Altered muscle activity in patients with ACL tear compared to healthy controls during stair descent

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**Introduction and Aim**

Anterior cruciate ligament (ACL) tears are frequent in active people [1] and induce altered kinematics and kinetics [2]. These changes are referred to neuromuscular adaptations due to altered neuromuscular alterations is sparse [3]. Consequently, the aim of this cross-sectional study was to investigate neuromuscular activity in patients suffering from acute ACL tears in comparison to healthy, matched controls during stair descent.

**Methods**

- Quadriceps (vastus medialis VM & lateralis VL) and hamstrings (biceps femoris BF & semitendinosus ST) activity was recorded using surface electromyography (sEMG) in 9 acute ACL-deficient participants (ACL-D), with an ACL rupture 1-3 weeks prior to test, and 9 ACL-intact (ACL-I) matched controls (Table 1).

**Table 1: Characteristics of participants**

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>ACL-I (N=9)</th>
<th>ACL-D (N=9)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age [years]</td>
<td>29.88 ± 5.1</td>
<td>30.4 ± 7.8</td>
</tr>
<tr>
<td>Height [cm]</td>
<td>174.1 ± 8.2</td>
<td>176.3 ± 6.8</td>
</tr>
<tr>
<td>Body weight [kg]</td>
<td>73.8 ± 7.8</td>
<td>70.1 ± 9.4</td>
</tr>
<tr>
<td>Female [%]</td>
<td>44.4</td>
<td>44.4</td>
</tr>
<tr>
<td>KOOS* (max. 168 points)</td>
<td>166.1 ± 1.1</td>
<td>112.3 ± 28.2</td>
</tr>
<tr>
<td>VAS** pain (pre-post measurements)</td>
<td>0.11, 0.27 resp.</td>
<td>0.76, 1.36 resp.</td>
</tr>
<tr>
<td>Tegner Score*** (max. 10 points)</td>
<td>5.1 ± 1.1</td>
<td>5.5 ± 1.6</td>
</tr>
</tbody>
</table>

Legend: *Knee Injury and Osteoarthritis Outcome Score [4]; **Visual analogue scale: indicates values on a 0-10 cm scale; ***Tegner activity score (pre-injury) range from 0 (sick leave or disability pension) to 10 (competitive sport on professional level) [5]

- For submaximal sEMG normalization, a 6-minute warm-up on a treadmill (5 km/h) with sEMG recordings in the last minute was used.
- Afterwards, the participants descended a 6-step, wooden stair 20 times at self-selected speed. Data from force plates on step 3 and 4 were used to define pre-activation (PRE), weight acceptance (WA) and push-off (PO) phase during stair descent (Fig. 1).
- Root mean squares for each muscle and leg per gait phase were calculated and normalized. Inter-group comparisons were made between the deficient leg of ACL-D & the matched leg of ACL-I. Intra-group comparisons concerned ACL-D (deficient and contralateral leg). The level of significance was set at p≤0.05.

**Results**

- The quadriceps of ACL-D showed an increased activity during PRE (11%; p>0.05) and a reduction during WA and PO (-40%, -31% respectively; p<0.05). (Figure 2)
- The hamstrings showed less activity during PRE (-35%, p<0.05) and PO (-7%, p>0.05), but more during WA (42%, p<0.05) for ACL-D (injured leg) compared to ACL-I (matched leg). (Figure 2)

**Recommendations and Practical implications**

During stair descent, altered muscle activity was detected for ACL-D compared to ACL-I. Intra-subject comparisons of ACL-D showed mainly less activity in PRE and PO, but an increase in WA for the injured side, indicating bilateral consequences. These neuromuscular alterations point at changes in the pre-programmed motor activity.

Therefore, rehabilitation following ACL tears should focus on sensorimotor control of both legs, not only of the injured side.

**Acknowledgment**

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**References**


**Key words**

Neuromuscular activity, anterior cruciate ligament tear, surface electromyography, stair descent, sensorimotor control

**Ethics**

This study was approved by the Ethics Committee of the Canton of Bern (KEK Number 213/15), Switzerland.

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**Figures**

- Figure 2: Mean muscular activity and standard deviation during pre-activation (PRE), weight acceptance (WA) and push-off (PO) phase
- Figure 1: Stair descent with sEMG, lateral view