Low back pain and disability in individuals with plantar heel pain

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ABSTRACT

Background: Lack of response to plantar heel pain (PHP) treatment may be related to unmanaged low back pain (LBP) and low back dysfunction, but a relationship between LBP and PHP has not been established. The purpose of this investigation was to compare the prevalence of LBP among individuals with and without PHP and to assess the association between low back disability and foot/ankle function.

Methods: A cross-sectional study compared the prevalence and likelihood of LBP in individuals with (n = 27) and without (n = 27) PHP matched to age, sex, BMI, foot posture, and foot mobility. In individuals with PHP, correlations were examined between foot/ankle function using the foot and ankle ability measure (FAAM), low back disability using the Oswestry low back disability questionnaire (OSW), duration of PHP symptoms, body mass index (BMI), and age.

Results: A greater percentage of individuals with PHP had LBP (74% versus 37% of controls, odds ratio = 5.2, P = 0.009) and higher levels of low back disability (17% higher OSW score than controls, P < 0.001). In individuals with PHP, FAAM scores were correlated with OSW scores (ρ = −0.463, P = 0.015), but not with duration of PHP symptoms, BMI, or age (P > 0.150).

Conclusions: Individuals with PHP had a greater prevalence of LBP and higher low back disability that was correlated to reduced foot and ankle function. Treatment to address both local and proximal impairments, including impairments related to LBP, may be warranted to improve the management of PHP.

1. Introduction

Plantar heel pain (PHP), commonly known as plantar fasciitis, is a difficult condition to treat. Clinically, the diagnosis of PHP is based on the patient’s symptom presentation (e.g., pain with initial steps after a period of inactivity), and tenderness localized to the calcaneal insertion of the plantar fascia [1–3]. Plantar heel pain is a nonspecific diagnosis and a variety of pathoanatomical findings may be present in individuals with PHP such as plantar fascia inflammation, degeneration or thickening, heel fat pad pathology, calcaneal injury, peripheral nerve pathology, and heel spurs [1,2,4–6]. Individuals with PHP frequently wait six months or more after symptom onset before they seek treatment [7–10], which reduces successful outcomes to conservative care [7,11,12]. In addition, 18–50% of individuals will still have symptoms after receiving conservative treatment directed at local impairments of the foot, ankle, and lower leg, and 30% will experience temporary improvement with eventual symptom recurrence [7,12–14]. These persistent and recurrent symptoms may be due, in part, to impairments present in the lumbosacral region that are not commonly addressed during PHP treatment.

While most studies of PHP exclude individuals with lumbar radioulectropy, low back pain (LBP) or low back dysfunction is not an exclusion criterion [6,13,15,16]. Yet, foot mechanics have a known association with LBP, including increased arch height, greater dynamic foot pronation that increases vertical ground reaction forces and loading rates, and decreased ankle dorsiflexion and navicular drop [17–19]. In addition, foot mechanics influence low back function; for example, foot eversion is associated with anterior pelvic tilt [20,21], lateral foot wedges are related to earlier onset of lumbar paraspinal muscle activity during gait [22], and low foot arch is associated with reduced shock absorption at the low back during running [23]. Neuropathological factors may also contribute to interdependence between the foot and the low back because of the innervation of the foot from the lower lumbosacral nerve roots. While neurogenic PHP has been attributed to nerve entrapment at the tarsal tunnel or at the medial heel [24], involvement of central neurological mechanisms is indicated given the widespread and bilateral hypersensitivity in unilateral PHP [15]. In addition, preliminary evidence that PHP improves with
transcranial direct current stimulation implies that PHP is related to central pain mechanisms [16].

Low back dysfunction including impaired posture/symmetry, decreased muscle performance and size, and L5/S1 structural pathology has been linked to lower extremity conditions such as hamstring, adductor, quadriceps and calf strains or tendinopathy [25-28]. While foot pain occurs frequently in individuals with LBP [29,30], the occurrence of LBP has not yet been assessed in individuals with PHP. To determine if there is a relationship between the low back and the foot, analogous to the relationship between the low back and more proximal musculotendon conditions (thigh/calf strains or tendinopathy), specific investigation is needed in individuals with PHP. Therefore, the purpose of this investigation was to compare the prevalence of LBP between groups of individuals with and without PHP and to assess the association between disability related to LBP and foot/ankle function.

2. Methods

2.1. Study design

This was a cross-sectional study with a matched control cohort. Frequency matching was used to match the PHP and the control cohorts based on age, sex, body mass index (BMI), foot posture, and foot mobility. This study received approval from the Des Moines University Institutional Review Board. All patients provided written and verbal consent to participate and were compensated with funding provided by the Iowa Osteopathic Education Research Fund.

2.2. Participants

Patients with PHP were recruited from the Des Moines University Foot and Ankle Clinic between January 2012 to May 2014 and individuals in the control cohort were Des Moines University Clinic patients and local community members. Individuals in the PHP cohort had a diagnosis of PHP from a doctor of podiatric medicine without any other foot or lower leg conditions, scored < 88% on the foot and ankle ability measure (FAAM) and had an average of current, best, and worst pain in the previous 24-h rated at a level of ≥3/10. The clinical diagnosis was based on palpatory tenderness of the proximal attachment of the plantar fascia, and pain worse with initial weight bearing after inactivity and with prolonged weight-bearing activities [1]. Individuals in the control cohort did not have a history of PHP, current PHP symptoms or any other foot or lower leg conditions; many were patients being seen for upper extremity conditions. Individuals were excluded from the study if they had a history of foot or lower leg surgery, rheumatic disease, or neurological conditions affecting the lower extremities including radiulopathy or tarsal tunnel syndrome.

2.3. Measures

Dorsal arch height (DAH) ratio was used as a metric for foot posture and calculated by the DAH at 50% of the foot length divided by the total length of the foot [31]. The difference between the DAH of the foot during bilateral standing and in non-weight bearing sitting was used as a metric for foot mobility [32]. Foot and ankle function was assessed using the activities of daily living subscale of the FAAM, and PHP severity was assessed using the numeric pain rating scale (NPRS). The activities of daily living subscale of the FAAM is a 21-item questionnaire that is scored from 0 to 100 (100 = highest level of disability and has no test–retest reliability of ICC = 0.84–0.91 [35]. Participants also reported any medical conditions of which they had been diagnosed by a doctor.

2.4. Power and statistical analyses

G*Power version 3.1.6 (Heinrich-Heine Universität, Düsseldorf, Germany) was used to determine the total number of participants needed for this study to detect an odds ratio of 2 with 80% power at a significance of P < 0.05. The result was a total sample size of 32, which was expected to account for missing data and increase the precision of estimates.

Descriptive statistics for PHP and control cohort characteristics were summarized as mean and standard deviation (continuous variables) or percentage (categorical variables). The distribution of each characteristic was examined for normality using the Shapiro–Wilks test (α = 0.01) and for homogeneity of variance using Levene’s test. For characteristics with normal distributions and homogeneous variance (age, sex, weight, DAH ratio), between-cohort differences for each characteristic were tested using paired t-tests (continuous variables) or Chi-square tests (categorical variables). For characteristics that were not normally distributed (BMI), log transformation was performed prior to testing between cohort differences. For variables with unequal variance (DAH difference), Welch’s tests were utilized (α = 0.05). For characteristics that could not be normalized via log transformation (number of medical conditions, NPRS, FAAM, OSW), differences between cohort means were examined using the Mann–Whitney U test. Logistic regression was used to determine the likelihood of LBP in individuals with PHP adjusting for age, sex, and BMI [36]. Prior to logistic regression analysis, collinearity was examined by the tolerance and VIF values and outliers examined using the Mahalanobis distance in addition to P–P and scatter-plots of the standardized residuals. Correlations between cohort characteristics were examined by calculating the Pearson product moment correlation coefficient or the Spearman’s rank correlation coefficient. All statistical tests were performed using SPSS Statistics Version 22 (IBM Corporation, Armonk, NY).

3. Results

Descriptive statistics for the 54 participants are summarized in Table 1. Statistical tests of between-cohort differences confirmed that the 27 individuals in the PHP cohort were matched to the 27 individuals in the control cohort with respect to age, sex, BMI, foot posture (DAH ratio) and foot mobility (DAH difference).

Table 1. Cohort characteristics reported as mean (standard deviation) unless otherwise noted.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Control (n = 27)</th>
<th>PHP (n = 27)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, years</td>
<td>50 (16)</td>
<td>52 (14)</td>
<td>0.685</td>
</tr>
<tr>
<td>Sex (females), n (%)</td>
<td>16 (59)</td>
<td>18 (67)</td>
<td>0.779</td>
</tr>
<tr>
<td>Weight, kg</td>
<td>83.8 (19.4)</td>
<td>86.2 (14.5)</td>
<td>0.617</td>
</tr>
<tr>
<td>Body mass index, kg/m²</td>
<td>28.9 (6.3)</td>
<td>30.9 (4.8)</td>
<td>0.262</td>
</tr>
<tr>
<td>PHP symptom duration, n (%)</td>
<td>≥ 7 months</td>
<td>NA</td>
<td>0.026 (0.018)</td>
</tr>
<tr>
<td>≥ 2 years</td>
<td>NA</td>
<td>15 (56)</td>
<td>NA</td>
</tr>
<tr>
<td>DAH difference</td>
<td>0.026 (0.018)</td>
<td>0.031 (0.038)</td>
<td>0.63</td>
</tr>
<tr>
<td>DAH ratio</td>
<td>0.275 (0.021)</td>
<td>0.266 (0.024)</td>
<td>0.213</td>
</tr>
<tr>
<td>Number of medical conditions[p]</td>
<td>0.5 (0.8)</td>
<td>1.2 (1.2)</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>NPRS</td>
<td>0.06 (0.19)</td>
<td>3.9 (1.8)</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>FAAM</td>
<td>99.4 (1.9)</td>
<td>67.9 (20.2)</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>OSW for those with LBP[q]</td>
<td>8.4 (6.1)</td>
<td>25.4 (15.6)</td>
<td>&lt; 0.001</td>
</tr>
</tbody>
</table>

Abbreviations: DAH, dorsal arch height; FAAM, foot and ankle ability measure; NPRS, numeric pain rating scale; OSW, Oswestry low back disability questionnaire; NA, not applicable.

[p] Medical conditions were reported by the participant and included any condition diagnosed by a doctor.
[q] PHP (n = 20), control (n = 10).
Seventy-four percent (20/27) of individuals with PHP had LBP, while only 37% of individuals in the control group had LBP (P = 0.006, Fig. 1). The odds ratio indicated that individuals with PHP were 5.2 times (95% CI: 1.5, 17.8) more likely to have LBP than individuals without PHP (P = 0.009) (Table 2). Age, BMI, and sex of individuals did not have a significant effect on predicting the presence of LBP (Table 2). Individuals with LBP in the PHP cohort reported higher OSW scores compared to individuals with LBP in the control cohort (mean difference: 17, 95% CI: 8.8, 25.2).

Greater low back disability (OSW scores) was moderately correlated with lower foot and ankle function (FAAM scores) for the PHP cohort (Spearman’s ρ = −0.463, P = 0.015; Fig. 2). However, the FAAM scores were not correlated with the duration of PHP symptoms (Spearman’s ρ = 0.242, P = 0.224), BMI (Spearman’s ρ = −0.285, P = 0.150), or age (Spearman’s ρ = −0.156, P = 0.438).

The average number of medical conditions recorded was significantly greater for individuals in the PHP cohort than for individuals in the control cohort (Table 1; U = 2.364, P < 0.001). Participant-reported medical conditions are summarized in Table 3. The percentage of individuals with a BMI > 30 kg/m² (obese) did not differ between those with and without LBP (χ² = 0.989, P = 0.320); 14 of the 30 individuals with LBP (46.7%) and eight of the 24 individuals without LBP (33.3%) were obese.

### 4. Discussion

Seventy-four percent of individuals in the PHP cohort had LBP, which was significantly higher than the control cohort. The prevalence of LBP in the PHP cohort was also higher than the adjusted point prevalence (12%) and unadjusted prevalence of similar aged individuals (42%) with LBP in the general population [37]. Further, individuals with LBP and PHP had more severe low back disability compared to those without PHP. Higher levels of low back disability were correlated with lower levels of foot and ankle ability. No other prospective studies were found that examined the prevalence of LBP in individuals with PHP or the relationship between low back disability and foot function. Further corroboration of this study’s results is needed in larger samples and in different locations.

This study was not designed to elucidate the mechanistic relationship between low back pain/disability and the foot, but previous studies provide evidence that biomechanical [17–23] and neurophysiological [15,16,38] mechanisms may be involved. Regardless of the mechanism linking PHP and LBP, concurrent treatment of LBP and dysfunction in individuals with PHP may help to improve PHP management, especially if the history and examination indicate that the low back is related to the PHP symptoms. Clinical guidelines for primary care management of LBP recommend education and advice to stay active, supervised and graded exercise, combined exercise and cognitive-behavioral intervention, and consideration of spinal manipulation [39]. Guidelines for

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**Table 2**

<table>
<thead>
<tr>
<th>Explanatory Variables</th>
<th>B</th>
<th>SE</th>
<th>P</th>
<th>OR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMI</td>
<td>0.51</td>
<td>0.055</td>
<td>0.356</td>
<td>1.05 (0.95, 1.17)</td>
</tr>
<tr>
<td>Age</td>
<td>−0.026</td>
<td>0.021</td>
<td>0.204</td>
<td>0.97 (0.94, 1.01)</td>
</tr>
<tr>
<td>Sex</td>
<td>0.337</td>
<td>0.636</td>
<td>0.596</td>
<td>1.4 (0.4, 4.89)</td>
</tr>
<tr>
<td>Group (PHP/control)</td>
<td>1.644</td>
<td>0.631</td>
<td>0.009</td>
<td>5.18 (1.5, 17.83)</td>
</tr>
</tbody>
</table>

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**Fig. 2.** The activities of daily living subscale of the foot and ankle ability measure (FAAM), plotted against the Oswestry low back disability questionnaire score (OSW) for the individuals in the PHP cohort (n = 27).

**Fig. 1.** Percentage of individuals with LBP in the control (n = 27) and PHP cohorts (n = 27).
physical therapist management of LBP also recommends manipulation and non-thrust mobilization of the lumbar sacral spine and hip [40]. In addition to benefits for LBP, lumbar sacral manipulation impacts plantar pressure distribution of the foot during gait, which is commonly affected in individuals with PHP [41–43]. Thus, it may be warranted to refer individuals with concomitant LBP and PHP to healthcare professionals, such as a physical therapist, who can address both proximal and local factors related to PHP. Although no studies were found that assessed outcomes of concurrent management of low back impairments and PHP intervention, inclusion of hip interventions with local foot and ankle treatment for PHP has been successful [44,45]. Further studies are warranted to determine if management of LBP and low back dysfunction can improve outcomes of individuals with PHP and to determine which patients will benefit from combined low back and PHP treatment. The low risk to potential benefit ratio associated with recommended LBP intervention prompts consideration in treatment.

Limitations of this study include having a sample from only one clinical practice, a lack of specific lumbar and neurological testing, and an inability to identify causation. Because the participants in this study were not drawn randomly from the PHP population, the results of this study are subject to selection bias and results should be interpreted with caution. Few studies were found that investigated the relationship between the low back and PHP. In a retrospective analysis of a subspecialty practice, Schon et al. [38] reported 17/33 (52%) PHP patients with a clinical suspicion of a neurologic etiology had LBP. In addition, a cross-sectional study by Were [46] found that 77/101 (76%) of patients with neuropathic PHP reported back pain. Both Schon et al. [38] and Were [46] did not report the features that caused the providers to suspect neurological etiology, but in the absence of gross motor or sensory changes, accurately differentiating lumbar radiculopathy from lower extremity pain including PHP is challenging [47,48]. Patient inclusion in the current study relied upon the clinical examination of a podiatric physician to differentiate the diagnosis of PHP from a peripheral nerve condition such as lumbar radiculopathy or tarsal tunnel syndrome. Standards are needed to establish valid neurological examination procedures that result in improved management of PHP including differential diagnosis of neurological PHP [48]. In addition, no further imaging of the foot was performed to identify specific pathoanatomical features associated with PHP and therefore the results of this study apply only to individuals with a clinical diagnosis of nonspecific PHP. While three factors related to PHP prognosis (body mass, age and duration of symptoms) [1] were not found to be correlated to FAAM scores in this study, the individuals in the PHP cohort had an average of 0.7 more medical conditions than individuals in the control cohort (Table 3). The sample of this study was too small to assess the influence of any specific medical condition, but a retrospective study of 182 PHP patients found that comorbidities including diabetes, heart disease, and rheumatoid arthritis did not affect reported FAAM scores [10]. Because PHP and comorbidities (e.g., hypertension, diabetes and LBP) share an association with higher body mass and limited activity [2], it is likely that these conditions will be found together and the treatment will be interdependent.

5. Conclusions

The prevalence of LBP was higher among individuals with PHP than those without and was also higher than the global prevalence of LBP. In addition, more severe low back disability was associated with decreased foot and ankle function. Consideration of proximal factors that may contribute to PHP may be warranted depending upon initial treatment response and when the patient demonstrates a history of LBP or lumbar sacral dysfunction that appears related to PHP upon examination. Interdisciplinary treatment to address both local and proximal impairments may be warranted to improve the management of PHP, but additional evidence is needed to support the efficacy of concurrent LBP and PHP management.

Brief summary

- Plantar heel pain can be a difficult condition to treat because of multiple factors associated with the problem.
- Following treatment for plantar heel pain, many individuals will still have symptoms or will have recurrent pain.
- Plantar heel pain treatment is often limited to the foot, ankle, and lower leg.
- Individuals with plantar heel pain were 5 times more likely to have low back pain than individuals without plantar heel pain.
- Higher low back disability in individuals with plantar heel pain was associated with lower foot and ankle function.
- Management decisions of individuals with PHP may benefit from consideration of proximal factors including impairments related to LBP.

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