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The Relationship between Plantar Fasciopathy and Hip Muscles Strength Deficits

Nehal Fathy Ebrahim*, Salwa Fadl Abdelmegeed,
Ahmed Omar Abdelnaeem, Mohammed Moustafa Aldosouki Hegazy, Karim Ghuiba
Department of Physical Therapy for Musculoskeletal Disorders and Its Surgery,
Faculty of Physical Therapy, Cairo University, Egypt
***Corresponding author:** Nehal Fathy Ebrahim, **Mobile:** (+20-01224457007), **E-Mail:** nehalfathy26@yahoo.com

ABSTRACT

Background: Plantar fasciopathy (PF) is a cumulative excessive strain on the enthesis of the plantar fascia. One cause of PF is a prolonged pronated foot. Numerous studies have shown that weakness of hip muscles may be one factor contributing to PF. **Objective:** To identify whether there is a relationship among PF and hip abductors as well as external rotators' weakness.

Patients and Methods: Two groups were included in this study, each group had forty participants. Participants in group (A) had PF whereas those in group (B) were healthy participants. The isometric muscle strength of the hip abductors and external rotators was assessed utilizing a hand-held dynamometer. For the reason to verify a PF diagnosis, ultrasound device was used.

Results: Our results revealed significant decrease in the hip abductors' muscle strength of the involved side of the examined group when contrasted with the non-involved side in the same group ($p = 0.006$), and a significant decrease in the strength of the hip external rotators of the involved side of the examined group when contrasted with the non-involved side in the same group ($p = 0.007$). Additionally, there was a substantial decline in hip abductors and external rotators muscle strength on the involved side of the study group in comparison with the matched side of the control groups.

Conclusion: This study showed that the deficits in the proximal hip abductors and external rotators muscles were associated with plantar fasciopathy.

Keywords: Planter fasciopathy, Hip abductors, Hip external rotators.

INTRODUCTION

Our feet perform an important role in gait and posture control, foot pathologies can affect quality of life. It has been demonstrated that occurrence of foot pathologies are about 61% to 79% [(1)].

Plantar fasciopathy (PF) is a pathology that affects people of all ages with sedentary and active lifestyles [(2)]. Although it is more common in individuals over 40, anyone from 7 to 85 might be affected by it, and it does not appear to have any type of gender preference [(3)].

It is reported that 10% of the general population will have PF at least one time in their life [(4)].

Research have identified evidence of a degenerative disease processes without signs for inflammation, indicating that the word fasciitis could be a misnomer and that fasciosis or fasciopathy are more accurate [(5)]. Plantar Fasciopathy is characterized by sharp pain, especially when getting up and moving around after a period of rest, and can be bilateral or unilateral [(6)].

Prolonged overpronation of the foot can be one of the causes of plantar fasciopathy [(7)].

Kinematically, the hip abductors and external rotator muscles (including gluteus medius (GMed)) dysfunction causes biomechanical changes associated with foot over pronation. As a result, while standing on one leg, the pelvis drops in the coronal plane [(8)], the hip rotates medially [(9)], and the knee encounters a valgus force [(10)].

Therefore, decreased hip musculature function accompanied with repeated loading stress of the lower limb may rise the possibility of injuries throughout the lower extremity, not just the knee [(11)].

Ultrasound imaging is used to assess echogenicity, thickness, partial and complete plantar fascial ruptures [(15)].

PATIENTS AND METHODS

The investigation was performed in the Outpatient Clinic of Banha University (Al-Qalyubia Governorate, Egypt). G*Power (version 3.0.10) was utilized for calculating the required sample size. Eighty individuals were enrolled for this research. They were allocated into 2 groups of equivalent number. The study started in February 2022 and last for duration of 12 months.

Ethical Approval

The investigation was approved by the Ethics Committee of Cairo University, and all essential trial information was provided to the cases. Participants were told about the study's procedures and any potential adverse effects. Each participant provided a signed, informed consent form prior to participation in the investigation. This work has been performed in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans. (Ethical Committee approval no. P.T.REC/012/003303).

Inclusion Criteria

Participants included in the study had one or more of these criteria: Male and female participants who

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experienced symptoms of moderate to severe intensity of pain for at least 6 weeks [12], the age ranged from 45 to 65 years [13], body mass index (BMI) was more than 30 Kg/m^2 [14], feelings of pain or discomfort with activity, rest, or palpation along the medial tuberosity of calcaneus and plantar aponeurosis, or attachment of the plantar fascia into the calcaneus [15].

Clinical evidence of plantar heel pain (**PHP**) e.g. pain increased after a period of rest or when taking the initial steps in the morning and pain at the starting of weight bearing [15].

Exclusion Criteria: Past history of corticosteroid injection, past history of any operation on the involved lesser extremity, any additional pathologies that can elicit heel pain, any painful conditions affecting hip or knee, and any psychological problems [14].

Methods: The assessment of planter fasciopathy was carried out by gathering the patient's history (e.g. age, gender, VAS, weight, and BMI). Patients were also asked about the onset, course, and duration of their pain. Physical examination included, palpation of both the medial tubercle of the calcaneus and the proximal portion of the plantar fascia, or the patient reported severe pain in the anteromedial part of the heel by palpation as shown in figure (1).

Figure (1): Medio-plantar region of the heel where most pain is elicited.

Participants' muscular strength of abductors and external rotators was assessed utilizing a hand-held dynamometer (HHD) (Lafayette Model 3790, Lafayette Instrument Company, USA) to quantify their isometric hip abductors' and external rotators' muscle power as shown in figure (2 & 3). For PF diagnosis ultrasonography imaging device was used (The ultrasonography model GE Logiq p7, serial number Lp7000172, manufactured in 2019. 36), as it was found to be more accurate and trustworthy than other reference standards like MRI.

Figure (2): HHD with a stabilizing belt for hip abduction.

Figure (3): HHD with a stabilizing belt for hip external rotation

Statistical analysis

G * Power (version 3.0.10) was utilized for calculating the required sample size. It was determined to use an unpaired t-test. A total of eighty participants were required to conduct statistical testing with a level of significance of 0.05 (2-tailed) with an effect size of 0.74; a pair of groups as well as two response variables.

RESULTS

Forty patients with plantar fasciopathy (Study group) and forty healthy subjects (Control group) were involved in this study. Data collected from both groups concerning hip abductors and external rotators' strength were statistically analyzed and compared. Study group mean ± SD values for age, weight, height, and BMI were 48.3 ± 4.89 years, 95.82 ± 14.42 kg, 161.3 ± 6.94 cm, and 36.63 ± 3.4 kg/m^2 respectively, as revealed in table (1) and figure (4).

Control group involved forty healthy subjects. They had mean ± SD values for age, weight, height, and BMI of 47.4 ± 3.53 years, 94.6 ± 14.71 kg, 160.52 ± 6.57 cm, and 36.48 ± 3.41 kg/m^2, respectively, as revealed in table (1) and figure (4).

Table (1): Demographic data for study participants in both groups

	Study group	Control group	MD	t-value	p-value	Sig
	$\overline{X}$ ± SD	$\overline{X}$ ± SD				
Age (years)	48.3 ± 4.89	47.4 ± 3.53	0.9	0.94	0.34	**NS**
Weight (kg)	95.82 ± 14.42	94.6 ± 14.71	1.22	0.37	0.71	**NS**
Height (cm)	161.3 ± 6.94	160.52 ± 6.57	0.78	0.51	0.61	**NS**
BMI (kg/m²)	36.63 ± 3.4	36.48 ± 3.41	0.15	0.19	0.84	**NS**

Affected side: The mean of hip abductors' strength on the involved side of the study group was 2.26 ± 0.73 kg and that of the matched side of the control group was 3.18 ± 0.89 kg. The mean variance among both groups was -0.92 kg. There was a substantial decrease in hip abductors strength on the involved side of the examined group as contrasted with that of the matched side of the control groups (p = 0.001) as shown in table (2) and figure (5).

Non-affected side: The non- involved side mean value for hip abductors strength was 2.56 ± 0.64 kg, while the matched side of the control group had strength of 3.05±0.52 kg. The mean variance among both groups was -0.49 kg. The strength of the hip abductors on the study group's non-involved side substantially decreased when contrasted to the matching side in the control groups (p = 0.001) as shown in table (2) and figure (5).

Table (2): Comparison of hip abductors' strength between the study and control groups

Hip abductors' strength (kg)	Study group	Control group	MD	t-value	p-value	Sig
	$\overline{X}$ ± SD	$\overline{X}$ ± SD				
Affected side	2.26 ± 0.73	3.18 ± 0.89	-0.92	-4.99	0.001	**S**
Non-affected side	2.56 ± 0.64	3.05 ± 0.52	-0.49	-3.68	0.001	**S**

The mean hip external rotator muscles strength of the involved side of the examined group was 2.58 ± 0.92 kg and that of the matched side of the control group was 3.12 ± 0.61 kg. The mean variance among both groups was -0.54 kg. There was a substantial decrease in the hip external rotators' strength of the involved side of the examined group in contrast with that of the matched side of the control groups (p = 0.003) as revealed in table (3). The mean hip external rotator muscles strength of the non-involved side of the examined group was 2.72 ± 0.91 kg and that of the matched side of the control group was 3.13 ± 0.45 kg. The mean variance among both groups was -0.41 kg. There was a substantial decrease in the hip external rotators' strength of the non-involved side of the examined group in comparison with that of the matched side of the control groups (p = 0.01) as revealed in table (3).

Table (3): Comparison of hip external rotators' strength between the study and control groups

Hip external rotators' strength (kg)	Study group	Control group	MD	t-value	p-value	Sig
	$\overline{X}$ ± SD	$\overline{X}$ ± SD				
Affected side	2.58 ± 0.92	3.12 ± 0.61	-0.54	-3.09	0.003	**S**
Non-affected side	2.72 ± 0.91	3.13 ± 0.45	-0.41	-2.55	0.01	**S**

The mean hip abductor muscles' strength of the involved side of the examined group was 2.26 ± 0.73 kg and that of the non-involved side was 2.56 ± 0.64 kg. The mean difference among the two groups was -0.3 kg. There was a substantial reduction in the hip abductor muscles strength of the involved side of the examined group in contrast with that of the non-involved side (p = 0.006) as demonstrated in table (4). The mean hip external rotator muscles strength of the involved side of the examined group was 2.58 ± 0.92 kg and that of the non-affected side was 2.72 ± 0.91 kg. The mean difference among the two groups was -0.14 kg. There was a substantial decrease in the external rotator muscles strength of the involved side of the examined group in contrast with that of the non-involved side (p = 0.007) as revealed in table (4).

Table (4): Comparison of hip abductors as well as external rotators' strength between affected and non-affected sides of the study group

Strength (kg)	Affected side	Non-affected side	MD	t-value	p-value	Sig
	$\overline{X}$ ± SD	$\overline{X}$ ± SD				
Hip abductor	2.26 ± 0.73	2.56 ± 0.64	-0.3	-2.91	0.006	**S**
Hip external rotators	2.58 ± 0.92	2.72 ± 0.91	-0.14	-2.82	0.007	**S**

Discussion:

The study's objective was to explore if there was a relationship among hip abductors and external rotators muscle deficits and plantar fasciopathy.

The results of our study reported that there was a substantial decline in hip abductors as well as external rotators muscle' strength in the involved lower limb in comparison with the non-affected limb. In comparison between and within both groups (group A and group B) the study indicated that the affected lower limb side

distribution of the examined group stated that there were 25 (62.5%) subjects with the dominant side affected and 15 (37.5%) subjects with the non-dominant side affected. During bilateral tasks the non-dominant limb provides supporting, whereas the dominant limb is favored for mobilizing in addition to manipulating behaviors [16]. Throughout a bilateral task, the dominant foot will exhibit more mobility and control than the non-dominant foot [17].

When the difference was compared between hip abductors' muscle strength in the examined group (A) as well as control group (B), the study group had substantially weakened hip abductors muscles than the control group, with a mean difference of -0.92 kg. These results agree with **Lee *et al*.** [18] that proximal muscles of hip muscles weakness are associated with the cause of plantar fasciopathy, a neuromuscular connection among the hip as well as distal joint complexes suggested a physiological connection between hip muscle function and foot, ankle, as well as leg injuries [19].

Numerous intervention studies, on the contrary, examined how the hip muscles' strength influences the knee adduction moment among patients having symptomatic knee osteoarthritis. Programs of exercise have been shown to improve hip abductor muscle strength by 13%-43%, although no substantial change in maximum knee adduction moment has been shown in these studies [20]. In addition, some authors identified that when strengthening exercises were included in addition to the stretching exercises for plantar fasciopathy treatment, lasting for eight weeks, they failed to achieve better results when compared to stretching exercises isolated [21].

When the difference between hip external rotators muscles' strengths in the examined group (A) and control group (B) was compared, it showed that the strength of hip external rotators muscles was substantially declined in examined group than control group, mean difference among the groups was -0.54 kg. These results come in agreement with Trendelenburg, [22] that external hip rotators and abductors dysfunctions have been shown to lead to a chain of biomechanical deviations like those referred to exaggerated foot pronation [23].

The importance of proximal hip impairment in the occurrence of lower extremity injury is proved by evidence of the efficacy of core stability exercise focusing on hip muscle strengthening in the treatment of lower extremity disorders [10, 24].

On the other hand, some research and systematic reviews revealed that there was a limited correlation between proximal hip muscles weakness and foot, ankle and leg injuries. The evidence of a relationship is barely able to inform us whether or not poor hip muscle function shares a part in the occurrence of injury, or whether or if hip muscles weakness occurs following the beginning of the injury as a consequence of lower activity level related to pain [12].

When the difference of hip muscles abductors strength was compared to involved and non-involved sides of the lower limb in the examined group (A). It demonstrated a substantial decline in the hip abductor muscles' strength of the involved side of the examined group when contrasted to that of the non- involved side. There was a -0.3 kg as a mean difference between the 2 groups. Also, in comparison of difference of hip external rotator muscles' strength in involved as well as non-involved sides of the lower limb in examined group (A) there was a substantial decline in the hip external rotator muscles' strength of the involved side of the examined group when contrasted to that of the non-involved side. The mean difference in weight was -0.14 kg.

Lower extremity overuse injuries have been linked to asymmetry in the hip abductor, flexor as well as adductor muscle strength, according to some authors. Their adductor muscles were substantially stronger, while their abductors and flexors on the affected side of their hips were substantially weakened [25]. Flexion muscle, which result in increasing the pressure on the plantar fascia and the weakness of hip abductor muscles can alter the posture stability in frontal and sagittal planes of lower limbs, which lead to Trendelenburg gait and participate in shifting pressure of the body lateral to the heel and forefoot [27].

Clinical implications: The conclusions of the present research indicated the value of the evaluation of hip muscles performance, which may be a predisposing factor to foot injury or may be altered by the injury. Despite the fact that most rehabilitation and preventative programs concentrate around improving foot, ankle, as well as leg muscle performance, physiotherapist should give more focus to hip joint muscles as a whole lower kinetic chain. The weakness of hip muscles' power increases the compensatory mechanisms of the ankle and may have produced planter heel pain [26].

Further studies recommendations: The initial recommendation is to examine the muscles of the hips, including the adductors, extensors and flexors to see whether there is a connection between them and plantar fasciopathy. The second is to investigate if proximal hip muscle deficiencies in PF are correlated with the length of the disease. The third guideline is to investigate any associations between hip abductors and external rotators weakness and VAS in PF patients.

CONCLUSION

Plantar fasciopathy appear to be associated with proximal hip abductors and external rotators muscle deficits.

DECLARATIONS

- **Consent for publication:** All authors agreed to submit the work.

- **Availability of data and material:** Available
- **Competing interests:** None
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