STUDY OF THE DIFFERENCES IN THE GAIT PARAMETERS OF HEALTHY AND DISEASED LIMBS IN PATIENTS WITH KNEE OSTEOARTHRITIS

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Abstract

Knee osteoarthritis is a prevalent condition that affects millions of people worldwide. It is a degenerative disease that occurs when the protective cartilage in the knee joint wears down over time, leading to pain, stiffness, and swelling in the knee. The actuality of knee osteoarthritis lies in its high prevalence, significant healthcare costs, and impact on quality of life. The article presents the results of the study of the difference in gait parameters of healthy and diseased limbs in patients with knee osteoarthritis. Twenty patients were examined. The diagnosis of knee osteoarthritis was established according to the criteria of the American College of Rheumatology. Gait parameters were studied using the GAITRite® system. The following parameters were studied: Temporal Definitions (Step Time, Gait Cycle Time, Single Support, Initial Double Support, Stance); Spatial Parameters and Definitions (Step Length, Stride Length, H-H Base of Support, Toe In / Toe Out). Among the investigated indicators, two demonstrated reliable differences between healthy and diseased limbs. It was found that Step Time for diseased limb was statistically significantly greater than for the opposite limb. At the same time, the foot support time of the healthy limb and, accordingly, the Initial Double Support indicator statistically significantly exceeded the similar indicators for the diseased limb. Summarizing the results of epy study, it can be stated that patients with knee osteoarthritis have a gait disorder in the form of asymmetric steps. Thus, the time of support on the foot decreases, and accordingly, the time of transferring the foot of the diseased limb increases. Changes in the diseased limb are also reflected in the opposite, healthy limb. An effort to increase the speed of movement during the examination causes an increase in movement on a relatively healthy limb in the form of an increase in the length of the step and a reduction in the time of transfer of the foot of the diseased limb.

Keywords: *knee joint; osteoarthritis; gait parameters; GAITRite.*

INTRODUCTION

Knee osteoarthritis is a prevalent condition that affects millions of people worldwide. It is a degenerative disease that occurs when the protective cartilage in the knee joint wears down over time, leading to pain, stiffness, and swelling in the knee [1]. The actuality of knee osteoarthritis lies in its high prevalence, significant healthcare costs, and impact on quality of life [2; 3].

According to scientific literature, knee osteoarthritis is one of the leading causes of disability worldwide, with an estimated 10% of men and 18% of women aged over 60 years being affected by the condition [4]. In the United States, it is estimated that over 14 million people have symptomatic knee osteoarthritis, and this number is expected to increase due to an aging population and rising obesity rates [5].

The epidemiology of knee osteoarthritis is complex, with several risk factors playing a role in its development [6]. These risk factors include age, obesity, genetics, joint injury, and repetitive knee use. Women are also more likely than men to develop knee osteoarthritis, although the reasons for this gender difference are not fully understood.

In terms of treatment, there is currently no cure for knee osteoarthritis, and treatment options focus on managing symptoms and improving function [7]. These options include non-pharmacologic interventions such as exercise, weight loss, and physical therapy, as well as pharmacologic

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such as nonsteroidal anti-inflammatory drugs (NSAIDs) and corticosteroid injections. In severe cases, surgical interventions such as knee replacement may be necessary.

Taking into account the changes in the functional state of the limb affected by knee osteoarthritis, it is interesting from both a scientific and a practical point of view to study the gait characteristics of such patients.

The aim of the study was to study the differences in gait parameters of healthy and diseased limbs in patients with knee osteoarthritis.

Materials and Methods

The study was conducted in accordance with the main provisions of the Helsinki Declaration of the World Medical Association on the ethical principles of scientific medical research involving human subjects (2000) and the order of the Ministry of Health of Ukraine No.281 dated November 1, 2000. The research protocol was approved by the biomedical ethics committee of National Pirogov Memorial Medical University, Vinnytsya.

The study was conducted on the basis of the Department of Traumatology and Orthopedics and the Department of Neurology with Neurosurgery of National Pirogov Memorial Medical University, Vinnytsya.

As part of the study, 20 patients with knee osteoarthritis were examined. The age of the patients was (62.3±9.1) years.

The diagnosis of knee osteoarthritis was established according to the criteria of the American College of Rheumatology [8].

Gait parameters were studied using the GAITRite® system (CIR Systems Inc., USA) [9].

Due to the peculiarities of our study, we selected the parameters of the GAITRite® system, which allow us to compare the function of healthy and diseased limbs [9]:

1. Temporal Definitions (Step Time, Gait Cycle Time, Single Support, Initial Double Support, Stance);

2. Spatial Parameters and Definitions (Step Length, Stride Length, H-H Base of Support, Toe In / Toe Out).

"Step Time – it is the time elapsed from first contact of one foot to first contact of the opposite foot (sec)" [9].

"Gait Cycle Time – it is the elapsed time between the first contacts of two consecutive footfalls of the same foot (sec)" [9].

"Single Support – it is the time elapsed between the Last Contact of the current footfall to the First Contact of the next footfall of the same foot. It is measured in seconds (sec) and expressed as a percent (%) of the Gait Cycle time of the same foot" [9].

"Initial Double Support – it occurs from heel contact of one footfall to toe-off of the opposite footfall. It is measured in seconds (sec) and also expressed as a percent (%) of the Gait Cycle time for the same foot" [9].

"Stance – it is the time elapsed between the First Contact and the Last Contact of two consecutive footfalls on the same foot. It is presented as a percentage (%) of the Gait Cycle time" [9].

"Step Length – it is measured along the length of the walkway, from the heel center of the current footprint to the heel center of the previous footprint on the opposite foot (cm) " [9].

"Stride Length – it is measured on the line of progression between the heel points of two consecutive footprints of the same foot – left to left, right to right (cm)" [9].

"H-H Base of Support – it is the vertical distance from heel center of one footprint to the line of progression formed by two footprints of the opposite foot (cm)" [9].

"Toe In / Toe Out – it is the angle between the line of progression and the midline of the footprint (degrees)" [9].

The obtained data of instrumental studies were processed statistically using the IBM SPSS Statistics 20.0 application program package. The mean (M) and standard deviation (SD) were calculated. Comparison of parameters of contralateral limbs was performed using the T-test method for repeated measurements.

Results and Discussion

Levels of studied Temporal Definitions and Spatial Parameters and Definitions of healthy and diseased limbs in patients with knee osteoarthritis are presented on the *Fig. 1* and *Fig. 2*.

According to the data of the statistical analysis, it was found that the time of transferring the diseased foot (Step Time) in patients with knee osteoarthritis was statistically significantly ($p=0.044$) greater than the time of transferring the opposite limb, i.e. the support was carried out on the foot of the healthier limb.

In patients, an increase in the duration of the step (Gait Cycle Time) of the healthy limb was noted, in comparison with the duration of the step of the diseased limb. However, due to the significant spread of the parameter (from 0.95 s to 1.82 s), the differences were not statistically significant ($p=0.362$). As for the Single Support parameter, it was also demonstrated that there were no differences ($p=0.941$) between the diseased and healthy limbs.

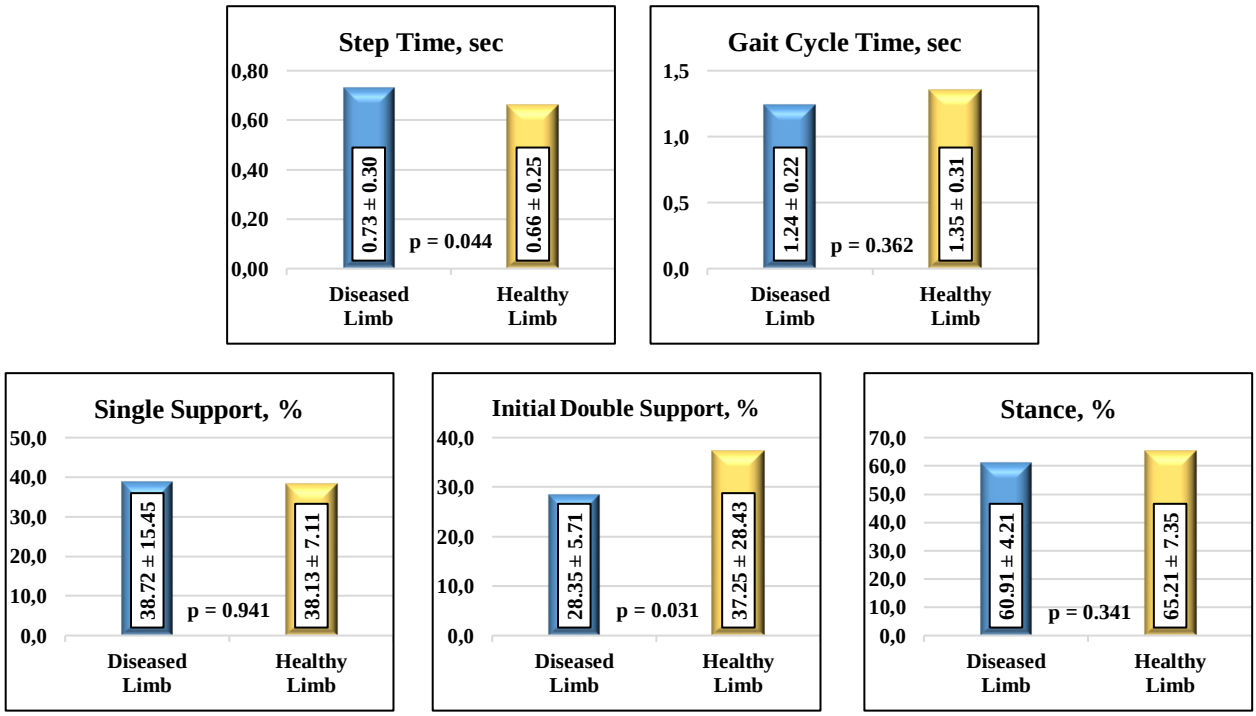

Fig. 1. Levels of studied Temporal Definitions of healthy and diseased limbs in patients with knee osteoarthritis.

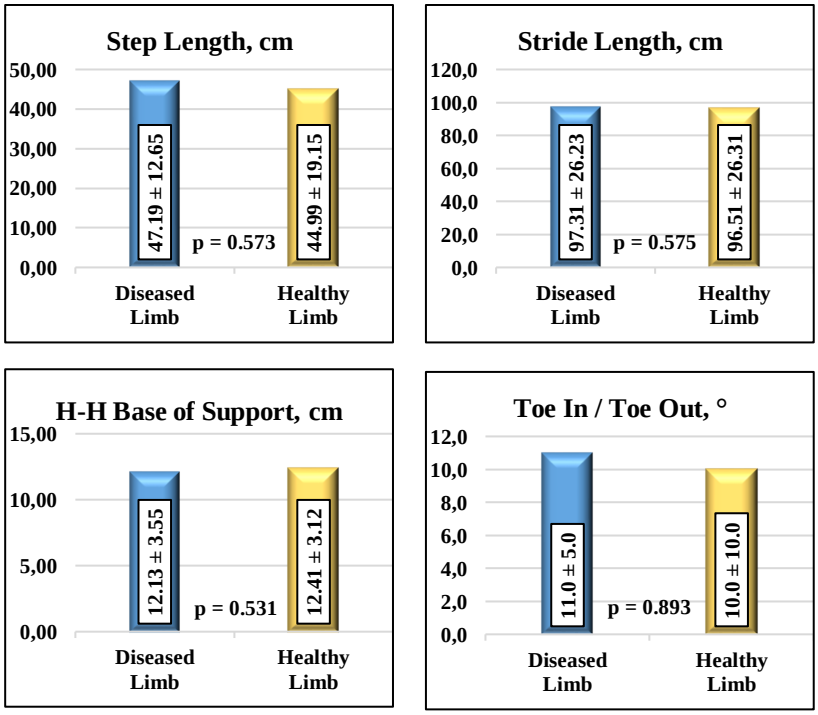

Fig. 2. Levels of studied Spatial Parameters and Definitions of healthy and diseased limbs in patients with knee osteoarthritis.

At the same time, statistical analysis showed that in patients with knee osteoarthritis, the foot support time of the healthy limb and, accordingly, the Initial Double Support indicator statistically significantly (p=0.031) exceeded the similar indicators for the diseased limb.

The study of the Stance indicator revealed that the studied contingent had a noticeable, although

statistically unreliable (p=0.341) decrease in support on the foot of the affected limb. This parameter is indicative due to its ability to determine the supportability of the feet. A decrease in the duration of support on the foot may indicate the presence of discomfort or pain syndrome.

In patients with knee osteoarthritis, although a slight increase in the length of the short step (Step Length) of the diseased limb by (2.11±8.89) cm was noted in comparison with the opposite healthy limb, however, the statistical significance of the differences could not be proven (p=0.573).

A similar picture was observed when studying the Stride Length parameter. In patients it was noted an increase in this indicator by (2.02±8.77) cm for the diseased limb, compared to the healthy one, but these differences were not statistically significant (p=0.575).

Statistical analysis of the parameter H-H Base of Support, or the width of the support, showed that the patients had no difference in the width of the support for both limbs, that is, its symmetry, as evidenced by the absence of statistically significant differences (p=0.531).

In patients with knee osteoarthritis, the foot is turned, mostly outward, which can be explained by additional adaptation to maintain balance while leaning on the limb. Thus, according to the results of the study of the Toe In / Toe Out indicator, the examined patients showed an increased angle of outward turning of the foot to an average of 10°, and this applied to both the diseased and healthy limbs. At the same time, the statistical significance of the differences was not observed (p=0.893).

Gait disorders refer to any deviation from normal gait that affects a person's ability to walk smoothly and efficiently [10; 11]. People with knee osteoarthritis often exhibit a slow, stiff, and uneven gait, which may be due to the different conditions that accompanies the disease.

Gait disorders can have a significant impact on a person's life, leading to reduced levels of physical activity, reduced functionality, and an increased risk of falls and fractures [2; 12; 13]. Some studies have shown that people with knee osteoarthritis and gait disorders are at higher risk of falls that can lead to serious injury. In addition to the physical consequences, gait disturbances can also affect a person's psychological health, causing anxiety, depression, and leading to social isolation.

Gait problems in knee osteoarthritis can be caused by several factors, including pain, joint stiffness, muscle weakness, and joint instability [14–17].

Pain is the most common cause of gait disturbance in knee osteoarthritis [14]. As the cartilage that cushions the knee joint wears out, the bones rub against each other, causing pain and inflammation. Pain can make it difficult for people with knee osteoarthritis to walk normally, resulting in a protective gait that includes slower walking and smaller steps to reduce stress on the knee joint. This gait pattern, also known as antalgic gait, can result in an uneven and stiff gait that can place additional stress on other joints such as the hip and ankle [18].

Joint stiffness is another important factor that may contribute to the development of gait disturbances in knee osteoarthritis [15]. As the disease progresses, the ligaments and muscles around the knee joint weaken, making it difficult to maintain proper position and balance. Stiffness in the knee joint can lead to reduced range of motion, making it difficult to bend the knee and lift the foot. This can result in a slow and shuffling gait with limited ability to lift the foot and push off the ground.

Muscle weakness is another factor contributing to the development of gait disturbances in knee osteoarthritis [16]. As the condition of the knee joint deteriorates, the muscles surrounding the joint may become weak and atrophy. This can lead to reduced muscle strength, making it difficult to maintain body weight and maintain proper gait mechanics. Weakness in the quadriceps is especially common in people with knee osteoarthritis and can lead to difficulty with activities such as climbing stairs and rising from a sitting position.

Joint instability is also an important cause of gait disturbance in knee osteoarthritis [17]. As the disease progresses, the ligaments and muscles around the knee joint weaken, making it difficult to maintain proper position and balance. This can lead to a wobbly, unsteady gait, which can increase the risk of falls and injury. Joint instability can also cause the knee joint to twist or deform, making proper movement difficult.

Summarizing the literature data and results of our study, it can be stated that patients with knee osteoarthritis have a gait disorder in the form of asymmetric steps. Thus, the time of support on the foot decreases, and accordingly, the time of transferring the foot of the diseased limb increases. Changes in the diseased limb are also reflected in the opposite, healthy limb. An effort to increase the speed of movement during the examination causes an increase in movement on a relatively

healthy limb in the form of an increase in the length of the step and a reduction in the time of transfer of the foot of the diseased limb.

Conclusion

In patients with knee osteoarthritis, there is a gait disorder in the form of asymmetry of steps, which is manifested by a decrease in the time of support on the foot, and accordingly, an increase in the time of transfer of the foot of the diseased limb.

In the future, a comparative study of gait parameters before and after knee arthroplasty in patients with knee osteoarthritis is planned.

DECLARATIONS:

Disclosure Statement

The authors have no potential conflicts of interest to disclosure, including specific financial interests, relationships, and/or affiliations relevant to the subject matter or materials included.

Data Transparency

The data can be requested from the authors.

Statement of Ethics

The authors have no ethical conflicts to disclosure.

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Consent for publication

All authors give their consent to publication.

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