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ORIGINAL ARTICLE

Role of Magnetic Resonance Imaging in Evaluation of Post-Traumatic Ankle Joint

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ABSTRACT:
Background: Post-traumatic ankle injuries represent a significant cause of morbidity, with accurate diagnosis essential for appropriate treatment planning. This study aims to evaluate the efficacy of Magnetic Resonance Imaging (MRI) in diagnosing post-traumatic ankle pathologies compared to clinical examination and conventional radiography. **Methods:** A prospective study was conducted on 84 patients with post-traumatic ankle injuries between January 2023 and December 2024. All patients underwent clinical evaluation, radiographic examination, and MRI. Diagnostic accuracy was assessed, and findings were correlated with surgical outcomes in patients who underwent operative management. **Results:** MRI demonstrated superior sensitivity (94.7%) and specificity (92.3%) in diagnosing ligamentous injuries compared to clinical examination (sensitivity 78.5%, specificity 76.2%) and radiography (sensitivity 42.1%, specificity 87.5%). For osteochondral lesions, MRI showed 96.8% sensitivity and 93.4% specificity. MRI accurately detected 97.2% of tendon injuries. Surgical correlation in 42 patients showed 93.8% concordance with MRI findings. **Conclusion:** MRI provides comprehensive evaluation of post-traumatic ankle pathologies with high diagnostic accuracy, enabling precise treatment planning and potentially improving clinical outcomes.

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INTRODUCTION

Ankle injuries account for approximately 20% of all sports-related injuries and represent one of the most common musculoskeletal complaints in emergency departments worldwide.[12] While conventional radiography remains the initial imaging modality for acute ankle trauma, it has limited sensitivity for soft tissue injuries, which constitute a significant proportion of ankle pathologies.[3]

The ankle joint, a complex structure comprising multiple ligaments, tendons, and articular surfaces, requires accurate diagnosis of injury for appropriate management. Delayed or missed diagnoses may lead to chronic pain, instability, and progressive joint degeneration.[4] Magnetic Resonance Imaging (MRI) has emerged as a valuable tool in evaluating post-traumatic ankle conditions due to its multiplanar capabilities and excellent soft tissue contrast.[5]

This study aims to evaluate the role of MRI in diagnosing post-traumatic ankle pathologies, including ligamentous injuries, osteochondral lesions, tendon abnormalities, and occult fractures, comparing its diagnostic accuracy with clinical examination and conventional radiography.

MATERIALS AND METHODS

Study Design and Patient Selection

This prospective study was conducted at University Medical Center between January 2023 and December 2024. Institutional review board approval was obtained, and informed consent was secured from all participants. Eighty-four patients (47 males, 37 females; mean age 34.8 ± 12.6 years) with post-traumatic ankle injuries were included. Inclusion criteria were: (1) history of ankle trauma within 14 days, (2) clinical suspicion of significant injury requiring further evaluation, and (3) age 18-65 years. Exclusion criteria included: (1) previous ankle surgery, (2) contraindications to MRI, (3) inflammatory arthropathy, and (4) advanced degenerative joint disease.

Clinical and Radiographic Evaluation

All patients underwent standardized clinical examination by an orthopedic specialist blinded to imaging findings. Anterior drawer test, talar tilt test, squeeze test, and specific tendon evaluations were performed. Pain was quantified using Visual Analog Scale (VAS). Initial conventional radiographs included anteroposterior, lateral, and mortise views.

MRI Protocol

MRI examinations were performed using a 3T scanner (Siemens Magnetom Skyra, Erlangen, Germany) with a dedicated ankle coil. The standardized protocol included:

- Sagittal T1-weighted spin-echo (TR/TE 550/15ms)
- Axial and coronal proton density-weighted images with fat suppression (TR/TE 3000/30ms)
- Sagittal STIR (TR/TE/TI 4000/30/150ms)

- Axial and coronal T2-weighted fat-suppressed fast spin-echo (TR/TE 4000/70ms)

Slice thickness was 3mm with a 0.3mm gap. Field of view was 14-16cm.

Image Analysis

Two musculoskeletal radiologists with 8 and 12 years of experience, blinded to clinical findings, independently evaluated the MRI studies. Discrepancies were resolved by consensus. The following structures were systematically evaluated:

- Lateral ligament complex (anterior talofibular, calcaneofibular, posterior talofibular)
- Medial (deltoid) ligament complex
- Syndesmotic ligaments
- Tendons (Achilles, peroneal, posterior tibial, anterior tibial, toe extensors)
- Articular surfaces for osteochondral lesions
- Bones for occult fractures or bone contusions

Surgical Correlation

Forty-two patients underwent surgical intervention based on clinical and imaging findings. Surgical findings were documented and compared with preoperative MRI diagnoses to determine concordance.

Statistical Analysis

Statistical analysis was performed using SPSS software (version 26.0, IBM). Sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) were calculated for clinical examination, radiography, and MRI for each pathology category. Inter-observer agreement for MRI interpretation was assessed using Cohen's kappa coefficient. A p-value <0.05 was considered statistically significant.

RESULTS

Patient Demographics and Injury Patterns

The most common mechanism of injury was inversion (58.3%), followed by eversion (16.7%), direct impact (14.3%), and axial loading (10.7%). The mean interval between injury and MRI was 5.4 ± 3.2 days. Clinical examinations suggested ligamentous injury in 61 patients (72.6%), tendinous injury in 29 (34.5%), and suspected osteochondral injury in 23 (27.4%).

Ligamentous Injuries

MRI identified ligamentous injuries in 64 patients (76.2%), with anterior talofibular ligament (ATFL) being the most commonly injured (54 patients, 64.3%).

Table 1. Ligamentous Injuries Detected by MRI

Ligament	Number of Patients	Percentage (%)
Anterior talofibular ligament	54	64.3
Calcaneofibular ligament	38	45.2
Posterior talofibular ligament	12	14.3
Deltoid ligament	29	34.5
Syndesmotic injuries	21	25.0

Table 2. Diagnostic Performance of Different Modalities for Ligamentous Injuries

Diagnostic Modality	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)
Clinical Examination	78.5	76.2	83.6	69.6
Conventional Radiography	42.1	87.5	84.2	48.9
MRI	94.7	92.3	95.8	90.6

Osteochondral Lesions

MRI detected osteochondral lesions in 31 patients (36.9%), with the majority involving the talar dome (27 patients, 32.1%).

Table 3. Distribution of Osteochondral Lesions on MRI

Location	Number of Patients	Percentage (%)
Medial talar dome	17	20.2
Lateral talar dome	10	11.9
Tibial plafond	3	3.6
Navicular	1	1.2

Table 4. Diagnostic Performance of Different Modalities for Osteochondral Lesions

Diagnostic Modality	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)
Clinical Examination	61.3	73.6	56.5	77.0
Conventional Radiography	41.9	90.6	68.4	75.4
MRI	96.8	93.4	88.2	98.1

Tendon Injuries
Tendon abnormalities were identified in 36 patients (42.9%) on MRI.

Table 5. Tendon Injuries Detected by MRI

Tendon	Number of Patients	Percentage (%)
Peroneal tendons	19	22.6
Achilles tendon	12	14.3
Posterior tibial tendon	8	9.5
Anterior tibial tendon	5	6.0
Extensor digitorum longus	2	2.4

Table 6. Types of Tendon Pathologies Identified on MRI

Pathology	Number of Patients	Percentage (%)
Tenosynovitis	22	26.2
Partial tear	11	13.1
Complete rupture	3	3.6

Table 7. Diagnostic Performance of Different Modalities for Tendon Injuries

Diagnostic Modality	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)
Clinical Examination	69.4	81.3	72.4	78.9
Ultrasound	83.3	85.4	78.9	88.7
MRI	97.2	95.8	94.6	97.9

Table 8. Occult Fractures Detected by MRI but Not Visible on Radiographs

Location	Number of Patients	Percentage (%)
Lateral malleolus (avulsion)	7	8.3
Talar body/neck	5	6.0
Navicular	4	4.8

Table 9. Bone Contusions Detected by MRI

Location	Number of Patients	Percentage (%)
Lateral malleolus	25	29.8
Talus	23	27.4
Navicular	9	10.7
Calcaneus	8	9.5
Medial malleolus	6	7.1

Surgical Correlation
Among the 42 patients who underwent surgery, overall concordance between MRI findings and surgical observations was 93.8%.

Table 10. Concordance Between MRI Findings and Surgical Observations

Pathology	Number of Surgical Cases	Concordance (%)	Discordance (%)
Ligamentous injuries	38	94.7	5.3
Osteochondral lesions	31	96.8	3.2
Tendon injuries	36	97.2	2.8
Overall	42	93.8	6.2

Inter-observer Agreement
Table 11. Inter-observer Agreement for MRI Interpretation

Pathology	Kappa Coefficient (κ)	Agreement Level
Tendon injuries	0.89	Excellent
Osteochondral lesions	0.87	Excellent
Fractures	0.92	Excellent
Ligamentous injuries	0.82	Good

DISCUSSION

This study demonstrates the high diagnostic value of MRI in evaluating post-traumatic ankle injuries. The multiplanar capabilities and superior soft tissue contrast of MRI provide comprehensive assessment of ankle structures, surpassing the diagnostic accuracy of clinical examination and conventional radiography.

Ligamentous injuries, particularly of the lateral ligament complex, are among the most common ankle pathologies.[6] Our findings show that MRI detected ligamentous injuries with high sensitivity (94.7%) and specificity (92.3%), significantly outperforming clinical examination and radiography. This aligns with previous studies by Oae et al.[7] and Tan et al[8], who reported MRI sensitivities of 91-97% for lateral ligament injuries. The accurate detection of syndesmotic injuries (25.0% in our cohort) is particularly important, as these injuries often require specific management approaches and can lead to significant disability if missed.[9]

Osteochondral lesions of the talus represent another critical post-traumatic pathology that may not be apparent on conventional radiography. In our study, MRI detected 31 osteochondral lesions, while radiography identified only 13 (41.9%), consistent with findings by O'Loughlin et al.,[10] who reported radiographic sensitivity of only 40% for these lesions. The high sensitivity (96.8%) and specificity (93.4%) of MRI for osteochondral lesions in our study underscore its value in evaluating articular surfaces.

Tendon pathologies, often clinically challenging to diagnose precisely, were accurately identified by MRI in our cohort, with 97.2% concordance with surgical findings. The ability to distinguish between tenosynovitis, partial tears, and complete ruptures directly impacts treatment decisions, ranging from conservative management to surgical intervention.[11]

The detection of occult fractures in 19.0% of patients represents a significant advantage of MRI over conventional radiography. These fractures, predominantly involving the lateral malleolus and talus, could potentially progress to non-union or malunion if undiagnosed, leading to chronic pain and functional limitation.[12]

Bone contusions, identified in 56.0% of our patients, represent trabecular microfractures that are invisible on radiographs but may cause persistent pain and require modified rehabilitation protocols.[13] While not always requiring specific treatment, awareness of these lesions aids in patient counseling regarding expected recovery timelines.

The high overall concordance (93.8%) between MRI findings and surgical observations validates the diagnostic accuracy of MRI for post-traumatic ankle pathologies. This accuracy enables precise preoperative planning, potentially improving surgical outcomes and reducing unnecessary procedures.

Several limitations of this study warrant consideration. First, not all patients underwent surgical intervention, which limits complete validation of MRI findings. Second, the relatively short follow-up period precludes assessment of long-term outcomes based on treatment decisions guided by MRI findings. Additionally, the study was conducted at a single institution, which may limit generalizability.

CONCLUSION

MRI provides comprehensive evaluation of post-traumatic ankle pathologies with high diagnostic accuracy, enabling precise characterization of ligamentous injuries, osteochondral lesions, tendon abnormalities, and occult fractures. The superior diagnostic performance of MRI compared to clinical examination and conventional radiography supports its implementation in the evaluation algorithm for significant ankle injuries. Future research should focus on the cost-effectiveness of routine MRI in ankle trauma and its impact on long-term clinical outcomes.

REFERENCES

1. Waterman BR, Owens BD, Davey S, Zacchilli MA, Belmont PJ Jr. The epidemiology of ankle sprains in the United States. J Bone Joint Surg Am. 2010;92(13):2279-84.
2. Doherty C, Delahunt E, Caulfield B, Hertel J, Ryan J, Bleakley C. The incidence and prevalence of ankle sprain injury: a systematic review and meta-analysis of prospective epidemiological studies. Sports Med. 2014;44(1):123-40.
3. Mink JH, Deutsch AL. MRI of the musculoskeletal system: a teaching file. New York: Raven Press; 2020.
4. van Rijn RM, van Os AG, Bernsen RM, Luijsterburg PA, Koes BW, Bierma-Zeinstra SM. What is the clinical course of acute ankle sprains? A systematic literature review. Am J Med. 2008;121(4):324-31.
5. Bencardino JT, Rosenberg ZS, Serrano LF. MR imaging of tendon abnormalities of the foot and ankle. Magn Reson Imaging Clin N Am. 2017;25(1):131-45.
6. Ferran NA, Maffulli N. Epidemiology of sprains of the lateral ankle ligament complex. Foot Ankle Clin. 2006;11(3):659-62.
7. Oae K, Takao M, Uchio Y, Ochi M. Evaluation of anterior talofibular ligament injury with stress radiography, ultrasonography and MR imaging. Skeletal Radiol. 2010;39(1):41-7.
8. Tan DW, Teh DJW, Chee YH. Accuracy of magnetic resonance imaging in diagnosing lateral ankle ligament injuries: A comparative study with surgical findings and timings of scans. Asia Pac J Sports Med ArthroscRehabil Technol. 2016;7:15-20.
9. Hunt KJ, Phisitkul P, Pirolo J, Amendola A. High ankle sprains and syndesmotic injuries in athletes. J Am AcadOrthop Surg. 2015;23(11):661-73.
10. O'Loughlin PF, Heyworth BE, Kennedy JG. Current concepts in the diagnosis and treatment of osteochondral lesions of the ankle. Am J Sports Med. 2010;38(2):392-404.
11. Chhabra A, Subhawong TK, Carrino JA. MR imaging of deltoid ligament pathologic findings and associated impingement syndromes. Radiographics. 2010;30(3):751-61.

12. Rankin EA, Hsu RY, Garcia RM, Aiyer AA. Lateral process of the talus fractures: a systematic review. J Foot Ankle Surg. 2019;58(5):976-81.
13. Verma S, Hamilton K, Hawkins HH, Kothari R, Singal K, Telang GH, et al. Clinical outcomes and return to sport after acute ankle fractures: a systematic review. J Foot Ankle Surg. 2021;60(2):372-6.