Does perceived 'threat' of pain during selected functional tasks influence regional lumbar kinematics of people with chronic low back pain?

De Vecchis, M.[1]; Van Deursen, R.[1,2,3]; Sheeran, L.[1,2]

[1]Cardiff University, School of Healthcare Sciences, Cardiff, U.K.
[2]Cardiff University, Arthritis Research UK Biomechanics & Bioengineering Centre, Cardiff, U.K.
[3]Cardiff University, Research Centre for Clinical Kinaesiology, School of Healthcare Sciences, Cardiff, U.K.

Introduction
Altered kinematics of the lumbar spine are believed to be one contributing factor perpetuating chronic low back pain (CLBP). Previous research investigated differences in lumbar kinematics during different function tasks with inconclusive evidence[1,2]. This could be due to variation in methods as well as the tasks selected. Regarding the latter, limited attention is given to whether people CLBP move differently during daily function tasks they do or don't associate with pain.

Purpose
To investigate differences in regional upper lumbar (ULx), lower lumbar (LLx) and total lumbar (TLx) kinematics during forward bending (FB) (reported pain provoking) and sit-to-stand (STS) (reported not pain provoking) in people with CLBP compared to pain free controls.

Materials and methods
A between-subjects, observational cross-sectional study design was employed. A purposive sample of people with CLBP (n=10, 5 males, 5 females) was recruited from physiotherapy waiting lists in Cardiff and Vale University Health Board and from Cardiff University's staff. Patients had not started the treatment yet when they were recruited. Healthy subjects were recruited from Cardiff University (n=10, 5 males, 5 females). Al participants gave full written Informed Consent prior to data collection. The study obtained ethical approval from Wales Research Ethics Committee 3 (10/MRE09/28). Subjects with LBP had current symptoms of central CLBP. Healthy subjects did not have history of LBP or previous spinal disorders, did not have other diseases and were matched to subject with CLBP by age, sex, weight, height and Body Mass Index (BMI). Potential participants were excluded if they had referred pain to lower limbs or previous spinal fracture, surgery or malignancy. Subjects were not included if they presented red flags indicating serious illnesses. Pregnant or breastfeeding women, people with neurological or vestibular disorders those unable to perform the tasks unaided, subjects unable to understand written or spoken English were excluded.
Kinematic data were collected with Vicon motion analysis system (Vicon 512, Vicon Motion Systems Ltd, Oxford, UK), using ten optoelectronic cameras sampling at 120 Hz. Thirteen retro-reflective markers were placed on spinous process of 7th cervical vertebra, 10th and 12th thoracic vertebrae; two markers on the sides of the spinous processes of 2nd lumbar and 4th lumbar vertebrae; Posterior superior and anterior superior iliac spines (bilaterally) and the upper edge of the iliac crest, aligned vertically with the greater trochanter (bilaterally). The marker set utilised was custom-designed (Cardiff University, UK).
Each participant attended a single session lasting approximately 1.30 hours. Participants underwent a comprehensive subjective and objective physiotherapy assessment, carried out by an experienced physiotherapist (LS). Then, participants performed 10 repetitions of FB and STS in randomised order. No instruction on how to perform the tasks was given. Pain score was recorded on completion of each task with 10-point Visual Analogue Scale (VAS). Participants had minimum rest between the two tasks. Data were processed with Vicon Nexus (version 2.6.1; Vicon Motion Systems Ltd, Oxford, UK). Gaps in trajectories of up to 10 samples were joined with linear interpolation filtered with a quintic spline filter (Woltring; mean square error of 15). Custom analysis scripts were created in Matlab software (version 2015a; The MathWorks Inc., Natick, MA, USA) to calculate kinematic data. A relative coordinate system was utilised for performing analyses, with pelvic girdle (markers on ASISs and PSISs) as a reference.
Mean sagittal range of motion (ROM), peak flexion angle and angular velocity were analysed in ULx, LLx and TLx, in each group. Mean time to complete each task was also explored. Independent t-test and Mann-Whitney U test were used to assess the between group differences for each task ($\alpha > 0.05$).

Results

There were no significant differences in demographic and anthropometric characteristics between groups (Table 1). CLBP sufferers had a duration of symptoms between 2 years and 2 months and 20 years (mean 9.78 ± 8.16 SD). There was no difference in the CLBP group mean VAS score performing FB (3.13 ±1.19) and STS (3.21±1.20). The CLBP group took significantly longer to complete the FB (p=.043), and in this task, they had significantly greater ROM in the ULx (p=.042), similar LLx (p=.410) and TLx (p=.444) compared to the pain free controls (Table 2). There was no between group difference detected in the velocity or any other lumbar kinematic measures when performing STS (Table 3).

Table 1. Demographic and anthropometric data of participants

	Group means ± SD (range)		Mean difference	Level of significance
	CLBP subjects (n=10)	**Healthy subjects (n=10)**		
Age (years)	43.5 ± 10.2 (31-62)	40.50 ± 12.3 (24-67)	3.00	0.560
Height (m)	1.71 ± 0.09 (1.57-1.86)	1.67 ± 0.09 (1.53-1.80)	0.04	0.375
Weight (Kg)	75.40 ± 11.95 (56-94)	72.10 ± 15.17 (50-91)	3.30	0.596
BMI (Kg/m^2)	25.82 ± 2.99 (21.6-32.9)	25.89 ± 4.82 (19.0-34.4)	0.07	0.969

Key: SD = Standard Deviation; CLBP = Chronic Low Back Pain; n = number; m = meters; Kg = Kilograms; BMI = Body Mass Index; Kg/m^2 = mass in Kilograms, divided by height in squared meters**.**

Table 2. TLx, ULx and LLx kinematic outcomes during bending forward in both groups

	FB	Group means ± SD		Mean difference	Level of significance
Lumbar regions		**CLBP subjects (n = 10)**	**Healthy subjects (n = 10)**		
TLx	**ROM (°)**	31.2 ± 11.7	27.5 ± 9.2	3.9	0.444
	Angular velocity (°/s)	13.5 ± 7.8	14.9 ± 6.3	1.4	0.660
	Peak flexion angle (°)	9.2 ± 7.2	11.9 ± 7.2	2.7	0.415
ULx	**ROM (°)**	9.8 ± 8.4	1.8 ± 8.0	8.0	0.042*
	Angular velocity (°/s)	4.7 ± 3.9	3.7 ± 2.3	1.0	0.853
	Peak flexion angle (°)	5.4 ± 5.4	5.6 ± 3.2	0.2	0.904
LLx	**ROM (°)**	21.3 ± 11.3	25.7 ± 11.8	4.4	0.410
	Angular velocity (°/s)	9.2 ± 6.3	13.7 ± 6.6	4.5	0.140
	Peak flexion angle (°)	3.8 ± 4.4	6.3 ± 4.8	2.4	0.257

Key: SD = Standard Deviation; CLBP = Chronic Low Back Pain; n = number; TLx = Total Lumbar Spine; ULx = Upper Lumbar Spine; LLx = Lower Lumbar Spine; ROM = Range Of Motion; ° = degrees; °/s = degrees per second; in peak flexion angle, positive value: flexion; * = denotes significant difference**.**

Table 3. TLx, ULx and LLx kinematic outcomes during sit to stand in both groups

	STS	Group means ± SD		Mean difference	Level of significance
Lumbar regions		**NSCLBP subjects (n = 10)**	**Healthy subjects (n = 10)**		
TLx	**ROM (°)**	16.7 ± 9.9	18.1 ± 8.0	1.4	0.737
	Angular velocity (°/s)	6.3 ± 3.8	6.4 ± 2.6	0.1	0.941
	Peak flexion angle (°)	-5.3 ± 9.9	2.4 ± 10.4	7.7	0.107
ULx	**ROM (°)**	5.6 ± 5.9	1.1 ± 6.36	4.5	0.121
	Angular velocity (°/s)	2.5 ± 1.5	2.1 ± 1.3	0.4	0.483
	Peak flexion angle (°)	1.1 ± 8.1	4.9 ± 4.7	3.8	0.217
LLx	**ROM (°)**	11.1 ± 7.4	17.0 ± 9.8	5.9	0.147
	Angular velocity (°/s)	4.3 ± 2.9	5.6 ± 2.8	1.5	0.260
	Peak flexion angle (°)	-6.4 ± 5.2	-2.5 ± 7.9	3.9	0.203

Key: SD = Standard Deviation; NSCLBP = Non-Specific Chronic Low Back Pain; n = number; TLx = Total Lumbar Spine; ULx = Upper Lumbar Spine; LLx = Lower Lumbar Spine; ROM = Range Of Motion; ° = degrees;°/s = degrees per second; in peak flexion angle, positive value: flexion, negative value: extension.

Conclusion

The preliminary findings of this study indicate that compared to pain free controls, the CLBP group demonstrated altered lumbar kinematics during a task perceived as pain provoking with no kinematic alterations during a task they perceived as not pain provoking. This is with the pain scores reported when performing each task being similar. Further analysis with larger sample and number movement tasks is currently being conducted to investigate the role of pain perception in spinal movement behaviour. This study was funded by Versus Arthritis. The authors declare no conflicts of interest.

Relevance

People with CLBP may demonstrate altered lumbar kinematics in some but not all function tasks. The perceived ‘threat’ of pain during the task, rather the pain itself, may potentially be important although further research is needed to determine any potential relevance when prescribing exercises for CLBP sufferers.

Keywords

Chronic low back pain, regional lumbar kinematics, sit to stand, bending forward, pain threat.

References

1 Laird, R. A. et al., Comparing lumbo-pelvic kinematics in people with and without back pain: a systematic review and meta-analysis. *BMC Musculoskeletal Disorders* 2014; *15*(1); 229.
2 Knox et al, 2018, Spine J, 18(10):1934-1949