

A STUDY OF SPECTRUM OF FINDINGS OF MAGNETIC RESONANCE IMAGING IN ANKLE JOINT PATHOLOGIES

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ABSTRACT

Aims & Objectives: This study is being carried out to describe various MRI features in the pathologies of ankle joint. Trauma to the ankle joint is a significant cause of morbidity in the young & active individuals especially amongst labourer's, road traffic accident patients and athletes. A correct diagnosis regarding traumatic/ non traumatic ankle joint pathologies is essential for early operative as well as non-operative treatment. Magnetic resonance imaging (MRI) has now been accepted as the best modality for non-invasive evaluation of ankle pathologies. This study was undertaken to study different pathologies of ankle joint and its incidence by MR imaging.

MATERIALS AND METHODS:

A total of 50 cases of clinically suspected & diagnosed of having any pathology of ankle joint by MR imaging of the ankle, at the department of Radiodiagnosis, AMC MET Medical college, L.G hospital, Maninagar, Ahmedabad. Study was performed between December 2018 to December 2019. MRI was carried out on SIEMENS 1.5 T MAGNETOM_ESSENZA machine

Results:

Of the total 50 patients evaluated, most common pathology of ankle joint being anterior talofibular ligament tear & tenosynovitis, 20(40%) cases of each, followed by stress fractures 17(34%) & contusions 16(32%). Associated findings include joint collection, marrow edema & soft tissue changes.

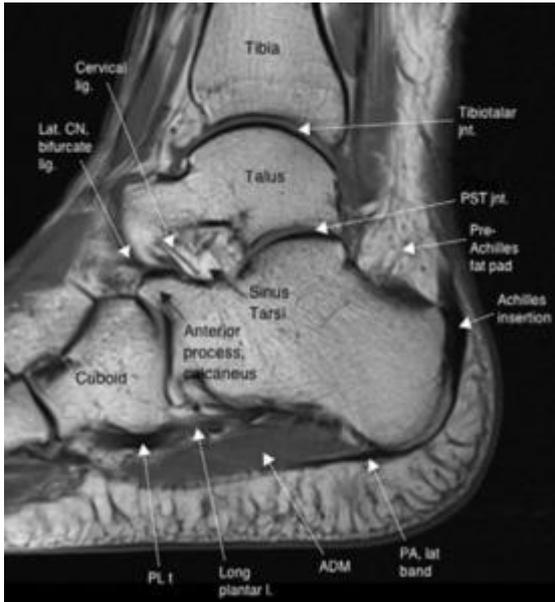
Interpretation and Conclusions:

From these observations, it is found that MRI is an excellent, noninvasive, radiation free imaging modality with multiplanar capabilities and better soft tissue delineation. It can accurately detect, localize and characterize various ligamentous, tendinous, bony & soft tissue pathologies related to ankle joint and thereby guiding in further management of the patient.

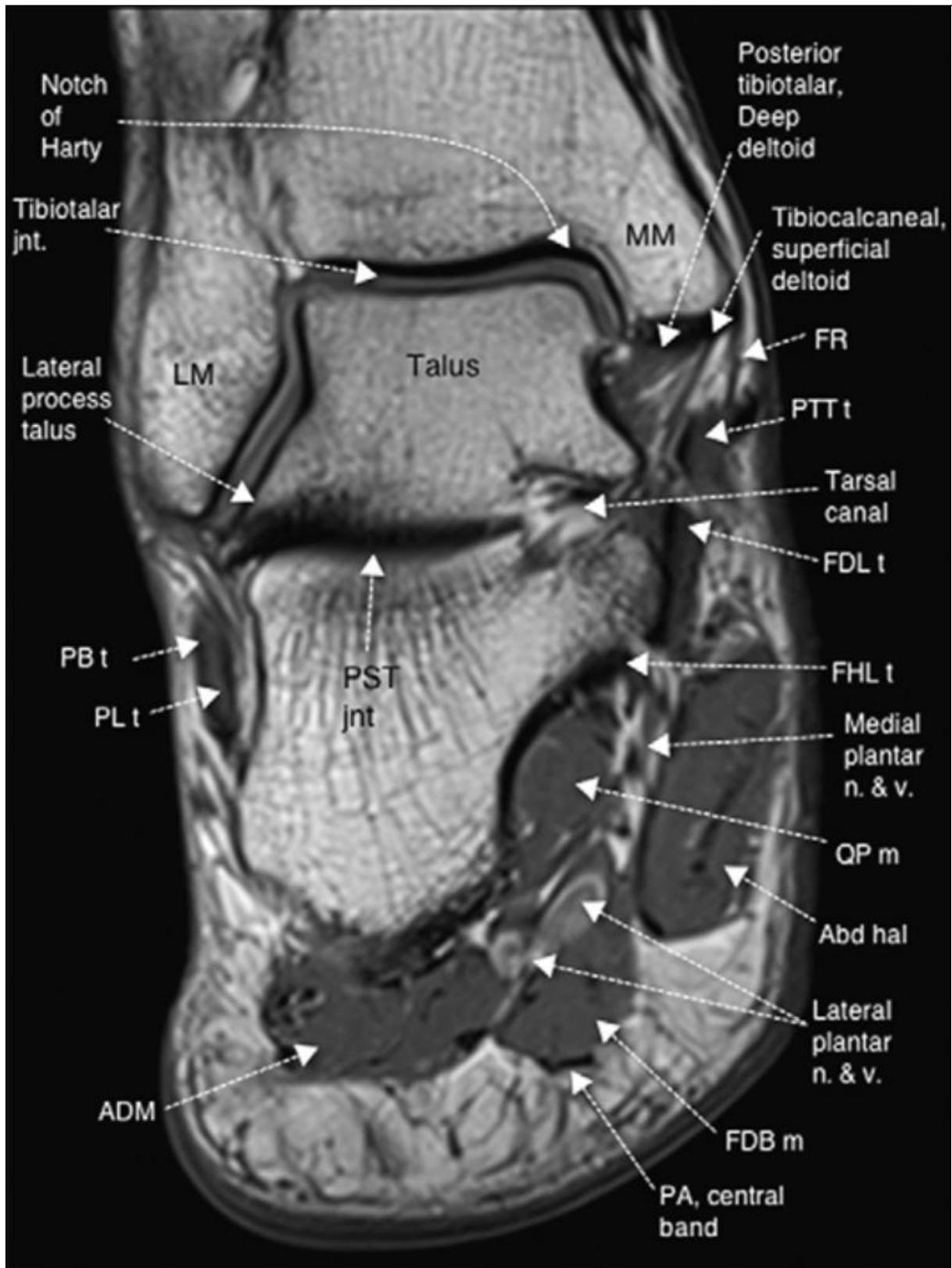
Keyword: Spectrum, Magnetic Resonance Imaging, Ankle Joint Pathologies.

INTRODUCTION

Magnetic resonance imaging (MRI) has revitalized the study of musculoskeletal disease in the ankle joint and foot pathologies due to noninvasive imaging, high soft-tissue contrast resolution, multiplanar capabilities, lack of ionizing radiation, and possible postcontrast imaging. MRI has the unique capability to evaluate osseous, ligamentous, tendinous, and soft tissue/muscular pathologies about the ankle, with a single imaging study before they become evident in other imaging modalities and often difficult to diagnose. Injuries to specific soft-tissue structures can be accurately detected by MRI, allowing appropriate therapeutic intervention and rehabilitation.¹ The most widely used diagnostic modalities for the joint pathology are arthroscopy, CT scan and MRI. Arthroscopy is accurate but it is invasive and can cause complications. Magnetic resonance imaging (MRI) has now been accepted as the best modality for non-invasive evaluation of ankle joint pathologies. It has been reported to have high diagnostic accuracy and does not involve use of ionizing radiation. In the background of trauma, post-traumatic limited range of motion and mechanical symptoms, it is generally considered valuable diagnostic modality.^{1,2}



NORMAL MR ANATOMY IMAGES:



PA: planter aponeurosis, FDL: flexor digitorum longus, FDB: flexor hallucis brevis, FHL: flexor hallucislongus, PL: peroneous longus, PB: peroneous brevis, FR: flexor retinaculum, MM: medial malleolus, LM: lateral malleolus, ST: subtalar joint.

AIMS & OBJECTIVES: -

- Study of the spectrum of MRI findings in all consecutive cases of ankle joint pathologies diagnosed by MRI ankle joint, at the department of Radiodiagnosis, AMC MET Medical college, L.G hospital, Maninagar, Ahmedabad.

MATERIALS AND METHODS: -

- A total of 50 cases of clinically suspected & diagnosed with pathologies of the ankle joint by MR imaging of the ankle joint at the department of Radiodiagnosis, AMC MET Medical college, L.G hospital, Maninagar, Ahmedabad.
- Study was performed between December 2018 to December 2019. MRI was carried out on SIEMENS 1.5 T MAGNETOM ESSENZA machine. T1 & PDFS weighted sequences in sagittal and coronal planes & T2 weighted in axial, coronal and sagittal planes were taken. MRI examination of the ankle joint was done in the axial, coronal, and sagittal planes paralleling the tabletop. Field of view (FOV) included the entire ankle/hindfoot up to the level of the metatarsal bases.
- Patients from all age groups including both men and women with pain in the ankle joint (rotating or twisting injuries) or without a history of trauma were included in the study. On MRI, patients with fractures/dislocations of or around the ankle joint and tumorous conditions involving the ankle joint and patients with infections and inflammatory arthritis were also included in the study. This data was analysed manually to meet the objectives of the study.
- The patient was positioned in supine position with the medial malleolus centered in the coil to evaluate the ankle joint. The foot was allowed to rest in a relaxed position, generally in 10°–20° of plantar flexion and 10°–30° of external rotation. The placement of localizers was as follows. An axial localizer at the level of tibiotalar joint for obtaining sagittal images with images obtained perpendicular to transmalleolar line covering from the medial malleolar to the lateral malleolar soft tissues. A sagittal localizer for obtaining axial images with images obtained parallel to the long axis of calcaneum extending from the posterior soft tissues to the metatarsal bases.
- **Inclusion Criteria:**
 - Patients diagnosed with ankle joint pathologies, by MR imaging.

Exclusion Criteria: -

- Patients with cardiac pacemakers and metallic implants were not subjected to MRI.
- Motion disorder and claustrophobia, if severe may make the examination difficult.
- Post-operative cases

RESULTS

Table1: Age distribution of patients studied

AGE	Number of patients
Upto20	7
21-30	8
31-40	11
41-50	13
>50	11
Total	50

Figure 1: Age distribution of patients studied
Most common age group to be involved was between 41-50years.

Table 2: Gender wise distribution

Gender	Number of patients	Percentage (%)
Male	29	58
Female	21	42
Total	50	100

Males are affected more

Table 3: Duration of the symptoms amongst patients

Duration of symptoms	Number of patients	Percentage (%)
Acute	22	44
Chronic	28	56

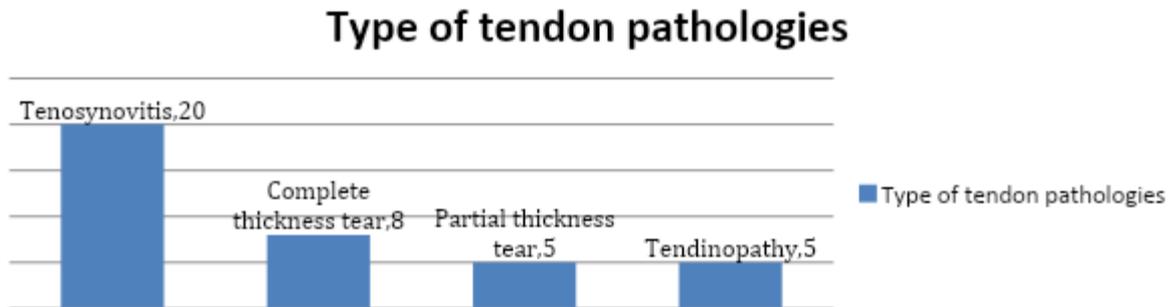
Total	50	100
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Patients were presented with chronic pathologies more commonly.

Table 4: Type of tendon pathologies

Tendon pathology	No. of patients	Percentage (%)
Tenosynovitis	20	40
Complete thickness tear	8	16
Partial thickness tear	5	10
Tendinopathy	5	10
Total	38	76

Figure 4: Type of tendon pathologies



The most common pathology of tendons being tenosynovitis, followed by tear.

Table 5: Frequency of tear of tendon

Tendon tear	Number of patients	Percentage (%)
Achilles tendon	4	8
Flexor tendon	3	6
Extensor tendon	1	2
Peroneus tendon	5	10
Total	13	26

Figure 5: Frequency of tear of tendon

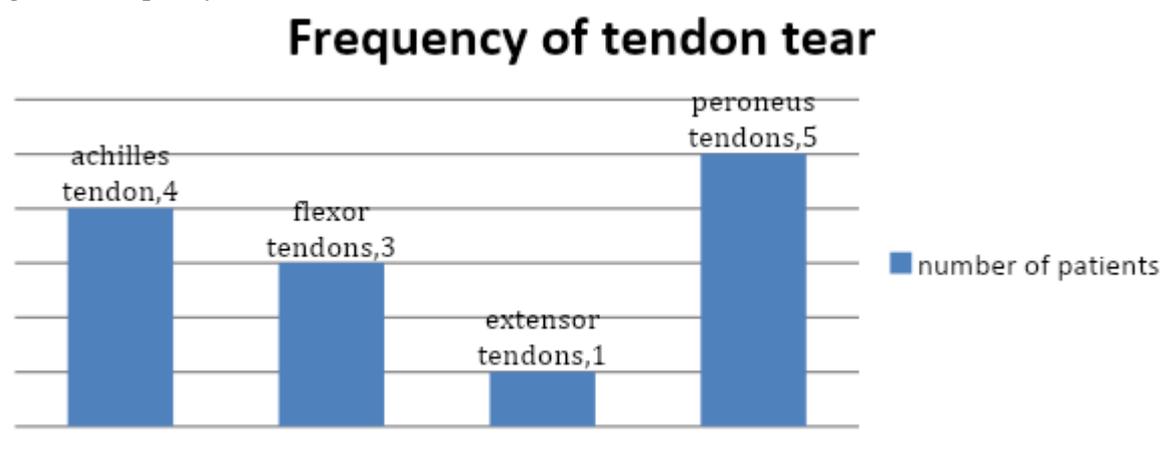


Table 6: Frequency of ligament tear

Ligament tear	Number of patients	Percentage (%)
Anterior talofibular ligament	20	40
Posterior talofibular ligament	6	12
Calcaneofibular ligament	8	16
Deltoid ligament	3	6
Talocalcaneal ligament	3	6

Talonavicular ligament	2	4
Total	42	84

Figure 6: Frequency of ligament tear

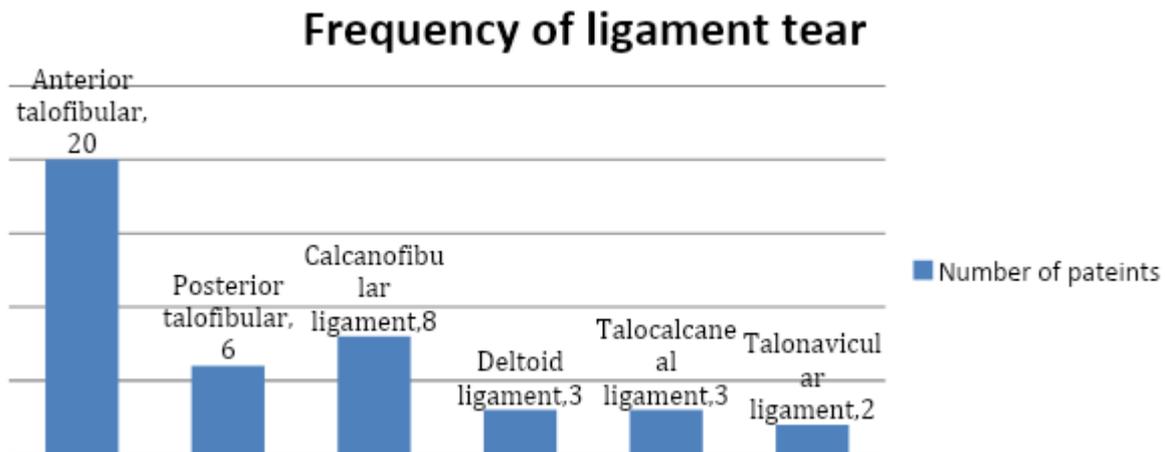


Table 7: Type of bony pathologies:

Bone pathologies	Number of patients	Percentage (%)
Marrow edema	28	56
Contusions	16	32
Stress fracture	17	34
Osteomyelitis	11	22
Post traumatic fracture	9	18
Pathological fracture	2	4
Osteochondral fracture	3	6
Osteonecrosis	7	14
Tumor	2	4

Figure 7: Type of bony pathologies:

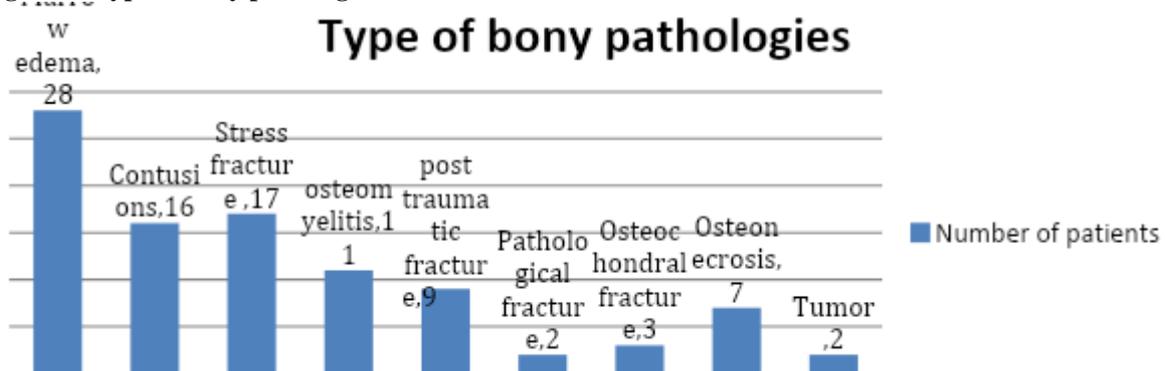


Table 8: Soft tissue pathologies, joint pathologies & miscellaneous conditions

Soft tissue pathologies, joint pathologies & miscellaneous conditions	Number of patients	Percentage (%)
Progressive villonodular synovitis	3	6
Soft tissue ganglionic cysts	4	8
Post traumatic osteoarthritis	12	24
Inflammatory arthritis	3	6
Charcot's joint	1	2
Planter fasciitis	5	10
Tarsal tunnel syndrome	1	2
Morton neuroma	1	2

Total	30	60
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Figure 8: Soft tissue & miscellaneous conditions

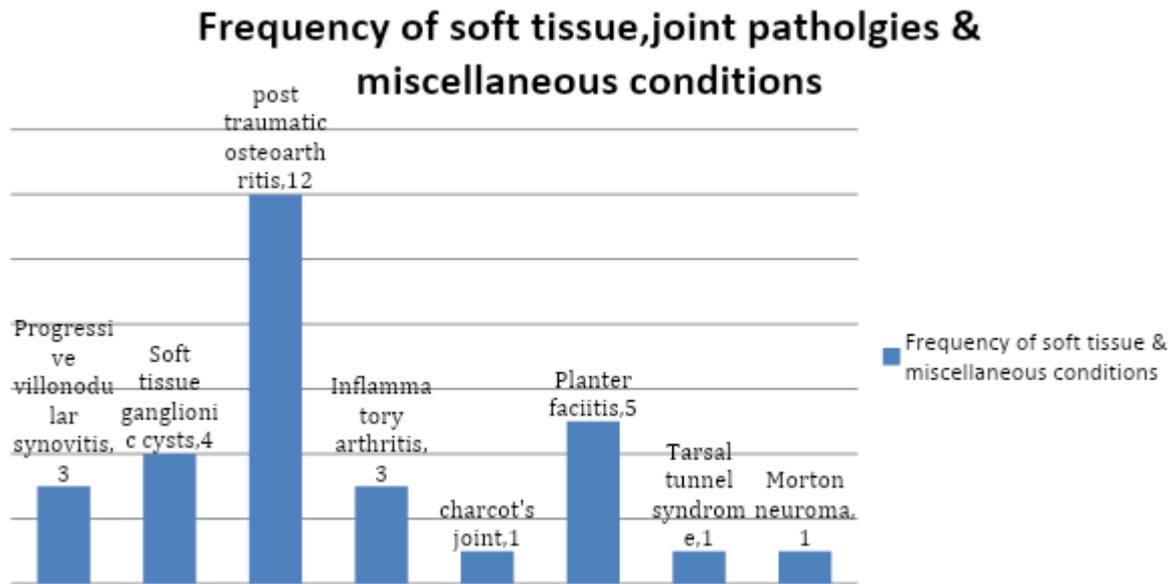


Table 9: Sites of osteomyelitis in the studied patients

Site of the lesion	Number of patients	Percentage (%)
Metatarsal	6	55
Tarsal	3	27
Lower end of tibia	1	9
Calcaneum	1	9
Total	11	100

Table 10: Sites of stress fracture in studied patients:

Sites of stress fracture in studied patients	Number of patients	Percentage (%)
Metatarsals	9	53
Lower end fibula	5	29
Lower end tibia	2	12
Tarsals	1	6
Total	17	100

Table 11: Sites of osteonecrosis in the studied patients

Sites of osteonecrosis in the studied patients	Number of patients	Percentage (%)
Talus	4	57
Navicular	2	29
Calcaneum	1	14
Total	7	100

Table 12: Joint collection

Joint collection	Number of patients	Percentage (%)
Present	29	58
Absent	21	42
Total	50	100

Table 13: Spectrum of MRI findings

MRI findings	Positive findings (n=50)	%
Tenosynovitis	20	40
Tendinopathy	5	10
Complete thickness tear of tendon	8	16
Partial thickness tear of tendon	5	10

Achilles tendon	4	8
Flexor tendon	3	6
Extensor tendon	1	2
Peroneus tendon	5	10
Anterior talofibular ligament tear	20	40
Posterior talofibular ligament tear	6	12
Calcanofibular ligament tear	8	16
Deltoid ligament tear	3	6
Talocalcaneal ligament tear	3	6
Talonavicular ligament tear	2	4
Marrow edema	28	56
Contusions	16	32
Stress fracture	17	34
Osteomyelitis	11	22
Post traumatic fracture	9	18
Pathological fracture	2	4
Osteochondral fracture	3	6
Osteonecrosis	7	14
Tumor	2	4
Progressive villonodular synovitis	3	6
Soft tissue ganglionic cysts	4	8
Post traumatic osteoarthritis	12	24
Inflammatory osteoarthritis	3	6
Charcot's joint	1	2
Planter fasciitis	5	10
Tarsal tunnel syndrome	1	2
Morton neuroma	1	2
Joint collection	29	58

DISCUSSION

- This study comprises 29 (58%) males and 21 (42%) females. The most common age group affected was 41–50 years, followed by age groups of 31–40 & more than 50 years. The least affected group was less than 20 years of age. The patients most frequently came with complaints of pain with or without history of trauma and swelling of the ankle joint and foot. The duration of the pathologies based on patient's clinical history was classified into acute and chronic, with majority of the patients 28(56%) cases presenting with chronic complaints more than 3-4 weeks.

- Traumatic pathologies:**

- Ligament injury

In our study, we found anterior talofibular ligament to be most commonly affected 20 (40%) followed by calcaneofibular ligament 8(16%) and posterior talofibular ligament 6(12%). The talonavicular ligament was least commonly affected-2(4%).

Ankle joint injuries are the most common injuries in sports and recreational activities.

Anterior talofibular ligament due to its vulnerable position during plantar flexion is most commonly ruptured in lateral ankle sprain, followed by a combination of rupture of the anterior talofibular and the calcaneofibular ligaments. The posterior talofibular ligament being a very strong ligament is less commonly injured, as in severe ankle trauma.^{3,4}These injuries most commonly occur in young people.⁵

In our study, we found that the deltoid ligament complex was less commonly 3(6%) injured.

The deltoid ligament complex is one of the strongest ligaments of the ankle joint serving as the primary stabilizer of the ankle. Forced eversion and pronation of the ankle is the most classical mechanism of injury, most often resulting in a medial malleolus avulsion fracture.^{2,3}

MRI findings in ligament tear: On fluid sensitive sequence such as T2W images, there is thickening of the affected ligament, area of hyperintensity at the site of tear, indicating discontinuity of the ligament, with or without associated soft tissue hyperintensity to suggest edematous changes.

1. Tendon injury

In our study the most frequent tendon tear is of peroneus tendon, accounting for 5 (10%), followed by Achilles tendon tear, accounting for 4 (8%). Peroneus tendon injuries are more associated with inversion movements. They are more commonly seen in athletes, runners and persons wearing wrong size of footwears.^{5,6}

The Achilles tendon despite being the strongest and thickest tendon is the most commonly ruptured occurring in healthy, active young to middle-aged population.^{5,7} In our study, we found that the most common location of the Achilles tendinopathy is preinsertional part and middle free tendon.

MRI findings of tendon tear: T2W images show a hyperintense signal within the substance of the affected tendon. Complete tear may show the retraction of the tendon ends. There may be associated marrow hyperintensities, suggesting marrow edema.

2. Bone injury

Marrow edema, bone contusions, joint collection & post traumatic bone fractures were found as the traumatic bony insults.^{8,9} Out of them, joint collection 29(58%), marrow edema 28(56%) & contusions 16(32%) were found commonly. Post traumatic bone fractures were found in 9(18%) of patients.

MRI findings: On T1W & proton density fat saturation images a linear hypointensity, on T2W images linear hyperintensity is seen, suggesting fracture line. Associated findings include marrow edema, contusion & soft tissue edema.

3. Miscellaneous conditions:

Ankle osteoarthritis secondary to trauma was the most common cause of ankle osteoarthritis.¹⁰ In our study, we found 12 (24%) of posttraumatic osteoarthritis of the ankle joint and 3(6%) of inflammatory arthritis.

MRI findings of osteoarthritis: Proton density & T1W images show full or partial thickness articular cartilage loss. T2W & STIR images show ill-defined patchy area of hyperintensity in subchondral bone, suggests subchondral sclerosis. T2W & STIR images show well defined hyperintense lesion in the subchondral bone, suggests subchondral cyst. Associated joint collection is seen in some case.

• Nontraumatic pathologies

1. Osteomyelitis:

Our study showed 11(22) cases of osteomyelitis, among which majority of cases were above 45 years of age and majority were male patients. Etiology of osteomyelitis in our study were, post traumatic, diabetes, tuberculosis & mycetoma, with most common etiology being post traumatic 5(45%) followed by diabetic foot 3(27%). Tubercular osteomyelitis & mycetoma accounted for 2(18%) & 1(9%) patient respectively.

Pedal osteomyelitis is a common complication of diabetes, with or without presence of bone marrow edema, soft-tissue swelling, extensive wound defect, or fistula attached to the bone and bone marrow edema concurrent with tenosynovitis in patients with diabetic foot syndrome.^{7,8} In our study base & body of the metatarsals is most commonly affected, 6(55%), followed by tarsal bones, 3(27%), lower end of tibia 1(9%) & calcaneum 1(9%).

MRI findings: In cases of acute osteomyelitis, T1W & T2W images show ill-defined areas of hypointensity & hyperintensity in the affected bone, respectively, suggesting inflammation. In case of subacute osteomyelitis, T2W images show area of hyperintensity, due presence of granulation tissue & surrounding hypointense rim, due to sclerotic reactive bone, called "Penumbra sign". In chronic osteomyelitis, T1W & T2W images show area of hypointensity due to devitalized necrosed bone.

2. Osteonecrosis & bone infarcts might be a sequela of diabetic foot, post traumatic status or a sequela of other inflammatory & infective etiologies.¹¹ In our study we found total 7(14%) osteonecrosis cases. Avascular necrosis of talus was more commonly seen, accounting for 4(57%) cases, followed by navicular bone 2(29%) & calcaneum 1(14%). MRI findings: On T1W & T2W images, cortical ill-defined or wedge shaped hypointense area in the affected bone, suggesting devitalized necrosed bone due to ischemic event.

3. Charcot osteoarthropathy is progressive, painless, degenerative arthropathy of single or multiple joints involving most commonly the peripheral joints due to underlying neurological deficits. It is more frequently seen in diabetic population.¹² In our study, we

found 1(2%) case with ankle joint diabetic osteomyelitis complicated by Charcot osteoarthropathy.

MRI findings: T1W & proton density images show hypointensity in the subchondral area. T2W & STIR images show hyperintense area in the subchondral bone, suggesting marrow edema & subchondral sclerosis. Associated joint collection is seen.

4. Inflammatory osteoarthritis

In our study, we found 3(6%) case of inflammatory arthritis of the ankle joint with a mean age of 50 years and female predominance. The most common manifestations were tenosynovitis, commonly affecting the flexor tendons, subtalar joint arthritis, and the synovial pannus.

MRI findings: Proton density & T1W images show full or partial thickness articular cartilage loss. T2W & STIR images show ill-defined patchy area of hyperintensity in subchondral bone, suggests subchondral sclerosis. T2W & STIR images show well defined hyperintense lesion in the subchondral bone, suggests subchondral cyst. Associated joint collection & synovial thickening is seen in some case.

5. Planter fasciitis

Plantar fasciitis is most likely caused by repetitive trauma and mechanical stress, which cause microtears and inflammation of the fascia soft tissues. It is common in runners and obese patients. The presenting symptom is pain at the origin of the plantar fascia. The pain is exacerbated by dorsiflexion of the toes and more severe in the morning.^{13,14} In our study, we found 5(10%) cases of plantar fasciitis, with a middle-aged female predominance.

MRI findings: T1W & proton density images show intermediate signal. T2W & STIR images show hyperintensity & thickening of planter fascia at its proximal part & extends to the calcaneal insertion. Hyperintense signal on T2W & STIR images in the adjacent soft tissue & in the calcaneal tuberosity suggests soft tissue & marrow edema respectively.

1. Stress fractures & osteochondral fractures

A stress fracture defined as a small crack in a bone or bruising in a bone. They are common in runners & athletes, participating in running sports, such as soccer and basketball.^{5,6,15} Stress fractures occur often in the second and third metatarsals, talus, calcaneus, & fibula. In our study we found 17(34%) cases of stress fracture, metatarsals found most commonly 9(53%), followed by lower end of fibula 5(29%), lower end of tibia 2(12%) & tarsals 1(6%).

MRI findings: On T1W & proton density fat saturation images a linear hypointensity, on T2W images linear hyperintensity is seen, suggesting fracture line, located perpendicular the axis of the bone.

2. Progressive villonodular synovitis

Pigmented villonodular synovitis is characterized by inflammatory proliferation of the synovium, with hemosiderin deposition. It may be present in joint, tendon sheath, or bursa but is most frequently seen in the knee, hip, ankle, and elbow. In our study we found 3(6%) cases of progressive villonodular synovitis at ankle joint.¹³

MRI findings: T2W images show mass like synovial tissue proliferation, of low to intermediate signal. STIR images show predominantly high signal. Gradient echo images may show blooming due to inter hemorrhage.

3. Soft tissue ganglion cysts

Ganglion cysts are unilocular or multilocular cysts consisting of mucoïd material & adjacent fibrous capsule. They may communicate with an adjacent joint or tendon sheath but may also be a completely separate lesion. The most frequent location is the wrist, followed by the ankle and knee.¹⁶ In the ankle and foot, ganglion cysts are seen most frequently in the dorsal aspect or in the region of the sinus tarsi, where they can compress the posterior tibial nerve, causing tarsal tunnel syndrome. In our study we found 1(2%) case of ganglion cyst.

MRI findings: Uniloculated or multiloculated well circumscribed area with of hypo & hyperintensity on T1W & T2W images respectively.

4. Tarsal tunnel syndrome

It is defined clinically as pain and paresthesia in the plantar aspect of the foot and toes. Contrary to the carpal tunnel syndrome, it is unilateral usually. Entrapment of nerve or compression can occur at the level of the posterior tibial nerve or its branches. Intrinsic and extrinsic causes of posterior tibial nerve compression have been described. Intrinsic lesions that often produce tarsal tunnel syndrome are accessory muscles, ganglion cysts,

neurogenic tumors, lipomas, synovial hypertrophy, and scar tissue. Foot deformities, hypertrophic and accessory muscles, accessory ossicle (ostrigonum), and excessive pronation during participation in some sports are just a few of the extrinsic causes of this syndrome.^{16,17} In our study we found 1(2%) case of tarsal tunnel syndrome.

MRI findings: MRI depicts the anatomy & boundaries of the tarsal tunnel & the responsible pathology.

5. Morton's neuroma

Morton neuroma (interdigital neuroma) is a fibrosing degenerative reaction produced by compression of a plantar digital nerve. The condition is seen in female population, predominantly. It is commonly seen between the heads of the third and fourth metatarsals, although all web spaces may be involved. There is thickening of nerve and associated bursitis is often present. Exquisite tenderness is elicited on lateral compression of the metatarsals.^{16,18} In our study we found 1(2%) case of Morton's neuroma at the level of head of 3rd metatarsal.

MRI findings: Hypointense or isointense signal on T1W images. Hypointense or intermediate signal on T2W images, in the web space between the metatarsal bones.

6. Neoplastic pathologies

In our study, we found 1(2%) case of primary aneurysmal bone cyst (ABC) of the calcaneus in 39 years old male patient. ABC is a locally aggressive nonneoplastic tumor-like lesion of bone, cystic cavities containing blood. It is commonly seen in the metaphyseal regions of the long bones. The tumor shows peak incidence in the second decade and is more common in the female population.¹⁹

In our study we found 1(2%) case of giant cell tumor (GCT) of talus in a 37 years old female patient. It is a locally aggressive tumor which involves long bones ends in skeletally mature persons. The common clinical symptoms are pain related to affected bone, swelling, and decreased range of movement in adjacent joint.²⁰

MRI findings: i) Aneurysmal bone cyst- Sagittal T2W images show hyperintense lesion with multiple fluid-fluid levels, consistent with aneurysmal bone cyst. ii) Giant cell tumor- proton density images show an iso to hypointense expansile soft tissue mass in talus, causing cortical destruction & extension into adjacent soft tissues.

SUMMARY & CONCLUSION

MRI is an excellent, noninvasive, radiation free imaging modality with very good soft tissue delineation. It can accurately detect, localize and characterize various ankle joint pathologies and thereby guiding further management. In the present study, 50 patients with ankle joint pathologies, referred for magnetic resonance imaging of the ankle joint were evaluated.

1. The most common age group to be involved was between 41-50 years with male predominance.
2. Most common pathology was ligamentous tear, of which anterior talofibular ligament being most common & complete tears were more common. Frequency wise, ligamentous & tendinous tears were followed by tenosynovitis.
3. Amongst the tendinous tears, peroneus brevis tendon is most commonly involved, followed by Achilles tendon tear.
4. Amongst the cases of osteoarthritis, most common etiology was traumatic.
5. Amongst the osteomyelitis cases reported, the most common etiology was trauma, followed by diabetic foot.
6. Other associated abnormalities like hemarthrosis, joint collection, osteochondral fractures, osteonecrosis and others were accurately detected, characterized & frequency wise distribution done with the help of magnetic resonance imaging.

ILLUSTRATIVE CASES



Image 1) Anterior talofibular ligament tear on STIR image - Peritendinous fluid collection & discontinuity of the tendon fibers of the anterior talofibular ligament on STIR image shown above.

Image 2) Achilles tendon tear on T2W sagittal image: Focal hyperintensity noted in upper course of Achilles tendon, along its entire width, on T2W image, suggest full thickness tear.

Image 3) Osteomyelitis on STIR image: Sagittal T2W images show bony destruction involving cuneiform & base of 1st metatarsal & altered marrow signal intensity, consistent with osteomyelitis.

Image 4) osteonecrosis of talar dome: Sagittal T1W images show mild flattening of the talar dome with diffuse altered signal of the majority of the talus bone with relative sparing of the anterior most aspect of the talar head, consistent with osteonecrosis.

Image 5) osteoarthritis: Sagittal proton density images show diffuse loss of articular cartilage involving tibio-talar joint & altered marrow signal intensity involving calcaneum & talus, consistent with osteoarthritis.

Image 6) Stress fracture of talar neck: Sagittal T2W images show grade II stress fracture of the talar neck.

Image 7) Stress fracture of 2nd metatarsal: axial STIR images show cortical break seen involving the medial cortex of shaft of 2nd metatarsal near the neck. It is surrounded by edema and callous formation.

Image 8) Ganglion cyst of ankle joint: Coronal T2W images show well defined homogeneously hyperintense lesion, extending into anterolateral soft tissue on medial aspect of right ankle joint.

Image 9) Aneurysmal bone cyst: Sagittal T2W images show multiple fluid-fluid levels, consistent with aneurysmal bone cyst.

Image 10) Giant cell tumor of talus: Sagittal proton density images show an iso to hypointense expansile soft tissue mass in talus, causing cortical destruction & extension into adjacent soft tissues.

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