



## Application of Ottawa Ankle Rules

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Available online at: [www.isca.in](http://www.isca.in), [www.isca.me](http://www.isca.me)

Received 30<sup>th</sup> August 2014, revised 14<sup>th</sup> September 2014, accepted 24<sup>th</sup> September 2014

### Abstract

Ankle injury is a common injury sustained in an outdoor activity or as a sport injury presenting to the emergency department. Emergency physicians usually order radiographs for nearly all ankle injury patients, and 85% of these are negative for fracture. So, low cost high volume tests, such as plain radiographs, contribute as much to increasing costs of providing health care as high technology, low-volume procedures. University of Ottawa (Canada) estimated that US \$500 million is spent every year on ankle radiographs in North America and suggested that the money spent in negative radiographs can be better utilized elsewhere in health care systems. This prospective study was conducted in the department of Orthopaedics at B.P. Koirala Institute of health Sciences, Nepal in two phases. We validated OAR in 100 patients in 1<sup>st</sup> phase and in the 2<sup>nd</sup> phase we implemented the clinical decision rule of Ottawa ankle rule (OAR) in another 100 patients. All individuals coming to this institute with complains of ankle pain secondary to blunt ankle trauma were labeled as suspected case of ankle sprain and included in this study. The cases were examined by the postgraduate junior residents of Orthopaedic department. Exclusion criteria included patients less than 18 years, injury more than 10 days, those who have been referred along with radiographs, those who have ankle/foot wound, multiple trauma patients, pregnant females or comatose/unconscious or uncooperative patients. Statistical analysis showed that in validation phase (phase I) sensitivity is 100%, specificity is 42.5% with Positive predictive value (PPV) of 30.30%, Negative predictive value (NPV) of 100% and accuracy of 54%. Similarly, in implementation phase the sensitivity is 100%, specificity is 42.5% with Positive predictive value (PPV) of 31.25%, Negative predictive value (NPV) of 100% and accuracy of 56%. The need for radiographs was reduced in 36% of patient. The average time saved in persons who were not subjected to radiography was about an hour and the money saved by the patient was 250 Rs/- per person. We conclude that implementing Ottawa Ankle Rule can identify all clinically relevant fractures of ankle and foot. The need for need for radiography is reduced by 36% saving patients money and time spent in emergency department.

**Keywords:** Clinical decision rule, Ottawa ankle rule, OAR.

### Introduction

Ankle injury is a common injury sustained in outdoor activity or as a sport injury presenting to the emergency department<sup>1</sup>. Although generally benign, 20% or more of these injuries may have prolonged morbidity. It is thus incumbent on the emergency physician to diagnose accurately and treat appropriately, those who present with ankle injuries<sup>2</sup>. Nearly less than 15% of patients with blunt trauma ankle have clinically significant fracture<sup>2-7</sup>. Physicians usually order radiography for nearly all ankle injury patients, and usually most of these radiographs are negative for fracture<sup>8</sup>. Low cost and high volume investigations, such as plain radiographs, contribute as much to increasing costs in providing quality health care as high technology low-volume investigations<sup>9</sup>. University of Ottawa (Canada) estimated that US \$500 million is spent every year on ankle radiographs in North America. They suggested that a part this money spent in negative radiographs can be used elsewhere in health care systems<sup>8</sup>.

In the past there were no widely accepted parameters to help clinicians to be more specific in their requesting an ankle radiograph<sup>3</sup>. To address this clinical problem, Stiell IG et al conducted a two phase project to develop and test decision rules for the use of radiography in acute ankle injuries<sup>10</sup>. In the 1st phase they developed Ottawa ankle rules (OAR) by assessing 750 adult ankle injury patients prospectively for 32 clinical findings<sup>11</sup>. Two physicians examined 100 ankle injury patients to determine the reliability of the findings by kappa analysis<sup>12</sup>. Rules were then derived by recursive partitioning multivariate analyses. In the second phase, they refined and prospectively validated the rules in another 1485 patients<sup>13</sup>. They demonstrated sensitivity of OAR to be 1.0 for detecting both malleolar and mid foot fractures without missing any fracture and its ability to reduce the number occasions needing radiography by 30%. OAR has been used worldwide to decrease the use of radiography in acute ankle injuries. The aim of this study is to validate and implement OAR in Indian population so that these rules can be used at our primary health centre and community health centre by physicians and nurses so as to help

them to screen patients who need x-ray and referral in acute ankle injury patients. This would help in reducing the number of referrals to tertiary health care centre and need for x-ray.

**Aims and objectives:** This study was aimed to i. validate the accuracy of OAR. ii. implement the OAR in Orthopaedics department and iii. assess the impact of OAR at our hospital with regards to reduction in radiography, the time spent in hospital and treatment cost in ankle injury patient.

**Material and Methods**

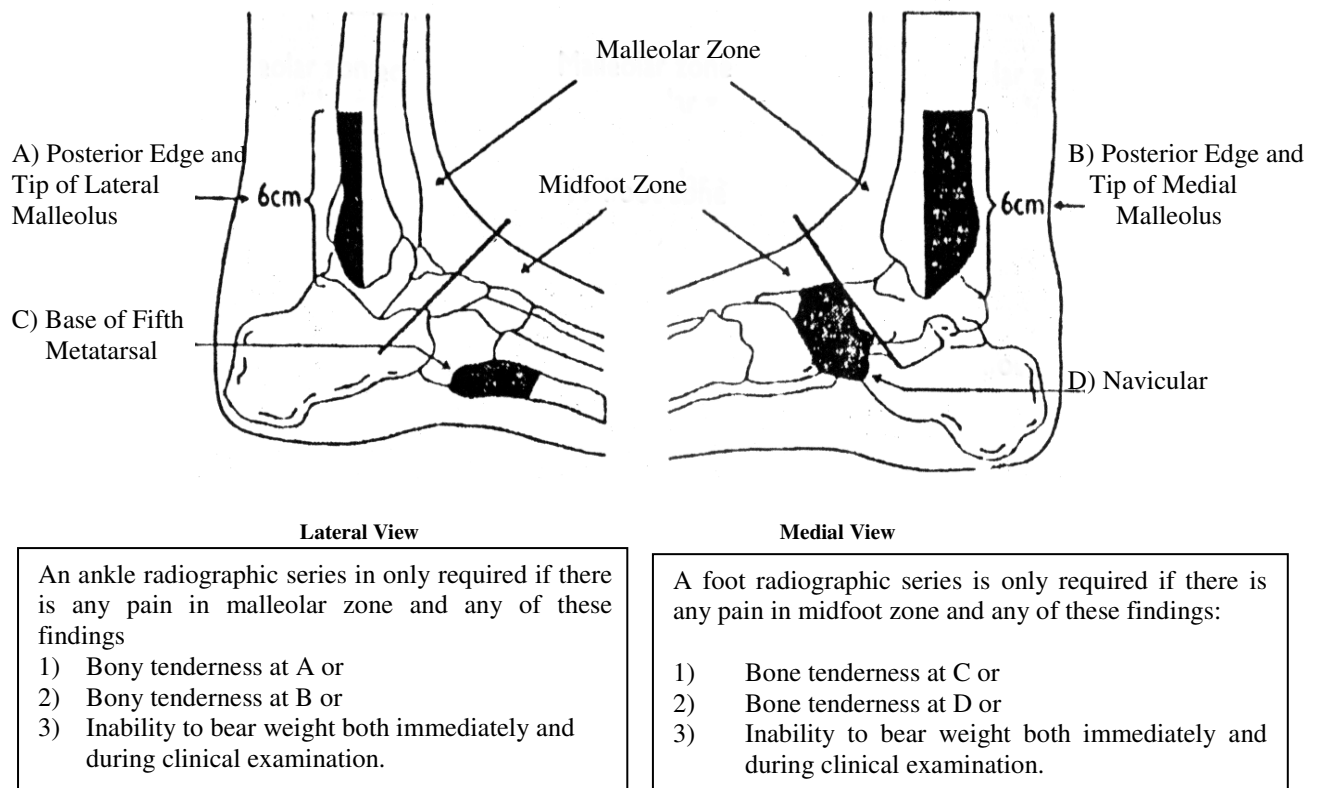
This prospective study was conducted by Orthopaedics department in a tertiary care hospital during a two year period in two phases. In the 1st phase we validated OAR in 100 patients and in the 2nd phase we implemented OAR in 100 patients. The study was cleared by institutional ethical committee. Informed written consent was obtained from subjects before including the patients in this study.

All individuals coming to this institute either in out-patient department of orthopaedics or in casualty with complaints of ankle pain secondary to blunt trauma were labeled as suspected case of ankle sprain and included in this study. The cases were examined by the postgraduate junior resident of Orthopaedic department. The junior resident in the department of Orthopaedics were given a power point demonstration of the Ottawa ankle rule. They were also given the printed charts and

similar charts were also placed in emergency department in the patient examination area. Exclusion criteria included patients less than 18 years, injury more than 10 days, those who have been referred along with radiographs, those who have ankle/foot wound, multiple trauma patients, pregnant females or comatose/unconscious or uncooperative patient.

Ankle is defined to include the area usually involved in common twisting injuries and is further divided into malleolar and mid foot zones. Zones are defined to include the following structure and their overlying soft tissues. i. Malleolar zone: distal 6 cm of tibia and fibula and talus. ii. Midfoot zone: Navicular, cuboid, cuneiform, anterior process of calcaneus and base of 5th metatarsal. Not included were body and tuberosity of calcaneus<sup>10</sup> (figure-1).

As per OAR an ankle radiographs are only required if there is any pain in malleolar zone and any of these findings: i. bony tenderness at posterior edge or tip of lateral malleolus ii. bony tenderness at posterior edge or tip of medial malleolus or iii. inability to bear weight both immediately and in emergency department. Foot radiographs are only required if there is any pain in mid foot zone and any of these findings: i. bony tenderness at base of 5th metatarsal, ii. bony tenderness at navicular or ii. inability to bear weight both immediately and in emergency department.



**Figure-1**  
 Showing site of tenderness to be examined in ankle area and mid-foot area

1st Phase-Validation of OAR: In this phase all patients were first examined as per OAR method and diagnosis was reached and recorded in a proforma. The radiograph was then ordered only after a clinical diagnosis was made. The radiographs were evaluated by an Orthopaedic consultant and a radiographic diagnosis was made and recorded in the proforma. The final diagnosis was made by the Orthopedics consultant after evaluating both clinical and radiological findings and patient treated as per the final diagnosis made by the consultant.

2nd Phase -Implementation of OAR: In this phase the patients was first examined by the postgraduate junior resident in orthopedic department and the clinical diagnosis reached and recorded in the proforma and then treated as per the OAR. Those who were diagnosed as having no clinically relevant fractures of ankle and mid-foot area were followed after 5 days and/or 10 days and asked following questions: i. Is the pain better than before? ii. Is the ability to walk better than before? iii. Is he able to walk without assistance? iv. Has he returned to normal daily activity (excluding sports)? v. Is he having any plans to see a second doctor about his injury?

Patients who satisfied all these criteria were assumed as not to have a missed fracture. Time spent in the hospital by the patient, total money spent by the patient, including treatment cost was recorded. All the data (Clinical examination data, diagnosis and radiographic diagnosis) was entered in Microsoft Excel 8.0 to prepare master chart and calculation was done by using EP Info 2000 program.

## Results and Discussion

Phase I (Validation phase): The mean age of the patients was 35.7 years. Maximum number of patients 42(42%) belonged to 18-30 years age group. There were 56 females (56%) and 44 males (44%). Left side ankle injury was present in 54 patients (54%) and right side in 46 patients (46%). Clinical examination revealed suspicion of having clinically relevant fractures (positive for fracture according to OAR) in 66 patients. But radiological examination revealed only 20 patients actually had fracture and rest 46 didn't have any bony injury. Clinical examination showed no suspicion of fractures in 34 patients according to OAR and radiographs revealed they were also negative for fractures. Statistical analysis showed that in phase I sensitivity is 100% (20/20), specificity is 42.5% (34/80) with Positive predictive value (PPV) of 30.30% (20/66), Negative predictive value (NPV) of 100% (34/34) and accuracy of 54%(54/100) (table 1).

Phase II (Implementation phase): The mean age of the patients was 33.94 years. Forty-four (44%) patients were in 18-30 year age group. There were 68 males (68%) and 32 (32%) females. Right side was injured in 52 patients (52%) as compared to left side in 48 patients (48%). Clinical examination revealed suspicion of having clinically relevant fracture in 64 patients (positive for fracture according to OAR). But radiological

examination revealed only 20 were positive for fracture. Remaining 44 patients who did not show bony ankle injury on radiography were followed up on tenth day. Rest 36 patients who did not raise suspicion of fractures on clinical examination (negative for fracture according to OAR) were followed on fifth day and asked specific preselected questions regarding pain and their ability walk with or without support. Four such patients did not satisfy the clinical examiner regarding their functional capabilities. These 4 patients were followed on tenth day and at this time they satisfied the clinical examiner and were recorded as having no fracture. The amount of money saved in radiographic evaluation in these patients was Rs 250 Rs/- per patient and the patients were able to leave emergency room and go home about an hour (average: 67 minutes) earlier than other patients.

**Table-1**  
**Clinical Diagnosis/Radiological Diagnosis in Validation Phase**

Clinical Diagnosis	Patients	Radiological Diagnosis	
		Positive	Negative
Positive	66	20	46
Negative	34	0	34
Total	100	20	80

Sensitivity: 100%, Specificity: 42.5%, PPV: 30.30%, NPV: 100%, Accuracy: 54.0%.

Statistical analysis showed that in phase II sensitivity is 100% (20/20), specificity is 45.0% (36/80) with positive predictive value (PPV) of 31.25% (20/64), negative predictive value (NPV) of 100% (36/36) and accuracy of 56% (56/100) (table 2).

**Table-2**  
**Clinical Diagnosis/Radiological Diagnosis Implementation Phase**

Clinical Diagnosis	Patients	Radiological Diagnosis	
		Positive	Negative
Positive	64	20	44
Negative	36	0	36
Total	100	20	80

Sensitivity: 100%, Specificity: 45.0%, PPV: 31.25%, NPV: 100%, Accuracy: 56.0%.

**Discussion: OAR in different countries:** A French study done to validate the Ottawa ankle rules and its ability to predict fractures showed a sensitivity of 0.98, a specificity of 0.45, and a negative predictive value of 0.99 in detecting ankle fractures: a sensitivity of 1, a specificity of 0.29, and a negative predictive value of 1 in detecting midfoot fractures. Authors concluded that application of these rules by medical examiners in emergency can reduce ankle or mid foot radiographs by 33%<sup>14</sup>.

Againaga BJR et al validated the Ottawa ankle rules in Spanish population had global sensitivity of the OAR of 97.3%, specificity of 33.3 %, positive predictive value of 15.6%. Radiography requests can

be reduced by 29.5 %.The authors believed that even triage nurses can apply OAR<sup>15</sup>. Szczesny G et al applied the OAR in polish population. They found specificity of the method 86% and the risk of misdiagnosing fracture was less than 1%<sup>16</sup>. In a study done on Asian population, the authors reported the sensitivity as 0.9 and specificity as 0.34 of the OAR for detecting the fractures. They then modified the rules and the sensitivity improved to 0.99. They concluded that OAR are not applicable to asian population because of inadequate sensitivity but when modified become acceptable and can reduce the number of x-ray studies requested by 28%<sup>17</sup>. Yuen MC et al validated Ottawa ankle rules in Hong Kong. The sensitivity and specificity of the OAR for ankle injury was 98% and 40.8%. For midfoot injury, the sensitivity and specificity of the OAR was 100% and 43.8%<sup>18</sup>.

Papacost as E et al validated Ottawa ankle rules protocol in Greek athletes. They reported sensitivity for predicting fractures and negative predictive value as 100% in both mid-foot and malleolar zone. Specificity was 0.3 for ankle fractures and 0.4 for mid foot fractures. Positive predictive values were 0.16 and 0.28 respectively. Reduction in need for radiographs was of 28.7%<sup>19</sup>. Pijenburg AC et al validated the Ottawa ankle rules and 2 Dutch ankle rules in diagnosing clinically significant fractures from insignificant fractures and other injuries in patients with a painful ankle presenting to the casualty. They reported that Ottawa ankle rules had a sensitivity of 98 % for diagnosing clinically significant fractures, while the local rules scored 88% and 59 %, respectively. The potential saving in radiographs for the 3 decision rules were 24 %, 54% and 82% respectively. They concluded that because the identification of all relevant fractures is more important than a reduction in radiographs, the higher sensitivity of the OAR makes these most suitable for implementation in the Netherlands<sup>20</sup>. In a study done to assess the use of OAR, validate the OAR and, explore the effect of implementing the rules on x-ray rates in a primary care setting in New Zealand, the authors reported that awareness of the OAR was low. The sensitivity of the OAR of diagnosing fractures was 100% and the specificity was 47%. Implementing the OAR would reduce X-ray utilization by 16%. The OAR is valid in a New Zealand primary care setting<sup>21</sup>.

**OAR applied by nurses:** Allerston J et al conducted a study of use of OAR by nurse practitioners and compared with medical staff in requesting radiographs for ankle injury patients. The aim was to compare the percentage of x-ray requested by nurse practitioners to those requested by medical practitioners. The study was conducted in an A&E department where nurses had the authority to request X-ray photographs for ankle injuries. Ottawa ankle rules (OAR) were applied by nurses in 187 patients. Results showed that fractures were identified correctly in 29.6% of patients sent for x-ray by nurses as compared with 22.8% in patients seen by doctors. This difference was not significant. Four patients who were assessed by nurse practitioners and judged not to need an x-ray photograph were subsequently found to have a fracture<sup>22</sup>.

In a study to find out whether the rate of negative ankle radiography can be reduced by including the OAR into an existing protocol, pediatric emergency department (ED) nurses were used as clinical examiner. The OAR was correctly interpreted by nurses in 98.4% of subjects. The sensitivity of the OAR was 97% with a specificity of 25%. Use of the OAR reduced the radiography rate by 21%. The authors concluded that trained nurses can accurately apply and interpret ankle injuries<sup>23</sup>.

In this present study we validated the OAR in phase I in 100 patients. This study had the sensitivity and specificity of 100 % and 42.5% respectively with positive predictive value (PPV) of 30.30% and negative predictive value (NPV) of 100%. In the second phase we implemented the OAR in 50 patients with acute ankle injury. Out of 100 patients, 64 i.e. 64% of the patients were clinically positive according to OAR. When these patients were radiographed, 20 patients had fracture i.e. 20% of the population studied and was treated accordingly.

Forty four patients were negative on radiograph for fracture and treated with below knee plaster of Paris cast. These patients were followed on 10th day and they all satisfied 10th day questionnaire. Rest 36 patients i.e. 36% were clinically negative according to OAR and was treated conservatively with below knee plaster of Paris cast. They were followed on 5th day and only 4 patients (4%) of the population studied failed to satisfy 5th day questionnaire. They were followed on 10th day. On 10th day they satisfied the given questionnaire and it was assumed that they did not have any fracture. In this study, we did not miss any fracture i.e. 100% sensitivity and we were able to save 36 patients from x-rays i.e. 36% reduction in radiograph ordered. The net cost saved was Rs. 220/- per patient. The duration of stay of patient in emergency department was decreased by a minimum of one hour.

In an Asian study with similar patient profile as ours the sensitivity of OAR in was reported as 90%, but when the researchers modified the rules i.e. they included patients who were unable to bear weight immediately after injury or in the casualty, the sensitivity increased to 99%<sup>17</sup>. This was because many patients were not able to say definitely whether they were able to bear weight immediately at the time of injury or not. The difference in rates of sensitivity may also depend upon the level of training and expertise of the clinical examiner. In our study the sensitivity was 100%. We believe that this high level sensitivity is also dependent on level of expertise and duration of training of the clinical examiner. Studies done with orthopedic department junior resident should show a higher sensitivity as compared to studies done with general medical practitioner as a clinical examiner, who is not an expert in trauma patients.

In a French study done on 252 consecutive adult patients presenting to accident and emergency departments to assess any advantage of

OAR vs. local guidelines. A comparison was made to determine the degree of reduction in radiographs required by following the Ottawa criteria. The accuracy of both guidelines was also assessed. Both guidelines had a sensitivity of 1.0 and a negative predictive value of 1.0. Ottawa guidelines showed a specificity of 0.48 and a positive predictive value of 0.15 while local guidelines showed a specificity of 0.19 and positive predictive value of 0.1. Ottawa guidelines produced a highly significant reduction in radiography by 37% ( $p < 0.001$ ) while missing no clinically relevant fractures<sup>24</sup>. In our study the reduction in number of radiography was 36% ( $p < 0.001$ ) which quite comparable.

In our study we did not take job profile of the patient into account. In a study done on U.S. army personnel in South Korea showed a low sensitivity (70%) but high specificity (73%). The authors recommended the use of OAR with caution for a military population which maintains a high intensity of physical training<sup>25</sup>.

In this study we have showed the usefulness of OAR for excluding fractures of ankle and mid-foot in patients presenting to us with an acute ankle sprain. The dissemination and use of the rule by the physician and the patient agreeing to the implementation of the rule remains a problem. Also the medico-legal aspect of missing a fracture using relatively newer diagnostic criteria as compared to the established technique of x-ray remains a pre-occupation in the mind of the primary health care contact of the patient leading to decreased use of the rule although the sensitivity has been shown to be 100% in our study. Studies have shown that medical practitioners continue to use OAR after the study has been introduced to them<sup>26</sup>.

Cameron C et al showed that, the impact on clinical behavior of the clinicians remains less even when they receive the well, the information regarding the advantages of using the widely accepted clinical decision rule of ankle(OAR)<sup>27</sup>. An active plan to implement the use of OAR is necessary to encourage physicians to adopt clinical guidelines.

## Conclusion

We conclude that OAR are very effective & can identify all fractures of ankle so the need for unnecessary x-ray is avoided. These rules can be used at our primary health centre and community health centre by physicians and nurses so as to help them to screen patients who need x-ray and referral in acute ankle injury patients. This would help in reduction of number of referral of patients to tertiary health care centre and need for x-ray.

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