Randomized Controlled Evaluation

The Biomechanics of the Lumbosacral Region In Acute And Chronic Low Back Pain Patients

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Background: A previous study examined the relationship between the sacral inclination angle (SIA), lumbosacral angle (LSA) and sacral horizontal angle (SHA) and spinal mobility in acute low back pain and chronic low back pain patients. We chose to investigate the lumbar lordosis angle, segmental lumbar lordosis angle, SIA, LSA and SHA in acute and chronic low back pain (LBP) patients as well as the correlation between spinal stability and these angles.

Objectives: To investigate the biomechanics of the lumbosacral spine region in acute and chronic LBP patients, as well as to examine the correlation between spinal stability and lumbosacral angles.

Study Design: Randomized controlled evaluation

Setting: Physical Medicine and Rehabilitation outpatient clinic

Methods: Sixty participants with LBP were recruited and categorized as either acute LBP (pain < 3 months) or chronic LBP (pain > 6 months), with 30 subjects in each group. All subjects underwent standing, lateral lumbosacral x-rays, which were analyzed for lumbar stability, SIA, LSA, SHA, lumbar lordosis angle and segmental lumbar lordosis angles.

Results: The mean age of the ALBP subjects was 41.00 ± 11.63 (18 – 66) and that of the chronic LBP subjects 49.26 ± 15.6 (22-74), with females comprising 50% of the acute LBP group and 73.3% of the chronic LBP group. Lumbar stability was observed in 62.1% of acute LBP patients and 36.8% of chronic LBP patients. A statistically significant difference was found between the 2 groups in terms of age, gender, and lumbar stability. There was no statistical difference regarding SIA, LSA, SHA, total and segmental lordosis angles between acute and chronic LBP patients (p>0.05).

Conclusion: We were unable to find a difference between the radiological values for the shape of the SIA, LSA, SHA, and total and segmental lordosis as noted on screening x-ray techniques regarding the occurrence of acute or chronic LBP, but a statistically significant difference was found for lumbar stability. Further extensive studies are needed to examine lumbar stability and its relationship between angles of lumbosacral region.

Key words: biomechanic, acute low back pain, chronic low back pain, lumbar stability, lumbosacral, sacral, lumbar lordosis

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Low back pain (LBP) is a highly common problem and causes much morbidity and socioeconomic loss in the community (1), with lifetime incidence rates reported between 50% and 90%. It is known that several complex factors affect the lumbar curve (2). Clinical observations suggest that aberrations of posture may play a role in the development of LBP (3). Various studies have examined the relationship between changes in the angle of the lumbar spine and back pain (2,4-6). A previous study (4) examined the relationship between the sacral inclination angle (SIA), lumbosacral angle (LSA) and sacral horizontal angle (SHA) and spinal mobility in acute low back pain (ALBP) and chronic low back pain (CLBP) patients. We chose to investigate the lumbar lordosis angle (LLA), segmental lumbar lordosis angle (SLA), SIA, LSA and SHA in acute and chronic LBP patients as well as the correlation between spinal stability and these angles.

A definition of instability of the lumbar spine and its relationship to clinical symptoms has not been established. Little has been reported on long-term follow-up patients with radiographic instability, and the pathophysiology of this condition has not been determined (7). The objective of this study was to investigate the biomechanic features of the lumbosacral region in acute and chronic LBP patients and the relationship between spinal stability and angles of lumbosacral region.

Methods

Participants

A total of 292 LBP patients were admitted to our clinic's outpatient department between July 2004 and July 2005. Subacute LBP patients (48 patients) were excluded from the study. Subjects with a self-reported diagnosis of spondylolisthesis (10 patients), spondylolysis (6 patients), sacroiliac joint problems (10 patients), scoliotic deformity (15 patients), myofascial pain syndrome (21 patients), pregnancy (6 patients), osteoporosis (19 patients), metabolic diseases (6 patients), or neoplasm (2 patients) were also excluded from the study. In addition, individuals with congenital deformities (11 patients) and spinal surgery (18 patients) were also excluded.

The study was conducted on 120 informed participants with LBP who presented at the Physical Medicine and Rehabilitation outpatient clinic. The subjects were randomized by an independent investigator using a computer-generated random numbers table producing 2 study groups with 60 patients each categorized as the acute LBP or chronic LBP groups and half of each group was then removed by randomization. Participants in the acute group had LBP for less than 3 months. Participants in the chronic group had LBP of continuous or recurrent nature for more than 6 months. Subacute LBP is usually defined as LBP more than 3 months but less than 6 months.

Inclusion Criteria

Patients were included if they were over age 18, able to give informed consent, and had no objective neurologic signs (i.e., degenerative disc disease with or without herniation, mechanical back pain, facet joint syndrome, muscular injury, ligamentous injury) or osteoarthritis of the spine.

Assessment and Outcome Measures

All patients' demographic features were recorded. After a detailed clinical examination, both groups were subjected to lumbosacral radiography in the lateral position while standing. Measurements were made directly from the radiographs. Patients were assessed by parameters such as lumbar stability, SIA, LSA, SHA, LLA and SLA.

Lumbar stability was evaluated using a vertical line drawn from the centre of the L3 vertebra. Lumbar stability was accepted to be present if this line passed through the corpus of the L5 vertebra (8). Measurement of the lumbar stability is shown in Fig. 1.

The SIA was measured between the vertical line and line drawn tangential to the posterior border of the S1 vertebra (4,9,10) (Fig. 2).

The LSA was subtended by lines drawn across the upper border of the sacrum and the lower border of the L5 vertebra (4,9,10) (Fig. 3).

The SHA was measured between a horizontal line and a line drawn tangentially to the upper surface of the sacrum (4) (Fig. 4).

Total lordosis was measured from the cephalad endplate of the first lumbar vertebra to the cephalad endplate of the sacrum (4,11).

Segmental lordotic measurements were made in similar fashion from L1 to L3 and L3 to S1 (11) (Fig. 5).

All measurements were made using the Cobb method by the same experienced and independent observer. A specially sized translucent goniometer allowing direct measurements of these angles from the lateral roentgenogram was used.

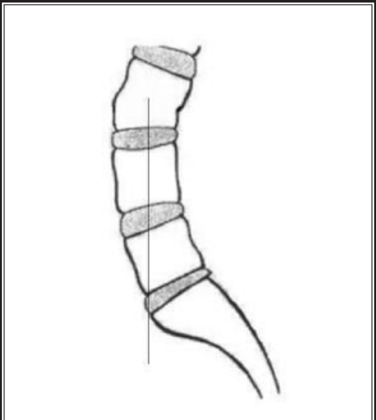

Fig. 1. *Measurement of the lumbar stability.*

Fig. 2. *Measurement of the sacral inclination angle (SIA).*

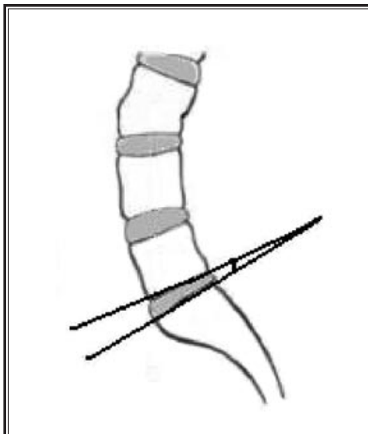

Fig. 3. *Measurement of the lumbo-sacral angle (LSA).*

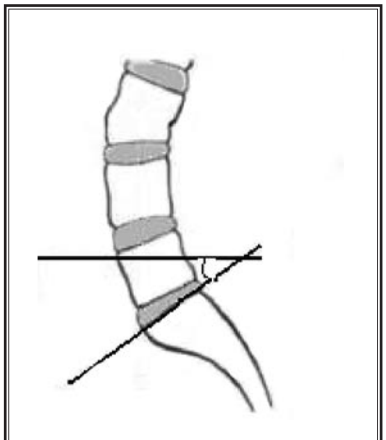

Fig. 4. *Measurement of the sacral horizontal angle (SHA).*

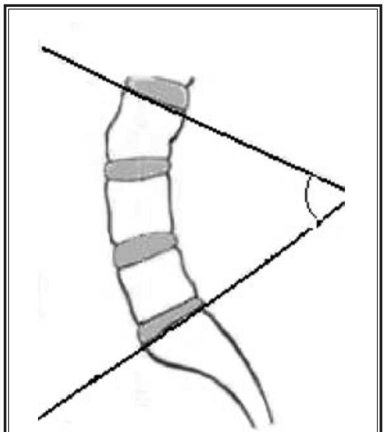

Fig. 5 *Measurement of the Segmental lordotic angle L3 to S1.*

Statistical Analyses

The means and standard deviations of all angles were calculated. Statistical differences between the angles of both groups were calculated using the Mann-Whitney U test. Correlation of spinal instability with the angles of the lumbar spine was assessed with the Spearman's correlation analysis in SPSS for Windows, version 11.00.

Results

Table I shows the demographic data and lumbar stability for each group. There was a significant difference between the groups for mean age and gender distribution with the acute LBP group consisting of younger subjects with a greater proportion of males.

Figure 1 shows a flowchart for this study.

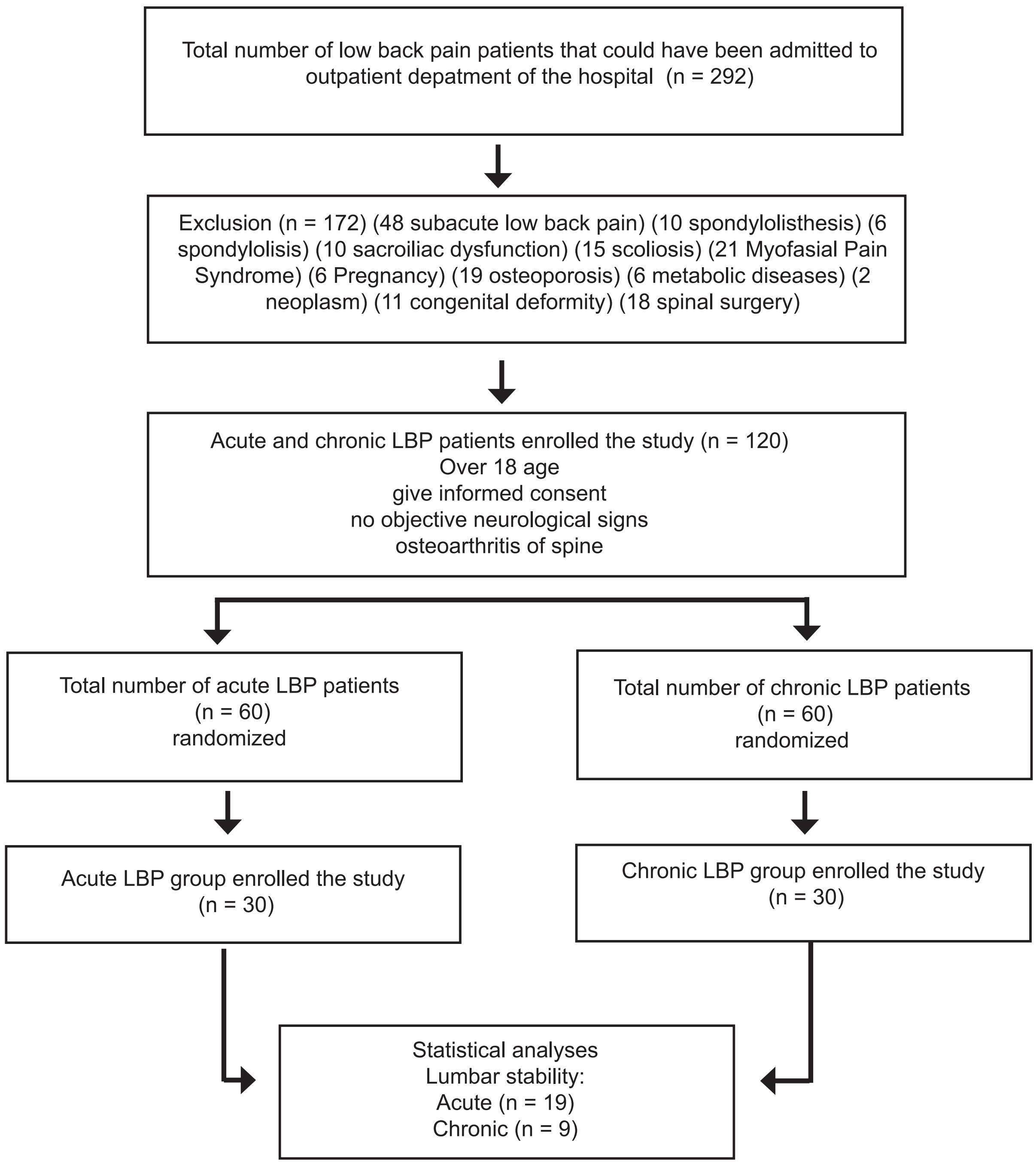

Fig. 1. *Flow diagram for randomized subject assignment in this study.*

Table I. *Mean age, gender, and lumbar stability in acute and chronic low back pain patients.*

	Acute Group (30)	Chronic Group (30)	P
Mean age	41.00±11.63	49.26±15.6	<0.05
Gender (n) *Female* *Male*	 50 (15) 50 (15)	 73.3 (22) 26.7 (8)	<0.05
Lumbar stability (n)	62.1 (19)	36.8 (6)	<0.05

Table 2. *SIA, LSA, SHA, LLA, and SLA (L1-L3 and L3-S1) of acute and chronic low back pain patients.(°)*

	Acute Group (n = 30)	Chronic Group (n = 30)	P
SIA °	46.38 ± 10.4	45.03 ± 9.9	>0.05
LSA °	139.59 ± 15.56	140.89 ± 11.91	>0.05
SHA °	35.45 ± 7.23	36.42 ± 9.56	>0.05
LLA °	47.9 ± 10.84	51.95 ± 12.46	>0.05
SLA (L1-L3) °	13.52 ± 4.82	13.74 ± 5.75	>0.05
SLA (L3-S1) °	34.03 ± 10.29	38.13 ± 12.69	>0.05

Lumbar stability was observed in 19 (62.1%) acute LBP patients and 6 (36.8%) chronic LBP patients and a statistically significant difference was found between the 2 groups ($P < 0.05$) (Table 1).

Table 2 shows the angles of the lumbosacral spine region in both groups. There was no statistical difference between acute and chronic LBP patients for the SIA, LSA, SHA, and total and segmental lordosis angles ($P > 0.05$) (Table 2).

A mild relationship was found between lumbar stability and LLA, SIA, SHA, and a weak relationship was found between lumbar stability and SLA (L1-L3), SLA (L3-S1), and LSA.

Discussion

The lumbosacral region is the most important region in the vertebral column in terms of mobility and weight bearing. Mechanical disorders of this region cause LBP.

Various studies have examined the relationship between changes in the angle of the lumbar spine and back pain (2,4-6).

Segmental instability can be defined as loss of motion and segment stiffness such that force application to that motion segment will produce greater displacements than would occur in a normal structure (12). An unequivocal definition of instability in lumbar disease is yet to be established, and the relationship between radiographic lumbar instability and the angles of the lumbosacral region is unclear (7). The sacral inclination, lumbar lordosis, and lumbosacral angle are useful parameters that are employed in the evaluation of spinal function and assessment of LBP (9).

The shape of the lumbar lordosis has been reported to be of importance in the occurrence of LBP (11,13).

Changing lumbar lordosis seems to depend on the abdominal muscles, back muscles, and pelvic/back ligament function and tonus, and this may affect the diagnosis and treatment in LBP patients and also affect the planning of a proper exercise program for the back or abdominal muscles (4).

This study was designed to analyze postural aberrations of the lower back region in patients with acute and chronic low back pain.

Different authors have measured the lumbar lordosis angles with various methods. Christie et al (4) used the method described by Flint (2). Using the lateral photograph, lines were extended from the T12 and L5 pointers and the angle at their intersection was recorded (2). Hansson et al (5) used the angle between a line parallel to the cranial endplate of L1 and one parallel to the cranial endplate of S1.

The changes in LSA and SIA and the curvature of the lumbar spine during aging have previously been reported. Marked differences were noted between the angles of males and females. In younger individuals, male LSAs were greater than female angles, while females had greater lumbosacral angles in older age groups. Male SIAs were generally smaller than female angles and the lumbar spines of females were more lordotic than those of males (9). We did not find a significant difference between younger patients (ages 10-39 years) and older patients (40 years and over) in terms of SIA ($P = 0.67$), LSA ($P = 0.23$), SHA ($P = 0.21$), LLA ($P = 0.48$), SLA (L1-L3) ($P = 0.86$), and SLA (L3-S1) ($P = 0.36$).

There is general agreement that females have greater angles than males (9,13). Youdas et al (14) observed that gender correlated highly with pelvic inclination and lumbar lordosis but found no correlation of lumbar lordosis with abdominal muscle performance in either males or females. We found a weak relationship between lumbar lordosis and gender ($r = -0.118$, $P = 0.340$), sacral inclination and gender ($r = -0.170$, $P = 0.169$).

An increase in LSA was expected in chronic LBP patients, but we could find no difference in LSA between the 2 groups ($P = 0.698$).

Hansson et al (5) compared the extent of lumbar lordosis and the ages of asymptomatic, acute and chronic LBP patients. No difference was observed between the groups, except for gender. Some other investigators have also found no difference in lumbar lordosis and pelvic inclination between asymptomatic subjects and chronic LBP patients (15,16). Some investigators have compared lordotic measurements of normal, chronic and acute LBP patients and reported that patients with chronic LBP had hypolordosis, whereas the acute back pain group was hyperlordotic with the largest L1-5 angle, Cobb angle, Ferguson's angle and pelvic tilt angle (17). Jackson et al (10) reported that lumbar lordosis was significantly lower and not age or gender related in chronic back pain patients.

We found no difference between the 2 groups for LLA ($P = 0.168$) and SIA ($P = 0.590$).

Korovessis et al (18) reported that L5-S1 segmental lordosis was greater in chronic back pain patients.

We found no difference between the groups for the segmental lordosis angle between L3 and S1. ($P = 0.161$)

Sacral inclination appeared to be a more important determinant of the degree of lumbar lordosis (9).

Evcik and Yücel (4) found that the SIA was larger in chronic LBP patients and that there was a relationship between this angle and the maximal range of lumbar extension for both males and females. In contrast, Tuzun et al (19) found that no significant differences between acute and chronic LBP patients in terms of SIA and similarly we could find no difference in SIA between the 2 groups. This angle is mostly related with spondylolisthesis and isthmic pathologies. It also increases in spondylolisthesis and isthmic pathologies and thus correlates with the maximal range of lumbar extension (4).

The lumbar lordosis angles are related to each other. As lumbar lordosis increases, sacral inclination and lumbosacral and sacral horizontal angles also increase. However, studies examining the relationships between lumbar lordosis angles in chronic LBP patients have reported different results (4). Kendall et al (20) reported that lumbar lordosis should be associated with pelvic inclination because of the muscle balance between the back/hip muscles and abdominal muscles in the standing position. In contrast, Walker et al (21) found a weak relationship between lumbar lordosis and pelvic inclination in the standing position in asymptomatic patients.

Korovessis et al (22) found that sacral inclination correlated with thoracic kyphosis and lumbar lordosis and decreased as lumbar lordosis decreased. We found a minor relationship between lumbar lordosis and pelvic inclination in LBP patients ($r = 0.404$, $P = 0.001$).

Conclusion

We were unable to find a difference between the radiological values for the shape of the SIA, LSA, SHA, and total and segmental lordosis as noted on screening x-ray techniques regarding the occurrence of acute or chronic LBP, but a statistically significant difference was found for lumbar stability. Lumbar stability was observed in 19 (62.1%) acute LBP patients and 6 (36.8%) chronic LBP patients. A mild relationship was found between lumbar stability and LLA, SIA, and SHA, and a weak relationship was found between lumbar stability and SLA (L1-L3), SLA (L3-S1), and LSA. Further extensive studies are needed to examine lumbar stability and its relationship between angles of lumbosacral region.

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