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# Relevance of adjacent joint imaging in the evaluation of ankle fractures

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ABSTRACT

*Background:* Routinely obtaining adjacent joint radiographs when evaluating patients with ankle fractures may be of limited clinical utility and an unnecessary burden, particularly in the absence of clinical suspicion for concomitant injuries.
*Methods:* One thousand, three hundred and seventy patients who sustained ankle fractures over a 5-year period presenting to two level 1 trauma centers were identified. Medical records were retrospectively reviewed for demographics, physical examination findings, and radiographic information. Analyses included descriptive statistics along with sensitivity and predictive value calculations for the presence of adjacent joint fracture.
*Results:* Adjacent joint imaging ($n = 1045$ radiographs) of either the knee or foot was obtained in 873 patients (63.7%). Of those, 75/761 patients (9.9%) demonstrated additional fractures proximal to the ankle joint, most commonly of the proximal fibula. Twenty-two of 284 (7.7%) demonstrated additional fractures distal to the ankle joint, most commonly of the metatarsals. Tenderness to palpation demonstrated sensitivities of 0.92 and 0.77 and positive predictive values of 0.94 and 0.89 for the presence of proximal and distal fractures, respectively. Additionally, 19/22 (86.4%) of patients sustaining foot fractures had their injury detectable on initial ankle X-rays. Overall, only 5.5% (75/1370) of patients sustained fractures proximal to the ankle and only 0.2% (3/1370) of patients had additional foot fractures not evident on initial ankle X-rays.
*Conclusion:* The addition of adjacent joint imaging for the evaluation of patients sustaining ankle fractures is low yield. As such, patient history, physical examination, and clinical suspicion should direct the need for additional X-rays.
*Level of evidence:* Level IV.



## Background

Health care costs in the United States surpassed 2.5 trillion dollars or 17.6% of the gross domestic product (GDP) in 2009 and are projected to exceed 16 trillion by 2030 [1,2]. The causes of rising health care costs are multifactorial and complex and include the high-risk legal environment, low dissemination of clinical practice guidelines, and poor correlation between evidence-based medicine and practice [3,4].

Plain radiographs are the most commonly utilized imaging modality to assess for musculoskeletal injury. There is a commonly held dogma that a thorough radiographic evaluation involves the joints both proximal and distal to a suspected injury, despite a lack of evidence to support this practice. Additionally, patients often receive X-rays prior to medical evaluation, likely resulting in a gross over-utilization of resources [5]. Although certain fractures may have a higher incidence of concomitant injuries (for example, radius fractures and elbow injuries), others do not and may not warrant the blind application of this long-standing practice.

Despite the development of clinical guidelines which aim to limit unnecessary imaging of patients with ankle injuries [6], those receiving ankle X-rays for suspected or known fracture often have adjacent joint imaging performed. The benefits of such imaging may be low, and reliance on physical exam findings and clinical judgment may better direct the need for additional X-rays. The purpose of this study is to evaluate the clinical value of adjacent joint imaging in patients sustaining ankle fractures.

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## Methods

We retrospectively reviewed all patients presenting with ankle fractures at two level 1 trauma centers over a 5-year period. This study was approved by the Institutional Review Boards of both institutions. Using a prospectively collected trauma database, 1668 patients were identified during this time period. Patients were included if they were at least 18 years of age and had X-rays that included at least an anteroposterior (AP) and lateral view of the ankle. Exclusion criteria included patients with open physes, pathologic fractures, pilon fractures, and patients with ankle injuries initially treated at another institution.

For patients meeting inclusion criteria, demographic information including age, sex, and mechanism of injury were recorded. Radiographs were reviewed and classified according to the Danis-Weber [7] and Lauge-Hansen classification systems [8]. Patients who had additional adjacent joint imaging in the form of proximal or distal X-rays were documented. Proximal adjacent joint imaging was defined as an AP and/or lateral view of the knee and/or an AP and lateral view of the proximal tibia-fibula where the malleoli were not visualized. Distal adjacent joint imaging was defined as an AP and/or lateral view of the foot. The presence of additional injuries on those X-rays was recorded, along with the initial documented history and physical examination. Tenderness to palpation was particularly noted when documented in the physical examinations. Descriptive statistics and sensitivity analyses were completed using Microsoft Excel (Redmond, WA).

## Results

One thousand, three hundred and seventy patients met study inclusion criteria. Patient demographics, injury mechanisms, and fracture classifications are displayed in Tables 1 and 2.

Adjacent joint imaging, either proximal or distal to the ankle, was obtained in 873/1370 patients (63.7%), resulting in a total of 1045 additional X-rays. Knee or proximal tibia-fibula X-rays accounted for 761 and foot X-rays accounted for 284 of these additional X-rays (Table 3). Of those who had proximal imaging performed, 75/761 (9.9%) radiographs demonstrated additional fractures, with the most common fracture being that of the proximal fibula. As a percentage of the entire cohort of patients, only 5.5% (75/1370) of patients sustained a fracture proximal to the ankle joint. Of those who had distal imaging performed, 22/284 (7.7%) radiographs demonstrated additional fractures, most commonly of the metatarsals. Therefore, as a percentage of the entire cohort of 1370, only 1.6% (22/1370) of patients sustained a fracture distal to the ankle joint.

The majority of patients with adjacent joint injuries had associated tenderness to palpation documented in their history and physical examination. One-hundred percent of patients who sustained a concomitant proximal tibia fracture and 90.4% who sustained a proximal fibula fracture had documentation of proximal lower leg tenderness, yielding a sensitivity of 0.92 and a positive predictive value of 0.94. Seventeen of 22 foot fractures had documentation of distal tenderness, yielding a sensitivity of 0.77 and a positive predictive value of 0.89. Additionally, 19/22 (86.4%) of patients sustaining foot fractures had the concomitant fracture detectable on initial ankle X-rays. Therefore, only 3/1370 (0.2%) of patients had additional foot fractures not evident on initial ankle X-rays (two minimally displaced phalanx fractures and one minimally displaced metatarsal fracture).

**Table 1**
Study Population Characteristics.

| Characteristic | *n* (%) |
|---|---|
| Age (years) | 47.6 ± 18.4 (range 18–99) |
| Sex | |
| Male | 703 (51.3) |
| Female | 667 (48.7) |
| Side | |
| Right | 727 (53.1) |
| Left | 643 (46.9) |
| Injury Mechanism | |
| Fall | 967 (70.6) |
| Motor Vehicle Collision | 145 (10.6) |
| Other | 258 (18.8) |
| Treatment | |
| Operative | 806 (58.9) |
| Nonoperative | 564 (41.1) |

**Table 2**
Ankle Fracture Classification.

| Classification System | *n* (%) |
|---|---|
| *Danis-Weber* | |
| A | 59 (4.3) |
| B | 1038 (75.8) |
| C | 273 (19.9) |
| *Total* | 1370 (100.0) |
| *Lauge-Hansen* | |
| Supination-External Rotation (SER) | 1168 (85.3) |
| Supination-Adduction (SAD) | 95 (6.9) |
| Pronation-External Rotation (PER) | 90 (6.6) |
| Pronation-Abduction (PAB) | 16 (1.2) |
| *Total* | 1370 (100.0) |

**Table 3**
Additional Adjacent Joint Imaging.

| Additional Imaging | *n* (%) |
|---|---|
| Proximal to ankle: knee X-rays | 761 (55.5) |
| Proximal fibula fracture | 71 (5.2) |
| Tibial plateau fracture | 3 (0.2) |
| Tibial shaft fracture | 1 (0.07) |
| Distal to ankle: foot X-rays | 284 (20.7) |
| Metatarsal fracture | 15 (1.1) |
| Tarsal fracture | 5 (0.3) |
| Phalanx fracture | 2 (0.1) |

## Discussion

Plain radiographs are the most commonly utilized imaging modality to assess for musculoskeletal injury. They are readily available, quickly obtained with little operator dependence, and relatively low cost with a high sensitivity and specificity for detecting injury. Nevertheless, in view of rising health care costs and increasing awareness of the long-term effects of ionizing radiation, clinical guidelines for obtaining radiographs have been proposed for various anatomic-specific injuries. The Ottawa ankle rules and Pittsburgh knee rules are such examples designed to limit unnecessary imaging [6,9].

Despite these established guidelines which demonstrate 99% sensitivity and specificity for identifying a clinically meaningful ankle injury, factors such as increased time constraints, lack of direct patient evaluation prior to radiography, and perceived medico-legal risks may influence the indiscriminate use of imaging. Some argue that imaging reduces the chance of missed injuries, which are reported in as many as 50–60% of trauma cases, and may result in delayed diagnosis, mismanagement, or even long

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