The Anatomic Pattern of Injuries in Acute Inversion Ankle Sprains

A Magnetic Resonance Imaging Study

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Background: There are little data on the incidence and patterns of injuries seen on magnetic resonance imaging (MRI) in acute inversion ankle sprains. This study may help in the understanding of the pathomechanics, natural history, and outcomes of this common injury.

Study Design: Case series; Level of evidence, 4.

Methods: From June 2011 to June 2013, a total of 64 consecutive patients had MRI of the ankle performed for acute inversion injury to the ankle. All injuries/pathologies reported were recorded.

Results: Only 22% of patients had isolated lateral ligament complex injuries. Twenty-two percent of patients had other pathologies but no lateral ligament injury, and 53% had lateral ligament injuries in combination with other pathologies or injuries. The most common associated finding with lateral ligament injuries was bone bruising (76%) followed by deltoid ligament injury (50%). The overall incidence of bone bruising was 50%. Thirty percent of ankles had tendon pathology, 27% had deltoid ligament injury, and 22% had occult fractures.

Conclusion: Isolated lateral ligament ankle injury is not as common as is believed. The pattern of injury seems complex, and most patients appear to have more injuries than expected. MRI reveals additional information that may have significance in terms of diagnosis, treatment, and prognosis in this common injury.

Keywords: ankle; sprain; magnetic resonance imaging; sports injuries

Ankle "sprains" are common injuries. The incidence has been reported to be between 2 and 7 per 1000 person-years.[4,10,24] The absolute risk of ankle sprains had been estimated to be 1 per 1000 sports hours[23] and makes up a significant amount of lost playing time.[12] In addition to the loss of sporting time, the cost of treating ankle sprains can be high for the individual and health care systems.[11,23] It is generally believed that 80% to 90% of ankle ligament injuries involve lateral ligaments, with the anterior talofibular ligament (ATFL) being the most vulnerable.[8,12] Nonetheless, there may be other associated injuries that are sometimes overlooked or difficult to detect at physical examination. Conventional treatment involves rest, ice, compression, and elevation followed by active range of motion and neuromuscular coordination and peroneal strengthening. However, the optimal length of treatment is unknown, and insufficient rehabilitation of the ankle may result in residual symptoms. Physical examination during the acute situation can be unreliable because of pain. Magnetic resonance imaging (MRI) of the ankle is now an available adjunct to clinical assessment of ankle sprains. Although reports of the sensitivity and specificity of MRI for the diagnosis of ankle sprains have been variable in the literature,[3,13,18] it is still a useful tool to identify other occult injuries that would otherwise go unrecognized. MRI is often limited to patients with persistent pain and swelling because of high costs, the high incidence of sprains, and limited resources. As such, most of the available studies on the usefulness of MRI in ankle sprains focus on patients with chronic symptoms.[13,18] There is little information on the pattern of injury seen on MRI in acute ankle injuries. We aim to report the patterns of injury seen on MRI of the ankle in patients presenting with acute inversion ankle sprains. We believe that MRI is likely to identify many occult or unexpected injuries.

METHODS

This study was performed with the approval of our local institutional review board. For the purpose of this study, all patients presenting to a single foot and ankle surgeon's clinic from June 2011 to June 2013 with ankle sprains were

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The authors declared that they have no conflicts of interest in the authorship and publication of this contribution.

The Orthopaedic Journal of Sports Medicine, 1(7), 2325967113517078
DOI: 10.1177/2325967113517078
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TABLE 1
Breakdown of MRI Findings (N = 64 Patients)[a]

MRI Finding	n (%)
Normal	2 (3.1)
Lateral ligament injury only	14 (21.8)
ATFL only	9
ATFL + CFL	5
No lateral ligament injury but other findings	14 (21.8)
Lateral ligament injury + other findings	34 (53.1)
Total	64 (100)

[a]ATFL, anterior talofibular ligament; CFL, calcaneofibular ligament.

reviewed. It was the surgeon's routine practice to offer an MRI scan of the ankle to all patients who presented to his clinic with ankle sprains.

We retrospectively selected 64 consecutive patients from the radiology archives. The medical records were reviewed for the mechanisms of ankle injuries and time of injury to MRI scan. Only patients who reported inversion injury to the ankle and also had MRI of the ankle within 3 months of injury were selected for this series. The formal MRI reports were reviewed, and all reported findings, including that of sprains, partial and complete ligament tears, bone edema, fractures, tendonitis, tendon tears, syndesmosis injury, and osteochondral lesions were recorded into an Excel (Microsoft Corp, Redmond, Washington, USA) database. Anterior inferior tibiofibular ligament injuries were included in the syndesmosis injury group. We excluded patients who had radiographic evidence of fracture, including flake-like avulsion fractures, prior ankle surgery, or chronic ankle pathology.

RESULTS

The mean age of the 64 patients (55 males, 9 females; 33 right ankles) was 25 years (range, 13-49 years). The mechanisms of injury were sporting activities (n = 35; 54.6%), walking (n = 18; 28.1%), fall (n = 9; 14.1%), and road traffic accidents (n = 2; 3.1%). The median time from injury to MRI was 6 weeks (range, 4 days to 12 weeks). Only 14 patients (22%) had isolated lateral ligament complex injuries. Fourteen patients (22%) had other injuries but no lateral ligament injury. Thirty-four patients (53%) had lateral ligament injury and other concomitant injuries (Table 1). The overall incidences of the MRI findings are listed in Table 2.

Lateral Ligament Injury

Forty-eight patients (75%) had injury to the ATFL, 26 (41%) had injury to both ATFL and calcaneofibular ligament (CFL), and 3 (5%) had posterior talofibular ligament (PTFL) injury. Thirty-four of the 48 patients (71%) with lateral ligament injury also had other concomitant findings on MRI (Table 3). The most common associated finding was bone bruising (26/34; 76%), followed by deltoid injury (17/34; 50%). Nine of 34 patients (26%) had lateral ligament injury and 1 other concomitant finding, 15 patients (44%) had 2 other findings, 5 (15%) had 3 other findings, and 5 (15%) had 4 other findings.

TABLE 2
Total Number and Overall Incidence of Each MRI Finding[a]

MRI Finding	n	Incidence, %
ATFL injury	48	75
Bone bruise	32	50
CFL injury	26	41
Tendon pathology	19	30
Deltoid injury	17	27
Fracture	14	22
Osteochondral lesion	9	14
Syndesmosis injury	5	8
PTFL injury	3	5
Sinus tarsi change (obliteration of fat signal)	1	2

[a]ATFL, anterior talofibular ligament; CFL, calcaneofibular ligament; PTFL, posterior talofibular ligament.

TABLE 3
Injuries on MRI Occurring in Association With Lateral Ligament Injury (n = 34 Patients)

Associated Injury	n	Incidence, %
Bone bruise	26	76
Deltoid injury	17	50
Tendon injury	11	32
Fracture	10	29
Osteochondral lesion	6	18
Syndesmosis injury	2	6
Sinus tarsi change	1	3

Other Pathology

Overall, 32 patients (50%) had bone bruising, 19 (30%) had tendon pathology, and 14 (22%) had fractures. One patient had ATFL tear and obliteration of sinus tarsi fat. Twelve patients (19%) did not have lateral ligament complex injuries but had other findings on MRI. The locations of the fractures are illustrated in Table 4. The overall incidence of fracture was 22%, of which 13% were avulsion-type fractures and 9% were non-avulsion-type.

DISCUSSION

Ankle sprains are common injuries, particularly in young individuals participating in sports. However, rather surprisingly, little is known with regard to the best diagnostic techniques, management, and outcomes. There are even less data on the patterns of injury seen on MRI when performed in acute ankle sprains. In the management of ankle sprains, most would advise conservative management, the duration of which is variable, while advanced imaging is

TABLE 4
Location of Occult Fractures Recorded on MRI

Patient	Laterality	Sex	Age, y	Mechanism of Injury	Time From Injury to MRI	Fracture Location
1	Left	Male	17	Walking	10 days	Distal tibia medial epiphysis extending into physeal plate
2	Right	Male	20	Sports injury	6 weeks	Avulsion fracture of talus at deltoid insertion
3	Right	Male	22	Sports injury	9 weeks	Avulsion fracture medial malleolus
4	Right	Male	21	Walking	4 weeks	Avulsion fracture lateral malleolus
5	Left	Male	28	Sports injury	5 weeks	Lateral tibial plafond fracture
6	Right	Male	19	Fall	7 weeks	Avulsion fracture of lateral malleolus and deltoid attachment
7	Left	Male	45	Sports injury	12 weeks	Avulsion fracture of lateral malleolus
8	Right	Male	27	Fall	4 weeks	Avulsion fracture of medial malleolus
9	Right	Male	30	Sports injury	12 weeks	Fracture of navicular
10	Right	Male	49	Walking	4 weeks	Fracture of cuboid
11	Right	Female	24	Walking	5 weeks	Third metatarsal base fracture
12	Right	Male	19	Sports injury	2 weeks	Avulsion fracture of lateral malleolus
13	Right	Female	38	Walking	8 weeks	Avulsion fracture of lateral malleolus
14	Right	Male	20	Sports injury	8 weeks	Avulsion fracture of lateral malleolus

usually only offered to those with persistent symptoms. Ankle sprains are most commonly inversion injuries with supination and plantar flexion of the foot and external rotation of the tibia. They are classified as grades 1 through 3 in order of severity. In grade 1 injuries, there is stretch to the ligament with no increase in laxity; grade 2, macroscopic rupture with some increased laxity; and grade 3 indicates complete rupture. However, this grading system concentrates on the severity of the injury to the lateral ligaments, with no focus on the possibility of other concomitant injuries.

Clinical assessment in the acute setting may not be reliable as it may be limited by pain. Frey et al[7] evaluated 15 patients with inversion injuries to the ankle who had MRI within 48 hours of injury and found physical examination to be only 25% accurate in the diagnosis of grade 2 injuries. They found that clinicians often underestimate the damage with grade 2 ligament tears.[7] Treatment options include rest, early mobilization, immobilization, or surgical repair of torn ligaments. However, it has been estimated that between 30% and 74%[2,20] of patients with injuries of the ankle ligaments have residual symptoms of pain or instability regardless of treatment, suggesting that perhaps other factors or associated injuries may have an impact on outcome. This remains a controversial topic at present. Although a high proportion of patients with ankle sprains have residual symptoms, most returned to sports or work within 3 months.[2,27]

In our series of patients, only 22% had isolated lateral ligament injury, whereas 53% also had concomitant pathologies on MRI. The most common associated finding was bone bruising. Bone bruises are thought to represent trabecular microcontusions. Their significance and natural history in the ankle, unlike the knee where they tend to resolve in 1 to 4 months after injury, is unknown.[1,21,27] In the ankle, bone bruises may persist beyond this period,[21] suggesting that increased time may be needed for their healing. In addition, whether bone bruises develop into subsequent osteochondral pathology remains unknown.[16] Although bone bruises are often associated with ligamentous injury, they have been found to be more common in runners suggesting that, under these circumstances, bone bruises may also be caused by exercise.[15] The incidence after ankle sprains has been reported to be between 7% and 40%.[14,17,19] The incidence of bone bruises in this series (50%) was consistent with the reported literature. There appears to be an increased frequency of bone bruises in ankles with multiple ligament injuries.[14,19] In a series of 54 patients where approximately half did not have ligament injury on MRI, Yammine and Fathi[26] suggested that isolated bone bruise and tendon injury may present with similar clinical signs as ankle sprains. We found 1 randomized controlled trial evaluating the significance of bone bruises and clinical outcome.[1] In this series of 95 patients, 27% of patients had bone bruises but they did not affect clinical outcome, time to return to work, or mobility at 3 months. The significance of bone bruises found on MRI and whether they require treatment or follow-up remains unknown.

Deltoid ligament sprains were also common in this series, with an overall incidence of 27%. In the subgroup of patients with MRI evidence of lateral ligament injury, the incidence of deltoid injury was 35%. Deltoid ligament injuries occurred in 50% of patients with lateral ligament injuries in combination with other pathologies. The deltoid ligament is an important medial structure that plays a role in preventing ankle eversion and some degree of external rotation. The position of the foot appears to have a role in injuries sustained during sprains. Damage to the deltoid ligament is believed to be a result of an external rotation force to the foot. One cadaveric study evaluating external rotation force in a neutral or everted foot with the ankle in dorsiflexion found that deltoid ligament injury is more likely when the foot was in neutral while a similar force is likely to damage the syndesmosis in the everted foot.[25] Injury to the deltoid ligament has been found to be present in patients with chronic ankle instability who may or may not present with symptoms of medial pain.[5,9] The incidence of deltoid ligament injury was found to be 68% in patients who underwent lateral ligament surgery for chronic instability noted in their preoperative MRI.[5] Hintermann

et al[9] performed arthroscopic evaluation of 148 chronically unstable ankles and found the incidence of deltoid injury to be about 40%, and all of these patients had damage to the lateral ligament complex. About one third of these patients reported symptoms on the medial aspect of the foot or ankle. The incidence of deltoid ligament injury in acute "sprains" in our study matches these 2 studies of patients with chronic ankle instability. Interestingly, the incidence of deltoid ligament injury in our study is similar to the incidence of residual pain and instability in outcome studies of ankle sprains. We do not know the significance of our findings. At present, there are no guidelines for the management of deltoid injuries in the absence of fracture. There is a possibility that damage to the deltoid ligament could serve as a predictor of future instability, and this group of patients may require closer follow-up and/or a longer duration of protected mobilization. A better understanding of the role of the deltoid ligament in ankle stability may also facilitate strategies designed to prevent chronic instability.

Patients who present with ankle sprains with normal radiographs may have occult fractures of the ankle and foot. The incidence of osseous injuries in patients presenting with ankle sprains based on radiographs have been reported between 4.6% and 14.4%.[6,22] Sujitkumar et al,[22] in a review of 1600 patients presenting with all ankle injuries, found the incidence of minor flake fractures to be 4.6%. Another study of 639 patients presenting with ankle sprains found the incidence of fractures to be 14.4%.[6] This group excluded ankle fractures apart from avulsion fractures. Both these studies used radiography to evaluate injuries in the ankle and foot. The use of MRI could explain the higher incidence of fractures reported in our study. We did not find any other studies evaluating the incidence of fractures with the use of MRI in ankle sprains.

Our study has limitations. First, it is a retrospective study with a small sample size. There was a substantial range of time from injury to MRI because of delays between presentation to the emergency department, review by the foot and ankle specialist, and time to obtain outpatient MRI. We felt that the mean time of 6 weeks from injury to MRI was a reasonable criterion for acute injuries. In addition, the MRI imaging protocol was not standardized, and the scans were read by different radiologists. It would have been meaningful to perform correlation studies between MRI findings and clinical outcome; however, this was not the aim of our study.

CONCLUSION

The role of early MRI in acute inversion ankle sprains and the significance of the injury patterns remain unclear. The results of this study indicate that ankle sprains may not be as simple as believed. There are many questions yet to be answered in the diagnosis and management of this common injury. More research is needed to correlate the MRI findings to the clinical presentation, natural history, and outcomes of treatment for inversion ankle injuries.

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