

## Research Article

# Study of Different Ankle Pathologies on MRI

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**Abstract: Introduction:** The purposes of this study are to present a state-of-the-art routine protocol for MRI of the ankle, to provide problem-solving tools based on specific clinical indications, and to introduce principles for the implementation of ultrashort echo time MRI of the ankle, including morphologic and quantitative assessment. **Materials and methods:** This study include 30 patients (23 male and 24 female) with different complains of ankle including pain around the ankle, decreased movement of ankle joint, difficulty in walking, swelling around the ankle, tenderness around the ankle and trauma to the ankle underwent Magnetic Resonance Imaging (MRI) of the ankle joint. **Results:** In our study included 47 patients with different ankle complain were subjected to MRI of the affected ankle after initial examination and basic investigation including plain radiography. Maximum number of pathologies was detected in the age group of 41 to 60 years in 46.80% of the patients. Most common structure involved were joints, it was involved in 28 patients (59.57%). Traumatic etiology was more common in our study and seen in 18 patients (38.29%) followed by degenerative etiology in 11 patients (23.40%). Lateral ligament complex was most frequently injured ligament representing 83.33%. Although it is the strongest tendon in the human body, Achilles tendon was the most commonly injured ankle tendon. **Conclusion:** Because of exquisite soft-tissue contrast resolution, noninvasive nature, and multiplanar capabilities of MR imaging make it especially valuable for the detection and assessment of a variety of soft-tissue as well as osseous and bone marrow disorders.

**Keywords:** MRI, Bones, Joints, Soft tissue, Neurovascular bundle, Muscles.

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## INTRODUCTION

Ankle injuries are common among high-performance athletes and the general population, accounting for as many as 10% of emergency department visits [1]. Ankle injuries have been reported to be the most common type of lesion in 24 of 70 sports, ankle sprain being the most frequent [2]. 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 [3]. Achilles tendon injury is one of the most common overuse injuries in athletes, and it includes the tendon and surrounding soft tissues [4].

Pathologic entities that commonly affect the ankle vary in tissue type, mechanism of injury, and acute versus chronic presentation. When the complex anatomy of the ankle is factored into these components of the equation of MRI diagnosis, it is necessary to leverage all tools at our disposal for accurate characterization of disease [5]. The acquisition of optimal MR images of the ankle has inherent challenges beyond complex anatomy. The ankle is the transition

point between the distal leg and foot, structures oriented at right angles to one another. Because of this configuration, imaging at or near this magic angle is difficult to avoid [6].

The peripheral position of the ankle calls for attention to maintaining imaging at the isocenter of the bore to leverage homogeneous field strength and gradients. Although consideration of imaging plane and pulse sequence choice is primarily emphasized for both routine and tailored protocols, the coils for image acquisition cannot be taken for granted [7]. Use of dedicated surface coils improves spatial resolution and field homogeneity, particularly for the imaging of small peripheral joints. Dedicated extremity coils are generally used to optimize signal-to-noise ratio (SNR) [8]. Local transmit coils reduce radiofrequency power and the associated specific absorption rate compared with the effects of receive-only coils. This allows more slices per acquisition. Use of multichannel coils increases SNR and the ability to use parallel imaging techniques [9].

Although not crucial, there are significant advantages to ankle MR image acquisition with a 3-Tesla (3-T) system. The main advantage of higher field strength results from a near linear increase in SNR, which can be used to improve resolution, decrease acquisition time, or both [10]. There are also possible limitations to increased field strength. Metallic susceptibility increases with increasing field strength, resulting in greater signal loss, geometric distortion, and heterogeneous fat suppression, among other things. Chemical shift and pulsation artifacts are also more pronounced. T1, and to a lesser degree, T2 relaxation times are affected by field strength, requiring alterations in pulse sequence parameters [11].

The goal of this study is to provide an update on musculoskeletal imaging techniques for ankle evaluation, targeting clinical questions and diagnostic challenges. We offer guidance and considerations for routine protocols, provide indication-driven protocols addressing specific clinical concerns, and profile the application of Ultrashort Echo Time (UTE) MRI techniques in the ankle.

## AIMS AND OBJECTIVE

To categorize different ankle pathology using MRI based on their aetiology and evaluate the prevalence of different pathologies in different age group and evaluate involvement of different structure in various ankle pathologies.

## MATERIALS AND METHODS

This is a prospective, observational and descriptive study conducted after getting approval from the institutional ethics committee. Study conducted in the Department of Radiodiagnosis, Subbaiah Institute of Medical Sciences from June 2020 to November 2020.

### Inclusion Criteria

- Patients above the age of 18 years old presented with ankle joint related complains.

### Exclusion Criteria

- Patients who are having any type of orthopaedic implants in ankle region.
- Patient with metallic hip implants and cardiac pace maker.
- Patient with pregnancy.

## METHODS

Clinical information included brief history of patient, with whole spectra of varied symptoms including pain in and around ankle, restriction of joint movement, difficulty in walking, swelling with or without tenderness around the ankle and fever with or without chills which caused the clinician to get done an MRI ankle.

### MRI Examination

- MRI was performed using GE signa hdxt 1.5 tesla MRI machine.

### Patient position and coils

- Imaging was done with the foot about 20° of plantar flexion with the patient in a supine position. A standard knee coil was used.

### Scanning protocol

- The MR imaging criteria for the diagnosis of acute rupture of ligament include morphologic and signal intensity alterations within and around the ligament [12].
- Clinical information included brief history of patient, with whole spectra of varied symptoms including pain in and around ankle, restriction of joint movement, difficulty in walking, swelling with or without tenderness around the ankle and fever with or without chills which caused the clinician to get done an MRI ankle.
- The imaging planes, sequences, and even the selection of which coil to use varied depending on the clinical circumstances. The lower extremity was externally rotated and the planes of imaging were oriented to the anatomy of the foot, rather than to the magnet. Only the extremity with a suspected abnormality was imaged to employ a small field of view to increase the detail and resolution of the images.
- The FOV included the distal tibia and fibula, all of the tarsal bones, and the bases of the metatarsals.
- Slice thickness ranged from 3-5 mm with gap of 1 mm.
- Matrix 256/192.

### MRI Sequences

- T1-Weighted (T1-W) images: It was evaluated for normal anatomy of bones, ligaments, tendons, joints, synovium, soft tissue and neurovascular bundle in axial, coronal and sagittal planes.
- T2W images: It was evaluated for pathologies of bones, ligaments, tendons, joints, synovium, soft tissue and neurovascular in axial, coronal and sagittal planes.
- PD FS (Proton Density Fat Saturation) images: It is particularly important when tendons and ligaments are site of clinical concern and evaluated in axial, coronal and sagittal planes.
- STIR (Short T1 Inversion Recovery) images: It was particularly evaluated for bone marrow, bone tumour and metastasis in axial, coronal and sagittal plane.
- Post contrast T1W images: It has evaluated in case of bone or soft tissue mass and other infective aetiology as and when required.

## STATISTICAL ANALYSIS

Data analysis: Was done in Microsoft Excel by descriptive analysis of different ankle pathologies on MRI sequences and characterize them.

## RESULT

MRI features of different pathologies were evaluated using various conventional as well as specific MR sequences and characterized based on their

etiology, structure involve in the pathology and associated abnormalities. After careful evaluation of different MR sequences and patients clinical complain, final diagnosis was made.

The patients in our study were arranged in age groups of 20 years beginning from below 20 years. The youngest patient in our study was 18 years old, whereas the oldest patient was 70 years old.

**Table-1: Classification of different aetiology in various age groups**

AGE GROUP (Years) (n=60)	Traumatic	Neoplastic	Infective/Inflammatory	Degenerative	Miscellaneous
Below 20	4	2	2	0	2
20-40	6	4	4	2	2
41-60	10	0	6	8	4
61-80	0	0	2	2	0

In table 1, out of the 60 case studies, maximum number of pathologies was detected in the age group of 41 to 60 years, followed by 20 to 40 years age of the patients. In our study, traumatic etiology was most commonly seen in the patients of 41-60 years age group involving 10 patients. On the other hand, there was no any patient of traumatic and neoplastic etiology in 61-80 years age group.

Neoplastic etiology found in 20-40 years age group involving 4 patients, only 2 patients have neoplastic etiology in age group of below 20 years. Infective/inflammatory etiology most commonly seen

in 41-60 years age group involving 6 patients, second most common age group was 20-40 years involving 4 patients, followed by 2 patients in the age group below 20 years and 61-80 years.

Degenerative etiology most commonly seen in 41-60 years age group involving 8 patients, second most common age group was 20-40 years and 61-80 years involving 2 patients each. Other miscellaneous etiology most commonly found in age group of below 20 year and 41-60 years involving 2 patients each and 4 patients were between 41-60 years.

**Table-2: Classification based on various structures involved**

Structure involved	Number(n=70)	Percentage %
Tendons	15	23.3
Ligaments	21	36.6
Bones	24	56.6
Joints	19	60
Synovium	5	10
Soft tissue	7	16.6
Neurovascular bundle	0	0
Muscles	0	0

In our study, 60 patients found that different structure involved in ankle joint such as tendons, ligaments, bones, joints, synovium and soft tissue were involved in different pathology. The most common

structure involved was joints 60% patients and second most common structure involved was bones 56.6%. There were no involvement of neurovascular bundle and muscles seen in any of the patients.

**Table-3: Classification based on types of etiology**

Type of etiology	Number (n=60)	Percentage %
Traumatic	20	33.3
Neoplastic	6	10
Infective/inflammatory	14	23.3
Degenerative	12	20
Miscellaneous	8	13.3

Patients were broadly grouped into categories based on their etiology into traumatic, neoplastic,

infective/inflammatory, degenerative and miscellaneous. We found that traumatic etiology was

more common seen in 20 patients (33.3%) followed by Infective/inflammatory etiology seen in 14 patients (23.3%) while least etiology was neoplastic seen in 6 patients (10%). Degenerative etiology was seen in 12 patients (20%) and other miscellaneous etiology was

seen in 8 patients (13.3%) which include synovial chondromatosis, os trigonum, focal marrow edema isolated joint effusion and reflex sympathetic dystrophy.

**Table-4: Classification of various pathologies involving different ligamentous compartments**

Ligamentous compartment (n=22)	Medial compartment ligaments	Lateral compartment ligaments	Syndesmotic ligaments
Complete thickness tear (n=5)	3 (60%)	1 (20%)	1 (20%)
Partial thickness tear (n=12)	5 (41.6%)	4 (33.3%)	3 (25.0%)
Sprain (n=7)	3 (42.8%)	2 (28.5%)	2 (28.5%)

In our study, we encountered that complete thickness tear of ligaments seen in involving medial compartment, lateral compartment and syndesmotic ligaments however commonly involving medial compartment in 5 patients (60%) and lateral compartment ligament and syndesmotic ligaments in 1 patients (20%).

medial compartment in 5 patients (41.6%), lateral compartment ligament in 4 patients (33.3%) and syndesmotic ligaments in 3 patients (25.0%).

Partial thickness tear of ligaments seen in involving medial, lateral compartments and syndesmotic ligaments however commonly involving

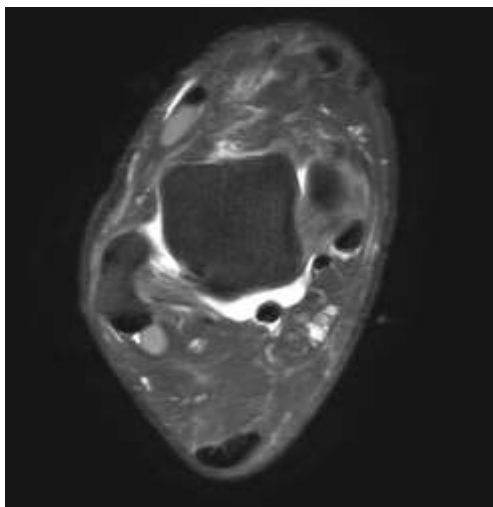
Sprain of ligaments also seen in involving medial, lateral compartments and syndesmotic ligaments however commonly involving lateral compartment ligaments in 3 patients (42.8%) and followed by medial compartment ligaments and syndesmotic ligaments in 2 patients (28.5 %).

**Table-5: Classification of various pathologies involving the different tendons**

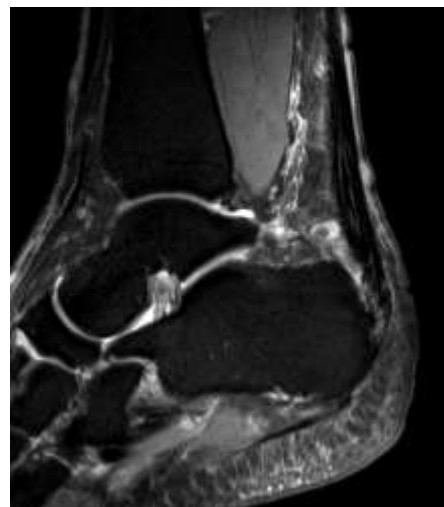
Pathologies	Achilles tendon	Plantaris	Tibialis posterior tendon	Peroneal tendons	FDL	EDL
Complete thickness tea	1	0	0	0	0	0
Near complete thickness tear	1	1	0	0	0	0
Partial thickness tear	1	0	1	1	0	0
Tendinosis	2	0	1	1	0	0
Tendinitis	0	0	1	1	0	0
Giant cell tumor	0	0	1	1	1	1
Ganglion cyst	0	0	0	0	1	0

In our study, we encountered that complete thickness tear of tendon seen only involving Achilles tendons no other tendons shows complete thickness tear, near complete thickness tear of tendon seen involving Achilles tendons and plantaris tendon in 1

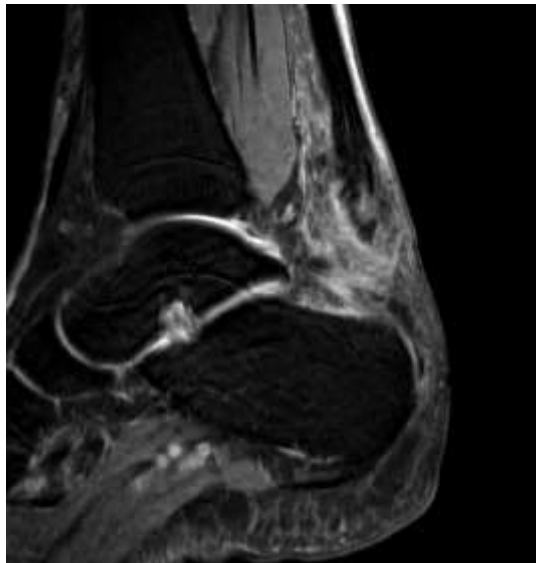
patient each (50%), partial thickness tear was seen involving Achilles tendon, tibialis posterior and peroneal tendons however it was seen involved Achilles tendon most commonly which was seen in 2 patients.



**Fig-1: Axial PDFS image shows complete tear of the anterior talofibular ligament**



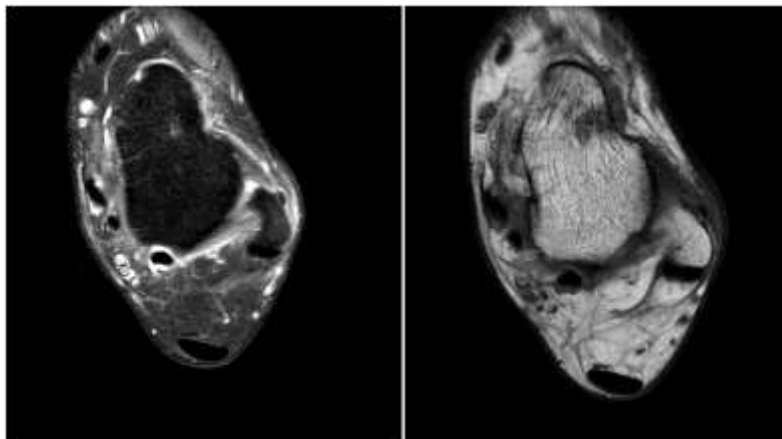
**Fig-2: Degenerative changes with partial tear of achilles tendon**



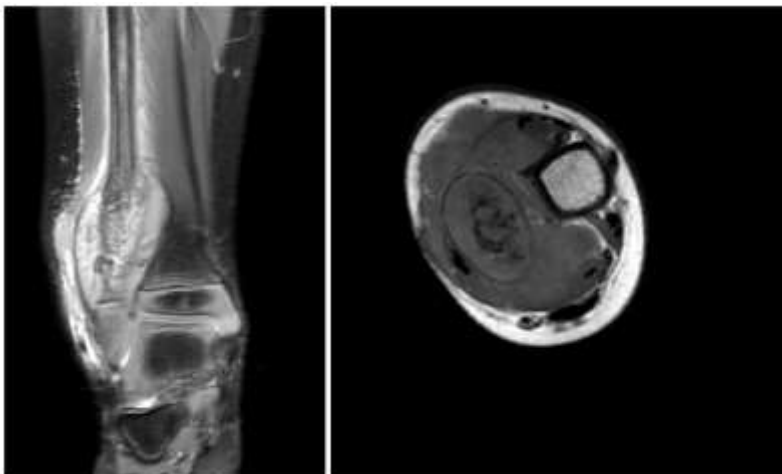
**Fig-3:** After 2 months showing full thickness tear of achilles tendon



**Fig-4:** Sagittal PDFS image shows full thickness traumatic tear of tendoachilles



**Fig-5:** Axial PDFS and axial T1 weighted image showing partial tear of anterior talofibular ligament



**Fig-6:** PDFS coronal and axial T1 weighted image of ankle showing Ewing sarcoma

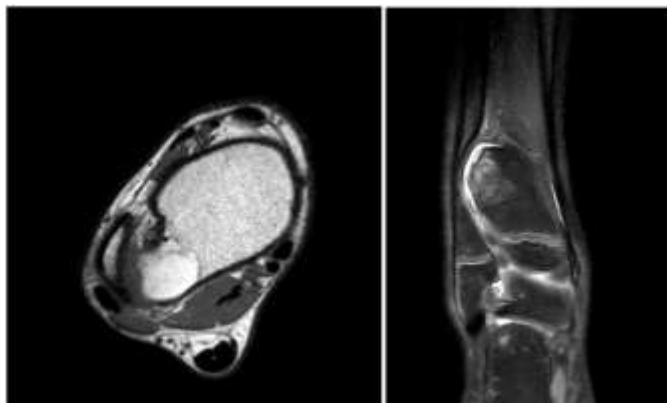


Fig-7: Axial T1 weighted image and coronal PDFS image showing osteochondroma

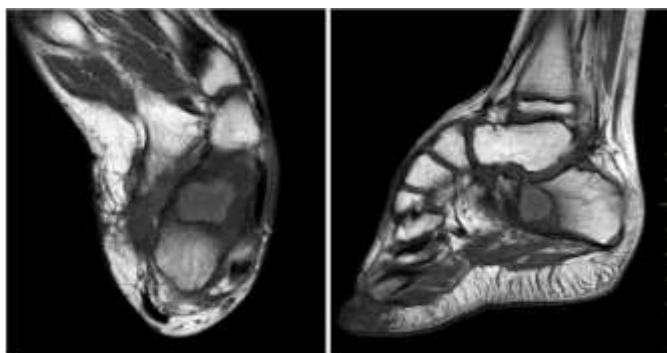


Fig-8: Axial and sagittal T1 weighted images of ankle shows osteomyelitis of calcaneus

## DISCUSSION

In our study, tendinosis was seen involving Achilles tendon, tibialis posterior and peroneal tendons equally in 1 patient each. Tendinitis was seen equally involving tibialis posterior and peroneal tendons. We have found only one case of giant cell tumor involving tendon sheath of tibialis posterior, peroneal, FDL and EDL tendons.

Out of the 30 case studies, we come to know that different aetiologies were common in different age group. In our study, traumatic etiology was most commonly seen in the patients of 41-60 years age group involving 10 patients (55.55%) which is matched with De Smet AA *et al.* who reported that tendon ruptures are commonly affecting the middle aged between 35 and 60 years [13]. However, they have included only traumatic tendon injury among the different age group which is lacking the prevalence of other aetiology in different age group which was included in our study.

Although it is the strongest tendon in the human body, Mesgarzadeh M *et al.* 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 [14]. Our result coincides with this hypothesis as Achilles tendon injury represents 50% of all diagnosed tendon injuries. In our study, tibialis posterior tendon showed 4 pathological entities (8.5% of all cases, and 28.57% of all tendons

pathologies). Shows 1 case of tendinosis, partial thickness tear, tendinitis and giant cell tumour of tendon sheath represents 25% each of pathological Tibialis posterior tendons.

Deltoid/medial ligament complex was less likely to be injured compare to lateral ligament complex. This coincides with Brody AS *et al.* work which is stated that lateral ligament complex is the most commonly torn ankle ligaments and in 70% of ankle sprains lateral ligament complex is torn. The deltoid ligament is the strongest [15].

Of the three medial ankle tendons, the tibialis posterior tendon is the most frequently affected. Although there was small number of tibialis posterior tendon pathology in our study group, our results were similar to the results achieved by Chen CA *et al.* [16] Of the remaining medial ankle tendons, the FDL tendon is rarely affected by pathological changes [16]. Our study included one case of giant cell tumor involving FDL. Although the anterior ankle tendons are rarely affected with pathology in comparison with the other ankle tendons, our study included 1 case with giant cell tumour of EDL tendon sheath. This agreed with Toumi H *et al.* who reported that TA tendon injuries are uncommon [17].

Longitudinal split tears of the peroneus brevis tendon have been increasingly reported as a source of lateral ankle pain and disability. According to Krepkin K *et al.* studied the longitudinal split tear of the

peroneus brevis tendon and reported that MRI is useful in identifying the appearance of longitudinal split tears of the peroneus brevis tendon to differentiate this entity from other causes of chronic lateral ankle pain [18]. Rasinski P also reported that MR imaging is useful in identifying the appearance of longitudinal split tears of the peroneus brevis [19]. Canale ST *et al.* stated that the use MRI had demonstrated a high degree of differentiation in helping to distinguish partial thickness from tendinosis [20].

## CONCLUSION

Because of exquisite soft-tissue contrast resolution, noninvasive nature, and multiplanar capabilities of MR imaging make it especially valuable for the detection and assessment of a variety of soft-tissue as well as osseous and bone marrow disorders.

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