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Complex muscular adaptation to perturbations after induction of experimental low back pain in healthy participants

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Introduction
• Movement and stability of the spine during standing activities is related to complex processes.
• Stability is considered affected in low back pain (LBP) but the consequence of pain on muscle activation patterns (MAP) remains relatively unknown.
• Spinal control and stability can be explored by analysis of MAP after surface perturbations.

Aim
The aim was to analyse MAP in the trunk muscles during multidirectional surface perturbations to investigate the effect of experimental LBP combined with fatigue and muscle soreness.

Methods
• 19 healthy participants were examined on 3 subsequent days, before and after injections of hypertonic saline (1 ml, 5.8%) into m. longissimus.
• The participants were standing on a moveable platform and 20 multi-directional perturbations were conducted randomly (Table 1).

<table>
<thead>
<tr>
<th>Perturbation</th>
<th>ROM ° or mm</th>
<th>VELOCITY m/s or °/s</th>
<th>Acceleration</th>
<th>Onset quality</th>
<th>Max, acc.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anterior tilt</td>
<td>5 1</td>
<td>30°/s</td>
<td>Smooth</td>
<td>200°/s</td>
<td></td>
</tr>
<tr>
<td>Posterior tilt</td>
<td>0 1</td>
<td>30°/s</td>
<td>Smooth</td>
<td>200°/s</td>
<td></td>
</tr>
<tr>
<td>Left tilt</td>
<td>10 1</td>
<td>40°/s</td>
<td>Smooth</td>
<td>140°/s</td>
<td></td>
</tr>
<tr>
<td>Right tilt</td>
<td>10 1</td>
<td>40°/s</td>
<td>Smooth</td>
<td>140°/s</td>
<td></td>
</tr>
<tr>
<td>Left displacement</td>
<td>100 mm</td>
<td>0.4 m/s</td>
<td>Smooth</td>
<td>140 m/s</td>
<td></td>
</tr>
<tr>
<td>Right displacement</td>
<td>100 mm</td>
<td>0.4 m/s</td>
<td>Smooth</td>
<td>140 m/s</td>
<td></td>
</tr>
</tbody>
</table>

Table 1: Perturbation characteristics. The participants were standing on a moveable platform and randomly perturbed in the sagittal and frontal plane.

Methods (continued)
• Bilateral (BP) respectively unilateral (UP) LBP was induced in 2 subsequent trials on each day, and the intensity was scored on a visual analogue scale (VAS).
• Day 2 included injections post-exercise low back extensor muscle fatigue (EMF) and day 3 during delayed onset back muscle soreness (DOMS).
• Bilateral electromyography (EMG) was recorded from abdominal (m. obliquus internus and externus and m. rectus abdominals) and back (m. iliocostalis, m. longissimus and m. multifidus) muscles.
• The root-mean-square (RMS) EMG was extracted. Changes (ΔRMS) and absolute changes (ΔA-RMS) in RMS from baseline of the day were calculated and averaged among back and abdominal muscles.
• Statistical comparison between days were conducted with Friedman test and post-hoc comparison of day and conditions with Wilcoxon rank sign tests.

Results (continued)
• VAS scores were higher during BP in EMF (P<0.01) and DOMS compared with day 1 (P<0.01).
• Pain were present and the intensity > VAS 1 during all 20 perturbations all days after injections (Fig. 1).
• ΔRMS back increased in BP pain day 1 (P<0.02) and decreased in UP day 1-3 (P<0.01) (Fig. 2).

Results
• Abdominal ΔRMS decreased in BP day 2 (P<0.01) and in UP all 3 days (P<0.01) and increased in BP day 3 (P<0.01) (Fig. 2).
• ΔA-RMS were significantly different between BP and UP all 3 days (P<0.01); in day 1 BP were higher, in day 2 and 3 ΔA-RMS conditions and muscles varied (Fig. 3).

Conclusion
• UP resulted in decreased trunk muscle activity in all conditions, while the effect of BP differed depending on EMF and fatigue combined with pain. BP resulted in higher pain intensity and variability in the muscle activity and more complex trunk muscle interaction.
• Pain may challenge spinal stability during motor tasks in acute pain conditions and the reorganization of the muscle activity seems to be even further affected after bilateral pain during fatigue and muscle soreness. These results may be useful in screening of the neuromuscular control and stability of the back during pain conditions.

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