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Magnetic Resonance Imaging in Ankle and Foot Pathologies: A Diagnostic Overview of Trauma and Non-Trauma Cases

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ABSTRACT

Background: Ankle injuries, particularly sprains and fractures, are common, with young athletes being more susceptible. Magnetic Resonance Imaging (MRI) is pivotal in diagnosing ankle pathologies due to its non-invasiveness, excellent soft tissue contrast, and multiplanar capabilities. This study aims to explore the imaging spectrum of ankle and heel pain through MRI, focusing on osseous, ligamentous, and tendinous derangements in both traumatic and non-traumatic cases. **Objectives:** The primary objectives include assessing the prevalence and distribution of ankle pathologies, categorizing traumatic and non-traumatic cases, and identifying specific tendon and ligament injuries using MRI. Additionally, the study aims to correlate MRI findings with patient demographics and clinical history**.**

Methodology: This descriptive cross-sectional study was conducted at a tertiary care hospital from October 2017 to September 2019. Fifty patients with ankle pain, swelling, or movement restrictions were included. A 1.5 T Siemens Magnetom Essenza with Tim and dot system was used for MRI examinations. Data was collected through a proforma, and statistical analysis was performed using SPSS version 24.

Results: The study comprised 32 males and 18 females, with the most affected age groups being 41-50 years for males and 31-40 years for females. Chronic injuries were more common than acute ones, with non-traumatic causes accounting for 56% of pathologies. Anterior talofibular ligament injuries were most prevalent, followed by calcaneofibular ligament injuries. Tendon injuries frequently involved the Achilles tendon. Inflammatory arthritis, osteomyelitis, and ganglion cysts were prominent non-traumatic pathologies.

Conclusion: MRI emerges as a valuable tool in diagnosing ankle and foot pathologies, offering detailed insights into ligament, tendon, and osseous abnormalities. The study underscores the importance of MRI in both traumatic and non-traumatic cases, facilitating accurate diagnoses for appropriate therapeutic interventions and rehabilitation.

Keywords: *Ankle injuries, Magnetic Resonance Imaging, Ligamentous injuries, Tendon pathologies, Foot and ankle pathologies.*

1. INTRODUCTION

Ankle joint is one of the most frequent joints to become damaged. Sprains and fractures, which affect the ligaments and bones of the ankle, are the most frequent types of ankle injuries. Because of the abundance of soft tissues in the ankle, MRI is a highly helpful tool in assessing diseases in the ankle area. Young athletes are more likely to suffer from ankle sprains than older athletes, and inversion of the foot is the most typical mechanism of injury.[1]

MRI plays a significant role in determining the cause of ankle and foot pain in patients. Due to its rapid non-invasive imaging, excellent soft-tissue contrast resolution, multiplanar capabilities, lack of ionizing radiation, and capacity for postcontrast

imaging, magnetic resonance imaging (MRI) has rekindled research into musculoskeletal illness in the ankle joint and foot.[2]

Before they become apparent in other imaging modalities and are often difficult to diagnose, osseous, ligamentous, tendinous, and muscular injuries around the foot and ankle may be evaluated by MRI using a single imaging examination. With the use of MRI, injuries to certain soft-tissue structures may be correctly diagnosed, allowing for the therapeutic intervention and rehabilitation that are necessary.[3]

The examination of bone and tendon abnormalities, including osteomyelitis, concealed fractures, and partial and total rips of the Achilles, tibialis posterior, and peroneal tendons, is the most frequent reason for MR imaging of the foot and ankle.[4] The diagnosis of a number of soft-tissue abnormalities specific to the foot and ankle, such as Neuropathic Joint, Osteomyelitis, Ganglion Cyst, Synovitis, Tuberculous Arthritis, Rheumatoid Arthritis, and Plantar Fasciitis, has also been demonstrated to benefit from the use of magnetic resonance imaging.[5]

Because of its excellent soft tissue contrast resolution and multi-planar capabilities, MRI is recommended for ankle injuries. It diagnoses ankle injuries non-invasively. MRI is useful for examining ankle soft tissues such as tendons, ligaments, nerves, and fascia and finding concealed bone injuries.[6]

Regardless of LCLC damage complexity, CLAI surgery patients often suffered deltoid ligament or syndesmosis injuries. 3T MRI detects all ankle ligament injuries. Pre-operative MRI interpretation is crucial. The objective of the study is to describe the imaging spectrum in patients with ankle and heel pain by MRI and to assess the role of MRI in detection of various osseous, ligamentous and tendinous derangement of ankle in traumatic and non-traumatic patients.[7]

2. METHODOLOGY

This research was carried out as a descriptive cross-sectional investigation at the Department of Radio Diagnosis in a tertiary care hospital in Puducherry. The study spanned from October 2017 to September 2019. The participants included patients exhibiting clinical symptoms of ankle pain, swelling, or restricted movement, encompassing acute and chronic symptoms with traumatic and non-traumatic origins. Exclusions were made for patients with congenital ankle anomalies, those who had undergone ankle surgeries, individuals with open ankle fractures, and those with absolute contraindications for MRI. A total of 50 patients were included in the study. Comprehensive patient history, followed by obtaining consent from either the patient or their attendant for magnetic resonance imaging, was conducted. Participants were briefed on the study, assured of strict confidentiality, and given the option to decline participation. Written informed consent was acquired before the interview. The Informed consent document is provided in both English and Tamil. A proforma was utilized to record demographic and clinical details. The imaging procedure was performed using a 1.5 T Siemens Magnetom Essenza with Tim and dot system, employing various relevant sequences. The examination included studying images for soft tissue lesions, ligamentous pathologies, tendon injuries, fluid collections around the joint, and signal changes in the surrounding bones and muscles.[8]

3. RESULTS

This study, with a sample size of 50, is descriptive in nature, focusing on patients presenting with ankle pain, swelling, and restricted movements, particularly those with a history of trauma. The research involved MRI examinations of the ankles in our department. **Table 1** provides the distribution of baseline study participants (n=50) based on age groups and gender. In terms of age, the participants are distributed across various groups: 2% are in the 11-20 age group, 20% in the 21-30 range, 24% in the 31-40 range, 26% in the 41-50 range, 14% in both the 51-60 and 61-70 age groups. The gender distribution shows that 64% of the participants are male, while 36% are female. This table offers a snapshot of the demographic composition of the study participants, providing insights into the age and gender distribution within the sample population. This suggests a notable gender disparity within the study population.

Table 1: Distribution of Baseline study participants (n=50)

Variables	N=50	Percentage
Age Group (Years)		
11-20	1	2
21-30	5	20
31-40	12	24
41-50	13	26
51-60	7	14

61-70	7	14
Gender		
Male	32	64
Female	18	36

Table 2 summarizes cases related to traumatic ankle pathologies. It reveals a distribution of lesions based on their duration, with chronic lesions being more prevalent (64%). The involvement of various tendons is outlined, with Achilles Tendon, Flexor Tendons, Extensor Tendons, and Peroneus Tendons showing distinct percentages. The distribution of lesion types indicates that traumatic lesions account for 44% of cases, while non-traumatic lesions constitute 56%. Ligamentous pathologies primarily affect the Anterior Talofibular Ligament (52.9%) and Calcaneofibular Ligament (17.6%). Magnetic Resonance Imaging (MRI) findings for tendon lesions include Tenosynovitis (30%), Complete Rupture (14%), and Tendinopathy (14%). Ligamentous pathologies on MRI reveal Full Thickness Tear (16%), Partial Tear (8%), and Grade I Sprain (12%). These results provide valuable insights into the prevalence and characteristics of traumatic ankle pathologies within the studied cases.

Table 2: Distribution of Cases in Traumatic Ankle Pathologies

Variables	**n**	**Percentage**
Duration of the lesion		
Acute	16	32
Chronic	34	64
Site of the tendon pathologies (n=28)*		
Achilles Tendon	6	12
Flexor Tendons	12	24
Extensor Tendons	3	6
Peroneus Tendons	7	14
Distribution of type of lesion		
Traumatic	22	44
Non-Traumatic	28	56
Site of the ligamentous pathologies (n=17) *		
Anterior Talofibular Ligament	9	52.9
Posterior Talofibular Ligament	2	11.7
Calcaneofibular Ligament	3	17.6
Deltoid Ligament	1	5.8
Tibio calcaneal Ligament	1	5.8
Tibio navicular Ligament	1	5.8
Magnetic Resonance Imaging Findings –Tendon lesion*		
Tenosynovitis	15	30
Complete Rupture	7	14
Encased	1	2
Partial Thickness Tear	3	6

Tendinopathy	7	14
No Lesions	25	50
Magnetic Resonance Imaging Findings – Ligamentous Pathologies		
Full Thickness Tear	8	16
Partial Tear	4	8
Grade I Sprain	6	12

Table 3 presents the distribution of cases in nontraumatic ankle pathologies (n=28). The most prevalent condition is Neuropathic Joint, constituting 53.7% of cases, followed by Osteomyelitis at 28.5%, and Ganglion Cyst at 14.2%. Other observed pathologies include Tuberculous Arthritis, Rheumatoid Arthritis, Plantar Fasciitis, and Tenosynovitis, each accounting for 10.7% of cases. Additionally, the table provides insights into the presence of Joint Effusion, with 56% of study participants experiencing it, and the occurrence of Bone Contusion, observed in 24% of cases. This breakdown offers a comprehensive overview of the prevalence and distribution of nontraumatic ankle pathologies within the study cohort.

Table 3: Distribution of Cases in Nontraumatic Ankle Pathologies (n=28)		
Neuropathic Joint	5	53.7%
Osteomyelitis	8	28.5%
Ganglion Cyst	4	14.2%
Tuberculous Arthritis	3	10.7%
Rheumatoid Arthritis	3	10.7%
Plantar Fasciitis	3	10.7%
Tenosynovitis	2	7.1%
Joint Effusion Among the Study Participants		
Yes	28	56%
No	22	44%
Bone Contusion		
Yes	12	24%
No	38	76%

*Multiple responses allowed

4. DISCUSSION

This research, involving 50 participants, aimed to evaluate the effectiveness of MRI in examining ankle lesions, especially those related to tendons and ligaments. Conducted at a tertiary care hospital using a 1.5T Magnetic Resonance system, the participants comprised 32 males (64%) and 18 females (36%). The most affected age groups were 42 to 50 years, followed by 31 to 40 years, while the under-20 age group was the least affected. Common complaints included pain and swelling in the ankle joint and foot.

In terms of patient demographics, this study noted a significant difference from Thomas et al., who observed a stronger association of foot and ankle pain with age over 40 years. In contrast, with 26 patients above 40 years, this study identified a gender disparity, with male patients more frequently reporting pain in the ankle joint and foot.[9] Clinical history categorized pathologies as either acute or chronic, with the majority presenting as chronic conditions. Non-traumatic factors contributed to 56% of ankle joint and foot pathologies, while the remaining 44% were attributed to trauma.

Among the identified injuries, the anterior talofibular ligament was the most commonly affected, followed by the calcaneofibular and posterior talofibular ligaments. Low ankle sprains involved injuries to the ligaments within the ankle joint complex, whereas high ankle sprains encompassed injuries to the tibiofibular ligament or syndesmosis. Inversion sprains

leading to lateral ligament injuries were the most prevalent, while high ankle sprains resulted from eversion injuries coupled with fractures or deltoid ligament complex lesions.[10] The anterior talofibular ligament emerges as the most commonly ruptured in lateral ankle sprains, closely followed by the calcaneofibular ligament. Conversely, the posterior talofibular ligament, considered robust, experiences rare injury, typically only in severe ankle trauma. Studies by Taga et al., and van Dijk et al., reveal a noteworthy occurrence of osteochondral lesions in the talar dome among acute ankle injuries. Grana et al., (1990) reported chondral lesions in 80% and osteochondral lesions in 6.5% of acute ankle injuries. This study identified a singular case of osteochondritis dissecans in the superolateral aspect of the talar dome, associated with injuries to the lateral ankle ligament complex. Notably, the talus ranks as the third most commonly affected site for osteochondritis dissecans, following the knee and elbow joints. [11,12]

Joint effusion was identified in 23 cases, consistent with Jacobson et al.'s assertion that MRI surpasses ultrasonography in sensitivity for detecting ankle effusion. Notably, Achilles tendon injuries demonstrated a male predominance, in line with Maffulli et al.'s observation that these injuries are approximately ten times more frequent in runners compared to age-matched controls. The presence of osteomyelitis in eight cases was notably higher in individuals aged 45 and above, with a male predominance, supporting Croll et al.'s findings, which reported a mean age of 66 years for osteomyelitis in diabetic foot infections. These insights reinforce the diagnostic capabilities of MRI in revealing joint-related and tendon injuries, as well as age and gender patterns in specific pathologies.[13]

Charcot osteoarthropathy complicating diabetic osteomyelitis was observed in two cases, consistent with findings by Donegan et al. The prevalence of Charcot Foot ranged from 0.08% in the general diabetic population to 13% in high-risk diabetic patients.[14]

Three cases of Tuberculosis affecting the ankle joint and foot were identified, presenting with manifestations such as osteomyelitis, bone destruction, tenosynovitis, and retrocalcaneal bursitis. Among eight cases of inflammatory arthritis, predominantly in females, three were diagnosed as rheumatoid arthritis. Manifestations included tenosynovitis, subtalar joint arthritis, and synovial pannus.

In addition, three cases of plantar fasciitis, predominantly in females, displayed features like thickened plantar fascia, perifascial edema, and bone marrow abnormalities in the calcaneus.[15] In this study, three cases of plantar fasciitis with female predominance. They showed thickened plantar fascia, perifascial edema, and bone marrow abnormalities in the calcaneus.

5. CONCLUSION

Magnetic Resonance Imaging (MRI) emerges as a non-invasive and radiation-free modality with exceptional soft tissue delineation, playing a pivotal role in evaluating ankle pathologies. Its multiplanar capabilities make it especially advantageous for assessing soft tissue structures around the ankle, including tendons, ligaments, nerves, and fascia, and for detecting occult bone injuries. MRI is crucial in diagnosing both non-traumatic and traumatic ankle and foot pathologies. Additionally, it aids in the precise grading of ligament injuries and has become indispensable in planning surgical treatments. The review explores MRI's significance in diabetic foot infections, neuroarthropathy differentiation, and objective assessment of conditions like plantar fasciitis, offering insights into various foot and ankle abnormalities.

Conflict of Interest: Nil

1(A)

1(B)

Figure 1 (a), 1 (b) show MRI of the right ankle in a 50 years old male patient who presented with difficulty in walking and a prior history of trauma. The Sagittal Proton density (a) and Sagittal T2 weighted (b) images of right ankle reveal central dehiscence of Achilles tendon (blue arrow) with retraction of central portion of the tendon and intact concentric peripheral fibers indicating a partial rupture of Achilles tendon.

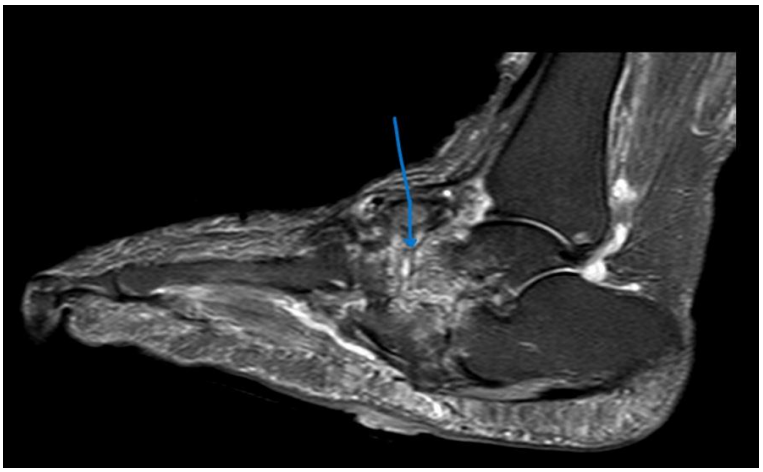

Figure 2, shows MRI of the right ankle in a 66 years old female patient with a history of an ulcer in the dorsal aspect of right foot. The Sagittal Short tau inversion recovery (STIR) image reveals abnormal marrow edema in the tarsal bones (blue arrow) along with destruction and disorganization of intertarsal joints with multiple bony erosions indicative of a Neuropathic joint.

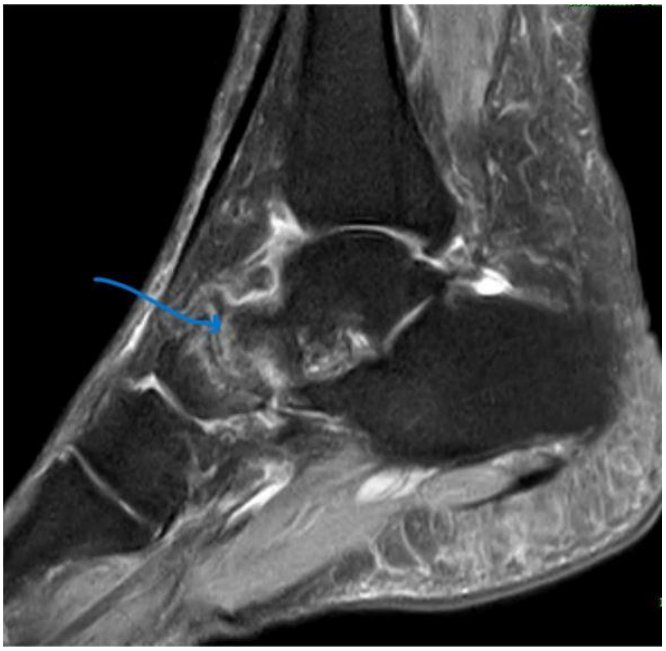

Figure 3 shows MRI of the right ankle in a 52 years old female patient who presented with right ankle pain. The Sagittal Short tau inversion recovery (STIR) image reveals a subchondral hyperintense signal with marginal erosions (blue arrow) along the articular surface with loss of articular cartilage at talonavicular joint consistent with Rheumatoid arthritis.

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