

Role of MRI in Evaluation of Traumatic Ankle Injuries

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ABSTRACT

Background: MR imaging has become the diagnostic modality of choice for the evaluation of traumatic ligamentous, tendinous injuries of the ankle and occult bony trauma. This article reviews the current applications of MR imaging for the evaluation of most of these lesions. Ankle sprains are considered the most common lower limb injuries (incidence between 5 - 7 per 1000 persons/year in Europe), affecting more frequently young athletes; the most common mechanism of injury is represented by inversion of the foot (less frequently eversion).

Aim of the Work: The aim of the current study is to emphasize the value of Magnetic Resonance Imaging (MRI) in evaluation of patients with ankle pain caused by traumatic injury.

Patients and Methods: A descriptive study, conducted from March 2017 till June 2017. Sixty patients underwent MRI examination (patients with traumatic ankle pain) during this period. Twenty patients have normal MRI examination and not included in the study while forty patients have positive MRI findings. All patients were performed MRI in radiology department, Ain Shams University Hospital. The examination carried out after signing the informed consent by the patient himself or his guardian if the patient is incapacitated by any means.

Results: According to the data collected from our study, we have 70 pathologies diagnosed by MRI after traumatic ankle injuries.

- 17 (24.3%) of them were ligamentous injuries.
- 16 (22.9%) were tendon injuries.
- 14 (20%) were bone injuries [3 (21.43%) of them were fractures and 5 (35.71%) of them were osteochondral lesions and 6 (42.86%) of them were Bone contusions].
- 23 (32.8%) from the seventy pathology have joint effusion.

Conclusion: 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.

Keywords: MRI, Traumatic Ankle Injuries.

INTRODUCTION

Magnetic resonance imaging (MRI) has become the diagnostic modality of choice for the evaluation of traumatic ligamentous, tendinous injuries of the ankle and occult bony trauma. This article reviews the current applications of MR imaging for the evaluation of most of these lesions ⁽¹⁾.

Since, 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 ⁽²⁾.

Ankle injuries can happen to anyone at any age. 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. Half of all ankle sprains occur during an athletic activity. Every

day in the U.S., 25,000 people sprain their ankle. And more than 1 million people visit emergency rooms each year because of ankle injuries. The most common ankle injuries are sprains and fractures, which involve ligaments and bones in the ankle. But you can also tear or strain a tendon ⁽³⁾.

Ankle sprains are considered the most common lower limb injuries (incidence between 5 - 7 per 1000 persons/year in Europe), affecting more frequently young athletes; the most common mechanism of injury is represented by inversion of the foot (less frequently eversion) ⁽⁵⁾.

MRI is particularly suited for evaluation of the complex bone and soft tissue anatomy of the foot and ankle because of its superior soft tissue contrast and the ability to image in multiple planes. In addition new fast

scan techniques provide improved efficiency and allow dynamic studies to be performed. MR Arthrography technique has improved significantly in recent years resulting in more routine use of this technique ⁽⁶⁾.

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 but more specific than other radiological modality ⁽⁷⁾.

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 ⁽³⁾.

AIM OF THE WORK

The aim of the current study is to emphasize the value of Magnetic Resonance Imaging (MRI) in evaluation of patients with ankle pain caused by traumatic injury.

PATIENTS AND METHODS

Patients

A descriptive study, conducted from March 2017 till June 2017. Sixty patients underwent MRI examination (patients with traumatic ankle pain) during this period. Twenty patients have normal MRI examination and not included in the study while forty patients have positive MRI findings. All patients were performed MRI in radiology department, Ain Shams University Hospital. The examination carried out after signing the informed consent by the patient himself or his guardian if the patient is incapacitated by any means.

Inclusion criteria:

- Any patient with ankle pain following traumatic insult, with no age or sex predilection.

Exclusion criteria:

- 1) Any patient with a history of non-traumatic ankle pain which includes: osteoarthritis and rheumatoid arthritis.
- 2) Patients who had surgeries to the ankle joint.
- 3) Patients with metabolic diseases.
- 4) Ankle Joint tumors.
- 5) Any electrically, magnetically or mechanically activated implants: cardiac pacemakers, cochlear implants and hearing aids, intracranial aneurysmal clips (unless made of Titanium), Ferromagnetic surgical clips or staples,

Metallic foreign body in the eye and metal shrapnel or bullet.

History

All patients were subjected to full history taking involving:

Age, sex, special habits (smoking or alcohol intake), dietary habits as well as drugs.

- Related risk factors such as systemic diseases, trauma and familial diseases.
- Patient complaint such as ankle pain, swelling, instability.
- Previous surgeries.
- Previous treatment.

MRI Examination:

- MRI was performed using Philips Achieva device (1.5 T).

Patient position and coils:

- Imaging was done with the foot at right angles to the lower leg with the patient in a supine position. A standard extremity coil generally was employed for the ankle and if it was not available, the knee coil was used.

Scanning protocol:

- 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.
- Ankle MRI protocol took **45 to 60 minutes**.
- **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.

Planes:

- 1- The straight sagittal plane was our survey plane and usually the first plane acquired in all ankle MRI protocols.
- 2- At least two axial orientations were typically used, straight axial slices and oblique axial slices.

- 3- At least three ways to orient slices in the coronal plane, least commonly used was the straight coronal plane, oblique coronal slices were used much more often than straight coronal slices and the third one was mortise coronal slices.
- 4- Lastly, mortise sagittal slices which was the survey plane we used for osteochondral lesions of the talus.

Sequences:

- 1- Fat suppressed fast-pin echo T2-weighted sequence or an inversion recovery sequence (edema-sensitive sequences) in all the planes.
- 2- T1-weighted images in all imaging planes whenever the tendons were not the primary site of interest.
- 3- When the tendons were the site of clinical concern, proton-density-weighted images were used, along with T2-weighted sequences, in the straight axial and oblique coronal planes.

They were read side-by-side with edema sensitive images to look for abnormal amounts of fluid in the tendon sheaths.

Protocol of MRI ankle:

- Axial T1W / TSE
- Axial T2W / TSE
- Axial - STIR / TSE
- Sagittal T2W / TSE
- Sagittal STIR / TSE
- Coronal T1W / TSE
- Coronal T2W / TSE
- Coronal STIR / TSE

The study was approved by the Ethics Board of Ain Shams University.

Data Analysis:

All images were interpreted on the computer workstation by two expert radiologists blinded to the patient's history and the diagnosis was established, then statistical analysis were done using statistical Program for Social Science (SPSS) version 20.0. Quantitative data were expressed as mean± standard deviation (SD). Qualitative data were expressed as frequency and percentage.

The following tests were done:

- Chi-square (χ^2) test of significance was used in order to compare proportions between two qualitative parameters.

- The confidence interval was set to 95% and the margin of error accepted was set to 5%. So, the p-value was considered significant as the following:

□ Probability (P-value)

- P-value ≤ 0.05 was considered significant.
- P-value ≤ 0.001 was considered as highly significant.
- P-value > 0.05 was considered insignificant.

The study was approved by the Ethics Board of Ain Shams University.

RESULTS

The study included 40 patients (12 females and 28 males) ranged in age between 12 and 60 years with mean age 12-60 [Mean± SD: 28.98±12.44], 60% of the patients were < 30 years and 40% of them were ≥ 30 years (Table 1).

Table (1): Age distribution of the study group

Age (years)	No.	%
<30 years	24	60
≥ 30 years	16	40
Total	40	100
Range [Mean± SD]	12-60 [28.98±12.44]	

In our study, we had 22 cases (55%) presented with acute ankle pain and 18 cases (45%) presented with chronic ankle pain (Fig 1).

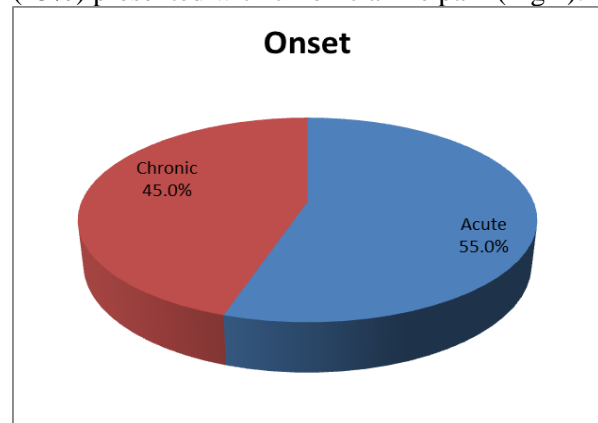


Fig. (1): Pie chart representing distribution of the onset of ankle pain in the study group.

Seventeen out of included 40 patients had ligament injuries, 15 patients had ATFL injuries while 2 patients had Deltoid ligament injury.

From the 17 patients with ligaments injuries, 7 patients (42.2%) had ligament sprain, 4 patients 23.5% had partial ligament tear and 6 patients (35.3%) present with complete tear (Fig 2).

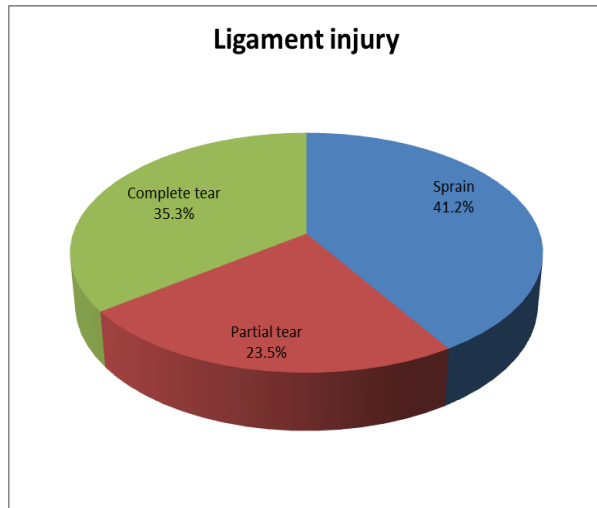


Fig. (2): Types of ligament's injuries diagnosed by MRI.

From the 40 patients included in our study, 16 patients had tendon injuries.

Eight patients (50%) of them had tenosynovitis, 3 patients (18.8%) had partial tear and 5 patients (31.3%) had complete tear (Fig 3).

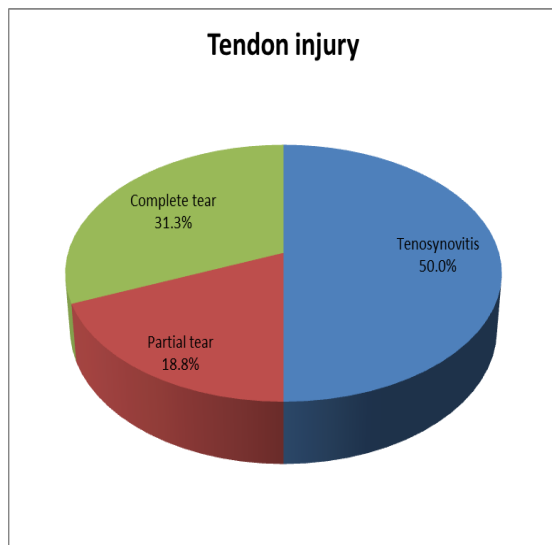


Fig. (3): Types of tendon injuries diagnosed by MRI.

From the included 40 patients, 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 (Fig 4).

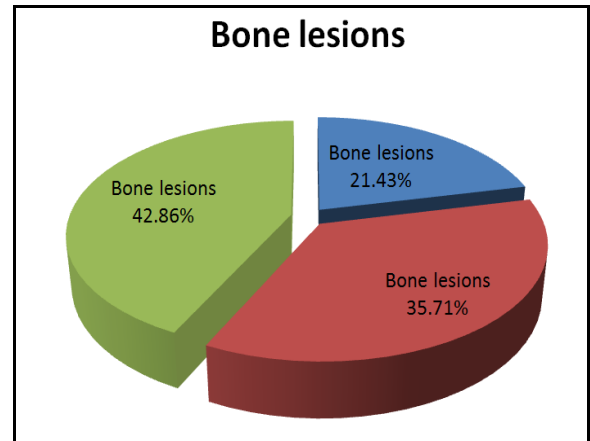


Fig. (4): Bone injuries diagnosed by MRI. From the 40 patients included in the study, 23 patients (32.8%) had joint effusion (Fig 5).

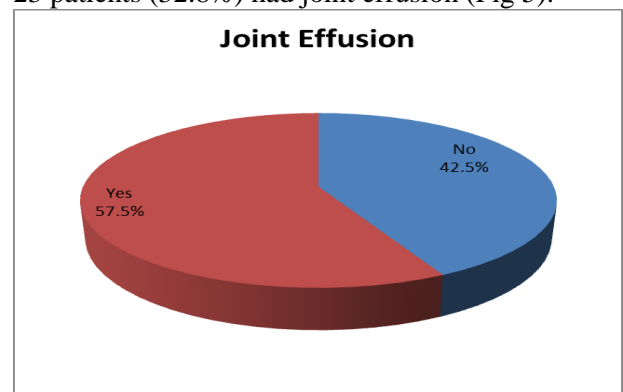


Fig. (5): Pie chart representing joint effusion distribution of the study group.

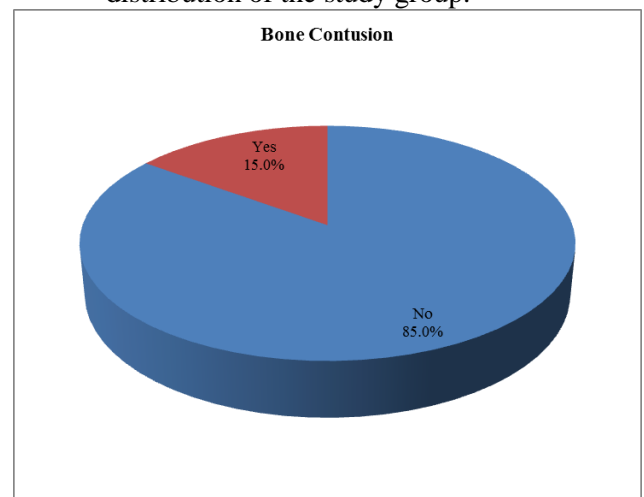


Fig. (6): Pie chart representing bone contusion distribution of the study group.

According to the data collected from our study , we had 70 pathologies diagnosed by MRI after traumatic ankle injuries, 17 (24.3%) of them were ligamentous injuries, 16 (22.9%) were tendon injuries, 14 (20%) were bone injuries [3 (21.43%) of them were fractures and 5 (35.71%) of them were osteochondral lesions and 6 (42.86%) of them

were bone contusion], and finally we had 23 (32.8%) from the seventy pathology had joint effusion (Fig 6).

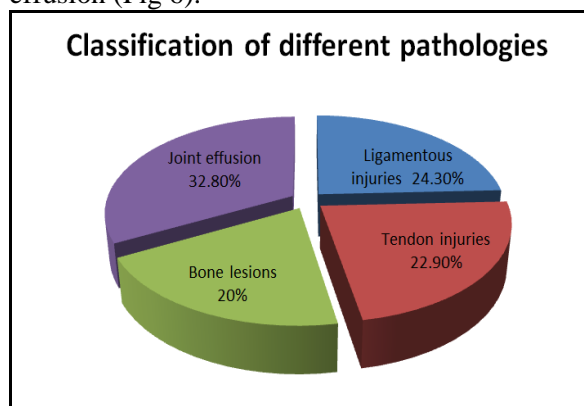


Fig. (7): Classification of different diagnoses seen on MRI after ankle trauma.

The different MRI findings seen in our patients included: (32.8%) joint effusion, (21.4%) ATFL injuries, (11.4%) Achilles tendon injuries, (11.4%) tenosynovitis, (8.6 %) bone contusion, (7.1%) osteochondral lesions, (4.3%) fractures finally (2.9%) patients had deltoid injuries (Fig 7).

Regarding the relation between the age and MRI findings among the study group, the ATFL injuries, tenosynovitis, joint effusion, bone contusions and fractures were found more in patients below 30 years. Achilles tendon and deltoid ligament injuries were equally found below and above 30 years, while osteochondral lesions were found more in patients above the 30 years (Tab 2).

Table (2): Relation between age (years) and MRI findings of the study group.

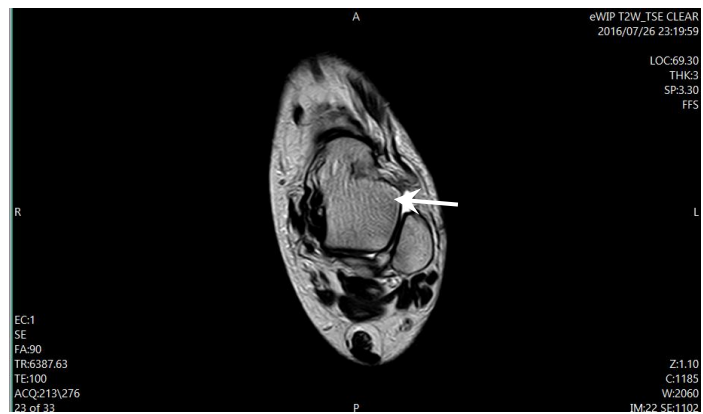
Findings	Age (years)				Chi-square test	
	<30 years(N=24)		≥30 years(N=16)			
	No.	%	No.	%	X ²	p-value
ATFL	10	41.7%	5	31.3%	0.444	0.505
Achilles	4	16.7%	4	25.0%	0.417	0.519
Deltoid	1	4.2%	1	6.3%	0.088	0.767
Tenosynovitis	5	20.8%	3	18.8%	0.026	0.872
Fracture	2	8.3%	1	6.3%	0.060	0.806
Joint Effusion	16	66.7%	7	43.8%	2.063	0.151
Osteochondral lesion	2	8.3%	3	18.8%	0.952	0.329
Bone Contusion	4	16.7%	2	12.5%	0.485	0.522

Finally we can show the relation between the onset and MRI findings among the study group, ATFL, bone contusion, tenosynovitis have no statistical significant, joint effusion were more in acute onset than that in chronic, the fracture only seen in acute cases, Achilles tendon and deltoid ligament injuries were equally in acute and chronic, while the osteochondral lesions were only found in chronic cases (Tab 3).

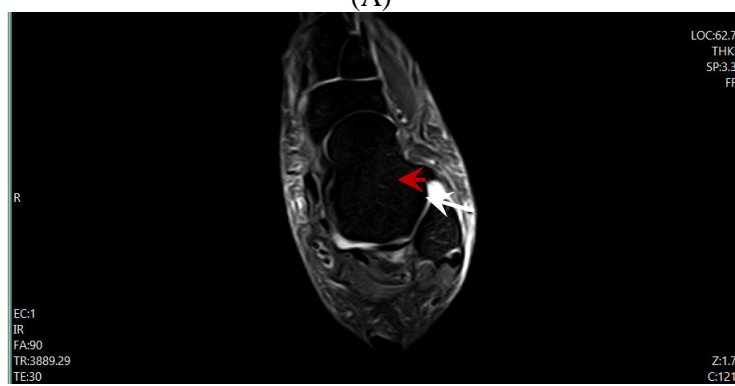
Table (3): Relation between onset and MRI findings of the study group.

Findings	Onset				Chi-square test	
	Acute		Chronic			
	No.	%	No.	%	X ²	p-value
ATFL	9	40.9%	6	33.3%	0.242	0.622
Achilles	4	18.2%	4	22.2%	0.101	0.751
Deltoid	1	4.5%	1	5.6%	0.021	0.884
Tenosynovitis	5	22.7%	3	16.7%	0.227	0.634
Fracture	3	13.6%	0	0.0%	2.654	0.103
Joint Effusion	15	68.2%	8	44.4%	2.283	0.131
Osteochondral lesion	0	0.0%	5	27.8%	6.984	0.008
Bone Contusion	4	18.2%	2	14.7%	0.016	0.900

CASE 1: 57 years old male patient with left ankle pain, he had history of trauma 2 years ago.



(A)

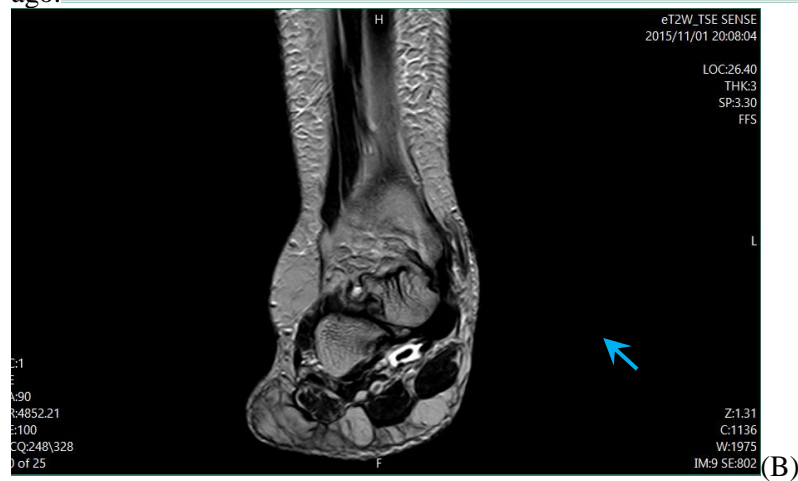


(B)

MRI manifestation: (A) axial T2WI ankle MR image shows absent ATFL with fluid collection (arrow red) denoting it is complete tear. (B) axial STIR image demonstrates the same finding with retracted torn ATFL anteriorly (arrow) denoting complete tear.

Diagnosis: ATFL complete tear.

CASE 2: 62 years old female patient presented with ankle pain following trauma 3 days



MRI Manifestation: (A&B) Sagittal and Coronal T2WI showing fluid collection along the FHL tendon distal to posterior talar process consistent with tenosynovitis.

Diagnosis: Tenosynovitis around FHL tendon.

CASE 3:

10 years old male patient, presented with medial left ankle pain and past history of eversion ankle sprain.





MRI manifestation: (A&B) Coronal: T1 & T2 weighted images showing fracture line passing directly through the metaphysis, growth plate and down through the epiphysis of the distal tibia with mild bony displacement and minimal joint effusion.

Diagnosis:

- Lower Tibial Salter Harris fracture (type IV).

DISCUSSION

Because the ankle bears the majority of the body's weight when standing, walking, and running, a variety of traumatic pathologies are seen ⁽⁸⁾. MRI has the unique capability to evaluate osseous, ligamentous, tendinous, and muscular injuries about the ankle, in a single imaging study. MRI also allows for characterization of injury based on known biomechanical patterns ⁽⁹⁾.

This study included forty cases with ankle pain post trauma to evaluate the role of MRI in assessment of different injuries of the ankle joint especially those related to ankle tendons and ligaments ⁽¹⁰⁾.

MRI is the current standard imaging modality for the diagnosis of ankle problems. When in-homogeneity of the tendon is visualized on MRI scans, it could be due to tendinitis, a partial tear, degeneration, or another tendinopathy and all these entities fall into a spectrum of disorders, and determining when one ends and another begins is difficult, so all of these entities should be considered in the differential diagnosis. While applying their classification, Rosenberg et al found MRI for diagnosing ruptures of the tendons to be sensitive in (95%) of cases and specific in (100%). MRI has (96%) accuracy in detecting tendon rupture ⁽¹¹⁾.

Sixteen tendon injuries were diagnosed in this study which represented about (22.9%) of the total ankle injuries. 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 ⁽¹⁰⁾.

In our study only eight cases were diagnosed as Achilles tendon injuries.

Of all the tendons of the ankle, the Achilles is the only one for which disorders have a male predominance. Complete ruptures of the Achilles tendon occur typically at one of two locations. One site is low, 3 to 5 cm just proximal to the calcaneal insertion; this is a relatively hypovascular watershed region. The second site is relatively high, up at the musculotendinous junction ⁽¹²⁾.

In our study, we had the same result with male predominance, while we found all cases at low location.

Of the three medial tendons of the ankle, the posterior tibial is the most prone to tear, characteristically along the portion that curves around the medial malleolus ⁽¹²⁾.

In our study, no any case of posterior tibial tendon injury was diagnosed by MRI.

Of the remaining medial ankle tendons, the flexor digitorum longus tendon is rarely affected by traumatic insults. Traumatic injuries of flexor hallucis longus tendon has been reported more frequently than the flexor digitorum longus ⁽¹²⁾. Our study also included no cases of FDL injuries while we found Eight cases of FHL tenosynovitis which were diagnosed by MRI.

The anterior ankle tendons are occasionally affected in comparison with the other ankle tendons ⁽¹²⁾.

Our study did not include any case of anterior tendons injuries.

Helms *et al.* ⁽¹³⁾ stated that the anterior talofibular ligament is the most commonly torn ligament of the ankle. It is often an isolated tear, but if the traumatic forces are great enough, the other ligaments may tear in a sequential fashion. That is, after the anterior talofibular ligament tears, the calcaneofibular ligament tears, followed, only rarely, by the posterior talofibular ligament. In our study seventeen ligamentous injuries were diagnosed which representing (24.3%) of the encountered total ankle joint injuries. Anterior talofibular ligament was the most frequently injured ligament representing (37.5%) of the whole ligamentous injuries followed by Deltoid ligament (5%). This coincides with different literatures evaluating ankle ligaments.

Twenty-three cases with joint effusion were diagnosed in the present study, which representing (32.8%) of the different encountered joint abnormalities. Our results coincided with those of **Jacobson *et al.*** ⁽¹⁴⁾ 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.

MRI generally is used to diagnose fractures only when conventional radiographs are normal or inconclusive. The ability of MRI to show fractures is exquisite and is particularly useful for Talar dome Osteochondral fractures and stress and insufficiency fractures throughout the ankle. Any soft tissue abnormalities also are evident ⁽¹³⁾.

In our study, MRI could diagnose Five cases of osteochondral lesions of the talus in different grades as well as one case of tibial Salter Harris fracture, one case of fibular fracture and lastly one case of Calcaneal fissure fracture representing (20%) of the encountered total ankle injuries.

CONCLUSION

We can conclude that MRI is modality of choice in evaluating ankle injuries due to its high soft tissue contrast resolution, and multi-planar capabilities.

It provides a non-invasive tool for the diagnosis of Ankle injuries, which are often

difficult to diagnose with alternative modalities. MRI is particularly advantageous for assessing soft tissue structures around the ankle such as tendons, ligaments, nerves, and fascia and for detecting occult bone injuries.

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