RESEARCH PAPER

Radiological and Functional Correlates of Calcaneal Spur Dimensions in Plantar Fasciitis: A Retrospective Cross-Sectional Study

[1*]Dr Sudharsanan K, [2]Dr Arun Kumar V, [3]Dr Pradeep E, [4]Dr Ashwin VY, [5]Dr Sheik Mohideen MS,
[6]Dr Shivaani Venkatramanan and [7]Dr Chockalingham kasi

[1]Junior Resident, Department of Orthopaedic Surgery, Chettinad Hospital and Research Institute, Rajiv Gandhi Salai (OMR Chennai) , Kelambakkam, Kanchipuram Tamilnadu*
[2]Professor, Department of Orthopaedic Surgery, Chettinad Hospital and Research Institute, Rajiv Gandhi Salai (OMR Chennai) , Kelambakkam, Kanchipuram Tamilnadu
[3]Professor, Department of Orthopaedic Surgery, Chettinad Hospital and Research Institute, Rajiv Gandhi Salai (OMR Chennai) ,Kelambakkam,Kanchipuram Tamilnadu
[4]Department of Orthopaedic Surgery, Chettinad Hospital and Research Institute, Rajiv Gandhi Salai (OMR Chennai) ,Kelambakkam,Kanchipuram Tamilnadu
[5]Assistant professor, Department of Orthopaedic Surgery, Chettinad Hospital and Research Institute, Rajiv Gandhi Salai (OMR Chennai) ,Kelambakkam,Kanchipuram Tamilnadu
[6]Junior Resident, Department of Orthopaedic Surgery, Chettinad Hospital and Research Institute, Rajiv Gandhi Salai (OMR Chennai) ,Kelambakkam,Kanchipuram Tamilnadu
[7]Junior Resident, Department of Orthopaedic Surgery, Chettinad Hospital and Research Institute, Rajiv Gandhi Salai (OMR Chennai) ,Kelambakkam,Kanchipuram Tamilnadu
Email ID: [1]selvisanan@gmail.com, [2]arun5684@gmail.com, [3]dr_prad87@yahoo.co.in, [4]ashvyrocks@gmail.com, [5]sheik.145@gmail.com, [6]shivaanivenkat@hotmail.com and [7]chockz.k@gmail.com*
Orcid Id: [1]0009-0000-1621-4466, [2]0000-0001-8590-0988, [4]0009-0002-4051-5263, [5]0009-0008-9491-0983, [7]0009-0000-1774-0572
***Corresponding Author:** Dr Sudharsanan K*
selvisanan@gmail.com

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ABSTRACT

Background: Plantar fasciitis (PF) is the primary etiology of plantar heel pain in adults, representing a substantial fraction of musculoskeletal outpatient consultations worldwide. Calcaneal spurs often coexist with plantar fasciitis (PF); however, the impact of the physical dimensions of these spurs on perceived pain and functional outcomes is not well elucidated in the literature. This study investigated the correlation between calcaneal spur length and clinical as well as functional parameters in patients with plantar fasciitis (PF).

Methods: A retrospective analysis of 103 patients diagnosed with PF who visited a tertiary orthopedic outpatient clinic from January 2018 to December 2022. Lateral weight-bearing calcaneal radiographs from the institutional archive was got and used computer-aided digital calipers to measure the length of the calcaneal spur in millimeters from the tip of the spur to the base of the calcaneus. A visual analogue scale (VAS) was used to record the intensity of pain. The Foot Function Index (FFI) was used to measure how well the foot worked. Pearson correlation and multivariate linear regression analyses, showed results that were statistically significant at $p < 0.05$.

Results: Out of 103 patients, 65 (63.1%) were female and 38 (36.9%) were male, with an average age of 49.1 ± 9.6 years (range: 31–66 years). A calcaneal spur was found in 82 patients (79.6%). The average length of the spur was 4.09 ± 3.51 mm, with a range of 0 to 13.8 mm. There was a strong link between spur length and age ($r = 0.342$, $p = 0.001$), BMI ($r = 0.271$, $p = 0.003$), symptom duration ($r = 0.389$, $p < 0.001$), VAS pain score ($r = 0.358$, $p = 0.001$), FFI pain subscore ($r = 0.301$, $p = 0.001$), FFI disability subscore ($r = 0.461$, $p < 0.001$), and FFI total score ($r = 0.429$, $p < 0.001$). In a multivariate regression analysis, symptom duration and BMI emerged as the independent predictors of spur length ($p < 0.05$).

Conclusion: The length of the calcaneal spur is strongly linked to the severity of pain and loss of function in PF. These results indicate that spur dimensions constitute a clinically significant radiological parameter that ought to be integrated into the functional evaluation and treatment strategy for patients with PF.

Keywords: plantar fasciitis; calcaneus; Heel spur; retrospective study; cross sectional study; radiology

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**Author for Correspondence: selvisanan@gmail.com*

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INTRODUCTION

Plantar fasciitis (PF) is the most common reason adults have pain in the bottom of their feet. The condition significantly impacts physical function and health-related quality of life, often leading to chronic disability if not properly addressed [1].

Calcaneal spurs, traction-induced microtrauma and subsequent periosteal ossification at the insertion of the plantar fascia and the flexor digitorum brevis muscle, have been observed in 75–89% of patients with plantar heel pain [2,3].

A prospective study by Kuyucu et al. subsequently yielded significant preliminary evidence indicating that spur length correlates with VAS pain scores and the Foot Function Index (FFI), establishing spur dimensions as a potentially valuable clinical marker [4].

The Foot Function Index is a validated, self-administered tool that assesses three aspects of foot-related health—pain, disability, and activity limitation—through 23 items. The Turkish version of the FFI has been shown to work for PF [5,6].

There is a lot of overlap between the risk factors for PF and calcaneal spur formation like being older, having a high body mass index (BMI), having pes planus or pes cavus, and having a job that requires you to carry a lot of weight for a long time [7]. Despite the frequent association of Plantar Fasciitis with Calcaneal Spur, the clinical significance of spur length remains unclear, For instance, studies by Okçu M et al. suggest that calcaneal spurs may be incidental and not directly related to pain severity. [16]

The objective of the current study is to fill this knowledge gap by conducting a retrospective cross-sectional analysis of a larger patient cohort. The main goal was to look at the relationship between the length of the calcaneal spur and clinical factors like pain level (VAS), foot function (FFI subscores and total score), and demographic factors like age, sex, BMI, and how long the symptoms had been going on.

AIM

The main goal of this study was to find out if the length of the calcaneal spur, as seen on lateral calcaneal radiographs, was strongly linked to the perceived pain level (VAS) and the foot functional impairment (FFI) in people with PF.

Secondary objectives included: (i) investigating correlations between spur length and demographic and clinical variables such as age, sex, BMI, and symptom duration; (ii) assessing the prevalence of radiological calcaneal spurs within this cohort; and (iii) identifying independent predictors of calcaneal spur length through multivariate regression analysis.

MATERIALS AND METHODS

Design and Setting of the Study: This was a retrospective study conducted at the Department of Orthopaedics and Traumatology, Chettinad Hospital. Electronic medical records and radiological archives from the time period March 2022 – March 2024 were used and data was analysed from November 2025 to January 2026. The Institutional Ethics Committee gave its approval, and the need for individual patient consent was dropped because the study looked back in time.

Study population:
Records of patients presenting with plantar heel pain and clinically diagnosed plantar fasciitis (PF) were reviewed. A total of 103 patients were included based on diagnosis of PF based on established clinical findings like Localized plantar fascia tenderness, Positive heel pressure test, Morning pain and stiffness, Availability of lateral weight-bearing calcaneal radiograph, Age between 18 and 70 years. Patients with Prior calcaneal or ankle fracture or surgery, Coexisting conditions affecting foot function, Inflammatory joint diseases (including ankylosing spondylitis and related spondyloarthropathies), or had received prior extracorporeal shock wave therapy or corticosteroid injection before radiographic evaluation were excluded from the study.

Sample Size:

Data collection: This data included age, sex, BMI, side of involvement, symptom duration(weeks).

Measurement by X-ray: Lateral calcaneal weight-bearing radiographs from the Picture Archiving and Communication System (PACS) was obtained. A musculoskeletal radiologist with a decade of experience, unaware of clinical outcome data, conducted all measurements. Using computer-aided digital calipers on dedicated workstation software (Carestream Vue PACS), the length of the calcaneal spur in millimeters from the spur tip to the calcaneal base was measured. This method is the same as the one described by Johal and Milner [3].

To evaluate intra-rater reliability, a random sample of 30 radiographs was re-evaluated by the same radiologist at four-week intervals. The intraclass correlation coefficient (ICC) was performed to figure out how reproducible the measurements were.

Measures of Outcome: Pain intensity was evaluated retrospectively using VAS scores recorded during the initial outpatient visit.

Patients' functional status was taken from the FFI tests they did at their first visit. The FFI is a 23-item questionnaire that you fill out yourself.

Analysis of Statistics:

Software used:

- IBM SPSS Statistics, version 26.0

Data presentation:

- Continuous variables: Mean ± standard deviation (SD)
- Categorical variables: Frequencies and percentages

Normality testing:

- Shapiro–Wilk test used to assess distribution of continuous variables

 Correlation analysis:

- Pearson correlation for normally distributed variables
- Spearman's rank correlation for non-normally distributed variables

Comparative analysis:

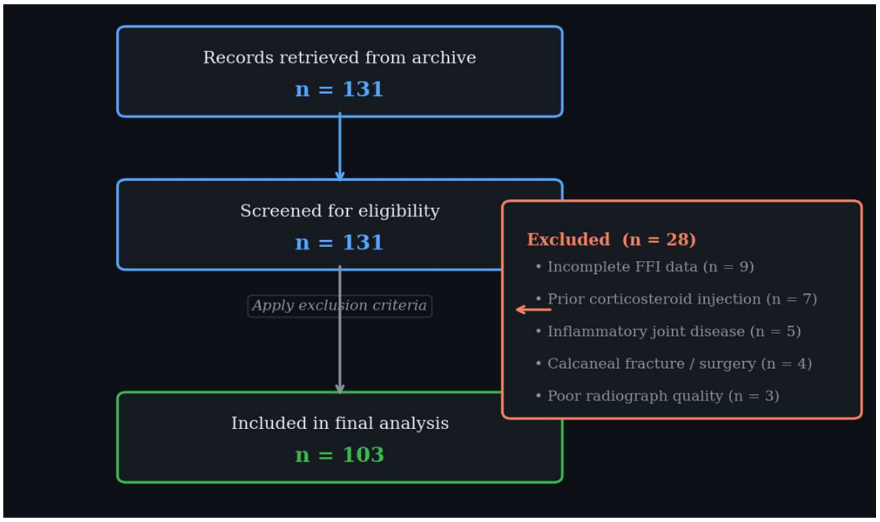
- Independent samples t-test to assess association between spur length and sex
- One-way ANOVA to compare spur length across BMI categories
  - Post hoc Tukey HSD test for multiple comparisons

Regression analysis:

- Multivariate linear regression performed
- Dependent variable: Calcaneal spur length
- Independent variables:
  - Age
  - Sex
  - BMI
  - Symptom duration
  - VAS score

RESULTS

A total of 131 patient records were initially retrieved. After applying exclusion criteria, 103 patients were included in the final analysis (Figure 1). Of those excluded, nine had incomplete FFI data, seven had received prior corticosteroid injection, five were diagnosed with concurrent inflammatory joint disease, four had a history of calcaneal fracture or surgery, and three had radiographs of insufficient diagnostic quality.



Fig/Table 1. Patient selection flowchart (CONSORT style)

The cohort comprised 65 females (63.1%) and 38 males (36.9%). Mean age was 49.1 ± 9.6 years (range: 31–66 years). Mean BMI was 28.5 ± 4.1 kg/m² (range: 21.1–38.4 kg/m²). The majority of patients (69.9%) were in the overweight or obese BMI categories. Mean symptom duration at presentation was 33.8 ± 30.9 weeks (range: 3–112 weeks). Plantar fasciitis was right-sided in 47 patients (45.6%), left-sided in 28 (27.2%), and bilateral in 28 (27.2%). All 103 patients (100%) reported morning stiffness. The heel pressure test was positive in 67 patients (65.0%). Demographic and clinical parameters are summarised in Table 1.

Fig/Table 2. Demographic and clinical characteristics of the study cohort (n = 120).

Parameter	Category / Value	n (%) or Mean ± SD
Sex	Female	65 (63.1%)
	Male	38 (36.9%)
Age (years)	Mean ± SD	49.1 ± 9.6
BMI (kg/m²)	Normal (18.5–24.9)	11 (10.7%)
	Overweight (25–29.9)	46 (44.7%)
	Obese (≥30)	46 (44.7%)
Mean BMI (kg/m²)	Mean ± SD	28.5 ± 4.1
Symptom duration (weeks)	Mean ± SD	33.8 ± 30.9
Side of involvement	Right	47 (45.6%)
	Left	28 (27.2%)
	Bilateral	28 (27.2%)
VAS score (0–10)	Mean ± SD	6.2 ± 1.9
FFI Total score	Mean ± SD	97.1 ± 32.8
Morning stiffness	Present	103 (100%)
Heel pressure test positive	Present	67 (65.0%)
Calcaneal spur present	Yes	82 (79.6%)
Calcaneal spur length (mm)	Mean ± SD	4.09 ± 3.51

BMI, body mass index; VAS, visual analogue scale; FFI, Foot Function Index; SD, standard deviation.

A calcaneal spur was identified radiologically in 82 of 103 patients (79.6%). The mean calcaneal spur length across all participants (including those with no spur, assigned a length of zero) was 4.09 ± 3.51 mm (range: 0–13.8 mm). Among patients with a visible spur, mean spur length was 5.11 ± 3.09 mm (range: 1.1–13.8 mm). Intraclass correlation coefficient for intra-rater reliability of spur length measurement was 0.96 (95% CI: 0.92–0.98), indicating excellent reproducibility.

Pearson correlation analysis revealed significant positive correlations between calcaneal spur length and the following variables: age ($r = 0.342$, $p = 0.001$), BMI ($r = 0.271$, $p = 0.003$), symptom duration ($r = 0.389$, $p < 0.001$), VAS pain score ($r = 0.358$, $p = 0.001$), FFI pain subscore ($r = 0.301$, $p = 0.001$), FFI disability subscore ($r = 0.461$, $p < 0.001$), and FFI total score ($r = 0.429$, $p < 0.001$). No significant correlation was found between spur length and sex ($p = 0.412$), FFI activity limitation subscore ($r = 0.038$, $p = 0.681$), or heel pressure test positivity ($p = 0.204$). Detailed correlation results are presented in Table 2.

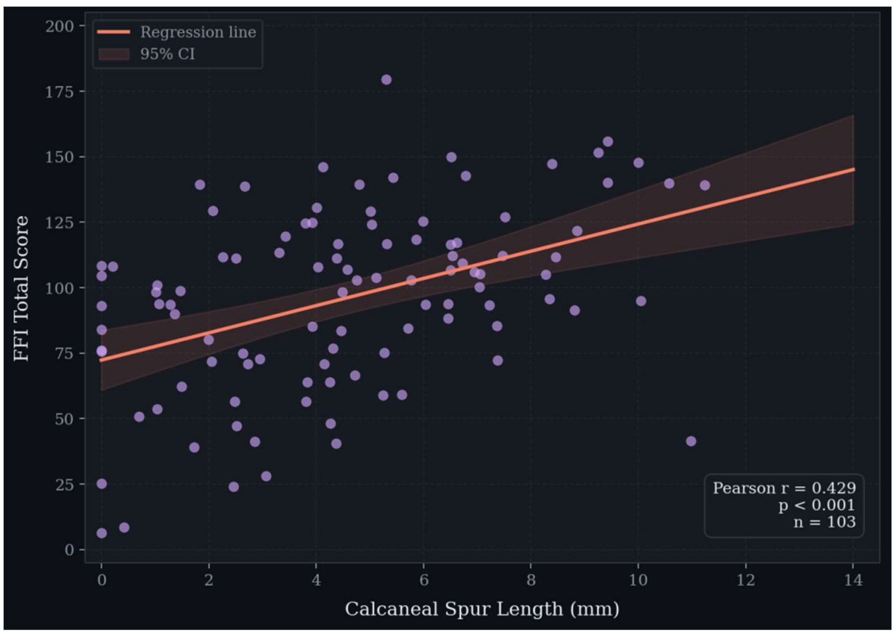
**Author for Correspondence: selvisanan@gmail.com*

Fig/Table 3. Pearson correlation analysis of calcaneal spur length, VAS score, and FFI total score with demographic and clinical variables.

Parameter	Spur length r	Spur length p	FFI total r	FFI total p	VAS r	VAS p
Age	0.342	0.001*	0.229	0.012*	0.121	0.190
Symptom Duration	0.389	<0.001*	0.284	0.002*	0.301	0.001*
BMI	0.271	0.003*	0.348	<0.001*	0.364	<0.001*
VAS	0.358	0.001*	0.872	<0.001*	—	—
FFI Pain Score	0.301	0.001*	0.861	<0.001*	0.870	<0.001*
FFI Disability Score	0.461	<0.001*	0.938	<0.001*	0.779	<0.001*
FFI Activity Limitation	0.038	0.681	0.291	0.001*	0.119	0.196
FFI Total Score	0.429	<0.001*	—	—	—	—
Morning Stiffness	0.228	0.012*	0.118	0.200	0.252	0.006*
Heel Pressure Test	0.141	0.204	0.048	0.601	0.165	0.073

* *Statistically significant (p < 0.05). VAS, visual analogue scale; FFI, Foot Function Index; BMI, body mass index.*

Fig/Table 4. Calcaneal Spur Length vs VAS pain score



Fig/Table 5. Calcaneal spur length vs FFI total score

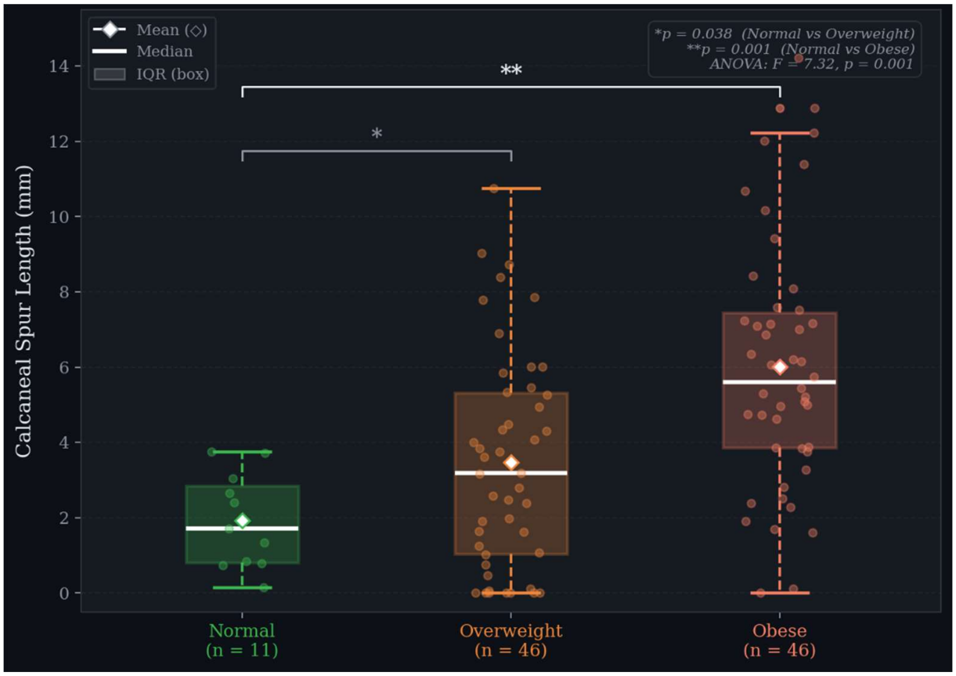
One-way ANOVA revealed a significant difference in mean calcaneal spur length across BMI categories (F = 7.32, p = 0.001). Post hoc Tukey HSD analysis demonstrated that mean spur length was significantly greater in obese patients (5.76 ± 3.58 mm) than in patients with normal BMI (2.17 ± 1.84 mm; p = 0.001). The difference between overweight and normal BMI groups was also significant (p = 0.038). These findings are presented in Table 3.

Fig/Table 6. Mean calcaneal spur length stratified by BMI category.

BMI Category	n	Mean Spur Length (mm)	SD
Normal (18.5–24.9 kg/m²)	11	2.17	1.84
Overweight (25–29.9 kg/m²)	46	3.94	3.19
Obese (≥30 kg/m²)	46	5.76	3.58

One-way ANOVA: F = 7.32, p = 0.001. Post hoc Tukey HSD: Normal vs Obese, p = 0.001; Normal vs Overweight, p = 0.038; Overweight vs Obese, p = 0.061. SD, standard deviation.

*Author for Correspondence: selvisanan@gmail.com



Fig/Table 7. Calcaneal spur length by BMI category

Multivariate linear regression analysis identified symptom duration (β = 0.301, 95% CI: 0.018–0.058, $p < 0.001$) and BMI (β = 0.228, 95% CI: 0.041–0.312, p = 0.004) as independent predictors of calcaneal spur length. Age approached significance (β = 0.159, 95% CI: −0.003–0.189, p = 0.058) but did not reach the predefined threshold. VAS score was not an independent predictor after controlling for the other variables (β = 0.112, p = 0.204). The regression model explained 28.4% of the variance in calcaneal spur length ($R^2 = 0.284$, adjusted $R^2 = 0.258$, F = 11.22, $p < 0.001$). Regression coefficients are presented in Table 4.

Fig/Table 8. Multivariate linear regression analysis with calcaneal spur length as the dependent variable.

Variable	β	95% CI	t	p
Symptom duration (weeks)	0.301	0.018 – 0.058	4.12	<0.001*
BMI (kg/m²)	0.228	0.041 – 0.312	2.98	0.004*
Age (years)	0.159	-0.003 – 0.189	1.91	0.058
VAS score	0.112	-0.142 – 0.631	1.28	0.204
Sex (male vs female)	0.073	-0.491 – 1.382	0.82	0.412

** Statistically significant ($p < 0.05$). $R^2 = 0.284$, Adjusted $R^2 = 0.258$, F = 11.22, $p < 0.001$. β, standardised regression coefficient; CI, confidence interval; BMI, body mass index; VAS, visual analogue scale.*

DISCUSSION

The principal outcome of this retrospective cross-sectional study revealed a significant positive correlation between calcaneal spur length and pain intensity, evaluated using the Visual Analog Scale (VAS), as well as with foot functional impairment, assessed by the Foot Function Index (FFI), encompassing its pain and disability subscores and total score, in a cohort of 103 patients with clinically diagnosed plantar fasciitis (PF). Multivariate regression analysis demonstrated that symptom duration and BMI function as independent predictors of spur length. These findings validate and augment the previous prospective study conducted by Kuyucu et al. [4], which analyzed 75 patients with PF and first established formal correlations between spur length and pain, as well as spur length and function.

The prevalence of radiological calcaneal spurs in this cohort (80.0%) aligns with statistics reported in the existing literature. Johal and Milner performed a retrospective study with 100 patients suffering from plantar fasciitis (PF) and 100 with ankle sprains. They found that calcaneal spurs were present in 85% of the PF group, which is much higher than the number of ankle sprains [3]. Their study confirmed the association between spur presence and PF. This study enhances the research by treating spur length as a continuous variable and analyzing its quantitative relationship with pain and function.

The correlation between spur length and age observed in this data (r = 0.342, p = 0.001) is consistent with results from multiple independent studies. Biyani et al. examined the radiological characteristics of calcaneal spurs in a large community cohort, demonstrating that spur length and the prevalence of radiological spurring increased progressively with advancing age [8].

The significant association between spur length and BMI (r = 0.271, p = 0.003) in this study. In this subgroup analysis, obese patients demonstrated a mean spur length 2.65 times greater than individuals with a normal BMI (5.76 mm vs 2.17 mm), a difference that was statistically significant in post hoc testing. BMI was an independent predictor of spur length in multivariate analysis ($\beta = 0.228$, $p = 0.004$), suggesting that the relationship is not solely affected by confounding variables such as age or symptom duration.

The association between symptom duration and spur length ($r = 0.389$, $p < 0.001$) signifies the most robust relationship and the most consequential independent predictor ($\beta = 0.301$, $p < 0.001$) in the regression model, illustrating conceptual coherence. The formation of spurs is a gradual process of ossification that happens when entheseal stress is applied repeatedly. It is biologically plausible to consider that an extended disease duration would result in prolonged spur growth. This underscores the importance of timely diagnosis and intervention in the management of PF.. But the data now shows that the size of spur elongation may indicate about how bad the pain is in people with symptomatic PF. This interpretation aligns with the perspective that calcaneal spurs, similar to osteophytes in osteoarthritis, represent structural indicators of degenerative severity rather than mere incidental radiological findings [9].

The relationship between spur length and the FFI disability subscore ($r = 0.461$, $p < 0.001$) was stronger than with any other single outcome variable. The FFI total score also showed a strong relationship ($r = 0.429$, $p < 0.001$). The study's data further clarify a dimensional correlation: larger spurs are associated with greater functional impairment.

It is significant to observe that spur length exhibited a weak correlation with the FFI activity limitation subscore ($r = 0.038$, $p = 0.681$). The activity limitation domain of the FFI assesses the extent to which foot pain impedes specific functional activities, such as prolonged standing, stair climbing, and indoor walking. A similar trend was observed in the parent study by Kuyucu et al., where the activity limitation subscore demonstrated the weakest correlations [4].

This study has a number of important methodological strengths that should be noted. Employing a larger sample size (n = 120) compared to prior studies, in conjunction with a multivariate regression methodology, enabled the identification of independent predictors of spur length while controlling for confounding variables. Strict eligibility criteria ensured a clinically homogenous sample. The retrospective design, enabled the examination of a broader temporal spectrum of clinical records and a more diverse patient demographic .

It's important to remember some of the study's limitations when you look at the results. The retrospective design inhibits causal inference; the direction of observed associations cannot be confirmed without longitudinal data. Ultrasonography was not used to measure the thickness of the plantar fascia, which is known to be a strong link to PF severity and a possible link between spur length and functional outcomes [10,11]. The angle between the calcaneal body and the spur shaft, a potentially important geometric feature, was not measured. Relying on VAS and FFI scores that are recorded on a regular basis instead of standardized assessments that are done ahead of time could cause inconsistencies in how outcomes are recorded during the study period. Additionally, the cohort was derived from a single tertiary referral center, thereby limiting the generalizability of the findings to the broader community-attending PF population. Lastly, like all retrospective radiological studies, control for selection bias related to radiation in patients for whom imaging was thought to be clinically necessary could not be controlled.

Future research in this area should employ longitudinal cohort designs to examine the evolution of calcaneal spur length over the course of plantar fasciitis and to evaluate the relationship between spur dimensions and treatment results.

CONCLUSION

The findings derived through this retrospective cross-sectional investigation indicate that calcaneal spur length significantly correlates with both levels of pain and functional limitations experienced by individuals having plantar fasciitis, and that calcaneal spur length, in turn, correlates with age, body mass index (BMI), duration of symptoms, a visual analogue scale (VAS) pain score, and the Foot Function Index (FFI) pain subscale and disability subscale. A stepwise multiple regression model exhibited significant independence between the duration of symptoms and the BMI as a predictor of calcaneal spur length supporting the biomechanical hypothesis that an increase in the length of the calcaneal spur (or multiple calcaneal spurs) has occurred within individuals that are more likely to develop progressively longer calcaneal spurs than those at lower risk. The absence of a statistically valid correlation to the FFI activity limitation score signals that further exploration of this relationship should be performed. Ultimately, the traditional measurement of calcaneal spurs describes important clinical knowledge and should become part of the clinical outcome and specific functional assessment used when creating individualised treatment plans for patients with plantar fasciitis.

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