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IJABR

International Journal of Advanced Biotechnology and Research
ISSN 0976-2612, Online ISSN 2278–599X,
Vol-17, Issue2, 2026, p 33-40

Research Article

MRI Evaluation of Ligament Injuries in Acute Ankle Sprain: A Prospective Observational Study

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Article Info

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Received: 17/05/2026
Accepted: 15/06/2026
Published: 18/06/2026

DOI: 10.5281/zenodo.20812019

Publisher's Note: IJABR Press stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Abstract

Background: Acute ankle sprain is a common musculoskeletal injury, but clinical examination alone may underestimate the severity and extent of ligamentous damage. MRI provides detailed assessment of ligament integrity and associated soft tissue and osseous abnormalities.

Materials and Methods: This prospective observational study included 100 patients with acute ankle sprain who underwent MRI of the affected ankle. Ligament injuries were evaluated according to site and grade as sprain, partial tear, or complete tear. Associated findings such as bone marrow edema, joint effusion, osteochondral lesion, tendon abnormality, and soft tissue edema were also recorded.

Results: The anterior talofibular ligament was the most commonly injured ligament, followed by the calcaneofibular ligament. Partial tear was the commonest MRI grade. Clinical severity showed significant association with MRI grading.

Conclusion: MRI was useful for comprehensive evaluation of acute ankle sprain and helped identify ligament injury severity and associated abnormalities.

Keywords: Ankle sprain, MRI ankle, ligament injury, anterior talofibular ligament.

Introduction

Ankle sprain is one of the most frequent musculoskeletal injuries encountered in emergency, orthopaedic, sports medicine and radiology practice, and the lateral ligament complex is most commonly affected because

inversion injury places maximal stress on the lateral stabilizers of the ankle [1]. Acute ankle sprain may appear clinically simple, but the underlying structural injury can vary from mild ligament sprain to partial tear, complete tear, multiligament injury, bone contusion, tendon injury or osteochondral lesion [2].

The anterior talofibular ligament is the most frequently injured ligament in ankle sprain, followed by the calcaneofibular ligament, while posterior talofibular ligament injury is less common and usually associated with more severe trauma [3]. Clinical examination remains the first step in evaluation, but pain, swelling and guarding in the acute stage may limit accurate assessment of the exact ligament involved and the severity of tear [4].

Magnetic resonance imaging has an important role in ankle sprain because it allows direct visualization of ligament morphology, continuity, edema, hemorrhage and associated intra-articular or periarticular abnormalities [1]. MRI can classify ligament injuries as sprain, partial tear or complete tear, and can also identify associated findings such as joint effusion, bone marrow edema, tendon injury and occult osteochondral lesions [2].

Bone marrow edema is a common MRI finding after ankle trauma and may help indicate the mechanism of injury, site of impact and associated ligamentous or chondral damage [5].

Apart from ligament assessment, MRI is useful because patients with acute ankle sprain may have associated injuries that are not evident on plain radiographs or routine clinical examination [6]. Identification of these associated abnormalities is clinically relevant because missed multiligament injury or osteochondral injury may contribute to persistent pain, instability, delayed recovery and recurrent ankle sprain [7]. Therefore, systematic MRI evaluation can improve diagnostic accuracy and provide a structured radiological basis for treatment planning [4].

The present study aims to evaluate the MRI findings in patients presenting with acute ankle sprain, with specific emphasis on the frequency and pattern of ligamentous injuries. The objectives are to identify the ligaments involved, classify the severity of injury as sprain, partial tear or complete tear, assess single versus multiple ligament involvement, and document associated MRI findings such as bone marrow edema, joint effusion, tendon injury and osteochondral lesions.

Materials and Methods

Study Design: This study was conducted as a prospective observational study to evaluate the pattern of ligamentous injuries detected on magnetic resonance imaging in patients who presented with acute ankle sprain. The study was approved by the Ethical Committee of the Institute. Informed consent was taken from all patients before performing the MRI.

Study setting: The study was carried out in the Department of Radiodiagnosis in collaboration with the Department of Orthopaedics / Emergency Medicine at a Rural Hospital in South India. Patients who presented with clinical features of acute ankle sprain and were referred for MRI evaluation of the ankle were considered for inclusion in the study.

Study Duration: It was conducted over a period of 12 months from January-2025 to December-2025.

Study Population: The study population included 100 patients who presented with acute ankle sprain following trauma and were referred for MRI evaluation of the ankle. Acute ankle sprain was defined as ankle pain, swelling, tenderness, restricted movement, or difficulty in weight-bearing following twisting, inversion, eversion, or rotational injury of the ankle occurring within 4 weeks before MRI examination.

Sampling Method: A consecutive sampling method was used.

Inclusion Criteria:

1. Patients of either sex who presented with acute ankle sprain.

2. Patients aged 18 years and above.
3. Patients with a history of ankle trauma due to inversion, eversion, twisting injury, sports injury, fall, or road traffic accident.
4. Patients who presented within 4 weeks of injury.
5. Patients who were referred for MRI evaluation of the ankle.
6. Patients who were willing to provide written informed consent.

Exclusion Criteria:

1. Previous ankle surgery on the affected side.
2. Previous fracture or deformity of the affected ankle.
3. Chronic ankle instability or recurrent ankle sprain.
4. Known inflammatory arthritis or infective arthritis.
5. Congenital or developmental deformity of the ankle.
6. Polytrauma patients in whom MRI evaluation could not be performed.
7. Contraindications to MRI such as incompatible metallic implants, pacemakers, cochlear implants, or severe claustrophobia.
8. Poor-quality MRI images due to motion artefacts or incomplete examination.
9. Patients who were unwilling to provide informed consent.

Method of Data Collection:

All patients who fulfilled the eligibility criteria were enrolled in the study. A detailed clinical history was obtained from each patient, including age, sex, side of injury, mode of injury, time interval between injury and MRI examination, symptoms, and difficulty in weight-bearing.

Clinical details such as pain, swelling, tenderness, restricted range of movement, and suspected mechanism of injury were recorded in a structured proforma.

The mechanism of injury was categorized as:

1. Inversion injury
2. Eversion injury
3. Twisting injury
4. Sports-related injury
5. Fall
6. Road traffic accident
7. Other mechanisms

The affected side was recorded as right or left ankle. Duration since injury was recorded in days.

MRI Technique:

MRI of the affected ankle was performed using a 3 Tesla MRI scanner using a dedicated ankle coil or extremity coil. The patient was positioned supine on the MRI table with the ankle placed in a neutral position. The affected ankle was immobilized as much as possible using cushions or padding to reduce motion artefacts. Proper positioning was ensured so that the ankle joint was centered within the coil.

Variables Studied

The variables included in the study were divided into demographic, clinical, and MRI variables:

Demographic Variables

1. Age
2. Sex

Clinical Variables

1. Side of injury
2. Mode of injury
3. Duration since injury
4. Pain
5. Swelling
6. Tenderness
7. Difficulty in weight-bearing
8. Clinical grade of sprain, if available

MRI Variables

1. Anterior talofibular ligament injury
2. Calcaneofibular ligament injury
3. Posterior talofibular ligament injury
4. Deltoid ligament injury
5. Syndesmotic ligament injury
6. Single ligament injury
7. Multiple ligament injury
8. Sprain
9. Partial tear
10. Complete tear
11. Bone marrow edema

12. Joint effusion
13. Osteochondral lesion
14. Tendon injury
15. Soft tissue edema
16. Occult fracture

Observations and Results

Table 1: Distribution of Study Subjects According to Age and Sex

Age Group	Male	Female	Total	Percentage	p-value
18–25 years	22	10	32	32.0%	
26–35 years	20	8	28	28.0%	
36–45 years	12	10	22	22.0%	
46–55 years	6	5	11	11.0%	
>55 years	3	4	7	7.0%	
Total	63	37	100	100.0%	0.214

As seen in Table 1, most patients were in the younger age groups, with 32% belonging to 18–25 years and 28% to 26–35 years. A Chi-Square test was used and males formed the majority of the study population, accounting for 63% of cases. The association between age group and sex distribution was not statistically significant, with p = 0.214.

Table 2: Distribution According to Mode of Injury and Side Involved

Mode of Injury	Right Ankle	Left Ankle	Total	Percentage	p-value
Inversion injury	36	22	58	58.0%	
Twisting injury	12	9	21	21.0%	
Sports injury	7	4	11	11.0%	
Fall	4	3	7	7.0%	
Road traffic accident	2	1	3	3.0%	
Total	61	39	100	100.0%	0.963

As seen in Table 2, Inversion injury was the commonest mode of trauma, seen in 58% of patients, followed by twisting injury in 21%. Right ankle involvement was more frequent than left ankle involvement. However, the association between mode of injury and side affected was not statistically significant, with a p value of 0.963 via the Chi-Square test.

Table 3: Frequency of Ligament Injuries Detected on MRI

Ligament Injured	No. of Patients	Percentage	p-value
Anterior talofibular ligament	72	72.0%	<0.001
Calcaneofibular ligament	38	38.0%	0.018
Posterior talofibular ligament	9	9.0%	<0.001
Deltoid ligament	16	16.0%	<0.001
Syndesmotic ligament complex	12	12.0%	<0.001
No definite ligament tear	8	8.0%	<0.001

As seen in Table 3, the anterior talofibular ligament was the most commonly injured ligament, seen in 72% of patients. Calcaneofibular ligament injury was present in 38%, while posterior talofibular ligament injury was uncommon. The distribution of ligament involvement was statistically significant, with ATFL injury being the predominant MRI finding. A Chi-Square goodness-of-fit test was used.

Table 4: MRI Grading of Ligamentous Injury

Grade of Injury on MRI	No. of Patients	Percentage	p-value
No ligament injury	8	8.0%	
Grade I: Sprain	29	29.0%	
Grade II: Partial tear	41	41.0%	
Grade III: Complete tear	22	22.0%	
Total	100	100.0%	<0.001

As seen in Table 4, partial ligament tear was the commonest MRI grade, observed in 41% of patients, followed by sprain in 29% and complete tear in 22%. Only 8% had no definite ligament injury. The distribution of MRI grades was statistically significant, indicating that partial tears were the most frequent injury pattern. A Chi-Square goodness-of-fit test was used.

Table 5: Association Between Clinical Grade of Ankle Sprain and MRI Grade of Ligament Injury

Clinical Grade	No Ligament Injury	MRI Sprain	Partial Tear	Complete Tear	Total	p-value
Grade I clinical sprain	6	18	7	1	32	
Grade II clinical sprain	2	9	27	8	46	
Grade III clinical sprain	0	2	7	13	22	
Total	8	29	41	22	100	<0.001

As seen in Table 5, clinical severity showed a significant association with MRI grade of injury. Most clinically Grade I cases showed sprain or no tear, while Grade II cases commonly showed partial tear. Complete tears were most frequent among clinically Grade III cases. The association was statistically significant, with $p < 0.001$ as per the Chi-Square test.

Table 6: Single Versus Multiple Ligament Injury Pattern on MRI

Injury Pattern	No. of Patients	Percentage	Mean Age ± SD	p-value
No ligament injury	8	8.0%	29.75 ± 8.46	
Single ligament injury	49	49.0%	31.62 ± 10.12	
Two-ligament injury	28	28.0%	34.18 ± 11.36	
Three or more ligament injuries	15	15.0%	38.40 ± 12.25	
Total	100	100.0%	33.74 ± 11.18	0.041

As seen in Table 6, single ligament injury was the most common pattern, noted in 49% of patients. Multiple ligament involvement was seen in 43% of patients. Mean age increased with the number of ligaments involved. This difference was statistically significant, with $p = 0.041$, suggesting more extensive ligament injuries in older patients via the one way ANOVA.

Table 7: Associated MRI Findings in Patients with Acute Ankle Sprain

Associated MRI Finding	Present	Absent	Percentage Present	Association with Complete Tear, p-value
Bone marrow edema	54	46	54.0%	0.003
Joint effusion	48	52	48.0%	0.011
Soft tissue edema	67	33	67.0%	0.021
Osteochondral lesion of talus	14	86	14.0%	0.036
Tendon sheath fluid / tenosynovitis	18	82	18.0%	0.048
Occult fracture	6	94	6.0%	0.027
Tendon tear	5	95	5.0%	0.064

As seen in Table 7, soft tissue edema was the commonest associated MRI finding, present in 67% of patients, followed by bone marrow edema in 54% and joint effusion in 48%. Bone marrow edema, joint effusion, osteochondral lesion, tenosynovitis and occult fracture showed significant association with complete ligament tear. Tendon tear was not statistically significant. A Fisher's exact test was used.

DISCUSSION

This prospective observational study evaluated MRI findings in 100 patients with acute ankle sprain, focusing on ligamentous injuries and associated abnormalities. Most patients were young adults, with male predominance. Inversion injury was the commonest mechanism, and the right ankle was more frequently affected. MRI showed that the anterior talofibular ligament was the most commonly injured ligament, followed by the calcaneofibular ligament. Partial tear was the most frequent MRI grade. Clinical severity correlated significantly with MRI grading. Associated findings included soft tissue edema, bone marrow edema, joint effusion, osteochondral lesions and tenosynovitis, confirming MRI's value in comprehensive ankle sprain assessment.

In 2016, Tan et al. [8] assessed MRI accuracy for lateral ankle ligament injuries and found that MRI was more reliable for ATFL injury than CFL injury, with ATFL partial tear accuracy of 74% and complete tear accuracy of 79%; for CFL, accuracy was 66% for partial tears and 88% for complete tears. This was comparable to our study, where ATFL injury was the commonest finding, present in 72/100 patients, while CFL injury was present in 38/100 patients. The predominance of ATFL involvement in our study was statistically significant ($p < 0.001$), while CFL involvement was also significant but less frequent ($p = 0.018$). The lower CFL frequency in our study supports Tan et al.'s observation that CFL injuries are more difficult and less consistently detected than ATFL injuries. Both studies therefore emphasized that MRI was particularly useful for evaluating the lateral ligament complex, especially ATFL tears.

In 2021, Xu et al. [9] evaluated 3-dimensional MRI for ATFL injury and reported high diagnostic performance, with sensitivity and specificity of 100% and 97% for sprain, 78% and 100% for partial tear, and 83% and 82% for complete tear, respectively. They also reported diagnostic accuracy of 98% for sprain, 91% for partial tear, and 82% for complete tear. In our study, MRI grading showed 29% sprain, 41% partial tear, and 22% complete tear, with only 8% showing no definite ligament injury. The distribution of MRI grades was statistically significant ($p < 0.001$), indicating that partial tear was the commonest injury grade. Compared with Xu et al., our study did not evaluate diagnostic accuracy against surgery, but the pattern was similar in showing that MRI could classify ATFL-related injuries into sprain,

partial tear, and complete tear. The higher partial-tear burden in our study supported the usefulness of MRI grading.

In 2023, Miranda et al. [10] studied acute ankle injuries and reported that MRI findings increased with clinical severity, noting that high-grade sprains showed greater structural injury, including complete ATFL tears and associated ancillary findings. Their study reported that complete ATFL tears were present in 43% of complete injuries and that ATFL involvement was seen in 100% of high-grade sprains. In our study, clinical severity also correlated strongly with MRI severity: among clinically Grade III sprains, 13/22 patients showed complete tear, while Grade I sprains mainly showed sprain or no ligament tear. This association between clinical grade and MRI grade was statistically significant ($p < 0.001$). Compared with Miranda et al., our complete tear rate was 22% overall, but it was concentrated in clinically severe cases. Both studies therefore supported the view that MRI severity paralleled clinical severity and that high-grade sprains should be evaluated carefully for complete ligament disruption and associated injuries.

In 2022, Baltes et al. [11] evaluated acute clinical assessment for syndesmotic injury in athletes and included 150 acute ankle injuries, with MRI used to identify partial or complete syndesmotic discontinuity. Their study focused on patients presenting within 7 days and undergoing 3-T MRI within 10 days, making it highly relevant to acute ankle trauma. In our study, syndesmotic ligament complex injury was detected in 12/100 patients, and its frequency was statistically significant when compared with other ligament injury patterns ($p < 0.001$). The proportion in our study was lower than in many athletic cohorts, which may be because our population included general ankle sprain patients rather than only athletes. However, our findings still supported Baltes et al.'s emphasis that syndesmotic injury must be actively assessed in acute ankle sprain. MRI was especially useful because syndesmotic injury may be missed if attention is limited only to the lateral ligament complex.

Conclusion

MRI was highly useful in the evaluation of acute ankle sprain by accurately identifying the pattern, severity, and extent of ligamentous injury. In this study, the anterior talofibular ligament was the most commonly injured ligament, followed by the calcaneofibular ligament. Partial ligament tear was the most frequent MRI grade. Clinical grading showed a significant association with MRI findings, confirming that increasing clinical severity correlated with more severe structural damage. MRI also detected important associated abnormalities such as bone marrow edema, joint effusion, soft tissue edema, osteochondral lesions, and tenosynovitis, thereby helping in comprehensive diagnosis and treatment planning.

Limitations

The study had a limited sample size and was conducted at a single center. MRI findings were not correlated with arthroscopy or surgical findings. Long-term clinical outcomes and follow-up assessment of ankle instability were not included.

Disclosure statements

Acknowledgement: None stated.

Conflict of Interest: The authors declare that there are no conflicts of interest

Funding: This study did not receive any grant from commercial, public or non-profit funding agencies.

Declaration of Non-Use of AI: The authors confirm that no artificial intelligence tools were used in this study.

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