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Original Article

Comparison of sagittal lumbosacral parameters in patients with ankylosing spondylitis and chronic mechanical back pain

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Abstract

Aim: Lumbosacral parameters can be affected in ankylosing spondylitis (AS) and chronic mechanical back pain.We compared lumbosacral parameters between patients with AS and chronic mechanical back pain to identify specific changes in AS.

Material and Methods: This study has a retrospective design. A total of 42 patients with AS (16 females, 26 males) and 66 patients with chronic mechanical back pain (31 females, 35 males) were enrolled in the study. Lumbar lordosis angle (LLA), lumbosacral angle (LSA), sacral tilt (ST), and lumbosacral disc angle (LSDA) were measured using digitalized standing lateral lumbar radiographs. CRP and ESR concentrations of AS patients were obtained from the hospital database.

Results: LLA, LSA, ST and LSDA were significantly smaller in the patients with AS ($p < 0.05$).CRP and ESR were significantly and negatively correlated with LLA and LSA ($r = -0.516$, $p < 0.001$; $r = -0.401$, $p = 0.009$ for CRP and $r = -0.623$, $p < 0.001$; $r = -0.474$, $p = 0.002$ for ESR). In AS patients, LLA was significantly and positively correlated with LSA and ST ($r = 0.490$, $p = 0.001$; $r = 0.399$, $p = 0.009$). Additionally, LSA was significantly and positively correlated with LSDA ($r = 0.613$, $p < 0.001$).

Conclusion: The sagittal lumbosacral parameters of patients with AS were found to be significantly different from those of patients with chronic mechanical back pain. İnflammation negatively affects lumbosacral alignment in AS. The identification of specific changes in sagittal spinal alignment in patients with AS will contribute to the establishment of appropriate rehabilitation strategies and surgical plans.

Keywords: Ankylosing Spondylitis; Lumbosacral Balance; Lumbosacral Alignment; Lumbar Lordosis; Inflammation.

INTRODUCTION

Ankylosing spondylitis (AS) is a chronic inflammatory rheumatic disease characterized by inflammation of the vertebrae, which progresses to bone fusion of the spinal column. AS is the main and prototype rheumatic disorder of the spondyloarthropathies group which includes extra-articular manifestations such as inflammatory bowel disease, lung abnormalities, uveitis, cardiac abnormalities, psoriasis and amyloidosis (1,2). Inflammatory back pain is a key feature of the disease, which occurs as a consequence of sacroiliitis and spondylitis. When the disease progresses to the thoracic vertebrae, a significant increase develops in dorsal kyphosis and the patient's shoulders fall forward (3). Sagittal spinal balance can be influenced from the onset of the disease and rigid, non-flexible spinal column and thoracolumbar kyphosis can occur (4). Patients stand with flexed knees in order to maintain their center of gravity, depending on the severity of the spinal involvement (3).

Lumbosacral alignment which plays a crucial role in maintaining appropriate spinal balance, provides upright and stable posture. The vertebral column, pelvis, and lower extremities are in a constant relationship with each other to decrease energy expenditure, provide body balance, and avoid deformations (5). The spine, pelvis, and lower extremities try to compensate for sagittal plane deformations in order to pass the body weight through the most appropriate point (6). One of the important well described causes of impaired lumbosacral alignment is chronic back pain. Patients with chronic back pain have been found to have differences in spinal alignment when evaluated regardless of age and sex (7). Patients with chronic low back pain have a more flattened spine and a

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more vertical sacrum as compared with healthy controls (8,9).

Chronic back pain is a common symptom in patients with AS. The disorder of spinal alignment in patients with AS cannot be attributed solely to the disease itself because lumbosacral alignment is impaired in patients with chronic back pain. Therefore, comparing AS patients with chronic mechanical back pain patients is more acceptable than with healthy volunteers. The primary aim of our study was to compare lumbosacral alignment between patients with AS and patients with chronic mechanical back pain. A secondary aim was to determine the associations between inflammatory markers and lumbosacral alignment in patients with AS.

MATERIAL and METHODS

Study design and participants

This is a retrospective study. A total of 83 patients with AS were recorded in our clinic with axial AS between January 2018 and August 2018. Between the same dates, 468 patients with chronic mechanical back pain presented to our clinic. Patients with any record of spinal surgery, spinal abscess,pseudarthorosis, discitis, spinal trauma,severe lumbar disc herniation and radiculopathy, drop foot, excessive vertebral fracture, hip fracture, spinal tumor, scoliosis, contractures in the lower extremities, muscular dystrophy, myopathy, lower extremity prosthesis, lower extremity shortness, stroke, hemiplegia,and sequel of poliomyelitis were excluded from the study. Patients without a standing lateral lumbar radiograph or who were not placed in the appropriate position were also excluded from the study. After applying the exclusion criteria, 42 patients with AS and 66 age, sex matched patients with chronic mechanical back pain were enrolled in the study. Patients with AS in this study met the modified New York criteria (10).

The Medical Ethics Committee of Kahramanmaras Sutcu Imam University approved the study.

Measurement of Lumbosacral Angles

Standing lateral lumbar radiographs and patient records were obtained from our hospital's electronic database. We evaluated spinal sagittal balance using digitalized standing lateral lumbar radiographs of the patients. Our hospital's software program, which allows placing lines on lumbar radiographs and measuring lumbosacral angles was used for the evaluation of spinal sagittal balance (Mia Med Hospital Information Management Service, Mia Technology Ankara, Turkey). Lumbosacral angle measurements were determined as follows:

Lumbar lordosis angle (LLA): The intersection of lines drawn tangent to the superior end plate of L1 vertebra and tangent to the inferior end plate of L5 vertebra forms LLA.

Lumbosacral angle (LSA): The intersection of lines drawn from the upper end plate of sacrum and horizontal line forms LSA. LSA is also known as the sacral slope (SS) in the literature.

Sacral tilt (ST): The intersection of the lines tangent to the posterior edge of sacrum and vertical line forms ST.

Lumbosacral disc angle (LSDA): The intersection of lines drawn from the inferior end plate of L5 vertebra and the superior end plate of S1 vertebra (11,12).

All lumbosacral angles were measured twice by the same researcher (BFK) and the measurements were averaged.

Laboratory Assessment

C-reactive protein (CRP) (mg/dl) and the erythrocyte sedimentation rate (ESR) (mm/h) were analyzed using standard laboratory techniques. The CRP and ESR concentrations of patients with AS were obtained from the hospital database. Blood samples were obtained from patients with AS on the same day as the radiologic assessment.

Statistical analysis

SPSS version 20.0 for Windows (SPSS Inc., Chicago, IL, USA) was used for the statistical analyses of data. All results are expressed as mean value and standard deviation and number. Distribution of data was assessed using the Shapiro-Wilk test. Comparisons of groups were evaluated using the Chi-square test in in categorical variables and the independent sample t test in continuous variables. The Pearson or Spearmen test was performed for the correlation analysis according to the Shapiro-Wilk test results. P values lower than 0.05 were considered as statistically significant.

RESULTS

A total of 42 patients with AS (16 females, 26 males) and 66 patients with chronic mechanical back pain (31 females, 35 males) were enrolled in the study. The mean age of the patients with AS and the chronic mechanical back pain was 34.88 ± 6.97 years and 37.07 ± 10.14 years, respectively. No significant difference was detected between the groups in terms of age and sex ($p > 0.05$).

LLA, LSA, ST, and LSDA were significantly smaller in the patients with AS compared with patients with chronic mechanical back pain ($p < 0.001$, $p < 0.001$, $p < 0.001$ and $p = 0.012$, respectively) (Table 1).

Table 1. Comparison of lumbosacral angles between the groups

	AS (n = 42)	Chronic mechanical back pain (n = 66)	p
LLA (0)	31.77 ± 6.14	38.09 ± 7.33	<0.001
LSA (0)	30.92 ± 7.64	37.50 ± 7.88	<0.001
ST (0)	33.91 ± 3.74	39.21 ± 6.38	<0.001
LSDA (0)	7.79 ± 1.94	8.94 ± 2.45	<0.012

AS, ankylosing spondylitis; LLA, lumbar lordosis angle; ST, sacral tilt; LSA, lumbosacral angle; LSDA, lumbosacral disc angle; n, number

When the associations between inflammatory markers and lumbosacral angles were evaluated in patients with AS, CRP and ESR were significantly and negatively correlated with LLA and LSA ($r = -0.516$, $p < 0.001$; $r =$

-0.401, p = 0.009 for CRP and r = -0.623, p < 0.001; r = -0.474, p = 0.002 for ESR) (Table2, Table 3). No significant correlations were detected between inflammatory makers and ST and LSDA.

Table 2. Correlations between CRP concentration and lumbosacral angles

	rho	p
LLA	-0.516	<0.001
LSA	-0.401	0.009
ST	-0.288	0.064
LSDA	-0.186	0.238

CRP, C reactive protein; LLA, lumbar lordosis angle; ST, sacral tilt; LSA, lumbosacral angle; LSDA, lumbosacral disc angle

Table 3. Correlations between ESR concentration and lumbosacral angles

	rho	p
LLA	-0.623	<0.001
LSA	-0.474	0.002
ST	-0.295	0.058
LSDA	-0.068	0.667

ESR, erythrocyte sedimentation rate; LLA, lumbar lordosis angle; ST, sacral tilt; LSA, lumbosacral angle; LSDA, lumbosacral disc angle

When the associations of lumbosacral angles with each other were assessed in patients with AS, LLA was significantly and positively correlated with LSA and ST (r = 0.490, p = 0.001; r = 0.399, p = 0.009). Additionally, LSA was significantly and positively correlated with LSDA (r = 0.613, p < 0.001).

When the associations of lumbosacral angles with each other were assessed in patients with chronic mechanical back pain, LLA was significantly and positively correlated with LSA and ST (r = 0.551, p < 0.001; r = 0.319, p = 0.009). Additionally, LSA was significantly and positively correlated with ST (r = 0.463, p < 0.001).

DISCUSSION

The evaluation of sagittal spinal alignment and lumbosacral angles has an important role in the treatment of AS-related spinal deformities.Few studies have evaluated sagittal spinal alignment in AS (13-15). In these studies, healthy volunteers were evaluated as a control group or AS patients were divided into groups within themselves. Chronic back pain has been found to influence sagittal spinal alignment (8,9). It is not possible to evaluate whether misalignment of the spine is related to AS or chronic back pain when patients with AS are compared with healthy controls. Therefore, we compared lumbosacral angles between patients with AS and patients with chronic back pain. In this way, the variations in spinal sagittal alignment could be attributed to AS. We found no studies that evaluated the relationship between inflammation markers and lumbosacral angles in AS. Therefore, we investigated the link of CRP, ESR, and lumbosacral alignment in this study.

Sagittal spinal parameters in patients with AS were found to be significantly different. LLA, LSA, ST, and LSDA were significantly lower in patients with AS.Back pain has been demonstrated to be related with lower levels of lumbar lordosis (16). Additionally, LLA has been shown to be negatively correlated with pain levels (17). In our study, patients with AS had a more flattened spine as compared with patients with chronic mechanical back pain. Similar to our results, Lee et al. (14) and Shin et al. (15) reported lower levels of LLA and LSA in patients with AS compared with healthy controls. Pan et al. (18) compared spinopelvic parameters between patients with AS and patients with thoracolumbar fracture and reported decreased degrees of LLA and LSA.Our study suggests that patients with AS have lower levels of LLA, LSA, ST, and LSDA, independent of chronic back pain.Along with the changes caused by chronic back pain, structural damage in the spine may cause deterioration of lumbosacral alignment.

We investigated the association between spinal sagittal balance and inflammation. CRP and ESR were significantly and negatively correlated with LLA and LSA. Patients with AS with higher inflammation levels have a more flattened spine.Inflammation in AS starts in the sacroiliac joints, often seen as subchondral bone marrow edema on magnetic resonance imaging (MRI). In some patients, structural changes such as erosions, sclerosis, and ankyloses develop during the course of the disease (19). Researches have reported the association between levels of inflammation and new bone formation, particularly at the beginning of the disease (20). Inflammation leads to progression of vertebral corner lesions that may be recognized in MRI, which increases the intensity of the syndesmophytes by a metaplasia process (21). Higher levels of CRP or ESR have been independently related with radiologic progression in AS (22). All these structural changes triggered by inflammation influence sagittal spinal balance in patients with AS. Although the relationship between inflammation and radiologic progression has been assessed many times in the literature, the relationship between inflammation and lumbosacral angles has not been evaluated.Our results suggest that levels of inflammation influence lumbosacral angles in patients with AS.

The positive and negative correlations of lumbosacral parameters with each other have an important role for providing a functional and proper spino-pelvic unit. We consider that the evaluation of lumbosacral parameters provides a better understanding of the primary compensatory mechanisms in patients with sagittal malalignment. Therefore, we assessed the correlations of lumbosacral angles with each other.Patients with AS and chronic mechanical back pain were found to have similar compensation mechanisms.LLA was significantly and positively correlated with LSA and ST in both groups. Additionally, LSA was significantly and

positively correlated with LSDA in patients with AS and LSA was significantly and positively correlated with ST in patients with chronic mechanical back pain. LSA is a major compensatory regulator of lumbosacral alignment. Decreased levels of LSA have been found to cause deterioration in spinal alignment in patients with AS (18). Similar to our results, previous authors reported positive and significant correlations between LLA and LSA (23,24). In the presence of a significant and positive correlation between LLA and LSA, the ability of LLA to be preserved within a set of normality is ensured.

This study has some limitations. We could not evaluate symptom duration, body mass index, and symptom severity as a consequence of the retrospective design. We only evaluated patients with AS who had standing lateral lumbar radiographs. This condition led to a small sample size. We could not obtain ASDAS-CRP and BASDAI data of all patients from the hospital's database. Therefore, we could not assess these data. As a result of the retrospective design, we could not evaluate pain levels (visual analogue scale), functionality (bath ankylosing spondylitis functional index), metrological measurements (bath ankylosing spondylitis metrology index, finger to floor distance, modified Schober value). Although patients with contractures in the hip, knee or ankle were excluded from the study, we did not assess interactions with hip, knee and ankle joints.

CONCLUSION

In conclusion, the sagittal lumbosacral parameters of patients with AS were found to be significantly different from those of patients with chronic mechanical back pain. Our results demonstrate that significant relationships exist between sagittal lumbosacral parameters in both groups. Our results may help to better understand lumbosacral alignment in patients with AS.The identification of specific changes in sagittal spinal alignment in patients with AS will contribute to the establishment of appropriate rehabilitation strategies and surgical plans.Future studies regarding sagittal spinal alignment in AS should include body mass index, symptom severity, symptom duration, medication use, working status and physical activity levels to acquire more reliable and accurate results.

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