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Original Research Paper

Radio-Diagnosis

THE ROLE OF MAGNETIC RESONANCE IMAGING IN THE EVALUATION OF TRAUMATIC INJURIES OF ANKLE JOINT

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ABSTRACT

Background: Because of its wide array of advantages, MRI has gained popularity in evaluation of the musculoskeletal system. The advantages include non-invasiveness, lack of ionizing radiations, superior soft-tissue imaging and direct multiplanar imaging. Excellent visualization of cartilage, ligaments, tendons and bones can be achieved by the high resolution images of MRI. MRI can provide a comprehensive evaluation of ankle, including soft tissue and bone pathology. The soft tissue contrast resolution of MRI is superior to that of CT, and MRI is as good as or better than CT for most bone pathology. MRI is more sensitive than CT in the detection of stress fractures and trabecular bone injury.[4] **Aim & Objective:** 1.To study the normal anatomy of ankle joint on MRI.2 To assess acute traumatic injury patterns of ankle joint.3.To study the role of MRI in the evaluation of traumatic injuries of ankle joint..4 To study the chronic sequelae of ankle injuries. **Methods:** Cross sectional study **Study setting:** Tertiary care center. Study duration: 2 years (from October 2019 to March 2021). **Study population:** The study population included all the cases with traumatic ankle injury referred to the Dept. of Radiodiagnosis our institute for MRI scan with or without X-ray findings admitted at a tertiary care center such cases were included in the study. **Sample size:** 50 **Results:** Majority of cases found in 20-30 years age group 18(36%) followed by 40-50 group 12 cases (24%), 9 cases in 30-40, 7 cases in >50 and 4 cases in 10-20. Males contributing 34 (68%) and females 16 (32%). Deltoid ligament injuries are observed in 12 patients. However, isolated injuries are not seen. Deltoid ligament injuries are associated with bone, other ligamentous and tendon injuries. Anterior compartment tendon injuries were not observed in this study. 16 patients had a history of acute inversion injury. **Conclusions:** MRI plays an important role for planning further management and to decide whether the patient will require conservative or surgical management. Even though anatomical variants and technical artefacts can mimic a tear on MRI, it is still considered the primary imaging modality for optimal depiction of internal derangement in ankle injury. Common injuries observed in our study are - anterior talo- fibular ligament injury, deltoid ligament injury, tenosynovitis, bone contusions and joint effusion.

KEYWORDS : lateral ligamentous complex injuries, Syndesmotic ligamentous injuries, Inversion injuries

INTRODUCTION:

Normal functioning of the ankle joint is necessary for day to day life activities and in many popular sports. The ankle joint is a hinge joint and is composed of the tibio-talar articulation. Laterally, it is stabilized by the anterior talo-fibular ligament (ATFL) and the calcaneo- fibular ligament (CFL). Deltoid ligament stabilizes the ankle joint medially whereas it is stabilized posteriorly by the strong posterior talo-fibular ligament (PTFL). The anterior talo- fibular ligament (ATFL) lies within the capsular layers but is a distinct structure. The calcaneo-fibular ligament (CFL) crosses both ankle and subtalar joints and lies deep to the peroneal tendons. It is oriented in line with the superior peroneal retinaculum.

The ankle is a complex joint that is capable of a wide range of movement: inversion, eversion, flexion and extension as well as a combination of other movements. All this is necessary for locomotion and to traverse uneven ground. The ankle joint takes the whole body weight. The forces that are exerted on the ankle joint in running and jumping are significant. Lateral inversion sprain is the most common acute ankle injury.

The ankle joint is frequently subjected to injuries. In order to get a better understanding of these lesions, a classification based on the anatomic origin is outlined. The spectrum of injuries is classified as: (1) Osseous lesions, (2) Ligamentous injuries, (3) Tendinous lesion, (4) Miscellaneous injuries [1]

AP, lateral and weight bearing radiographs of the ankle are used to rule out fractures. According to Ottawa ankle rule - ankle radiographs should only be needed if there is pain or tenderness in either malleolus and one of the following-

1) Tenderness of the bone at the tip or posterior edge (within 6 cm) of either the lateral or medial malleolus.
2) Patient unable to bear weight at the time of injury and on arrival to the emergency department. (Weight-bearing is determined by the patient's ability to take four steps).[2]

MRI uses magnetic fields to create an image of the ankle instead of radiations. MRI has clear edge over other diagnostic modalities, such as plain X-ray imaging and Computed Tomography (CT) because of its ability to image soft tissues and fluid within the joint. Magnetic resonance imaging (MRI) has important application in musculoskeletal medicine. It is now widely used by orthopedic surgeons in the diagnosis of bone and soft tissue pathology.[3]

Because of its wide array of advantages, MRI has gained popularity in evaluation of the musculoskeletal system. The advantages include non-invasiveness, lack of ionizing radiations, superior soft-tissue imaging and direct multiplanar imaging. Excellent visualization of cartilage, ligaments, tendons and bones can be achieved by the high resolution images of MRI. MRI can provide a comprehensive evaluation of ankle, including soft tissue and bone pathology. The soft tissue contrast resolution of MRI is superior to that of CT, and MRI is as good as or better than CT for most bone pathology. MRI is more sensitive than CT in the detection of stress fractures and trabecular bone injury.[4]

MRI is playing an increasingly important role in evaluation of the injured ankle and foot. Accurate detection of soft-tissue abnormalities including ligament injury, tendon injury and bony abnormalities such as stress fractures has become

possible due to MRI. The interpreter of magnetic resonance images should systematically view the images, noting normal structures and accounting for changes in soft-tissue and bony signal.[5]

AIMS:

1. To evaluate the role of magnetic resonance imaging in traumatic injuries of ankle joint.

OBJECTIVES:

1. To study the normal anatomy of ankle joint on MRI.
2. To assess acute traumatic injury patterns of ankle joint.
3. To study the role of MRI in the evaluation of traumatic injuries of ankle joint.
4. To study the chronic sequelae of ankle injuries.

MATERIAL AND METHODS

Study design: Cross sectional study.

Study setting: Department of Radiodiagnosis of tertiary care centre.

Study duration: 2 years (from October 2019 to March 2021).

Study population:

The study population included all the cases with traumatic ankle injury referred to the Dept. of Radiodiagnosis our institute for MRI scan with or without X-ray findings admitted at a tertiary care center such cases were included in the study.

Sample size: 50

Inclusion Criteria:

All patients with traumatic ankle injury referred to the Dept. of Radiodiagnosis in our institute for MRI scan with or without X-ray findings will be included in the study.

Exclusion Criteria:

1. Patients who don't consent to be a part of the study.
2. Patients with claustrophobia, metallic implants (contraindicated for MRI), cardiac pacemakers and cochlear implants.

Approval for the study:

Written approval from Institutional Ethics committee was obtained beforehand. Written approval of Radiodiagnosis department and related department was obtained. After obtaining informed verbal consent from all patients with traumatic ankle injury admitted in tertiary care centre such cases were included in the study.

Methods of Data Collection and Questionnaire:

Predesigned and pretested questionnaire was used to record the necessary information. Questionnaires included general information, such as age, sex, residential address, and date of admission. Medical history- chief complain, past history, Data on demographic profile of neck patient, investigation, and personal history, medical past history .The study was approved by institutional ethical committee.

All patients referred to our Department of Radiodiagnosis with traumatic ankle injury fulfilling the inclusion criteria were considered part of the study. First informed consent was taken from patients or their relatives. Then patient was screened for ferromagnetic objects and aneurysm clips etc. Complete clinical history and past history of patient was noted. Emergency drugs like Inj. Hydrocortisone, Adrenaline, Dexamethasone and resuscitation apparatus were kept ready. Patient was positioned supine on scanning table, immobilization of the patient's foot was achieved and the standard extremity coil was applied. Patients were subjected to MRI scanning.

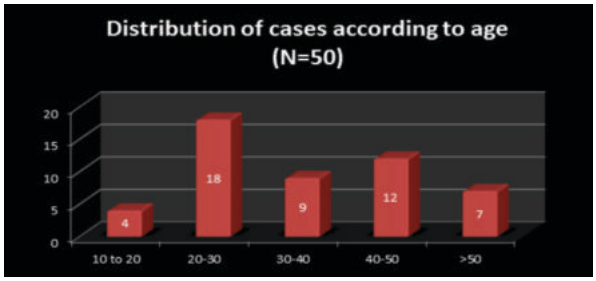
When necessary, adequate sedation was given by the anaesthetist. MRI was assessed for any osseous or soft tissue (ligaments, tendons) injury. Depending on the radiological features a provisional diagnosis was made correlating with the clinical features and history.

RESULTS AND OBSERVATIONS

Table no:1 Distribution of cases according to age

Age in years	No of cases	Percentage
10-20	04	8%
20-30	18	36%
30-40	09	18%
40-50	12	24%
>50	07	14%
Total	50	50 (100%)

The above table shows majority of cases found in 20-30 years age group 18(36%) followed by 40-50 group 12 cases (24%), 9 cases in 30-40, 7cases in >50 and 4 cases in 10-20.

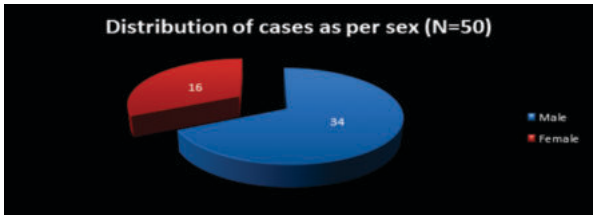


The above figure shows majority of cases found in 20-30 years age group 18(36%) followed by 40-50 group 12 cases (24%), 9 cases in 30-40, 7cases in >50 and 4 cases in 10-20.

Table No. 2: Distribution of cases as per sex (N=50)

Gender	Frequency	Percentage
Male	34	68%
Female	16	32%
Total	50	50 (100%)

Above table shows that majority of study cases were Males contributing 34 (68%) and females 16 (32%)



Above figure shows that majority of study cases were Males contributing 34 (68%) and females 16 (32%)

Table no: 3 Injuries associated with lateral ligamentous complex injuries.

Associated injuries	Bones			Ligament tears	Tendon injuries
	Talus	Tibia	Fibula		
No. of patients	Marrow oedema - 9	Marrow oedema -4	Marrow oedema - 11	Deltoid ligament - 9	TP-6
					FHL-4
	Marrow oedema Fracture - 1	Marrow oedema Fracture - 5	Marrow oedema Fracture – 6	Syndesmotic ligaments a. AITFL-8 b. PITFL-1 c. Interosseous ligament 1	PL -2 PB-3 Achilles tendon-1

The above table shows Deltoid ligament injuries are observed in 12 patients. However, isolated injuries are not seen. Deltoid ligament injuries are associated with bone, other ligamentous and tendon injuries.

Table no:4 Injuries associated with deltoid ligament injuries

Associated injuries	Bones			Ligament tears	Tendon injuries
No. of patients	Talus	Tibia	Fibula		
	Marrow oedema - 8	Marrow oedema - 7	Marrow oedema - 2	a. ATFL- 2	TP-6
				b. ATFL+ CFL- 5	FHL-3
	Marrow oedema + Fracture - 1	Marrow oedema+ Fracture - 5	Marrow oedema + Fracture – 3	c. ATFL+ CFL+ PTFL- 2 d.Syndesmotic ligaments- 5	PL -0
					PB-0
					Achilles tendon-1

Table no:5 Injuries associated with those of syndesmotic ligaments

Associated injuries	Bones			Ligament tears	Tendon injuries
No. patients of	Talus	Tibia	Fibula		
	Marrow oedema – 3	Marrow oedema – 0	Marrow oedema – 3	Deltoid ligament – 5	TP-4
					FHL-2
	Marrow oedema +Fracture-0	Marrow oedema +Fracture – 3	Marrow oedema +Fracture – 2	ATFL-8	
				PTFL-1	PL-0
				CFL-6	PB-1

Table no: 6 Tendon Injuries

COMPARTMENTS	TENDONS	NO. OF PATIENTS
Anterior	Tibialis Anterior	0
	Extensor halluces longus	0
	Extensor digitorum longus	0
	Peroneus tertius	0
Lateral	Peroneus longus	2
	Peroneus brevis	3
Posterior	Tibialis Posterior	7
	Flexor hallucis longus	6
	Flexor digitorum longus	0
	Achilles	4

The above table shows Anterior compartment tendon injuries were not observed in this study

Table no:7 Ankle injuries in Inversion injuries.

Associated injuries	Bones			Ligament tears	Tendon injuries
	Talus	Tibia	Fibula		
No. of patients	Marrow oedema - 6	Marrow oedema - 3	Marrow oedema - 5	Deltoid ligament – 3	TP-2
					FHL-1
				Syndesmotic	PL-0
				ligaments – 1	
				ATFL -15 PTFL-1 CFL-8	PB-1
	Marrow oedema Fracture - 0	Marrow oedema+ Fracture-0	Marrow oedema+ Fracture-4		

The above table shows 16 patients had a history of acute inversion injury.

DISCUSSION:

MRI is the diagnostic modality of choice for optimal detection of soft-tissue disorders of the ligaments, tendons and other soft tissue structures of the ankle. This modality is also valuable in the early detection and assessment of a variety of bony abnormalities seen in this anatomic location.[6]

The study was carried out in 50 patients presenting with a history of trauma to the ankle which were referred from the Orthopaedics department in our hospital. Most common mechanism of injury reported in the patients was an acute inversion of the ankle following which there was swelling, pain and sensation of giving way. Four patients were involved in road traffic accidents with gross swelling and disfiguration at the ankle.

In this study, we evaluated the 50 cases to determine the prevalence of bone, ligament and tendon injuries in Ankle trauma and their associations. We observed a male preponderance for ankle injuries (68 % compared to 32 % in females). The 20-30 year age group constituted the dominant age group in our study (36 %), followed by the 40-50 year age group (24 %).

Out of 50 patients, the most commonly injured ligaments were the lateral ligamentous group ligaments, being injured in 32 patients (64 %) and followed by injury to the deltoid ligament, being injured in 12 patients (24 %). The most common ligament sprained in trauma to the ankle was in agreement with Rosenberg et al. 2000 and Sonin et al. 2010 who observed that lateral ankle sprains represented 21% of all sports-related traumatic injuries and also found that 85% of ankle sprains occur laterally. [7] Lateral ankle sprain is one of the most common athletic injury. The lateral ankle sprains have been reported to represent up to 45% of basketball injuries and 31% of soccer injuries [8]. In addition, it has been reported that 17% to 25% of sports injury time-loss was directly related to ankle sprains [8] Most (up to 85%) sprains were caused by inversion forces during plantar flexion with damage to the lateral ligaments.[8] Also, our prevalence of deltoid sprains in patients with ankle trauma was in agreement with Sonin et al 2010, who observed that deltoid ligament sprain represented 10 to 15% of all ankle sprains and were less frequent than lateral injury. Of the lateral ligamentous complex tears (32), isolated tears of Calcaneo-fibular ligament and isolated tears of Posterior talo-fibular ligament were never observed in our study.

Most common isolated lateral ligamental tear in our study was

that of Anterior talo- fibular ligament, seen in 15 out of the 32 patients with lateral ligamentous complex injuries (46 %). Anterior talo-fibular and calcaneo-fibular ligaments were also commonly injured in unison in our study population, being injured in 15 out of the 32 patients with lateral collateral ligament tears (46 %).

This is in conjunction with Mark H. Awh et al. 2001 who stated that the lateral ligamentous complex of the ankle consists of the anterior talofibular ligament, the calcaneo-fibular ligament and the posterior talofibular ligament. The anterior talofibular ligament is the most commonly torn ligament of the lateral complex and is consistently visible on axial images of MRI. The calcaneofibular ligament, usually well visualized on coronal MR images, is often injured in association with anterior talofibular ligament tears. [9]

Anterior talo-fibular ligament was the most common ligamental injury in our entire study population (64 %). Out of 32 cases of Lateral ligamentous complex injuries, most commonly associated injuries were marrow contusions of Fibula, seen in 11 patients (34 %), with most common associated lower fibula (including lateral malleolus) fractures, seen in 6 patients out of 32 having lateral ligamental tears (19%).Of the ligamentous injuries, syndesmotic ligamentous injuries were also commonly associated with those of lateral ligamentous injuries, observed in 8 out of 32 patients with lateral ligamentous complex tears (25 %). Posterior compartments tendons were seen to be more commonly injured in patients with lateral ligamentous complex injuries (25 %) than lateral compartments tendons (9%). Deltoid ligament injuries were found in 12 out of 50 patients (24 %), with no case of complete tear of the ligament.

However, deltoid injuries were always associated with a concomitant injury to either the articulating bones, other ligaments, muscle tendons or their combination in various forms. Of the associated bone injuries the most common were bone contusions of talus and lower tibia (including medial malleolus), being seen in 8 (67 %) and 7 (58 %) out of 11 patients, respectively. The most common fracture associated with deltoid injury was that of the tibia (including medial malleolus), seen in 5 patients out of 12 patients having deltoid ligament injury (42 %). All these patients had injury of the deep portion (tibio-talar ligament) of the Deltoid ligament.

The most common ligamentous injury associated with that of deltoid ligament were the combined tears of anterior talo-fibular ligament and the calcaneo-fibular ligament and also the tears of syndesmotic ligaments, seen in 5 patients each having deltoid injury (42%).

Our findings were in agreement with Min Sung Jeong et al 2014 who observed that the common associated injuries were ankle fracture (63.9 %), syndesmosis tear (55.6%), and lateral collateral ligament complex tear (44.4 %) [10]. The observed injury pattern of the deltoid ligament was complex and associated with concomitant ankle pathology.

Deltoid ligament consists of tibio-talar (deep), tibio-spring, tibio-navicular and tibio- calcaneal (superficial) components. In our study, complete tear of deltoid ligament was not observed in any patient with a history of trauma to the ankle. However, sprains (increased intra-ligamentous intensity) were found in 12 patients.

The most frequently injured was the tibio-talar (deep) component, seen in 7 out of 12 patients with deltoid ligament injury (58 %), followed by tears of tibio-spring ligament, seen in 3 patients (25 %). Tibio-calcaneal component injuries were seen in 2 patients (17%).

This was in conjunction with Avneesh Chhabra et al 2010 who found that deep deltoid ligament injuries (Tibio-talar component) were more frequent than injuries of other components of the ligament. [11]Of the tibio-fibular syndesmotic ligamentous Injuries, Antero-inferior tibio-fibular ligament was the most common ligament torn in isolation, seen in 6 out of 8 patients (75%) with syndesmotic ligament tears.

Postero-inferior tibio-fibular ligament and Interosseous ligament were never injured in isolation in our study. They were always associated with a sprain of Anteroinferior tibio-fibular ligament. Antero-inferior tibio-fibular ligament and Interosseous ligament were sprained in unison in 1 out of 8 patients (13 %). Antero-inferior tibio-fibular ligament and postero-inferior tibio-fibular ligament were also injured together in 1 out of 8 patients (13%).

The prevalence of syndesmotic injuries (16 %) was in agreement with the literature prevalence of 1-18%.[12] In our study, isolated tears of tibio-fibular syndesmotic ligaments without any other bone, ligament or tendon injury were not seen. Associated injuries were always seen in all 8 patients. Of the associated bone injuries, lower tibial (including medial malleolus) fractures were most frequently associated, seen in 5 out of the 8 patients having syndesmotic ligamental injury (63%). Of the associated ligamental injuries, sprains of lateral ligamentous complex were most commonly seen, especially of anterior talo-fibular ligament which was injured in all 8 patients with syndesmotic ligamental injuries (100 %). Tibialis posterior was the tendon most commonly injured with syndesmotic ligaments, seen in 4 patients (50 %).

Kevin Brown et al 2004 observed that in patients having syndesmotic injuries, Anterior talofibular ligament injury (acute or chronic) was seen on MRI in 74% (44). Bone bruises were seen in 24%. Of these, talar dome osteochondral lesions were seen in 28%. The tibiofibular joint was incongruent in 33%. Osteoarthritis was present in 10%.

Tendon injuries were mostly observed in our study as collections in tendon sheaths in periarticular locations (tenosynovitis). The most common tendon to be affected was the tendon of tibialis posterior, being injured in 7 patients (14 %).

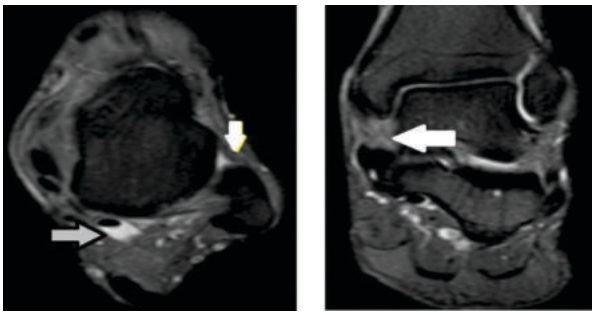
Partial tear of Tibialis posterior tendon was observed in 1 patient (Type I). Complete tear with tendon discontinuity was not seen in any patient. Anterior compartment tendons were also not injured in any patient in our study.

In our study population, Achilles tendon tears were observed in 4 patients (8 %). Out of the 4 tears, complete tear with retraction was seen in 1 patient whereas remaining 3 were partial tears. All the 3 Achilles tendon partial tears were located just above its insertion into calcaneum (approx. 4 cm above insertion).

This finding was consistent with Bencardino et al 1999 who stated that degeneration of the tendon characteristically occur 2 cm to 6 cm proximal to the calcaneal insertion, this has been related to both relative ischemia in the portion of the tendon because of watershed phenomenon and an intrinsic weakness in the tendon at this location as the fibres of the gastrocnemius and soleus tendon internally forming the common tendon. [13] In our study, 16 patients gave a history of a single episode of Ankle inversion,

following which they had swelling, pain and tenderness mainly on the lateral aspect. Majority of those patients were young male patients. We found that the ligaments most commonly injured in inversion injuries were those of the lateral ligamentous complex, with the Anterior talo-fibular sprained

in 15 out of 16 patients with inversion injury (94 %). The calcaneofibular ligament was sprained in 8 patients, not in isolation, but in unison with sprain of Anterior talo-fibular ligament (50 %). The Posterior talo-fibular ligament was sprained in 1 patient, in unison with the Anterior talo-fibular ligament and the calcaneofibular ligament. The syndesmotic ligaments was sprained in 1 patient (6 %).The deltoid ligament (especially the tibio-talar component) was sprained in 3 patients (19 %). Here our finding was in conjunction with Tochigi et al. 1998 who observed that anterior talofibular ligament was torn in 23 patients, calcaneo-fibular ligament lesion in 15 patients, posterior talofibular ligament lesion in 11 patients, interosseous talocalcaneal ligament injury in 13, cervical ligament lesion in 12, and deltoid ligament injury in 8 in 24 patients with Acute inversion injuries [14]. Our findings were also in conjunction with Ahmad MA et al 1998 who observed that in 24 patients having suffered an acute inversion injury, MRI showed ligament abnormalities in 16 patients, 10 of these were isolated ATFL tears, 5 had combined ATFL and CFL tears and 1 case showed in addition abnormal signal in the PTFL. MRI revealed associated injuries to other ligaments, soft tissue and osseous structures of the ankle in twelve patients. [15]



A B

A Sprain Involving Anterior Talofibular Ligament With Tenosynovitis Of Flexor Hallucis Longus Tendon –
Axial PDFS image showing fluid along FHL tendon s/o tenosynovitis (grey arrow) and hyperintense signal in ATFL s/o sprain (white arrow)

B- Partial Tear Of Tibiotalar Component Of Deltoid Ligament-
Coronal PDFS image showing bulky tibiotalar component (white arrow) of deltoid ligament with hyperintense signal within and loss of few fibres s/o partial tear.

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