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## Role of MRI in the evaluation of ankle joint and foot pathologies

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### Abstract

**Aim:** To evaluate the role of MRI in the evaluation of ankle joint and foot pathologies.

**Material and Method:** The present prospective observational study was conducted on 61 patients in any age group referred to the Department of Radio-diagnosis and Imaging, Subharti Medical College & Hospital, Swami Vivekanand Subharti University, Meerut (U.P.) with clinical suspicion of ankle and foot pathologies. Relevant history followed by patient or patient attendant consent for magnetic resonance imaging was taken and the patients were subjected to MRI according to the standardised protocol. MRI was performed with GE Signa HD (1.5 T). Data so collected was tabulated in an excel sheet, under the guidance of statistician and analysed using SPSS 22.00 (for windows; SPSS inc, Chicago, USA).

**Results:** Our study was conducted on 61 patients. Maximum subjects were from the age group of 21-30 years (27.87%) followed by 31-40 (21.31%) and 41-50 years (19.67%). In our study the most common symptom was pain which included all 61 (100%) subjects. Acute and chronic pain was reported among 55.74% and 44.26% of the subjects respectively. Traumatic ankle injury was reported in 34 out of 61 patients, Ligament injury was found to be the most common which was seen in 14 patients followed by tendon injury in 09 and bone injury in 11 patients. 12 patients showed MRI findings of infection and 5 patients' study revealed neoplastic pathologies. 10 miscellaneous cases included 3 patients each of Morton's Neuroma and Medullary Infarct, 2 patients of Plantar Fibromatosis and 1 patient each of Freiberg Disease and OS Navicular.

**Conclusion:** We can conclude that MRI is the modality of choice in evaluating ankle and foot pathologies due to its high soft tissue contrast resolution, and multi-planar capabilities.

**Keywords:** Ankle pathology, foot pathology, MRI

### Introduction

Traumatic injuries of the ankle and hind foot are the most common musculoskeletal injuries and account for approximately 10% of all visits to emergency departments [1]. The common reasons for patient's presenting to the foot and ankle clinic are; pain, swelling, deformity, stiffness, instability and/or abnormal gait.

Ankle injuries can happen to anyone at any age. Pathologies can be seen in all age groups, ranging from osteoarthritis and coalitions involving the osseous structures to ligament ruptures and tendon abnormalities [2-4]. However, men between 15 and 24 years old have higher rates of ankle sprain, compared to women older than age 30 who have higher rates than men [5]. Ankle injuries are common among high-performance athletes and the general population, accounting for as many as 10% of emergency department visits, ankle sprain being the most frequent. Lateral ankle sprains represent 16%–21% of all sports-related traumatic injuries and Osteochondral lesions of the ankle are being recognized as an increasingly common injury and have been reported in as many as 50% of acute ankle injuries, particularly sports-related injuries [6].

Tendon injuries can be grouped into six categories: tendinosis, peritendinosis, tenosynovitis, entrapment, rupture, and dislocation. These conditions often coexist, and overlap in their clinical, gross, and histologic manifestations which can make them indistinguishable at MR imaging. Achilles tendon injuries may be classified as non-insertional or insertional. The former group includes diffuse acute and chronic peritendinosis, tendinosis, and a rupture 2–6 cm above the insertion of the tendon on the calcaneus [2]. Standard first line investigations include assessment of osseous structures with plain radiograph and common soft tissue problems with high frequency ultrasonography. Despite conventional radiography being usually the first imaging technique performed to assess any potential bony abnormalities,

soft-tissue affection usually escapes and it has disadvantages of improper assessment of cartilaginous, ligamentous, and tendinous lesions [7]. Therefore due to inherent limitation of assessment of deeper soft tissue and subtle soft tissue and osseous abnormalities with these imaging modalities, MR imaging is gold standard problem solving non-invasive imaging tool [8].

The MR arthrography technique has improved significantly in recent years resulting in a more routine use of this technique as it allows the most accurate assessment of the capsular recesses [9]. The present prospective study is to outline the role of MRI in the evaluation of ankle and foot pathologies and assess the diagnostic validity of imaging, thus helping the clinician in making an accurate approach to the diagnosis and its management.

**Materials and Methods**

The present prospective observational study was conducted on the patients referred from OPD/IPD of C.S.S. Hospital, to the Department of Radio-diagnosis and Imaging, Subharti Medical College & Hospital, Swami Vivekanand Subharti University, Meerut (U.P.), under the aegis of N.S.C.B Subharti Medical College, Meerut for evaluation of ankle and foot pathologies. The subjects were recruited according to the following inclusion and exclusion criteria:

**Inclusion criteria**

1. All patients in any age group referred to the radiology department with clinical suspicion of ankle and foot pathologies.
2. Patients with ankle and foot swelling

3. Patients with Ankle and Foot Instability

**Exclusion criteria**

1. Patients with ferromagnetic implants, pacemaker, and aneurysm clips
2. Patients with congenital abnormalities of the foot.
3. Patients with previous ankle surgery.
4. Patients with interventional intra-articular procedures.

Relevant history followed by patient and/or patient attendant consent for magnetic resonance imaging was taken and the patients were subjected to MRI according to the following protocols.

**MRI examination**

All patients will have MR imaging of the ankle and foot on a high field-strength scanner. MRI was performed using the device GE Signa HDe (1.5 T).

**Patient positioning**

Every patient was laid in supine with the ankle and foot in neutral position, and plantar flexion of 20–30 degrees for reducing the “magic angle” artifact. No movement was allowed during examination by supporting the ankle using pads. Knee coil was used in all cases for study in our department.

**Protocol of MR imaging**

Patients included in the study shall be subjected to routine MRI of the ankle by various pulse sequences and imaging planes as shown in Table 1:

**Table 1:** MRI sequences

Image plane	Slice thickness	Fov (cm)	Matrix	Acquisition	Image time
Sagittal T1 SE	3mm/ skip 0.5mm	20x 20	256x256	1	4 min
Sagittal T2WI FSE	3mm/ skip 0.5mm	20x20	320x 256	1	2 min 40s
Sagittal PD FSE	3mm/skip 0.5mm	20x 20	320x 256	1	2 min 46s
Fat suppressed FSE T2WI (Axial, coronal, sagittal)	4mm/ skip 0.5mm	19x19	256x256	1	3 min 58s
coronal T1 SE	4mm/ skip 0.5mm	19x 19	320x 190	1	2 min 40s
Coronal STIR	3mm/ skip 1mm	19x 17	320x 160	1	2 min 40s
Axial PD	4mm/ skip 0.5mm	19x 19	320x 256	1	3 min 40s

**Statistical analysis**

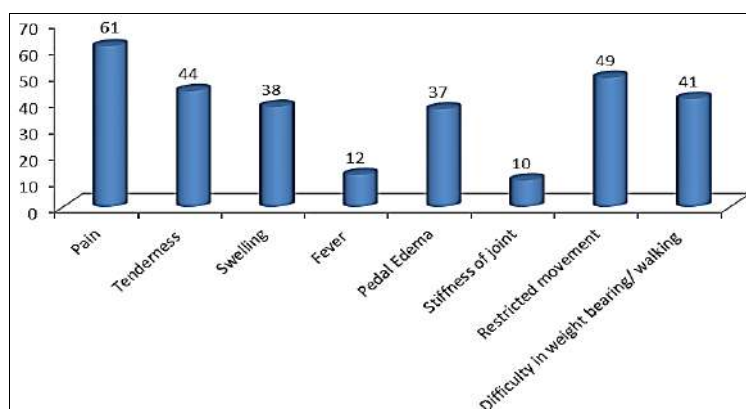
Data so collected was tabulated in an excel sheet, under the guidance of statistician and analysed using SPSS 22.00 (for windows; SPSS inc, Chicago, USA).

**Results**

The study group comprised total of 61 patients out of which 38 (62.30%) were males and the remaining 23 (37.70%) were females thus showing male predominance in our study.

The mean age of the study subjects was 42.19±15.34 years. Maximum subjects were from the age group of 21-30 years (27.87%) followed by 31-40 (21.31%) and 41-50 years (19.67%).

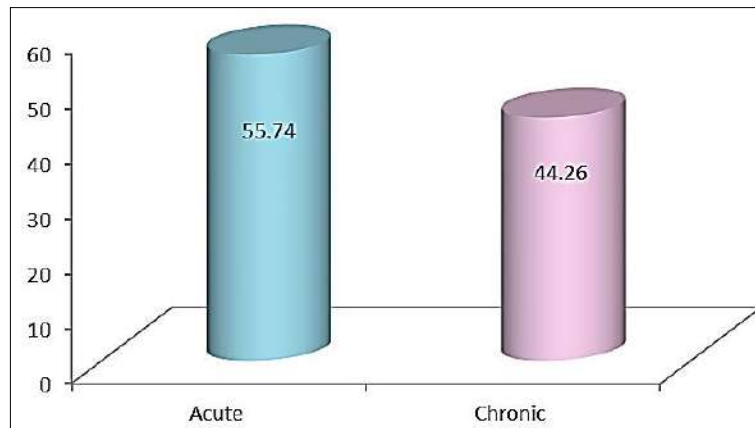
In our study the most common symptom was pain which included all 61 (100%) subjects and the least common complaint was stiffness of joint which only had 10 (18.03%) patients (graph 1).



**Fig 1:** Distribution of symptoms/signs of study participants

Graph 2 shows the distribution of the onset of ankle pain in the study group. Acute and chronic pain was reported

among 55.74% and 44.26% of the subjects respectively.



**Fig 2:** Distribution of the onset of ankle pain in the study group

In our study of total 61 patients, 34 patients (55.74%) had ankle injury and MRI of ankle was performed. Out of 34 patients of ankle injury, on MRI it was revealed that 14

patients had ligament injury, 09 patients had tendon injury, 11 patients had bone injury and 27 patients had joint effusion (Table 2).

**Table 2a:** Distribution of various types of injuries in the participants of the study group

Type of injury	N	%
Ligament Injury	14	41.17
Tendon Injury	09	26.47
Bone Injury	11	32.35

**Table 2b:** Presence of injuries with associated joint effusion in the participants of the study group

Joint effusion	N	%
Present	27	79.41
Absent	07	20.59

In our study, ligament injury was found to be the most common which was seen in 14 out of 34 patients of ankle trauma. In our study the total of 16 patients showed the signs of ligament injury on MRI examination. 2 patients' study revealed more than 1 ligament injury i.e. in 2 patients ATFL and CFL injury were seen together. Lateral Ligament Complex was found to be the most commonly injured

ligament complex of ankle joint. 13 out of 16 patients showed lateral ligament complex injury in which ATFL injury was seen in 7 patients, CFL injury in 5 patients and PTFL injury in only 1 patient. Medial Deltoid Ligament injury was seen in 3 patients. Total of 7 patients were reported with ligament sprain, 5 patients with partial ligament tear and 4 patients with complete tear (Table 3).

**Table 3:** Distribution of ligament injuries in the study group

Injury	N	%	
Present	14	22.95	
Absent	47	77.05	
Ligament Injury	N = 14		
1. Lateral Ligament Complex	13 (81.25%)		
ATFL	7 (43.75%)		
CFL	5 (31.25%)		
PTFL	1 (6.25%)		
2. Medial Deltoid Ligament	3 (18.75%)		
PTTL	3 (18.75%)		
Ligament	Sprain	Partial ligament tear	Complete tear
ATFL	3	2	2
CFL	2	2	1
PTFL	1	0	0
PTTL	1	1	1
Total, N (%)	7 (43.75%)	5 (31.25%)	4 (25%)

In our study, tendon injury was found among 9 subjects. Among the tendon injuries, anterior, posterior, lateral and medial compartment was revealed in 1 (9.09%), 4 (36.36%), 2 (18.18%) and 4 (36.36%) of the subjects respectively.

Achilles tendon was the most common tendon injury, reported in 4 (36.36%) patients. Partial tear was the most common findings of tendon injury with 5 (45.45%) patients involved followed by Tendinosis in 4(36.36%), complete

tear 1 (9.09%) and exudative tenosynovitis in 1 (9.09%) tendon. Total of 11 patients showed signs of injury in our study wherein 2 patients showed more than 1 tendon injury. 1 patient had Tibialis posterior tendon along with Achilles Tendon injury and the other had flexor digitorumlongus

associated with flexor hallucis longus tendon injury. Partial tendon tear was found to be the most common type of tendon injury with 5 subjects followed by tendinosis in 4 and complete tear and exudative tenosynovitis with 1 in each (Table 4).

**Table 4:** Distribution of tendon injuries in the study group

Injury	N	%		
Present	9	(14.75%)		
Absent	52	(85.24%)		
<b>Tendon Injuries</b>	<b>N=9</b>	<b>%</b>		
Anterior Compartment	1	9.09		
Tibialis Anterior	1	9.09		
Extensor HallucisLongus	0	-		
Extensor Digitalis Longus	0	-		
Medial Compartment	4	36.36		
Tibialis Posterior	2	18.18		
Flexor DigitoriumLongus	1	9.09		
Flexor HallucisLongus	1	9.09		
Lateral Compartment	2	18.18		
PeroneousLongus	2	18.18		
Posterior Compartment	4	36.36		
Achilles	4	36.36		
<b>Tendon injuries</b>	<b>Tendinosis</b>	<b>Partial tear</b>	<b>Complete tear</b>	<b>Exudative tenosynovitis</b>
Tibialis Anterior	1	0	0	0
Extensor HallucisLongus	0	0	0	0
Tibialis Posterior	1	1	0	0
Flexor DigitoriumLongus	0	1	0	0
Flexor HallucisLongus	1	0	0	0
Achilles	0	2	1	1
PeroneousLongus	1	1	0	0
<b>Total</b>	<b>4 (36.36%)</b>	<b>5 (45.45%)</b>	<b>1 (9.09%)</b>	<b>1 (9.09%)</b>

Bone injury was found in total of 11 patients out of 34 patients of ankle injury. Marrow edema was the most common type of bone injuries seen in 6 subjects followed by bone contusion in 4 subjects, fractures in 3 subjects and osteochondral lesions in 2 subjects. All 3 patients of fracture in our study showed marrow edema and 1 patient showed bone contusion (Table 5).

**Table 5:** Distribution of bone injuries in the study group

Injury	N	%
Present	11	18.03
Absent	50	81.97
<b>Bone injuries</b>	<b>N=11</b>	<b>%</b>
Fractures	3	27.27
Osteochondral Lesions	2	18.18
Bone Contusions	4	36.36
Marrow Edema	6	54.54

In our study of total 61 patients it was found that Traumatic Injury was the most common pathology of ankle joint and foot pathologies (34,55.74%) followed by Infection (12,19.67%), Miscellaneous Pathologies (10,16.39%) and Neoplastic Pathologies (5,8.20%) as shown in Table 6.

**Table 6:** Summary of the findings in the study group

Pathology	Total	%age
Trauma	34	55.74
Infection	12	19.67
Neoplastic Pathology	5	8.20
Miscellaneous	10	16.39
<b>Total</b>	<b>61</b>	<b>100</b>

**Discussion**

Imaging plays a crucial role in the evaluation of ankle tendons and ligaments. Magnetic resonance imaging has been proven to provide excellent evaluation of ligaments around the ankle, with the ability to show various types of soft tissue and bone abnormalities. MRI is very helpful in local staging and surgical planning because it confirms the diagnosis in cases when radiographs are normal or equivocal, because it is as sensitive as and more specific than other radiological modality. MRI is the most accurate diagnostic procedure for the evaluation of traumatic ankle injuries like ligamentous injuries, given its high contrast resolution and accuracy in the detection of bone edema [2]. Out of 61 patients, 38 (62.30%) were males and 23 (37.70%) were females, thus showing male predominance in our study. AmitKharat *et al.* [9] and Elgohary MMIA *et al.* [10] in their study revealed similar gender distribution. Their study comprised of 33 (66%) males and 17 (34%) females. Dissimilar results were reported by Eman K. Sultan *et al.* [12] in their study, i.e. males represented 39% of all patients while females represented 61%. The difference might be due to the study setting, location and its design. Elgohary MMIA *et al.* [10] in their study included 40 patients, out of which 12 were females and 28 were males. This is accordance with our study. Acute and chronic pain was reported among 55.74% and 44.26% of the subjects respectively in the present study. Elgohary MMIA *et al.* [10] in their study found that 22 cases (55%) presented with acute ankle pain and 18 cases (45%) presented with chronic ankle pain. Similarly AmitKharat *et al.* [9] in their study found that acute and chronic pain was reported among 34% and 66% of the subjects respectively.

Injuries to the ankle joint are the most common injuries in sports and recreational activity. These injuries most commonly occur in young people. Injuries to the ligaments of the ankle joint complex are called low ankle sprains. High ankle sprains include injuries of tibiofibular ligament or the syndesmosis. Inversion sprains resulting in injury of the lateral ligaments of the ankle joint complex are most common. High ankle sprains usually occur due to an eversion injury combined with fractures or lesions of the deltoid ligament complex. In our study, ligament injury was found among 22.95% of the subjects. Among the ligament injuries, lateral ligament involvement was revealed in 81.25% of the subjects while medial deltoid ligament was reported only in 18.75% of the subjects. ATFL injury and PTTL ligament injury was revealed among 43.75% and 18.75% of the subjects respectively. Sprain, partial and complete ligament tear was reported among 43.75%, 31.25% and 25% of the subjects respectively in the present study. Anterior talofibular ligament due to its vulnerable position during plantar flexion is the most commonly ruptured ligament in lateral ankle sprain. The deltoid ligamentous complex is the strongest ligament of the ankle joint serving as the primary stabilizer of the axially loaded ankle. It accounts for only 5% of all ankle sprains. Forced eversion and pronation of the ankle is the most classical mechanism of injury, most often resulting in a medial malleolus avulsion fracture. These often result in mechanical instability [12]. Nevien El-Liethy [13] in their study revealed that Anterior talofibular ligament (ATFL) was the most frequently injured ligament representing 57.2% of the whole ligamentous injuries followed by the posterior talofibular ligament (PTFL) (19%) and calcaneofibular ligament (CFL) (14.3%). Deltoid ligament was the least ligament injured (9.5%). This coincides with different literatures evaluating ankle ligaments. Cheng *et al.* [14] stated that anterior talofibular ligament is the most commonly torn ankle ligament followed by calcaneofibular ligament, and in 70% of ankle sprains, only the anterior talofibular ligament is torn, while the calcaneofibular ligament is also torn in 20% of cases. The deltoid ligament is the strongest ankle ligament and least to be injured. These results were in accordance to our study.

In our study, tendon injury was found among 14.75% of the subjects. Among the tendon injuries, anterior, posterior, lateral and medial compartment was revealed in 9.09%, 36.36%, 18.18% and 36.36% of the subjects respectively. Achilles was the most common tendon injury, reported in 36.36% of the subjects. Tendinosis, partial tear, complete tear and exudative tenosynovitis was reported among 36.36%, 45.45%, 9.09% and 9.09% of the subjects respectively. Although the Achilles tendon is the strongest tendon in the human body, all literature agreed that it is the most commonly injured ankle tendon. In a severe injury of the Achilles tendon, too much force on the tendon can cause it to tear partially or rupture completely. Liffen (2014) [15] agreed that the Achilles tendon is the most commonly injured ankle tendon, with the site of pathological findings is typically a zone of relative avascularity 2–6 cm from the calcaneal insertion.

Bone injury was found among 18.03% of the subjects. Among the bone injuries; fractures, osteochondral lesions, bone contusions and marrow edema was revealed in 27.27%, 18.18%, 36.36% and 54.54% of the subjects respectively in our study. In a study by Elgohary MMIA *et*

*al.* [10], 14 patients had bone injuries. 3 patients (21.43%) have fractures and 5 patients (35.71%) have osteochondral lesions and 6 patients (42.86%) have bone contusions. In our study, joint effusion was reported among 79.41% of the subjects. Our results coincided with those of Jacobson *et al.* [16] who concluded that MRI was more sensitive than ultrasonography in ankle effusion detection MRI could detect intra-articular fluid of 1 ml while sonography could reproducibly detect 2 ml of fluid. They also agreed that for both imaging types, evaluation of ankle in plantar flexion allowed the greatest sensitivity.

In our study, acute osteomyelitis, chronic osteomyelitis and infective arthritis was found among 4.92% (3), 11.48% (7) and 3.28% (2) of the subjects respectively. Kharat *et al.* in their study reported 15 cases of osteomyelitis and one case of inflammatory arthritis [9].

In the present study, neoplastic pathologies were reported among 8.20% of the subjects. Among the neoplastic pathologies Giant Cell Tumor (GCT), Hemangioma, Primary Aneurysmal Bone Cyst (ABC), and Soft Tissue Sarcoma was reported among 2 (40%), 1 (20%), 1 (20%) and 1 (20%) subject respectively. Hettis *et al.* [17] stated that neoplastic lesions around the ankle are rare and are mostly benign. (Added)

Morton's Neuroma, Medullary Infarct, Plantar Fibromatosis, Freiberg Disease and OS Navicular were reported among 4.92%, 4.92%, 3.28%, 1.64% and 1.64% of the subjects respectively in the present study. A Mehta *et al.* [18] in their study reported Morton's Neuroma in 41 (23.7%) cases. From the results of the study, it can be said that MR imaging is the modality of choice for assessment of pathologic conditions of the ankle and foot.

## Conclusion

We can conclude that MRI is modality of choice in evaluating ankle injuries due to its high soft tissue contrast resolution, and multi-planar capabilities. It provides a non-invasive tool for the diagnosis of Ankle injuries, which are often difficult to diagnose with alternative modalities. MRI is particularly advantageous for assessing soft tissue structures around the ankle such as tendons, ligaments, nerves, and fascia and for detecting occult bone injuries.

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