THE EFFECT OF PAIN ON SPINAL KINEMATICS

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SUMMARY
Low back pain (LBP) sufferers display altered kinematics. The role of pain in producing such changes is not known. This study aims to investigate the effects of pain on lumbar kinematics. Twenty chronic low back pain sufferers with movement evoked pain completed some painful movements before and after oral pain relief whilst lumbar kinematics were recorded using two motion sensors. Results show some statistically significant changes in side bending kinematics however all changes are small and have questionable clinical significance. This suggests movement patterns displayed by low back pain sufferers may not be influenced by pain.

INTRODUCTION
It is well known that LBP sufferers display kinematics that differ from matched controls [1]. It is unclear if these alterations represent functional adaptation minimising the provocation of pain or are indicative of an impairment or sub-optimal function. Furthermore the cause of such differences are not known.

Pain has been cited as a possible causative mechanism behind these kinematic changes [2]; however reviews have failed to clearly describe such a relationship [3]. Previous studies have investigated the effect of pain relief on lumbar kinematics but did not isolate pain relief as the intervention or study its effect on functional movement [4,5]. Therefore it remains unclear if pain is the key variable driving kinematic change.

This study aims to investigate the effects of pain on lumbar spinal kinematics.

METHODS
Twenty chronic LBP sufferers were recruited from general practitioner referrals to a physiotherapy clinic. Inclusion criteria were movement evoked LBP present on at least 3 days per week, every week for at least 12 months, with pain confined to between the lower ribs and inferior gluteal folds. Exclusion criteria included leg pain, a history of cancer, spinal fracture or surgery.

Two motion sensors (3DM-GX3-25, Microstrain, USA) were attached to the skin overlying the S1 and L1 spinous process with wires attached to the body to prevent them erroneously moving the sensor. The sensors combine tri-axial accelerometers, tri-axial gyroscopes and tri-axial magnetometers and had dimensions of 44x25x11mm. The sensors were attached to a purpose built datalogger (H-scientific, UK) running at 100Hz and the relative orientations between the two sensors were calculated from the direction cosine matrices.

Participants performed three trials of flexion, extension, left and right side bending, left and right rotation as well as lifting a 3.5kg box. The moment of change in their baseline pain was registered by a pain switch pressed by the participant during the movement. The degree of movement evoked pain was measured using a visual analogue scale. Once completed the participants self-administered their usual oral analgesia and were given a 45-60 minute break before the procedure was repeated. There was no restriction on the type of analgesia. All sensors remained attached throughout the experiment.

All processing was completed using MatLab (MathWorks 2008b). Movement-time curves for each painful movement were calculated and differentiated to yield velocity and acceleration curves. Mean peak displacement, velocity and accelerations were calculated for each movement as well as observing the kinematics at the moment of evoked pain. These variables were compared before and after the analgesia using a paired t-test. Movement-time curves were time-normalised and coefficient of multiple correlation (CMC) and root mean square errors (RMSE) were calculated, for the primary movement plane, to determine similarity in movement behavior.

RESULTS AND DISCUSSION
The mean (sd) duration of back pain was 9.4 (7.4) years; VAS for the week preceding data collection was 46 (22) mm and Tampa Scale of Kinesiophobia (TSK) was 39 (7).

Mean change in VAS and lumbar kinematics can be seen in Table 1. T-tests revealed that pain-relief resulted in a statistically significant increase in flexion acceleration (positive acceleration) during flexion; flexion velocity (positive velocity) during extension and all displacement, velocities and accelerations relating to side bending movements. Pain was evoked within a few degrees of peak displacement and was often associated with deceleration as the person nears the peak range of the movement or the transition in movement direction (see fig 1).

This study focused on determining the effect of pain-relief on lumbar kinematics in chronic LBP sufferers during functional movements. The results show that the reduction of pain causes a statistically significant increase in side bending kinematics and temporal kinematics associated with flexion and extension (table 1).
Despite these statistically significant findings the clinical significance of such small changes in kinematic variables should be questioned. Therefore when taken in a clinical context it appears that pain-relief has little effect in modifying lumbar kinematics. This finding suggests that if clinicians target pain relief as an intervention to alter lumbar kinematics they should expect little effect. Furthermore it implies that pain may not be the key mechanism driving the ongoing alteration in lumbar kinematics.

CONCLUSIONS
Lumbar displacement, velocity and acceleration are not altered by a clinically significant amount by relieving pain in LBP sufferers. This finding suggests pain is not important in maintaining movement patterns in chronic low back pain sufferers.

ACKNOWLEDGEMENTS
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REFERENCES

Table 1: Mean change in variables associated with pain-relief for each movement. Positive Velocity/Acceleration relates to flexion, left side bending and left rotation. Negative velocity/acceleration relates to extension, right side bending and right rotation. A positive result means an increase in the particular variable; negative result means a decrease.

<table>
<thead>
<tr>
<th></th>
<th>Flexion</th>
<th>Extension</th>
<th>Left Side-Bending</th>
<th>Right Side-Bending</th>
<th>Left Rotation</th>
<th>Right Rotation</th>
<th>Lifting</th>
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<tbody>
<tr>
<td>VAS (mm) pre-analgesia</td>
<td>39</td>
<td>41</td>
<td>31</td>
<td>43</td>
<td>38</td>
<td>39</td>
<td>52</td>
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<tr>
<td>VAS (mm)</td>
<td>-37</td>
<td>-22</td>
<td>-28</td>
<td>-26</td>
<td>-25</td>
<td>-35</td>
<td>-24</td>
</tr>
<tr>
<td>Displacement/°s⁻¹</td>
<td>0.1</td>
<td>1.0</td>
<td>1.1 *</td>
<td>0.9</td>
<td>-0.1</td>
<td>-0.7</td>
<td>0.4</td>
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<tr>
<td>Positive Velocity/°s⁻¹</td>
<td>2.6</td>
<td>1.8</td>
<td>1.4</td>
<td>3.0 *</td>
<td>0.5</td>
<td>-0.5</td>
<td>-0.2</td>
</tr>
<tr>
<td>Negative Velocity/°s⁻¹</td>
<td>1.2</td>
<td>2.1</td>
<td>3.6 *</td>
<td>1.6</td>
<td>-0.4</td>
<td>-1.5</td>
<td>0.6</td>
</tr>
<tr>
<td>Positive Acceleration/°s⁻²</td>
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<td>4.8</td>
<td>5.5 *</td>
<td>8.0 *</td>
<td>1.4</td>
<td>-4.3</td>
<td>3.2</td>
</tr>
<tr>
<td>Negative Acceleration/°s⁻²</td>
<td>0.5</td>
<td>5.1 *</td>
<td>8.9 *</td>
<td>4.8 *</td>
<td>0.4</td>
<td>-2.8</td>
<td>-3.3</td>
</tr>
</tbody>
</table>

* p = <0.05