Zagazig University Medical Journal
www.zumj.journals.ekb.eg

DOI 10.21608/zumj.2019.13171.1236 *Radio-diagnosis*

ORIGINAL ARTICLE

The Value of Ultrasonography in Diagnosis of Acute Ankle Injury Compared With Magnetic Resonance Imaging

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Submit Date: 01-06-2019
Revise Date: 24-07-2019
Accept Date: 02-08-2019

ABSTRACT

Background: The ultrasound technique is a rising up modality, widely available, cheaper and faster technique than MRI. in evaluation of the musculoskeletal diseases. The aim of this work was to evaluate the diagnostic accuracy of ultrasonography technique in cases of acute ankle injury compared to magnetic resonance technique. **Methods:** Our study was carried out in Radiology department, Zagazig University Hospital, and had been approved by the Zagazig University Institutional Review Board (I.R.B.). We targeted ٢٤ patients. Where 66.7 % were males and 33.3 % were females representing of all patients, with mean age 29.75 year. Thirteen patients complained of right side ankle trauma representing 54.2%, while the other eleven patients complained of left side acute ankle trauma representing 45.8% of all patients **Results:** In our study, 24 studied patients with 39 lesions, with the majority were tendonous lesions, 21 tendon injuries representing 53.8% of all lesions. The other 5 patients showed 7 ligamentous injuries representing 17.9% of all lesions. Among the studied patients, 11 patients showed non tendonous non ligamentous injuries. **Conclusion:** Ultrasonography with the advent of high resolution linear-array as a dynamic, rapid and inexpensive imaging tool and with a high accuracy as magnetic resonance imaging, can be used as a first line diagnostic modality in patient with acute soft tissue injuries. Magnetic resonance imaging is an excellent technique for those cases where the diagnosis is uncertain or cannot be confirmed by ultrasonography, especially when surgical interference is planned.

Keywords: Ultrasonography, ankle, injury, MRI.

INTRODUCTION

Acute ankle injury is a common injury to a major joint of the body, where the tendon and ligament injuries are the most common that could happen in general population during ordinary social life or during sport activities [1].

There are many mechanisms by which the ankle injury can be happened, the inversion injury and blunt trauma are the most common causes especially in athletic people and mainly causing a tendon tear, ligament tear or sprain and even a bony avulsion fracture [2].

The ankle injury can be diagnosed clinically by signs and symptoms, for example; ankle pain, ankle swelling and stiffness even joint instability [2].

For confirming the diagnosis of musculoskeletal ankle traumatic lesions, there are different radiological modalities including; X-ray, ultrasonography, computed tomography scan, magnetic resonance imaging, among these modalities the ultrasonography, and magnetic resonance imaging can be considered as alternative modalities with an advantage of lack of radiation [1, 3].

Because of its high soft tissue resolution, the magnetic resonance technique is considered as a superior technique among these different modalities and the first choice technique in the diagnosis of acute events [4].

Ultrasonography is a good technique with high-resolution images that provide a good soft tissue structures evaluation including muscles, tendons, ligaments and peripheral nerves [3].

Since 1970s ultrasonography technique has continuous development with a remarkable improvement in both their transducers frequencies and increase in its image resolution, so it started to take a fundamental place in the diagnosis of musculoskeletal lesions especially in assessment of soft tissues abnormalities [3].

Ultrasonography has many significant advantages; no radiation, high resolution and fewer artifact images, widely available, movable, easy accessible technique and can provide a dynamic examination [3,5,6] that all make it, the first musculoskeletal diagnostic technique in evaluation of soft tissue lesions including foreign bodies, ligament or tendon tears [3] .

METHODS

Our study was carried out in Radiology department, Zagazig University Hospital, and had been approved by the Zagazig University Institutional Review Board (I.R.B.). It was a prospective study, done during the period from April/2017 to November/2017

We targeted ٢٤ patients referred from the emergency and orthopedic surgery departments and outpatient clinics with a history of recent ankle injury. Sixteen patients were males representing 66.7 % and eight patients were females representing 33.3 % of all patients, with mean age 29.75 year.

Thirteen patients complained of right side ankle trauma representing 54.2%, while the other eleven patients complained of left side acute ankle trauma representing 45.8% of all patients

Inclusion criteria:

1. Patient who agree to complete examination with both technique.
2. A patient who has a recent acute ankle injury.
3. No age or sex limitation.

Exclusion criteria:

1. Patient unwell to complete the study with both techniques.
2. A patient who has a contraindication to M.R.I. examination: e.g. Patient with a cardiac pacemaker.
3. Severely traumatic, unconscious patient

Methods:

1- Clinical assessment:

Full historytaking:

A. Onset, mechanism of injury.
B. History of previous trauma.

2- local examination:

Clinical examination of injured ankle focusing on: site of trauma, erythema, swelling, and joint instability or stiffness.

3- Imaging:

1-Ultrasonography examination using Siemens (Acuson X300) machine by superficial linear high-frequency transducers (7-10 MHz) and a dynamic scan

All patients were examined in the longitudinal and transverse scan to the affected side of all ankle compartments including muscles and tendons around the joint as well as the joint ligaments, the dynamic scan was performed.

Examination of the ankle begins with the patient in the supine position, with the knee flexed and the foot rested on the examination table.

The anterior joint is first examined in the longitudinal plane to assess a joint effusion. The evaluation of the extensor tendons done with the patient in the same position, the anterior tibial tendon is evaluated in both longitudinal and transverse planes from its superior extent to its insertion on the first cuneiform. The extensor hallucis longus is similarly evaluated and be followed to its insertion on the great toe.

The medial aspect of the ankle was scanned after placing the patient in either the right or left lateral oblique position. The posterior tibial tendons, flexor digitorum longus, and flexor hallucis longus are examined in both longitudinal and transverse planes. To identification and evaluation of the flexor hallucis longus, the patient's great toe is gently flex and extend (dynamic maneuvers). After assessment of the medial tendons, the

components of the deltoid ligament are evaluated.

The peroneal tendons in the lateral aspect are examined in both longitudinal and transverse planes. The peroneus brevis is examined to its insertion at the base of the fifth metatarsal. The longus is examined to the cuboid groove, where it turns medial to course along the plantar foot. After assessment of the lateral tendons, the components of the lateral collateral ligaments are evaluated.

The posterior aspect, for examination of the Achilles tendon, the patient is in prone position with the foot hanging over the examination table. The tendon is examined from its origin from the gastrocnemius and soleus muscles to its insertion on the calcaneus in both transverse and longitudinal planes. Dynamic evaluation is achieved by actively plantar flexing and dorsi-flexing the ankle to evaluation of suspected tendon tears.

The sonographic criterion used to identify a tendon or ligament tear is disruption of the uniformly parallel echogenic fibers by one or more hypoechoic gaps which may or may not extend to peripheral surface.

2-Magnetic resonance imaging was performed in Zagazig University hospital and a private center, using Philips Achieva 1.5 T scanner.

All patients who underwent ultrasonography examination were suspected to multi-planner magnetic resonance imaging of the injured ankle with multiple planes, using multiple sequences (T1, T2, STIR, proton density, and fat suppression), by using the following parameters:

T1 weighted imaging: the repetition time = 500-600 msec, Echo time = 20-25 msec, the slice thickness = 4 mm, and the field of view = 17 cm.

T2 weighted imaging: the repetition time = 3000-4000 m sec, Echo time = 15-17 msec, the slice thickness = 4 mm, and the field of view = 17 cm.

Proton density imaging: the repetition time = 1000 m sec, Echo time = 10-30 msec, the slice thickness = 4 mm, and the field of view = 17 cm.

STAIR imaging: the repetition time = 5000 m sec, Echo time = 30 msec, the slice thickness = 4 mm, and the field of view = 17 cm

Fat suppression T2 weighted imaging: the repetition time = 3500-3600 m sec, Echo time = 90-100 msec.

Fat suppression proton density imaging: the repetition time = 2000-2500 m sec, Echo time = 40-50 msec.

Images interpretation

Ultrasonography and magnetic resonance images are assessed and evaluated for any lesions according to:

- Number and site of lesions
- Types of lesion:
  -Tendinous or ligamentous/Partial, complete tear or strain
- Associated lesions: -Edema -Joint effusion

Data analysis

Data were statically analyzed and presented in terms of frequencies percentage when appropriated, also terms of sensitivity, specificity, positive and negative predicting values and accuracy are presented.

All data were analyzed using IBM SPSS Statistics for Windows, version 19 (IBM Corp. Armonk, N.Y. USA).

RESULTS

This study included 24 patients who came to Zagazig medical university hospitals with history of a recent ankle injury, showing 39 acute ankle soft tissue lesions. 16 patients were males representing 66.7 % and 8 patients were females representing 33.3 % of all patients. 13 patients complained of right side ankle trauma representing 54.2%, while the other 11 patients complained of left side acute ankle trauma representing 45.8% of all patients.

24 studied patients with 39 lesions, with the majority were tendonous lesions, 21 tendon injuries representing 53.8% of all lesions.

In this study, ultrasonography was capable in detection of all tendonous injuries and ranging them in severity from tendinosis, tendosynovitis, partial tear to complete tear

Among 21 tendinous lesions, ultrasonography diagnosed 19 lesions.

Ultrasonography missed a diagnosis of longitudinal split tear of peroneal tendon in one patient as well as a diagnosis of flexor hallucis longus tenosynovitis in another patient.

In our study, ultrasonography diagnosis of ankle tendonous injury showed 97.4% sensitivity, 93.2% specificity, 92.3% positive predictive value and 95.83% accuracy.

7 ligamentous injuries were diagnosed in our study 20.8% of total cases and 15.3% of all traumatic conditions

The anterior talofibular ligament was the most frequent affected ligament, and was isolated in 4 patients (80%) of all patients with ligamentous injury and associated with calcaneofibular and posterior talofibular ligaments lesions in one patient.

In our study we found that 20% of all ankle injuries was traumatic ligamentous injuries was ligament sprain, where partial and complete tear were found in 40% for each.

In our study ultrasonography was able to detect the anterior talofibular ligament and the calcaneofibular ligament injuries that identified on the magnetic resonance imaging with missing of one case of anterior talofibular ligament sprain.

In our study, the sensitivity of ultrasonography in diagnosis of ligament injuries was 88.33%, with 81.8% specificity and 91.84%accuracy.

Table 1. Frequency and classification of different ankle traumatic lesions in this study

pathology	No of lesions	%
Tendon pathology	21	53.8
Ligament pathology	7	17.9
Ankle Joint effusion	2	5.1
Ankle Soft tissue edema	9	23.2

Table 2. Accuracy of US findings in diagnosis of tendon lesion.

Ultrasonography values	%
Sensitivity	97.4
Specificity	93.2
Predictive value positive	96.1
Predictive value negative	92.3
Accuracy	95.83

Table 3. Accuracy of US findings in diagnosis of ligament lesions.

Ultrasonography values	%
Sensitivity	88.33
Specificity	81.8
Predictive value positive	86.4
Predictive value negative	80.7
Accuracy	91.84

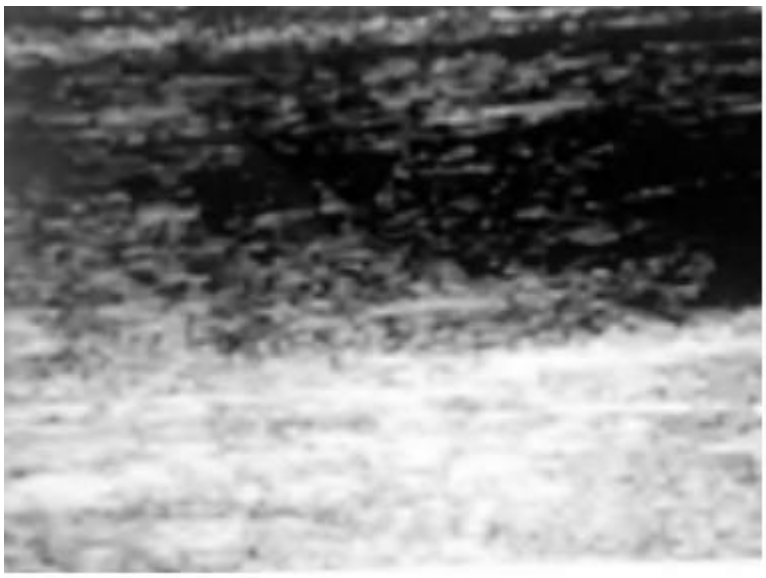

Figure 1A. Longitudinal ultrasonographic scan of right Achilles tendonitis.

Figure 1B. MRI: sagittal T2 weighted images of right Achilles tendonitis.

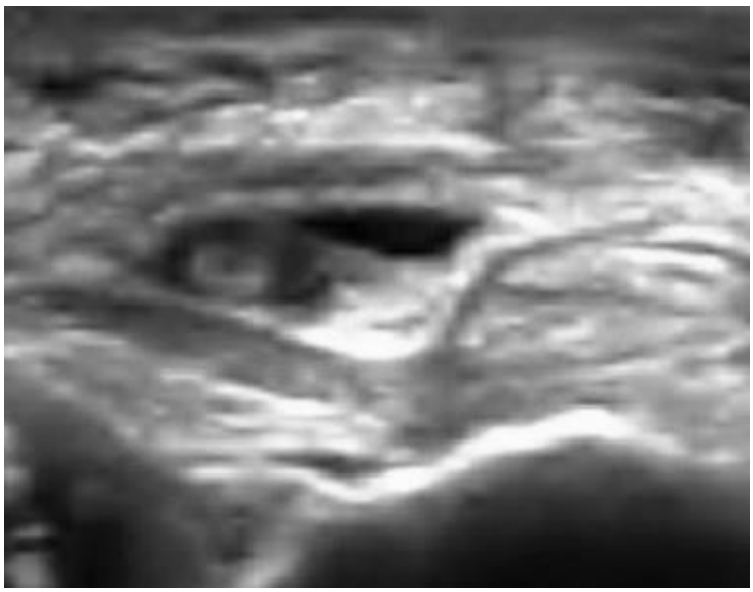

Figure 2A: Transverse ultrasonographic scan of right tibialis posterior tendon partial tear with Tendosynovitis.

DISCUSSION

The ankle injury is an overworld common trauma to a major joint which supports the body and plays an important role in walking mechanism and distribution of the body weight. [1]

The ankle joint can be injured by various ways. The most common one is the inversion injury. [2]

Different imaging modalities can be used to assess the ankle joint injury or trauma, including conventional radiography, computed tomography, magnetic resonance imaging, and ultrasonography. [7]

Magnetic resonance imaging has been proven to be a superior modality with excellent evaluation of the soft tissues of the ankle, providing high imaging details of the anatomical structures and identifying the pathological abnormalities.[3]

The ultrasonography recently showed a continuous development of a high frequency probes, making it an advanced modality in soft tissue assessment with a detailed anatomical presentation and advantage of real-time dynamic examination. [7]

The aim of our study was to compare the diagnostic accuracy of ultrasonography with the magnetic resonance imaging in assessment of soft tissue acute injuries around the ankle joint including tendonous and ligamentous acute insults.

We included twenty-four patients presented with a recent history of unilateral acute ankle injury. All patients were subjected to real-time high-resolution ultrasonography and magnetic resonance imaging of the affected ankle. There was no conflict of interest.

In this study, majority of the patients were males [66.7%] with a mean age of 32.25 years. Fifty-four percentages of the patients were within the age group of 26-35 year.

Thirteen patients suffered from right side ankle tendonous injury, this is in agreement with Hassan Barzegari, Azim Motamedfar, et al,2014[8] , and Klauser Andrea S, Miyamoto Hideaki, et al., 2013[9] who reported that tendon injuries are commonly affecting the middle-aged male individuals

Seventeen patients were diagnosed with a tendonous traumatic injury representing 43.6% of the all diagnosed lesions. Nine patients had Achilles tendon injuries, two patients [22.3%] had complete tendon rupture, four patients [44.4%] had a partial tendon tear, and two patients [22.3%] had Achilles tendinitis.

In concordance to Refaat M. Medhata, Eslam M. et al, [2016] [7] and Liffen Neil, [2014], [47] who stated that the Achilles tendon is the most commonly injured ankle tendon, our results revealed that the Achilles tendon injuries represented 40.9% of diagnosed ankle tendinous injuries and ranged in severity from tendinosis, partial tear to complete tear, and

the Achilles partial tear was the most common one

In our study, ultrasonography was capable in detection of all Achilles tendon injuries which are diagnosed by magnetic resonance imaging [100% sensitivity] and succeeded to classify Achilles injuries similar to the magnetic resonance imaging regarding tendinosis, partial tear, and a complete tear. Our results matched to those of Liffen Neil, 2014 [10] and Margetic Petra, Salaj Martina, et al., 2009 [11] who reported that ultrasonography has been used as a first-line approach for assessing Achilles tendon disorders with estimated 100% sensitivity.

The medial compartment tendons of the ankle were the most second tendons to be affected, the tibialis posterior tendon was the most common one in our study.

The tibialis posterior tendon injuries [in two patients] showed 4 traumatic conditions representing 19% of all tendonous traumatic injuries.

Ultrasonography was showed 100% sensitivity with ability to detect the tibialis posterior tendon injuries identified at the magnetic resonance imaging. This is agreed with Fessell DP, and Jacobson JA., 2013 [12]

All the tibialis posterior tendon lesions were diagnosed by ultrasonography and magnetic resonance imaging and were classified as partial tear and tendosynovitis. Our results were similar to the results achieved by Nevien El-Liethy, and Heba Kamal, 2016 [5] who reported that ultrasonography succeeded to classify tibialis posterior tendon injuries similar to the magnetic resonance imaging regarding partial tear.

In this study, three patients with flexor hallucis longus tenosynovitis were diagnosed. One case was missed by ultrasonography which confirmed by magnetic resonance imaging, however we didn't diagnose any flexor digitorum longus traumatic lesion during this study, this agreed with Refaat M. Medhata, Eslam M. El-Shazlya, et al., 2016 [7] who reported that the flexor digitorum longus tendon is rarely affected by traumatic changes.

The anterior compartment tendons were the least affected tendons in our study presented with one case of tibialis anterior tendon complete tear. Ultrasonography was capable to dignose tibialis posterior tendon injury which was confirmed by magnetic resonance imaging. This comes in agreement with Narvaez JA, Cerezal L., 2003 [13] who reported that anterior compartment tendon injuries are uncommon.

In the current study, the lateral compartment tendons of the ankle were represented with four peroneus brevis tendon lesions which were confirmed by magnetic resonance imaging. Ultrasonography imaging missed a diagnosis of a longitudinal split tear of peroneal brevis tendon where it diagnosis the tenosynovitis in the same patient. The peroneal tendons showed four traumatic lesions representing 19% of all traumatic tendinous lesions. This is in agreement with Lee et al., 2013 [14] who reported that the longitudinal split injury of the peroneus brevis tendon has been increasingly reported as a source of lateral ankle pain and disability.

Our study reported 97.4% sensitivity, 93.2% specificity with 96.1% positive predictive value ultrasonography in diagnosis of ankle tendonous injury with which was higher than Hassan Barzegari, Azim Motamedfar et al., 2017 **[**8**]** who reported that the sensitivity of ultrasonography is equal to 95.2%, the specificity 88.3%, and positive predictive value 80%, in diagnosis of the tendon injury.

Five patients with ligamentous injury were diagnosed in our study 20.8% of total cases and 15.3% of all traumatic conditions.

The anterior talofibular ligament was the most frequent injured ligament [five patients] representing 71.4% of the whole ligamentous injuries followed by the calcaneofibular ligament and the posterior talofibular ligament [14.3% each], and no other ankle ligament injury was detected in this study. This agreed with Artul S, and Habib G., 2014 [15] who reported that the lateral collateral ligament complex is affected in 80–90% of all ankle ligament injuries, and Cheng Y, Cai Y. et al., 2014 [16] who reported that anterior talo-fibular ligament is the most common torn ankle ligament.

In our study, injury of the anterior talo-fibular ligament was an isolated injury in four patients, and a combined injury in one patient. calcaneofibular ligament and posterior

talofibular ligament ruptures were found in one patient with the presence of anterior talo-fibular ligament and calcaneofibular ligament ruptures. This agreed with Stoller DW., 1993 [17] who reported that combined anterior talo-fibular ligament and calcaneofibular ligament tears occur in 40% of anterior talo-fibular ligament tears, and calcaneofibular ligament tears without anterior talo-fibular ligament tears are quite unusual. Also Van Den Bekerom Michel PJ., 2013 et al [18]reported that, after an inversion ankle injury, the visualization of intact anterior talo-fibular ligament virtually excludes rupture of any of the other lateral collateral ligaments.

Regarding the studied ligamentous injury, ultrasonography showed 91.84% accuracy. This is almost like Klein EE, Weil L Jr, 2012 et al [19] who found that the sensitivity of the ultrasonography in the diagnosis of ankle ligament injuries was 91.5%.

Regarding anterior talo-fibular ligament tears ultrasonography showed a sensitivity of 92% which was nearly similar to the results achieved by Cheng Y, Cai Y, Wang Y., 2014 [16] who showed that ultrasonography succeeded to diagnose 14 out of 15 anterior talofibular ligament tears with a sensitivity of 93%, And similar to Margetic Petra, Salaj Martina, et al., 2009 [11] who reported that the ultrasonography results were equal to the operative findings in all patients with anterior talo-fibular ligament injury. However, D'Erme M., 1996 [20] concluded that the magnetic resonance imaging was superior to ultrasonography in the diagnosis of ankle collateral ligaments injuries.

Our results of ultrasonography diagnosis of ankle ligamentous injury showed 91.84 % accuracy which was almost close to Milz P, Milz S, et al., 2017 [21] and Mennatalla S., Sherin M., et al. [22] in their study where they concluded that ultrasonography can identify normal ankle ligaments with about 90% accuracy in evaluation of the ankle ligament injuries.

CONCLUSION

Ultrasonography with the advent of high resolution linear-array as a dynamic, rapid and inexpensive imaging tool and with a high accuracy as magnetic resonance imaging, can be used as a first line diagnostic modality in patient with acute soft tissue injuries

Magnetic resonance imaging is an excellent technique for those cases where the diagnosis is uncertain or cannot be confirmed by ultrasonography, especially when surgical interference is planned.

We recommend that ultrasonography should be used as a first-line in diagnosis of acute soft tissue injury of the ankle joint. In addition, the data collected in our study included patients with a history of a recent trauma only. Therefore, further studies would be performed in all types of tendinous and ligamentous pathology to expand the research group.

Conflict of interest: Nothing to declare.

Financial disclosure: Nothing to declare.

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Cite This Article - VANCOUVER Style

Alnaas, H., Hemat, E., Fahmy, H., Alfawal, M. The Value Of Ultrasonography In Diagnosis Of Acute Ankle Injury Compared With Magnetic Resonance Imaging. *Zagazig University Medical Journal*, 2020; (1048-1056): -. doi: 10.21608/zumj.2019.13171.1236