Journal of Experimental and Clinical Medicine
https://dergipark.org.tr/omujecm

Research Article

J Exp Clin Med
2024; 41(1): 108-111
doi: 10.52142/omujecm.41.1.18

Correlation of acute back pain and sagittal balance acute sagittal imbalance: A new term?

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Received: 25.09.2023 • **Accepted/Published Online:** 25.02.2024 • **Final Version:** 29.03.2024

Abstract
The aim of our study is to investigate the effect of acute low back pain on spinopelvic parameters. Pre-pain and post-pain scoliosis radiographs of the patients who applied with the complaint of low back pain of acute onset (less than 12 weeks) were taken. Measurements of the spinopel-vic parameters were performed for each patient, including pelvic incidence (PI), sacral slope (SS), pelvic tilt (PT), lumbar lordosis (LL), and the sagittal vertical axis (SVA). 65 patients were included in the study. In the statistical study in acute low back pain, changes in SVA, PT, LL, and SS were found to be significant (p = 0.014, 0.006, 0.003, 0.003) Lumbar lordosis decreases as a result of pathologies, such as asymmetric disc degeneration and facet joint hypertrophy that occur in a chronic process, and the sagittal imbalance appears as a consequence of all these. After that, the mechanisms utilized to compensate for the resulting sagittal imbalance led to low back pain. However, differently, in the case of acute low back pain, the patient changes the sagittal alignment first, to yield a less painful posture.

Keywords: acute back pain, sagittal balance, spinopelvic parameters, lumbar lordosis

1. Introduction

Having spinopelvic balance enables individuals to stand upright in an ideal manner and with the least energy consumption (1). There are studies in the literature on the effects of spinal diseases, such as spondylolisthesis, degenerative spinal disorders, scoliosis, and spinal deformities on sagittal spinal alignment. The effects of the spinal changes occurring during the chronic processes on the spinopelvic alignment are well known (2-5). However, there are few studies about the effects of acute low back pain on sagittal alignment, which remained under-researched. In this study, we aimed to investigate the effects of acute low back pain on spinopelvic parameters.

2. Materials and methods

The present study was conducted between June 2019 and December 2019 at Trabzon Fatih State Hospital following the ethical, legal, and scientific rules. Written informed consent was obtained from the volunteers to conduct this study. Our study was carried out in accordance with the Helsinki Declaration. Patients with acute onset of low back pain without chronic low back pain were included in this study. Patients with a history of previous spinal surgery, a history of trauma, or a diagnosis of radiculopathy, osteoporosis, or scoliosis were excluded. Patients with pain associated with radiculopathy, patients over the age of 45, patients with previous complaints of low back pain, and patients with secondary causes, such as infectious, inflammatory, tumoral, or metabolic disorders that may be the source of low back pain, patients with pain possibly reflective from the abdominal or pelvic organ pathologies were also excluded from this study.

Indications for inclusion in this study were as follows:

1. Being under the age of 45

2. The presence of low back pain that began less than 12 weeks ago

3. Not having a history of radiculopathy

4. Not having a history of trauma

5. No history of metabolic disease, tumor, or infection

6. Not having any neurological deficits

Bilateral scoliosis radiographs of the patients who presented with the complaint of acute-onset low back pain (less than 12 weeks) were taken. To obtain a standard and high-quality radiographic image, a balancing filter was used between the patient and the X-ray source, and it was ensured that the appropriate contrast between the thoracic cavity, where the beam penetrates easily, and the lumbosacral region, where it is more difficult to penetrate, was maintained. Radiography

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was performed using a unilateral height in one patient because of leg length discrepancy. Afterward, scoliosis graphs were transferred to the computer and spinopelvic parameters were measured using the Surgimap (Nemaris, Inc.) program. Measurements of the spinopelvic parameters were performed for each patient, including pelvic incidence (PI), sacral slope (SS), pelvic tilt (PT), lumbar lordosis (LL), and the sagittal vertical axis (SVA) (Fig. 1).

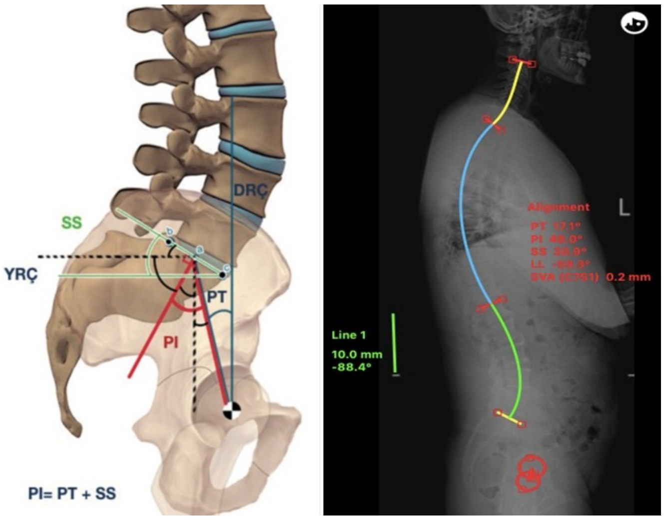

Fig. 1. Measurements of the spinopelvic parameters

Explanations and definitions of spinopelvic parameters are given in Table 1 (Table 1).

Table 1. Definition of spinopelvic parameters

Lumbar lordosis	L1 is defined as the angle between the line drawn perpendicular to the line passing through the upper endplate and the line drawn perpendicular to the line passing through the sacral endplate.
Pelvic Incidence	It is defined as the angle between the perpendicular line passing through the midpoint of the upper sacral endplate and the line joining the femoral head axis to this midpoint.
Sacral Slope	It is defined as the angle between the line drawn from the upper sacral endplate and the horizontal line drawn from the midpoint of the upper sacral endplate.
Pelvic Tilt	It is defined as the angle between the vertical line passing through the axis of the femoral head and the line joining the axis of the femoral head to the midpoint of the sacral endplate.
Sagittal Vertical Axis	It is the vertical distance between the line drawn perpendicularly down from the C7 vertebra and the posterior upper edge of the sacrum.

Conservative treatments were administered for the low back pain of the patients. These conservative treatments consisted of administration of medications, rest, exercise, physical therapy, and injections for algological purposes. Control scoliosis radiographs were obtained after the complaints of low back pain were resolved in the clinical follow-up of the patients. Sagittal parameters were determined using the Surgimap program in the control scoliosis radiographs taken approximately five weeks later, as was also done with the first radiographs.

3. Results

Although 70 patients were first included in this study, the follow-up of the five patients could not be maintained because the patients could not be reached. Therefore, this study continued with 65 patients. The clinical follow-up period of the patients was between 2-4 weeks, on average, three weeks. Of the 65 patients included in the study, 42 (64.6%) were female and 23 (35.4%) were male. The mean age of the patients was 44.7± 11.3. None of the patients had neurological deficits. Descriptive statistics were employed to summarize the patient data. A two-way repeated measures ANOVA test was utilized to compare numerical variables measured prior to and after the administration of analgesia and to investigate gender differences. IBM SPSS Statistics for Windows, version 26 (IBM Corp., Armonk, N.Y., USA) was employed for statistical analysis. Before the analgesia administration values were LL: 26.4 ± 12°, PT: 30.8 ± 5.8°, SS: 18.9 ± 3.3°, SVA: 9.3 ± 2.7 mm and TK: 18.2 ± 7.8°, while post-analgesia values were as follows: 42.6 ± 11.7°, PT: 16.3 ± 1.8°, SS: 32.5 ± 7.5°, SVA: 5.1 ± 2 mm and TK: 30.9 ± 5.7°. Changes in these values were found to be statistically significant ($p < 0.001$) An increase in LL, SS, and TK was observed after the application of analgesia, whereas PT and SVA values decreased. There were no statistically significant gender-related differences in LL, PT, SS, and TK ($p = 0.568$, $p = 0.069$, $p = 0.662$, $p = 0.138$, respectively). However, the post-analgesia change in SVA values was found to be statistically different between genders ($p < 0.001$). Mean values are given in Table 2 (Table 2).

Table 2. Analysis of statistical data

	Pre			Post			p	
	Total (n=65)	Female (n=42)	Male (n=23)	Total (n=65)	Female (n=42)	Male (n=23)	Time	Timex Group
LL	26.4±12	28.2±11.4	22.9±12.6	42.6±11.7	43.7±13.4	40.6±7.5	<0.001	0.568
Pİ	49.7±5.3	48.8±5.6	51.3±4.3	49.6±5.4	48.6±5.7	51.3±4.4	0.187	0.128
PT	30.8±5.8	30±5.6	32.3±5.9	16.3±1.8	16.4±1.9	16.1±1.5	<0.001	0.069
SS	18.9±3.3	18.9±3.2	19.2±3.5	32.5±7.5	32.1±7.8	33.2±6.9	<0.001	0.662
SVA	9.3±2.7	10±2.7	8.1±2	5.1±2	4.6±1.3	5.9±2.8	<0.001	<0.001
TK	18.2±7.8	16±6.3	22.3±8.7	30.9±5.7	30±5.6	32.5±5.7	<0.001	0.138

LL: Lumbar lordosis, PI: Pelvic Incidence, SS: Sacral Slope, PT: Pelvic Tilt, SVA: Sagittal Vertical Axis

4. Discussion

The number of clinical and radiological studies on the subject of sagittal alignment has been increasing in the last decade (6-8). The posture that requires the least energy to achieve the ideal sagittal alignment is keeping the head roughly over the pelvis. It has been reported in the literature that parameters of the quality of life (HRQOL) are affected in patients with impaired sagittal alignment (9). Various compensation mechanisms are involved in providing the proper sagittal alignment. The most prominent of these compensation mechanisms are the patient's knee flexion, pelvic retroversion, thoracic hypokyphosis, and cervical hyperlordosis. The effects of pelvic retroversion on spinopelvic parameters are an increase in pelvic tilt value (PT) and a decrease in sacral slope (SS) value (10). In younger patients, pelvic retroversion can be performed sufficiently to create the sagittal balance, but compensation mechanisms may become insufficient with advancing age. Pelvic retroversion becomes a more frequently used mechanism for compensation with advancing age, due to the relative weakness and insufficiency of the back muscles (11). There is a strong relationship between PI, PT, SS, and LL values in the lumbar spine of healthy individuals to ensure a balanced posture. However, there is no consensus in the literature regarding which of these parameters is more significant. Radovanovic et al. reported that the correction of the sagittal imbalance that arises from the anterior deterioration in SVA seen in individuals with degenerative spinal diseases is critical in obtaining good clinical results (12). Also, Kim et al. reported that VAS and ODI scores improved by bringing PT, one of the spinopelvic parameters, to normal limits (13). In another study, it was reported that increased PT value was associated with chronic low back pain (14, 15). Aruju et al. reported that the most prominent change that arises from chronic low back pain on spinopelvic parameters is the anterior deterioration of the SVA (16).

In our study, we observed that patients with acute low back pain utilized compensation mechanisms to reduce pain rather than trying to maintain proper sagittal alignment. Several pathologies that may lead to acute low back pain may cause some changes in spinopelvic parameters, especially in the lumbar lordosis. Multifidus muscles provide two-thirds of the spinal segmental stabilization and therefore are critical for proper sagittal alignment. Pathologies in this muscle group provoke muscle strain and loss of function, which may bring about a decrease in the LL parameter (17). In patients with facet syndrome, there is inflammation in the facet joints, which may cause an increase in pain due to mechanical axial pressure in an instance of hyperlordosis. Patients then try to compensate for this pathology by reducing Lumbar Lordosis to alleviate the pain (18). Pelvic incidence (PI) is a morphological parameter; it is not affected by posture or pelvis position and is considered to stay constant along with age for each person after the growth ends (19). There are studies in the literature reporting that patients with higher PI values have more risk of spondylolisthesis development and progression (20, 21). In our study, we observed that among the parameters measured by evaluating the scoliosis radiographs taken during the painful and painless periods of the patients with low back pain, the increase in PT, decrease in SS, decrease in LL and anterior increase in SVA were statistically significant. Especially among the patients whose VAS (visual analog scale) pain scores were higher were observed to have higher SVA values. It was also observed that the PT values of the patients increased during the painful period, and the PT values remained within the healthy population levels during the painless period. Another result we found in our study was that patients with higher PI values had higher VAS scores.

With the aging of the spine, pathologies, such as asymmetric disc degeneration and facet joint hypertrophy appear in older patients. After that, the lumbar lordosis decreases, and the sagittal vertical axis increases due to these pathologies. Upon these changes, pelvic retroversion is tried to be increased to provide global balance (22). Waist and hip muscles work even harder to increase pelvic tilt (PT) and this situation further may increase the patient's pain. In chronic low back pain, sagittal alignment is disrupted due to various reasons, and this sagittal malalignment increases the pain by acting as a trigger (23). Differently, in acute low back pain, the pain itself acts as a trigger, and sagittal balance is impaired due to pain. Without knowing when the clinical findings first appeared, one must not decide whether the patient has a sagittal imbalance by evaluating only the scoliosis graphs. The relationship between sagittal balance and pain brings to mind a chicken and egg situation. Nobody knows which comes first. Thus, it is necessary to determine carefully whether the impairment of the sagittal balance is the cause or the result in patients in whom conservative or surgical treatment is planned. In other words, the question should be asked whether the sagittal imbalance is the trigger of the pain or a consequence of the pain. The main difficulties in clinical decision-making mostly occur in the presence of acute clinical findings seen in patients with chronic low back pain. We consider that this problem can be solved in this patient group by analyzing whether the sagittal imbalance has occurred in an acute or chronic process. We define the term acute sagittal imbalance, which has not before been used in the literature, as a type of sagittal imbalance that occurs with sudden back or leg pain within 12 weeks. The small size of our patient group is one of the factors limiting our study. By analyzing the factors causing acute low back pain one by one with detailed studies to be conducted in the future, the relationship between acute low back pain and sagittal balance will be clearer to understand.

Lumbar lordosis decreases as a result of pathologies, such as asymmetric disc degeneration and facet joint hypertrophy that occur in a chronic process, and the sagittal imbalance appears as a consequence of all these. After that, the mechanisms utilized to compensate for the resulting sagittal imbalance led to low back pain. However, differently, in the case of acute low back pain, the patient changes the sagittal alignment first, to yield a less painful posture. Therefore, better definition, recognition, and distinction of this group with acute sagittal imbalance will play a significant role in the correct treatment process for the patients.

Ethical Statement

The Ethics Committee Approval date is 17.12.2020 and the number 2020/80.

Conflict of interest

The authors have no conflict of interest declaration.

Funding

There is no financial support for our study.

Acknowledgments

None to declare.

Authors' contributions

Concept: N.A., A.A.A., Design: N.A., A.A.A., Data Collection or Processing: N.A., A.A.A., Analysis or Interpretation: N.A., A.A.A., Literature Search: N.A., A.A.A., Writing: N.A., A.A.A.

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