RESEARCH PAPER

THE CORRELATION BETWEEN ABNORMAL CALCANEAL MORPHOLOGY AND CALCANEAL SPURS IN ACHILLES TENDINITIS AND PLANTAR FASCIITIS – AN OBSERVATIONAL STUDY

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ABSTRACT

Background

Plantar heel discomfort is often connected with plantar fasciitis, whereas posterior heel pain is typically related to insertional Achilles tendinitis. This study seeks to illustrate the correlation between atypical calcaneal shape and the existence of calcaneal spurs indicative of various tendinopathies.

Methods

A prospective observational research was conducted for patients exhibiting heel pain suspected of insertional Achilles tendinitis or plantar fasciitis at SRM MCH Department of Orthopaedic. Standing lateral and axial radiographs were assessed for the Fowler-Philip Angle (FPA), calcaneal width, and Parallel Pitch Lines (PPL). The existence of posterior and plantar calcaneal spurs were associated with these morphological characteristics.

Results

Patients with posterior spur demonstrated a greater mean FPA (68.31°) than those without the spur (66.11°), along with an increased calcaneal width (40.63 mm vs. 39.59 mm). Abnormal PPLs were markedly more common in patients with posterior spur (56.3%) and plantar spur (48.1%) than in those without spurs (23.1% and 29.2%, respectively). A composite prediction model produced an Area Under the Curve (AUC) of 0.72 for the development of posterior spurs.

Conclusion

A clinically significant correlation exists between aberrant calcaneal morphology and the occurrence of both posterior and plantar calcaneal spurs. Abnormal PPLs, particularly when associated with increased calcaneal width and elevated FPA, are significant radiographic markers of heel pain disorders.

Keywords: Calcaneal Spur, Plantar Fasciitis, Achilles Tendinitis, Heel Pain, Fowler-Philip Angle.

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Introduction

Plantar and posterior heel discomfort are primarily attributed to plantar fasciitis and insertional Achilles tendinitis, respectively. Radiographically, osteophytes at the medial calcaneal tubercle are common observations that frequently serve as mechanical factors in plantar fasciitis [1].

An aberrant posterosuperior calcaneal protrusion, termed as 'Haglund deformity', elevates mechanical strain on the rearfoot. This may result in retrocalcaneal bursitis and insertional Achilles tendinitis, a clinical triad known as Haglund syndrome.

The Achilles tendon, plantar fascia, and calcaneum operate as an integrated biomechanical unit. Persistent high tension in this unit sometimes results in the simultaneous formation of both posterior and plantar calcaneal spurs, a condition increasingly documented in recent epidemiological research [5, 6].

This study propose that atypical calcaneal morphology induces this persistent inflammatory response within the Achilles-calcaneum-plantar fascia complex. Also, seeks to assess the correlation between particular aberrant calcaneal morphologies and the occurrence of related heel spurs.

Methods

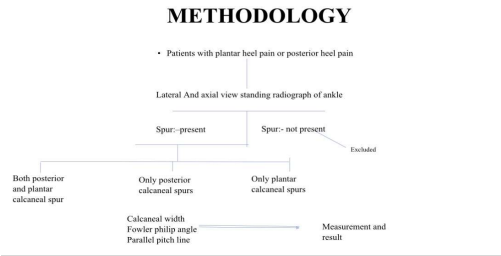
Research Design and Environment

An observational study was undertaken at the Orthopaedic Department of SRM Medical College Hospital and Research Centre from November 2024 to April 2025.

Patient Selection

Inclusion criteria included individuals over 18 years of age exhibiting plantar and/or posterior heel discomfort, clinically classified as insertional Achilles tendonitis or plantar fasciitis. Patients were excluded if they had a prior history of trauma or surgery involving the calcaneus or Achilles tendon, non-insertional Achilles tendinopathy, inflammatory arthropathy, or were under 18 years of age.

Radiological Evaluation



Patients who satisfied the inclusion criteria received lateral and axial standing radiographs of the afflicted ankle. The radiographs were assessed for calcaneal spurs, classified as isolated posterior spurs, isolated plantar spurs, or both **(Figure 1)**.

Calcaneal morphology was assessed utilising three principal outcome analysis instruments

- The standard reference range for the Fowler-Philip Angle (FPA) is defined as 44° to 69°.
    - Taken on a lateral X-ray of the foot
    - Draw two lines:A line along the inferior surface of the calcaneus, a line from the posterior superior tuberosity to the anterior process of calcaneus.The angle formed between these two lines is the Fowler–Philip angle. (Fig:1: A) (Fig:2- C,D)

- Parallel Pitch Lines (PPL): Assessed for normalcy to evaluate posterosuperior calcaneal prominence.Normally,posterosuperior calcaneal prominence lies at or below the upper line.
    - On a lateral xray,Draw a line along the inferior border of the calcaneus (plantar surface), Draw a second line parallel to the first, passing through the posterior facet of the subtalar joint(fig:1 – A)

- Calcaneal Width: The normative reference range is defined as 30 to 35 mm.
    - Calcaneal width refers to the anteroposterior thickness of the calcaneus at its posterior part, measured on a lateral foot radiograph to assess bony prominence behind the heel.
    - Use a lateral X-ray of the foot, identify the posterior aspect of the calcaneus,measure the maximum anteroposterior dimension of the posterior calcaneal tuberosity.(fig 2-E,F)

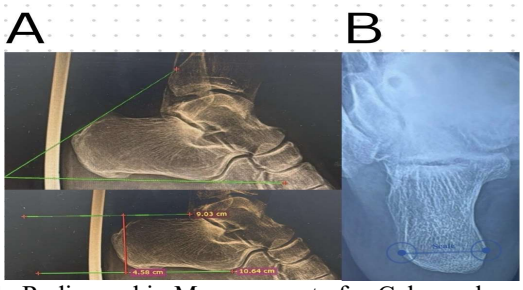


Figure 1: Radiographic Measurements for Calcaneal Morphological Evaluation. A) Lateral Radiographs, B) Axial Radiograph

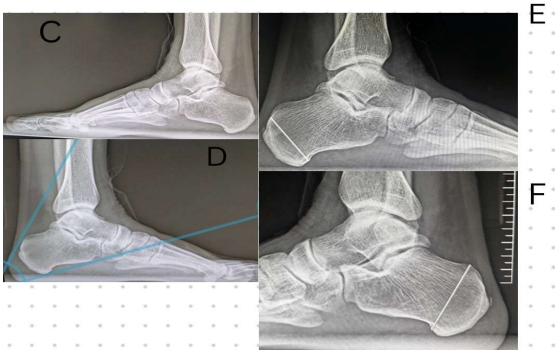


Figure 2: C,D,E,F – lateral weight bearing radiographs of foot measuring fowler-Philip angle (D), and Calcaneal width(E,F).

Results

The study assessed the radiographic characteristics

about the existence or non-existence of posterior and plantar spurs.

Posterior Spur analysis

Analysis of Posterior Spur Patients with a posterior calcaneal spur exhibited a greater mean FPA (68.31°) than those lacking a posterior spur (66.11°). The calcaneal breadth in the posterior spur group was elevated, measuring 40.63 mm, in contrast to 39.59 mm in the control group. Moreover, aberrant PPLs were detected in 56.3% of patients with posterior spurs, as contrast to merely 23.1% in those without spur. **(Figure 3)**.

Plantar spurs analysis

Analysis of Plantar Spurs revealed that patients with a calcaneal spur had a mean Foot Progression Angle (FPA) of 67.40°, while those without a spur had a mean FPA of 66.92°. The mean calcaneal width was higher in the plantar spur group (40.60 mm) compared to the group without plantar spurs (39.53 mm). Abnormal PPLs were observed in 48.1% of patients with plantar spurs, compared to 29.2% in patients without them.**(Figure 3)**.

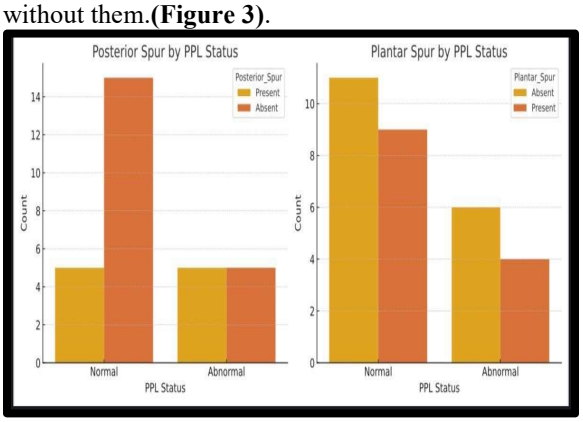


Figure 3: Evaluating the occurrence of normal and atypical Parallel Pitch Lines (PPL) in individuals with and without posterior and plantar calcaneal spurs.

Predictive modelling

Receiver Operating Characteristic (ROC) curve analysis was conducted to assess the predictive accuracy of these parameters. A logistic regression model integrating FPA, calcaneal width, and PPL status exhibited enhanced prediction accuracy for posterior spur formation, achieving an Area Under the Curve (AUC) of 0.72 **(Figure 4)**.

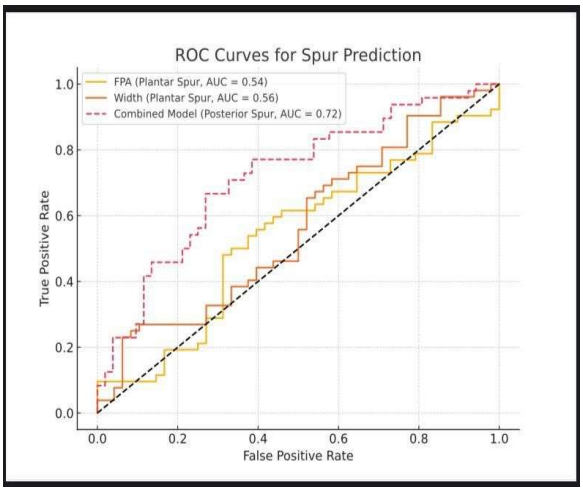


Figure 4: Receiver Operating Characteristic (ROC) curves assessing the prediction accuracy of the Fowler-Philip Angle, calcaneal width, and a composite logistic regression model for the formation of calcaneal spurs.

Discussion

This study reveals a notable radiographic correlation between atypical calcaneal shape and the occurrence of heel spurs. Our study indicated that an increased Fowler-Philip Angle (FPA) is moderately correlated with posterior heel spurs, consistent with the notion that a prominent posterosuperior calcaneus directly leads to insertional Achilles tendinopathy [7]. Nonetheless, FPA exhibited inadequate predictive accuracy for plantar spurs, signifying its specificity to posterior pathology rather than encompassing entire heel pathology.

In contrast, Parallel Pitch Lines (PPL) and calcaneal breadth surfaced as more comprehensive indicators of heel disease. Abnormal PPLs were substantially correlated with both posterior and plantar spurs, a result that aligns with previous studies assessing calcaneal step-offs [8]. Moreover, an augmented calcaneal breadth was common among patients with any spur type, presumably indicating persistent, distributed mechanical stress on the bone [9]. The integration of FPA, calcaneal width, and PPL into a unified predictive model markedly enhanced the diagnostic precision for posterior spur formation (AUC ~0.72), underscoring the therapeutic value of multi-parameter evaluations [10].

Ultimately, our data substantiate the notion of the Achilles-calcaneum-plantar fascia unit as an integrated biomechanical complex [11]. The recurrent simultaneous occurrence of both posterior and plantar spurs in our cohort clearly indicates a same

pathomechanical mechanism. This corroborates the contemporary concept of a cohesive "heel spur syndrome," in which modified osseous morphology induces persistent inflammatory alterations and mechanical overload over the entire rearfoot [12].

Conclusion

This study demonstrates a clear association between altered calcaneal morphology and the development of both posterior and plantar heel spurs. Radiographic parameters such as abnormal Parallel Pitch Lines, increased calcaneal width, and a higher Fowler-Philip angle collectively provide valuable insight into underlying heel pathology. These findings support the concept of a unified biomechanical relationship within the Achilles–calcaneus–plantar fascia complex and highlight the importance of comprehensive radiological assessment in guiding effective management of chronic heel pain.