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

Dr. Gurveen Kaur Bajwa, Dr. Shubhda Sagar, Dr. Brij Bhushan Thukral, Dr. Sunil Malhotra and Dr. Vipin Bhati

DOI: http://dx.doi.org/10.33545/26644436.2021.v4.i1c.174

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 parent 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 HDe (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 Mortons’ Neurona and Medullary Infarct, 2 patients of Plantar Fibromatosi 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 osteoarthritides 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 HD (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:

| Image plane          | Slice thickness | Fov (cm) | Matrix | Acquisition | Image time |
|----------------------|----------------|----------|--------|-------------|------------|
| Sagittal T1 SE       | 3mm/ skip 0.5mm | 20x20    | 256x256| 1           | 4 min      |
| Sagittal T2WI FSE    | 3mm/ skip 0.5mm | 20x20    | 320x256| 1           | 2 min 40s  |
| Sagittal PD FSE      | 3mm/ skip 0.5mm | 20x20    | 320x256| 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 | 19x19    | 320x190| 1           | 2 min 40s  |
| Coronal STIR         | 3mm/ skip 1mm   | 19x17    | 320x160| 1           | 2 min 40s  |
| Axial PD             | 4mm/ skip 0.5mm | 19x19    | 320x256| 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.

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).

![Fig 2: Distribution of the onset of ankle pain in the study group](image)

| 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
Diagnosis 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. Amit Kharat 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 rep-resented 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. 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 Amit Kharat et al. [9] in their study found that acute and chronic pain was reported among 34% and 66% of the subjects respectively.

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                 | 9  | 14.75% |
| Absent                  | 52 | 85.24% |
| Tendon Injuries         |    |     |
| 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 DigitortiumLongus | 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% |

Table 4: Distribution of tendon injuries in the study group

| Tendon injuries         | Tendinosis | Partial tear | Complete tear | Exudative tenosynovitis |
|-------------------------|------------|--------------|---------------|-------------------------|
| Tibialis Anterior       | 1          | 0            | 0             | 0                       |
| Extensor HallucisLongus | 0          | 0            | 0             | 0                       |
| Tibialis Posterior      | 1          | 1            | 0             | 0                       |
| Flexor DigitortiumLongus | 0       | 1            | 0             | 0                       |
| Flexor HallucisLongus   | 1          | 0            | 0             | 0                       |
| Achilles                | 0          | 1            | 0             | 0                       |
| PeroneousLongus         | 1          | 1            | 1             | 0                       |
| Total                   | 4          | 5            | 1             | 1                       |

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 (5.8.0%) 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% |
| Total          | 61    | 100%  |
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 to 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 PTFL 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 Anteriotalofibular 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 80.09%, 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 [19].

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. Hetts et al. [17] alstated 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.

References
1. Martella I, Azzali E, Milanese G et al. MRI in acute ligamentous injuries of the ankle. Acta, Biomed 2016;87(3):13-19.
2. Kier R, McCarthy S, Dietz MJ, Rudicel S. MR appearance of painful conditions of the ankle. Radiographics 1991;11:401-414.
3. Rosenberg ZS, Beltran J, Bencardino JT. From the RSNA Refresher Courses. Radiological Society of North America. MR imaging of the ankle and foot. Radiographics 2000;20:S153-179.
4. Wang XT, Rosenberg ZS, Mechlin MB, Schweitzer ME. Normal variants and diseases of the peroneal tendons and superior peroneal retinaculum: MR imaging features. Radiographics 2005;25:587-602.
5. Lucas P. MRI of the Foot and Ankle. Current Problems In Diagnostic Radiology 1997;26(5):209, 211-266.
6. Dunfee WR, Dalinka MK. Imaging of athletic injuries to the foot and ankle. Radiol Clinic North Am 2008;40:289-312.
7. Sharma UK, Shrestha D. Musculoskeletal ultrasound: Is
8. Rosenberg ZS, Beltran J, Bencardino JT. MR imaging of the ankle and foot. Radiographics 2008;20:153-179.
9. Kharat A, Ghosh A, Jain K, Karanjule P, Gandage SG. Magnetic resonance imaging in evaluation of traumatic and non-traumatic ankle joint and foot pathologies. Med J DY Patil Vidyapeeth 2019;12:239-49.
10. Elgohary MM, Abdul Rahim SA, Ibrahim TA. Role of MRI in Evaluation of Traumatic Ankle Injuries. The Egyptian Journal of Hospital Medicine 2017;69(3):2016-24.
11. Sherief MF, Sultan EK, Mashaly M. Role of ultrasound and magnetic resonance imaging in diagnosis of the etiology of chronic ankle pain. The Medical Journal of Cairo University 2018;86:473-82.
12. Saenz R, Ries S, Giese J, Knapp D. MRI of ankle and hindfoot pain. J Am Osteopath CollRadiol 2015;4:5-15.
13. El-Liethy N, Kamal H. High resolution ultrasonography and magnetic resonance imaging in the evaluation of tendino-ligamentous injuries around ankle joint. The Egyptian Journal of Radiology and Nuclear Medicine 2016;47(2):543-55.
14. Cheng Y, Cai Y, Wang Y. Value of ultrasonography for detecting chronic injury of the lateral ligaments of the ankle joint compared with ultrasonography findings. Br J Radiol 2014;87:1-6.
15. Liffen Neil. Achilles tendon diagnostic ultrasound examination: a locally designed protocol and audit. IntMusculoskelet Med 2014;36(1):1-12.
16. Jacobson JA. Ultrasound in sport medicine. Radiol Clin N Am 2015;40:363-369.
17. Hetts SW, Hilchey SD, Wilson R et al. Case 110: Non-ossifying Fibroma. Radiology 2007;243:288-92.
18. Mehta A, Chourasia A, Urigo C. All forefoot’s pain are not morton’s neuroma-a pictorial review of the forefoot musculoskeletal conditions mimicking mortons neuroma. Int J Radiol Radiat Ther 2018;5(5):280-4.