

**Suspected Ankle Fractures
EVIDENCE TABLE**

| Reference | Study Type | Patients/ Events | Study Objective (Purpose of Study) | Study Results | Strength of Evidence |
|---|------------|---------------------|--|--|-------------------------|
| 1. Berbaum KS, el-Khoury GY, Franken EA, Jr., Kathol M, Montgomery WJ, Hesson W. Impact of clinical history on fracture detection with radiography. <i>Radiology</i> 1988; 168(2):507-511. | 9 | 40 | To assess impact of clinical history (localizing signs and symptoms) on detection of fractures in radiographs of trauma patients. | Localization clues help in the detection of fractures. Greater accuracy with localizing clues was based on higher true-positive rates rather than lower false-positive rates. | 2 |
| 2. Berbaum KS, Franken EA, Jr., el-Khoury GY. Impact of clinical history on radiographic detection of fractures: a comparison of radiologists and orthopedists. <i>AJR</i> 1989; 153(6):1221-1224. | 9 | 40 | To determine whether methods used by radiologists in interpreting imaging studies are different from those of attending physicians. | Localization clues increase fracture detection rates for radiologists and orthopedists but more for orthopedists. | 2 |
| 3. Brandser EA, Berbaum KS, Dorfman DD, et al. Contribution of individual projections alone and in combination for radiographic detection of ankle fractures. <i>AJR</i> 2000; 174(6):1691-1697. | 9 | 260 | Retrospective review to determine whether the standard three-view ankle radiographic series could be replaced by a two-view combination, and if so, which two-view combination (anteroposterior with lateral or mortise with lateral) would be superior. | Reducing the ankle radiographic series from three to two views would result in a small but significant decrease in the detection of fractures of the ankle and foot. Both two-view combinations are equivalent for fracture detection. | 2 |
| 4. Clark TW, Janzen DL, Ho K, Grunfeld A, Connell DG. Detection of radiographically occult ankle fractures following acute trauma: positive predictive value of an ankle effusion. <i>AJR</i> 1995; 164(5):1185-1189. | 10 | 33 | Prospective study to determine if the presence of an ankle effusion on radiographs after acute ankle trauma is predictive of occult ankle fracture when no fracture is visible on the standard radiographic series. | Presence of ankle effusion on radiographs following acute ankle trauma suggest an underlying fracture. Ankle effusion ≥ 13 mm in total capsular distension has a PPV of 82% for occult fracture and is a reasonable threshold to prompt additional imaging. | 2 |
| 5. Clark TW, Janzen DL, Logan PM, Ho K, Connell DG. Improving the detection of radiographically occult ankle fractures: positive predictive value of an ankle joint effusion. <i>Clin Radiol</i> 1996; 51(9):632-636. | 10 | 26 | To assess the value of an ankle effusion on radiographs as a predictor of radiographically occult fracture after acute ankle trauma. | PPV of an effusion ≥ 15 was 83%. CT detected significant soft-tissue injuries in 4 (15%) patients. | 3 |
| 6. Anis AH, Stiell IG, Stewart DG, Laupacis A. Cost-effectiveness analysis of the Ottawa Ankle Rules. <i>Ann Emerg Med</i> 1995; 26(4):422-428. | 15 | N/A | Incremental cost-effectiveness analysis of implementation of the Ottawa Ankle Rules in emergency departments in the US and Canada. | Implementing the Ottawa Ankle Rules would lead to significant savings of health care dollars. | 2 |
| 7. Auletta AG, Conway WF, Hayes CW, Guisto DF, Gervin AS. Indications for radiography in patients with acute ankle injuries: role of the physical examination. <i>AJR</i> 1991; 157(4):789-791. | 10 | 201 | Prospective study to determine if physical examination could reduce the need for radiologic examinations in patients with acute ankle trauma. | 50% of radiographs can be eliminated by brief exam. One fracture would have been missed; tiny avulsion talus. Study suggests that brief physical examination can eliminate the need for a large percentage of radiographs. | 2 |

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| 8. Brand DA, Frazier WH, Kohlhepp WC, et al. A protocol for selecting patients with injured extremities who need x-rays. <i>N Engl J Med</i> 1982; 306(6):333-339. | 13 | 848 | Develop a protocol for selecting patients with injured extremities who need radiographs and test the protocol prospectively in patients to determine its safety and effectiveness. | Strict adherence to the protocol would have reduced radiographic usage by 12% for upper extremities and 19% for lower extremities but it actually reduced radiographic usage by 5% for upper extremities and 16% for lower extremities. Missed 1/287 fractures but treatment was adequate. | 1 |
| 9. Dunlop MG, Beattie TF, White GK, Raab GM, Doull RI. Guidelines for selective radiological assessment of inversion ankle injuries. <i>Br Med J (Clin Res Ed)</i> 1986; 293(6547):603-605. | 13 | 500 | Prospective study to establish guidelines for selective radiological assessment of inversion ankle injuries. | Distal fibular tenderness, age, ability to bear weight was the most important clinical variables in predicting important fractures ($p<0.001$). | 2 |
| 10. Gleadhill DN, Thomson JY, Simms P. Can more efficient use be made of x ray examinations in the accident and emergency department? <i>Br Med J (Clin Res Ed)</i> 1987; 294(6577):943-947. | 13 | 5,463 exams | To determine whether radiographic examinations can be used more efficiently in the accident and emergency department. | Clinical guidelines for selective radiography resulted in a significant and sustained reduction in the number of radiograph examinations requested by the department. | 2 |
| 11. Keogh SP, Shafi A, Wijetunge DB. Comparison of Ottawa ankle rules and current local guidelines for use of radiography in acute ankle injuries. <i>J R Coll Surg Edinb</i> 1998; 43(5):341-343. | 9 | 252 | Prospective study to assess any advantage of the Ottawa vs local guidelines for radiography of the acutely injured ankle or mid-foot. | <ul style="list-style-type: none"> • Both Ottawa and local guidelines had a sensitivity of 1.0 and NPV of 1.0. • Ottawa guidelines: specificity of 0.48 and PPV of 0.15. • Local guidelines: specificity of 0.19 and PPV of 0.1. | 2 |
| 12. Montague AP, McQuillan RF. Clinical assessment of apparently sprained ankle and detection of fracture. <i>Injury</i> 1985; 16(8):545-546. | 13 | 311 | To analyze clinical features and correlate them with radiographs in apparently sprained ankles. | Advanced age, bruising and swelling are strong indications for ankle radiography and absence of swelling is a strong contraindication. | 2 |
| 13. Pijnenburg AC, Glas AS, De Roos MA, et al. Radiography in acute ankle injuries: the Ottawa Ankle Rules versus local diagnostic decision rules. <i>Ann Emerg Med</i> 2002; 39(6):599-604. | 9 | 647 | Prospective blinded study to validate the Ottawa Ankle Rules and two Dutch ankle rules in distinguishing clinically significant fractures from insignificant fractures and other injuries in patients with a painful ankle presenting to the emergency department. | The Ottawa Ankle Rules had a sensitivity of 98% for identifying clinically significant fractures; the Leiden and Utrecht rules scored 88% and 59%, respectively. | 1 |

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| 14. Stiell IG, Greenberg GH, McKnight RD, et al. Decision rules for the use of radiography in acute ankle injuries. Refinement and prospective validation. <i>JAMA</i> 1993; 269(9):1127-1132. | 15 | 1,032 1 st stage (original rules) 453 2 nd stage (refined) | Prospective multicenter study to validate and refine previously derived clinical decision rules for the use of radiography in acute ankle injuries. | <u>First stage:</u> <ul style="list-style-type: none"> • Sensitivity of 1.0 (95% CI], 0.97 to 1.0) for detecting 121 malleolar zone fractures. • Sensitivity of 0.98 (95% CI, 0.88 to 1.0) for detecting 49 midfoot zone fractures. <u>Second stage:</u> <ul style="list-style-type: none"> • Sensitivity of 1.0 (95% CI, 0.93 to 1.0) for 50 malleolar zone fractures. • Sensitivity of 1.0 (95% CI, 0.83 to 1.0) for 19 midfoot zone fractures. Ottawa ankle rules is 100% sensitive for fractures, reliable, and have the potential to allow physicians to safely reduce the number of radiographs ordered in patients with ankle injuries by 1/3. | 1 |
| 15. Stiell IG, Greenberg GH, McKnight RD, Nair RC, McDowell I, Worthington JR. A study to develop clinical decision rules for the use of radiography in acute ankle injuries. <i>Ann Emerg Med</i> 1992; 21(4):384-390. | 15 | 155 pilot stage 750 main study | Prospective multicenter study to develop decision rules for the use of radiography in patients with ankle injuries. | One-third of cases can eliminate radiographs by examination with experienced clinician. Rule was 100% sensitive and 40.1% specific for detecting malleolar fractures and would allow a reduction of 36.0% of ankle radiographic series ordered. | 1 |
| 16. Stiell IG, McKnight RD, Greenberg GH, Nair RC, McDowell I, Wallace GJ. Interobserver agreement in the examination of acute ankle injury patients. <i>Am J Emerg Med</i> 1992; 10(1):14-17. | 15 | 100 | Prospective multicenter study to determine inter-observations variability for various physical signs of ankle fracture. | <ul style="list-style-type: none"> • Most reliable variables were ability to bear weight (.83); bone tenderness at the base of the fifth metatarsal (.78), at the posterior edge of lateral malleolus (.75), and at the tip of the medial malleolus (.66); and combinations of bone tenderness (.76). • Less reliable variables were soft-tissue tenderness (.41) or degree of swelling (.18) of the anterior talofibular ligament, ecchymosis (.39), range of motion (.33), bone tenderness at the proximal fibula (-.01), and the anterior drawer sign (-.03). | 1 |
| 17. Vargish T, Clarke WR, Young RA, Jensen A. The ankle injury--indications for the selective use of X-rays. <i>Injury</i> 1983; 14(6):507-512. | 13 | 150 | Prospective study to determine indications for selective use of radiography in patients with ankle injury. | Patient's ability to bear weight and presence of tenderness over the lateral aspect of the ankle below the malleolus was helpful. Study suggests careful patient assessment will allow more discriminating use of ankle radiographs. | 2 |

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| 18. Stiell IG, McDowell I, Nair RC, et al. Use of radiography in acute ankle injuries: physicians' attitudes and practice. <i>CMAJ</i> 1992; 147(11):1671-1678. | 15 | 1,831 5 months 732 6 months | Multicenter study. Retrospective chart review and prospective survey were conducted to examine the efficiency of radiography in patients with acute ankle injury and study attitudes and practice of physicians. | Physicians order radiography for most patients with ankle injury although they can accurately discriminate between fracture and non-fracture cases and clearly expect most of the radiographs to give normal results. | 2 |
| 19. Sujitkumar P, Hadfield JM, Yates DW. Sprain or fracture? An analysis of 2000 ankle injuries. <i>Arch Emerg Med</i> 1986; 3(2):101-106. | 15 | 1,600 | Retrospective survey to examine validity of the criteria commonly used in an accident and emergency department to assess severity of inversion injuries of the ankle joint. | Of 1,600 cases, 89 (5%-6%) had a significant fracture and 73 (4%-6%) had an avulsion fracture. The remaining 1,438 (89%-8%) had soft-tissue injuries of varying severity. | 2 |
| 20. Stiell IG, McKnight RD, Greenberg GH, et al. Implementation of the Ottawa ankle rules. <i>JAMA</i> 1994; 271(11):827-832. | 10 | 2,342 | To assess the impact of Ottawa ankle rules on clinical practice. | Rules had sensitivities of 1.0 (95% CI, 0.95 to 1.0) for detecting 74 malleolar fractures and 1.0 (95% CI, 0.82 to 1.0) for detecting 19 mid-foot fractures. The rules decreased use of ankle radiography, waiting times, and costs. | 1 |
| 21. Pigman EC, Klug RK, Sanford S, Jolly BT. Evaluation of the Ottawa clinical decision rules for the use of radiography in acute ankle and midfoot injuries in the emergency department: an independent site assessment. <i>Ann Emerg Med</i> 1994; 24(1):41-45. | 15 | 110 | Prospective patient survey to assess the efficacy of the Ottawa clinical decision rules for the use of radiography in acute ankle and mid-foot injuries in the emergency department. | <ul style="list-style-type: none"> Decision rules used by physicians resulted in sensitivity of 1.0, specificity of 0.19, NPV of 1.0. Decision rules used by nurses resulted in a sensitivity of 0.9 and specificity of 0.1, NPV of 0.88. Use of the Ottawa predictive rules by attending physicians would have resulted in a 19% reduction in use of mid-foot and ankle radiographs. | 2 |
| 22. Diehr P, Highley R, Dehkordi F, et al. Prediction of fracture in patients with acute musculoskeletal ankle trauma. <i>Med Decis Making</i> 1988; 8(1):40-47. | 13 | 587 | To test correlation of clinical variables with the final diagnosis of fracture, rupture, or sprain. | 21 variables were significant predictors of fracture and 15 were not significantly associated with final diagnosis. | 2 |
| 23. Wynn-Thomas S, Love T, McLeod D, et al. The Ottawa ankle rules for the use of diagnostic X-ray in after hours medical centres in New Zealand. <i>N Z Med J</i> 2002; 115(1162):U184. | 15 | N/A | To measure baseline use of Ottawa Ankle Rules, validate the Ottawa Ankle Rules and, explore the impact of implementing the rules on x-ray rates. | <ul style="list-style-type: none"> Ottawa Ankle Rules: sensitivity 100% (95% CI: 75.3-100); specificity 47% (95% CI: 40.5-54.5). General practitioners clinical judgment: sensitivity 100% (95% CI: 75.3-100); specificity 37% (95% CI: 30.2-44.2). | 3 |
| 24. Haapamaki VV, Kiuru MJ, Koskinen SK. Ankle and foot injuries: analysis of MDCT findings. <i>AJR</i> 2004; 183(3):615-622. | 9 | 388 | Retrospective review of imaging studies to assess MDCT findings and the advantages of MDCT compared with radiography in patients referred to a level one trauma center for diagnostic evaluation of acute ankle and foot trauma. | In patients with injuries from high-energy polytrauma and in those with complex ankle and foot fractures, the sensitivity of radiography is only moderate to poor; in these cases, MDCT is recommended as the primary imaging technique. | 2 |

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| 25. Rempik P, Stabler A, Merl T, Roemer F, Bohndorf K. Diagnosis of acute fractures of the extremities: comparison of low-field MRI and conventional radiography. <i>Eur Radiol</i> 2004; 14(4):625-630. | 9 | 78 | To compare low-field MRI (0.2 T) and conventional radiography for the detection of acute fractures of the distal part of the extremities. | <ul style="list-style-type: none"> • Accuracy in the detection of acute fractures: MRI 81.4%, radiography 79.5%. • Accuracy of MRI to detect fractures in the hand and forefoot is significantly inferior to conventional radiographic examinations; however, MRI had better accuracy for the examination of bones near a large joint. • MRI and conventional radiography have no statistical difference in diagnosis of acute fractures. • Routine use of low-field MRI as an alternative to conventional radiography to diagnose acute fractures of the extremities seems not to be justified. | 2 |
| 26. Nikken JJ, Oei EH, Ginai AZ, et al. Acute ankle trauma: value of a short dedicated extremity MR imaging examination in prediction of need for treatment. <i>Radiology</i> 2005; 234(1):134-142. | 8 | 197 | Prospective study to assess predictive value of a short MRI with or instead of radiography performed in patients with acute ankle trauma to identify those who require additional treatment vs those who do not and can be discharged without further follow-up. | A limited MRI in initial evaluation of acute ankle injury with radiography has additional predictive value in identification of patients who need treatment but does not add significant information in identification of those who can be discharged without further follow-up. A limited MRI cannot replace radiography for prediction of need for additional treatment. | 1 |

Evidence Table Key

Study Type Key

Numbers 1-7 are for studies of therapies while numbers 8-15 are used to describe studies of diagnostics.

1. Randomized Controlled Trial — Treatment
2. Controlled Trial
3. Observation Study
 - a. Cohort
 - b. Cross-sectional
 - c. Case-control
4. Clinical Series
5. Case reviews
6. Anecdotes
7. Reviews

8. Randomized Controlled Trial — Diagnostic
9. Comparative Assessment
10. Clinical Assessment
11. Quantitative Review
12. Qualitative Review
13. Descriptive Study
14. Case Report
15. Other (Described in text)

Strength of Evidence Key

- Category 1 - The conclusions of the study are valid and strongly supported by study design, analysis and results.
- Category 2 - The conclusions of the study are likely valid, but study design does not permit certainty.
- Category 3 - The conclusions of the study may be valid but the evidence supporting the conclusions is inconclusive or equivocal.
- Category 4 - The conclusions of the study may not be valid because the evidence may not be reliable given the study design or analysis.