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Comparison of static balance and gait between subjects with plantar fasciitis and age-matched controls

Abstract

Background. Since plantar fasciitis is characterized by foot pain and patients complain of tenderness to pressure at the origin of the plantar fascia on the medial tubercle of the calcaneus, the question arises to what extent foot pain and impaired foot function may affect gait and balance.

Objective: To identify differences in gait and balance between individuals with plantar fasciitis and age-matched controls.

Design: Cross sectional observational study.

Setting: Outpatient Rehabilitation Centre.

Participants: 29 subjects, 14 with plantar fasciitis (PF), and 15 age-matched asymptomatic (CG). The groups were homogeneous.

Main outcome measures: Foot pain, Foot function index (FFI), Static balance according to modified Romberg test, Static balance on TYMO® system, and gait with G-Walk System.

Results: Foot pain and foot function index were adversely related to balance and gait parameters in subjects with plantar fasciitis. Static balance with eyes open and eyes closed on firm and soft surface measured on TYMO® balance platform as well as gait parameters, were significantly lower in subjects with PF compared to those in age-matched controls.

Conclusion: Plantar fasciitis negatively affects parameters of static balance measured with TYMO® system and gait – with G-Walk System, but not static balance measured with modified Romberg test.

Keywords: plantar fasciitis, static balance, gait, foot function.

1. Introduction

The plantar fascia is a dense aponeurosis that begins at the posteromedial calcaneal tuberosity and attaches into each metatarsal head to shape and support the longitudinal arch of the foot [1]. It plays an important role in the normal biomechanics of the foot [2]. Even small changes in foot structures and perceived foot pain may have an effect on balance and gait [3, 4]; usually the pace and stride length of a person decreases, and the phases of walking become unbalanced [5].

The plantar fascia is one of the major stabilizing structures of the longitudinal arch of human foot [6]. Chronic overload of the plantar facia either from lifestyle or exercise might cause its degeneration [7]. Plantar fasciitis (PF) occurs when the plantar fascia is injured from too much pressure or activity [8] and is a common presentation in primary care [9] affecting 10% of sedentary individuals [10]. It is characterized by pain, sharpened with the first walking in the morning or after a long period of rest and dissipating when weight bearing is initiated [11].

During both static and dynamic balance, receptors in the foot transmit information about body position in space to the brain [12]. With less plantar fascia elasticity, motor error during standing and walking increases, and motor error may impair balance [13]. Activation of the intrinsic plantar muscles increases with increasing postural demand. These muscles are clearly important in postural control and are recruited in a highly co-ordinated manner to stabilise the foot and maintain balance [14]. The foot adapts to surface changes, controlling energy absorption and transfer [15]. Compared to healthy individuals, individuals with PF exhibit significant differences in foot kinematics and kinetics [16]. Studies have identified specific deviations in foot and ankle mechanisms in individuals with plantar heel pain compared to asymptomatic counterparts [17]. Therefore, we hypothesized that foot pain would adversely affect static balance and disturb gait. This study aimed to determine whether static balance and gait were different in people with painful plantar fasciitis compared to people without those symptoms.

2. Methods

2.1. Subjects

This study included 29 participants, 14 in the study group (PF) with plantar fasciitis, diagnosed by an Orthopaedic specialist and 15 age-matched asymptomatic participants as a control group (CG). The groups were homogeneous in terms of age and anthropometric indicators (Table 1.).

Inclusion Criteria for the study group participants were as follows: males and females with unilateral PF, pain greater than or equal to 3 on a 0-10 visual analogue scale (VAS), pain localized in the medial aspect of the calcaneus when taking first steps of the day, decrease in symptoms after low-intensity walking, and increased pain in the evening after daily activities; persistent symptoms for at least three months, age 35-60 years. Symptomatic subjects also had to meet at least one of the following criteria: pain after standing for a long time and pain upon weight bearing activity after extended intervals of inactivity.

Subjects were excluded if they had a history of trauma, surgery, fracture or orthopaedic disease in the lower limbs, discrepancy in length of the lower extremities greater than or equal to 1 cm, and systemic disease in the last six months that may predispose to heel pain (e.g., rheumatoid arthritis, gout, and lupus).

2.2. Procedure

The study was conducted at an outpatient rehabilitation centre, where patients with PF were referred for the treatment. Control group subjects were invited to participate in the study as volunteers by an advertisement of the rehabilitation centre. The study was approved by the Ethics Committee (Approval No. MNL-KIN(M)-2020-240) of Lithuanian Sports University and performed in accordance with the principles of the Declaration of Helsinki. Before testing, this study's aims and procedures were explained to participants in detail, and written informed consent

was obtained. Once participants agreed to participate in the study, their general characteristics were recorded, and measurements were taken.

2.3. Measurements

Pain. Subjective pain was assessed using a visual analogue scale (VAS). A 10 cm VAS is commonly used as a subjective measure of pain. The participants were asked to indicate on the 10 cm line where their 'current' pain intensity was situated [18]. A higher score indicates greater pain intensity: no pain (0–4 mm), mild pain (5–44 mm), moderate pain (45–74 mm), and severe pain (75– 100 mm).

Foot function index (FFI) is a self-reporting, foot-specific instrument measuring pain and disability and has been widely used to measure foot health [19]. The FFI consists of 23 items divided into 3 subscales that quantify the impact of foot pathology on pain (9 items), disability (9 items) and activity limitation (5 items). Every question is answered on a visual analogue scale for conversion to scores ranging from 0 to 9. The final result in percent was obtained calculating the sum score from subscales, divided by 230 and multiplied by 100. The higher the result, the more severe the pain or foot function restriction.

Static balance (1) was assessed by a modified Romberg test. The Romberg test is an appropriate tool to diagnose a gait disturbance caused by abnormal proprioception involving information about the location of the joints [20]. The examinee had to be barefoot, arms crossed on the chest. The test was performed in four different body positions: feet apart parallel (1); feet together (2); feet in semi-tandem (3); feet in tandem (4). Subjects were required to stand quietly for 10 seconds first with eyes open, then with eyes closed in all testing positions. The percentage of participants who could keep the testing position was counted.

Static balance (2) was assessed with a TYMO® system. The TYMO® balance test is a standardized assessment for balance analysis (posturography) to quantify balance and posture regulation in an upright stance. The TYMO® force sensors detect weight shifting and determine

the centre of force, the body swaying and load balancing over the feet. TYMO® system is a versatile measurement and therapy system consisting of TYMO Therapy Board and the software. The subject had to stand for 30 sec. on a platform and undergo four testing positions: feet apart, eyes open, firm base of support (FAEO firm); feet apart, eyes closed, firm base of support (FAEC firm); feet apart, eyes open, foam (FAEO foam); feet apart, eyes closed, foam (FAEC foam). Every position was tested once, and the displacement of the body mass centre was measured in cm.

Gait. G-Walk System by BTS Bioengineering Inc. was used in our study. G-WALK (GW) System is composed of a single wearable device equipped with a 16-bit 3-axis Accelerometer, a 3-axis 16-bit gyro, and a 3 axis 13-bit magnetometer in wireless Bluetooth communication with a PC running the G-Studio Software able to store and compute the main kinematic gait parameters. The sensor must be positioned in a lumbosacral region [21]. The subject had to walk 7 meters on a straight line. The sensor captured the position of the hips while walking, evaluating the gait symmetry (index), pelvis movements in sagittal, frontal and horizontal planes (index), deviation of walking speed from the norm (m/sec., step/sec.), walking phases: stance (%), swing (%), double support (%), single support (%), and step length (%), gait quality (index), and gait propulsion (index). The test results were compared with the norms calculated by the device according to individual characteristics. Gait propulsion index was evaluated on a 10-score scale, the closer it to ten, the better.

2.4. Statistical Analysis

SPSS (Statistical Package for Social Sciences) version 24.0 was used for statistical analysis of the study data. MS Excel 2010 was used to represent the graphs. Quantitative data are presented as a mean and standard deviation (Mean ± SD). The assumption of normality of the continuous variable was verified using the Shapiro–Wilk test. A nonparametric Student's t-test was used to compare the quantitative values of the two independent groups. The χ^2 test was used to compare qualitative variables between groups. It was considered statistically significant when $p < 0.05$.

Cohen's d effect size was calculated for comparing two group means. Cohen's d of 0.2 is considered as a 'small' effect size, of 0.5 - a 'medium' effect size, and a Cohen's d of 0.8 is considered as a 'large' effect size.

3. Results

All study group participants experienced foot pain and their foot function was impaired. As shown in Table 2, gait parameters, measured with G-Walk System, were significantly different in PF group compared to the asymptomatic participants. The amount of gait deviation from the individual norm was greater in subjects diagnosed with planar fasciitis than in healthy subjects ($p < 0.001$).

During modified Romberg balance test participants had to stand quietly for 10 sec. in four different body positions with eyes open and closed. As seen in Fig. 1, there were no subjects in either group who could stand quietly for 10 sec. in all test positions. Control group participants had balance problems with eyes closed in two testing positions: feet in semi-tandem (FS) and feet in tandem stance (TS). Participants with plantar fasciitis could not keep 5 testing positions, but statistically significant differences in time between groups were found only in tandem stance with eyes open.

It seems that TYMO® balance system was more sensitive than the modified Romberg test to reveal differences between controls and participants with plantar fasciitis as in all testing positions there were significant differences with high effect size (Table 3.).

The results showed that gait variables of the affected leg differed statistically significantly from those of the unaffected leg as well as those in the control group subjects with the exception of double support phase (Table 4).

As seen in Table 5, there was a statistically significant and strong correlation between the intensity of pain and foot function index (FFI) with parameters of balance and gait in subjects with plantar fasciitis.

4. Discussion

The primary aim of our research was to compare static balance and gait parameters between subjects with plantar fasciitis and age-matched controls. The secondary aim was to determine the relationship between pain and foot function index with measured parameters of balance and gait.

The mean age of subjects with PF participating in our study was 47.0 ± 7.5 years, and according to the literature this is the typical age of patients who develop PF [22, 23].

Not surprisingly, in our study statistically significant differences between the groups were found in the assessment of subjects' pain and the foot function index.

For the assessment of static balance, we used a modified Romberg balance test and TYMO® balance system. During Romberg test, the target for the subjects was to stand quietly in four testing positions with eyes closed and open for 10 sec. Not all subjects, even asymptomatic controls, reached the target time, but statistically significant difference between groups was seen only in Tandem stand position with eyes open, and other testing positions did not show differences between groups. Since the thickness of the plantar fascia in plantar fasciitis is found to be increased, and the elasticity of tissue to be lost [13], this might be the reason why static balance in subjects with PF was impaired, as this might be due to the reduced sensory input.

The study results did not show full agreement between the two methods used. The new Tyromotion device, which records the displacement of the centre of mass, showed statistically significant differences between PF group and age-matched controls in all four testing positions, but the Romberg test only in tandem stance with eyes open. From this we may conclude that modified Romberg test, which is widely applied in clinical physiotherapy practice [24], is not

sensitive enough in order to have reliable measurements [21]. Detection of small deviations may be useful to therapists in rehabilitation [25].

The foot is one of the most complex and intricate structures [26] and plays an important role in functional daily activities and mobility. Consequently, pain associated with plantar fascia can lead to gait disturbances [27]. During human walking, the centre of mass is outside the base of support for most of the time, which poses a challenge to stabilizing the gait pattern [28]. After performing the gait analysis with the G-walk device we found that gait symmetry index and the indexes of pelvis movements in all three planes in subjects with PF were significantly different from those in control group. Don Yoo et al. [26] reported that subjects with unilateral PF showed decreased maximum force and maximum pressure applied to the midfoot, which may be due to the centre of gravity being applied more to the pain-free, normal foot during gait. Usually, the stance phase is about 60% and the swing phase is about 40% of the gait cycle. It can be assumed that in the case of PF, the duration of stance phase in the affected leg is decreased, and in the unaffected leg is increased due to the need to protect the painful leg from the contact with the base of support (Table 4).

The plantar aponeurosis transmits large forces between the hindfoot and forefoot during the stance phase of gait [29]. Walking speed is defined as a valid, reliable, sensitive measure appropriate for assessing and monitoring functional status and overall health [5]. As we see from Table 1, deviation of walking speed from the norm, measured in m/sec. and step/min. was significantly higher in subjects with plantar fasciitis and this may be due to greater total rear foot eversion and increased medial forefoot plantar flexion at initial contact [16]. Furthermore, the patient's pain and decreased walking speed may adversely affect daily activities [30].

The study hypothesis was that in subjects with plantar fasciitis (PF) all measured variables would be reduced due to experienced pain. This hypothesis was confirmed. Statistical analysis of our results shows that there is a strong and significant correlation between pain, foot function and

measured parameters of balance and gait. The higher the pain and foot function index, the lower the balance and gait parameters.

Strengths and weaknesses

This study was conducted in small cohorts of age matched individuals - a study group with PF and a matched age group without PF. The group size itself is a limitation of the study and may not give strong enough evidence that painful plantar fasciitis is the main reason for the differences in the groups. However, most of the measured parameters were statistically significantly different between the groups, which gives a good indication that plantar fasciitis plays a big role in this. The personal, general fitness and anthropometric differences between the groups were not studied in detail, which also may distort the results, but the comparison to the well-established norms of the measured parameters gives some confidence in this regard.

The study protocol was established in detail before the measurements and the measures were taken according to the established guidelines by experienced professionals and entered the data pool simultaneously. The study measurement tools have been shown to be valid and reliable in clinical settings and easy to use and common in rehabilitation. Therefore, this study is a good example of clinically relevant and practical research approach yielding useful data for rehabilitation purposes.

No similar research examining the impact of the common condition, plantar fasciitis, on important parameters of daily function could be found, and therefore this study is an important addition to the knowledge base for rehabilitation practitioners.

Further studies are recommended to differentiate the role of pain and the role of the thickened plantar fascia with possible effects on sensory feedback, important in both functions, balance and gait. This would help in the planning and implementation of tissue specific rehabilitation approaches.

The use of more sensitive measures, e.g. TYMO® system, in clinical practice could also be investigated further, e.g. sensitivity in different conditions, inter- and intratester reliability in clinical settings and their usability. Detecting small changes in balance might help to take preventative actions early in this population. The use of TYMO® system should also be investigated in other populations with balance and gait issues.

5. Concussions

Walking and balance are important functions in humans' everyday life. Balance and gait disturbances are common and can appear at any age, and there are many and complicated reasons behind them.

This study focused on looking at the impact of painful plantar fasciitis on a wide variety of balance and gait parameters and found that all of them deviated from the norm and were also different in the similar control counterparts. Further investigations of the reasons for this in this complicated condition, and early detection by using sensitive measures will help rehabilitation professionals to better plan their methods to help their clients to continue their functional activities without balance and gait concerns.

Conflict of interest

The authors declare that they have no conflict of interest.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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No.

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Table 1. **Characteristic of the participants**

	PF group (n = 14) Mean ± SD	Control group (n = 15) Mean ± SD	P value
Gender (M: F)	4:10	5:10	0.782
Age (years)	47.0 ± 7.5	50.1 ± 8.0	0.297
Height (cm)	170.5 ± 9.4	169.3 ± 9.4	0.742
Weight (kg)	78.4 ± 14.9	76.9 ± 13.1	0.767
BMI (kg/m²)	26.6 ± 1.9	26.7 ± 2.3	0.873

Abbreviations: M – male, F – female, SD – standard deviation, BMI – body mass index

Table 2**. Comparison of pain, foot function and gait parameters between study group (PF) and control group subjects**

Variable	PF Group Mean ± SD (95% CI)	Control Group Mean ± SD (95% CI)	P value between groups	Cohen's d effect size
Pain (score)	3.36±1,39 (2.5−4.2)	0	-	-
Foot function (index)	17.36±2.9 (15.7−19.0)	0	-	-
Gait Symmetry (index)	68.98±6.09 (65.5−72.5)	88.95±3.47 (87.0−90.9)	p<0.001	4
Pelvis movements in Sagittal plane (index)	83,97±3,73 (81.8−86.1)	90.59±2.57 (89.2−92.0)	p<0.001	2.06
Pelvis movements frontal plane (index)	85.98±1.99 (84.8−87.1)	96.44±1.25 (95.7−97.1)	p<0.001	6.3
Pelvis movements horizontal plane (index)	90.63±2.01 (89.5−91.8)	97.16±1.19 (96.5−97.8)	p<0.001	4
Deviation of walking speed from the norm (m/sec.)	0.47±0.08 (0.4−0.5)	0.14±0.06 (0.1−0.2)	p<0,001	4
Deviation of walking speed from the norm (step/min.)	0,49±0,09 (0.4−0.5)	0,26±0,09 (0.2−0.3)	p<0.001	2

Table 3. **Comparison of Balance on TYMO® system measured for 30 sec. between study group (PF) and control group subjects**

Balance	PF group (cm ±SD)	Control group (cm ±SD)	P between groups	Cohen's d effect size
Eyes open firm	29.86±7.03	20.4±3.87	p<0.001	1.68
Eyes closed firm	40.29±4.89	30.13±3.16	p<0.001	2.46
Eyes open soft	49.57±3.63	38.6±3.46	p<0.001	3.09
Eyes closed soft	88.5±9.25	70.6±4.4	p<0.001	2.46

Table 4. **A comparison of gait variables between study group (PF) and control group subjects**

Variable	PF group Mean ± SD		Control group Mean ± SD	
	P. Fasciitis	Unaffected leg	Right	Left
Stance (%)	53.1±1.92* #	69.6±2.79	59.9±1.51	59.9±2.15
Swing (%)	46.9±1.92* #	30.4±2.79	40.1±2.15	40.3±1.63
Double support (%)	19.1±1.92	20.2±2.26	20.0±1.41	19.9±2.19
Single support (%)	34.0±2.18* #	49.4±4.72	39.5±1.81	40.0±1.31
Step length (%)	45.4±1.69* #	54.6±1.69	49.87±1.25	50.13±1.25
Gait Quality (index)	84.67±4,49* #	94.93±1,63	97.2±1.6	97.33±1.31
Gait propulsion (index)	3.98±0,73* #	5.37±0,48	8.35±0.61	8.59±0.49

* $p < 0.05$, compared to unaffected leg
# $p < 0.05$, compared to control group

Table 5. **Relationship between measured parameters in subjects with plantar fasciitis**

Parameters	Pain (score)	FFI
Pain		r = 0.851*
Foot Function Index (FFI)	r = 0.851*	
Balance semi tandem stance eyes open	r = 0.728*	r = -0.788*
Balance tandem stance eyes	r = -0.761*	r = -0.817*
Balance semi tandem stance eyes closed	r = -0.812*	r = -0.768*
Balance eyes open firm support	r = 0.842*	r = 0.993*
Balance eyes closed firm support	r = 0.840*	r = 0.993*
Balance eyes open soft support	r = 0.843*	r = 0.990*
Balance eyes closed soft support	r = 0.847*	r = 0.989*
Gait quality index healthy leg	r = - 0.851*	r = - 0.990*
Gait quality index affected leg	r = - 0.849*	r = - 0.996*
Gait symmetry index	r = - 0.849*	r = - 0.996*
Propulsion index healthy leg	r = - 0.843*	r = - 0.990*
Propulsion index affected leg	r = 0.849*	r = 0.984*
Pelvis movements in frontal plane	r = - 0.850*	r = - 0.993*
Deviation of walking speed from the norms	r = 0.843*	r = 0.992*
Deviation of steps per minute from norms	r = 0.845*	r = 0.993*
Single support healthy leg	r = 0.836*	r = 0.991*
Single support affected leg	r = - 0.827*	r = - 0.978*
Stance phase healthy leg	r = 0.837*	r = 0.993*
Stance phase affected leg	r = - 0.839*	r = - 0.978*
Swing phase healthy leg	r = - 0.837*	r = - 0.993*
Swing phase affected leg	r = 0.839*	r = 0.978*

* $p < 0.001$

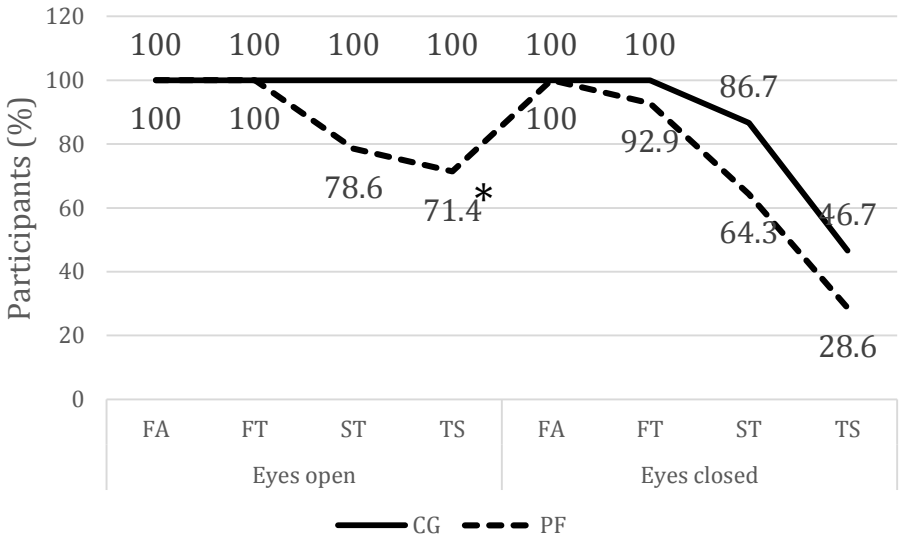

Fig. 1**. Comparison of balance according to modified Romberg test measured for 10 sec. in four different positions: (feet apart (FA); feet together (FT); feet in semi-tandem (ST); feet in tandem stance (TS)) between controls and subjects with plantar fasciitis**

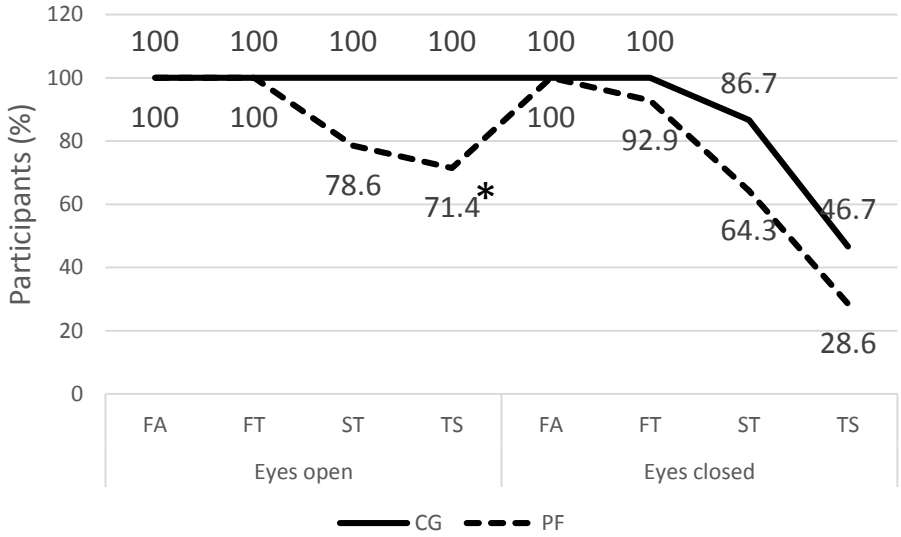

Fig. 1**. Comparison of balance according to modified Romberg test measured for 10 sec. in four different positions: (feet apart (FA); feet together (FT); feet in semi-tandem (ST); feet in tandem stance (TS)) between controls and subjects with plantar fasciitis**

Table 1. **Characteristic of the participants**

	PF group (n = 14) Mean ± SD	Control group (n = 15) Mean ± SD	P value
Gender (M: F)	4:10	5:10	0.782
Age (years)	47.0 ± 7.5	50.1 ± 8.0	0.297
Height (cm)	170.5 ± 9.4	169.3 ± 9.4	0.742
Weight (kg)	78.4 ± 14.9	76.9 ± 13.1	0.767
BMI (kg/m^2)	26.6 ± 1.9	26.7 ± 2.3	0.873

Abbreviations: M – male, F – female, SD – standard deviation, BMI – body mass index

Table 2**. Comparison of pain, foot function and gait parameters between study group (PF) and control group subjects**

Variable	PF Group Mean ± SD (95% CI)	Control Group Mean ± SD (95% CI)	P value between groups	Cohen's d effect size
Pain (score)	3.36±1,39 (2.5−4.2)	0	-	-
Foot function (index)	17.36±2.9 (15.7−19.0)	0	-	-
Gait Symmetry (index)	68.98±6.09 (65.5−72.5)	88.95±3.47 (87.0−90.9)	p<0.001	4
Pelvis movements in Sagittal plane (index)	83,97±3,73 (81.8−86.1)	90.59±2.57 (89.2−92.0)	p<0.001	2.06
Pelvis movements frontal plane (index)	85.98±1.99 (84.8−87.1)	96.44±1.25 (95.7−97.1)	p<0.001	6.3
Pelvis movements horizontal plane (index)	90.63±2.01 (89.5−91.8)	97.16±1.19 (96.5−97.8)	p<0.001	4
Deviation of walking speed from the norm (m/sec.)	0.47±0.08 (0.4−0.5)	0.14±0.06 (0.1−0.2)	p<0,001	4
Deviation of walking speed from the norm (step/min.)	0,49±0,09 (0.4−0.5)	0,26±0,09 (0.2−0.3)	p<0.001	2

Table 3. **Comparison of Balance on TYMO® system measured for 30 sec. between study group (PF) and control group subjects**

Balance	PF group (cm ±SD)	Control group (cm ±SD)	P between groups	Cohen's d effect size
Eyes open firm	29.86±7.03	20.4±3.87	p<0.001	1.68
Eyes closed firm	40.29±4.89	30.13±3.16	p<0.001	2.46
Eyes open soft	49.57±3.63	38.6±3.46	p<0.001	3.09
Eyes closed soft	88.5±9.25	70.6±4.4	p<0.001	2.46

Table 4. **A comparison of gait variables between study group (PF) and control group subjects**

Variable	PF group Mean ± SD		Control group Mean ± SD	
	P. Fasciitis	Unaffected leg	Right	Left
Stance (%)	53.1±1.92* #	69.6±2.79	59.9±1.51	59.9±2.15
Swing (%)	46.9±1.92* #	30.4±2.79	40.1±2.15	40.3±1.63
Double support (%)	19.1±1.92	20.2±2.26	20.0±1.41	19.9±2.19
Single support (%)	34.0±2.18* #	49.4±4.72	39.5±1.81	40.0±1.31
Step length (%)	45.4±1.69* #	54.6±1.69	49.87±1.25	50.13±1.25
Gait Quality (index)	84.67±4,49* #	94.93±1,63	97.2±1.6	97.33±1.31
Gait propulsion (index)	3.98±0,73* #	5.37±0,48	8.35±0.61	8.59±0.49

* $p < 0.05$, compared to unaffected leg
# $p < 0.05$, compared to control group

Table 5. **Relationship between measured parameters in subjects with plantar fasciitis**

Parameters	Pain (score)	FFI
Pain		r = 0.851*
Foot Function Index (FFI)	r = 0.851*	
Balance semi tandem stance eyes open	r = 0.728*	r = -0.788*
Balance tandem stance eyes	r = -0.761*	r = -0.817*
Balance semi tandem stance eyes closed	r = -0.812*	r = -0.768*
Balance eyes open firm support	r = 0.842*	r = 0.993*
Balance eyes closed firm support	r = 0.840*	r = 0.993*
Balance eyes open soft support	r = 0.843*	r = 0.990*
Balance eyes closed soft support	r = 0.847*	r = 0.989*
Gait quality index healthy leg	r = - 0.851*	r = - 0.990*
Gait quality index affected leg	r = - 0.849*	r = - 0.996*
Gait symmetry index	r = - 0.849*	r = - 0.996*
Propulsion index healthy leg	r = - 0.843*	r = - 0.990*
Propulsion index affected leg	r = 0.849*	r = 0.984*
Pelvis movements in frontal plane	r = - 0.850*	r = - 0.993*
Deviation of walking speed from the norms	r = 0.843*	r = 0.992*
Deviation of steps per minute from norms	r = 0.845*	r = 0.993*
Single support healthy leg	r = 0.836*	r = 0.991*
Single support affected leg	r = - 0.827*	r = - 0.978*
Stance phase healthy leg	r = 0.837*	r = 0.993*
Stance phase affected leg	r = - 0.839*	r = - 0.978*
Swing phase healthy leg	r = - 0.837*	r = - 0.993*
Swing phase affected leg	r = 0.839*	r = 0.978*

* $p < 0.001$