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Altered Patterns of Superficial Trunk Muscle Activation During Sitting in Nonspecific Chronic Low Back Pain Patients

Importance of Subclassification

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Study Design. A cross-sectional comparative study between healthy controls and two subgroups of nonspecific chronic low back pain (LBP) patients.

Objectives. To determine differences in trunk muscle activation during usual unsupported sitting.

Summary of Background Data. Patients with LBP commonly report exacerbation of pain on sitting. Little evidence exists to confirm that subgroups of patients with nonspecific chronic LBP patients use different motor patterns in sitting than pain-free controls.

Methods. A total of 34 pain-free and 33 nonspecific chronic LBP subjects were recruited. Two blinded clinicians classified nonspecific chronic LBP patients into two subgroups (active extension pattern and flexion pattern). Surface electromyography (sEMG) was recorded from five trunk muscles during subjects' unsupported "usual" and "slumped" sitting.

Results. No differences in trunk muscle activity were observed between healthy controls and nonspecific chronic LBP groups for usual sitting. When the classification system was applied, differences were identified. Compared with no-LBP controls, the active extension pattern group presented with higher levels of cocontraction of superficial fibers of lumbar multifidus (12%), iliocostalis lumborum pars thoracis (36%) and transverse fibers of internal oblique (43%). while the flexion pattern group showed a trend toward lower activation patterns (lumbar multifidus, −7%; iliocostalis lumborum pars thoracis, −6%, and transverse fibers of internal oblique, −5%). The flexion relaxation ratio of the back muscles was lower for nonspecific chronic LBP (superficial lumbar multifidus: $t = 4.5$; $P < 0.001$ and iliocostalis lumborum pars thoracis: $t = 2.7$; $P < 0.001$), suggesting a lack of flexion relaxation for the nonspecific chronic LBP.

Conclusion. Subclassifying nonspecific chronic LBP patients revealed clear differences in sEMG activity during sitting between pain-free subjects and subgroups of nonspecific chronic LBP patients.

Key words: sitting, low back pain, subclassification, surface electromyography. **Spine 2006;31:2017–2023**

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The increasing cost and disability relating to chronic low back pain (CLBP) is well documented.[1] Despite the large number of pathologic conditions that give rise to CLBP, 85% of this population is classified as having "nonspecific" CLBP as no radiologic abnormality is detected.[2]

Previous research has examined the function of the trunk muscles by means of surface electromyography (sEMG) amplitude in both controls and low back pain (LBP) subjects.[3,4] There is considerable evidence suggesting dysfunction of the neuromuscular system in the presence of nonspecific CLBP, although the nature of the dysfunction is highly variable. During static tasks, such as standing, inconsistent levels of trunk muscle activation in CLBP populations have been found. Specifically, CLBP subjects have been reported to have increased,[3,5] decreased,[6,7] and similar[6,8] sEMG amplitudes compared with controls. These contradictory results may reflect the heterogeneity of the nonspecific CLBP group, which is proposed to conceal different subgroups.[9,10]

Sitting is commonly reported to exacerbate and perpetuate LBP.[11–13] The sparse research into muscle activity in sitting and LBP, suggests no difference in the sEMG amplitude of LBP compared with controls, and large variability in raw values.[14] In contrast, based on clinical observation, O'Sullivan[15] described that during sitting nonspecific CLBP patients with a flexion pattern (FP) disorder posture themselves in end-range flexion and have reduced cocontraction of the lumbo-pelvic stabilizing muscles, while patients with an active extension pattern (AEP) disorder hold themselves "actively" into hyperextension.

Despite the known importance for classifying patients with nonspecific CLBP,[9,10] and clinical reports[15] suggesting differences based on subgrouping, no studies have reported trunk muscle activation patterns in sitting for specific subgroups of nonspecific CLBP.

Research evaluating the function of paraspinal muscles during spinal flexion has been more successful in identifying LBP patients from healthy controls. These studies suggest that LBP patients typically lack the flexion relaxation phenomenon, a period of myoelectrical silence of the back muscles when an individual stands in full flexion.[16–19]

Interestingly, despite its demonstrated discriminative validity in standing-flexion, the increase in sedentary lifestyle and the reported link between LBP and sitting, the flexion relaxation phenomenon has not been widely investigated during sitting. The available studies, on flexion relaxation phenomenon of the back muscles in sitting have reported on a no-LBP population only.[20,21]

Therefore, the objectives of the present study were to determine whether a difference exist between the trunk muscle activation patterns of healthy controls and CLBP subjects during usual unsupported sitting, to investigate the flexion relaxation phenomenon in sitting (by comparing usual sitting to slumped sitting) and finally to investigate the importance of classifying the nonspecific CLBP population into homogenous subgroups.

■ Methods

Participants. Sixty-seven volunteers (33 nonspecific CLBP patients and 34 controls) were recruited from the Perth metropolitan area. The Human Research Ethics Committee, Curtin University of Technology approved the study. All subjects provided written informed consent before testing. Control subjects were sampled on convenience and consisted of students, relatives of students and personnel affiliated with the University. They were excluded from the study if they had a history of LBP or leg pain over the previous 2 years and/or had received previous postural education. Nonspecific CLBP patients were recruited from a private orthopedic clinic.

Nonspecific CLBP patients were blindly assessed by two musculoskeletal physiotherapists (W.D. and P.O.), based on a subjective and physical examination.[15] The comprehensive history of the disorder involved: screening for psychosocial "yellow flags" (identification of beliefs, emotions and behaviors that interact with the pain problem)[22] and "red flags" (specific causes of LBP such as cauda equina syndrome or inflammatory disease),[23] reviewing medical imaging, questioning the patient regarding symptom provocation and relief. The full physical examination consisted of a series of active and functional movement tests, articular tests to determine mobility and level of symptom provocation, neurologic examination, and tests for spinal motor control.[15] Both assessments took place in a private orthopedic clinic in the Perth metropolitan area. There was a maximum of 1 week between both examinations and the laboratory testing. Only patients presenting with a clinical presentation of a FP or AEP disorder as determined independently by both clinicians were selected for this study. Previous research has identified that these subgroups can be reliably identified by trained clinicians (physiotherapists and medical physicians).[24] Table 1 presents the strict inclusion/exclusion criteria and a summary of clinical features of the two clinical patterns. Subject's characteristics are shown in Table 2.

Table 1. Inclusion and Exclusion Criteria

Inclusion criteria for nonspecific CLBP with motor control impairment of flexion pattern (FP) or active extension pattern (AEP)
- >3 months nonspecific LBP
- Revised Oswestry score >15%
- Pain localized to the lower lumbar spine (L4–L5 or L5–S1) region
- Absence of "red flags" (specific causes of LBP such as cauda equina syndrome or inflammatory disease)
- Absence of dominant "yellow flags" (identification of beliefs, emotions, and behaviors that interact with the pain problem)
- Clear mechanical basis of disorder
- Associated impairments in the control of the motion segment(s) in the provocative movement direction(s)
- Absence of impaired movement of the symptomatic segment in the painful direction of movement or loading (based on clinical joint motion palpation examination)
- Clinical diagnosis of an FP or AEP disorder, both clinicians (independently) agreed upon the diagnosis

Key clinical features of FP
- Aggravation of symptoms with movements and postures involving flexion of the lower lumbar spine
- Loss of segmental lordosis at symptomatic level, difficulty assuming and/or maintaining neutral lordotic postures with a tendency to flex lower lumbar spine
- Pain relief with spinal extension

Key clinical features of AEP
- Aggravation of symptoms with movements and postures involving extension of the lower lumbar spine
- Excess of segmental lordosis at symptomatic level with posture and movements
- Difficulty assuming and/or maintaining neutral lordotic postures with a tendency to position themselves into hyperextension
- Pain relief with spinal flexion

Exclusion criteria for nonspecific CLBP with motor control impairment of FP or AEP
- Previous spine surgery, pregnant at the time of the study or 6 months postpartum, recently undergone a period of motor control rehabilitation
- Not fulfilling inclusion criteria

Experimental Protocol. Synchronized recordings of the activation (sEMG) of ten superficial trunk muscles were obtained for each subject during two sitting conditions: "usual" and "slumped" sitting. Usual sitting was defined as the sitting posture subjects would usually adopt during unsupported sitting. Slumped sitting was defined as sitting in an attempt to fully relax and slouch the spine. Three trials of five seconds duration each were conducted, with approximately 1-minute rest between each trial.

Each participant sat on a stool (with no back support) with a flat, horizontal surface. The height of the stool was adjusted to ensure that the participants' upper legs were horizontal and the lower legs vertical. The feet were positioned shoulder width apart with arms hanging relaxed next to the thighs. Participants viewed a visual target set 1.5 m in front of the participants, at eye level to standardize the head posture.

Data Collection and Management

sEMG. Ten channels of sEMG data were sampled using two 8-channel Octopus Cable Telemetric systems (Bortec Electronics Inc., Calgary, Canada) at 1,000 Hz, bandwidth was 10 to 500 Hz, common mode rejection ratio was >115 dB at 60 Hz. All raw myoelectric signals were preamplified and amplified with an overall gain of 2000. Data were collected on a computer running LabVIEW V6.1 (National Instruments). Pairs of self-adhesive disposable Ag/AgCl (Red Dot, 3 M Health Care

Table 2. Characteristics of Subjects per Group

	No-LBP Controls (n = 34)	Flexion Pattern (n = 20)	Active Extension Pattern (n = 13)	Group Differences Significant
Gender				*
Males	18 (53%)	16 (80%)	5 (38.5%)	
Females	16 (47%)	4 (20%)	8 (61.5%)	
Age (yr)	32.0 (12.2)	35.7 (11.2)	39.9 (11.3)	*
Weight (kg)	68.4 (11.6)	80.1 (10.6)	72.8 (15.7)	*
Height (m)	1.71 (0.09)	1.8 (0.1)	1.70 (0.1)	
BMI (kg/m^2)	23.3 (2.9)	24.6 (2.5)	24.2 (2.8)	
R-Oswestry (%)	—	36.6 (11.0)	41.2 (14.2)	
Pain duration (yr)	—	4.9 (5.3)	7.4 (5.3)	

BMI = body mass index; LBP = low back pain.
Values are average (%) or average (SD).
*$P < 0.05$.

Products, London, Ontario, Canada) disc surface electrodes with an electrical contact surface of 1 cm^2 were placed parallel to the muscle fibers with a center-to-center spacing of 2.5 cm. Snap leads were used to connect the surface electrodes to the preamplifiers. Skin preparation for sEMG was according to Hermens *et al.*[25]

Pairs of surface electrodes were bilaterally positioned of three abdominal and three back muscles.

Rectus abdominis (RA): 1 cm above the umbilicus and 2 cm lateral to the midline.[26]

External oblique (EO): just below the rib cage and along a line connecting the most inferior point of the costal margin and the contralateral pubic tubercle.[26]

Transverse fibers of internal oblique (TrIO): 1 cm medial to the anterior superior iliac spine (ASIS) and beneath a line joining both ASISs.[26]

Superficial fibers of lumbar multifidus (sLM): at L5 and aligned parallel to the line between the posterior superior iliac spine (PSIS) and the L1–L2 interspinous space.[27]

Iliocostalis lumborum pars thoracis (ICLT): above and below the level of L1 spinous process midway between the midline and the lateral aspect of the body.[28]

Since two telemetric systems were used, two common earth electrodes were placed over the left iliac crest.

Before processing the raw sEMG data, a customized program in conjunction with visual inspection was used to detect and eliminate possible contamination by heartbeat and other artifacts. Raw data were then demeaned, full-wave rectified, and band pass filtered (4 Hz and 400 Hz) using a fourth order zero lag Butterworth filter,[29] and a linear envelope was calculated for each channel.

sEMG measurements were amplitude normalized to two standardized activities designed to elicit a stable submaximal voluntary isometric contraction (sub-MVIC). These normalization procedures have shown to be reliable both within-day and between-day.[30]

Sub-MVIC normalized muscle activation for usual and slumped sitting was averaged across the three trials for each subject. Finally, flexion/relaxation ratio[31] in sitting was calculated by dividing the average sEMG in usual sitting by the average activity in slumped sitting.

Reliability of the Measurements. Reliability of the measurement methods was assessed using an intraclass correlation coefficient [(3,1)] and the standard error of measurement.[32] The intertrial reliability of all sEMG measurements was excellent. Intraclass correlation coefficient values ranged between 0.87 and 0.99. The standard error of measurement ranged from 0.05 to 0.18 (% of sub-MVIC).

Statistical Analysis

All underlying assumptions to use parametric statistics were tested (using Levene's Test for Equality of Error variance) and found valid. To assess for group differences χ^2 was used for nominal data (gender and age) and ANOVA for weight, height and body mass index.

Independent *t* tests were used to compare the differences in sEMG activity between the no-LBP and nonspecific-CLBP (pooled) groups. Further, a one-way ANCOVA with *post hoc* comparisons (Bonferroni) was used to compare the differences between the No-LBP, FP, and AEP groups. Paired *t* tests were performed to compare differences between usual and slumped within each group. SPSS V11.5 (SPSS Chicago, IL) was used to perform all statistical tests and the alpha level was set at 0.05.

Results

Statistical analyses were performed for left and right sides. There were no differences; hence, we provided results from one randomly picked side (left). The mean and standard deviation of the muscle activation (percentage of sub-MVIC) for usual sitting, slumped sitting are presented in Figures 1 and 2 per muscles and per sitting condition for all groups (CLBP pooled/classified). All group comparisons and their statistical differences are listed in Table 3.

No-LBP Versus *Nonspecific CLBP (Pooled)*

Back Muscles. There was no difference in activity of sLM [t = −0.1, P = 0.909] and ICLT [t = −1.3, P = 0.207] between the No-LBP and nonspecific CLBP (pooled) groups in usual sitting. However, there was greater back muscle activity in the nonspecific CLBP patients (pooled) in slumped sitting [sLM: t = −3.4, $P <$ 0.001 and ICLT: t = −2.8, $P <$ 0.006].

Abdominal Muscles. No differences were observed for the abdominal muscles between No-LBP and nonspecific

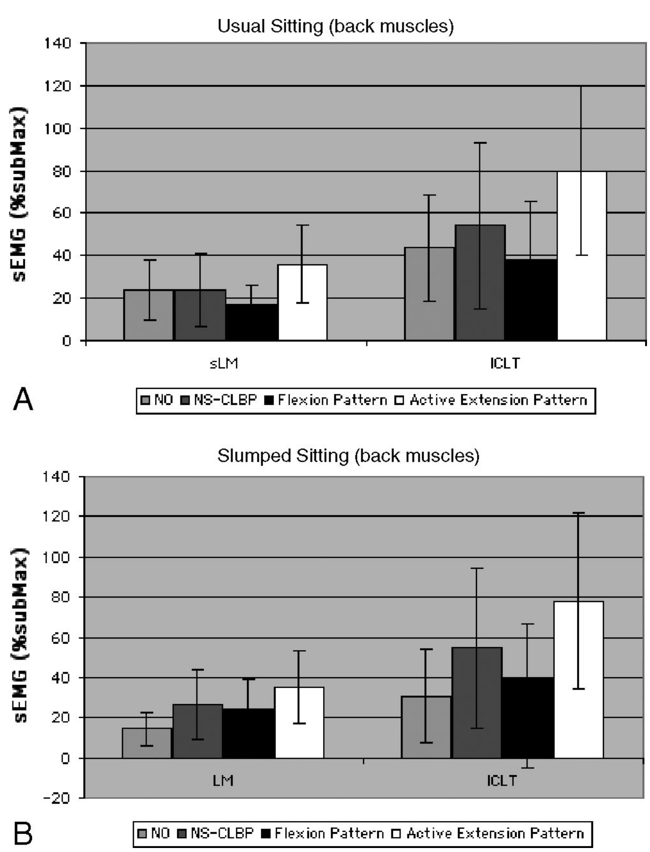

Figure 1. Mean and standard deviation (error bars) of the back muscle activation per muscles and per sitting condition for all groups (nonspecific CLBP pooled/classified). sLM = superficial lumbar multifidus; ICLT = iliocostalis lumborum pars thoracic.

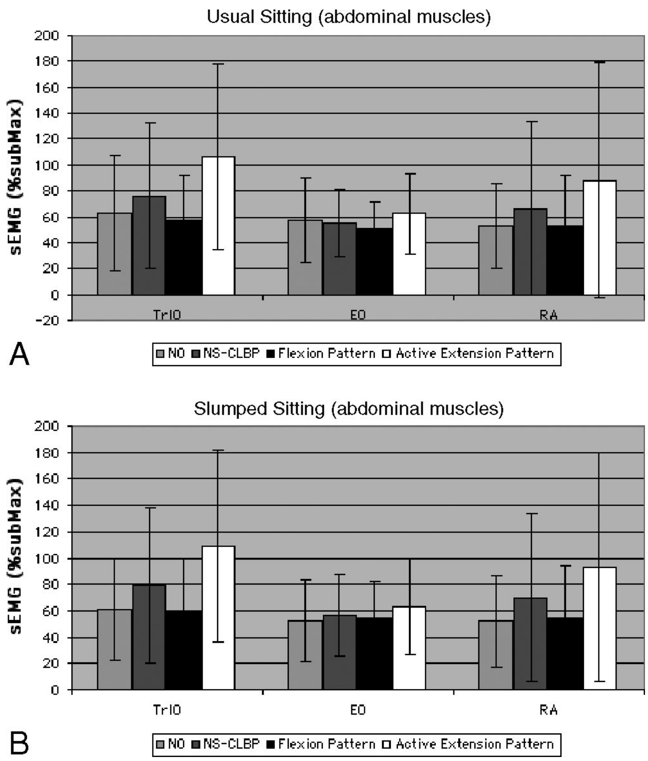

Figure 2. Mean and standard deviation (error bars) of the abdominal muscle activation per muscles and per sitting condition for all groups (nonspecific CLBP pooled/classified). TrIO = transverse fibers internal oblique; EO = external oblique; RA = rectus abdominis.

CLBP (pooled) for usual [TrIO: t = −1.0, P = 0.305; EO: t = 0.3, P = 0.758;RA: t = −1.0, p.306], and slumped sitting [TrIO: t = −1.4, P = 0.163; EO: t = −0.6, P = 0.536; RA: t = −1.4, P = 0.167].

No-LBP Versus *AEP and FP*

Back Muscles. AEP showed higher back muscles activity in usual [sLM: $F_{2,64}$ = 5.5; P = 0.006; ICLT: $F_{2,64}$ = 12.58.9; P < 0.001] and slumped sitting [sLM: $F_{2,64}$ = 6.6; P < 0.003; ICLT: $F_{2,64}$ = 9.9; P < 0.001], when compared with No-LBP and FP.

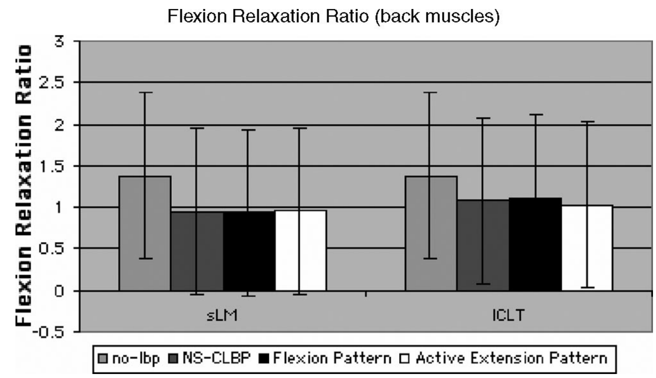

Figure 3. The mean and standard deviation (error bars) for the Flexion Relaxation Ratio for the back muscles and for each subgroup. sLM = superficial lumbar multifidus; ICLT = iliocostalis lumborum pars thoracic.

Abdominal Muscles. The activity of TrIO of AEP was higher, compared with No-LBP and FP in usual [$F_{2,64}$ = 4.2; P = 0.019] and slumped [$F_{2,64}$ = 5.1; P = 0.009] sitting. No differences were noted for EO [$F_{2,64}$ = 0.6; P = 0.527] and RA [$F_{2,64}$ = 2.3; P = 0.106] during usual sitting or slumped sitting [EO: $F_{2,64}$ = 0.4; P = 0.661; RA: $F_{2,64}$ = 3.0; P = 0.06].

Flexion Relaxation Ratio in Sitting

The mean and standard deviation for the flexion relaxation ratio of the back muscles is presented in Figure 3. The independent *t* test showed a significant difference in the FRR for both the sLM [t = 4.6; P < 0.001] and ICLT [t = 2.7; P < 0.001] between no-LBP and nonspecific CLBP (pooled). *Post hoc* Bonferroni testing did not reveal any difference between the AEP and FP subgroups (sLM: F = 10.28; P < 0.001; FP = AEP < no-LBP and ICLT: F = 3.83; P = 0.03; FP = AEP < no-LBP).

Table 3. Results for Back and Abdominal Muscles for Each Sitting Condition

			No-LBP *vs.* NS-CLBP: Independent *t* Test		No-LBP *vs.* FP *vs.* AEP: ANCOVA				
		Muscle	*t*	*P*	F	*P*	Post Hoc Bonferroni		
Back muscles	Usual	sLM	−0.11	0.909	5.5	0.006*	FP	NO	AEP
		ICLT	−1.27	0.207	8.9	<0.001*	FP	NO	AEP
	Slumped	sLM	−3.39	0.001*	6.6	0.003*	NO	FP	AEP
		ICLT	−2.82	0.006*	9.9	<0.001*	NO	FP	AEP
Abdominal muscles	Usual	TrIO	−1.03	0.31	3.2	0.04*	FP	NO	AEP
		EO	0.30	0.76	0.9	0.37	FP	NO	AEP
		RA	−1.03	0.31	2.3	0.11	NO	FP	AEP
	Slumped	TrIO	−1.41	0.16	3.4	0.04*	FP	NO	AEP
		EO	−0.62	0.54	0.1	0.92	NO	FP	AEP
		RA	−1.39	0.17	2.3	0.10	NO	FP	AEP

No-LBP = no low back pain; NS-CLBP = nonspecific chronic low back pain; FP = flexion pattern; AEP = active extension pattern; sLM = superficial lumbar multifidus; ICLT = iliocostalis lumborum pars thoracic; TrIO = transverse fibers internal oblique; EO = external oblique; RA = rectus abdominis.
EMG activity is ranked (from lowest to highest) underlined group data links those that do not significantly differ.
*Significant (P < 0.05).

Difference Between Usual and Slumped Sitting in Superficial Lumbar Multifidus Activity

When subjects with a FP moved from usual sitting to slumped sitting they showed a nonsignificant increase in sEMG (+4%; $t = -1.6$; $P = 0.11$) of the sLM (at the level of their LBP). Similar, the AEP subjects did not show a difference in sLM muscle activity when compared with usual upright sitting (37% *vs.* 36%; $t = 0.42$; $P = 0.685$). In contrast the no-LBP group showed a clear difference (23% *vs.* 14%; $t = 4.4$; $P < 0.001$) suggesting a relaxation response.

Discussion

This study found no differences in superficial trunk muscle activation patterns between healthy controls and nonspecific-CLBP (pooled) subjects during usual sitting. These findings are in agreement with several studies that have reported no differences in trunk muscle function during different posture and stress tasks in CLBP *versus* control subjects.[5,8,33,34] In contrast, other studies have reported that CLBP subjects have increased[3,5] or decreased[6,7] muscle sEMG amplitude.

The results of this study support the literature reporting the inherent heterogeneity of the CLBP population.[9,10,11] Indeed, when the nonspecific CLBP patients were subclassified, this study showed that in the AEP subgroup, CLBP was associated with increased levels of muscle coactivation for sLM, ICLT, and TrIO compared with the No-LBP and FP groups. These experimental findings are consistent with the clinical classification of AEP based on O'Sullivan's classification system.[15,35]

The above findings represent a "washout effect"[36] when nonspecific CLBP patients are pooled, where the findings in one subgroup of patients is "washed-out" by the opposite findings in another subgroup. This clearly highlights the importance of defining specific subgroups and developing a clinically meaningful classification system for the nonspecific CLBP. This has been ranked as a top research priority for several years, although limited progress has been made in its development and application.[9,37]

The difference between no-LBP and LBP in flexion relaxation ratio for the back muscles (Figure 3) reflects an absence of relaxation (AEP) and increased activity (FP) in the sLM and ICLT during slumped sitting *versus* a clear reduction in the no-LBP group (Figure 1). This latter finding is consistent with O'Sullivan *et al*[21] who demonstrated in no-LBP subjects that slumped sitting was associated with a period of myoelectrical silence of the trunk muscles. The absence of flexion relaxation in the nonspecific CLBP patients in this study is consistent with studies examining flexion relaxation in upright standing in back pain populations.[16–19]

This study clearly shows that there is not a homogeneous trunk muscle activation pattern in the nonspecific CLBP population identified during sitting. These results may reflect two different underlying mechanisms to the LBP disorder.

Flexion Pattern

The average back muscle activity during usual sitting in the FP patients (17%) was nonsignificantly less when compared with the no-LBP subjects (24%) ($P = 0.27$). This was associated with sitting with a flexed lower lumbar spine as reported by Dankaerts *et al.*[38] Since all FP subjects reported pain after prolonged sitting, it is hypothesized that this pattern of decreased muscular activation in association with increased lumbar spine flexion in this FP group[38] may produce mechanical stress into flexion leading to LBP.[39–41]

The nonsignificant trend ($P = 0.11$) of increased muscle activation, when actually asked to relax (moving from usual sitting to slumped sitting), was only seen in the sLM (local to the symptomatic region) of the FP patients, and it was linked with the direction of pain provocation (flexion) reported by these subjects. While the range of motion into flexion was similar to the controls,[38] this represented a difference in motor response. This increase in muscle activity seen in the FP group is consistent with a ligamento-muscular protective reflex at end range of lumbar spine flexion as reported by Solomonow *et al.*[39,40,42,43]

Active Extension Pattern

In contrast with the FP group and controls, "hyperactivity" was demonstrated in the back muscles and TrIO of the AEP patients. This was associated with a hyperlordotic posture[38] and subjectively reported extension related pain. Of importance is that these subjects did not report pain at time of testing, suggesting that this motor pattern was not directly driven by pain.

When asked to slump, the AEP subjects showed a lack of flexion relaxation (at the level of their LBP) when compared with usual upright sitting (37% *vs.* 36%; $t = 0.42$; $P = 0.685$). While it is not clear from the results why the AEP subjects present in this manner (despite slumping is a movement away from their direction of pain provocation), the observed "hyper"-activity coactivation pattern of this group associated with "hyper"-lordosis[38] may prevent motion and impose substantial extension load penalties on the lumbar spine, which may perpetuate LBP.[44–46]

These findings, in both FP and AEP patients, appear to represent maladaptive postural patterns with the potential to provoke strain and pain.

A number of limitations of this study need to be highlighted. The authors acknowledge that the strict inclusion/exclusion criteria applied limit the generalizability of the results for the whole LBP population. This study only examined a very short duration of sitting; therefore, the effects of prolonged sitting on trunk muscle activation are unknown and future studies will investigate this. The results of this study are limited to the superficial muscle sites under examination; therefore, future work should focus on the involvement of deeper muscles deemed important in LBP, such as quadratus lumborum and psoas, the deep fibers of sLM, and the transverses abdominis.[47,48]

Implications for Clinical Practice and Research

The results of this study may have important implications for therapeutic management and LBP research in subjects with nonspecific CLBP where sustained sitting postures are reported to be a primary aggravating factor.

Identifying a subgroup (AEP) with increased cocontraction of local stabilizing muscles is important clinically. For the AEP subgroup, a rehabilitation approach that focuses more on the inhibition of the dominant activation of these muscles while posturing the spine within a more neutral lordosis seems to be more appropriate.[15]

In this study, usual unsupported sitting in the healthy controls required low muscle activity while a neutral lumbar spine was adopted.[38] In contrast, there was a trend of decreased muscle activity in FP patients, accompanied with an increase in lumbar flexion.[38] It can be speculated that a logical approach for rehabilitation of these subjects would involve facilitation of neutral lordotic postures while facilitating low level muscular coactivation of the local spinal stabilizing muscles.[15,47] Randomized controlled trials are required to investigate if this approach would show a reduction in pain and disability in these LBP populations.

Finally, the results of this study may also have implications for LBP research. The heterogeneity of the nonspecific CLBP population highlights the importance for defining specific subgroups. Improved research methods, incorporating clinically meaningful classification systems for this population, will enhance the value of the results and prevent "washout."

■ Key Points

- Differences in muscular activity (as measured by sEMG) were studied in healthy controls and nonspecific CLBP patients during sitting.
- No differences were found during usual sitting when the nonspecific CLBP patients were pooled. Analysis based on subgrouping the patients revealed significant differences in muscle activation patterns and highlights the importance of subclassifying nonspecific CLBP patients.
- These differences in muscle activation pattern appear to represent maladaptive postural patterns with the potential to provoke strain and pain. They may reflect two different underlying mechanisms for CLBP during sitting.
- The results of this study may have important implications for therapeutic management and LBP research in subjects with nonspecific CLBP where sustained sitting postures are reported to be a primary aggravating factor.

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