Section: Radiodiagnosis

Original Research Article

MAGNETIC RESONANCE IMAGING SPECTRUM OF TRAUMATIC AND NON-TRAUMATIC ANKLE AND HINDFOOT PATHOLOGIES: A RETROSPECTIVE OBSERVATIONAL STUDY AT A SINGLE TERTIARY-CARE CENTER

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Received : 02/11/2025
Received in revised form : 17/12/2025
Accepted : 04/01/2026

Keywords:
Ankle, Hindfoot, MRI, Traumatic, Non-traumatic, Ligament injury, Tendon injury.

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DOI: 10.47009/jamp.2026.8.1.155

Source of Support: Nil,
Conflict of Interest: None declared

Int J Acad Med Pharm
2026; 8 (1); 810-814

ABSTRACT

Background: Ankle and hindfoot disorders, whether traumatic or non-traumatic, are frequent causes of pain, swelling, and functional limitation. Clinical evaluation and conventional radiographs often miss subtle ligamentous, tendinous, osseous, or cartilage injuries. Magnetic resonance imaging (MRI), with superior soft-tissue contrast and multiplanar capabilities, allows accurate characterization of these pathologies, facilitating targeted management and improved patient outcomes. The aim is to evaluate the MRI spectrum, distribution, and relative frequency of traumatic and non-traumatic ankle and hindfoot abnormalities in patients presenting to a tertiary-care center. **Materials and Methods:** A retrospective observational study was conducted at PES Institute of Medical Sciences & Research, Kuppam, Andhra Pradesh, from February to December 2025. Twenty-eight patients aged 10–59 years undergoing ankle or hindfoot MRI on a 1.5T GE scanner were included. Patients with prior ankle surgery were excluded. MRI findings were categorized as traumatic or non-traumatic and further subclassified into degenerative, infective, inflammatory, vascular, and post-infective etiologies. Descriptive statistical analysis was performed. **Result:** Of 28 patients, 13 (46.4%) had traumatic injuries and 15 (53.6%) had non-traumatic pathologies. Traumatic cases predominantly involved ligaments: anterior talofibular ligament in 69%, posterior talofibular ligament in 54%, and syndesmotic ligaments in 38%. Bone contusions were observed in 50%, and tendon injuries in 27%. Non-traumatic findings were heterogeneous: degenerative osteoarthritis 17%, tubercular arthritis 15%, infective pathologies including chronic osteomyelitis/Brodie's abscess 20%, vascular anomalies 7%, inflammatory arthritis 7%, and post-infective sequelae 3%. Joint effusion was the most common finding (75%), followed by subcutaneous edema (68%). Multifactorial involvement (ligaments, tendons, and bone marrow edema) occurred in 39% of patients. **Conclusion:** MRI accurately differentiates traumatic from non-traumatic ankle and hindfoot conditions and detects subtle injuries often missed on conventional imaging. This study reinforces MRI as a crucial tool for early, precise diagnosis, guiding timely interventions, preventing chronic disability, and enhancing clinical decision-making.

INTRODUCTION

Ankle and hindfoot pathologies are a common cause of pain, swelling, and functional limitation across all age groups. These pathologies may arise from trauma, including ligament sprains, tendon injuries, bone contusions, and fractures, or from non-traumatic causes, such as degenerative osteoarthritis, infectious arthritis, inflammatory conditions, vascular anomalies, and post-infective sequelae.[1,2] Given the complex anatomy of the ankle and hindfoot—with multiple articulations, ligaments, tendons, and neurovascular structures—accurate diagnosis is often challenging using conventional radiography alone.[3]

ISSN (O): 2687-5365; ISSN (P): 2753-6556

Magnetic resonance imaging (MRI) has emerged as the modality of choice for comprehensive evaluation of ankle and hindfoot disorders due to its excellent soft tissue contrast, multiplanar imaging capabilities, and sensitivity to bone marrow, cartilage, and ligamentous abnormalities.[4] MRI allows early detection of subtle injuries that may not be visible on X-rays or CT scans, including partial ligament tears, tendon injuries, marrow edema, synovitis, and small osteochondral lesions.[5] Several studies have highlighted the value of MRI in differentiating between acute and chronic injuries, traumatic and non-traumatic causes, and in guiding clinical management.[1,2]

Traumatic ankle injuries, particularly ligamentous sprains, are among the most frequent musculoskeletal injuries worldwide, often resulting from sports-related or accidental twisting mechanisms. Untreated or inadequately managed injuries may progress to chronic instability, osteoarthritis, or post-traumatic deformities.[3] Non-traumatic pathologies, such as tubercular arthritis, Brodie's abscess, or chronic degenerative changes, require early identification and appropriate intervention to prevent long-term morbidity.[2,5]

Despite the growing use of MRI, there is limited literature describing the spectrum of both traumatic and non-traumatic ankle and hindfoot pathologies in a single-center observational setting, particularly in the Indian population. Understanding the prevalence, patterns, and MRI features of these pathologies can aid radiologists and clinicians in accurate diagnosis, grading of severity, and appropriate management.[1,3]

MATERIALS AND METHODS

Study Design and Setting: This was a retrospective observational study conducted at PES Institute of Medical Sciences & Research, Kuppam, Chittoor, Andhra Pradesh, from February 2025 to December 2025.

Study Population: Twenty-eight patients aged 10–59 years who underwent MRI of the ankle or hindfoot for pain, swelling, or history of trauma were included. Patients with prior ankle surgery or contraindications to MRI were excluded.

MRI Protocol: Imaging was performed on a 1.5 Tesla GE MRI scanner. The following sequences were acquired: T1-weighted, T2-weighted, proton density (PD) fat-saturated, and STIR sequences in sagittal, coronal, and axial planes.

Data Collection: Demographic data, clinical indications, and MRI findings were recorded. Pathologies were classified as traumatic or non-traumatic. Traumatic lesions were further analyzed for ligamentous, tendinous, osseous, and joint involvement. Non-traumatic lesions were subclassified into degenerative, infective, inflammatory, vascular, and post-infective conditions. Soft-tissue abnormalities, including bursitis, tenosynovitis, sinus tarsi inflammation, subcutaneous edema, and vascular anomalies, were also noted.

Statistical Analysis: Data were summarized using descriptive statistics. Categorical variables, including trauma versus non-trauma, ligament and tendon involvement, and non-traumatic subtypes, were expressed as frequencies and percentages.

RESULTS

A total of 28 patients were included in the study, comprising 15 males (53.6%) and 13 females (46.4%), with ages ranging from 10 to 59 years. The most commonly affected age group was 41–50 years (25%), followed by 31–40 years (21%) and patients above 50 years (21%). Individuals below 20 years accounted for 18%, while the 21–30-year age group represented 15% [Table 1].

Of the 28 cases, 13 patients (46.4%) had traumatic ankle or hindfoot pathology, whereas 15 patients (53.6%) had non-traumatic conditions. Traumatic injuries were predominantly ligamentous, with ligament involvement identified in all traumatic cases. The anterior talofibular ligament was the most frequently involved structure, followed by the posterior talofibular, calcaneofibular, deltoid, and syndesmotic ligaments. The distribution of ligament injuries in traumatic ankle pathology is illustrated in [Figure 1].

Tendon injuries involving the peroneal tendons, tibialis posterior tendon, and Achilles tendon were observed in seven traumatic cases. Bone contusions or fractures were present in eight cases, and joint effusion was identified in nine traumatic patients. Syndesmotic injury was noted in three cases. Complex post-traumatic patterns with combined ligamentous tears, fractures, tenosynovitis, and bursitis were observed in select patients. A representative case demonstrating a Grade II tear of the deep fibers of the deltoid ligament on coronal proton density fat-saturated MRI is shown in [Figure 3].

Across the entire cohort, ligament involvement included the anterior talofibular ligament in 12 cases, posterior talofibular ligament in 10 cases, calcaneofibular ligament in 6 cases, deltoid ligament in 8 cases, and syndesmotic ligaments in 4 cases. Tendon abnormalities were identified in nine patients, most commonly involving the peroneal tendons (6 cases), followed by the Achilles tendon (6 cases), tibialis posterior tendon (5 cases), and flexor/extensor tendon groups (1 case). Bone marrow edema or contusions were identified in 11 patients, while fractures, pseudoarthrosis, or post-traumatic deformities were noted in six cases. Joint effusion or synovitis was present in 16 patients, and ankylosis or chronic post-traumatic sequelae were seen in two cases [Table 2].

Non-traumatic pathologies demonstrated considerable heterogeneity and included degenerative joint disease, tubercular arthritis,

ISSN (O): 2687-5365; ISSN (P): 2753-6556

chronic osteomyelitis/Brodie's abscess, inflammatory arthritis, vascular anomalies, post-infective sequelae, and congenital or synchondrosis-related conditions. The distribution of non-traumatic ankle and hindfoot pathologies is summarized in [Figure 2]. Additional soft-tissue findings included sinus tarsi edema or inflammation (4 cases), paratenonitis or retrocalcaneal bursitis (4 cases), subcutaneous edema or collections (7 cases), tenosynovitis (3 cases), and vascular lesions (2 cases). A representative sagittal PD fat-saturated image demonstrating retrocalcaneal bursitis with adjacent soft tissue edema is shown in [Figure 5].

Overall, traumatic ankle and hindfoot pathologies were predominantly ligamentous and tendinous, frequently associated with bone contusions and joint effusion, whereas non-traumatic conditions were most commonly degenerative or infective in etiology. MRI enabled accurate differentiation between traumatic and non-traumatic entities and demonstrated frequent multi-structure involvement not appreciable on conventional imaging.

Table 1: Demographic and Clinical Characteristics of the Study Population (n = 28)

Variable	Number (n)	Percentage (%)
Total patients	28	100
Male	15	53.6
Female	13	46.4
Age range (years)	10–59	—
Traumatic pathology	13	46.4
Non-traumatic pathology	15	53.6

Table 2: Distribution of MRI-Detected Ankle and Hindfoot Pathologies

Pathology	Number of Cases (n)	Percentage (%)
Ligament injuries	13	46.4
Tendon abnormalities	9	32.1
Bone marrow edema / contusion	11	39.3
Fracture / post-traumatic deformity	6	21.4
Joint effusion / synovitis	16	57.1
Degenerative changes	5	17.9
Infective pathology	5	17.9
Vascular anomalies	2	7.1

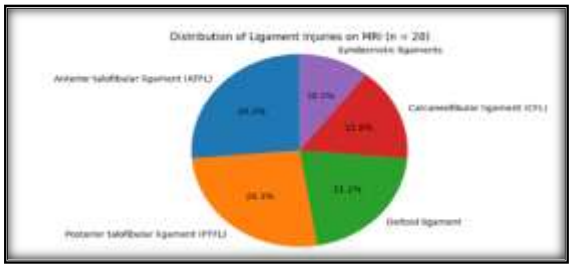

Figure 1. Distribution of ligament injuries in ankle trauma on MRI (n = 28).

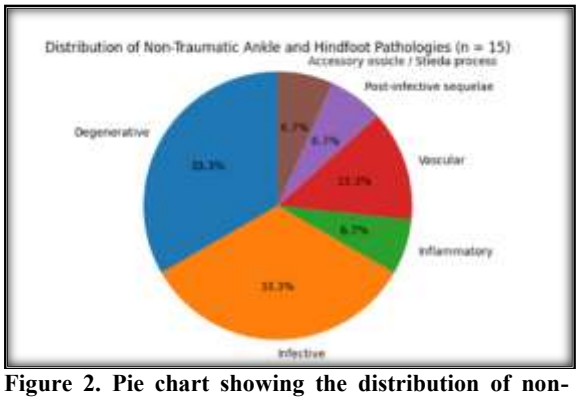

Figure 2. Pie chart showing the distribution of non-traumatic ankle and hindfoot pathologies on MRI.

The anterior talofibular ligament (ATFL) and posterior talofibular ligament (PTFL) were the most frequently involved ligaments, each accounting for 26.3% of ligament injuries, followed by the deltoid ligament (21.1%) and calcaneofibular ligament (15.8%). Syndesmotic ligament involvement was least common (10.5%). Multiple ligament involvement was observed in several patients, reflecting the complex nature of ankle trauma.

Degenerative and infective conditions constituted the largest proportion (33.3% each), followed by vascular anomalies (13.3%). Inflammatory disorders, post-infective sequelae, and accessory ossicles/Stieda process each accounted for 6.7% of non-traumatic cases.

Figure 3: Coronal proton density fat-saturated MRI image of the ankle showing a Grade II partial-thickness tear of the deep fibers of the deltoid ligament (arrow), characterized by increased intraligamentous signal intensity and discontinuity involving more than 50% of the ligament thickness, with surrounding edema. Findings are consistent with a traumatic deltoid ligament injury.

ISSN (O): 2687-5365; ISSN (P): 2753-6556

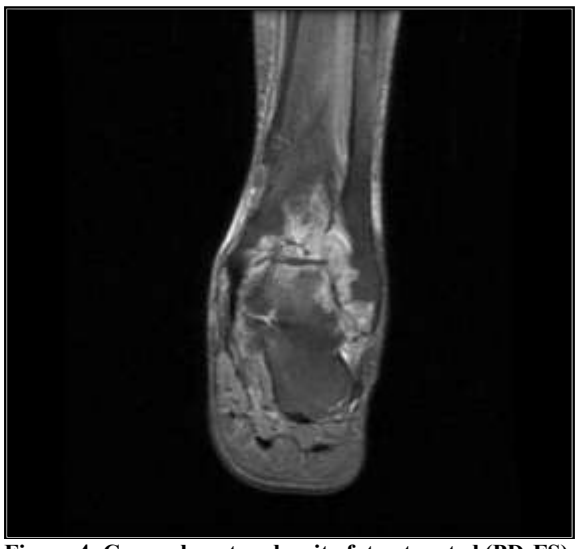

Figure 4: Coronal proton density fat-saturated (PD-FS) MRI of the ankle demonstrating features of tubercular arthritis.

The image shows diffuse synovial thickening involving the ankle joint with large erosions affecting the articular and subarticular regions of the distal tibia, distal fibula, and talar dome. Associated extensive bone marrow edema is noted within the distal tibia, fibula, and talus, consistent with infective inflammatory involvement.

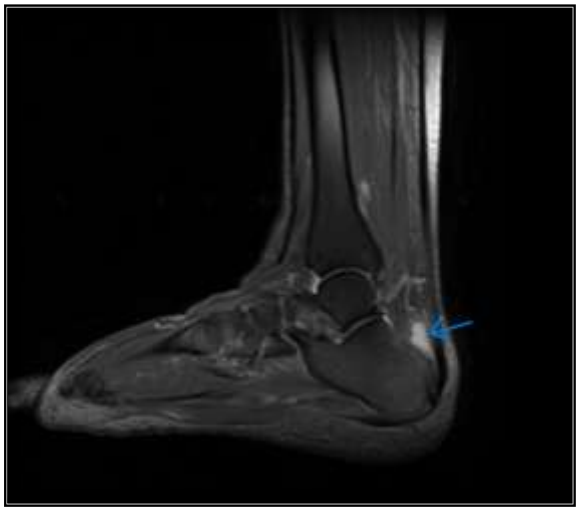

Figure 5: Sagittal PD fat-saturated MRI of the ankle

Sagittal proton density fat-saturated image of the ankle demonstrates fluid distension of the retrocalcaneal bursa with hyperintense signal intensity, without disruption of the Achilles tendon fibers. The tendon appears intact, and there is mild edema in the adjacent soft tissue, with no evidence of full-thickness tear.

DISCUSSION

Ankle and hindfoot pathologies are clinically challenging due to overlapping symptoms and complex regional anatomy. In our study of 28 patients, MRI demonstrated excellent diagnostic capability in differentiating traumatic from non-traumatic lesions and identifying multi-structure involvement, which may not be apparent on conventional radiographs.

Traumatic injuries constituted 46.4% of cases, with ligamentous involvement being the most frequent finding. The anterior talofibular ligament (ATFL) was involved in 12 cases, followed by the posterior talofibular ligament (PTFL), calcaneofibular ligament, deltoid ligament, and syndesmotic ligaments. These findings align with previous reports indicating the ATFL as the most commonly injured ligament in inversion ankle sprains.[1,2] Tendon injuries were observed in 9 patients, predominantly affecting the peroneal tendons, Achilles, and tibialis posterior, reflecting the importance of MRI in detecting subtle tendon abnormalities that may be clinically occult.[3] Bone marrow edema and contusions were present in 11 patients, highlighting MRI's sensitivity for early osseous changes. Joint effusion and synovitis were common across traumatic cases, consistent with prior studies emphasizing that soft tissue and joint assessment is crucial for grading injury severity.[4]

Non-traumatic pathologies comprised 53.6% of the cohort and exhibited considerable heterogeneity, including degenerative osteoarthritis, tubercular arthritis, chronic osteomyelitis, inflammatory arthritis, vascular anomalies, and post-infective sequelae. Tubercular arthritis cases demonstrated large articular and subarticular erosions with marrow edema, illustrating MRI's role in early detection and differentiation from other infective or inflammatory etiologies.[5] Degenerative changes and chronic osteomyelitis were also readily identified through signal alterations in bone and cartilage, supporting MRI as a comprehensive tool for diagnosis and treatment planning.

Overall, MRI facilitated accurate assessment of the anatomic location, severity, and extent of multi-structure involvement in both traumatic and non-traumatic cases. Incorporating MRI early in patients with persistent pain, suspected infection, or complex injury patterns can improve diagnostic confidence, guide targeted interventions, and potentially reduce long-term morbidity. Our findings are consistent with the literature emphasizing MRI as the modality of choice for evaluating ankle and hindfoot pathologies, particularly when radiographs are inconclusive.[1-5]

Limitations of our study include the relatively small sample size and single-center retrospective design. Further multi-center studies with larger cohorts could provide more generalizable data and allow correlation between MRI findings and functional outcomes or surgical results.

CONCLUSION

MRI is a highly valuable imaging modality for the comprehensive evaluation of both traumatic and non-traumatic ankle and hindfoot pathologies. It enables

ISSN (O): 2687-5365; ISSN (P): 2753-6556

precise identification of ligamentous, tendinous, osseous, and soft-tissue abnormalities, including subtle injuries that may be missed on conventional radiographs. Traumatic injuries were predominantly ligamentous and tendinous, often accompanied by bone contusions and joint effusion, whereas non-traumatic conditions were most commonly degenerative or infective. Early and accurate MRI assessment facilitates targeted clinical management, improves diagnostic confidence, and may reduce long-term morbidity in patients with complex or unresolved ankle and hindfoot conditions.

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ISSN (O): 2687-5365; ISSN (P): 2753-6556