

Radiometric assessment of chosen parameters concerning sagittal balance of the pelvis in persons with chronic low back pain younger than 64 years and older than 65 years

Radiometryczne badania położenia kości krzyżowej u chorych na dyskopatię lędźwiową w wieku do 64. roku życia i powyżej 65. roku życia z przewlekłym bólem krzyża

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Słowa kluczowe: osoby starsze, ból kręgosłupa, położenie kości krzyżowej.

Summary

The aim of the study was to assess changes in chosen parameters of sagittal balance of the pelvis in persons with chronic low back pain (CLBP) younger than 64 years and older than 65 years. Total number of randomly chosen hospitalized patients engaged in the study was 152. The patients were divided into 2 groups: persons younger than 64 years (group I, 117 persons, mean age 40.8 years) and older than 65 years (group II, 35 persons, mean age 69.7 years). Radiometric measurements were carried out using radiographs of the pelvis, sacral bone and lumbar spine taken in lateral projections. Results showed that angle A (pelvic angle) was statistically significantly larger in patients from group II (group I – 16°, group II – 21°). Distance D (sacral translation) was also statistically significantly different between groups (group I – 50.3 mm, group II – 61.6 mm). There was no statistically significant difference for angle B (pelvic morphology) (group I – 34.7° and group II – 29.3°) and angle C (lumbar lordosis, L1-L5) (group I – 29.2° and group II – 33°). Posterior rotation of the pelvis and sacral bone is often seen in persons with back pain.

It is most often accompanied by lumbar hypolordosis, which, together with increase in angle A, could reflect the muscular reaction to pain. Increased angle A and distance D in group of patients older than 65 years was more significant than in youngest one. It can be related with time of duration of back pain or accompany aging of muscles which supporting sagittal balance of the pelvis.

Streszczenie

Celem pracy była próba opisanie różnic położenia kości krzyżowej w grupach pacjentów do 64. roku życia (grupa I) i powyżej 65. roku życia (grupa II) z przewlekłym bólem dolnego odcinka kręgosłupa. Do badania zakwalifikowano 152 osoby. W całej grupie pacjentów dokonano podziału na osoby poniżej 64. roku życia (117 osób, średni wiek 40,8 roku) i powyżej 65. roku życia (35 osób, średni wiek 69,7 roku). Pomiary radiometryczne wykonywano na zdjęciach bocznych miednicy i kręgosłupa odcinka lędźwiowo-krzyżowego.

Po wykonaniu analizy statystycznej stwierdzono, że kąt A (*pelvic angle*) jest istotnie statystycznie większy u pacjentów w grupie II (grupa I – 16° i grupa II – 21°). Odległość D (*sacral translation*) uzyskała także istotną statystycznie różnicę (grupa I – 50,3 mm, grupa II – 61,6 mm). Nie uzyskano różnicy istotnej statystycznie dla kąta B (*pelvic morphology*) (grupa I – 34,7° i grupa II – 29,3°) i kąta C (lordoza lędźwiowa, L1–S1) (grupa I – 49,2° i grupa II – 55°). Rotacja tylna miednicy wraz z kością krzyżową jest często stwierdzana u osób z bólem kręgosłupa. Najczęściej towarzyszy jej hipolordoza lędźwiowa, co wspólnie ze zwiększeniem wartości kąta A może stanowić odruch mięśniowy na ból. W grupie chorych starszych stwierdzono zwiększenie kąta A i długości D w większym stopniu niż u chorych młodszych, co może być związane ze znacznie dłuższym okresem trwania zespołu bólowego u chorych starszych wiekiem lub z fizjologicznym osłabieniem mięśni, które stabilizują miednicę w rotacji przedniej.

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Background

Musculoskeletal diseases are the most common source of pain in persons aged 65 years and older. In about 25% of elderly people pain is present every day [1]. Epidemiological data show that frequency of back pain in people age 65 and older reaches several percent [1-3].

Factors responsible for higher frequency of chronic low back pain (CLBP) in elderly people are: degenerative changes, osteoporosis and mechanical insufficiency of paraspinal muscles and ligaments [4]. The above-mentioned changes disturb spinal functions, e.g. cause a decrease in spinal range of movement, and changes in spinal curvatures [4]. This results in dislocation of the centre of gravity, which may increase forces overloading the spine [5-7].

In practice we are able to diagnose osteoarthritis and osteoporosis. Following this we undertake attempts to treat and to prevent the disorders. Much less is known about changes in functions of the aging spine. Recognition of measurable symptoms of this condition would support treatment of back pain [5, 8].

We compared in our study two age groups with chronic low back pain. We tried to find parameters which are subject to aging-related changes and could characterize CLBP in elderly people.

For this purpose we attempted to characterize differences in radiometric measurements of the pelvis in persons with CLBP younger than 64 years and older than 65 years. Measurements concerning anatomical relations in the sagittal plane between the hip joints, spinal column and sacral bone were carried out. The above-listed structures are responsible for transmission of forces supporting the pelvis (hip joints) and forces opposite to those resulting from body gravity (sacral bone) [6, 9-12]. The forces do not act in the same axis in the sagittal plane and thus their spatial relations are of great importance [13-18]. In other words even a small change in sacral bone position with constant position of the femoral heads in a standing position could alter the loading forces acting on the spine and pelvis [19].

The aim of the study was to assess some parameters of anatomical relations between hip joints and the sacral

bone in patients with CLBP younger than 64 years and older than 65 years.

Material and method

The study involved 152 randomly chosen patients including 80 women and 72 men aged 25-77 years (mean age 47 years) with exacerbated CLBP hospitalized in the Spondyloneurosurgery and Neurology Department of the Rheumatology Institute in Warsaw, Poland. In every case the diagnosis was confirmed by MRI of the spine. All patients had a history of chronic complaints with duration of 3 to 480 months from their first pain episode in life to the day of hospital admission.

The patients were divided into two groups: the first with 117 patients younger than 64 years including 55 women and 62 men (mean age 40.8 years), and the second with 35 patients older than 65 years including 17 women and 18 men (mean age 69.7 years).

There were statistically significant differences in duration of the pain syndrome between compared groups (Table I).

Degenerative disc disease with disc herniation at the level of L3-L4 was diagnosed in 2 persons, at the level of L4-L5 in 54 persons, at the level of L5-S1 in 51 persons, at the levels of L4-L5 and L5-S1 in 31 persons, at the levels of L3-L4 and L4-L5 in 11 persons and at the levels of L3-L4, L4-L5 and L5-S1 in 3 persons.

The first phase of the study included medical history-taking as well as neurological and segmental orthopaedic assessment. Statistically significant differences in medical history findings and physical examination between group I and II comprised duration of pain syndrome (Table I) and frequency of L3-L4 degenerative disc disease, which was 8.24% in group I and 28.7% in group II ($p < .05$).

Radiological examination of pelvis and spine was carried out in the course of CLBP diagnostics [7, 9, 20]. Measurements were performed in reproducible conditions. Patients stood with maximally extended knee joints. The pelvis was positioned in a way that the axis crossing the femoral heads was perpendicular to the x-ray film cassette plane. Based on lateral radiogram data, pelvic angle (angle A), pelvic morphology angle (angle B), and

Table I. Patients' characteristics

Tabela I. Charakterystyka badanej grupy pacjentów

Parameters	Group I	Group II	P
Duration of back pain from the first incident in life (mean value)	134 months	194 months	0.02
Duration of back pain which influenced the decision concerning hospitalization (mean value)	42 months	54 months	0.04

lumbar lordosis angle (angle C) as well as sacral translation (distance D) were measured (Fig. 1).

Angle A is a parameter describing the position of the pelvis in relation to the axis crossing the hip joints. It is one of the parameters characterizing pelvic balance. Angle B reflects pelvic inclination in relation to the axis crossing the hip joints [7]. As pointed out by Jackson, pelvic morphology is characterized by limited individual variability [7].

The angle has an influence on standing lumbosacral lordosis. Angle C describes the degree of physiological lumbar curvature and is inversely proportional to angle B. Distance D describes the arm of the pair of opposite forces: the first one supporting the pelvis and the second one gravity. It is one of the parameters determining pelvic balance [7].

Statistical analyses were performed in the medical statistics laboratory using SAS software (version 8). Statistical tests included Student's t-test and Wilcoxon test. Statistical level of significance was $p < 0.05$.

Results

We measured angle A enclosed between the line running upright from the hip joint axis and the line crossing the posterior superior corner of the S1 endplate and the middle of the axis extending through central points of the femoral heads. Larger angle A was observed in patients from group II. In the first group mean value of the angle was 16° ($11-24^\circ$) and in the second group it was 21° ($14-31^\circ$). The difference was statistically significant ($p < 0.001$). Another parameter with a statistically significant difference between studied groups was distance D ($p = 0.02$) between the hip joint axis and a vertical line running through the posterior margin of the S1 endplate. In group I the mean distance D was 50.3 mm (20-82 mm) and 61.6 mm in group II (24-90 mm).

Pelvic morphology angle (angle B) enclosed between a horizontal line and a line tangential to the S1 terminal plate describes rotational movement of the sacral bone in the sagittal plane. Angle B was 34.7° in group I ($17-52^\circ$) and 29.3° in group II ($16-46^\circ$). The difference between groups was not statistically significant ($p = 0.25$). Similarly, the difference between lumbar lordosis angle value (angle C) did not reach the level of statistical significance ($p = 0.26$). In group I it was 29.2° ($9-56^\circ$) and 33° in group II ($10-51^\circ$).

Discussion

Aging-related changes in bones, joints and soft tissues influence the course of musculoskeletal diseases. A good example is the lumbar spine. In

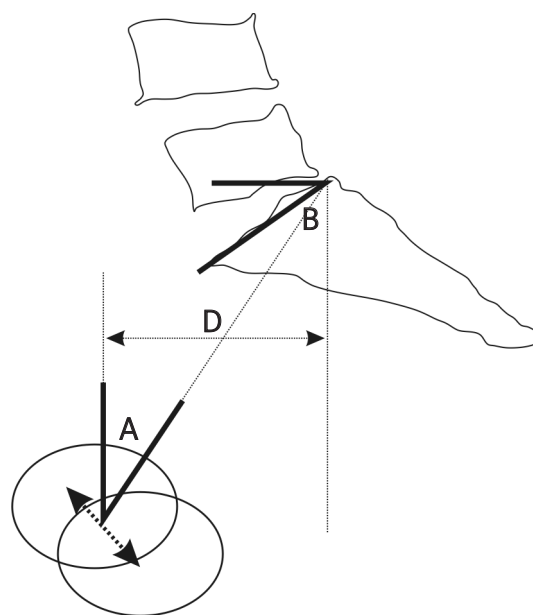


Fig. 1. Methodology of measurements concerning angles A, B and distance D. Angle A is enclosed between the line running upright from the hip joint axis and the line crossing the posterior margin of the S1 terminal plate and the middle of the axis extending through central points of the femoral heads. Distance D is measured between the hip joint axis and a vertical line running through the upper and posterior corner of the S1 endplate. Angle B is enclosed between a line tangential to the S1 endplate and line crossing the posterior margin of the S1 terminal plate and the middle of the axis extending through central point of the femoral heads.

Ryc. 1. Sposób pomiaru kątów A i B oraz odległości D. Kąt A jest zawarty między linią biegnącą pionowo przez środek osi stawów biodrowych i linią przecinającą tylny brzeg płytki granicznej górnej trzonu S1. Odległość D jest mierzona między pionowymi liniami przebiegającymi przez środek osi stawów biodrowych i tylny brzeg płytki granicznej górnej trzonu S1. Kąt B jest zawarty między linią biegnącą stycznie do płytki granicznej górnej kręgu S1 a linią biegnącą przez tylny brzeg płytki granicznej górnej kręgu S1 i środek osi łączącej centralnie punkty głów kości udowych.

the aging spine, prolapse of the nucleus pulposus is less frequent but pseudoradicular pain syndromes are more prevalent [21].

Differences in the course of musculoskeletal diseases result not exclusively from structural changes

characteristic for more advanced osteoarthritis [22]. Biomechanical influences which accompany musculo-skeletal aging play an additional significant role in the aetiology of the differences [23].

We attempted to assess changes in sacral position in relation to hip joints. Investigated parameters were compared between groups of younger and older patients with chronic low back pain.

The aim of the study was to explain which of the investigated parameters concerning sagittal balance of the pelvis in patients with low back pain were subject to time-related changes. We assumed that results of the study could be helpful in characterization of low back pain syndrome specific for elderly people.

Statistical analysis of the results showed significant differences between groups concerning angle A and distance D and comparable values concerning angle B and C.

Increase in angle A value is connected with rotation around the axis extending through the femoral heads [7]. Such a position of the pelvis and decrease in lumbar lordosis angle is often observed in patients with spinal pain [7, 21] and is caused by a reflexive increase in paraspinal and pelvic girdle muscle tone in response to pain [21].

Larger pelvic extension in the examined elderly people is reflected by an increase in distance D proportional to increased angle A. In both studied groups the lumbar lordosis angle was small and had no statistically significant difference. This may suggest similar changes of this angle induced by pain in compared groups. Lack of difference in angle C values may also be implicated to some extent by comparable intensity of pain on admission and discharge from the hospital in both groups.

Based on these data one may assume that the change in angle A results from the analgesic position of the spine, but there are suggestions in the literature proposing another mechanism of angle A increase in elderly people with CLBP.

Barrey and Sinaki pointed to disturbances in sagittal balance of the pelvis in elderly people [24, 25]. They described various grades of pelvic angulation during static and dynamic loads. During locomotion flexion of the pelvis around the hip axis is increased in contrast to standing, when extension of the pelvis is observed. Kapandji described mechanisms of pelvis stabilization in the sagittal plane [19]. In flexion the main stabilizing role is attributed to muscles, and in extension to ligaments. Decreased efficiency of muscles in the course of aging may explain the differences in spinopelvic balance. Newman described greater muscle fatigability in elderly people caused by static type of load [26].

Leaving aside attempts to give reasons for the increase in angle A values in group II, it must be underlined that this change influences the intensity of forces occurring in daily activity [6, 19, 27]. Rotation of the pelvis together with the sacral bone to the back in relation to the axis running through the femoral heads causes the sacral bone to recede from the perpendicular plane extending through the hip joints. This is suggested by the increase in distance D among patients from group II. In other words, equilibration of the arm of two opposite forces – supporting the pelvis and body gravity – requires higher activity of musculoskeletal elements. This may lead to increased load to the spine, pelvis and lower extremity joints [6, 19, 27].

Increase in angle A may also have an influence on the grade of thoracic kyphosis, as described by Barrey [24]. Decrease in lumbar lordosis and posterior rotation of the pelvis lead to anterior displacement of the C7 plumb line with an influence on the grade of thoracic kyphosis. Balzini reported the relation of chronic back pain and flexed posture [28].

Our results do not allow us to draw unequivocal conclusions concerning mechanical changes of sagittal balance of the pelvis; however, some aspects of those changes noted in the course of the study indicate the specific features of CLBP in elderly people which could have an influence on therapeutic approaches [24].

The research project will be continued with additional assessment of thoracic kyphosis grade.

Conclusion

In the group of patients with chronic low back pain (CLBP) older than 65 years parameters of sagittal balance of the pelvis are changed.

The change is manifested by larger posterior pelvic inclination than in younger patients with CLBP.

The reasons for the above-described position of the pelvis and sacral bone could not be unequivocally defined on the basis of gathered material.

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