Factors associated with severe pain in patients with plantar fasciitis: An association analysis

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ABSTRACT

Objective: The main purpose of our study was to describe the factors associated with more severe pain levels in a cohort of patients with plantar fasciitis (PF). The secondary purpose of this study was to study which of these factors were associated with higher levels of clinical improvement after conservative therapy. **Materials and Methods:** We conducted a prospective study in a cohort of patients with PF diagnosis. Each participant completed an ordinal pain scale (1-10) for first-step pain and end-of-day pain, and Foot Function Index-Revised (FFI-R) surveys at enrollment. Also, patient demographics were evaluated. The ankle joint dorsiflexion, the range of motion (ROM) for the first metatarsophalangeal joint (MTPJ), the gastrocnemius tightness, and the popliteal angle were evaluated through standard tests. **Results:** Our study included 214 participants, of which 64% (118 patients) were males, the average age was 49.67 years (SD 13.16) and the average BMI was 28.53 (SD 5.18). The multivariate analysis showed that the risk of having a Visual Analog Scale (VAS) score ≥8 increased when the patient reported standing for more than 6 hours (OR=1.17; P=0.03; CI95%: 1.02-1.359). The risk of a >8-VAS score was higher when the level of ankle dorsiflexion was <0 (OR=1.20; P=0.03; CI95%: 1.02-1.41). **Conclusion:** Our findings indirectly support the hypothesis that limited ankle dorsiflexion ROM plays a role as a risk factor associated with VAS scores ≥8, in PF patients.

Key words: Plantar fasciitis; heel pain; gastrocnemius tightness; eccentric strengthening; stretching.
Level of Evidence: IV

Factores asociados con dolor severo en pacientes con fascitis plantar. Un análisis de relaciones

RESUMEN

Objetivo: Describir los factores asociados con niveles de dolor más severo en una cohorte de pacientes con fascitis plantar. El objetivo secundario fue analizar cuáles de estos factores estaban asociados con niveles más altos de mejoría clínica luego del tratamiento conservador. **Materiales y Métodos:** Se evaluó a una cohorte prospectiva de pacientes con diagnóstico de fascitis plantar. Cada participante completó una escala ordinal visual de dolor (del 1 al 10) para dolor del primer paso y dolor al final del día y encuestas FFI-R (Foot Function Index-Revised). También se realizó una evaluación demográfica. La dorsiflexión de la articulación del tobillo, el rango de movilidad de la primera articulación metatarsofalángica, la rigidez del gastrocnemio y el ángulo poplíteo también se evaluaron de manera estándar. **Resultados:** Se incluyó a 214 pacientes. El 64% eran hombres (118 pacientes), la media de la edad era de 49.67 años (DE 13.16) y el índice de masa corporal promedio, de 28,53 (DE 5,18). En el análisis multivariado, se observó que el riesgo de un puntaje ≥8 en la escala de dolor aumentó cuando el paciente refirió estar de pie por más de 6 h (OR 1,17; p = 0,03; IC95% 1,02-1,35). El riesgo de un puntaje >8 fue mayor cuando el grado de dorsiflexión del tobillo fue <0° (OR 1,20; p = 0,03; IC95% 1,02-1,41). **Conclusión:** Nuestros hallazgos apoyan indirectamente la hipótesis de que la dorsiflexión limitada del tobillo juega un papel como factor de riesgo asociado a un puntaje ≥8 en la escala de dolor, en los casos de fascitis plantar.

Palabras clave: Fascitis plantar; talalgia; rigidez de gastrocnemios; fortalecimiento excéntrico; elongación.
Nivel de Evidencia: IV

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INTRODUCTION

Plantar fasciitis (PF) is the most common cause of plantar heel pain,[1,2] and has a detrimental impact on health-related quality of life.[3] Typical symptoms include pain in the medial plantar area of the heel, especially on taking the first steps of the day, which may progressively subdue with walking. At times, the heel pain can be exacerbated by prolonged standing or resting.[4]

Multiple factors have been associated with PF in the literature, such as limited metatarsophalangeal joint (MTPJ) motion, limited ankle range of motion (ROM) together with environmental and circumstantial influences. However, the empirical evidence available in the literature related to these factors influence in the development of PF is still limited. The authors of this paper are unaware of any studies that had specifically reported evidence on the pain severity of this condition.

John Orchard[5] reported a clinical review of PF and described five recommended and revised categories of treatment: 1) biomechanical (including orthosis, other footwear modification, and taping); 2) stretching techniques (including night splint); 3) extracorporeal shock wave therapy; 4) corticosteroid injections; and 5) surgery. However, there is no established algorithm and there is limited good-quality evidence.

The main purpose of our study was to describe the factors associated with more severe pain levels in a cohort of PF patients. The secondary purpose of this study was to study which of these factors were associated with higher levels of clinical improvement after conservative therapy.

MATERIALS AND METHODS

Participants

Between December 2017 and October 2018, we conducted a prospective study in a cohort of patients with PF diagnosis and no history of localized trauma on that area, who willingly agreed to participate in the study.

The enrollment of PF patients was performed based on the following inclusion criteria: pain in the plantar medial region of the plantar surface of the heel, with possible radiation toward the medial edge of the arch of the foot, which may increase with the first steps in the morning and after prolonged standing. All patients with neuromuscular conditions or history of recent trauma or surgery in the lower extremities were excluded.

Measurements

Each participant completed an ordinal pain scale (1-10) for first-step pain and end-of-day pain, and Foot Function Index-Revised (FFI-R) surveys at enrollment. This index measures the impact of the foot disease on function, with sections on pain, disability and activity restriction. The patient had to answer each question in a scale from 0 (no pain nor difficulty) to 10 (worst conceivable pain or such difficulties that assistance is required) so as to describe thoroughly foot pain during the previous week.[6,7]

Information regarding other potential variables was also recorded, including age, sex, duration of symptoms, height, weight, laterality, foot type, and previous medical conditions.

Ankle joint dorsiflexion was measured with no weight-bearing and the knee extended. The patient was placed in a supine position, and the subtalar joint was slightly supinated. A goniometer was aligned such that one arm of the goniometer bisected the shaft of the fibula on the lateral side of the leg, and the other arm was aligned with the lateral border of the foot. The ankle joint was manually dorsiflexed to first resistance. Dorsiflexion from -15° to 0° was considered not limited, and from 1° to 25°, limited.

The first MTPJ ROM was determined clinically with the foot loaded with plantar pressure to the forefoot. ROMs were measured with a goniometer using the midaxial line of the proximal phalanx and the plantar surface of the foot as reference points.[8]

Gastrocnemius tightness was evaluated by the Silfverskiold test: ankle equinus that was present when the knee was extended but that disappeared when the knee was flexed during application of load using moderate strength under the forefoot; this loss of dorsiflexion normalized when the knee was in flexion.[9]

The popliteal angle test evaluates the elasticity of the hamstrings muscles. The participant was asked to lie supine on the examination table with hip and knee flexed at 90°, then the knee was extended gradually until the participant complained of discomfort, due to firm resistance, in the posterior aspect of the thigh. At that time the angle formed by the lateral bisection of the thigh and leg was measured. The center of the goniometer was placed on the lateral aspect of the knee, coinciding with the axis of rotation. One arm was positioned parallel to the lateral bisection of the thigh, and the other was directed toward the lateral malleolus. The residual knee flexion angle was measured

as the degrees lacking from full extension (180°). The normal range was considered to be from 0° to 15°, while values of 16° to 34° corresponded to moderate hamstring contracture, and values ≥35° corresponded to severe contracture.[10]

All patients were assessed by a single foot and ankle specialist surgeon, and completed all the questionnaires on their studied foot during their follow-up visit of weeks 6-14.

The patient's satisfaction to treatment was assessed by asking patients whether they would recommend it to a relative or a friend.

Treatment protocol

All patients followed a treatment protocol which included myofascial release of the triceps muscle of calf and plantar fascia, ankle dorsiflexion self-mobilization and posterior kinetic chain dynamic flexibility, center of gravity displacement during an unipedal and bipedal standing, bilateral eccentric strengthening of the gastrocnemius muscles, and a deep, plantar fascia massage searching for maximal pain. Patients were instructed to follow a cryogenic treatment, three times daily, at their homes, rolling their foot over a frozen bottle (applying pressure) and gently stretching the gastrocnemius and the plantar fascia. They were instructed to perform their activities of daily living that would not aggravate their symptoms and to avoid any activity that would exacerbate them. This protocol was applied for 6 weeks.

Statistical analysis

Categorical variables were described as absolute values (n) and relative values (%), and continuous variables were described as mean and standard deviation (SD) or median and interquartile range according to their distribution. Distribution was evaluated using scatter plots and the Shapiro-Wilk test. The level of ankle dorsiflexion was classified into four categories according to Riddle *et al*. (>10; 5-10; 0-5 and ≤0), for a better interpretation.[11]

To evaluate the factors associated with more severe pain, the visual analogue scale (VAS) variable was dichotomized into ≥8 and <8 scores. To evaluate the patients that responded to treatment, we classified patients according to a cut-off point value of ΔVAS ≥4. Taking into account that some participants had bilateral plantar fasciitis and that cases were nested within patients, bivariate and multivariate analyses were conducted by regression models of generalized estimating equations, with an interchangeable correlation matrix, taking each patient as a group. The multivariate analysis allowed testing the potential interaction between variables. The final models met the QIC criteria. The statistical significance level was set at $P<0.05$. Statistical analyses were performed using the software Stata 13.0.

To assess potential bias due to loss to follow-up, we compared the baseline characteristics of the patients who complied with follow-up and those who were lost to follow-up.

RESULTS

We enrolled 182 patients with PF, 32 (17.52%) had bilateral fasciitis, which resulted in 214 cases, of which 64% (118 patients) were males, the average age was 49.67 years (SD 13.16) and the average body mass index (BMI) was 28.53 (SD 5.18). Baseline characteristics are shown in Table 1. Anatomic and functional characteristics, as well as those related to pain, are shown in Table 2.

Factors associated with more severe pain

According to our cut-off point of ≥8 VAS points, at baseline, 118 patients had a score ≥8 and 96 patients <8 (Table 3). The multivariate analysis showed that the risk of a ≥8-VAS score increased when the patient reported standing for more than 6 hours (OR=1.17; P=0.03; CI95%: 1.02-1.359). The risk of a >8-VAS score was higher when the level of ankle dorsiflexion was <0 (OR=1.20; P=0.03; CI95%: 1.02-1.41). Having a previous consultation was associated with a <8-VAS score at baseline (OR=0.79; P=0.001; CI95%: 0.69-0.91).

Follow-up

At final follow-up, there were 28 patients lost to follow-up, resulting in 154 patients and 186 cases. Follow-up median was 8.5 weeks (interquartile range, 6-14).

The changes in pain severity were presented as ΔVAS. We set a cut-off point at ΔVAS≥4, resulting in 118 cases classified as ΔVAS≥4 and 68 controls as ΔVAS<4. The analysis of the factors associated with a VAS score change

Table 1. Baseline characteristics of the study participants

Características	Total n=182
Sex (male)	118 (64.84%)
Age+	49.67 (13.16)
BMI+	28,52 (5.18)
Smoking	21 (11.54%)
Comorbidities	66 (36.26%)
Standing for more than 6 h	111 (60.99%)
Previous consultations	77 (42.31%)
Previous treatments No treatment Physical therapy with stretching Physical therapy without stretching Corticosteroid injections	 126 (69.23%) 19 (10.44%) 27 (14.84%) 10 (5.49%)
Follow-up	154 (84.62%)
Bilateral fasciitis	32 (17.52%)

+Average (SD)

Table 2. Baseline characteristics of the plantar fasciitis cases

Características	Total n= 214
Left foot	107 (50%)
Type of foot Neutral High arch foot Flat foot	 103 (48.13%) 67 (31.31%) 44 (20.56%)
Atypical pain	21 (9.81%)
Pain location Medial insertion Central insertion Not insertional	 107 (50%) 87 (40.65%) 20 (9.35%)
Pain radiation	12 (5.61%)
Limited first MTPJ dorsiflexion	64 (29.91%)
Positive Silfverskiold test	24 (11.21%)
Ankle dorsiflexion (degrees)	10 (0-15)
Ankle dorsiflexion (degrees) > 10 5 – ≤10 0 – ≤5 ≤ 0	 86 (40.19%) 40 (18.69%) 25 (11.68%) 63 (29.44%)
Popliteal angle+	32.03 (16.55)
VAS*	8 (6-9)
FFI-R (%)+	45.89 (10.88)

+Mean (SD). *Median (25th-75th percentile)

Table 3. Risk factor associated with a ≥8-VAS score in plantar fasciitis cases

	No of cases with VAS scores ≥8 (n= 118)	No of controls with VAS scores <8 (n=96)	OR (P value; CI 95%)	Adjusted OR
Age+	50.34 (13.3)	48.85 (13.01)	1 (0.41; 0.99-1.007)	
Males	36 (30.51%)	36 (37.5%)	0.90 (0.176; 0.78-1.04)	
BMI ≤ 25 >25 - ≤ 30 > 30	 29 (24.58%) 50 (42.37%) 39 (33.05%)	 22 (22.92%) 41 (42.71%) 33 (34.88%)	 1 0.96 (0.66; 0.80-1.15) 0.98 (0.80; 0.80-1.18)	
Comorbidities	41 (34.75%)	35 (36.46%)	0.97 (0.71; 0.84-1.12)	
Previous consultations	39 (33.95%)	52 (54.17%)	0.78 (0.001; 0.68-0.9)	0.79 (0.001; 0.69-0.91)
Type of foot Neutral High arch foot Flat foot	 56 (47.46%) 33 (27.97%) 29 (24.58%)	 47 (48.96%) 34 (35.42%) 15 (15.63%)	 1 0.94 (0.40; 0.80-1.09) 1.15 (0.12; 0.96-1.37)	
Standing for more than 6 h	79 (66.95%)	53 (55.21%)	1.19 (0.019; 1.03-1.37)	1.17 (0.03; 1.02-1.35)
Bilateral fasciitis				
Atypical pain	11 (9.32%)	10 (10.42%)	0.96 (0.75-1.23)	
Pain location Medial insertion Central insertion Not insertional	 52 (44.07%) 55 (46.61%) 11 (9.32%)	 55 (57.29%) 32 (33.33%) 9 (9.38%)	 1 1.10 (0.15; 0.96-1.28) 0.97 (0.78; 0.76-1.23)	
Pain radiation	8 (6.78%)	4.17 (4%)	1.1 (0.46; 0.84-1.45)	
Limited first MTPJ dorsiflexion	38 (32.20%)	26 (27.08%)	1.06 (0.43; 0.91-1.24)	
Positive Silfverskiold test	10 (8.47%)	14 (14.58%)	0.85 (0.127; 0.69-1.05)	
Ankle dorsiflexion (degrees) >10 5 - ≤ 10 0 - ≤ 5 ≤0	 38 (32.20%) 24 (20.34%) 14 (11.86%) 42 (35.59%)	 48 (50%) 16 (16.67%) 11 (11.46%) 21 (21.88%)	 1 1.15 (0.12; 0.96-1.39) 1.11 (0.34; 0.89-1.38) 1.25 (0.007; 1.06-1.48)	 1.15 (0.07; 0.99-1.35) 1.09 (0.40; 0.89-1.33) 1.20 (0.03; 1.02-1.41)
Popliteal angle+	30.35 (1.42)	33.4 (1.69)	1.00 (0.18; 0.99-1.006)	

+ Mean (SD)
OR adjusted for Standing for more than 6 hours, ankle dorsiflexion (degrees), previous consultations

>4 resulted in no differences between both groups in regards to sex, age, BMI and clinical features. However, we found that the chances of improving more than 4 points in the VAS were reduced by 20% for patients whose ankle dorsiflexion angle was <0° (Table 4).

Patient satisfaction was rated as excellent in 66 cases (35.48%), good in 83 (44.62%), regular in 30 (16.13%), and bad in 7 (3.76%). None of the variables under study were significantly associated with the satisfaction level.

Table 4. Factors associated with a ΔVAS ≥4 after standardized treatment

	No of cases with ΔVAS ≥4 (n= 118)	No of cases with ΔVAS <4 (n=68)	OR (P value; CI 95%)
Age+	50.55 (12.6)	48.39 (13.83)	1 (0.28; 0.99-1.003)
Males	39 (33.05%)	20 (29.41%)	0.97 (0.708; 0.83-1.13)
BMI ≤ 25 >25 - ≤ 30 > 30	 29 (24.58%) 50 (42.37%) 39 (33.05%)	 17 (25%) 28 (41.18%) 23 (33.82%)	 1 1.01 (0.90; 0.84-1.21) 1 (0.99; 0.83-1.21)
Comorbidities	42 (35.59%)	28 (41.18%)	1.05 (0.48; 0.91-1.22)
Previous consultations	44 (37.29%)	31 (45.59%)	1.08 (0.26; 0.94-1.25)
Previous treatment	32 (27.12%)	19 (27.94%)	1.02 (0.71; 0.88-1.20)
Type of foot Neutral High arch foot Flat foot	 59 (50%) 34 (28.81%) 25 (21.19%)	 33 (48.53%) 22 (32.35%) 13 (19.12%)	 1 1.03 (0.71; 0.87-1.22) 0.99 (0.90; 0.83-1.18)
Standing for more than 6 h	73 (61.86%)	37 (54.41%)	0.94 (0.496; 0.82-1.10)
Atypical pain	8 (6.78%)	8 (11.76%)	1.1 (0.83-1.46)
Pain location Medial insertion Central insertion Not insertional	 60 (50.85%) 49 (41.53%) 9 (7.63%)	 31 (45.59%) 28 (41.18%) 9 (13.24%)	 1 1.06 (0.49; 0.91-1.23) 1.13 (0.36; 0.87-1.47)
Pain radiation	5 (4.24%)	6 (8.82%)	1.23 (0.181; 0.91-1.68)
Limited first MTPJ dorsiflexion	38 (32.20%)	19 (27.94%)	0.98 (0.77; 0.84-1.14)
Positive Silfverskiold test	13 (11.02%)	11 (16.18%)	1.12 (0.26; 0.92-1.36)
Ankle dorsiflexion >10 5 - ≤ 10 0 - ≤ 5 ≤0	 46 (38.98%) 21 (17.80%) 13 (11.02%) 38 (32.20%)	 36 (52.94%) 14 (20.59%) 7 (10.29%) 11 (16.18%)	 1 0.97 (0.77; 0.81-1.17) 0.93 (0.52; 0.74-1.16) 0.81 (0.02; 0.68-0.96)
Popliteal angle+	30.35 (1.42)	33.4 (1.69)	1.00 (0.76; 0.996-1.004)

+Mean (SD)

DISCUSSION

PF is a common condition, making up 11-15% of the foot symptoms requiring professional care.[1,3]

Many causative factors for PF have been described in the literature and are commonly characterized as intrinsic or extrinsic. Intrinsic factors are characteristics of individuals that predispose them to injury.[12] Those suggested in the literature include limited first MTPJ ROM, limited ankle dorsiflexion ROM, leg length discrepancy, reduced heel pad thickness, increased plantar fascia thickness, excessive foot pronation, reduced calf strength, older age and increased BMI.[13-15] Environmental and circumstantial influences acting upon an individual are known as extrinsic factors, and include prolonged standing, inappropriate shoe fit, previous injury and running surface, speed, frequency and distance per week in athletes.[1,13,14] Empirical evidence for most of these factors is limited or absent,[1] meaning that the role (if any) of each of these factors in the development of PF is poorly understood.[16] To our

knowledge, no evidence has been published on the relation between the symptoms' severity and the level of clinical improvement.

Our findings indirectly support the hypothesis that limited ankle dorsiflexion ROM plays a role as a risk factor associated with VAS scores ≥8, in PF patients. Limited ankle dorsiflexion may be due to a contracture of the gastrocnemius-soleus complex or to an isolated contracture of the gastrocnemius muscle. Our findings coincide with those published by Riddle *et al*., whose matched case-control reported that limited ankle dorsiflexion on the involved side significantly increased the risk of PF after adjustment for the other variables in the study model. In addition, subjects who reported being on their feet for the majority of the workday also had a significantly increased risk of PF (OR, 3.6; 95% CI, 1.3 to 10.1) (P<0.05).[11,17]

Patel *et al*. studied the proportion of PF patients that have an associated isolated gastrocnemius contracture. They found that 57% (145 of 254) had an isolated contracture of the gastrocnemius, 26% (66 of 254) had a contracture of the gastrocnemius-soleus complex, and 17% (43 of 254) did not have a dorsiflexion limitation.[1]

In our study population, patients with a severe ankle joint equinus were more likely to respond favorably to a treatment program that centered on conservative care including Achilles tendon stretching. In line with our findings, there is a previous study which analyzes the fact that more ankle equinus at the start of physical therapy translates into improved outcome after conservative therapy,[15] and highlights the importance of an Achilles tendon stretching program as an integral part in the conservative management of PF.[16-18]

Apart from the limited ankle dorsiflexion, we found no other biomechanical factor associated with the treatment outcome. Although hamstring tightness has been implicated in PF development,[12-19] hip flexion did not correlate with the likelihood of achieving a favorable response in our patients. However, this finding was not entirely unexpected, as our treatment protocol does not contemplate an effort addressed to treat a possible contracture of the proximal limb posterior muscles.

Prolonged standing at work was also associated with PF development in our study population.

We were somewhat surprised by our findings that hallux limitus or functional hallux limitus were not associated with PF development nor to treatment response, despite Aranda and Munuera had already published a case-control study reporting significantly more first MTPJ dorsiflexion in controls than those with PF (71° vs. 49°).[12]

Finally, we found that patients with severe heel pain (>8/10) were more likely to respond favorably to conservative treatment; which means that patients who sought treatment suffering from mild to moderate symptoms were less responsive to conservative treatments for heel pain. In a largely self-limiting condition with a high placebo treatment effect,[2] it is not surprising to see that patients with the greatest pain may be more likely to experience relief with the introduction of stretching program.

The limitations of our study include the lack of a control patient population and the lack of a widely accepted gold standard for evaluation of ankle ROM. In addition, despite several participants being lost to follow-up, those who remained and those who were lost to follow-up had similar baseline characteristics, and so we considered that loss to follow-up was random and did not resulted in any bias. This study design does not allow establishing any cause-effect relationship since it does not provide data on temporal relationships between PF and the variables measured, by means of comparing cohorts, therefore the factors we studied as associated with PF may not be the only ones involved.

Further clinical studies focusing on the time required to achieve conservative therapy response and on establishing the pain relief they provide to each PF presentation, are warranted to determine the course of this condition.

Conflict of interests: Authors claim they do not have any conflict of interest.

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