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Original Research Article

Anatomical Correlation of Plantar Fascia Morphology with Symptom Severity in Plantar Fasciitis: An Ultrasound-Based Study

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Abstract:

Introduction: Heel pain brought on by recurrent tension on the plantar fascia is a common symptom of plantar fasciitis. The purpose of this study is to investigate the relationship between the severity of plantar fasciitis symptoms and morphological changes in the plantar fascia, such as thickness and the existence of calcaneal spurs.

Methodology: 180 people (60 controls and 120 patients with plantar fasciitis) participated in a cross-sectional study. Ultrasound imaging detected calcaneal spurs and evaluated the thickness of the plantar fascia. The Visual Analog Scale (VAS) was used to measure the degree of pain in the group with plantar fasciitis.

Result: There were more calcaneal spurs (52% vs. 15%, $p < 0.001$) and noticeably thicker plantar fascia (5.2 mm vs. 3.6 mm in controls, $p < 0.001$) in the group with plantar fasciitis. Higher VAS pain levels were associated with thicker fascia.

Conclusion: The degree of plantar fasciitis is closely correlated with morphological alterations in the plantar fascia, such as thickening, underscoring the diagnostic utility of ultrasound imaging.

Keywords: Plantar Fasciitis, Fascia, Visual analog scale (VAS).

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Introduction

Plantar fasciitis is a prevalent condition characterized by pain and inflammation in the heel, primarily due to repetitive strain on the plantar fascia, a thick connective tissue that supports the arch of the foot. It is estimated to affect up to 10% of the population, particularly athletes, individuals with obesity, and those who stand for prolonged periods [1]. Despite its prevalence, the precise etiology of plantar fasciitis remains unclear, with various anatomical, mechanical, and lifestyle factors implicated in its development. [2]

The plantar fascia plays a crucial role in foot biomechanics, especially in maintaining the foot arch and absorbing shock during weight-bearing activities. Anatomical variations in the structure of the plantar fascia, such as increased thickness or the presence of calcaneal spurs, have been hypothesized to contribute to the onset of plantar fasciitis.[3] These structural changes may result in altered tension distribution across the fascia, leading to microtears and subsequent inflammation. [4] Previous studies have highlighted the association between plantar fascia thickness and plantar fasciitis, but the extent to which morphological variations contribute to the severity of symptoms remains underexplored.[5] Additionally, the role of calcaneal spurs in the pathogenesis of plantar fasciitis is debated, with some researchers suggesting that spurs are a consequence of chronic stress rather than a primary cause of pain.[6, 7)

This cross-sectional study aims to examine the morphological variations in the plantar fascia, focusing on thickness, density, and the presence of calcaneal spurs. By comparing these anatomical features in patients with plantar fasciitis and asymptomatic controls, we seek to determine whether specific structural changes are associated with the severity of symptoms and the development of the condition.

Methodology

This cross-sectional study was conducted at a tertiary care hospital between June 2023 and February 2024. A total of 180 participants were recruited, consisting of 120 patients diagnosed with

plantar fasciitis and 60 asymptomatic controls. Inclusion criteria for the plantar fasciitis group included a clinical diagnosis based on heel pain lasting for more than three months and tenderness over the plantar fascia on palpation. Controls were selected based on the absence of heel pain and plantar fascia tenderness.

All participants underwent high-resolution ultrasound imaging using a 12 MHz linear transducer. The plantar fascia was measured at three locations: near its origin at the calcaneus, the mid-portion, and the distal attachment. Thickness was recorded at each site. The presence of calcaneal spurs and changes in echogenicity (indicative of tissue degeneration) were also noted. Ultrasound imaging was performed by two experienced radiologists blinded to the clinical diagnosis.

The severity of symptoms in the plantar fasciitis group was assessed using the Visual Analog Scale (VAS), where patients rated their pain from 0 (no pain) to 10 (worst possible pain). Statistical analysis was performed using SPSS software. Independent t-tests were used to compare plantar fascia thickness between groups, and chi-square tests were applied to assess the association of calcaneal spurs with plantar fasciitis. Correlation analysis was conducted to evaluate the relationship between morphological variations and VAS scores.

Results

The study found significant differences in plantar fascia thickness between patients with plantar fasciitis and controls.

The mean thickness of the plantar fascia in the plantar fasciitis group was 5.2 ± 1.0 mm, compared to 3.6 ± 0.8 mm in controls ($p < 0.001$).

Calcaneal spurs were present in 52% of patients with plantar fasciitis, while only 15% of the control group showed spurs ($p < 0.001$). Increased plantar fascia thickness was positively correlated with higher VAS scores ($r = 0.65$, $p < 0.001$).

Table 1:

Parameter	Plantar Fasciitis (n=120)	Controls (n=60)	p-value
Plantar fascia thickness (mm)	5.2 ± 1.0	3.6 ± 0.8	<0.001
Calcaneal spur presence (%)	52%	15%	<0.001
VAS score (mean)	7.2 ± 1.5	-	-

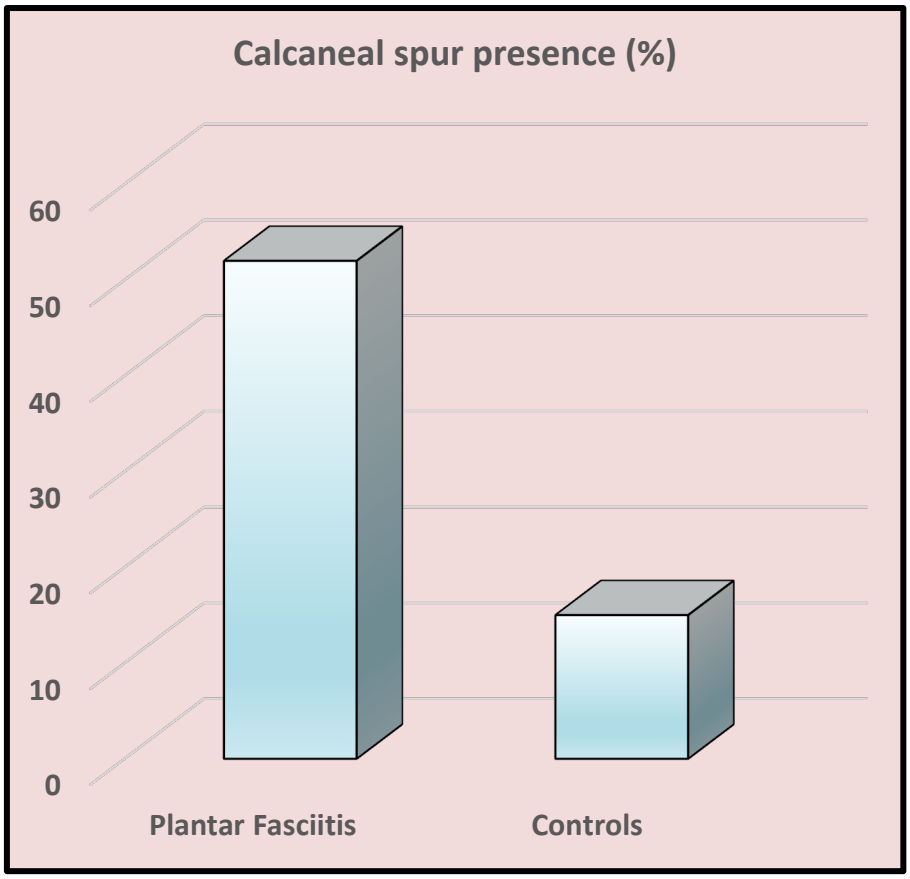

Figure 1: Calcaneal spur presence (%)

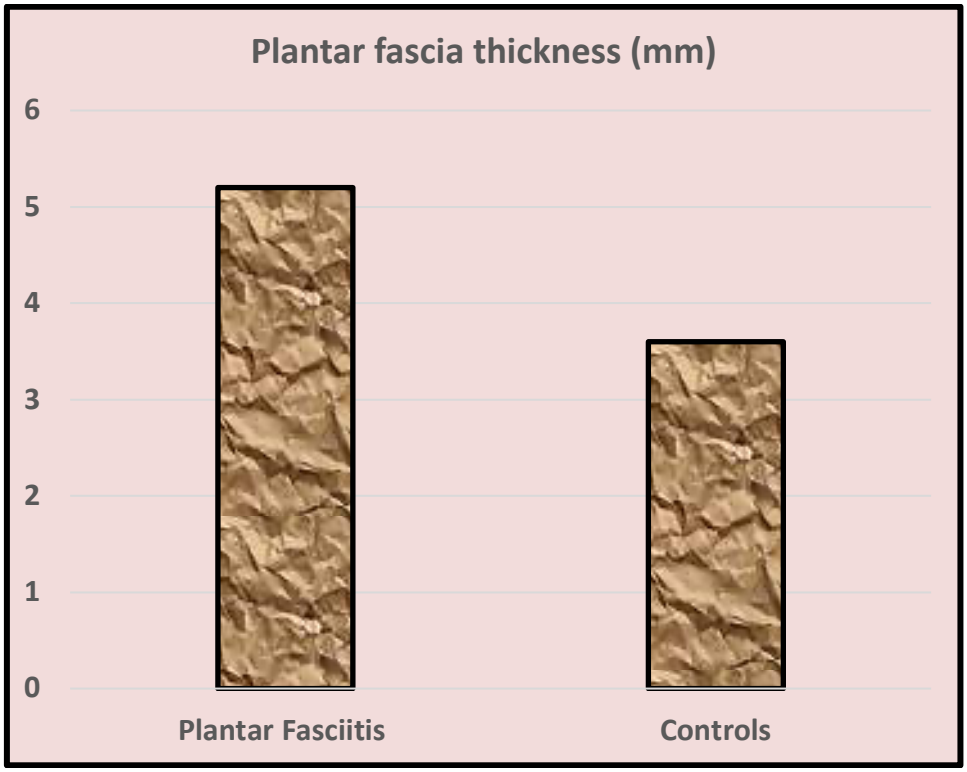

Figure 2: Plantar fascia thickness (mm)

Discussion

The findings of this study confirm a significant association between morphological variations in the plantar fascia and the development of plantar fasciitis. Increased plantar fascia thickness and the presence of calcaneal spurs were both strongly correlated with the occurrence and severity of plantar fasciitis symptoms. These results are consistent with previous studies that have identified plantar fascia thickening as a hallmark of plantar fasciitis, likely due to repetitive microtrauma and inflammation. [2, 5]

In our study, the mean plantar fascia thickness in patients with plantar fasciitis was 5.2 mm, which is comparable to the findings by Li et al. [5], who reported a similar increase in fascia thickness among symptomatic patients. Similarly, our results align with those of Wearing et al. [4], who found that structural changes in the plantar fascia, such as thickening, are closely related to the onset of pain and dysfunction. These changes likely contribute to decreased flexibility and increased tension in the plantar fascia, exacerbating symptoms. [4]

The role of calcaneal spurs remains controversial. In our study, calcaneal spurs were present in 52% of patients with plantar fasciitis, compared to only 15% of controls, suggesting a strong association between spur formation and plantar fasciitis. This supports the findings of Riddle et al. [6], who observed a higher incidence of calcaneal spurs in patients with chronic plantar fasciitis. However, other authors, such as Lemont et al. [7], argue that spurs are a secondary consequence of chronic stress and are not directly responsible for causing pain. Further longitudinal studies are needed to clarify this relationship. Our study also found a significant positive correlation between plantar fascia thickness and pain severity, as measured by the VAS score. This is consistent with the work of Kamel and Kotob [8], who demonstrated that patients with thicker plantar fascia experienced more intense pain. Early identification of these structural abnormalities could lead to more targeted treatment strategies, such as physical therapy and orthotic interventions, to prevent the progression of plantar fasciitis and alleviate symptoms. [9]

In conclusion, this study highlights the importance of morphological factors in the development and progression of plantar fasciitis. Ultrasound imaging offers a non-invasive and reliable method for assessing these changes, which can inform treatment decisions and improve patient outcomes.

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