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Assessment of Ankle Pain Caused by Different Musculoskeletal Disorders. A Comparative Study between Ultrasonography and Magnetic Resonance Imaging

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Abstract

Ankle pain is a common complaint in orthopedic practice. Various imaging techniques are available for assessment of ankle joint abnormalities. However, many ankle injuries were undiagnosed by conventional radiology and needs further evaluation to diagnose ligamentous, tendinous and muscle injuries as well as osseous lesions as stress fractures, osteochondral lesions, and avascular necrosis.

The aim of this study was to compare the diagnostic accuracy of both ultrasonography (US) and magnetic resonance imaging (MRI) for the assessment of pain around the ankle in different musculoskeletal disorders.

Ultrasonography and MRI are two complementary tools of investigation with the former being used as primary tool of investigation and the latter is done to confirm the diagnosis and the extent of the lesion especially when surgical interference is planned.

Keywords: *Ankle pain, Musculoskeletal disorders, Ultrasonography, MRI.*

Introduction

The ankle is a “hinged” joint capable of moving the foot in two primary directions: away from the body (plantar flexion) and toward the body (dorsiflexion). It is formed by the meeting of three bones. The end of both the tibia and the fibula meet the talus, to form the ankle. The end of the tibia forms the medial portion of the ankle, while the end of the fibula forms the lateral portion of the ankle. The hard bony knobs on each side of the ankle are called the malleoli. These provide stability to the ankle joints, which function as weight-bearing joints for the body during standing and walking ***(1)***.

Ligaments on each side of the ankle provide stability by tightly strapping the outside of the ankle (lateral malleolus) with the lateral collateral ligaments and the inner portion of the ankle (medial malleolus) with the medial collateral ligaments. The ankle joint is surrounded by a fibrous joint capsule. The tendons attach the muscles of the leg to the foot wrap around the ankle both from the front and behind. A large tendon (Achilles tendon) passes behind the ankle and attaches at the back of the heel. The posterior tibial tendon passes behind the medial malleolus. The peroneal tendon passes behind the lateral malleolus to attach into the foot ***(2).***

The normal ankle joint is capable of moving the foot from the neutral right-angle position to approximately 45 degrees of plantar flexion and to approximately 20 degrees of dorsiflexion. The powerful muscles that move the ankle are located in the front and back portions of the leg. ***(1).***

Ankle pain is usually due to an ankle sprain but can also be caused by ankle instability, arthritis, gout, tendonitis, fracture, nerve compression, infection and poor structural alignment of the leg and/or the foot.

Ankle pain may be associated with swelling, stiffness, redness, and warmth of the involved area. The pain is usually described as an intense dull aching that occurs upon weight bearing and ankle motion ***(3), (4), (5).***

Imaging tests can reveal damage to the tendons. X-ray produces images of hard tissues. Ultrasonography (US) can reveal signs of inflammation and damage to the Achilles tendon. Magnetic resonance imaging (MRI) can help to show details about tissue degeneration and tendon ruptures ***(6).***

During the process of the diagnosis of musculoskeletal disorders, there are several applications where both US and MRI may be considered good alternatives. And since that there are advantages and disadvantages to each imaging method, of it is unclear which should be considered for a specific indication ***(7).***

Musculoskeletal ultrasound (MSKUS) is a dynamic, non-invasive procedure that allows high-resolution, real-time evaluation of musculoskeletal disorders. MSKUS is considered as a unique modality that is highly operator-dependent, patient friendly and cost-effective. It has been traditionally seen as a complement to MRI and has gained recognition as a powerful diagnostic tool. The literature indicates that MSKUS is now equivalent to MRI in diagnosing and evaluating many musculoskeletal disorders ***(8).***

Many studies have demonstrated the increased sensitivity of MSKUS in the detection of bony erosions at numerous anatomical sites, including the hands, wrists, feet and shoulders in patients with RA ***(9), (10), (11), (12).***

MSKUS facilitates identification, localization and differentiation between synovial, tendinous and entheseal inflammation ***(13)*** , as well as joint, bursal and soft tissue fluid collection ***(14), (15).***

Aim of Work

The aim of this study was to compare the diagnostic accuracy of both ultrasonography and magnetic resonance imaging for the assessment of pain around the ankle in musculoskeletal disorders.

Patients and Methods

This study included fifty patients complaining of unilateral ankle pain, referred to radiology department of Cairo University Hospitals. They included 35 females and 15 males. Their ages ranged between 18-60 years.

All patients were subjected to:

- History taking.
- Clinical examination of the affected ankle.
- Real time high resolution ultrasonography of both ankles.
- MRI of the affected ankle.
- Plain X-ray of one or both ankles.

History Taking

Personal History

Included: age, sex, and occupation.

Present History

Included:

- Analysis of patient complaint (ankle pain): site, onset, course, duration, and the relationship to posture.
- Associated swelling, stiffness, and deformity.
- Loss of function.

Past History: previous trauma.

Clinical Examination

All patients were subjected to:

Inspection

- Skin, for scar or sinuses.
- Swellings.
- Muscle atrophy.
- Shape and symmetry.
- Position and movement of ankle.

Palpation

- Determination of the point of maximum tenderness.
- Tendon defect.
- Assessment of movements (active and passive) and muscle power.

Ultrasonographic Examination

All patients had standardized ultrasonography of both ankles to compare the symptomatic ankle to the contralateral normal side. Excess gel was used instead of the gel pad.

Ultrasound examinations were performed using one of the following devices:

- GE Logic pro6 (12 MHz).
- GE Logic 3 (12 MHz).

The ultrasonographic examination began with the patient in the supine position. Longitudinal scanning of the ankle was first performed to get an overall view of the tibiotalar joint and to detect joint effusion or intra-articular loose bodies. Then, the ankle joint syndesmosis and anterior inferior tibio-fibular ligament (AITFL) were assessed on transverse plane at anterolateral aspect of the distal tibia. Finally, while the patient in the same position; individual evaluation of the extensor tendons of the ankle was performed in both longitudinal and transverse planes starting from medial to lateral (tibialis anterior tendon(TA), then extensor hallucis longus tendon(EHL), and most laterally, extensor digotoum Longus tendon(EDL).

Thereafter, slight inversion of the foot was performed while the patient in the same position to examine the lateral collateral ligaments and peroneal tendons. The anterior talofibular ligament (ATFL) was first examined in oblique transverse plane from the tip of lateral malleolus, anteromedially and slightly downwards, till the talus. Then, the calcaneofibular ligament (CFL) was examined in oblique longitudinal plane form the lateral malleolar tip downwards and slightly backwards to the lateral surface of the calcaneus. Regarding the peroneal tendons, they were examined from their supramalleolar musculo-tendinous junction, then just behind the lateral malleolus till their inframalleolar course in both longitudinal and transverse planes. Dynamic examination was obtained in eversion and dorsiflexion position to detect tendon dislocation or subluxation.

The patient was then asked to laterally rotate the lower limb while lying supine to examine the deltoid ligament (DL) and flexor tendons. The former was examined in longitudinal scanning from its origin in the tip of the medial malleolus till its insertion into the talus, calcaneus, and navicular bones. The ankle flexor tendons were examined similar to the extensor tendons in longitudinal and transverse planes from medial to posterolateral: tibialis posterior tendon (TP), flexor digitorum longus tendon (FDL), and most laterally flexor hallucis longus tendon (FHL).

Finally the patient was asked to lie prone and rest on his/her toes. The Achilles tendon(AT) was examined from its musculo-tendinous junction to its calcaneal insertion in both longitudinal and transverse planes.

Power-Doppler imaging was used to detect tissue hyperemia in cases of tendinopathy, enthesopathy, synovitis, and inflammatory conditions.

MRI Examination

All patients had MRI of the affected ankle(s) on a high field-strength scanners.

MRI was performed using one of the following devices:

- GE Signa HDxt (1.5 T).
- Philips Achieva (1.5 T).

Knee coil was used in all cases.

Technique

Positioning

Every patient lied supine with the ankle and foot in neutral position, plantar flexion of 20 to 30 degrees has been advocated for reducing the “magic angle” artifact. No movement was allowed during examination by supporting the ankle using pads.

Protocol

The patients were examined by different pulse sequences including T1, T2, proton density, gradient echo and short T1inversion recovery (STIR). The examinations were done in different planes.

We started examination by obtaining coronal localizers scout in order to have properly aligned sagittal images. Sagittal T1Wis for the ankle region were obtained at first. Sagittal images allow recognition of the proper plane of the ankle joint which is essential to adjust the Achilles tendon, articular cartilage, subtalar joint, tarsal sinus and plantar fascia.

The second pulse sequence is to be obtained is the axial images in fast spin echo T2Wis. T2Wis in axial plane are demonstrating the bright signal of soft tissue edema, fluid in synovial sheath and joint effusion. The extension of this effusion outside the joint capsule is considered a strong indirect evidence of rupture of anterior talofibular(ATFL) and posterior talofibular (PTFL) ligaments.

T1Wis are taken in the coronal planes. It allows further evaluation of the articular cartilage. The deltoid (DL) and the calcaneofibular (CFL) ligaments can also be evaluated properly at the coronal plane.

STIR pulse sequence was done to detect abnormal marrow signal and to differentiate marrow edema (which appears very bright at STIR) from other lesions which appear hypointense in T1Wis such as focal sclerosis.

The axial planes can visualize the talofibular and tibiofibular ligaments as well as the flexor and extensor tendons.

Our usual protocol of examination was:

- Sagittal T1Wis.
- Axial T1Wis.
- Axial T2Wis.
- Axial proton density images.
- Coronal T1Wis.
- Sagittal or coronal STIR.

Other parameters applied include slice thickness ranged from 3 to 5 mm, matrix 256/192 or 512/224, number of excitation 2 to 3 and field of view ranged from 12 to 16 cm, better kept < 14 cm.

Results obtained from the ultrasonographic examination were compared to those obtained from MRI examination for each patient.

Results

This study included 50 patients with painful ankle.

Table 1. *shows the age, sex, and lateralization of the examined patients.*

Age in years		Sex		Lateralization	
Range	Mean	Female	Male	Left	Right
18-60	37	35	15	28	22

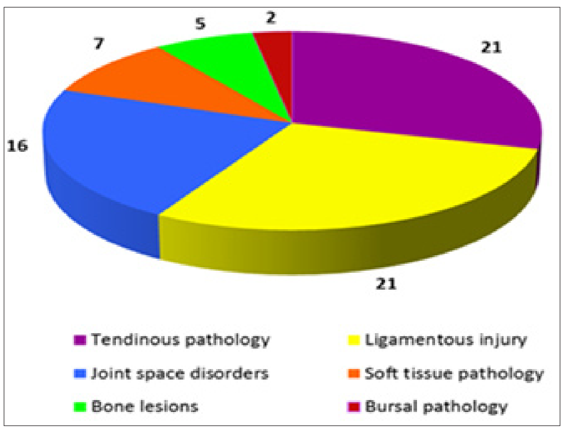

Chart 1. *Classification of 72 pathological entities, diagnosed by different imaging modalities in 50 ankle joints.*

In our study, traumatic ankle lesions were the most prevalent etiology of pain (approximately 74%).

Tendon Injuries

Table2. *Distribution of different tendinous pathological entities diagnosed in this study.*

Tendon	No. of cases	No. of Pathological entities diagnosed by all imaging modalities	No. of pathology diagnosed by MRI	No. of pathology diagnosed by U/S
Achilles	11	11	11	11
TP	2	3	3	3
FDL	1	1	1	1
FHL	1	1	1	1
TA	1	1	1	1
EDL	1	1	1	1
Peroneal	3	3	3	3
Total	20	21	21	21

The present study included 20 cases with tendon pathology that were diagnosed into 21 pathological entities by both ultrasonography and MRI modalities with no difference in interpretation between them (100% sensitivity for tendon pathology).

Table 3. *Distribution and classification of different tendinous pathological entities.*

Pathology	Frequency
Achilles tendon:	**11**
- Tendinosis	5
- Enthesopathy	1
- Partial tear	3
- Complete tear	2
Tibialis posterior tendon:	**3**
- Partial tear	2
- Exudative tenosynovitis	1
Peroneal tendons:	**3**
- Tendinosis	1
- Partial tear	1
- Exudative tenosynovitis	1
Tibialis anterior tendon:	**1**
- Tendinosis	1
Flexor hallucis longs tendon:	**1**
- Exudative tenosynovitis	1
Flexor digitorum longus tendon:	**1**
- Exudative tenosynovitis	1
Extensor digitorum longus tendon:	**1**
- Exudative tenosynovitis	1
Total	**21**

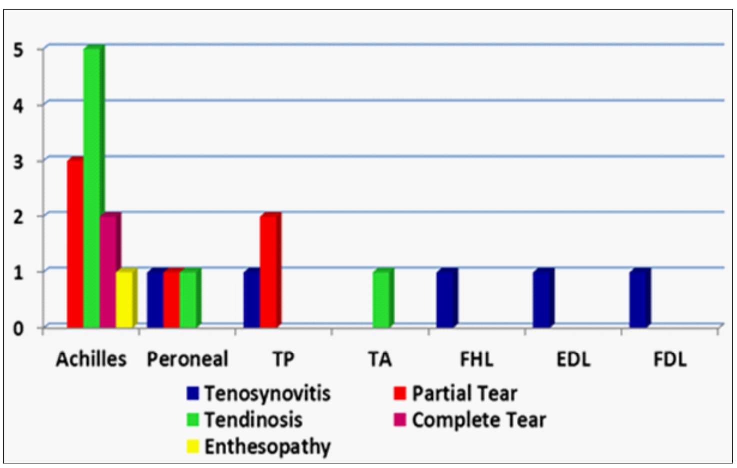

Chart 2. *Distribution and classification of different tendinous pathological entities in this study.*

Table 4. *Incidence of different tendinous injury.*

Tendon	No. of pathological entities	%
Achilles	11	52.4
TP	3	14.3
FDL	1	4.75
FHL	1	4.75
TA	1	4.75
EDL	1	4.75
Peroneal	3	14.3

Chart (2) and Tables (2, 3 and 4) show the distribution and classification of different tendinous pathological entities in this study. Achilles tendon showed 11 pathological entities (22% of all cases, 15.3% of all pathologies and 52.4% of all pathological tendons). 5 cases (45.4 % of Achilles tendon pathology) presented with tendinosis; 3 cases (27.3% of pathological Achilles) were presented with partial tear; 2 cases (18.2% of Achilles tendon pathology) were presented with complete rupture; and one case (9.1% of Achilles tendon pathology) of enthesopathy.

Peroneal tendons showed 3 pathological entities (6% of all cases, 4.2% of all pathologies, and 14.3% of pathological tendons). 1 case of tenosynovitis, 1 case of partial split tear of peroneus brevis (PB) , and 1 case of tendinosis, each representing 33.33% of pathological peroneal tendons.

Tibialis posterior tendons showed 3 pathological entities (6% of all cases, 4.2% of all pathologies, and 14.3% of pathological tendons). 2 cases of partial tear representing 66.66% of pathological tibialis posterior tendons, and 1 case of tenosynovitis representing 33.33% of pathological tibialis posterior tendons.

Tenosynovitis was detected, one case of each of FHL, FDL, and EDL, each representing 2% of all cases and 4.75% of all tendinous pathologies.

Tendinosis was diagnosed in anterior tibial tendon (4.75% of tendinous pathology).

Ligamentous Injuries

Our study showed that ultrasonography could detect all of the ligamentous lesions identified by MRI (100% sensitivity for pathological ligament). However, two ligamentous lesions that were interpreted as partial tear by ultrasonography were diagnosed as complete tear by MRI.

Table 5. *Distribution of different ligamentous pathological entities diagnosed in this study.*

Ligament	Frequency
Lateral ligament complex:	**19**
- ATFL	12
- CFL	3
- PTFL	4
Medial (deltoid) ligament:	**2**
-PTTL(posterior tibiotalar ligament)	2
Total	**21**

Table 6. *Incidence of different ligamentous injury.*

Ligament	No. of cases	%
ATFL	12	57.2
CFL	3	14.3
PTFL	4	19
DL	2	9.5

Table 7. *Distribution and pathological classification of ligamentous injury diagnosed in this study.*

Injury	Frequency	Distribution				%
		ATFL	PTFL	CFL	PTTL	
- Sprain	7	3	4	0	0	33.3
- Partial tear	6	5	0	1	0	28.6
- Complete tear	8	4	0	2	2	38.1

Chart (3) and Tables (5, 6 and 7) show the distribution and incidence of different pathological ligamentous lesions in the present study. Ultrasonography was able to show 21 cases of ligamentous injury constituting 42% of the total cases and 29.2% of all pathologies. The study showed mild sprain of 4 PTFL and 3 ATFL, partial tear of 5 ATFL, and 1 CFL as well as complete tear of 4 ATFL, and 2 CFL, and 2 DL.

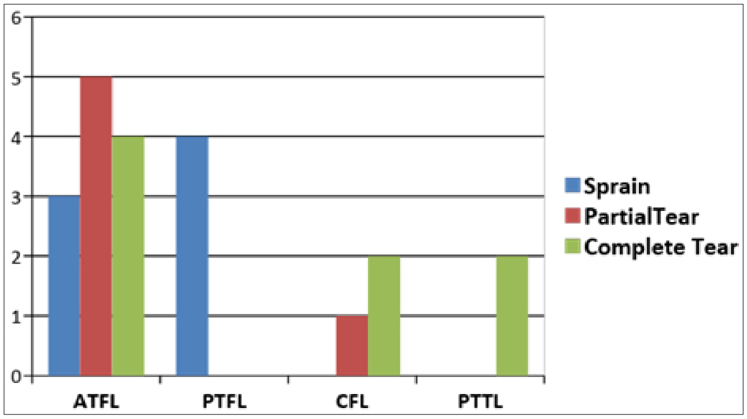

Chart 3. *Distribution and pathological classification of ligamentous injury in this study.*

Table 8. *Correlation between US and MRI findings in 14 ligamentous injuries diagnosed as partial and complete tears.*

Modality	Pathology	No. of cases		Total
U.S. Diagnosis:	Partial tear	ATFL	6	**14**
		CFL	2	
	Complete tear	ATFL	3	
		CFL	1	
		DL	2	
MRI Diagnosis:	Partial tear	ATFL	5	**14**
		CFL	1	
	Complete tear	ATFL	4	
		CFL	2	
		DL	2	

Bursal Pathology

This group included two cases of retrocalcaneal bursitis representing 4% of the cases and 2.8% of the total pathologies.

These cases were diagnosed by both imaging modalities.

Joint Space Disorders

This group included 16 cases:

- 10 cases with ankle joint effusion representing 20% of the cases, 13.9% of the total pathologies and 62.5% of the joint space disorders.

- 3 cases with rheumatoid arthritis representing 6% of cases and 4.2% of total pathologies as well as 18.8% of the joint space disorders.

- 3 cases with posterior synovitis representing 6% of cases and 4.2% of total pathologies as well as 18.8% of the joint space disorders.

Table 9. *Correlation between US and MRI findings in detection of ankle joint effusion in 50 cases subjected to both imaging modalities.*

Modality	Effusion	Sensitivity
US	10	100%
MRI	10	100%

Bone Lesions

This group included five cases. Two cases with talar osteochondral lesion, the third case was fracture talar neck, the fourth case was fissure fracture of the lateral aspect of the fibular cortex, and the fifth case was benign bone tumor of cartilage origin (osteochondroma). Ultrasonography could identify the latter two of these five cases (40% sensitivity for bone pathology), while MRI adequately demonstrated all of these cases.

Soft Tissue Pathology

This group included seven cases:

- Six cases of ganglion cyst representing 12% of cases and 8.3% of total pathologies. They were diagnosed by both ultrasound and MRI.

- One case of lateral ankle lipoma which was detected by both ultrasound and MRI.

Table 10. *Distribution of all 72 diagnosed pathologies by all imaging modalities of total 50 cases of the study.*

Cases	Pathology diagnosed	No. of cases	No. of pathological entities
1-4	- Achilles tendinosis	4	4
5	- Achilles enthesopathy.	1	1
6-8	- Achilles tendon partial tear.	3	3
9-10	- Achilles tendon complete tear.	2	2
11	- Achilles tendinosis. - Retrocalcaneal bursitis.	1	2
12	- Peroneal tenosynovitis. - ATFL complete tear. - CFL complete tear. - Ankle joint effusion.	1	4
13	- Peroneal tendinosis.	1	1
14	- Talar OCL (Talar osteochondral lesion) - Ankle joint effusion.	1	2
15	- Talar OCL. - Ankle joint effusion. Deep venous thrombosis (DVT).	1	2
16	- Fracture talar neck.	1	1
17-19	- Ganglion cyst.	3	3
20	-Tibialis posterior partial tear.	1	1
21	- TP tendon partial split tear. - TP tenosynovitis.	1	2
22	- TA tendinosis. - ATFL partial tear. - Ankle joint effusion	1	3
23	- FHL tenosynovitis. - ATFL partial tear. - Ankle joint effusion.	1	3
24	- ATFL partial tear. - Retrocalcaneal bursitis.	1	2
25	- PB tendon longitudinal split tear.	1	1
26	• Benign bone tumor of cartilage origin.	1	1
27	- Lipoma.	1	1
28	• PTTL complete tear.	1	1
29-31	- ATFL sprain.	3	3
32	- ATFL partial tear. - Ankle joint effusion.	1	2
33	• ATFL partial tear. • CFL partial tear. • Fracture fibula.	1	3
34-36	• ATFL complete tear.	3	3
37	• PTFL sprain. -Tarsal varicosities (tarsal tunnel syndrome).	1	1
38	• PTTL complete tear.	1	1
39-42	Ankle joint effusion.	4	4
43	• PTFL sprain. • Posterior joint synovitis. • Ganglion cyst.	1	3
44	• CFL complete tear.	1	1

45-47	• Rheumatoid arthritis.	3	3
48	• Posterior ligamentous complex sprain. • Synovitis. • Ganglion cyst. • EDL tenosynovitis.	1	4
49	• PTTL sprain. • Synovitis. • Ganglion cyst.	1	3
50	• FDL tenosynovitis.	1	1
Total		50	72

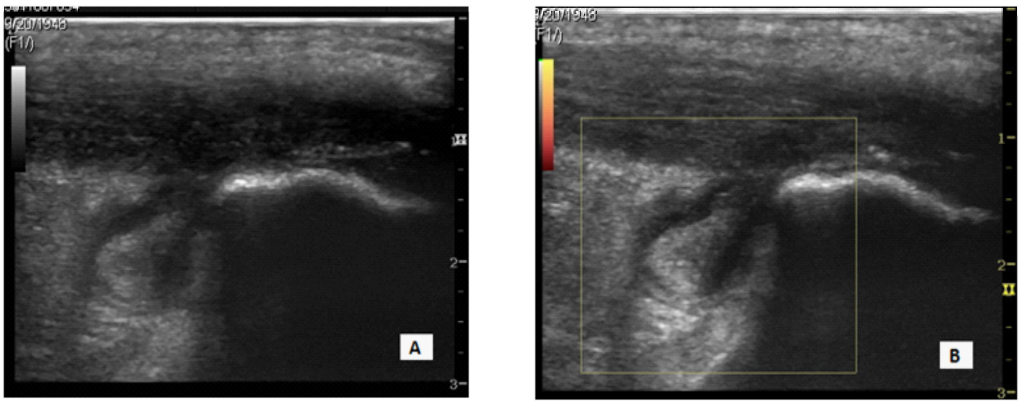

Fig 1. *Achilles tendinosis. (A) Longitudinal US image of the right Achilles tendon showing thickened hypoechoic distal portion of the tendon with pre-Achilles bursa which is seen distended with echogenic fluid (complicated, bursitis). (B) No increased vascularity on power Doppler imaging (chronicity).*

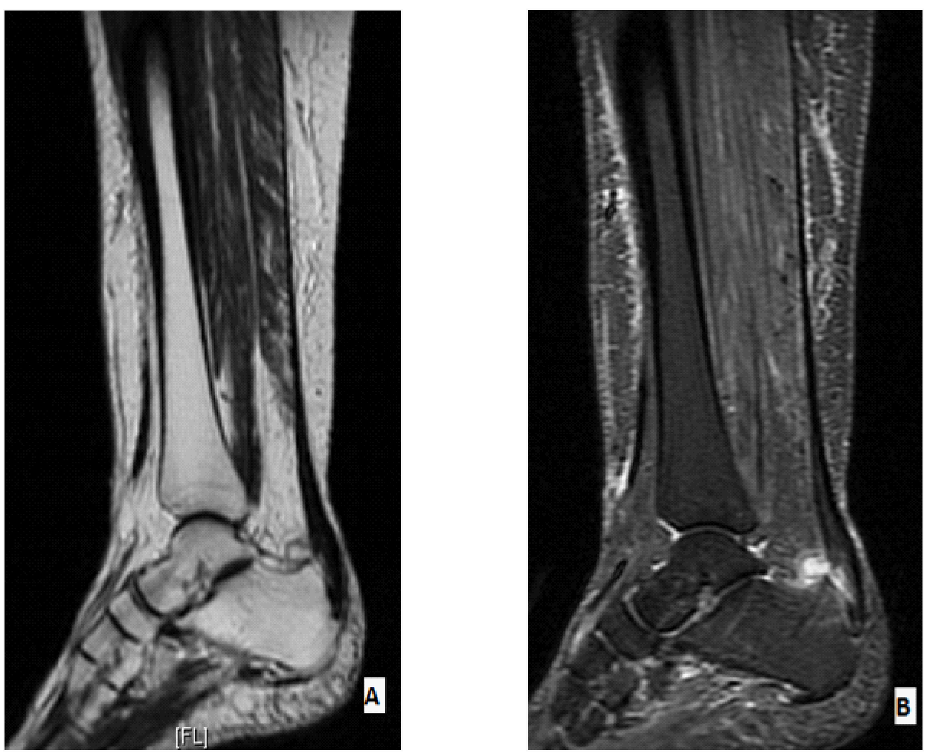

Fig 2. *Achilles tendinosis. (A) Sagittal T2 and (B) STIR images of the right ankle showing thickened distal Achilles tendon and increased its signal with comma-shaped pre-Achilles retro-calcaneal bursa.*

Fig 3. *Achilles tendon partial tear. Longitudinal US image of the left Achilles tendon showing discontinuity of its fibers and herniation into the Kagar's fat.*

Fig 4. *Achilles tendon partial tear. Sagittal STIR (A) and axial MERGE (B) MR images showing increased signal intensity of the Achilles tendon partially interrupting its mid portion.*

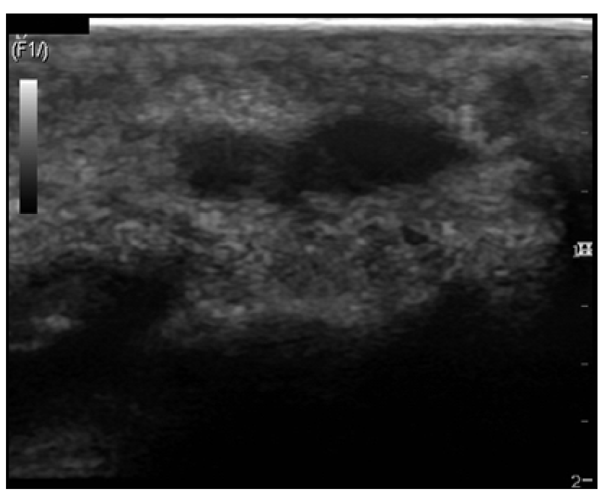

Fig 5. *Ganglion cyst. Oblique US scanning of the posterior left ankle showing fluid-filled structure projecting over superior aspect of posterior portion of calcaneus.*

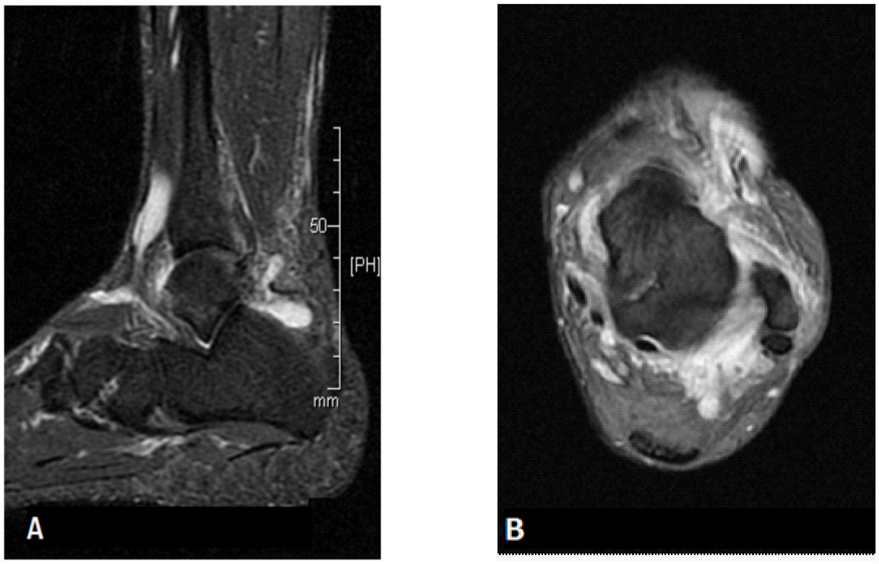

Fig 6. *Left ankle posterior soft tissue impingement and EDL tenosynovitis. (A) Sagittal STIR and (B) axial MERGE images showing protrusion of the fluid-filled synovium through thickened posterior ligament complex; and fluid signal within the synovial sheath of the EDL tendons as well with normal girth and signal of the tendons.*

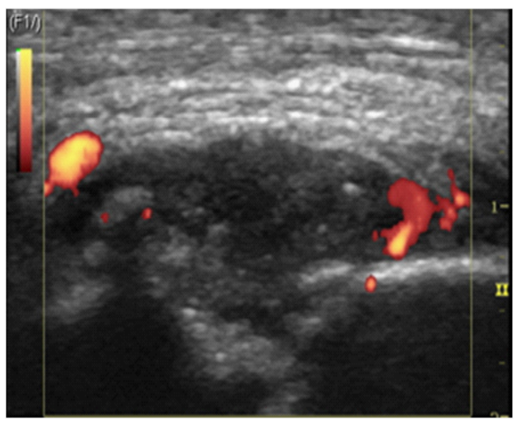

Fig 7. *Rheumatoid arthritis of the right ankle joint. Longitudinal power Doppler US image showing thickened synovium and pannus with increased and evidence of underlying bone erosions.*

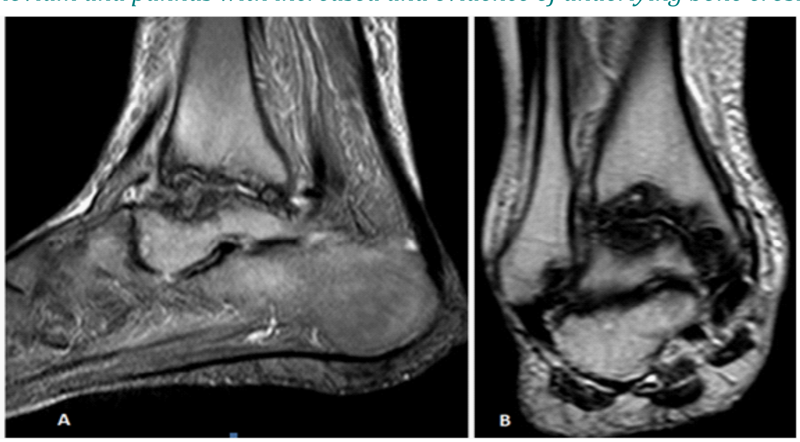

Fig 8. *RA of the right ankle joint. (A) Sagittal and (B) coronal T2 MR images showing advanced articular surface cortical irregularity and subchondral erosions are seen more clearly with flattened talar dome and narrowed joint space with diffuse synovial thickening and possible loose bodies.*

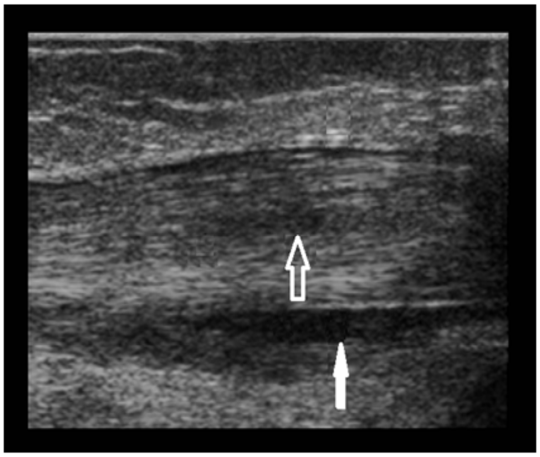

Fig 9. *Tibialis posterior tendon longitudinal split tear. Longitudinal US image of the right ankle showing thickened tibialis posterior tendon with hypoechoic central area (hollow arrow) representing partial tear. Associated mild tenosynovitis is as well shown (solid arrow).*

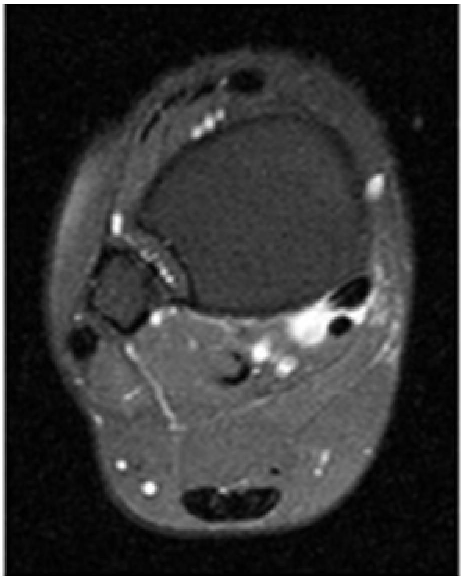

Fig 10. *Tibialis posterior tendon longitudinal split tear. Axial PD fat suppressed MR image of the right ankle showing thickened TP tendon with linear high signal intra-substance intensity denoting longitudinal split partial tear with associated tenosynovitis.*

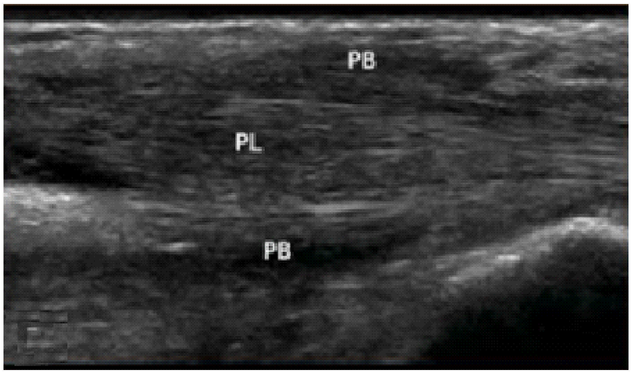

Fig 11. *Longitudinal split tear of the peroneus brevis tendon. Longitudinal US scan showing splitting of the peroneus brevis (PB) tendon around the normal peroneus longus (PL) tendon.*

Fig 12. *Longitudinal split tear of the peroneus brevis tendon. Axial T2 MR image showing C-shaped (split) peroneus brevis tendon (red arrow) around the normal peroneus longus tendon with high signal fluid seen around.*

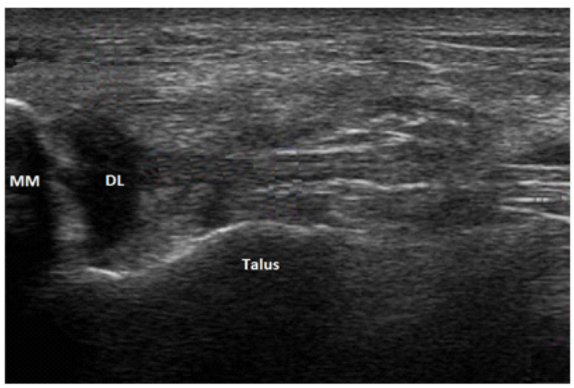

Fig 13. *Posterior tibio-talar ligament complete tear. US image with the probe is in the coronal plane showing the disrupted deltoid ligament (DL) underneath the medial malleolus (MM) with loss of its attachment to the talus.*

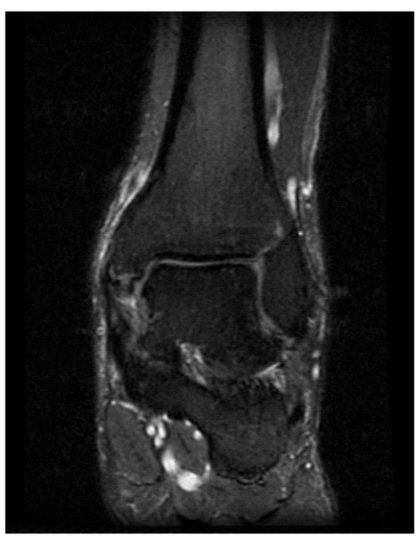

Fig 14. *Posterior tibio-talar ligament complete tear. Coronal T2 fat suppressed MR image showing indistinct posterior tibio-talar ligament with abnormal bright signal seen along its normal anatomical course.*

Discussion

The ankle joint is one of the most frequently injured joint of all weight bearing joints in the body ***(16).*** Ankle injuries account for about 25% of athletic injury ***(17).***

Ankle pain is a common complaint in orthopedic practice. The etiology of ankle pain includes various pathologies such as tendinous and ligamentous injuries, joint disorders, osseous lesions and soft tissue pathologies ***(18).*** Tendons can be affected by trauma, degenerative, and inflammatory process while ligaments are mostly affected by tears ***(19).***

Clinicians usually start dealing with ankle injury by plain radiographic examination as it is cheap, easy to perform and has a great ability in demonstrating fractures, arthritis, intra-articular loose bodies, osteophytes, tendinous calcifications as well as lytic and sclerotic bone lesions. However, many ankle injuries are misdiagnosed by conventional radiology and needs further evaluation to diagnose ligamentous, tendinous and muscle injuries as well as osseous lesions such as stress fractures, osteochondral lesions, and avascular necrosis ***(17).***

Certain procedures can be added to conventional radiography in-order to help detecting soft tissue injuries. These include stress radiography, tenography, and arthrography. The sensitivity of stress radiography in evaluating ankle injuries may be difficult to perform due to pain and swelling ***(20).***

MRI has become the 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 related injuries, which are often difficult to diagnose with alternative modalities. MRI is particularly useful for evaluating soft tissue structures around the ankle such as tendons, ligaments, nerves, and fascia and for detecting occult bone injuries ***(21).*** However, the high cost and the relatively long duration of the examination, have been a major obstacle to a wide application ***(22).***

Ultrasonography has been used to evaluate the musculoskeletal system for approximately 25 years, however, high resolution ankle sonography has not been widely utilized in diagnosing and characterizing different ankle pathologies. This limited acceptance may be due – in part – to the paucity of ankle ultrasonographic studies in clinical practice compared to the magnetic resonance imaging studies, the frequent lack of local radiological expertise, and difficult recognition of the relevant anatomy and pathology on hard-copy ultrasonographic images ***(23).***

Also ultrasonographic evaluation of the ankle has a limited role in ankle injuries due to the inability of the ultrasonographic waves to penetrate the bones. It has other limitations as it is operator dependent technique, lack of proper contrast resolution and the complex anatomy of the ankle regions that makes the examination difficult ***(17)***

Although ultrasonography is unable to demonstrate changes in the bone marrow and has only limited capability in evaluating articular cartilage, erosions can be shown along with changes in the tendons and tendon sheaths, synovium, and ligaments ***(24).***

The development of high-frequency high-resolution modern electronic transducers increased the ability of ultrasonography in detecting normal small anatomic structures and assessing a variety of musculoskeletal disorders. These improvements along with economic factors and availability resulted in increasing interests in using ultrasound as a diagnostic tool. The efficacy of ultrasound has been compared to other modalities, in particular MRI, as a cost effective imaging alternative ***(19).*** When dealing with small lesions. The higher spatial resolution of sonography is a major advantage over MRI ***(25).***

MRI is considered as a valuable tool when a global assessment of a joint requires evaluation of the muscles, tendons, cartilage, and bone marrow is needed. However, ultrasonography can produce similar results when a focused evaluation of muscle, tendon, ligament, and joint recesses is needed. Frequently this can be performed for less cost and with less delay when compared with MRI ***(23).***

Another advantage of ultrasonography over MRI is the ability to focus the examination precisely at the region of symptoms. Ultrasound examination is also valuable in assessing ankle disorders when metallic artifacts would limit imaging with MRI or CT ***(23).***

Dynamic sonography or imaging during joint motion, can help in evaluating tendon tears, transient subluxation, and dislocation of tendons or nerves

(26). In tendon tears, dynamic sonography is very helpful in differentiating full thickness from partial thickness tears because tendon retraction indicates full thickness tear ***(23).*** Dynamic sonography can also evaluate tendon impingement, which may occur only with specific movements ***(26).***

The aim of this study was to compare the diagnostic accuracy of both ultrasonography (US) and magnetic resonance imaging (MRI) for the assessment of pain around the ankle in musculoskeletal disorders.

Our study included fifty patients complaining of unilateral ankle pain. All patients were subjected to plain X-ray, real time high resolution ultrasonography and MRI of the affected ankle.

Twenty one entities of tendon injury were diagnosed in this study which represented about 29.2% of the pathological entities encountered. There were 11 cases of Achilles tendon injuries representing 52.4% of the tendinous injuries. 18.2% of these cases (2 cases) were presented with complete rupture of the Achilles tendon. Their ages ranged between 35-60 years. This was matched with ***Ostlere (27)***, who reported in ***2003*** that Achilles tendon ruptures commonly affects the middle aged individuals and abnormal tendons. The rest of Achilles tendon injuries in our study presented with partial tear, tendinosis, and enthesopathy representing 27.3%, 45.4% and 9.1% of the Achilles tendon injuries, respectively.

Although it is considered as the strongest tendon in the human body, all literatures agreed that the Achilles tendon is the most commonly injured ankle tendon, with the site of pathologic findings is typically a zone of relative avascularity 2-6 cm from the calcaneal insertion ***(28).*** Our results coincided with this hypothesis as Achilles tendon injuries represented 52.4% of all diagnosed ankle tendons' injuries and ranged in severity from tendinosis, partial tear to complete tear.

In our study, ultrasonography was capable in detecting all Achilles tendon injuries identified at MRI (100% sensitivity). During the follow-up for Achilles tendon injuries, MRI was 100% sensitive in diagnosing surgically proved complete tears.

As regards characterization of Achilles lesions, ultrasonography succeeded in classifying Achilles injuries similar to MRI regarding tendinosis, partial tear, and complete tear. Similarly, ***Hartgerink and co-workers in 2001(28)*** reported that ultrasonography was 100% sensitive in detecting Achilles tendon injuries in 26 cases taking surgical findings as the standard reference.

One of the potential advantages of ultrasonography over MRI in cases of Achilles injuries is its ability to detect intra-tendinous calcifications or ossifications which are usually missed among the similar low signal pattern of the tendon at MRI ***(18).*** Accordingly, in our study, ultrasonography could identify distal Achilles small intra-tendinous calcific foci in one case which was not evident by MRI.

In our study, tibialis posterior tendon showed 3 pathological entities (6% of all cases, 4.2% of all pathologies, and 14.3% of all pathological tendons). 2 cases of partial tear representing 66.66% of pathological TP tendons, and 1 case of tenosynovitis representing 33.33% of pathological TP tendons.

Of those three medial ankle tendons, the tibialis posterior tendon was the most frequently affected ***(29).*** In our study, only three cases of tibialis posterior tendon pathology were diagnosed by ultrasonography and MRI. In spite of the small number of tibialis posterior tendon pathology in our study group, our results were similar to the results achieved by ***Miller and co- workers in 1996 (30)***, who correlated ultrasonography findings in tibialis posterior tendon injuries with surgical findings and showed that ultrasonography allowed correct diagnosis in all of the 17 cases of tendon diseases, including tendinosis, tenosynovitis, partial and complete tear. They also stated that ultrasound can demonstrate bony spurs or osteophytes adjacent to the tibialis posterior tendon that may be difficult to identify by MRI unless it contains fatty marrow.

In our study, ultrasonography was capable of detecting all tibialis posterior tendon injuries identified at MRI (100% sensitivity). However, regarding characterization of TP tendon lesions, ultrasound succeeded to classify TP tendon injuries similar to MRI regarding partial tear, and tenosynovitis with an exception of only one case of partial tear which was diagnosed by MRI and interpreted by US as tibialis posterior tendinosis. In ***2001 Hartgerink and co-workers (28)*** stated that the use of neither sonography nor MRI had demonstrated a high degree of differentiation in helping to distinguish partial thickness from tendinosis. However, this distinction may not be of great clinical importance since a partial thickness tear or tendinosis, in the absence of a full thickness tear, is usually treated with non-surgical means.

During evaluation of tibialis posterior tendon, in ***2002***, ***Premkumar and his co-workers (31)*** reported that it is important to recognize the pathology of tibialis posterior tendon as neglected tear leads to a flat foot and secondary osteoarthritis.

Of the remaining medial ankle tendons, the FDL tendon is rarely affected by pathologic changes, but can be detected by ultrasonography ***(32).*** Our study included one case of FDL tenosynovitis which was diagnosed by US and approved by MRI study.

Our study included only one case of FHL tenosynovitis which was diagnosed by US and approved by MRI study. The pathology of FHL tendon has been reported more frequently than the FDL tendon. Because of its deep location and changes in its direction, evaluation of the FHL tendon using US can be difficult ***(32).***

Although the anterior ankle tendons are rarely affected with pathology in comparison with other ankle tendons ***(33),*** our study included 1 case with tibialis anterior tendinosis and 1 case with EDL tenosynovitis. This agreed with the work done by ***Narvez and co-workers in2003 (34)*** who reported that TA tendon injuries are uncommon and tenosynovitis and tendonitis are more common than tendon rupture.

In our study, lesions of the peroneal tendons were diagnosed by both MRI and ultrasonography. Peroneal tendons showed 3 pathological entities (6% of all cases, 4.2% of all pathologies, and 14.3% of pathological tendons).They were as follows: 1 case of tenosynovitis, 1 case of tendinosis, and 1 case of partial split tear of peroneus brevis tendon, each representing 33.33% of pathological peroneal tendons.

Longitudinal split tears of the peroneus brevis tendon have been increasingly reported as a source of lateral ankle pain and disability according to ***Nancy and co-workers in 2000(35)*** who 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. In ***2000***, ***Major and co-workers(36)*** also reported that MR imaging is useful in identifying the appearance of longitudinal split tears of the peroneus brevis.

21 cases of ligamentous injury were diagnosed in our study representing 42% of total cases and 29.2% of the whole encountered pathological entities. Anterior talofibular ligament was the most frequently injured ligament representing 57.2% of the whole ligamentous injuries followed by the posterior talofibular ligament (19%) and calcaneofibular ligament (14.3%). Deltoid ligament was the least ligament injured (9.5%). This coincides with different literatures evaluating ankle ligaments. In ***2002, Jacobson (23)*** stated that anterior talofibular ligament is the most commonly torn ankle ligament followed by calcaneofibular ligament, and in 70% of ankle sprains; only the anterior talofibular ligament is torn, while the calcaneofibular ligament is also torn in 20% of cases. The deltoid ligament is the strongest ankle ligament and the least to be injured.

Although rupture of ATFL may be an isolated injury, CFL and PTFL ruptures are not found in the presence of an intact ATFL. In ***1993, Stoller (37)*** stated that combined ATFL and CFL tears occur in 40% of ATFL tears, and CFL tears without ATFL tears is quite unusual.

Thus, after inversion ankle injury, visualization of an intact ATFL virtually excludes rupture of any of the lateral collateral ligaments ***(38).*** In our study, ATFL injury was associated with two cases diagnosed as having CFL injury. Similar results were also achieved by ***Martinoli and Bianchi in 2007 (33) .***

In our study, correlation between the ability of ultrasonography against MRI in detecting ligamentous tears yielded a sensitivity of 100%. Our results were nearly similar to the results achieved by ***Campbell and co-workers in 1994 (39)***, who showed that ultrasonography succeeded to diagnose 14 out of 15 anterior talofibular ligament tears with a sensitivity of 93%. Similarly, in ***1993, Friedrich and co-workers (40)*** reported that US results agreed in 100% of the cases with operative findings for ATFL and 92% for CFL. However, in ***1996, D'Erme (41)*** indicated that MR imaging was superior to ultrasonography in diagnosing ankle collateral ligaments injuries. On the other hand, ***Milz and co-workers in1996 (42)*** yielded promising improvement of ultrasonographic accuracy by using high frequency transducers (13 MHz); they concluded that ultrasonography can identify normal ankle ligaments with high accuracy and it showed the greatest accuracy in evaluating the anterior talofibular and calcaneofibular ligaments (90% and 87%, respectively).

In our study, the lateral collateral ligament complex was affected in 90.5% of all ankle ligament injuries. In ***2001, Kaplan and co-workers (43)*** also reported that the lateral collateral ligament complex is affected in 80% to 90% of all ankle ligaments injuries.

In our study, two cases of retrocalcaneal bursitis were diagnosed representing 4% of the cases and 2.8% of the total pathologies in the study group. Ultrasonography and MRI were capable of identifying the size and extension of the bursa in all cases. In ***2002, Patel and co-workers (44)*** stated that bursal distension more than 3 mm in anteroposterior dimension detected by ultrasonography is generally considered abnormal.

Sixteen cases of joint disorders were diagnosed in our study constituting 22.2% of the different pathological entities. Ankle effusion constituted its main subgroup being detected in ten cases representing 20% of the cases, 13.9% of the total pathologies and 62.5% of the joint space disorders. Compared to MRI, ultrasonography yielded, in our study, 100% sensitivity in detecting ankle joint effusion. However, in ***1998, Jacobson and co-workers(45)*** and in ***1999, Fessell and Van Holsbeeck (18)*** concluded that MRI is more sensitive than ultrasonography in detecting ankle effusion; MRI could detect intra-articular fluid of 1 ml while sonography could reproducibly detect 2 ml of fluid.

In our study, 3 cases with posterior ankle joint synovitis representing 6% of cases and 4.2% of total pathologies as well as 18.8% of the joint space disorders (in addition, to another three cases of tibiotalar synovitis in patients known to have rheumatoid arthritis) were diagnosed by MRI, as well as by ultrasonography based on the sonographic criteria of synovial thickness, hyperemia on color Doppler, effusion and articular erosions. In ***2003, Breidhal and Stafford (46)*** confirmed that ultrasonography was able to detect synovitis based on that ultrasonography and Doppler have a great ability to differentiate synovitis from joint effusion, a distinction that requires intravenous gadolinium injection at MRI.

In our study, five cases with bone lesions were diagnosed representing 6.9% of the total pathological entities. Of which, two cases of osteochondral lesions of talar dome and one case of fracture talar neck were diagnosed on basis of MR imaging. Ultrasonography was not capable of establishing the diagnosis in any of these three cases. In ***1999, Bianchi and Martinoli (47)*** stated that ultrasonography was not useful in assessing osteochondral injuries except in stage 4 lesions which may be detected as intra-articular loose bodies. On the other hand, in ***1997, Haygood (48)*** stated that talar dome osteochondral fractures are the most common type of talar fractures. In agreement with ***Jeroen and co-workers in 2005 (49),*** we observed that MRI has a high sensitivity in detecting occult fractures. In ***2002, Dunfee and Dalinka (50)*** reported that MRI can properly identify osteochondral injuries at its different stages.

Ultrasonography is not the primary imaging modality in diagnosing fractures due to its limitation in evaluating structures that are deep in relation to the soft tissue / bone interface. However, fractures may be strongly suspected by focal cortical irregularities ***(51)***. In our study, ultrasonography could identify one case of fissure fracture of the lateral aspect of the fibular cortex, and another case of benign bone tumor of mixed bone and cartilage matrix, constituting 40% of bone lesions (40% sensitivity for bone pathology), while MRI adequately demonstrated all bone lesions.

In ***1999, Van der Woude and Vanderschueren (52),*** stated that ultrasonography can detect musculoskeletal tumors. It can be used as the initial imaging technique for evaluation. Ultrasonography is used primarily to determine if a soft tissue mass is cystic or solid. In addition, ultrasonography can determine the size of the extra-osseous soft tissue mass and its relation to the surrounding structures as well as associated bony cortical irregularity, erosions and expansions. Ultrasonography can also be used instead of MRI when metallic artifacts secondary to orthopedic hardware (including prosthesis) prevent evaluation of specific areas. Color Doppler sonography aids much in assessing tumoral vascularity and its relation to the surrounding vasculature.

In spite of the aforementioned role of ultrasonography in assessing musculoskeletal tumors, still MRI is the modality of choice in this issue as it is much superior in delineating soft tissue masses and their extension due to its superior soft tissue contrast and is also unique in evaluating bone marrow and intra-osseous lesions ***(52).***

Our study included one case of lipoma which was diagnosed by ultrasonography and confirmed by MRI. In ***1994, Johnston and Beggs (53)*** reported that MRI can provide further specificity in some cases.

In our study, three cases of ganglionic cyst were diagnosed by MRI and ultrasonography, representing 4.2% of the pathological entities. In ***2003, Fessell and co-workers (54) and*** in ***2008, Teefey and co-workers (55)*** reported the accuracy of ultrasonography in estimating the size and the localization of the cyst.

In our study, three cases of posterior ankle impingement (PAI) syndrome associated with synovitis and posterior ligament complex sprain were diagnosed by MRI and ultrasonography. In ***2002, Robinson and White (56)*** stated that MRI clearly detects bony and soft tissue abnormalities associated with PAI syndrome, and that the role of ultrasonography is limited as it may only detect associated soft tissue injuries.

Our study included one case of tarsal tunnel syndrome due to varicosities, diagnosed by MRI and ultrasonography. In a study which included 17 cases of tarsal tunnel syndrome in ***2005***, ***Masahiro and Hiromi (57),*** diagnosed varicosities as the etiological cause in 3 cases (17.6% of the cases) that were adequately diagnosed by ultrasonography and were consistent with the intra-operative findings.

A work done by ***Ostlere*** in ***2003 (58)*** and ***Jeroen and co-workers*** in ***2005(59)***, showed that imaging plays a major role in the management of ankle problems. Ultrasonography and MRI are two complementary tools of investigation. Ultrasonography is considered as an excellent tool for imaging focal soft tissue abnormalities, and is used as a primary tool of investigation. MRI is an excellent technique for those cases where the diagnosis is uncertain as it can exclude most clinically relevant pathologies, especially when surgical interference is planned.

Conclusion

MRI is the modality of choice for optimal detection of most soft-tissue disorders of the tendons, ligaments, and other soft tissue structures of ankle, and when global evaluation of the osseous and soft tissue structures of the ankle is needed. This modality is also valuable in the early detection and assessment of a variety of osseous abnormalities seen in this anatomic location.

Ultrasonography is an excellent cost-benefit widely available imaging modality that has high spatial resolution making it helpful tool in diagnosing musculoskeletal ankle disorders mainly when evaluating soft tissue structures and extremely valuable when a focused evaluation is needed for a soft tissue structure or precisely examining the region of symptoms. Ultrasound examination is also valuable in assessing ankle disorders when metallic artifacts would limit imaging with MRI. Dynamic ultrasonography and additional duplex examination are two further specific advantages of ultrasonography.

Ultrasonography and MRI are two complementary tools of investigation with the former being used as primary tool of investigation and the latter is done to confirm the diagnosis and the extent of the lesion especially when surgical interference is planned.

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