

American College of Radiology ACR Appropriateness Criteria®

Clinical Condition:

Suspected Ankle Fracture

Variant 1:

Patient Meeting Ottawa Rules.

- 1. Inability to bear weight immediately after the injury OR**
- 2. Point tenderness over the medial malleolus, or the posterior edge or inferior tip of the lateral malleolus or talus or calcaneus OR**
- 3. Inability to ambulate for four steps in the emergency room.**

Radiologic Procedure	Rating	Comments	RRL*
X-ray ankle AP lateral and mortise views	9		Min
<u>Rating Scale:</u> 1=Least appropriate, 9=Most appropriate			*Relative Radiation Level

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SUSPECTED ANKLE FRACTURES

Expert Panel on Musculoskeletal Imaging: Murray K. Dalinka, MD¹; Naomi P. Alazraki, MD²; Richard H. Daffner, MD³; Arthur A. De Smet, MD⁴; George Y. El-Khoury, MD⁵; John B. Kneeland, MD⁶; B.J. Manaster, MD, PhD⁷; William B. Morrison, MD⁸; Helene Pavlov, MD⁹; David A. Rubin, MD¹⁰; Lynne S. Steinbach, MD¹¹; Barbara N. Weissman, MD¹²; Robert H. Haralson III, MD.¹³

Summary of Literature Review

The musculoskeletal expert panel has reviewed pertinent articles dealing with more than 21,000 adult patients with ankle injuries. Some of the reviewed papers were written by authors from the United States and deal with various issues, including the impact of the clinical history on performance [1,2], missed fractures [3], the role of the physical examination [4], and overutilization and cost containment [4-7]. The driving force behind most of the studies from Great Britain and Canada relate to the establishment of clinical criteria that would decrease the number of ankle radiographs without missing significant injuries [8-18].

In one large series, radiographs were obtained in 89% of all patients who presented to the emergency room with a history of extremity trauma; only 17% of these cases had abnormalities that altered treatment [5]. Ankle radiographs account for approximately 10% of all radiographs ordered in the emergency room [3]; they are the third most common study ordered and are exceeded in frequency only by chest and cervical spine films [3]. Stiell and colleagues reported that more than 92% of patients with ankle trauma in the ER setting had radiographs ordered [15]. In a retrospective review of more than 600 patients, Vargish et al [19] found that less than 25% had adequate physical examinations, and more than 99% had radiographs. In another study, all patients for whom radiographs were ordered were subjected to a physical examination by the radiology resident; there were no significant differences in the percentages of indicated studies ordered by triage personnel and residents in the emergency room [4]. The percentage of significant injuries detected on the radiographs was equivalent for the two groups [4]. It is, therefore, not surprising that nurse practitioners, nurses, and medical students had similar

percentages of abnormal x-rays because radiographs were ordered by almost everyone seen with ankle trauma.

Gleadhill et al [7] concluded that it is possible to establish guidelines that would increase the quality and efficiency of service and influence the diagnostic skills and referral habits of physicians ordering ankle radiographs in the emergency room. De Lacey et al [10] have utilized a simple guideline “no swelling adjacent to a malleolus, no radiographs.” Dunlop et al [3] in a prospective study of 500 patients with inversion injuries of the ankle concluded that radiographs should be performed only for patients with distal fibula tenderness or inability to bear weight, or who are older than age 60. In their case, material swelling was absent in 11% of malleolar fractures and in two of four calcaneal fractures [19]. Sujitkumar et al [18] analyzed 2,000 ankle injuries and concluded that swelling alone is an unreliable indicator of injury and that patients with minimal pain and swelling who are able to bear weight do not require radiographs. Stiell et al [13-17], in a number of well designed, elaborate papers, have concluded that focal tenderness over the malleolus and the inability to bear weight will detect virtually 100% of patients with significant ankle fractures. They evaluated 1,032 patients prospectively and validated their criteria on 453 new patients [13]. They believed that if this rule were used, significant fractures could be detected with a sensitivity of 1 (100%) and a confidence level of 95% [13]. Foot and ankle radiographs could be reduced 30% without missing any significant injuries [13]. When these rules were implemented there was a decrease in the number of ankle films ordered, which decreased patient waiting times and costs without patient dissatisfaction or missed fractures [16]. This study was confirmed at an independent site by Pigman and colleagues, who reported a 19% reduction in ankle and midfoot radiographs [12].

In the clinical setting, radiographs of the foot and ankle are often obtained together even though the pain can almost always be localized to one area or another. Cockshott et al [9] stated that ordering both reflects an inadequate clinical examination; on the rare occasions when fifth-metatarsal fractures occur in association with inversion injuries of the ankle, they can be detected clinically. In the presence of an inversion injury of the ankle, foot radiographs have no role in management [9,20]. It is widely accepted that an adequate radiograph of the ankle should include the base of the fifth metatarsal bone distal to the tuberosity.

The committee believed that the guidelines established by Stiell et al [13-17] and confirmed by Pigman and colleagues should be adopted in the evaluation of patients with ankle trauma. These guidelines for obtaining ankle

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radiographs in patients with the following clinical findings: 1) inability to bear weight immediately after the injury, or 2) point tenderness over the medial malleolus, or the posterior edge or inferior tip of the lateral malleolus or talus or calcaneus, or 3) inability to ambulate for four steps in the emergency room. It has been convincingly demonstrated that one can approach a sensitivity of 100% in excluding significant ankle fractures using these simple criteria [7,13-17]. Limiting ankle radiographs to patients who meet these criteria can eliminate a considerable number of ankle and midfoot radiographs (estimated range 19%-36%) without missing significant injuries [7]. This would result in a considerable savings in patient cost and waiting time.

The validation and cost effectiveness of these rules has since been confirmed in multiple subsequent series [21-24].

An evaluation of the traumatized ankle should consist of anteroposterior (AP), lateral, and mortise views of the ankle. Additional views can be added to the minimal series in questionable cases. The fifth metatarsal base distal to the tuberosity should be seen on at least one projection. The use of a pertinent clinical history for the site of point tenderness will decrease the miss rate for subtle fractures by approximately 50% [2,11].

Geusens et al [25] utilized a reverse oblique view of the ankle in addition to the three standard views and found that 10 of 29 fractures were seen only on the reverse oblique view; seven of the ten were avulsion fractures of the anterolateral aspect of the calcaneus. These figures should be confirmed by others, as this is a high percentage of missed fractures and a very high percentage of avulsion fractures of the calcaneus.

Clark et al [26,27] have shown that occult fractures of the ankle may present with an ankle effusion in the absence of a visible fracture. They found that approximately one third of patients with effusions in the absence of a visible fracture will have a fracture on computed tomography (CT) of the ankle. Haapamaki et al [28] used multidetector CT (MDCT) of the ankle in multitrauma patients and compared the MDCT findings with the radiographs. When compared to MDCT, radiographs were 87% sensitive in the detection of calcaneal fractures, 78% sensitive in talar fractures and 25%-33% sensitive in midfoot fractures. Only 5 of 21 Lisfranc fracture dislocations were detected on radiographs. They recommended MDCT for patients with high energy polytrauma and in those with complex foot and ankle fractures.

Remplik et al [29] compared low field (0.2 Tesla) magnetic resonance imaging and conventional radiography and found no statistical difference in the detection of acute fractures of the distal extremities.

Relative Radiation Level Information

Potential adverse health effects associated with radiation exposure are an important factor to consider when selecting the appropriate imaging procedure. Because there is a wide range of radiation exposures associated with different diagnostic procedures, a relative radiation level (RRL) indication has been included for each imaging examination. The RRLs are based on effective dose, which is a radiation dose quantity that is used to estimate population total radiation risk associated with an imaging procedure. Additional information regarding radiation dose assessment for imaging examinations can be found in the ACR Appropriateness Criteria® [Radiation Dose Assessment Introduction](#) document.

Relative Radiation Level Designations	
Relative Radiation Level	Effective Dose Estimate Range
None	0
Minimal	< 0.1 mSv
Low	0.1-1 mSv
Medium	1-10 mSv
High	10-100 mSv

References

- Berber KS, el-Khoury GY, Franken EA, Jr., Kathol M, Montgomery WJ, Hesson W. Impact of clinical history on fracture detection with radiography. *Radiology* 1988; 168(2):507-511.
- Gratton MC, Salomone JA, 3rd, Watson WA. Clinically significant radiograph misinterpretations at an emergency medicine residency program. *Ann Emerg Med* 1990; 19(5):497-502.
- Dunlop MG, Beattie TF, White GK, Raab GM, Doull RI. Guidelines for selective radiological assessment of inversion ankle injuries. *Br Med J (Clin Res Ed)* 1986; 293(6547):603-605.
- Berber KS, Franken EA, Jr., el-Khoury GY. Impact of clinical history on radiographic detection of fractures: a comparison of radiologists and orthopedists. *AJR* 1989; 153(6):1221-1224.
- Auletta AG, Conway WF, Hayes CW, Guisto DF, Gervin AS. Indications for radiography in patients with acute ankle injuries: role of the physical examination. *AJR* 1991; 157(4):789-791.
- Brooks SC, Potter BT, Rainey JB. Inversion injuries of the ankle: clinical assessment and radiographic review. *Br Med J (Clin Res Ed)* 1981; 282(6264):607-608.
- Gleadhill DN, Thomson JY, Simms P. Can more efficient use be made of x ray examinations in the accident and emergency department? *Br Med J (Clin Res Ed)* 1987; 294(6577):943-947.
- Brand DA, Frazier WH, Kohlhepp WC, et al. A protocol for selecting patients with injured extremities who need x-rays. *N Engl J Med* 1982; 306(6):333-339.
- Cockshott WP, Jenkin JK, Pui M. Limiting the use of routine radiography for acute ankle injuries. *Can Med Assoc J* 1983; 129(2):129-131.
- de Lacey G, Bradbrooke S. Rationalising requests for x-ray examination of acute ankle injuries. *Br Med J* 1979; 1(6178):1597-1598.
- Montague AP, McQuillan RF. Clinical assessment of apparently sprained ankle and detection of fracture. *Injury* 1985; 16(8):545-546.
- 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. *Ann Emerg Med* 1994; 24(1):41-45.

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13. Stiell IG, Greenberg GH, McKnight RD, et al. Decision rules for the use of radiography in acute ankle injuries. Refinement and prospective validation. *JAMA* 1993; 269(9):1127-1132.
14. 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. *Ann Emerg Med* 1992; 21(4):384-390.
15. Stiell IG, McDowell I, Nair RC, et al. Use of radiography in acute ankle injuries: physicians' attitudes and practice. *CMAJ* 1992; 147(11):1671-1678.
16. Stiell IG, McKnight RD, Greenberg GH, et al. Implementation of the Ottawa ankle rules. *JAMA* 1994; 271(11):827-832.
17. Stiell IG, McKnight RD, Greenberg GH, Nair RC, McDowell I, Wallace GJ. Interobserver agreement in the examination of acute ankle injury patients. *Am J Emerg Med* 1992; 10(1):14-17.
18. Sujitkumar P, Hadfield JM, Yates DW. Sprain or fracture? An analysis of 2000 ankle injuries. *Arch Emerg Med* 1986; 3(2):101-106.
19. Vargish T, Clarke WR, Young RA, Jensen A. The ankle injury--indications for the selective use of X-rays. *Injury* 1983; 14(6):507-512.
20. Diehr P, Highley R, Dehkordi F, et al. Prediction of fracture in patients with acute musculoskeletal ankle trauma. *Med Decis Making* 1988; 8(1):40-47.
21. Anis AH, Stiell IG, Stewart DG, Laupacis A. Cost-effectiveness analysis of the Ottawa Ankle Rules. *Ann Emerg Med* 1995; 26(4):422-428.
22. Keogh SP, Shafi A, Wijetunge DB. Comparison of Ottawa ankle rules and current local guidelines for use of radiography in acute ankle injuries. *J R Coll Surg Edinb* 1998; 43(5):341-343.
23. Pijnenburg AC, Glas AS, De Roos MA, et al. Radiography in acute ankle injuries: the Ottawa Ankle Rules versus local diagnostic decision rules. *Ann Emerg Med* 2002; 39(6):599-604.
24. 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. *N Z Med J* 2002; 115(1162):U184.
25. Geusens E, Geyskens W, Brys P, Janzing H. The role of the reversed oblique radiograph in trauma of the foot and ankle. *Eur Radiol* 2000; 10(3):476-479.
26. 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. *AJR* 1995; 164(5):1185-1189.
27. 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. *Clin Radiol* 1996; 51(9):632-636.
28. Haapamaki VV, Kiuru MJ, Koskinen SK. Ankle and foot injuries: analysis of MDCT findings. *AJR* 2004; 183(3):615-622.
29. Remplik P, Stabler A, Merl T, Roemer F, Bohndorf K. Diagnosis of acute fractures of the extremities: comparison of low-field MRI and conventional radiography. *Eur Radiol* 2004; 14(4):625-630.

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