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Topics in Diagnostic Imaging

Diagnostic Ultrasonography of an Ankle Fracture Undetectable by Conventional Radiography: A Case Report

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Abstract

Objective: The purpose of this study is to present diagnostic ultrasonography assessment of an occult fracture in a case of persistent lateral ankle pain.

Clinical Features: A 35-year-old woman presented to a chiropractic clinic with bruising, swelling, and pain along the distal fibula 3 days following an inversion ankle trauma. Prior radiographic examination at an urgent care facility was negative for fracture. Conservative care over the next week noted improvement in objective findings, but the pain persisted.

Intervention and Outcome: Diagnostic ultrasonography was ordered to assess her persistent ankle pain and showed a minimally displaced fracture of the fibula 4 cm proximal to the lateral malleolus. The patient was referred to her primary care physician and successfully managed with conservative care.

Conclusion: In this case, diagnostic ultrasonography was able to identify a Danis-Weber subtype B1 fracture that was missed by plain film radiography.
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Introduction

Ankle injuries are responsible for more than 5 million emergency department visits annually.[1,2] Compared with sprains, there is an 8 to 1 ratio of ankle sprain to fracture.[3] Ankle fracture is the most common intraarticular fracture of a weight-bearing joint.[4] Affecting up to 187 per 100,000 individuals yearly, ankle fractures can present with similar symptoms as a sprain and may require imaging studies to rule out the presence of a fracture.[5–8] Whereas ankle sprains are typically managed conservatively, fractures may require surgical stabilization depending on the type of fracture.[6,9] In most cases, ankle fractures are a straightforward diagnosis and uncommonly require advanced workup.

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The acute ankle fracture can present with symptomatology consistent with an ankle sprain.[6] Tissue swelling and ecchymosis, along with pain and ligament laxity and decreased range of motion, can accompany either fractures or sprains. An inability to bear weight with pain at the medial, lateral, or posterior aspect of malleolus or obvious deformity is an indication for further examination by radiography, ultrasonography (US), or magnetic resonance imaging/computed tomography.[6] Tuning fork tests have some value in ruling out fractures but are not sufficiently reliable or accurate for widespread clinical use.[10] The use of the Ottawa Ankle rules as an initial screening tool may aid in diagnostic decision making between fracture and sprain and limit the need for imaging studies.[6,11–13] Patients that fail this screen have a high probability of fracture and will require imaging.[6,14] Sprain injury or tendon injury can also result in failure of the Ottawa Ankle rules. The relatively low specificity (48.4%) is reflective of the other potential injuries seen with ankle inversion.[15] The purpose of this case report was to demonstrate the ability of diagnostic US to image an occult fibula fracture.

Case Presentation

A 35-year-old white woman presented for chiropractic care 3 days following an inversion ankle injury. She reported immediate self-management with rest and ice and woke up the next morning with severe pain in the lateral ankle area. She went to her local urgent care facility where plain film radiographs were performed and interpreted by a radiologist as negative for fracture and gross abnormality (Fig 1A and B). The radiology report indicated incidental bone spurs at the plantar surface of the calcaneus as well as the Achilles tendon insertion. Pain was reported with active dorsiflexion and inversion of the ankle, rated 6 on a scale of 1-10. She described moderate difficulty going up and down stairs, walking on her toes, and initiating walking from rest.

Physical examination observed bruising and edema over the lateral ankle and foot with intact sensory and motor findings. Palpation demonstrated tenderness along the anterior talofibular ligament, Achilles insertion, and diffusely around the lateral malleolus and distal fibula. Pain could not be reproduced with palpation to the medial malleolus, base of the fifth metatarsal, and/or navicular. Pain was reproduced with passive dorsiflexion and inversion. Talar tilt maneuver was negative with eversion. Ankle drawer test was painful, but no laxity was noted. Vibration from a tuning fork placed over the lateral malleolus and distal fibula produced pain.

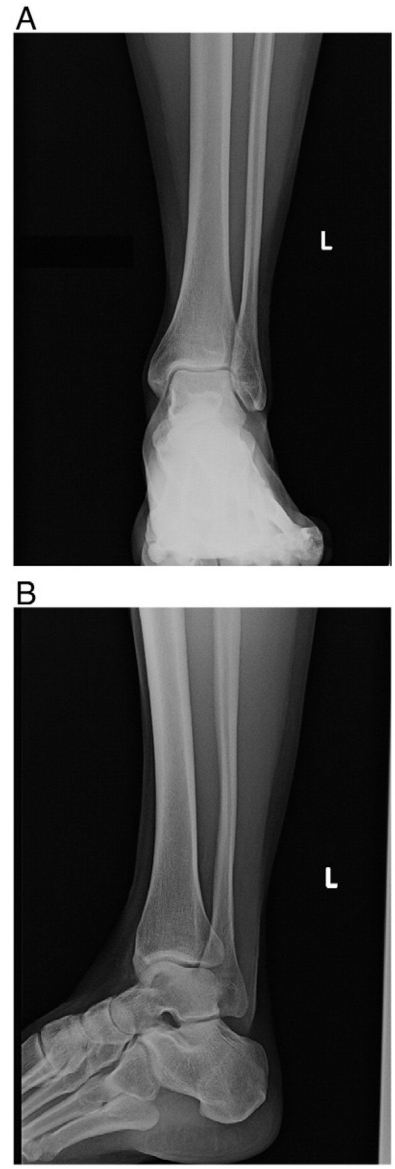

Fig 1. A and B, Anteroposterior and oblique projections of the ankle demonstrate no evidence of corticol disruption to suggest fracture. There is no evidence of dislocation.

She was diagnosed with a grade II lateral ankle sprain and treated conservatively with ankle mortise dorsiflexion mobilization, lymphedema taping, open chain ankle range of motion exercises, and instruction in ice application. Grade II classification describes incomplete ligament tear with moderate functional impairment and usually present with moderate pain and swelling, mild to moderate ecchymosis, tenderness, and mild/moderate instability on stress examination.[16] She presented 2 more times in the next week for follow-up care. Objective improvement in bruising and edema was noted; however, she continued to experience severe pain with walking. Less than 2 weeks following initial presentation, the patient was directed to Logan College of Chiropractic's Department of Radiology for advanced imaging with diagnostic US.

Diagnostic US revealed a minimally displaced fracture of the distal fibula approximately 4 cm proximal to the lateral malleolus (Figs 2A-B and 3). In addition, there were a number of soft tissue findings: grade I sprain of the anterior talofibular ligament (Fig 4), small fibular insertional tear of the extensor retinaculum (Fig 5), and mild fibularis tenosynovitis. Upon review of her US findings, the patient was referred to her primary care physician. The patient was fitted by her primary care physician with a temporary walking boot and was recommended the Rest, Ice, Compression, and Elevation acute injury protocol.[17] She wore the boot for a couple of weeks and was never totally non–weight bearing. She presented 7 more times for follow-up pain management and rehabilitation with chiropractic care. Treatment at follow-up sessions consisted of lymph edema taping, acupuncture, myofascial release, and rehabilitative exercise progressing from open chain to closed chain weight-bearing movements. Presence of mechanical sensitivities and activity tolerance were used to guide patient rehabilitation (Table 1). At 1-year follow-up, the patient indicated that she was pain-free and without any limitations in her activities of daily living. The patient provided consent for publication of deidentified clinical information and imaging.

Discussion

Fracture of the ankle is commonly encountered following inversion injury. Following an inversion injury, clinical screening for fracture can be accomplished by means of the Ottawa foot and ankle rules.[18] Although the Ottawa rules are quite sensitive (96.8% as recently reported by Wang et al[15]), specificity is lacking (48.4%).[19] At the time of presentation for chiropractic care, the patient met the Ottawa criteria for

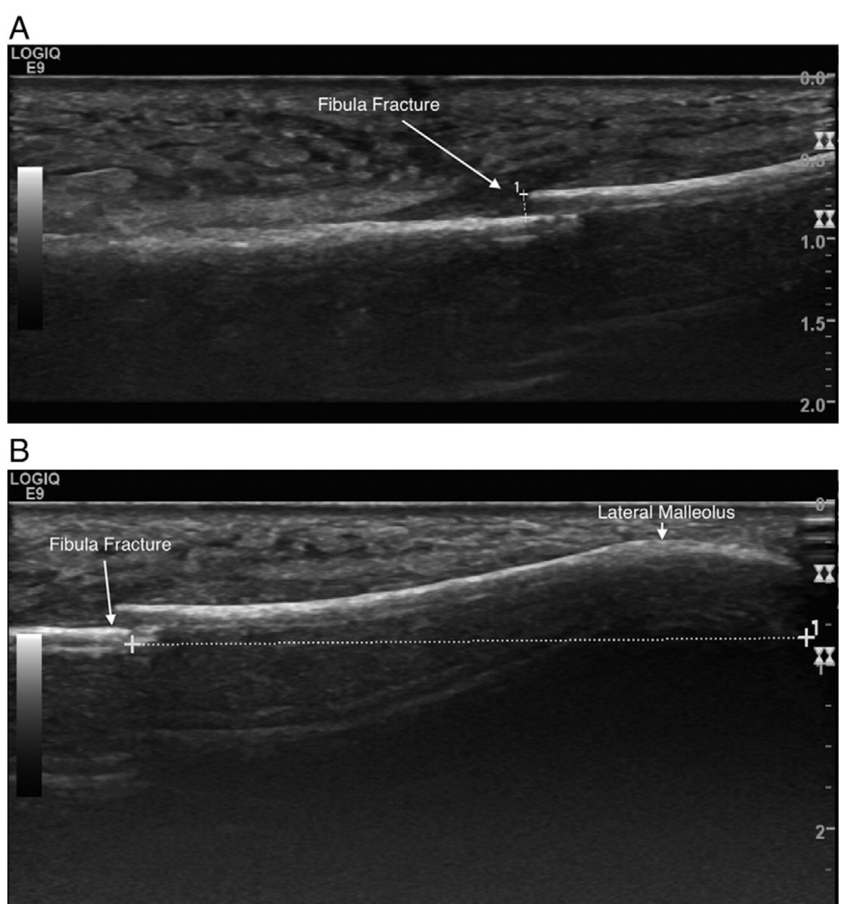

Fig 2. A and B, Grayscale US images demonstrates cortical offset with overlying hematoma consistent with a fracture located approximately 4 cm proximal to the lateral malleolus.

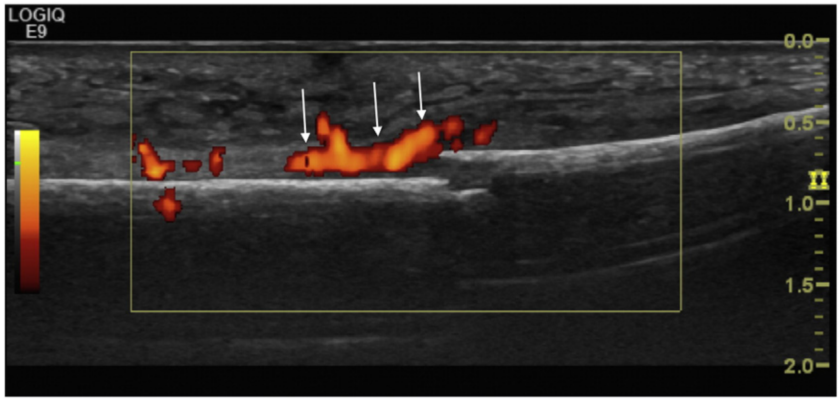

Fig 3. Power Doppler imaging demonstrates active vascular response at the site of fracture.

ankle radiographs because of tenderness of the distal fibula. Although there was tenderness in the lateral malleolar zone, the patient was able to bear weight and continued to do so for several days following her inversion injury. Prior radiographic examination following injury was negative for fracture, further confusing the clinical presentation. In light of continued pain following negative radiographic examination, further imaging was warranted.[20] Ultrasonography identified a fracture located 4 cm proximal to the malleolus, within the 6 cm proposed in the Ottawa rules. Tenderness was present with palpation at the fracture site but also diffusely around the malleolus at the time of US examination. Repeat radiography may be used for occult fracture detection; however, the clinician was interested in the integrity of the anterior talofibular ligament and surrounding soft tissue structures as well, thus the decision to assess the patient with sonography.

For description of fractures, the foot is divided into the malleolar zone and midfoot zone.[6] Fractures can occur at the tibia, fibula, and talar dome. However, lateral malleolus fractures are the most common.[6] Ankle fractures can be described based on fracture location (Danis-Weber classification) or by injury mechanism (Lauge-Hansen classification).[21] The Danis-Weber classification describes ankle injury based on fibular fracture location in relation to the tibiotalar joint. Types A, B, and C are described. Type A injuries include a fracture of the fibula distal to the tibiotalar joint. The medial malleolus may also be fractured. Type B injuries include a fibular fracture, typically an oblique fracture, at the level of the tibiotalar joint space. The tibiofibular syndesmosis may be partially torn. Associated medial malleolar injury may also be seen with type B injuries. Type C injuries include a fracture of the fibula proximal to the tibiotalar joint. In type C injuries, the tibiofibular syndesmosis is more severely disrupted. This causes widening of the distal tibiofibular joint space. Medial malleolar injury, including fracture and/or deltoid ligament disruption, is present with type C injury.[21]

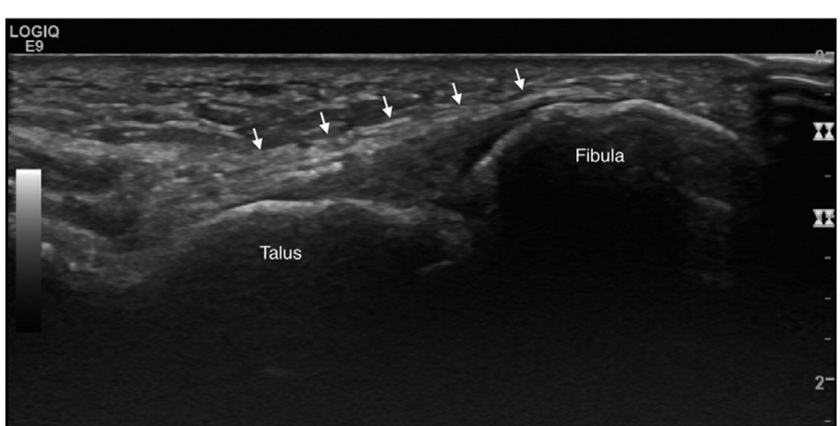

Fig 4. The anterior talofibular ligament is slightly thickened and hypoechoic consistent with grade 1 sprain injury. No full- or partial-thickness ligament disruption is identified.

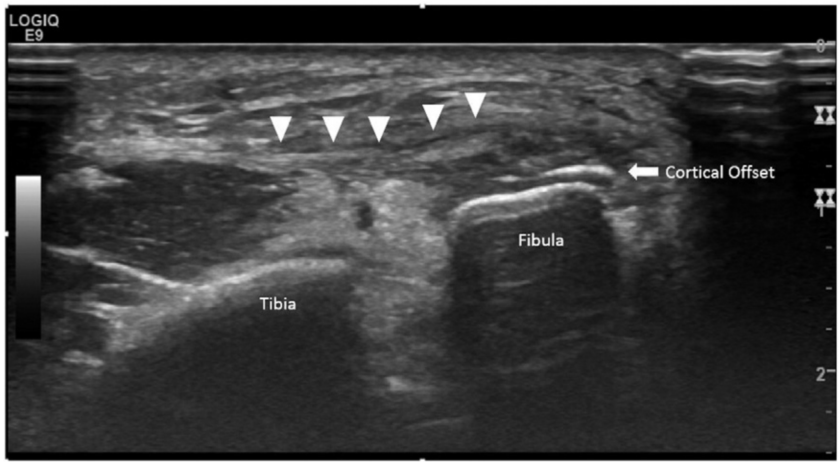

Fig 5. Thickening and hypoechogenicity of the superior extensor retinaculum are identified adjacent to the site of cortical offset.

For the purpose of simplification, the Danis-Weber classification will be used in this manuscript.

Ultrasonography is a useful tool for evaluation of fractures in the ankle and several other superficial anatomical areas.[11–13,22–27] In a study by Cangasabey et al, US had a sensitivity of 90.9% (95% confidence interval [CI], 65.7%-98.3%) and a specificity of 90.9 (95% CI, 88.1%-91.7%) for detection of ankle fractures in Ottawa rule–positive patients. Nine patients in their study had sonographically detectable fractures following negative radiography. Ultrasonography demonstrated a positive likelihood ratio of 10.00 (95% CI, 5.526-11.901) and negative likelihood ratio of 0.100 (95% CI, 0.018-0.389). Only 1 fracture was not seen on US with a positive radiographic examination.[12] In cases such as the one presented, US is an ideal choice for further examination in patients with continued pain and negative radiography. In addition to the fracture detection, soft tissue injury was also identified as described above, adding further value to the utilization of US.

The Danis-Weber classification may be used to categorize ankle fractures. The fracture in our case was above the ankle mortise, thus making it a Weber B fracture, subtype 1. Surgical intervention was not indicated because the fracture was minimally displaced and there were no unstable soft tissue injuries. In more complex type B fractures (fracture at the level of the ankle mortise with disruption of the deltoid ligaments and/or medial malleolar fracture) or type C fractures (fracture above the ankle mortise joint with disruption of the tibiofibular syndesmosis, disruption of the deltoid ligaments, and/or medial malleolar fracture), surgical intervention is indicated.[28] Our patient was treated conservatively with rest, use of a walking boot, and physical rehabilitation. No complications were encountered.

Ultrasonography may also be used to assess fracture healing.[22,23] Serial sonography can demonstrate callus formation and fracture union. Analysis of fracture healing may be especially useful in evaluation of individuals for return to play or activity. Fracture union can is diagnosed on average 2 weeks earlier via US compared with radiograph.[29] If union is detected with US and clinical union has been achieved, the patient may return to play. The nonionizing nature of US imaging is well suited for interval examination. Our patient elected not to undergo interval examination to monitor healing.

Table 1 Diagnostic Progression

Day	Event
Day 0	Initial injury
Day 1	Present to urgent care; plain film radiographs taken
Day 3 (visit 1)	Present for chiropractic care
Day 11 (visit 3)	Diagnostic US imaging ordered
Day 12	Diagnostic US performed; referred for co-management with medical provider
Day 136 (visit 10)	Released from chiropractic care for ankle injury

Limitations

The limitations are consistent with those typical of all case reports in that the information is anecdotal in nature and cannot be generalized beyond the individual case. Furthermore, this case lacked any numerical outcome measures to evaluate you progression of care. This particular patient has a tendency toward catastrophizing her symptoms; therefore, follow-up up Numeric Rating Scale was intentionally not monitored to minimize catastrophization.[30] The Lower Extremity Functional Scale and Medical Outcomes Study Short Form–36 could have been used to monitor patient progress.[31]

Conclusion

In this case, use of plain film radiography was not sufficient to reveal the Danis-Weber subtype B1 fracture, and diagnostic US was necessary for correct diagnosis. Ultrasonography may be an effective for advanced imaging with persistent ankle pain. It has the ability to be used dynamically and can identify soft tissue injury in addition to cortical irregularities—such as fractures.

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No funding sources or conflicts of interest were reported for this study.

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