DOI: https://doi.org/10.30795/jfootankle.2025.v19.1892

Original Article

Ottawa Ankle Rules and their association with ligamentous or chondral injuries of the ankle: a prospective observational study

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Abstract

Objective: Evaluate the association between the Ottawa Ankle Rules (OAR) and the presence of ligamentous and chondral injuries identified on magnetic resonance imaging (MRI).

Methods: A prospective observational study was conducted in 48 patients who underwent clinical evaluation using the OAR with subsequent MRI assessment. Variables analyzed included patient age, gender, laterality, and presence of ligamentous or chondral injuries. Statistical analyses were performed using the Shapiro-Wilk test for normality, Student's t-test for age comparisons, and Pearson's chi-square test to assess associations between categorical variables.

Results: Mean age of patients was 41.06 years, ranging from 15 years to 82 years. Groups with positive and negative OAR results were homogeneous regarding age ($p = 0.29$), gender ($p = 0.42$), and laterality ($p = 0.09$). No significant association was found between a positive OAR and the presence of ligamentous injuries ($p = 0.42$) or chondral injuries ($p = 0.83$) on MRI.

Conclusion: The OAR were not associated with ligamentous or chondral injuries identified on MRI, suggesting their limitations in predicting these specific findings. Further studies are needed to develop a more accurate predictive model incorporating clinical and imaging parameters.

Level of Evidence IV; Prospective Observational; Case Series

Keywords: Ankle injuries; Ligaments; Cartilage; Ottawa Ankle Rule; Magnetic resonance imaging

Introduction

Ottawa Ankle Rules (OAR) are a well-established set of clinical guidelines designed to help clinicians determine the necessity of radiographic imaging in patients with acute ankle injuries[1]. Their primary objective is to reduce unnecessary radiographs while maintaining a high sensitivity for detecting clinically significant fractures. According to the OAR, ankle radiographs are recommended if patient meets one of the following criteria: (1) inability to bear weight immediately after the injury or in the emergency department for four steps, or (2) point tenderness over the posterior edge or tip of the lateral malleolus, medial malleolus, base of the fifth metatarsal, or navicular bone[2].

The effectiveness of the OAR have been validated across different populations, demonstrating a high sensitivity, ranging from 92% to 100%[3]. While the OAR effectively minimize cases of missed fractures, their low specificity can lead to false positives, increasing the number of radiographs

Study performed at the Instituto Vita, São Paulo, SP, Brazil.

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Conflicts of interest: None. **Source of funding:** None. **Date received:** March 23, 2025. **Date accepted:** May 13, 2025.

How to cite this article: Dinato MCM, Duarte MPM, Pereira Filho MV, Freitas MF, Sato GFN, Baptista AD, et al. Ottawa Ankle Rules and their association with ligamentous or chondral injuries of the ankle: a prospective observational study. J Foot Ankle. 2025;19(2):e1892.

performed unnecessarily. The OAR use has been shown to reduce healthcare costs and patient wait times without compromising clinical outcomes[2]. These guidelines are applicable to both adults and children over the age of five and are widely used in emergency departments and sports medicine settings[3].

Despite the extensive validation of the OAR for guiding radiographic imaging, there is no direct evidence linking them to the use of magnetic resonance imaging (MRI) as primary diagnostic tool in the initial assessment of acute ankle injuries.

The American College of Radiology Appropriateness Criteria indicate that MRI is not typically the first-line imaging modality for acute ankle trauma, even when the OAR suggest the need for radiographs. Instead, MRI is primarily used in cases where occult fractures, ligamentous injuries, or chondral damage are suspected but not evident on initial radiographs[1].

While MRI offers superior soft tissue contrast and is highly accurate in detecting ligamentous or chondral injuries, its role in the initial evaluation of acute ankle trauma remains uncertain[4]. This raises the question of whether a positive OAR assessment correlates with an increased likelihood of ligamentous or chondral injuries on MRI.

The objective of this study is to evaluate the relationship between a positive OAR assessment and the presence of ligamentous and chondral injuries diagnosed through MRI in patients with acute ankle trauma.

Methods

Study design

This is a prospective observational study analyzing the association between the OAR and the presence of ligamentous or chondral injuries identified on MRI. The study was conducted at a single medical center, where all clinical evaluations and imaging studies were performed following standardized protocols.

Ethical approval

The study was approved by the local ethics committee and conducted in accordance with the Declaration of Helsinki and Good Clinical Practice guidelines. This study is reported following the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines for observational studies[5].

Participants

Inclusion criteria were patients who were 15 years of age or older, had sustained an acute ankle trauma assessed using the OAR, and underwent MRI as part of the diagnostic evaluation. Two senior practitioners from the same healthcare center conducted patient evaluations, exercising autonomy in selecting diagnostic tests deemed most appropriate for the assessment of acute trauma. A third evaluator independently applied the OAR to patients, without any interaction or communication with the initial evaluators. Due to the private nature of the facility, MRI scans were highly accessible and feasible in such cases. Exclusion criteria included a history of previous ankle surgery or fracture, incomplete medical records or records missing imaging data, and MRI performed for reasons unrelated to acute trauma.

Data collection

Patient data were prospectively collected from electronic medical records, including demographic information, clinical findings based on the OAR, and MRI reports. The presence of ligamentous injuries (e.g., anterior talofibular ligament tears) or chondral lesions was recorded (Figure 1). The MRI interpretation was performed by board-certified radiologists following institutional imaging protocols.

Outcome measures

The primary outcome was the presence or absence of ligamentous and chondral injuries on MRI in patients with positive or negative OAR assessments. Additional variables included patient age and sex and the laterality of the injury.

Statistical analysis

Statistical analyses were conducted using the R software. Descriptive statistics, including mean and standard deviation, were calculated for continuous variables. The Shapiro-Wilk test was applied to assess the normality of age distribution. For group comparisons, Student's t-test was used for age, while Pearson's chi-square test was employed for categorical variables such as sex, laterality, and MRI findings. A p-value ≤ 0.05 was considered statistically significant. A post hoc power analysis was performed considering a moderate effect size (W = 0.3).

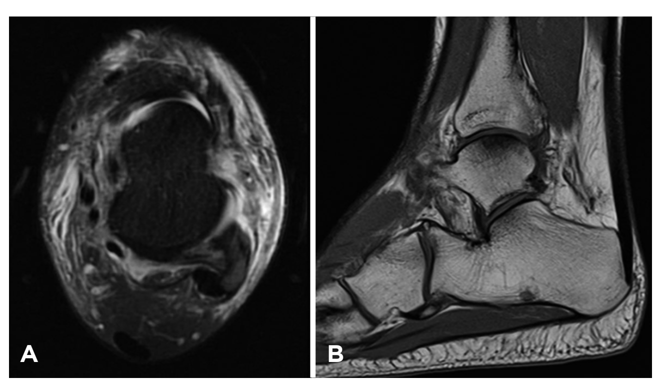

Figure 1. (A) Magnetic resonance imaging showing a ligamentous injury in an ankle trauma case. (B) Magnetic resonance imaging illustrating a chondral lesion in an ankle trauma case.

Results

The study included 48 patients with ages ranging from 15 years to 82 years (mean = 41.06 years). When analyzing age according to the OAR, mean age was 46.63 years and standard deviation (SD) was 15.41 in the negative test group, and 39.95 years (SD = 16.81) in the positive test group. However, this difference was not statistically significant (p = 0.29), indicating that age did not influence test positivity.

The sample consisted of 18 men (37.5%) and 30 women (62.5%), with no statistically significant differences between the positive and negative OAR groups (p = 0.4237). Regarding laterality, 23 patients (47.9%) had right-sided involvement, while 25 patients (52.1%) had left-sided involvement. In the negative test group, six patients had right-sided injuries, and two patients had left-sided injuries; in the positive test group, 17 patients had right-sided involvement, and 23 patients had left-sided involvement. There was no statistically significant association between laterality and the OAR result (p = 0.09).

These findings indicate that the groups with positive and negative OAR were homogeneous in terms of age, sex, and laterality.

OAR and MRI findings

Statistical analysis was performed to evaluate the relationship between a positive OAR and the presence of ligamentous or chondral injuries identified on MRI. The distribution of these findings is illustrated in Figure 2, which presents the proportion of ligamentous and chondral injuries among patients with positive and negative OAR results.

Chondral injuries

Among patients with a positive OAR result, 36 had no chondral injury, while four presented with a chondral lesion.

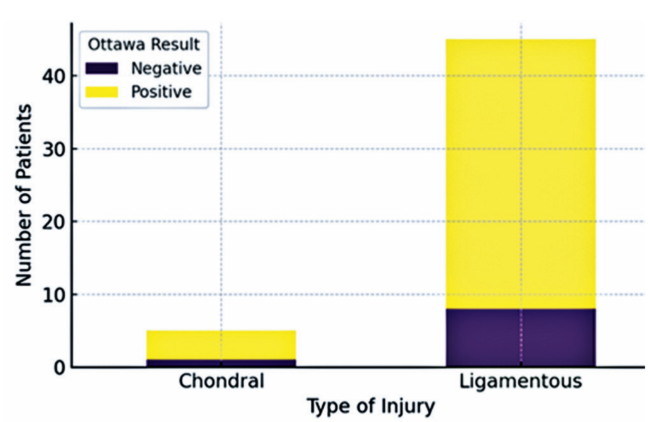

Figure 2. Association between the Ottawa Ankle Rules (OAR) and magnetic resonance imaging findings. The stacked bar chart represents the distribution of ligamentous or chondral injuries among patients with positive or negative OAR results.

In the negative OAR group, seven patients had no chondral injury, and one had a chondral lesion. There was no significant association between a positive OAR result and the presence of chondral injury (p = 0.83).

Ligamentous injuries

Among patients with a positive OAR result, three had no ligamentous injury, while 37 had ligamentous involvement. In the negative OAR group, eight patients had a ligamentous lesion. No significant association was observed between a positive OAR result and the presence of ligamentous injury (p = 0.42).

Discussion

The present study provides new insights into the relationship between the OAR and ligamentous or chondral injuries identified on MRI. While the OAR are widely used to determine the necessity of radiographs in acute ankle trauma, our findings suggest that soft tissue injuries are not well diagnosed by these rules. Findings suggest that a positive OAR result is not associated with a high likelihood of ligamentous or chondral injuries, reinforcing that the OAR should primarily be used to rule out fractures rather than to predict complex ankle pathologies.

The OAR have been extensively validated, demonstrating a high sensitivity (92%–100%) for detecting fractures, which makes them a valuable tool for reducing unnecessary radiographs and optimizing healthcare resources[2]. However, their low specificity (7.8%–68%) leads to a proportion of false positives that may result in some patients undergoing imaging that ultimately does not reveal fractures[6].

While previous studies have confirmed the effectiveness of the OAR in ruling out fractures, no prior research has investigated a direct link between OAR results and MRI findings. Our study contributes to filling this gap, as no significant association was found between positive OAR and the presence of ligamentous or chondral injuries.

Our findings align with previous literature, suggesting that, while the OAR are highly effective in reducing unnecessary radiographs, the rules do not necessarily correlate with other imaging modalities such as MRI[1].

Despite differences in specificity, alternative clinical decision rules, such as the Bernese Ankle Rules (BAR) and the Shetty Test (ST), have not demonstrated the same level of sensitivity as the OAR[7]. While the BAR offers higher specificity, their lower sensitivity limits their clinical utility. Similarly, the ST, which focuses on dynamic evaluation, has been found to be less reliable in emergency settings due to its lower sensitivity compared to the OAR[6].

Given the high sensitivity but low specificity of the OAR, it is not surprising that no significant association was found between a positive OAR result and the presence of ligamentous or chondral injuries. The OAR may underdiagnose a great sort of injuries that could be evidenced on MRI evaluation and may lead to late diagnosis or sequelae. These findings align with previous literature, which emphasizes the OAR as a reliable screening tool for fractures but not necessarily for more complex injuries involving ligaments and cartilage[8].

Limitations

This study has some limitations that should be considered. Its design may introduce selection bias, as only patients who underwent MRI were included, a potential overrepresentation of cases with more severe symptoms may exist. Additionally, the sample size, while adequate for initial analysis, may not have been large enough to detect smaller but clinically meaningful associations. A post hoc power analysis was performed considering a moderate effect size (W = 0.3). With 48 patients included and an alpha level of 0.05, estimated statistical power was approximately 54.7%. Although below the conventional 80% threshold, this level of power is considered acceptable.

The lack of functional outcome assessment limits the ability to determine the clinical relevance of MRI-detected ligamentous and chondral injuries, as some may be asymptomatic while others, with persistent pain, may have no visible abnormalities.

Finally, being a single-center study, findings may not be fully generalizable to different healthcare settings, where variations in clinical protocols, physician experience, and MRI availability could influence the applicability of results. Future multicenter studies with larger and more diverse populations are needed to confirm these findings.

Interpretation

Findings suggest that, while the OAR remain an essential tool for fracture exclusion, these rules do not reliably predict ligamentous or chondral injuries detected on MRI. This reinforces their well-established role in guiding the use of radiographs in acute ankle trauma but highlights the need for additional clinical judgment when evaluating soft tissue injuries.

Future research should focus on refining predictive models that integrate clinical findings, imaging features, and patient-reported symptoms to improve the decision-making in acute ankle injuries. Additionally, further studies incorporating long-term functional outcomes could provide valuable insights into the clinical relevance of MRI-detected injuries.

Generalizability

Although the OAR have been widely validated in various populations and healthcare settings, findings of this study should be interpreted considering its limitations. Differences in MRI utilization across institutions and the homogeneity of the study population may affect the generalizability of results, particularly in settings where MRI is not routinely used for acute ankle trauma. Variations in clinician experience, imaging availability, and institutional protocols could also influence how the OAR are applied and their association with MRI findings. Despite these factors, this study reinforces the primary role of the OAR as a fracture screening tool rather than a predictor of ligamentous or chondral injuries.

Developing a more comprehensive predictive model that incorporates clinical findings, imaging parameters, and patient-reported symptoms should be addressed in future studies. Expanding this research across multiple centers with larger and more diverse populations will help determine the broader applicability of these findings.

Conclusion

The OAR were not associated with ligamentous or chondral injuries identified on MRI, suggesting limitations in predicting these specific findings. Further studies are needed to develop a more accurate predictive model incorporating clinical and imaging parameters.

Authors' contributions: Each author contributed individually and significantly to the development of this article: MCMD *(https://orcid.org/https://orcid.org/0000-0001-6572-1771) Conceived and planned the activities that led to the study, bibliographic review, formatting of the article, wrote the article; MPMD *(https://orcid.org/0000-0002-2846-3280) Data collection, bibliographic review, survey of the medical records; MVPF *(https://orcid.org/0000-0002-2320-9769) Conceived and planned the activities that led to the study, bibliographic review, survey of the medical record; MFF *(0000-0002-6219-0407) Conceived and planned the activities that led to the study, participated in the review process; GFNS *(https://orcid.org/0000-0003-2717-3609) Bibliographic review, formatting of the article; ADB *(https://orcid.org/0000-0002-5991-1701) Participated in the review process, formatting of the article; RGP *(https://orcid.org/0000-0002-6064-2027) Conceived and planned the activities that led to the study, interpreted the results of the study, participated in the review process; GFF *(https://orcid.org/0000-0001-8032-3077) Interpreted the results of the study, statistical analysis, bibliographic review, formatting of the article, wrote the article. All authors read and approved the final manuscript. *ORCID (Open Researcher and Contributor ID) iD.

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