Assessment of dynamic postural control in plantar fasciitis

Dina S. Abd Allah¹, Salwa Fadl¹, Lilian A. Zaki¹ and Aly M. El Zawahry²

¹Physical therapy department for musculoskeletal disorders and its surgery, Faculty of physical therapy, Cairo University, Egypt.
²Orthopedic surgery, Faculty of Medicine, Cairo University, Egypt.

*Correspondence: dr_dina_pt2020@yahoo.com Accepted: 09 Sep 2018 Published online: 26 Sep. 2018

The aim of this study was to investigate the relation between plantar fasciitis and dynamic postural control as a predictor of lateral ankle sprain. The design of the study is non-randomized controlled pilot study. The study was at the out-patient clinic and the balance assessment laboratory, Faculty of physical therapy, Cairo University. The subjects shared in this study were 13 male and female patients with age ranged from 25 to 35 years old diagnosed with plantar fasciitis and other 13 male and female volunteers had participated in this study. Intervention: Group (A) patients with plantar fasciitis (study group) and Group (B) age matched healthy volunteers (control group). Main measures: initially foot print angle was performed for both patients and the age matched healthy volunteers in both groups, then dynamic postural control assessment via Biodex stability system was performed. The results were obtained via The unpaired t test revealed that there was a statistical significant difference in the value of overall stability index (OASI), Anterior posterior stability index (APSI) and Medial lateral stability index (MLSI) in group (A) when compared by group (B) with P<0.001. Finally it was concluded that it had been concluded that plantar fasciitis has significant effect on dynamic postural control.

Keywords: Plantar fasciitis, Dynamic postural control assessment.

INTRODUCTION

Foot problems were identified to be an important falls risk factor. In general, painful feet are associated with a high risk of falling and low mobility. Several factors could affect the ability to control balance in cases of plantar fasciitis such as: abnormal foot position, deficient muscle function of the ankle and foot or direct effect of pain associated with weight bearing. Pain can affect the pressure exerted beneath the calcaneous and forefoot. When the exerted pressure is decreased, it can affect the sensory inputs from the plantar mechanoreceptors (Voloshin et al., 2002). The plantar fascia is one of the major stabilizing structures of the longitudinal arch of human foot, especially during the gait cycle (Davies et al., 1999). The orientation of the plantar fascia helps to maintain the arch throughout gait and contributes significantly to the appropriate amount and timing of pronation and supination during the gait cycle (Fuller, 2000). Planter fasciitis is very common Plantar fasciitis is highly prevalent painful musculoskeletal disorder that affects approximately more than one million persons per year either athletes or non-athletes (Fuller, 2000). It is a common cause of heel pain. It can be described as a degenerative condition of the plantar aponeurosis. Both male and female actually are equally affected. Plantar fasciitis could be from repetitive microtrauma as part of an overuse syndrome, or due to a predisposing factor, which could be either anatomic: such as high arched (pescavus), low arched (pesplanus), leg length discrepancy and excessive pronation or...
biomechanical: such as poor foot wear, nerve entrapment, obesity and over-training, muscle tightness (as tight Achilles tendon), (Riddle et al., 2003).

**MATERIALS AND METHODS**

This study included 13 male and female patients with plantar fasciitis with normal foot arch in group (A) (study group) and other 13 male and female volunteers with normal foot arch in group (B) (control group). All participants signed a consent form before enrollment in the study. The study was conducted between January 2016 and February 2018. The study proposal was approved from the ethical committee of the faculty of physical therapy, Cairo University.

![Flow of participants through the study](image1)

**Figure (1):** Flow of participants through the study.

![Normal foot type](image2)

**Figure (2):** Normal foot type (normal foot print angle (FA)= "42°.44’").

![Patient single leg support on the Biodex stability system](image3)

**Figure (3):** Patient single leg support on the Biodex stability system.
Figure (1) shows the progression through the study. The therapist explained the assessment procedure to the patients. Assessment procedures were conducted before the beginning of the first session for the following: Footprint analysis, for the imprint material, we utilized hypoallergenic powder each subject was asked to stand over powder, then asked to stand with single leg support over the tested (dominant side) then the footprint imprinted over a transparent sheet. Footprints from all patients and healthy volunteers were recorded using a footprint analysis in accordance with the procedures of (Billis et al., 2007; Menz and Munteanu, 2005; Levinger and Gilleard, 2006; Menz, 1998; Weiner and Rome, 1998; McPoil and Cornwall, 1996; Hawes et al., 1992; Welton, 1992; Hamill et al., 1989; Cavanagh and Rodgers, 1987 and Brody, 1982). The patients and healthy volunteers were asked to stand from sitting position over the carbon paper single leg support and they stood motionless, in the anatomical position, with weight fully supported on single foot for two seconds. Then, they were asked to take off their supported feet as carefully as possible as they sit down again. The same procedure was then carried out with the other foot. Two footprints of the dominant foot (either left or right) were recorded and the average of the two measures per foot was used for analysis. According to Forriol and Pascual (1999) a foot angle (FA) More than 42° up to 44° indicates a normal morphological medial longitudinal arch (MLA), Figure (2). Dynamic postural control assessment via Biodex balance system, the volunteers in both groups were familiarized with the device. For the familiarization trial, patients stood barefoot single leg support, with the dominant side, on the platform with their hands at their sides while maintaining a comfortable knee angle. Then in this position, the stability platform was unlocked to allow motion. Then the patients instructed to adjust their feet positions until they found a position at which they were able to maintain a moving point in the center or near the center of the circles, with the difficulty level of 8 (the easiest level). Next, the platform was locked and the feet placement were recorded and saved. To achieve indexes from each subject, we asked them to complete three test trials with visual biofeedback (with open eyes), Figure (3). Each trial lasted 60 seconds, with the difficulty level of 8, and then the average was taken for each patient (Arnold and Schmitz, 1998).

RESULTS
At baseline, there was no difference in the demographic data in both experimental groups as shown in table (1).

Foot angles of normal foot arch in both groups A&B.
The mean values±SD of foot angles in normal foot arch in both groups A&B were 42.66 ± 0.79°and 42.77 ± 0.59°, respectively. The unpaired t test revealed that there was no statistical significant difference between the two groups (t value=-0.394, p= 0.697) (Table 2).

Balance indices of normal foot arch in both groups A&B
Overall stability index (OASI). The mean values±SD of overall stability index in normal foot arch in both groups A&B were 4.24 ± 0.73 and 2.20 ± 0.18, respectively. The unpaired t test revealed that there was significant statistical difference between the two groups (t value= 9.713, p= 0.001) (Table 3, Figure 4).

Anterior posterior stability index (APSI).
The mean values±SD of anterior posterior stability index (APSI) in normal foot arch in both groups A&B were 3.72±0.69 and 1.85±0.19, respectively. The unpaired t test revealed that there was significant statistical difference between the two groups (t value= 9.331, p= 0.001) (Table 3, Figure 4).

Table (1): Demographic data of normal foot arch in both groups A&B.

<table>
<thead>
<tr>
<th></th>
<th>Group A (n= 13)</th>
<th>Group B (n= 13)</th>
<th>t value</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (yrs)</td>
<td>30.62 ± 2.84</td>
<td>30.38 ± 3.12</td>
<td>0.197</td>
<td>0.846 (NS)</td>
</tr>
<tr>
<td>Female</td>
<td>10 (76.9%)</td>
<td>8 (61.5%)</td>
<td>χ²= 0.722</td>
<td>0.395 (NS)</td>
</tr>
<tr>
<td>Male</td>
<td>3 (23.1%)</td>
<td>5 (38.5%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Height (cm)</td>
<td>166.62 ± 7.22</td>
<td>167.62 ± 8.09</td>
<td>-0.333</td>
<td>0.742 (NS)</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>71.00 ± 4.76</td>
<td>70.62 ± 7.48</td>
<td>0.156</td>
<td>0.877 (NS)</td>
</tr>
</tbody>
</table>

*SD: standard deviation, P: probability, S: significance, p>0.05=NS: non-significant, χ²: Chi square test.
Table (2): Foot angles of normal foot arch in both groups A&B.

<table>
<thead>
<tr>
<th>Foot Angle</th>
<th>Group A (n=13)</th>
<th>Group B (n=13)</th>
<th>t value</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>42.66° ± 0.79°</td>
<td>42.77° ± 0.59°</td>
<td>-0.394</td>
<td>0.697 (NS)</td>
</tr>
</tbody>
</table>

*SD: standard deviation, P: probability, NS= p> 0.05= not significant, S= p< 0.05= significant.

Table (3): Balance indices of normal foot arch in both groups A&B.

<table>
<thead>
<tr>
<th></th>
<th>Group A (n=13)</th>
<th>Group B (n=13)</th>
<th>t value</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>OASI</td>
<td>4.24 ± 0.73</td>
<td>2.20 ± 0.18</td>
<td>9.713</td>
<td>0.001 (S)</td>
</tr>
<tr>
<td>APSI</td>
<td>3.72 ± 0.69</td>
<td>1.85 ± 0.19</td>
<td>9.331</td>
<td>0.001 (S)</td>
</tr>
<tr>
<td>MLSI</td>
<td>3.25 ± 0.79</td>
<td>1.15 ± 0.27</td>
<td>9.068</td>
<td>0.001 (S)</td>
</tr>
</tbody>
</table>

*SD: standard deviation, P: probability, NS= p> 0.05= not significant, S= p< 0.05= significant.

Figure (4): Mean values of Balance indices of normal foot arch in both groups A and B.

Medial lateral stability index (MLSI).

The mean values±SD of medial lateral index (MLSI) in normal foot arch in both groups A&B. were 3.25 ± 0.79and 1.15 ± 0.27, respectively. The unpaired t test revealed that there was significant statistical difference between the two groups (t value= 9.068, p= 0.001) (Table 3, Figure 4).

DISCUSSION

The findings of this study were supported by Gonçalves et al., (2017), they found that subjects with plantar fasciitis (PF) displayed smaller reach distances in the overall star excursion balance test (SEBT), showing bilateral impairment of dynamic balance. Also, the higher Anterior/Posterior stability index (APSI) in group A (plantar fasciitis) when comparing with the age matched volunteers in group B, reflect less anteroposterior stability in plantar fasciitis patients this finding was supported by (Shawki, 2005). As Shawki (2005) found that higher APSI in plantar fasciitis patients compared to normal group, when he assessed the balance in plantar fasciitis by Biodex balance system. This may be due to impaired function of plantar fascia in plantar fasciitis patients than non-patients. As function of plantar fascia works more along sagittal plane in order to support the medial longitudinal arch of the foot “windlass mechanism” (Viel and Esnault, 1989 and Sarrafian, 1987). Dynamic postural control impairments in plantar fasciitis may be due to abnormal somatosensory input that results from the direct effect of heel pain associated with weight bearing, such pain affects the pressure exerted over the calcaneous and forefoot (Wearing et al., 2004&2003), abnormal foot pressure distribution could affect the sensory input from foot and ankle receptors, as sensory input is exaggerated from areas of high pressure, and
thus sensation is reduced from areas of low pressure that further resulting in balance disturbance (Voloshin et al., 2002). Deficient muscle function of the ankle and foot (Allen and Gross, 2003), medial calcaneal nerve neuropathy that is common to be associated with chronic plantar fasciitis (Chang et al., 2007; Bartold, 2004 and Rose et al., 2003) and abnormal foot posture and arch type (Young et al., 2001 and Barrett and O’mmely, 1999). Pain could affect dynamic postural control during weight bearing activities (Menz et al., 2005). Also, Menz et al., (2005) reported that foot pain was significant predictor of performance in each balance and functional ability tests. While Yaqci et al., (2007) proved that chronic musculoskeletal pain in the lower body affects negatively the balance ability in the healthy adults. Also, such dynamic postural control impairments in Individuals with plantar fasciitis could be explained as the following: plantar fasciitis individuals utilize compensatory strategies in order to eliminate the sense of discomfort and heel pain (Barbosa et al., 2013 and Pradels et al., 2013). They usually adopt antalgic gait pattern whereby they increase the support on the lateral and anterior face of the foot to minimize the heel contact time with the ground (Barbosa et al., 2013 and Pradels et al., 2013). These compensations change joint position sense and muscle activations, causing body sway that makes it difficult to maintain an upright posture within the base of support. This could impair both static and dynamic balances (Johal and Milner, 2012 and Kelly et al., 2012). Another explanation to the findings of this study, when performing a closed kinetic chain dorsiflexion movement, as during testing, the foot sole remains in contact with the ground and there is an anterior displacement of the tibia (Bressel et al., 2007). This leads to a stretching of the plantar fascia and, consequently, to increased tension and pain. In order to prevent further pain and discomfort during the test, individuals use compensation strategies in the ankle and foot, which makes it difficult to maintain their posture (Pradels et al., 2013 and McPoil et al., 2008). Wearing et al., (2006) concluded that by trying to reduce the loads imposed on the hindfoot, individuals with plantar fasciitis tend to overload the lateral aspect of the mid and forefoot during dynamic activities, and these adjustments could disturb one’s balance.

CONCLUSION

As plantar fasciitis has significant effect on dynamic postural control, so adding balance training in their treatment may be helpful in restoring dynamic postural control.

CONFLICT OF INTEREST

The present study was performed in absence of any conflict of interest.

ACKNOWLEGEMENT

The authors would like to thank the participants for their involvement in this study.

AUTHOR CONTRIBUTIONS

All authors contributed equally in all parts of this study.

REFERENCES


Bressel E, Yonker JC, Kras J, Heath EM.


Sarrafian SK.: Functional characteristics of the foot and plantar aponeurosis under tibialtalar loading. Foot Ankle 1987; 8:4–18.


