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Diagnostic Accuracy of Ottawa Ankle Rules in Acute Ankle Injuries in Patients Above Five Years of Age

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ABSTRACT

Ankle injuries are a common reason for emergency visits, but only 15% have fractures. The Ottawa Ankle Rules were introduced to reduce unnecessary imaging. **Objective:** To assess the diagnostic accuracy of Ottawa ankle rules in predicting ankle fractures and identify the main clinical predictors. **Methods:** This analytical cross-sectional study was conducted in the emergency department of Ghurki Trust and Teaching Hospital, Lahore, from July 2024 and March 2025 on consecutive patients with acute ankle trauma. OAR was used to evaluate patients, followed by radiography. Calculations were done on sensitivity, specificity, PPV, and NPV. Data were analyzed using frequencies and percentages for categorical variables and means with standard deviation for continuous variables. **Results:** In this cohort of 71 patients (66.2% male; mean age 36.6 ± 15.3 years), falls and road traffic accidents were the primary injury mechanisms. X-rays revealed fractures in 69.0% of the cases. The Ottawa Ankle Rules (OAR) achieved a sensitivity and negative predictive value of 100%, although the specificity was low at 13.6%, leading to 19 false-positive results. Notably, medial malleolus pain ($p<0.001$) and inability to bear weight ($p=0.003$) were the strongest predictors of fracture. **Conclusion:** Our study demonstrated 100% sensitivity and negative predictive value for detecting fractures and no false negatives, but specificity was low at 13.6%, resulting in 19 false positives. Fractures were present in 69.0% of cases and were found mostly to be bimalleolar (25.4%) and tri-malleolar (18.3%). Medial malleolus pain and inability to bear weight had the strongest capability to predict fractures clinically.

INTRODUCTION

There is a high incidence of ankle injuries, with ankle fractures occurring at a rate of 122 per year per 100,000 people. Acute trauma to the ankle joint constitutes one of the top reasons patients present to the emergency department (ED). Only around 15% of these patients actually turn out to have a fracture. X-rays are almost routinely prescribed for all, even though apparently 85% are negative for fracture. The individual cost per X-ray is cheap, but the total cost becomes substantial due to so many being performed. The Ottawa ankle rules were thus designed to limit unnecessary radiographs. These were introduced in 1992 [1-3]. These rules are included in guidelines in multiple countries around the world [4, 5]. The Ottawa ankle rules are constructed on the basis of objective criteria with the intention of making it as clear as possible while reducing the subjective aspects of clinical evaluation. These rules very clearly describe the indications for which radiographs must be taken leading to hospital cost savings, decreased ionizing radiation exposure, and waiting times in emergency departments. Based on the criteria, ankle films are only indicated when there is pain in the malleolar area and at least one of the following: bony tenderness along the distal 6 cm of the posterior edge of either malleolus (tibia or fibula), or inability to bear weight for four steps both immediately after the injury and in the emergency department. [1].

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Various studies have shown that OAR has a 93-100% sensitivity [6, 7]. A prospective study showed that the OARs have shown a sensitivity of 100% (95% confidence interval, 39.76–100.00) and specificity of 23.33% (95% CI, 15.06–33.43) with a negative predictive value of 100%. [8-10] Another study at a single hospital showed that OAR implementation significantly reduced unnecessary ankle radiographs without compromising patient care. Also, it can effectively decrease emergency department stay time and overcrowding in the ED [11, 12]. Ankle injuries are frequent in adults and children, often leading to emergency visits. However, many of these cases do not involve fractures, resulting in unnecessary X-rays, increased healthcare costs, and longer wait times. The Ottawa Ankle Rules (OAR) are a clinical tool developed to reduce unnecessary imaging by identifying low-risk patients. While the OAR has shown high sensitivity in adult populations, its effectiveness in patients over five years of age, especially children and adolescents, requires further validation. The study conducted by MacLellan et al. [13] was an assessment of OAR accuracy within the pediatric population. The authors determined that the foot rule used by NPPs was 100% sensitive (56-100% CI) and 17% specific (9-29 %CI) to clinically important fractures. NPPs used the ankle component of the rule to have a sensitivity of 88% (47-99% CI) and specificity of 31% (23-40% CI) in the clinically significant fractures. Evaluation of the diagnostic performance of the OAR in this age bracket is critical in safe and cost-effective care without over-radiating or missing a fracture. This research will be used to test the reliability of the OAR in patients with acute ankle injury of more than five years and aid in improved resource utilization and clinical decision-making. This study hypothesizes that the OAR is highly sensitive for detecting ankle fractures in patients over five years and aims to evaluate its diagnostic accuracy and identify key clinical predictors, including medial malleolus pain, lateral malleolus pain, and inability to bear weight.

This study aimed to assess the diagnostic accuracy of Ottawa ankle rules in predicting ankle fractures and identify the main clinical predictors

METHODS

This analytical cross-sectional study was conducted in the Emergency Department of Ghurki Trust and Teaching Hospital, Lahore. Ethical approval was obtained from the ethical review board of Ghurki Trust and Teaching Hospital (Ref. No. 2024/07/R-51), and the study followed the Helsinki regulations. Informed consent was obtained from all patients included in this study. Patients were assured that their participation was voluntary, their confidentiality would be maintained, and no identifying information would be disclosed in any publication or presentation. The paper used a non-probability convenience sampling method to include 71 patients who were presented to the ED between July 2024 and March 2025 using a convenience sampling technique. Inclusion criteria were: patients who had ankle trauma within the last 24 hours and were aged more than 5 years. Exclusion criteria were: polytrauma, pregnant females, patients with altered consciousness or suspected drug intoxication, open fractures, those with reduced or absent lower-limb sensations (due to any cause), and patients who refused radiography. An orthopedic surgeon examined all patients, and the questionnaire recorded the date. Biodata, address, and mechanism of injury were captured in the data. The presence of pain and localized tenderness over the tip or the distal 5cm of the medial and lateral malleolus, as well as the patient's ability to bear weight on the injured ankle, were noted. X-ray ankle anteroposterior, lateral, and mortise views were recommended in all subjects and analyzed by an examining and a senior orthopedic surgeon. The X-ray examinations in the study were conducted using a Toshiba Multix Impact X-ray machine, ensuring high-quality radiographic imaging for accurate fracture assessment. The interpretation of the X-ray was recorded. Diagnostic outcomes were defined as follows: True positives (TP) were cases where OAR indicated a fracture, and X-ray confirmed its presence. True negatives (TN) were cases where OAR correctly excluded a fracture, confirmed by a negative X-ray. False positives (FP) were cases where OAR suggested a fracture, but X-ray showed no fracture. False negatives (FN) were cases where OAR did not indicate a fracture, but X-ray confirmed one. The collected data were analyzed in SPSS version 28.0. Categorical variables (e.g., gender, residence, diabetes status, fracture presence) were reported as frequencies and percentages, while continuous variables (e.g., age) were summarized as mean ± standard deviation. The chi-square test or Fisher's Exact Test was used to assess associations, with $p \leq 0.05$ considered significant. Sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) were calculated using a 2×2 contingency table, with confidence intervals (95% CI) computed for diagnostic accuracy measures [9]. Sensitivity % = (TP / TP + FN) * 100, Specificity % = (TN / TN + FP) * 100, Positive predictive value (PPV) % = (TP / TP + FP) * 100, Negative predictive value (NPV) % = (TN / TN + FN) * 100, False positive rate (FPR) % = (FP / FP + TN) * 100% = 100 – Specificity, False negative rate (FNR) % = (FN / FN + TP) * 100 = 100 – Sensitivity.

RESULTS

Our sample (N=71) demonstrated a male predominance (66.2%) with a mean age of 36.6±15.3 years (range: 9–85), consistent with global trauma demographics. While most patients presented from Lahore (77.5%), 22.5% traveled

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from other districts. Diabetes prevalence (12.7%) mirrored national estimates, supporting metabolic generalizability. Mechanism of injury analysis showed falls as the leading cause of injury (53.5%), followed by RTAs (39.4%). The remaining 7.0% comprised miscellaneous mechanisms (Table 1).

Table 1: Characteristics of Patients (N=71)

Variable	N (%)
Gender (%)	
Male	47 (66.2%)
Female	24 (33.8%)
Age (Years)	36.62 ± 15.27 (9-85)
5-15	4 (5.6%)
16-30	25 (35.2%)
31-45	24 (33.8%)
>45	18 (25.4%)
Residence (%)	
Lahore	55 (77.5%)
Others	16 (22.5%)
Diabetes (%)	
Present	9 (12.7%)
Absent	62 (87.3%)
Mechanism of Injury (%)	
Fall	38 (63.5%)
RTA	28 (39.4%)
Others	5 (7.0%)

Fracture distribution revealed bimalleolar (25.4%) and tri-malleolar (18.3%) patterns most frequently, while 31.0% had no radiographic fracture. Talus involvement (5.6%) was uncommon but clinically significant due to the risk of osteonecrosis (Figure 1).

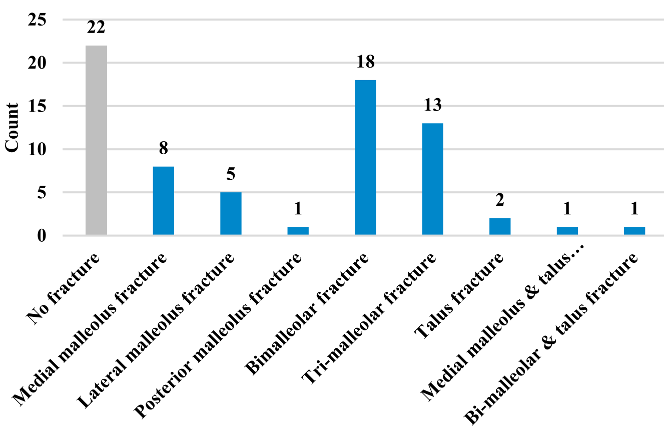

Figure 1: Frequency Distribution of Different Ankle Fracture Types Among the Study Participants (N=71)

The 2×2 contingency table presents the diagnostic performance of the Ottawa Ankle Rules (OAR) for 71 patients, comparing OAR predictions (OAR+ for positive, OAR- for negative) with radiographic outcomes (fracture confirmed or no fracture). Of the 68 patients with a positive OAR result, 49 were true positives with confirmed fractures, while 19 were false positives with no fractures. Among the 3 patients with a negative OAR result, all were true negatives with no fractures, and there were no false negatives. This data indicates a perfect sensitivity, as all 49 fractures were correctly identified by OAR, and a perfect negative predictive value, as no fractures were missed when OAR suggested their absence. However, the specificity was notably low at 13.6%, reflecting the 19 false positives out of 22 non-fracture cases, which suggests that OAR has limited utility for confirming fractures but significant value in ruling them out (Table 2).

Table 2: Diagnostic Accuracy of the Ottawa Ankle Rules (OAR)

Ottawa Ankle Rules (OAR)	Fracture confirmed on X-ray	No Fracture on X-ray	Total
OAR+	49	19	68
OAR -	0	3	3
Total	49	22	71

The perfect sensitivity and negative predictive value underscore OAR's reliability in ensuring no fractures are missed, making it an effective screening tool. However, the low specificity and moderate positive predictive value highlight a high false positive rate, leading to unnecessary X-rays for 19 patients, which necessitates supplementary clinical judgment to enhance fracture confirmation and optimize resource use (Table 3).

Table 3: Performance Metrics of the Ottawa Ankle Rules (OAR)

Parameters	Value (95% CI)
Sensitivity	100% (92.75% to 100%)
Specificity	13.64% (2.91% to 34.91%)
Positive Predicted Value	72.06% (68.60% to 75.28%)
Negative Predicted Value	100.0% (29.24% to 100%)
Accuracy	73.24% (61.41% to 83.06%)

The study revealed significant associations between clinical findings and ankle fractures in 71 patients, with medial malleolus pain (p<0.001) showing the strongest link (38 with fractures vs. 3 without), followed by inability to bear weight (p=0.003, 38 with fractures vs. 9 without), and lateral malleolus pain (p=0.009, 34 with fractures vs. 9 without). These findings, discussed in the context of the Ottawa Ankle Rules (OAR), highlight their role as key predictors, supporting OAR's perfect sensitivity in ruling out fractures. However, the low specificity (13.6%), leading to 19 false positives, suggests these signs may also trigger unnecessary X-rays, possibly due to subjective pain assessment or high fracture prevalence (69.0%) (Table 4).

Table 4: Association Between Clinical Findings and Fracture Diagnosis

Radiograph	Fracture	No Fracture	p-Value
Medial Malleolus pain			
Yes	38	3	*<0.001

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No	11	19	
Lateral Malleolus pain			
Yes	34	9	*0.009
No	15	14	
Unable to bear weight			
Yes	38	9	*0.003
No	11	13	

* Statistically significant at 0.05 level of significance

DISCUSSIONS

Acute ankle injuries are frequent and represent 6-12 % of emergency department visits. Radiography was generally requested on every patient presenting with trauma to the ankle, resulting in 85 percent of unnecessary radiographs. This results in increased emergency department stays, costs, and radiation exposure [14]. Our study confirmed that OAR has perfect sensitivity and NPV (100%) for detecting ankle fractures in patients above five; however, the low specificity led to 19 of 22 non-fracture patients classified as OAR+. This low specificity suggests that while OAR is highly effective for ruling out fractures, it may lead to over-referral for radiographs, increasing healthcare costs, radiation exposure, and ED wait times, particularly in resource-constrained settings. The diagnostic accuracy of OAR has been evaluated in many studies. A survey conducted by Morais et al showed a sensitivity of 100% and 26% specificity. This study included 148 patients. They also concluded that adding pain grading and the context of the accident to the criteria can increase its diagnostic accuracy [15]. In line with this research, Gomes et al. have found that the information on the diagnostic accuracy of the OAR could be extracted from all 15 studies involved. The sensitivity and specificity that were calculated in 15 studies were presented as data. Sensitivity and specificity point estimates ranged between 59-100 and 2-69, respectively, and were highly heterogeneous between studies (sensitivity: I2=94.3, p<0.01; specificity: I2=99.2, p<0.01) [16]. Earlier studies provided an excellent systematic review of the available material. The outcome of using the OAR is a 30–40% decrease in the number of needless radiography exams. There is proof that the OAR is a reliable clinical technique for ruling out ankle fractures. The OAR has a modest specificity and nearly 100% sensitivity. In our investigation, the OAR's sensitivity was 100%. Ankle fractures suggest a specificity of 45.8%, a positive predictive value of 48.4% and a negative predictive value of 96.5%. The OAR likewise claimed the performance of unnecessary radiographic examinations by 31.1% [17]. Several factors may explain the discrepancies in sensitivity and specificity across studies. First, differences in study populations, such as age distribution, injury severity, or prevalence of fractures, can influence OAR performance. For example, our study's fracture prevalence (69.0%) was higher than the 15% reported in the literature [14, 18], potentially inflating sensitivity but reducing specificity due to a smaller proportion of true negatives. Second, variations in clinical expertise and training in applying OAR may contribute to inconsistent specificity. In settings with less experienced clinicians, such as general practitioners versus orthopedic specialists, OAR may be applied more conservatively, leading to more false positives. Third, injury characteristics, such as the presence of edema or subtle fractures, may complicate OAR interpretation, particularly in pediatric or elderly populations. Beceren et al. (2013) reported a sensitivity of 74% (95% CI: 69–79%) and specificity of 65% (95% CI: 65–72%) in a diverse cohort, while Das et al. found 98% sensitivity (95% CI: 91–100%) but only 45% specificity (95% CI: 39–50%) [19-20]. These variations suggest that contextual factors, such as patient demographics and clinical settings, significantly impact OAR's diagnostic performance. The impact of these discrepancies on our findings is twofold. The high sensitivity (100%) reinforces OAR's reliability as a screening tool to rule out fractures, ensuring patient safety across diverse populations, including children over five years. However, the low specificity (13.6%) limits its utility for confirming fractures, leading to unnecessary radiographs in 19 of 22 non-fracture cases. This over-referral may strain ED resources and expose patients to avoidable radiation, particularly concerning younger patients, where radiation risks are higher. To address this, clinicians could integrate additional clinical factors, such as pain severity or injury mechanism, as suggested by Morais et al. [15], to improve specificity without compromising sensitivity. Furthermore, the high fracture prevalence in our study (69.0%) compared to the literature (15%) suggests a selection bias due to non-probability convenience sampling, which may have skewed our specificity downward by including more severe cases. The study's limitations, including the small sample size (n=71), single-center setting, and non-probability convenience sampling, may further contribute to the observed low specificity. A larger, multicenter study with a more representative sample could provide greater generalizability. Additionally, the lack of a power analysis limits the statistical robustness of our findings. Assuming a 15% fracture prevalence and 95% sensitivity, a sample size of approximately 200 patients would be required for 80% power, suggesting our study may be underpowered for detecting subtle differences in specificity.

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CONCLUSIONS

In a group of people (n=71) who have acute ankle injuries, the Ottawa Ankle Rules (OARs) demonstrated 100% sensitivity and negative predictive value for detecting fractures and no false negatives, but specificity was low at 13.6%, resulting in 19 false positives. Fractures were present in 69.0% of cases and were found mostly to be bimalleolar (25.4%) and tri-malleolar (18.3%). Medial malleolus pain ($p<0.001$) and inability to bear weight ($p=0.003$) had the strongest capability to predict fractures clinically.

Authors Contribution

Conceptualization: AUR
Methodology: HMF
Formal analysis: SS
Writing review and editing: AUR, FKJ, UR, AUZ, SS

All authors have read and agreed to the published version of the manuscript

Conflicts of Interest

All the authors declare no conflict of interest.

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REFERENCES

[1] Meena S and Gangary SK. Validation of the Ottawa Ankle Rules in Indian Scenario. Archives of Trauma Research. 2015 Jun; 4(2): e20969. doi: 10.5812/atr.4(2)2015.20969.
[2] Yilmaz SY, Arslan ED, Ozkan S, Aydin YY, Aydin M. Accuracy of Ottawa Ankle Rules for Midfoot and Ankle Injuries. Acta Bio Medica: Atenei Parmensis. 2021 Sep; 92(4): e2021241. doi: 10.23750/abm.v92i4.12141.
[3] Wallace W, Limaye N, Rao C, Menon S, Ratcliffe G, Mostafa A, *et al.* Assessing Compliance with Ottawa Foot and Ankle Rules in the Emergency Department: A Closed-Loop Quality Improvement Project. Cureus. 2025 May; 17(5). doi: 10.7759/cureus.84908.
[4] Jonckheer P, Willems T, De Ridder R, Paulus D, Holdt Henningsen K, San Miguel L, *et al.* Evaluating Fracture Risk in Acute Ankle Sprains: Any News Since the Ottawa Ankle Rules? A Systematic Review. European Journal of General Practice. 2016 Jan; 22(1): 31-41. doi: 10.3109/13814788.2015.1102881.
[5] Schiper SP, Rodrigues H, Reis JE, Silva MB, Dinato M, Pagnano RG. Implementação das Regras de Ottawa para Tornozelo em Pronto-Socorro de Hospital Universitário: Estudo Piloto. Acta Ortopédica Brasileira. 2023 Oct; 31: e266034. doi: 10.1590/1413-785220233105e266034.
[6] Lavrador Filho JM, Vogt PH, Coelho AR, Cho DK, da Silva JL, Padoani PW. Application of the Ottawa Protocol by Medical Students and Orthopedic Residents on Ankle Sprains at a Trauma Hospital. Revista Brasileira de Ortopedia. 2020 Dec; 55: 620-4. doi: 10.1055/s-0040-1702957.
[7] Ahmad I, Rehman S, ur Rehman I, Qayyum SF, Siraj N. Diagnostic Accuracy of Ottawa Rules in Diagnosing Ankle Fractures Among Patients Taking X Ray as Gold Standard. The Professional Medical Journal. 2025 May; 32(5): 522-7. doi:10.29309/TPMJ/2025.32.05.8843.
[8] Carvalho MO, Marcolino HD, Daleffe MR. Ottawa Ankle Rules: A Reliable Clinical Instrument to Detect Fractures in Children and Adolescents. Revista Brasileira de Ortopedia. 2025 Mar; 60(1): s00441800938. doi: 10.1055/s-0044-1800938.
[9] Swift A, Heale R, Twycross A. What Are Sensitivity and Specificity? Evidence-Based Nursing. 2020 Jan; 23(1): 2-4. doi:10.1136/ebnurs-2019-103225.
[10] Hespanhol L, Vallio CS, Costa LM, Saragiotto BT. Understanding and Interpreting Confidence and Credible Intervals Around Effect Estimates. Brazilian Journal of Physical Therapy. 2019 Jul; 23(4): 290-301. doi: 10.1016/j.bjpt.2018.12.006.
[11] Sharifudin MA, Hussen RA, Taib MN, Shokri AA. Reappraisal of the Use of X-Rays in Acute Ankle and Midfoot Injuries. A Prospective Evaluation of the Ottawa Ankle Rules (OAR) in a Single Tertiary Trauma Centre. IIUM Medical Journal Malaysia. 2024 Apr; 23(2). doi: 10.31436/imjm.v23i02.2350.
[12] Ho KM. Effectiveness of Initiating Radiographic Tests by Emergency Nurses Using the Ottawa Ankle Rules on Improving Healthcare Outcomes Among Patients with Ankle Injuries. The Chinese University of Hong Kong (Hong Kong). 2015. doi: 10.1016/j.ijnurstu.2016.08.016.
[13] MacLellan J, Smith T, Baserman J, Dowling S. Accuracy of the Ottawa Ankle Rules Applied by Non-Physician Providers in a Pediatric Emergency Department. Canadian Journal of Emergency Medicine. 2018 Sep; 20(5): 746-52. doi: 10.1017/cem.2017.399.
[14] Wang X, Chang SM, Yu GR, Rao ZT. Clinical Value of the Ottawa Ankle Rules for Diagnosis of Fractures in Acute Ankle Injuries. PLoS One. 2013 Apr; 8(4): e63228. doi: 10.1371/journal.pone.0063228.
[15] Morais B, Branquinho A, Barreira M, Correia J, Machado M, Marques N, *et al.* Validation of the Ottawa Ankle Rules: Strategies for Increasing Specificity. Injury. 2021 Apr; 52(4): 1017-22. doi: 10.1016/j.injury.2021.01.006.

DOI: https://doi.org/10.54393/pjhs.v6i11.3390

[16] Gomes YE, Chau M, Banwell HA, Causby RS. Diagnostic Accuracy of the Ottawa Ankle Rule to Exclude Fractures in Acute Ankle Injuries in Adults: A Systematic Review and Meta-Analysis. BMC Musculoskeletal Disorders. 2022 Sep; 23(1):885. doi: 10.1186/s12891-022-05831-7.
[17] Barelds I, Krijnen WP, Van de Leur JP, Van der Schans CP, Goddard RJ. Diagnostic accuracy of clinical decision rules to exclude fractures in acute ankle injuries: systematic review and meta-analysis. The Journal of Emergency Medicine. 2017 Sep; 53(3): 353-68.
[18] Ali M. Distal Radius Fracture: Incidence, Malunion, and Osteoarthritis. Lund University. 2022.
[19] Beceren GN, Yolcu S, Tomruk O, Atay T, Baykal YB. Ottawa Versus Bernese: Which is Better? European Journal of Trauma and Emergency Surgery. 2013 Apr; 39(2): 147-50. doi: 10.1007/s00068-012-0249-z.
[20] Daş M, Temiz A, Çevik Y. Implementation of the Ottawa Ankle Rules by General Practitioners in the Emergency Department of a Turkish District Hospital. Turkish Journal of Trauma and Emergency Surgery. 2016 Jul; 22(4): 361-4. doi:10.5505/tjtes.2016.72662.