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Prognostic value of measuring the angles of lumbar lordosis and thoracic kyphosis with the Saunders inclinometer in patients with low back pain☆

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ABSTRACT

Introduction: The objective of the study is evaluation of usefulness of measuring angles of lumbar lordosis and thoracic kyphosis in adults suffering from the low back pain (LBP).
Aim: The aim of this paper is to show the usefulness of measuring the angles of anteroposterior curvatures of the spine with the Saunders electronic inclinometer, using a direct method of measurement, in the LBP patients treated in a rehabilitation outpatient clinic.
Material and methods: The sample group included 87 people suffering from LBP, treated in the outpatient rehabilitation clinic. The angle of lumbar lordosis (LL) and the angle of thoratic kyphosis (TK) were measured with the use of the Saunders inclinometer. The differences between the compared groups were assessed on the basis of the Pearson χ^2 significance test.
Results and discussion: The LL angular values were mostly included within the 20°–40° in both, men and women, and they were found in 72%–78% of the examined patients. Lower LL was found to occur more often in men, but the difference was not statistically significant. Statistically significant functional shortenings of lower limbs above 1 cm were more often found in men (62.5%).
Conclusions: (1) An alteration of the spine shape in the sagittal plane can be regarded as one of the potential factors of the LBP risk. (2) Measurements of the LL and TK angular values seem to be a legitimate element of the orthopedic examination of the patients suffering from LBP. (3) Reduction of lumbar lordosis can be an LBP risk factor, particularly in men.

☆ The study was carried out at the first author's own expense.

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1. Introduction

Chronic low back pain (LBP) can be diagnosed when it persists for more than 6 months.[1] The LBP is one of the most common afflictions and it can affect about 80% of human population.[2] Many systematic review articles have been published with reference to the efficacy of various methods of the LBP treatment, but the results are inconclusive.[3] Many risk factors of LBP have been proposed, including age, gender and body mass index (BMI), or physical activity.[4–9] However, correlation between those risk factors and the LBP remains elusive. Alteration of anteroposterior curvatures of the spine is considered to be a possible risk factor of the LBP.[10,11] Disorders of body posture often result from static or dynamic imbalance of the spine, the source of which is in the disharmony of muscle tonus of different antigravitational muscle groups.[7,10,11]

Disorders of body posture manifest clinically with abnormal angles of anteroposterior curvatures of the spine.[8,12] Mutual interaction between different sections of the spine, as well as the role of the whole spine in the biomechanical chain, affects position of the pelvis, which can lead to abnormal anatomical interactions between the spine and the pelvis in a long-term perspective.[12–15]

2. Aim

The aim of this paper is to show the usefulness of measuring the angles of anteroposterior curvatures of the spine with the Saunders electronic inclinometer, using a direct method of measurement, in the LBP patients treated in a rehabilitation outpatient clinic.

3. Materials and methods

3.1. Patients

The studied group of patients consisted of 87 adults, 25–75 years of age (53.8 ± 13.8 years). There were 55 women (aged 54.65 ± 12.66) and 32 men (aged 52.5 ± 15.4), undergoing an LBP treatment in a rehabilitation outpatient clinic (Table 1). The patients were selected on the basis of the following criteria: chronic back pain located in the lumbar section of the spine, lasting minimum 6 months during the preceding 3 years. Patients who had the history of spinal surgeries or injuries – such as fractures, undergone surgical stabilizations, car crash accidents, falls from heights, psychological traumas, spondylolisthesis, scoliosis with Cobb angle exceeding 10°, or any other conditions (e.g. neurological) that could induce LBP of other origin than age-associated spondylosis, were excluded from the study.

Table 1 – Number, age and gender of the examined patients.

Age	Men		Women		Total	
	n	%	*n*	%	*n*	%
25–35	7	21.8	5	9.1	12	13.8
36–50	7	21.8	12	21.8	19	21.8
51–75	18	56.4	38	69.1	56	64.4
Total	32	100	55	100	87	100

The Human Subjects Research Committee of the University scrutinized and approved the test protocol as meeting the criteria of Ethical Conduct for Research Involving Humans. All subjects in the study were informed of the testing procedures and voluntarily participated in the data collection.

3.2. Protocol

The measurements have been carried out with a Saunders inclinometer. The evaluated parameters were magnitudes of lumbar lordosis (LL) and thoracic kyphosis (TK) (Fig. 1). The measurements have been carried out in accordance with guidelines elaborated by the inclinometer's manufacturer, on the basis of recommendations of American Medical Association.[16,17] In addition, the leg length discrepancy (LLD) was evaluated according to Derbolovsky sign, regarding at least 1 cm difference between the functional length of lower extremities as a positive result. Each researcher repeated

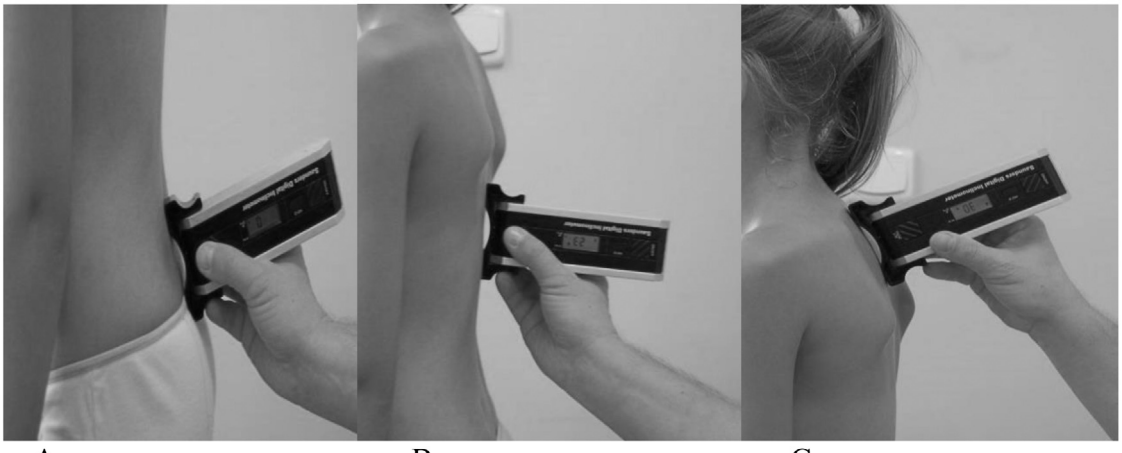

Fig. 1 – Lumbar lordosis assessment: (A) 1st phase, (B) 2nd phase read the angle of LL, then we reset the device; (C) move to the upper thoracic spine and read the angle of TK.

Table 2 – Frequency for LL and TK in three angular ranges in three age groups.

Lordosis angle,°	Age group, *n*(%)			Kyphosis angle,°	Age group, *n*(%)		
	20–35	36–50	51–75		20–35	36–50	51–75
<20	4(33%)	3(15.8%)	10(18.5%)	<20	5(41.7%)	4(21.1%)	13(24.1%)
20–40	7(58.3%)	16(84.2%)	43(79.6%)	20–40	7(58.3%)	14(73.7%)	38(70.4%)
>40	1(8.3%)	0	1(1.8%)	>40	0	1(5.3%)	3(5.6%)

Table 3 – Frequency for LL and TK in three angular ranges according to gender.

Lordosis angle,°	Gender, *n*(%)		Kyphosis angle,°	Gender, *n*(%)	
	Women	Men		Women	Men
<20	8(14.5%)	9(28.1%)	<20	12(21.8%)	10(31.1%)
20–40	43(78.2%)	23(71.8%)	20–40	38(69.1%)	21(65.6%)
>40	2(3.6%)	0(0%)	>40	3(5.4%)	1(3.1%)
No statistically significant difference between women and men was found ($P = 0.14$)			No statistically significant difference between women and men was found ($P = 0.25$)		

Table 4 – Frequency of occurrence of the positive result of the Derbolovsky test (Test *D*) in the sample group for women and for men.

Test *D*, cm	Gender, *n*(%)		Total
	Women	Men	
$D < 1.0$	38(69.9%)	12(37.5%)	50(57.5%)
$D \geq 1.0$	17(30.1%)	20(62.5%)	37(42.5%)
Statistically significant differences were found between women and men ($P = 0.004$). In women, more often than in men, the level of the *D* variable did not exceed 1.0 cm.			

each measurement three times, and subsequently, a mean result value was recorded in the report. The patients were divided into three groups, according to their age and gender (see Table 1).

3.3. *Statistics*

Statistic assessments were evaluated, describing collective data such as the median result and the standard deviation. The differences between the compared groups were assessed on the basis of the Pearson χ^2 significance test. Statistical significance was assumed to be at the $P < 0.05$ level. All calculations were made with the use of the IBM SPSS 23.0.

4. Results

The patients were divided into three age-related groups: 20–35 years of age, 36–50 years of age, and 51–75 years of age; their angular values of LL and TK were divided into three ranges: less than 20°, 20°–40°, and over 40° (Table 2). The lowest-grade lordosis (below 20°) was found in almost 20% of all the patients, with the highest occurrence in the eldest group (51–75 years of age). The most prevalent LL was a medium-grade lordosis (20°–40°), which was most common in the middle-aged patients (36–50 years of age). As to the TK, the most common magnitude in each age-related group was within the range of 20°–40°. The TK angle lower than 20° was more prevalent in younger patients, while the angle higher than 40° was more prevalent in oldest patients. There was a noticeable tendency to LL decrease and TK increase with age.

Gender-related differences in LL and TK angular values have been illustrated in Table 3. The LL angle below 20° was more common in men, while the angle over 40° was more commonly found in women, although the differences were not statistically significant. The same tendencies were observed in reference to the TK angles, and the differences were not statistically significant, either. Both in men and in women, the most prevalent angular values of the LL and TK were within the range of 20°–40°.

The prevalence of positive Derbolowsky sign is presented in Table 4. The percentage of patients who did not show LLD exceeding 1 cm was over 57%. LLD was more prevalent in men, and the difference was statistically significant.

5. Discussion

The most numerous group of patients included in the study (64.4%) comprised the eldest ones (51–75 years of age), which basically reflects age distribution in patients treated in rehabilitation outpatient clinics. Young people (20–35 years of age) contributed only 13.8% and, in contrast to the two remaining age-related groups, were mainly men (58.3%; see Table 1).

Because of a very small number of the published articles about the clinical evaluation of patients suffering from LBP with inclinometers, the results of our study have been

compared to the angles of spine curvatures obtained from the measurements carried out on lateral radiograms. The three ranges of angular values of the LL and TK used in our study (<20°, 20°–40°, and >40°, correspondingly) were selected on the basis of the results of some previous studies.[15–18]

When referring those values to research studies containing analysis of LL angular values, as well as parameters of pelvis placement in lateral X-ray photographs, Chanplakorn et al.[2] proposed division of the LL into three types. They have also introduced the term 'lumbo-pelvic alignment' (LPA) referring to the clinical evaluation of LL, according to the angle between the line drawn through the upper margin of the S1 vertebra and the line drawn through the upper margin of the L1 or the L2 vertebrae. Type 1, denoting the hyperlordosis (the LL angle more than 45°) occurred mainly in women. Type 3 denoting a hypolordosis (the LL angle less than 35°) and almost vertical placement of sacral bone, while Type 2 is intermediate as to the angle of LL (35°–45°). When comparing the classification quoted above to the classification introduced in our paper, one can attribute Type 1 to LL angle over 40°, Type 2 to LL angle range of 20°–40°, and Type 3 to the LL angular values below 20°. In their paper, the authors confirm the existence of gender-dependent differences in angular values of the LL between men and women with LBP; Type 1 being predominant in women, while Type 3 – in men.

Similar conclusions are contained in papers published by Vialle et al.,[18] Mitchell[19] and Janssen.[20] As it can be seen in Table 3, in our patients, the most prevalent angle of the LL – both in men and in women – was within the range of 20°–40°. When comparing the gender-dependent distribution of the LL and TK angles, much more common occurrence of values below 20° in men can be noticed, albeit this difference is not statistically significant (Table 3).

Mac-Thiong has drawn different conclusions,[10] because he has not observed any gender-related differences in angular values of the LL in the LBP patients. In our study, lower values of the LL angle occurred in younger people, and, generally, in men. The TK angle was most often within the range of 20°–40°, in all age-related groups. Similar to the LL angle, also the TK angle below 20° occurred mostly in the youngest patients. On the basis of analysis of spine curvatures in the sagittal plane – both in healthy individuals and in patients with discopathy – Rajnic et al.[21] concludes that a decreased LL angle is a risk factor for LBP.

After making a meta-analysis of research studies containing the evaluation of the spine shape in the sagittal plane – both in the LBP patients and in healthy individuals – using skin surface measurement technique, Laird et al.[22] state that the results of 8 articles have not confirmed the difference in the LL angle between the LBP patients and healthy persons, whereas the results of 19 other papers have confirmed a decreased LL angle in the LBP patients.

When referring to the gender-related difference in LBP occurrence, with apparently more frequent occurrence in women, Sagy et al.[23] suppose that women more eagerly come to pain treatment or rehabilitation outpatient clinics. When evaluating gender-related differences in the LL angle with an electromechanical device with a digital converter – both in the LBP patients and in healthy individuals – Norton et al.[24] reported greater LL angles in women, by 12° on average. These authors, however, have not found any gender-related differences in reference to the LBP cause or its correlation with the LL angle, so they suggest the existence of an additional mechanism of LBP in women, which can be related to the anatomy of the pelvis and various kinds of back pain.

Gardocki et al.[25] measured the LL angles on the basis of lateral radiograms of the spine, and analyzed mutual interactions between individual sections of the spine, starting from C7. Subsequently, the authors analyzed mutual correlations between angular values of the LL, TK, and sagittal balance of the spine. Finally, they stated that there is a statistically significant correlation between the LL and TK angles, so it is necessary to measure these parameters when treating patients with diseases of the spine.

In a study made by Jackson and McManus,[26] we can find a comparative analysis of body posture parameters, measured on the basis of lateral radiograms of the spine, both in the LBP patients and healthy volunteers. They analyzed angular values of sacral bone inclination in reference to vertical line drawn from C7 downwards; they also measured the Cobb angles of LL and TK. In patients treated because of the LBP, they found both the decreased LL angles and the decreased sacral bone inclination angles, with the LL angle alteration referring mainly to L4, L5, and S1 segments. Despite the fact that the method of measurement applied in the study mentioned above is based on X-ray photograph analysis, the way of drawing the LL angle is similar to that obtained by using the Saunders inclinometer.

Another studied parameter was the functional length of lower extremities. It has been found that the percentage of patients showing the LLD was about 42.5%. In a similar study made by D'Amico et al.[27] the percentage of patients showing the LLD among 300 patients with LBP equaled 70%. LLD exceeding 1 cm ($P = 0.004$) occurred more often in men than in women, and the difference was statistically significant (Table 4). On the basis of some criteria that indirectly refer to the clinical evaluation carried out in this paper, many studies included in the references[7,13,22,25,26,28,29,30,31] confirm the necessity to measure the LL, TK, as well as other parameters of lumbosacral complex, and show a direct correlation between a decreased LL angle and the risk of LBP occurrence. In everyday practice of a doctor working in a rehabilitation outpatient clinic, direct evaluation of body posture parameters seems to have a significant clinical and prognostic value. The evaluation of LL and TK angles can also have a prognostic value in the course of treatment of patients with LBP, as well as after the treatment. The opinions mentioned in this discussion show the necessity to continue research studies on body statics, with special attention paid to direct measurement of the LL and TK angles.

6. Conclusions

1. Any alteration of the spine shape in the sagittal plane can be regarded as one of the potential factors of the LBP risk.
2. Measurements of the LL and TK angular values seem to be a legitimate element of the orthopedic examination of the patients suffering from LBP.

3. Reduction of lumbar lordosis can be an LBP risk factor, particularly in men.

Conflict of interest

None declared.

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