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Full length article

## The feasibility of point-of-care ankle ultrasound examination in patients with recurrent ankle sprain and chronic ankle instability: Comparison with magnetic resonance imaging

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### ARTICLE INFO

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### ABSTRACT

**Objective:** To evaluate the feasibility of point-of-care ankle ultrasound compared with magnetic resonance imaging (MRI) for diagnosing major ligaments and Achilles tendon injuries in patients with recurrent ankle sprain and chronic instability, and to evaluate inter-observer reliability between an emergency physician and a musculoskeletal radiology fellow.

**Material and methods:** A prospective cross-sectional study was conducted in an emergency department. Patients with recurrent ankle sprain and chronic instability were recruited. An emergency physician and a musculoskeletal radiology fellow independently evaluated the anterior talofibular ligament (ATFL), calcaneofibular ligament (CFL), distal anterior tibiofibular ligament (ATiFL), deltoid ligament, and Achilles tendon using point-of-care ankle ultrasound. Findings were classified normal, partial tear, and complete tear. MRI was used as the reference standard. We calculated diagnostic values for point-of-care ankle ultrasound for both reviewers and compared them using DeLong's test. Intra-class correlation coefficients (ICCs) were calculated for agreement between each reviewer and the reference standard, and between the two reviewers.

**Results:** Eighty-five patients were enrolled. Point-of-care ankle ultrasound showed acceptable sensitivity (96.4–100%), specificity (95.0–100%), and accuracy (96.5–100%); these performance markers did not differ significantly between reviewers. Agreement between each reviewer and the reference standard was excellent (emergency physician, ICC = 0.846–1.000; musculoskeletal radiology fellow, ICC = 0.930–1.000), as was inter-observer agreement (ICC = 0.873–1.000).

**Conclusion:** Point-of-care ankle ultrasound is as precise as MRI for detecting major ankle ligament and Achilles tendon injuries; it could be used for immediate diagnosis and further pre-operative imaging. Moreover, it may reduce the interval from emergency department admission to admission for surgical intervention, and may save costs.

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### Introduction

Ankle injuries account for approximately 10% of patient encounters at primary care practices and emergency departments (ED) and occur at a rate of 7 per 1000 persons per year [1,2]. The lateral ankle ligaments are injured in up to 85% of cases [3,4]. The most commonly affected ligament is the anterior talofibular ligament (ATFL), followed by combined injury of this ligament and the calcaneofibular ligament (CFL). Generally, injuries to these ligaments are treated conservatively by applying a splint [5].

However, recurrent ankle injuries are a cause of failure of conservative management and can lead to chronic ankle instability (CAI) [6].

Recurrent ankle sprain in an individual with underlying CAI often necessitates surgical intervention [2,7]. In the pre-operative evaluation, magnetic resonance imaging (MRI) is well able to demonstrate both the anatomy and extent of injury to the ankle ligaments, noninvasively [8,9]. MRI is also useful for predicting the clinical outcome (return to sports activities and full weight-bearing) [10].

In most ED settings, our experience is that although recurrent ankle injury with CAI may require surgical intervention, these patients are treated conservatively with bracing and are discharged without an orthopedic surgeon being consulted. These

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patients subsequently attend the orthopedic outpatient clinic to schedule a date for pre-operative MRI and admission for surgery. Although MRI is the more objective modality, the usefulness of ankle ultrasound in diagnosing ankle ligament injuries has been described [11–13]. However, to date, the use of point-of-care ankle ultrasound in the ED has been restricted to ankle fractures and Achilles tendon injuries [14–18]. To the best of our knowledge, no published study has assessed the usefulness of point-of-care ankle ultrasound in patients with recurrent ankle sprains and CAI. We hypothesized that the two-step evaluation currently used (ED management with subsequent orthopedic outpatient clinic assessment, MRI, and admission, if required) can be changed to a non-stop evaluation (ED assessment with immediate admission, if required) by using point-of-care ankle ultrasound in the ED (Fig. 1).

The aims of this study were to evaluate the feasibility of point-of-care ankle ultrasound for diagnosing major ligament and tendon injuries in patients with recurrent ankle sprain and CAI, to compare ultrasound and MRI as diagnostic modalities, and to evaluate inter-observer reliability between an emergency physician and a musculoskeletal radiology fellow.

## Material and methods

### Study design, setting, and population

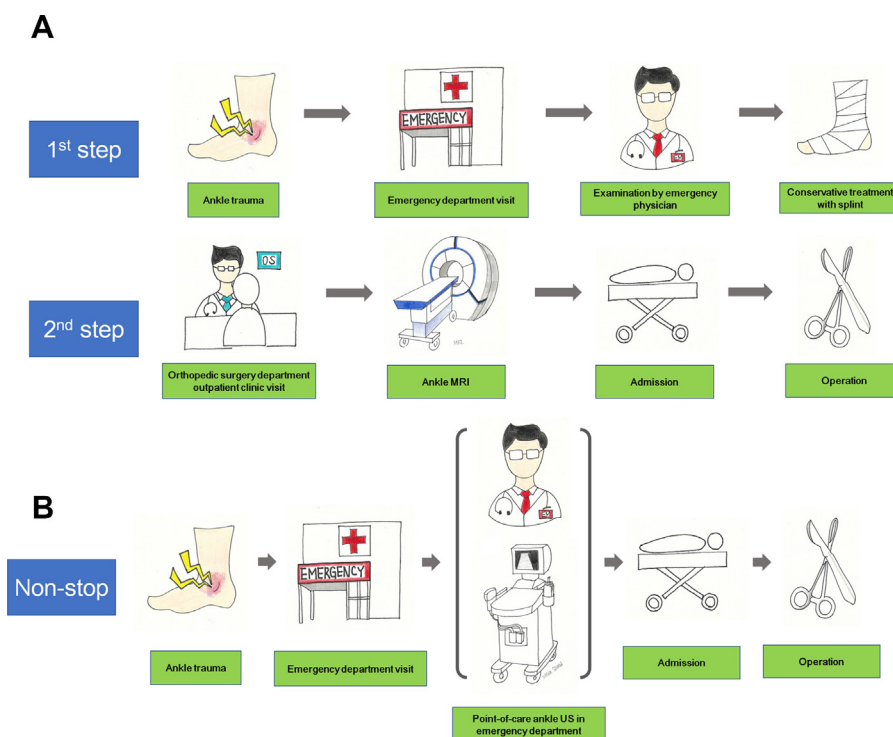
This prospective cross-sectional study was initiated after local ethics committee approval was granted. Written informed consent was obtained from all participants. The study was conducted in an academic ED with an annual census of 76 000 patients. We used a convenience sample of consecutive patients who presented with ankle injuries when the study sonologists (an emergency physician and a musculoskeletal radiology fellow) and research assistant were present in the department (5 days per week, 8:00 a.m. to

6:00 p.m.) from October 1, 2016 to March 31, 2017. Inclusion criteria were: (1) physically active adults aged 18–40 years with acute ankle sprain, (2) a history of ipsilateral recurrent ankle sprain (>3 episodes), (3) ankle instability despite conservative treatment for 6 months, and (4) ankle MRI performed within one month for preoperative evaluation after the ED visit. Ankle instability was evaluated using the anterolateral drawer and talar tilt tests. We excluded patients with the following: (1) fractures detected on plain radiograph or computed tomography images, (2) ankle subluxation or dislocation requiring reduction, (3) previous ankle surgery, and (4) refusal to consent to study participation.

A research assistant collected data from the patients' electronic medical records. These data comprised demographic characteristics, clinical course and cost (from the ED visit to the pre-operative ankle MRI examination), interpretation of the point-of-care ultrasound performed by the emergency physician (recorded in each patient's chart) and of the final report by the musculoskeletal fellow (recorded in the Picture Archiving and Communication System [PACS]), and the senior board-certified musculoskeletal radiologist's final MRI report. The radiologist was blinded to the findings of point-of-care ankle ultrasound.

### Ultrasound training

The study sonologist, a board-certified emergency physician at the time of recruitment, was a novice sonologist assigned to the musculoskeletal section of the radiology department at our institution for a 1-week period. The emergency physician was trained by a senior musculoskeletal radiologist with 10 years' experience in how to perform ankle ultrasound for evaluation of the ankle ligaments, including the ATFL, CFL, deltoid ligaments, distal anterior tibiofibular ligament (ATiFL), and Achilles tendon. The ultrasound equipment (LogiQ E9, GE Healthcare, Milwaukee,



**Fig. 1.** Illustrations depicting (A) the traditional treatment course and (B) the new treatment course using point-of-care ankle ultrasound in patients with recurrent ankle sprain and instability. EM, emergency medicine.

(A) 1-step: Acute trauma → Emergency department (ED) visit → Examination by emergency physician → Conservative treatment with splint. 2-step: Orthopedic surgery (OS) department outpatient clinic visit → Ankle magnetic resonance imaging (MRI) → Admission → Operation.

(B) Non-stop: Acute trauma → ED visit → Point-of-care ankle ultrasound examination in the ED → Admission → Operation.

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