- Significantly increased walking distance in the 6-minute walk test (+32.5 ± 29.5 m)
- Significantly reduced hip hiking
- High patient satisfaction, evaluated with the QUEST (Quebec user evaluation of satisfaction with assistive technology)
  - Device subscale score: 4.4 ± 0.3
  - Service subscale score: 4.8 ± 0.3
  - Total QUEST score: 4.6 ± 0.3

**Mean knee flexion angle of 57° at about 70% of the gait cycle**

During walking with E-Mag Active in unlocked mode (blue curve) there is a mean knee flexion angle of 57° at about 70% of the gait cycle, compared to full extension of the knee in the locked knee condition (brown curve).
Population

Subjects: 8 (5 male, 3 female)
Mean age: 46.9 ± 19.0 years
Mean body mass: 80.0 ± 11.5 kg
Use of E-MAG Active: since 3.3 ± 1.6 years
Etiologies: Incomplete spinal cord injury (4 patients), Poliomyelitis (3 patients), Myopathy (1 patient)

Study Design

Randomized 2x2 crossover design with intra-individual control:

- invitation to participate
- enrollment eligibility, informed consent
- 1 day in gait analysis laboratory
  - QUEST satisfaction questionnaire with E-MAG Active
  - randomized order of testing
  - E-MAG Active locked 6 MWT, gait analysis
  - rest of 2 hours
  - E-MAG Active unlocked 6 MWT, gait analysis
  - rest of 2 hours
  - E-MAG Active unlocked 6 MWT, gait analysis

Intervention: to walk with E-MAG Active in locked and unlocked mode.

Results

<table>
<thead>
<tr>
<th>Functions and Activities</th>
<th>Outcomes</th>
<th>Results for E-MAG Active in unlocked mode (vs locked mode)</th>
<th>sig.*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biomechanics – Static measures</td>
<td>Walking speed</td>
<td>The walking speed was significantly faster with E-MAG Active in unlocked mode</td>
<td>+++</td>
</tr>
<tr>
<td>Biomechanics – Gait analysis</td>
<td>E-MAG Active locked</td>
<td>E-MAG Active unlocked</td>
<td></td>
</tr>
<tr>
<td></td>
<td>walking speed [m/s]</td>
<td>0.88</td>
<td>0.94</td>
</tr>
<tr>
<td>Gait symmetry</td>
<td>Gait symmetry was marginally improved with E-MAG Active in unlocked mode</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>E-MAG Active locked</td>
<td>E-MAG Active unlocked</td>
<td></td>
</tr>
<tr>
<td></td>
<td>difference in stride length [m]</td>
<td>0.05</td>
<td>0.3</td>
</tr>
<tr>
<td></td>
<td>difference in stance phase length between orthotic and contralateral side [%GC]</td>
<td>7.3</td>
<td>6.5</td>
</tr>
</tbody>
</table>
## Category | Outcomes | Results for E-MAG Active in unlocked mode (vs locked mode) | sig.*
--- | --- | --- | ---
### Knee flexion angle
During walking in the unlocked mode, there was a mean knee flexion angle of $57^\circ \pm 15^\circ$ at about 70% of the gait cycle compared to full extension of the knee during walking in the locked condition. Every subject showed an increased knee flexion angle during swing in the unlocked mode within a range between $31^\circ$ and $80^\circ$.

### Compensatory movements
Compensatory movements were reduced with E-MAG Active in the unlocked mode.

- Hip hiking was reduced in 6 out of 8 subjects based on the angle of pelvis tilt (obliquity) in the coronal plane.
- Vaulting was reduced in 2 out of 3 subjects based on the sagittal angle and moment of the ankle.

### Functional tests
#### Functional walking Capacity
**“6-minute walk test”**

In the locked mode, subjects walked a shorter distance in the 6MWT than in the unlocked condition. The difference in the distance walked of $32.5 \pm 29.5$ m was statistically significant ($p = 0.04$).

<table>
<thead>
<tr>
<th></th>
<th>E-MAG Active locked</th>
<th>E-MAG Active unlocked</th>
</tr>
</thead>
<tbody>
<tr>
<td>distance [m]</td>
<td>284.4 ± 53.0</td>
<td>316.9 ± 59.6</td>
</tr>
</tbody>
</table>

### Satisfaction
**QUEST score**

QUEST scores showed a high overall satisfaction with the E-MAG Active in unlocked mode.

<table>
<thead>
<tr>
<th></th>
<th>rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>device subscale score</td>
<td>4.4 ± 0.3</td>
</tr>
<tr>
<td>service subscale score</td>
<td>4.8 ± 0.3</td>
</tr>
<tr>
<td>Total QUEST score</td>
<td>4.6 ± 0.3</td>
</tr>
</tbody>
</table>

“Quebec user evaluation of satisfaction with assistive technology, Version 2.0” (QUEST 5-point rating scale: 1 = “not satisfied at all”; 2 = “not very satisfied”; 3 = “more or less satisfied”; 4 = “quiet satisfied”; 5 = “very satisfied”)

* no difference (0), positive trend (+), negative trend (−), significant (++/−−), not applicable (n.a.)

### Author’s Conclusion
“Compared to the unlocked condition, the locked mode imposed a clinically meaningful restriction to the functional walking capacity on the subjects. Therefore, fitting of an SCO [stance control orthosis, E-MAG Active] may be considered beneficial in individuals dependent on a KAFO [knee-ankle-foot-orthosis] to improve their functional walking capacity.” (Schröder et al. 2017)
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