Research Article

Ultrasonographic assessment of ankle ligament injuries in post-sprained ankle pain.

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Abstract

Aim: to evaluate the diagnostic value of ultrasonography of the ankle in evaluation of ankle sprain-related ligamentous injuries. **Methods:** Fifty patients suffered from sprain-related ankle pain, underwent ankle ultrasonography using Xario-200 Toshiba machine with multi-frequency linear array transducer (selected frequency 12 MHz), then CT arthrography after ultrasonographic guided contrast injection. The sonographic evaluation of the ankle was targeted to lateral collateral, syndesmotic and deltoid ligaments**. Results:** The ultrasonography detected 38 injured ligaments in 28 cases; the most common affected ligament was ATFL(21), then the deltoid ligament(11), then CFL (6). Ultrasonography showed different positive and negative rates with subsequent different sensitivities in diagnosing ankle ligamentous tear when compared with CT arthrography as a stranded of reference method, the ATFL and DD had 100% specificity with very high accuracy 90% and 94% respectively. Beside ligamentous injury detection, ankle effusion and synovial thickening were frequently observed on ultrasonography. **Conclusion:** Ultrasonography is an accurate method for detection of anterior talo-fibular ligament and deep deltoid ligament tears.

Keywords: Ultrasonography, Ankle sprain, Ankle ligament tear.

Introduction

Ankle sprain is one of the most frequent injuries in lower extremity; it is common in case of fall on uneven surfaces or among athletes who participate in sports that involve running on changing terrains, repetitive jumping, or frequent changes in direction. Eighty-five percent of ankle sprains are resulted from excessive inversion with internal rotation of the foot in which the ankle rolls inward at a high velocity, leading to stretching or tearing of the lateral ligament complex. In fact, lateral ankle sprains account for about 20% of sports-related injuries. High ankle sprain (a.k.a. syndesmotic sprains) account for 10% of ankle sprains whereas medial sprains account for only about 5% of patients, combination injuries can occur in severe injuries.

Clinically, symptoms of sprained ankle include variable degree of pain, ankle/foot swelling, ecchymosis and limitation of motion. The injury can be severe enough so the patient may be unable or only partially able to bear weight on the injured ankle. Patients with syndesmotic sprains usually have tenderness over the anterior and posterior inferior tibio-fibular ligaments. [2, 3]

Sequelae of ankle ligament injuries include recurrent instability, recurrent sprains, peroneal nerve palsy, peroneal tendon dislocation/subluxation, degenerative arthritis from chondral injury/osteochondral lesions (OCL), and sural nerve injury.[4, 5]

Ultrasonography is a cheap, quick and radiation-free tool used in ankle imaging; it allows high-resolution dynamic study of the periarticular tendons and soft tissues. It can guide various interventional procedures in the ankle. The main disadvantage of ankle ultrasonography is its operator dependability; other disadvantages include incomplete evaluation of the joint cavity/synovium, and inability to evaluate the osseous structures.(6)

The operator must be familiar with artifacts commonly faced during musculoskeletal ultrasound; the most common and most important one is anisotropy. In general, any tendon or ligament should be imaged while perpendicular to the ultrasound beam in order to obtain the characteristic hyperechoic fibrillar appearance. If the ultrasound beam is angled relative to the long axis the structure being imaged, this hyperechogenicity might be lost; this can occur in as little as 5^o angulation, this change in ultrasound interaction with fibrillar structures is called anisotropy. In order to overcome such anisotropy, the transducer should be toggled or angled in a heel-toe maneuver to get the perpendicular relation with the imaged structure particularly in case of curved or angled ligament as in anterior talo-fibular ligament (ATFL). The main diagnostic applications of ankle ultrasonography are detection of soft tissue masses, inflammation or gas, foreign body detection, detection of fluid collections, detection of tendon pathology as tendinopathy/ tendon tears, detection of ligament tears, and as a guide for many interventional procedures such as joint aspiration, synovial or soft-tissue biopsy, and joint or tendon sheath injection.(7- 9)

Aim of the work

This study was aimed to evaluate the diagnostic value of ultrasonography of the ankle in evaluation of ankle sprain-related ligamentous injuries.

Patients and methods

This analytic observational study was conducted in the department of Diagnostic Radiology, Faculty of Medicine, Minia University, during the period from June 2017 through May 2019 after being ethically approved by the Medical Ethics Committee. Fifty patients, suffered from sprain-related ankle pain, were referred from orthopedic clinic to be recruited in the study; they underwent ankle ultrasonography and CT arthrography. Informed written consent was obtained from all patients prior to participating in the study.

Inclusion criteria for patients were based on chronic post-sprain ankle pain lasting more than three months either continuously or intermittently, subacute sprain-related persistent ankle pain more than 2 weeks duration despite adequate treatment protocol. Recurrent ankle sprain more than three episodes, currently presented with severe acute sprain less than two weeks duration. Patients with overlying soft tissue infection were excluded from the study.

All recruited patients were submitted to targeted ultrasonography of the injured ankle assessing different ankle ligaments using Xario-200 Toshiba machine with multi-frequency linear array transducer (selected frequency 12 MHz), then CT arthrography after ultrasonographic guided contrast injection.

The sonographic evaluation of the ankle was targeted to lateral collateral, syndesmotic and deltoid ligaments. Lateral evaluation was focused on ATFL and calcaneo-fibular ligament (CFL) as they can be assessed by ultrasound. The ATFL was localized by putting the transducer axially over the lateral aspect of the distal fibula at the extreme distal fibula tip, then the transducer was moved slightly superiorly and anteriorly until the level of the talus. The CFL was assessed in both long and short axes, at first; the transducer was placed in an oblique coronal plane between the fibular tip and the posterior heel.

The anterior tibio-fibular ligament (ATibFL) was evaluated by putting the transducer in axial oblique plane over the distal part of the ibia and fibula with the medial border of the transducer was superior.

Both superficial and deep components of the deltoid ligament were evaluated initially placed in the coronal plane at the medial malleolus for tibiocalcaneal component of the deltoid ligament, then with anterior and posterior rotations for other components.

Complete ligamentous tear appears as complete discontinuity of or non-visualization of ligament fibers. Partial tear morphology on ultrasound is variable; it can manifest as irregular contour, focal hypo-echogenicity/ defect or diffuse hypoechogenicity. Ultrasonographic guided contrast injection was then done for CT arthrography.

Results of Ultrasonography and CTA were recorded and tabulated, descriptive statistics were done for all data. Data were represented as or numbers and percent [N (%)] and means ± standard deviations (SD) when applicable. The statistical analysis was done using SPSS-16. Sensitivity, specificity and accuracy of sonographically detected ligamentous tear were done in comparison to CTA.

Results

This study was carried out on fifty patients suffered from ankle pain related to current or previous ankle sprain. There were 23 males and 27 females. The mean age of male patients was 30.83+6.56 y (range 17-44y); whereas the mean age of female patients was 37.3+9.18 y (range 22-50 y).

The ultrasonography detected 38 injured ligaments in 28 cases; the most common affected ligament was ATFL (21), then the deltoid ligament (11), then CFL (6).

Table (1) : Different ligamentous injuries in ultrasonography. (n = 50)

<table>
<tr><th colspan="3">Affected ligament</th><th>Number</th><th>Percent</th></tr>
<tr><td rowspan="5">ATFL</td><td colspan="2">Total number of ATFL tear (n =21)</td><td rowspan="5">21</td><td rowspan="5">42%</td></tr>
<tr><td>Irregular outline</td><td>11/21(52%)</td></tr>
<tr><td>Defect</td><td>2/21 (9%)</td></tr>
<tr><td>Hypoechoic</td><td>12/21 (57%)</td></tr>
<tr><td>Not seen</td><td>8/21 (38%)</td></tr>
<tr><td>CFL</td><td colspan="2">CFL tear</td><td>6</td><td>12%</td></tr>
<tr><td rowspan="3">Deltoid ligament</td><td>Hypoechoic DD</td><td>8/8 (100%)</td><td rowspan="2">8</td><td rowspan="2">16%</td></tr>
<tr><td>DD Defect</td><td>2/8 (25%)</td></tr>
<tr><td colspan="2">SD tear</td><td>3</td><td>6%</td></tr>
</table>

Ultrasonography showed different positive and negative rates with subsequent different sensitivities in diagnosing ankle ligamentous tear when compared with CT arthrography as a stranded of reference method.
(Table 2 and 3).

Beside ligamentous injury detection, ankle effusion and synovial thickening were frequently observed on ultrasonography. **(Table 4**).

Table (2): Positive and negative rates of sonographically detected ligamentous tear

Ligament	True positive	False positive	True negative	False negative
ATFL	21	0	24	5
CFL	3	3	44	0
DD	8	0	39	3

Table (3): Sensitivity and specificity of sonographically detected ligamentous tear

Ligament	Sensitivity	Specificity	PPV	NPV	Accuracy
ATFL	80	100	100	82.7	90
CFL	100	93	50	100	94
DD	72.7	100	100	92.8	94

Table (4): Non-ligamentous sonographic findings (n=50)

Feature	Number	Percent
Effusion	16	32
Synovial thickening	10	20

Discussion

The current study reported 38 injuries to different ankle ligaments (namely ATFL, CFL and deltoid ligaments) with no specification of whether the tear is partial or complete. When considering CTA as a stranded of reference, ultrasonography showed different sensitivities and specificities in detecting ligamentous pathologies among different ligaments. Regarding lateral the collateral ligament complex, ultrasonography

addressed 21 ATFLs as pathologic with 5 false negative cases (all of them were partial tear on CTA and 3 of them showed additional bowing) and subsequent 80% sensitivity and 100% specificity, there were 6 CFLs addr-essed abnormal on ultrasonography with 3 false positive cases and subsequent 100% sensitivity, 93% specificity and low PPV= 50%. In general, for any imaging study to be considered as an ideal technique, it should has a high rate of true positive and an acceptable false positive rate. Regarding ATFL and CFL tear in the current study, both of them have high true positive rates with only 3 false negative cases in CFL, the presence of 5 false negative cases in ATFL could be attributed to presence of many chronic cases in the study, as chronic ATFL tear may develop a scar tissue that will appear echogenic on ultrasonography, and in such a case, it could be difficult to detect especially in small partial tear. In addition, ligamentous bowing that readily detected on CTA can be easily missed on ultrasonography due to lack of joint distension as opposed to CTA. The low PPV in CFL could be explained by the anatomic nature of CFL, as it has a concave course, also the lateral malleolar tip is protuberant making assessment of fibular insertion of the CFL insertion quite difficult.[10]

Many reports studied the role of the ultrasonography in lateral ankle ligaments and concluded its usefulness. Margetic P. et al 2009 studied the ability of 7–15 MHz high frequency ultrasound to distinguish between intact and ruptured ankle ligaments; this was achieved by comparing the findings of ultrasonography with MR findings. Although they found that both ultrasonography and MRI had same sensitivity in diagnosing the presence of injury to ankle ligaments, MRI was more specific in diagnosing full ligamentous tear; furthermore there was statistically significant difference between US and MR findings in imaging of ATFL. Such higher specificity of MRI and statistically significant difference in ATFL were explained by superior soft tissue characteri-zation of MRI and its greater ability to identify mild increase in fluid within an injured ligament than do ultrasonography, so, there was a possibility for mildly injured ligament to still appear normal on ultrasono-graphic examination although having altered MR signal.[11] Hua Y. et al., (2012) investi-gated the value of ultrasonography in identi-fying chronic ATFL injury in 83 patients using ankle arthroscopy as a reference standard. They reported forty four patients found to have ATFL injury on arthroscopy with accuracy of ultrasonography was 95.2%, sensitivity of 97.7%, and specificity of 92.3%. [12]

In more recent study, Cheng Y. et al., (2014) assessed the accuracy of ultrasonography in diagnosis of chronic lateral ankle ligament injury in 120 patients; they compared their results with the operative findings. They reported 94 ATFL injuries, the sensitivity, specificity and accuracy were 98.9%, 96.2% and 84.2% respectively, and reported 65 CFL injuries with sensitivity, specificity and accuracy were 93.8%, 90.9% and 83.3%, respectively, they concluded that ultrasonography provides useful information in chronic pain after ankle sprain. The results of Hua Y. et al., (2012) and Cheng Y. et al., (2014) seem to be higher than what the present study reported especially the sensitivity; however this could be explained by their relative high number of study population compared with our study. [12, 13]

Regarding deep deltoid injury in the current study, there were 8 true positive cases detected by ultrasonography, all of them were partial tear, most of them had medial sprain and presented by either medial or diffuse ankle pain. There was no false positive rate with subsequent 100% specificity; however the presence of 3 false negative cases reduced the sensitivity to 72.7 %. Although all deep deltoid tears in the present study were partial with no complete ligamentous rupture, such finding could be in partial agreement with Chen PY, et al., (2008) who studied the ultra-sonographic examination of the deltoid ligament in bimalleolar equivalent fractures; they reported complete rupture of the deep deltoid ligament in six patients, all of them were confirmed in operative exploration; however in nine patients who had incomplete deltoid ligament tear, there was lack or reference standard method.

In addition, the present study could corroborate what Henari S, et al., (2011) study who utilized by ultrasonography exami-nation of the ankle in 12 patients with supination external rotation fractures requi-ring operative fixation, then followed by an arthrogram, they reported 100% correlation between ultrasonography and arthrogram findings in diagnosing medial deltoid rupture with a specificity of 100%. Both studies demonstrated ankle ultra-sonography to be an accurate imaging modality in assessing deltoid ligament in patients with ankle fractures. [14, 15]

All reported superficial deltoid ligament tears on ultrasonography belonged to cases other than the two cases of medial malleolar fascial sleeve tear detected on CTA, in such a case, obtaining sensitivity and specificity of them were not applicable. Actually, this point was a limitation issue in the present study in medial ankle pathology assessment, CTA was not able to detect superficial deltoid pathologies except when the contrast pass beyond the ankle joint into the tibialis posterior tendon sheath denoting medial malleolar fascial sleeve break, the other components of superficial deltoid ligament usually blend to each other with subsequent difficult identification on the basis of CT attenuation difference, on the other hand, the ultrasonography of the ankle lacks the ability to detect medial malleolar fascial sleeve tear which is a thin sheet of tissue continuous over the medial malleolus, another explanation is concerned with the clinical situation of that cases of medial malleolar fascial sleeve tear as both of them were chronic cases, and this chronicity would reflect on the sonographic appearance of ligamentous injury as there would be absence of ligamentous thickening and edema that could be observed in acute ones.[16]

The study suffered from some limitations, the first: There was relatively little number of surgically treated cases as surgery was primarily targeted to CTA-detected ligamentous tears in context of ankle instability, and although this allowed for assessment of some positive cases, negative case assessment was not available. The second: Although CTA might be considered as a reference for OCL detection, there was lack of ankle arthroscopy which is the traditional standard of reference method, as it was available in our institution for some logistic reasons.

Conclusion

Ultrasonography is an accurate method for detection of anterior talo-fibular ligament and deep deltoid ligament tears.

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