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Radiological classification and prevalence of plantar spur and their relationship with plantar fasciitis

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Abstract
Introduction: A presence or consequences of the plantar spur as a cause of plantar fasciitis are currently uncertain. But literature is deficient with conflicting findings regarding the relationship between the PS and PF. The study was undertaken to assess the incidence of types and sizes of the plantar spurs and to find the relationship between the plantar spur and plantar fasciitis.
Material & Methods: We studied 30 patients with the complaints of plantar fasciitis having plantar spur were included. Length and size of the plantar spur were assessed radiologically using lateral view ankle X-rays. Pain and functional assessment were evaluated using VAS and AOFAS score before and after treatment.
Results: Length of the plantar spur was classified as type 0/absent in 4 patients, 1/small in 4 patients, 2/medium in 12 patients and 3/large in 10 patients Plantar spur size was measure spurs as <5mm, 5-10mm, and >10mm. The highest incidence spurs size was 5-10mm and >10mm accounts for 36.67% each (n=11). Statistically, significant improvement was found in the mean VAS and AOFAS score in all the patients after treatment especially patient with a medium sized spur (grade 2).Cohen's Kappa statistic showed excellent intra and inter-observer agreement.
Conclusions: These suggest that the presence or consequences of the plantar spur are not necessarily as a cause of plantar fasciitis. These results may enlighten the knowledge to understand the role of the plantar spur in a patient with plantar fasciitis.

Keywords: Inferior calcaneal spur, calcaneal spur, plantar fasciitis, heel spur

Introduction
Calcaneus (Latin- heel bone) is the largest, strongest and longest tarsal bone, located just below the talus and forms posterior pillar for the bony arches of the foot [1]. Any bony outgrowth or enthesophyte from the calcaneus known as a calcaneal spur or heel spur. It is of two types based on its location at the calcaneus. It is said to be dorsal heel spur or Achilles spur if outgrowth is located at the back of the heel and as a plantar spur (PS) or calcaneal spur if outgrowth is located under the sole [2].
The plantar fascia is a thickened fibrous sheet of connective tissue that originates from the medial tubercle of the calcaneus and attaches to the plantar surface of the metatarsophalangeal joints. It acts as a dynamic stabilizer and shock absorber of the longitudinal arch of the foot. Plantar fasciitis is a common pathological condition affecting the hind foot and due to the confusion about the etiology of plantar fasciitis (PF), it can often be a challenge for clinicians to successfully treat [3, 4]. It is an overuse injury causing inflammation at the origin of the plantar fascia and surrounding perifascial structures, such as the calcaneal periosteum [5].
Heel pain syndrome, subcalcaneal pain syndrome calcaneodynia, subcalcaneal bursitis, calcaneal periostitis, neuritis, heel syndrome, subcalcaneal spur syndrome, stone bruise, medial arch sprain, runner's heel, jogger's heel, and policeman's heel are terms used synonymously in the literature for inflammation of the plantar fascia [6].
A presence or consequences of the plantar spur (PS) as a cause of plantar fasciitis (PF) are currently debatable. In a literature review, some authors reported the presence of PS in a patient without PF and other investigators reported the association of PS with PF [7, 8]. However, in the literature, we encounter the patients with painful PF but have no PS [9]. But literature is d.

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Material and Methods

This prospective study consists of 30 patients including both sexes, who referred for lateral view ankle radiographs, from the department of orthopaedics. The data was collected from the department of radiodiagnosis at Sri Siddhartha Medical College, Tumakuru during the period between September 2016 and November 2017. In the present study, 30 patients who were attended to outpatient department with the complaints of plantar fasciitis were included. The patients with the history of previous ankle fracture or surgery, any inflammatory joint disease and plantar fasciitis patients who received any surgical treatment were excluded. Clearance from the institutional ethical committee was obtained before initiating the study.

All radiographs with calcaneal spur were subsequently observed and graded by two independent observers (KHA, RP). Observers were requested to grade the PS from 0-3. PS recorded as 0 when there is no spur (Absent), 1 (small), 2 (medium), 3 (large). After a short period of time, the above-mentioned protocol was repeated by the same observers to assess intra and inter-observer reliability. Computer-aided measurement for the length of the calcaneal spur was calculated by using RadiAnt Dicom software (version 4.2.1).

Patients were assessed clinically, a thorough history and clinical examination were carried out, the subjective symptoms and objective signs were recorded and examined by two independent examiners (JC, BS) before starting the treatment. The independent examiners evaluated pain using a Visual Analogue Scale (VAS) from 0 (pain-free) to 10 (worst unbearable pain). Similarly, pain along with the functional activity of foot was measured using American Orthopaedic Foot and Ankle Society (AOFAS) from 0 to 100.

All patients were reviewed after the first month, second month, fourth month and sixth month. Patient feedbacks were collected during the first month, second month, fourth month and sixth-month visits. A conservative treatment was given during the follow-up periods. The pain and functional assessment of all the patients were repeated using VAS & AOFAS scores after conservative treatment.

The data obtained were statistically analyzed using GraphPad Prism 5 software (Version 5). The data was assessed using two-tailed paired Student's T-test to compare before treatment and after treatment VAS and AOFAS scores. A p-value <0.05 was considered as statistically significant. An initial intra- and inter-observer reliability was assessed using Cohen's Kappa statistics test.

Results

Out of 30 patients, 9 were males (30%) and 21 were females (70%). The average age of the patients was 43.13 ± 11.44 years (range 28-71 years). Mean spur length 6.923mm and mean spur grade 1.93. Other Demographic characteristics of the study population are summarized in Table 1.

Table 1: Demographical parameters of the study group

Variable	*n*= 30
Gender	
Male	9
Female	21
Laterality	
Right	19
Left	11
Occupation	
Former	4
Businessman	2
House Wife	21
Labourer	2
Mechanic	1
Body Mass Index (kg/m^2)	
Normal weight (18.5-24.9)	4
Overweight (25-29.9)	16
Obesity (>30)	10

According to the PS classification based on the types of Spurs, 12 (40%) of PS were type 2, 10 (33.33%) type 3, and 4 (13.33%) each in type 0 and type 1. VAS score and AOFAS score was used to assess the pain and functional outcome of the patient. Patients were analyzed for pain relief subjectively at 1st month, 2nd month, 4th month and 6th month. Pain score was assessed before treatment. The mean VAS score and AOFAS of all the patients before receiving the treatment were 9.27 ± 1.128 and 52.30 ± 7.169 respectively. The mean pain score at 6thmonth after conservative treatment was 2.58 ± 1.38. (Table 2 & Table 3).

Fig 1: shows the types of plantar spur. A) Type 0/absent,B) type 1/small,C)type 2/medium, D) type3/large**.**

Table 2: Patients Demographics based on types of plantar spur

Types of spur	No o Patients	Before Treatment VAS Score (Mean ± S.D)	After Treatment VAS Score (Mean ± S.D)	*P* Value	Before Treatment AOFAS Score (Mean ± S.D)	After Treatment AOFAS Score (Mean ± S.D)	*P* Value
Grade(Absent)	4	8.75 ± 1.89	3.0 ± 0.81	0.0114	61.5 ± 11.09	87.75 ± 0.5	0.0032
Grade(Small)	4	9.50 ±0.40	3.0 ± 0.0	0.000	54.25 ± 12.92	88.0 ± 0.0	0.004
Grade(Medium)	12	9.29 ± 1.14	2.58 ± 1.38	<0.0001	51.0 ± 1.8	96.0 ± 5.9	<0.001
Grade 3(Large)	10	9.35± 1.05	3.8 ± 0.63	<0.0001	49.40 ± 3.75	89.2 ± 3.8	<0.0001

Abbreviations: VAS: visual analog scale; AOFAS: American Orthopaedic Foot and Ankle Society

As a measure of agreement between the observers, Cohen's Kappa statistics were used. Inter-observer reliability was 0.83 and Intra-observer reliability was 0.90 which is substantial to excellent (Cohen's Kappa 0.81-1.00).

Table 3: Patients Demographics based on size of plantar spur

Size of spur	No. of Patients	Before Treatment VAS Score (Mean ± S.D)	After Treatment VAS Score (Mean ± S.D)	*P* Value	Before Treatment AOFAS Score (Mean ± S.D)	After Treatment AOFAS Score (Mean ± S.D)	*P* Value
<5 mm	8	9.125 ± 1.33	3.0 ± 0.53	<0.0001	57.88 ± 11.80	87.88 ± 0.35	<0.0002
5-10 mm	11	9.22 ±1.17	2.818 ± 1.16	<0.0001	50.91 ± 1.86	95.64 ± 6.05	<0.0001
>10 mm	11	9.41 ± 1.02	3.45 ± 1.29	<0.0001	49.64 ± 3.64	90.18 ± 4.85	<0.0001

Abbreviations: VAS: visual analog scale; AOFAS: American Orthopaedic Foot and Ankle Society

Discussion

The most common cause of plantar heel pain is PF, which is multifactorial in etiology, both intrinsic and extrinsic factors. The extrinsic factors like prolonged weight-bearing activities and inappropriate shoe wear. Intrinsic factors like excessive foot pronation, obesity, limited ankle dorsiflexion and inflammatory arthropathy, of which PS is the most common cause[10]. However, clear-cut associations of PS as a cause of plantar fasciitis (PF) are currently debatable.

But there exist only very few studies establishing the relationship between the PS and PF. A study conducted by Johal K S demonstrated the association between the lengths of PS with PF. They found that there was a higher prevalence of PS in patients with PF than the comparison subjects[7]. Another study conducted by Kuyucu *et al* documented the correlation of plantar spur length with clinical and functional status in patients with plantar fasciitis. They concluded that patients with larger spur had significantly worse pain and function than those with smaller spur[11].

In 2015, an endoscopic study conducted by Zhou *et al* classified PS into two types based on the location of PS in relation with plantar fascia i.e. type A spurs above and type B within the plantar fascia. They reported that those with type B spurs had significantly worse PF than those with type A spurs on MRI and physical examination[2].

Most Recently, Ahmed *et al* (2016) classified the PS into four types based on shapes of spurs. They grade the spur from 0-3: 0 (absent), 1 (horizontal), 2 (vertical) and 3 (hooked). They explored the association between the PS and functional status of PF before and after receiving nonsurgical treatment. They found that the patients with absent or smaller spurs had significantly worse PF before treatment on MRI than those with larger or horizontal spur. Above statement clarifies that the PS is not the cause of inflammation or pain with PF[10].

In the present study, we classified PS into 4 types based on the length of the spurs. Our classification was slightly different from the Ahmed *et al* [10]. PS recorded as 0 when there is no spur (Absent), 1 (small), 2 (medium), 3 (large). In our study, the most common type of PS was grade 2, accounts for 40% (n=12) cases. Type 3 PS was the second most common, observed in 33.33% (n=10). Type 0 and 1 was seen in 13.33% each (n=4). We also classified PS based on the size of the spurs. We measured and classified the size of the spurs as <5mm, 5-10mm, and >10mm. The highest incidence spurs size was 5-10mm and >10mm accounts for 36.67% each (n=11). The lowest incidence spurs size was <5mm accounts for 26.66% (n=8).

Pain and functional assessment for all of our study population were analyzed before and after receiving conservative treatment. Patient with small length spurs (grade 1) had significantly worse PF on VAS score than those with other size spurs. Similarly, those with spurs size 5-10mm had significantly worse PF on VAS score. Although all types of PS execute good functional outcomes after conservative treatment.But comparatively, a patient with medium sized spur (grade 2) achieved significantly greater improvement both in VAS and AOFAS score. VAS score (mean) for pain was significantly decreased from 9.29 before treatment to 2.58 after treatment ($p<0.05$) and AOFAS score (mean) for the function significantly increased from 51 before treatment to 96 after treatment ($p<0.05$).

In addition, a patient with spurs size 5-10mm performs significantly greater improvement both in VAS score and AOFAS score. VAS score (mean) for pain significantly decreased from 9.22 before treatment to 2.81 after treatment ($p<0.05$) and AOFAS score (mean) for the function significantly increased from 50.91 before treatment to 95.64 after treatment ($p<0.05$).

This finding proposes that different types and size of PS is independent of PF. We also suggest that the presence or consequences of the plantar spur (PS) are not necessarily as a cause of plantar fasciitis (PF). The present study had two important limitations. First, we excluded the patient without PF i.e. asymptomatic patients with PS. Second, we did not evaluate the degree of PF. We recommend a large scale population based study with long-term follow up to analyze the improvement in PF following the appropriate intervention.

Conclusion

The current study proposed the standard classification of the length of the plantar spur with the higher incidence was found to type 2/medium plantar spur. Patient with a medium sized spur (grade/ type 2) achieved significantly greater improvement both in VAS and AOFAS score than other types. These suggest that the presence or consequences of the plantar spur (PS) are not necessarily as a cause of plantar fasciitis (PF). These results may enlighten the knowledge to understand the role of the plantar spur in a patient with plantar fasciitis.

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Author contributions

Conception and design: KHA, JC,

Analysis and interpretation: KHA, RP,

Data collection: KHA, JC, BS

Writing the article: KHA & JC,

All authors have read and approved of the final version of the

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