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Effects of Mechanical Low Back Pain in Spatiotemporal Parameters of Gait

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Abstract

Background: Mechanical low back pain is one of the most common complaints of people, which may interfere with some aspects of daily living activity such as walking.
Objectives: The aim of the present study was to objectively assess the effects of mechanical low back pain on the gait pattern.
Methods: Thirty mechanical low back pain patients and 30 healthy subjects were recruited randomly (age 18 - 60). The spatiotemporal parameters of gait were assessed and recorded as subjects walked on a two-meter platform three times at their normal walking speed. Descriptive statistical methods were used to evaluate demographic characteristics. The independent samples *t*-test was used to compare the groups for the gait parameters.
Results: No significant differences were found between controls and patients in demographic variables. Significant differences were obtained between patients and healthy subjects in step length ($P < 0.04$), step time (0.009), single support time (0.04), stride length (0.04), stride time (0.01), velocity (0.03), and cadence (0.009).
Conclusions: The results of this study showed mechanical low back pain has a great influence on the spatiotemporal parameters of gait. The findings can be used in selecting better rehabilitation procedures.

Keywords: Low Back Pain, Gait, Walking

1. Background

Walking is one of the most common and primary movements performed by humans. For maintaining health, the physical activity should be of moderate intensity. For walking, it includes at least 100 steps per minute, equivalent to approximately 3,000 steps per half an hour (1). Since walking is a basic requirement for daily activity, any interference with this ability may have a considerable impact on the individual's life (2).

Walking as a complicated dynamic task requires a person to generate and face several multidirectional forces around each joint and with the ground. Gait, the pattern or style of walking, can be altered by insufficient passive mobility, muscle weakness, impaired proprioception and motor control, and pain (3). Therefore, any deficiency in muscular, skeletal, or nervous systems can be a reason for such changes in an ordinary gait pattern (4).

Low back pain (LBP) is a prevalent medical issue (5, 6) that has many repercussions including disability (7) and taking time off from work (7, 8). Mechanical low back pain (MLBP) excludes pain resulting from neoplasia, fracture, or inflammatory arthropathy that is referred from anatomical sites outside the spine, and in most cases, there is no precisely obvious underlying pathology (9). Mechanical back pain accounts for 97% of cases, arising from spinal structures such as bone, ligaments, discs, joints, nerves, and meninges (10).

Patients with low back pain repeatedly complaint of difficulties with walking, and usually walk slower than their healthy peers (11-17). Nevertheless, a few authors have examined the effect of MLBP on gait's spatiotemporal parameters. Healthcare professionals have long been concerned with the assessment of human gait; however, only recently could they utilize instrumental gait analysis in routine clinical practice for diagnosis and the selection of treatment methods for complex musculoskeletal and neurological disorders. Multiple treatment modalities are used to treat MLBP; however, strong evidence of being profitable is often lacking. The question is that to what extent using such modern technologies as gait analysis systems would assist healthcare professionals with managing musculoskeletal disorders, in particular, MLBP.

2. Objectives

The aim of the present study was to objectively assess the effects of MLBP on spatiotemporal parameters of gait.

3. Methods

In this case-control study, MLBP patients and healthy controls were recruited (n = 30 for each). The controls were matched to cases in demographic characteristics (age, height, weight, and BMI). All assessments were completed before testing. MLBP was defined as the pain experienced for at least three months located at lumbar, without inflammation signs, and not spreading to the lower extremities. The MLBP patients were diagnosed and referred by physical medicine and rehabilitation specialists.

The subjects were between 18 and 60-years-old. The gait performance of each subject was assessed at the biomechanics laboratory, AJA University of Medical Sciences.

The gait analysis was performed using the Zebris FDM system (ZEBRIS Medical GmbH, Germany). This measuring system can function using high-quality capacitive force sensors that are arranged in matrix form the platform to provide the accessibility of the spatiotemporal parameters of the gait in high accuracy. Gait measures were recorded as subjects walked a two-meter course three times at their normal walking speed.

We excluded subjects with spine congenital deformities, paresthesis, radicular pain in the lower extremities, limb length discrepancy, sacroiliac and hip disorder, history of spinal surgery, spine and lower limb fracture, major trauma and car accidents, and neoplasm or infections of the spine. In addition, individuals with structural and postural deformities in the lower limb were excluded.

All subjects were able to understand and complete the test and walk independently without aids and they signed a consent form. The evaluation was based on the dynamic gait analysis. Spatiotemporal parameters evaluated in this study include foot rotation, the percentage of pre-swing phase, swing phase, stance phase, load response, step length, step time, stride length, stride time, total double support, single support, cadence, and velocity variability.

The study data were analyzed using the statistical package for social sciences (SPSS) version 16 for Windows (SPSS Inc., Chicago, IL, USA). Descriptive statistical methods were used to evaluate sociodemographic characteristics. A P value of less than 0.05 was considered statistically significant. The independent samples *t*-test was used to compare groups for the gait parameters.

4. Results

No statistically significant difference was found between controls and patients in terms of age, gender, height, weight, and BMI (Table 1). Age and BMI variables were used as the indicators of normality assessment by utilizing the Kolmogorov-Smirnov test. The results demonstrated that in spite of enjoying a small sample size in each group, the study population was normally distributed (P value > 0.05); therefore, the statistical analysis was conducted using parametric tests. The results of *t*-test carried out to determine whether significant differences existed between the two groups are presented in Table 2. As can be seen, significant differences between patients and healthy subjects were obtained for step length (P = 0.02), step time (P = 0.02), single support time (P = 0.04), stride length (P = 0.03), and cadence (P = 0.02).

Table 1. Demographic Characteristics of the Study Groups

Variables	Healthy Controls	Patients
Age, y	43.4 ± 10	39.2 ± 11
Gender, %		
Male	60	66
Female	40	34
Height, m	1.69 ± 1	1.71 ± 1
Weight, kg	75.3 ± 11	72.9 ± 9
BMI, kg/m^2	25.3 ± 2	24.8 ± 1

[a] Values are expressed as mean ± SD.

5. Discussion

The aim of this study was to compare the changes in functional gait patterns in MLBP patients and healthy subjects. Almost all patients walked slower than the controls. The patients also took steps that were much shorter in length as indicated by the significant difference in stride length. Our findings are consistent with Barzilay et al. results showing that cadence, step length, and single support time were greater in healthy subjects than in nonspecific low back pain patients. They declared this different gait pattern is a protective strategy for patients who try to avoid extensive hip and spine range of motion and minimize force acting on the body, which may cause pain (18).

Single support time was longer in healthy subjects than in patients. In addition, cadence was less in patients than in healthy subjects. There are three basic factors in the various phases of any step that can be repetitively

Table 2. Gait Parameters Recorded for Patients and Controls[a]

Variables	Healthy Controls	Patients	Z	P Value
Step length, cm	56.8 ± 4.4	54.4 ± 5.7	-2.03	0.04
Step time, s	0.63 ± 0.06	0.67 ± 0.06	-2.6	0.009
Singe support, s	35.7 ± 1.5	34.6 ± 2.3	-1.9	0.04
Stride length, cm	112.9 ± 8.7	108.5 ± 11.6	-1.96	0.04
Stride time, s	1.29 ± 0.13	1.36 ± 0.13	-2.3	0.01
Cadence, step/min	47.1 ± 4.7	43.4 ± 6.9	-2.6	0.009
Velocity	3.09 ± 0.72	2.8 ± 0.66	-2.07	0.03

[a] Values are expressed as mean ± SD.

stressful to the lower back, including flexion of the lumbar spine during mid-single support phase, iliopsoas activity, and lateral trunk bending at toe off. The compensatory motions that are visible in chronic lower back pain patients consisting of decreased hip extension during a single support phase, flexed knee in mid-stance phase, and failure of heel lift during a single support phase probably caused shorter single support compared to healthy subjects (19). Smidt found that abnormal gait patterns are typically apparent in decreasing distance and increasing magnitude of parameters involving the time (20). Our outcomes are supported by the findings of Keefe and Hill who reported MLBP patients walked much more slowly, took shorter steps, and showed poor gait symmetry. They also demonstrated a higher level of overt pain behavior (21). They claimed that pain behaviors were much more likely to occur when patients were involved in movements such as walking or transferring from one position to another.

5.1. Conclusions

This study evaluated the effect of mechanical low back pain on gait parameters compared to healthy subjects. The findings of this study showed the accurate assessment of gait by using new technologies could be considered as an effective diagnostic method. The finding of the present study can provide a baseline for future interventional studies concerning mechanical low back pain.

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Footnotes

Authors' Contribution: Masoumeh Abedi contributed to conducting the tests, statistical analysis, and preparing the manuscript. Dr. Sharif Najafi contributed to study conception and supervising the project. Dr. Zahra Rezasoltani contributed to developing the study proposal and supervising the project.

Conflict of Interests: None declared.

Ethical Considerations: In this cross-sectional study, no intervention was imposed on the participants. Participating in the study was completely voluntary and informed consent was obtained from all participants. The study was approved by the Ethics Committee of AJA University of Medical Sciences. All the subjects were able to understand and complete the tests and walk independently without aids and they signed a consent form.

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