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Morphometric Analysis Of Calcaneal Enthesophytes In Dry Human Adult Calcanea From Western Gujarat: Implications For Anthropological And Clinical Studies

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Abstract:
Background *Calcaneal spurs are bony outgrowths that develop on the calcaneus (heel bone) and are frequently associated with heel pain conditions such as plantar fasciitis. Despite their clinical significance, there is limited understanding of the prevalence, distribution, and morphological characteristics of calcaneal spurs in specific populations. Addressing this knowledge gap is crucial for informing diagnostic and treatment approaches tailored to individual patient needs. Therefore, this study aimed to investigate the prevalence, distribution, and morphological features of calcaneal spurs in a sample population from western Gujarat. This study aimed to investigate the prevalence, distribution, and morphological features of calcaneal spurs in a sample population from western Gujarat.*
Materials & Methods: *A total of 300 adult dry calcanea were examined, with 264 included in the analysis. Calcaneal spurs were categorized based on location and morphological characteristics measured. Statistical analysis determined prevalence rates and differences between sides.*
Results: *The study revealed an overall prevalence rate of calcaneal spurs of 37.5%, with 99 out of 264 calcanei exhibiting spurs. Prevalence rates slightly differed between the right (35.38%) and left (39.55%) sides. Calcaneal spurs were categorized based on their location, with 22 solely on the posterior side, 21 solely on the inferior side, and 56 on both sides concurrently. Morphological analysis indicated that posterior spurs had an average length of 8.06 mm and breadth of 19.98 mm, while inferior spurs measured around 10.83 mm in length and 17.75 mm in breadth. Variations in spur origin and shape were observed, with most spurs originating from the median tubercle and exhibiting circular, triangular, or oblong shapes from a basal view and hook-like shapes from a side view.*
Conclusion: *This study highlights the multifactorial nature of calcaneal spur formation and underscores the importance of tailored treatment approaches for managing heel pain conditions based on comprehensive evaluation of prevalence and morphology.*
Keywords: *Morphometric Analysis, Calcaneal Enthesophytes, Human Calcanea, Western Gujarat*

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I. Introduction:

The calcaneum is the key bone and the largest in the skeleton of the foot. It plays the most significant role in weight transmission, weight bearing, posture, and gait. Occasionally, the calcaneum may also present itself with a set of accessory bones. Examples of these accessory bones include the os sub calcis and os aponeurosis plantaris. These accessory bones are typically found on the inferior or plantar surface of the calcaneum [1]. Calcaneus or os calcis forms a chief component of the skeleton of foot providing posterior pillars for bony arches of the foot and forms prominence of heel2. The calcaneum is first ossified bone among tarsus which forms the shape of the heel protrusion, and acts as a lever arm of the calf muscle.[2]. The mechanism of formation of calcaneal spur or enthesophytes could either due to longitudinal traction, due to vertical compression, chondroidal and intramembranous ossification, due to excessive traction of the origin of the plantar fascia at the calcaneal tuberosity 1. Many times anterior to calcaneal tuberosity a bony outgrowth has been observed (calcaneal or heel spur) extending along entire width. The apex of spur is seen embedded in plantar fascia, directly anterior to its origin2. Enthesophytes are observed as inferior spurs of the plantar fascia and the posterior or dorsal spurs of the tendo calcaneus. Plantar fascia is the most common site of a bony spur. The pain and sensitivity of the medial tubercule of the calcaneus on the anterior side is a characteristic symptom of heel spur syndrome [3]. Calcaneal spurs, characterized by bony protrusions around the calcaneal bone, are often linked to talalgia, or heel pain. This discomfort, a common symptom of calcaneal spurs, can stem from various causes. The origins of these spurs remain somewhat enigmatic [4]. So understanding the incidence and

morphology of calcaneal spurs is crucial for accurate diagnosis, treatment planning, patient education, resource allocation, research prioritization, and preventive strategies in addressing heel pain and related foot conditions.

II. Material And Methods:

Study Design: This study employed a cross-sectional design to investigate the prevalence, distribution, and morphological characteristics of calcaneal spurs in a sample population from western Gujarat.

Study Duration: The study duration spanned from January2023 to January2024, during which data collection and analysis were conducted.

Sample Size Calculation: A total of 300 adult dry calcanea were obtained from various medical colleges in western Gujarat, ensuring a representative sample size for the study objectives.

Inclusion Criteria: Calcanea from adult individuals were included in the study. Specimens with no gross deformity or damage were considered eligible for analysis.

Exclusion Criteria: Calcanea displaying gross deformity or damage were excluded from the study to ensure the integrity of the sample population.

Study Procedure:

- Calcanea were visually examined, and specimens with any outgrowths were identified using a magnifying glass as shown in Fig.1
- Outgrowths observed were considered calcaneal spurs.
- Calcaneal spurs were further categorized based on their location.
- Measurements of spur length and breadth were taken using a vernier caliper in millimeters, as illustrated in Figure 2.
- Length was measured from the tip of the spur to its base, while maximum breadth near the base was recorded.
- Data were recorded, analyzed, and presented as mean ± standard deviation using Microsoft Excel.
- Variations in spur shape, including triangular, oblong, circular, or hook shapes as depicted in Figure 3, were observed and documented using a digital camera.

Fig.1 Showing calcaneal spur on Inferior side, Posterior side and concurrently both sides

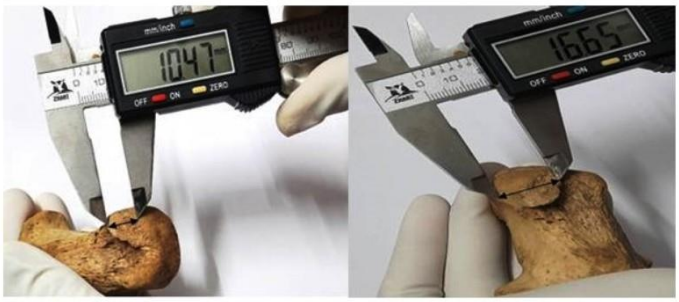

Fig.2 Showing methodology of taking length and breadth of calcaneal spur

Fig.3 Showing circular,triangular,oblong and hook shaped calcaneal spur

III. Results:

Out of 300 adult dry calcanea, 264 calcanei studied, 99 exhibited calcaneal spurs, indicating an overall prevalence rate of 37.5%. Interestingly, there was a slight difference in prevalence rates between the right (35.38%) and left (39.55%) sides. Calcaneal spurs were categorized based on their location, with some appearing solely on the posterior side, others solely on the inferior side, and some present on both sides concurrently. Notably, a significant proportion of individuals (56 out of 99) had spurs present on both the posterior and inferior sides, suggesting a co-occurrence of spurs in these locations. Morphological characteristics of calcaneal spurs, including size, origin, and shape, were also examined. Posterior spurs were found to have slightly larger dimensions compared to inferior spurs. Furthermore, inferior calcaneal spurs predominantly originated from the median tubercle. Various shapes were observed, such as circular, triangular, and oblong shapes from a basal view, and hook-like shapes from a side view. The results of present study are displayed in Table 1

Table 1 Showing various parameters of calcaneal spur studied in present study

Sr. no	Parameters	Right	Left	Total
1.	Calcaneal studied	130	134	264
	Calcaneal spur present	46	53	99
	Percentage	35.38	39.55	37.5
2.	Types of calcaneal spur			
	Only Posterior side	9	13	22
	Only Inferior side	8	13	21
	Both Posterior and Inferior sides	29	27	56
3.	Posterior Calcanei spur			
	Length (mm)	8.06 ± 4.08	7.76± 1.77	
	Breadth (mm)	19.98+ 5.64	18.82+ 4.65	
4.	Inferior Calcaneal spur			
	Length(mm)	10.83±4.1	10.85±3.69	
	Breadth(mm)	17.75+4.77	18.08+ 3.57	
5.	Variation of Inferior Calcaneal spur			
	Origin from median tubercle	33	37	70
	Origin from Lateral tubercle	1	0	1
	Origin from both tubercles	3	3	6
6.	Shape from basal view			
	Circular	24	26	50
	Triangular	9	12	21
	Oblong	4	2	6
7.	Shape from Side view			
	Hook like	22	23	45

IV. Discussions:

Calcaneal spurs offers valuable insights into a common orthopedic condition that affects a significant portion of the population. Understanding the prevalence, distribution, and morphological characteristics of calcaneal spurs is crucial for several reasons.The prevalence of calcaneal spurs observed in the present study done in western Gujarat, at 37.5%, is notably lower than rates reported in previous research. Perumal and Anand (2013)[1] documented a prevalence rate of approximately 56%, while Kullar et al. (2014)[2] reported a lower rate of 26%. Similarly, a radiological study conducted by R. Kevin Lourdes et al. (2016) [5]found an even higher incidence rate of 59%. Furthermore, epidemiological investigations have provided additional insights into calcaneal spur prevalence. One such study revealed that 11% of the adult U.S. population had developed calcaneal spurs, identified incidentally during radiographic examination (McCarthy DJ and Gorecki GE, 1979)[6]. Additionally, Prichasuk S and Subhadrabandhu T (1994)[7] reported varying incidence rates, with 15.5% observed in normal subjects and a substantially higher rate of 65.9% in patients experiencing plantar heel pain. These findings emphasize the wide variability in calcaneal spur prevalence across different populations and study contexts. Factors such as demographic characteristics, diagnostic criteria, and sample size may contribute to these variations. The cause of formation of clacaneal spur are multifactorial like age (Riepert T et al, 1995)[8], sex, obesity (Menz HB et al,2008)[9], profession (Cosentino R et al, 2001)[10] and orthopaedic diseases leading to variation in incidence.

In the present study disparity between the right and left sides (35.38% vs. 39.55%) suggests potential asymmetry in spur formation. In the present study left sided spur incidence was little more compared to right side in contrast to study by Perumal and Anand (2013)[1] and radiological study by ALTUNTAS, E. & UZUN, A (2022)[11] in which right sided spur has larger incidence . This highlights the need for a comprehensive evaluation of both feet in patients presenting with heel pain and related symptoms.

22 spurs were found solely on the posterior side, 21 solely on the inferior side, and 56 on both sides. This suggests that a significant proportion of calcaneal spurs are present on both the posterior and inferior sides simultaneously.

Posterior spurs had an average length of approximately 8.06 mm and breadth of 19.98 mm, while inferior spurs measured around 10.83 mm in length and 17.75 mm in breadth. These measurements offer insights into the size variability of calcaneal spurs, with inferior spurs generally appearing longer and narrower compared to posterior spurs.

The data also explore variations in the origin and shape of inferior calcaneal spurs. Most spurs originated from the median tubercle (70 cases), followed by those originating from both tubercles (6 cases) and the lateral tubercle (1 case).

Additionally, the shape of the spurs varied, with circular, triangular, and oblong shapes observed from a basal view, and hook-like shapes from a side view.

V. Conclusion

So present study highlights the prevalence of calcaneal spurs in the studied population is notable, with over a third of individuals exhibiting these bony protrusions. The coexistence of calcaneal spurs on both the posterior and inferior aspects of the heel, either independently or simultaneously, suggests the multifactorial nature of their formation. Variations in spur size, origin, and shape highlight the intricate morphological complexity of calcaneal spurs, suggesting a diverse interplay of etiological factors and biomechanical influences. This complexity likely arises from a combination of factors such as foot anatomy, gait mechanics, genetic predisposition, and external forces acting on the heel. As such, the presence of calcaneal spurs cannot be attributed to a singular cause but rather represents a culmination of multiple interacting factors contributing to their development.

Limitations of the study are the data collected from the western Gujarat not entire Gujarat, so further studies required to cover more demographic area. As the study is done on the dry bone specimen, patients age, sex and Body mass index(BMI) cannot be found along with other biomechanical factors which are responsible for development of calcaneal spur. So further studies required in living person which help in understanding symptoms and treatment modalities.

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