Section: Miscellaneous

Original Research Article

HIGH-RESOLUTION ULTRASOUND SPECTRUM IN NON-TRAUMATIC ANKLE PAIN AMONG RURAL POPULATIONS: A CROSS-SECTIONAL STUDY AT A TERTIARY CARE HOSPITAL

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ABSTRACT

Background: To characterize the spectrum of non-traumatic ankle pathologies detected by high-resolution ultrasound in a rural population and to assess the diagnostic utility of ultrasound relative to clinical and, where available, MRI findings.

Materials and Methods: This cross-sectional observational study included 85 patients (120 ankles) aged 18-60 years presenting with non-traumatic ankle pain. Ultrasound examinations were performed using a 13 MHz linear probe to evaluate tendons, ligaments, and surrounding soft tissues. Ultrasound findings were classified according to standardized criteria. MRI or surgical correlation was obtained in a subset of cases.

Results: Pathological findings were identified in 110 of 120 ankles (91.7%). The Achilles tendon was the most commonly affected structure (43.3%), with insertional tendinopathy (25.8%) and retrocalcaneal bursitis (13.3%) being predominant. Other tendons and a single ligament injury were also identified. Ultrasound findings showed high concordance with MRI and surgical correlation in the subset of patients evaluated. No significant differences in pathology prevalence were observed across sex or age groups.

Conclusion: High-resolution ultrasound effectively identifies a broad spectrum of nontraumatic ankle pathologies in a rural population. Pathologies commonly detected were involving Achilles tendon emphasizing the need for clinical suspicion for the same in cases on non-traumatic ankle pain. Ultrasound serves as a valuable first-line imaging modality in resource-limited settings, with diagnostic findings correlating well with MRI and clinical data.

Keywords: High-resolution ultrasound, Non-traumatic ankle pain, Ankle disorders, Musculoskeletal ultrasound, Tendinopathy.

INTRODUCTION

The ankle joint is one of the most frequently affected joints in both traumatic and overuse conditions.[1] Its complex anatomy can make clinical diagnosis challenging, especially when multiple tendons are involved. While chronic overuse is well-documented among athletes, it is equally prevalent in occupations such as farming and manual labor, which are common in rural southern India. Unfortunately, most studies on ankle pathology and imaging focus on athletes, limiting their relevance for the broader population.

In many rural and resource-limited settings, imaging options are often restricted to radiographs and ultrasound. High-resolution ultrasound is widely available, cost-effective, and particularly suited for evaluating superficial musculoskeletal structures. Despite a steep learning curve ultrasound allows for the assessment of tendons, tendon sheaths, muscles, ligaments, and bursae, with the added benefit of dynamic evaluation.[2] While MRI remains the gold standard for comprehensive assessment, ultrasound offers real-time, high-resolution imaging of superficial structures, making it an invaluable first-

line tool in rural and resource-constrained environments.[3]

With this background, our study set out to characterize the spectrum of non-traumatic ankle pathologies detectable by ultrasound in a rural Indian population and to assess the diagnostic utility of ultrasound relative to clinical and, where possible, MRI findings.

MATERIALS AND METHODS

Study Design and Population: This cross-sectional observational study with convenience sampling which included 85 patients from rural areas who presented to the orthopedics outpatient department with non-traumatic ankle pain. Of these, 35 had bilateral symptoms, resulting in a total of 120 ankles evaluated.

Inclusion Criteria

- Patients aged 18-60 years with non-traumatic ankle pain.

Exclusion Criteria

- Acute or chronic ankle trauma.
- Open wounds or skin disease over the ankle.
- Age <18 years (due to lack of chronic overuse) or >60 years (to minimize confoundingdue to age-related tendon degeneration).
- History of ankle surgery.
- systemic inflammatory diseases (e.g., rheumatoid arthritis, spondyloarthropathies).

Data Collection and Imaging Protocol: We collected demographic, clinical, and laboratory data for all patients. Written informed consent was obtained in the local language. Ultrasound examinations were performed using a Samsung V8 machine with a 13 MHz high-resolution linear probe. We systematically scanned the four compartments around the ankle-anterior, posterior, medial, and lateral. Tendons and ligaments were assessed for continuity, echogenicity, vascularity, and calcification. We also documented soft tissue edema and cortical irregularities where present.

Ultrasound findings were classified using standardized definitions based on recent consensus guidelines. In a subset of cases with equivocal findings or where clinically indicated, MRI or surgical correlation was obtained.

Descriptive terms relating to Achilles tendon pathologies lack uniform consensus, and terminologies may be confusing. We followed the definitions as per the study done by American Journal of Radiology Expert Panel Narrative Review Authors: Bill Pass et al,[4] and Nevien El-Liethy et al.[5]

Statistical Analysis: Data were analyzed using SPSS software. Descriptive statistics summarized demographic and clinical characteristics. Chi-square tests assessed associations between categorical variables (e.g., sex, occupation, pathology type), and t-tests were used for continuous variables (e.g., age). Statistical significance was set at p less than 0.05.

RESULTS

Demographics: Of the 85 participants, 43 were male (50.6%) and 42 were female (49.4%), indicating a balanced sex distribution as shown in [Figure 1]. The mean age was 42 years (range: 18-59). Most patients fell within the 40-49 (n=29) and 50-59 (n=27) age groups as shown in [Table 1].

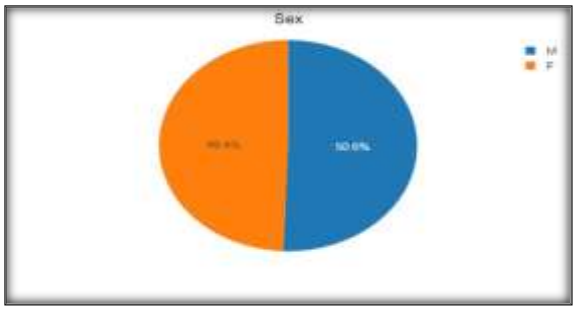

Figure 1: Distribution of patients according to sex.

Table 1: Age distribution

Age group (years)	Frequency
18 – 20	4
20 – 29	7
30 – 39	18
40 – 49	29
50 – 59	27
Total	85

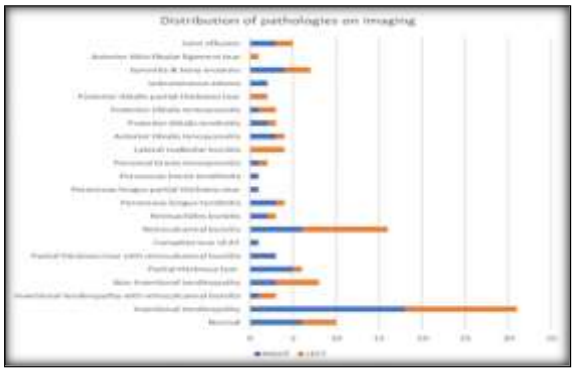

Figure 2: Distribution of pathologies on imaging with ultrasound

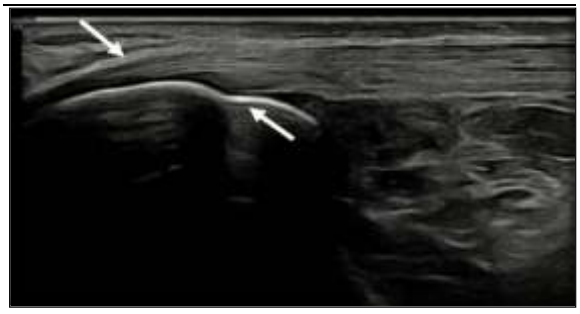

Figure 3: Normal Achilles tendon with its smooth insertion at calcaneus seen on sagittal sections on high resolution ultrasonography as indicated by white arrows.

Clinical and Imaging Findings: Forty-five patients had unilateral symptoms, while 35 had bilateral involvement, resulting in 120 ankles examined [Figure 2].

Pathological findings were identified in 110 ankles (91.7%), with normal findings in 10 ankles (8.3%) [Figure 3].

The Achilles tendon was the most commonly affected structure, with pathology in 52 patients (43.3%). Insertional Achilles tendinopathy was the most frequent diagnosis (25.8%), followed by retrocalcaneal bursitis (13.3%), non-insertional tendinopathy (6%), and partial thickness tears as shown in the [Table 2]. Other involved tendons included peroneus longus, peroneus brevis, anterior tibialis, and posterior tibialis. Only one case of ligament injury (anterior tibiofibular ligament) was identified.

Table 2: Diagnosis on high resolution ultrasound with lateralization of pathologies (n = 120)

Imaging Diagnosis	Right	Left	Total	%
Normal	6	4	10	8.3
Posterior Compartment				
Insertional tendinopathy	18	13	31	25.8
Insertional tendinopathy with retrocalcaneal bursitis	1	2	3	2.5
Non-insertional tendinopathy	3	5	8	6.6
Partial thickness tear	5	1	6	5.0
Partial thickness tear with retrocalcaneal bursitis	3	0	3	2.5
Complete tear of AT	1	0	1	0.8
Retrocalcaneal bursitis	6	10	16	13.3
Retro Achilles bursitis	2	1	3	2.5
Lateral Compartment				
Peroneus longus tendinitis	3	1	4	3.3
Peroneus longus partial thickness tear	1	0	1	0.8
Peroneus brevis tendinitis	1	0	1	0.8
Peroneal brevis tenosynovitis	1	1	2	1.7
Lateral malleolar bursitis	0	4	4	3.3
Anterior Compartment				
Anterior tibialis tenosynovitis	3	1	4	3.3
Medial Compartment				
Posterior tibialis tendinitis	2	1	3	2.5
Posterior tibialis tenosynovitis	1	2	3	2.5
Posterior tibialis partial thickness tear	0	2	2	1.7
Subcutaneous edema	2	0	2	1.7
Others				
Synovitis & bony erosions	4	3	7	5.8
Anterior tibio-fibular ligament tear	0	1	1	0.8
Joint effusion	3	2	5	4.2
Total	66	54	120	100.0

In the subset of patients who underwent MRI or surgical correlation (n=12), ultrasound findings showed high concordance for tendon and bursal pathologies, supporting the diagnostic accuracy of ultrasound for these conditions.

Statistical Associations: No significant differences were found in the prevalence of specific pathologies between sexes (p=0.34) or across age groups (p=0.21). Occupational data suggested a higher prevalence of Achilles tendinopathy among manual

laborers and farmers, but this did not reach statistical significance (p=0.07).

DISCUSSION

This study highlights the high prevalence of Achilles tendon pathology in rural patients presenting with non-traumatic ankle pain, aligning with previous reports that identify the Achilles tendon as a frequent site of injury, particularly in populations exposed to chronic overuse.[2] Achilles tendon is the most commonly injured ankle tendon, with pathological findings typically involving a zone of relative avascularity 2-6 cm from its insertion at calcaneum.[6]

Our results coincide with the study done by Liffen N et al. as Achilles tendon injuries detected in our study represented 43% of all diagnosed ankle pathologies.[1] Although Achilles tendon is designed to endure significant tensile forces, their specialized structure also makes them prone to acute and chronic injuries, which frequently affect not only athletes but also individuals in the general population.[7] Our findings are consistent with Artul et al., who reported Achilles tendinitis as the most common ultrasound finding at the heel, and tenosynovitis as the most frequent at the ankle in their cohort.[8] Similarly, a recent cross-sectional study from Japan found a notable burden of ankle osteoarthritis and related pathologies in older rural populations, further underscoring the importance of musculoskeletal imaging in these settings.[9]

The predominance of insertional Achilles tendinopathy (25.8% of patients) as clearly shown in [Figure 4] and retrocalcaneal bursitis (13.3%) in our cohort reflects the occupational demands of rural life, where repetitive stress and overuse are common. This is in line with the literature, which suggests that such pathologies are not limited to athletes but are also prevalent among individuals engaged in manual labor and farming.[10]

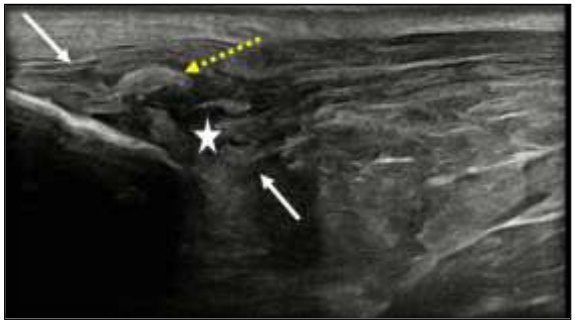

Figure 4: Insertional Achilles tendinopathy in patient of 54 years. Sagittal ultrasound section shows thickening of tendon at insertion site (white arrows) with disruption of fibrillar architecture (star) is seen.

Enthesophytes are seen (yellow dotted arrow): The age distribution in our study, with most patients between 40 and 59 years, mirrors the increased prevalence of degenerative and inflammatory ankle disorders in middle-aged adults.[10,11] Non insertional tendinopathy as depicted in [Figure 5] was seen in 6% of patients.

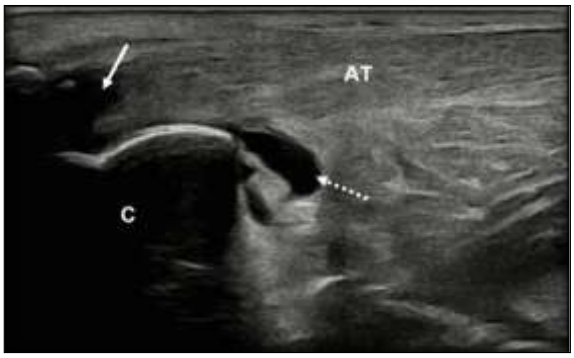

Figure 5: Non insertional Achilles tendinopathy in a patient of 50 years. Axial ultrasound section image of Achilles tendon shows intrasubstance anechoic areas of fiber disruption (white arrows) and dystrophic calcification (yellow dotted arrow).

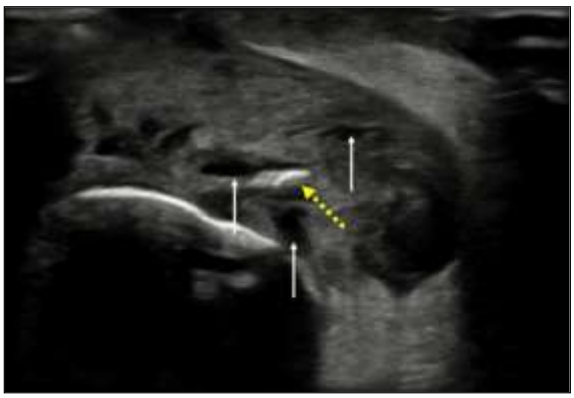

Figure 6: Retrocalcaneal bursitis in patient of 46 years. Sagittal ultrasound section shows fluid within retrocalcaneal bursa is seen (white dotted arrow) associated with disruption of tendon fibers at insertion site (white arrow). [AT– Achilles tendon; C – Calcaneum]

Retrocalcaneal bursitis as shown in [Figure 6] was the second most common imaging finding in our study found in 16 (13.3 %) patients. It is commonly associated with pathologies of Achilles tendon and can also be seen in conditions like Reiter disease, psoriasis, ankylosing spondylitis and, often, with calcaneal fractures.[12]

Other Achilles tendon pathologies seen were partial thickness tears as shown in [Figure 7], tendinitis and paratenonitis. Ultrasound was particularly useful in differentiating partial- and fullthickness tears due to dynamic imaging during ankle plantar flexion and dorsiflexion which defines the tendon anatomy.[13]

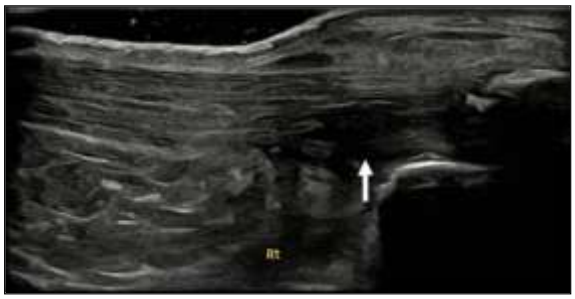

Figure 7: Partial thickness tear of Achilles tendon in a patient of 34 years. Sagittal ultrasound image shows anechoic area (white arrow) representing disruption of fibrillar architecture of tendon

Our results demonstrate the value of high-resolution ultrasound as a first-line imaging modality in resource-limited settings. The ability to perform dynamic assessments and real-time evaluation of tendon integrity and vascularity makes ultrasound particularly suited for diagnosing superficial tendon and bursal pathologies.[14] In our subset of patients with MRI or surgical correlation, ultrasound findings were confirmed, supporting its diagnostic accuracy for these conditions.

However, our study also highlights the limitations of ultrasound. In 10 patients (8.3%), no abnormalities were detected despite persistent symptoms, suggesting possible etiologies such as subtle biomechanical dysfunction, early degenerative changes not visible on ultrasound, or referred pain. This limitation is well-documented in the literature, which emphasizes the need for MRI in cases where intra-articular or bony pathology is suspected but not visualized on ultrasound.[14]

Notably, ligament injuries were rare in our non-traumatic cohort, with only one case of anterior tibiofibular ligament tear identified. This finding is consistent with other studies, which report that ligamentous injuries are more commonly associated with acute trauma rather than chronic overuse.[14]

Although MRI and clinical correlation were performed in a subset of patients and demonstrated high concordance with ultrasound findings, this study was primarily designed as a descriptive observational analysis rather than a diagnostic accuracy study. Consequently, sensitivity, specificity, and other diagnostic performance metrics of ultrasound were not calculated. The limited and selective use of MRI as a reference standard in only a subset of cases introduces potential verification bias, which restricts the validity of such calculations. Future prospective studies with systematic MRI or surgical correlation across all patients are necessary to rigorously evaluate the diagnostic accuracy of ultrasound in detecting ankle pathologies in rural populations.

Strengths and Limitations: Our study's strengths include its focus on a rural, non-athlete population-a group often underrepresented in musculoskeletal imaging research. By providing detailed data on the spectrum of ankle pathologies in this demographic, our findings can inform clinical practice in similar settings, where access to advanced imaging is limited and ultrasound serves as a critical diagnostic tool.[15]

Limitations of this study include the absence of universal MRI or surgical confirmation for all cases, and the inherent technical constraints of ultrasound in assessing deep or intra-articular structures. Future research should incorporate larger, prospective cohorts with standardized follow-up and broader use of reference standards to further validate and expand upon these findings.

CONCLUSION

High-resolution ultrasound is a valuable and accessible tool for diagnosing non-traumatic ankle pain in rural populations, especially where MRI is unavailable. The majority of cases involve the Achilles tendon, and ultrasound findings can guide clinical management effectively. However, clinicians should be aware of the modality's limitations and consider MRI when deeper or more complex pathology is suspected.

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