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SYSTEMATIC REVIEW

Evaluating fracture risk in acute ankle sprains: Any news since the Ottawa Ankle Rules? A systematic review

Pascale Jonckheer[a], Tine Willems[b,c], Roel De Ridder[c], Dominique Paulus[a], Kirsten Holdt Henningsen[a], Lorena San Miguel[a], An De Sutter[d] and Philip Roosen[c]

[a]Belgian Health Care Knowledge Centre, Belgium; [b]Department of Physiotherapy and Orthopedics, Ghent University, Belgium; [c]Department of Rehabilitation Sciences and Physiotherapy, Ghent University, Belgium; [d]Department of Family Medicine and Primary Health Care, Ghent University, Belgium

KEY MESSAGES

- The Ottawa ankle rules remain of utmost importance in identifying X-ray eligible patients with acute ankle sprains.
- The role of the Bernese ankle rules instead of the OAR and the added-value of the tuning fork test and ultrasound in patients with positive OAR are promising but should be confirmed.

ABSTRACT

Background Ankle sprain is frequently encountered, both in primary care and in emergency departments. Since 1992, the Ottawa ankle rules (OAR) can assist clinicians in determining whether an X-ray should be performed to exclude a fracture. Several guidelines recommend the use of OAR based on a systematic review from 2003. Ten years later, one can wonder if this recommendation should be changed.

Objective To review systematically the current evidence on the most accurate method to assess the fracture risk after an ankle sprain in adults.

Methods A methodical search for systematic reviews, meta-analyses and primary studies was carried out in Medline, Cochrane Database of systematic reviews, Embase, Pedro, CINAHL, Medion and specific guideline search engines. At least two independent researchers performed selection, quality appraisal (with validated checklists) and data extraction.

Results One systematic review and 21 primary studies were selected. Sensitivity and specificity of the OAR range from 92–100% and from 16–51%, respectively. To improve the OAR specificity, other tools are proposed such as the Bernese ankle rules. Vibrating tuning fork test and ultrasound could be useful in patient with OAR positive to decrease the need for radiographs. No evidence was found in favour of the use of magnetic resonance imaging (MRI) or computed tomography (CT) in the acute phase of ankle sprain.

Conclusion The findings confirm the value of the OAR at ruling out fractures after an ankle sprain and propose other or additional tools to decrease the need for X-rays.

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Introduction

Ankle sprains: a frequent problem

Ankle sprains cover lesions of various gravities, from a mild sprain to a complete rupture of one or more ligaments supporting the ankle. The incidence estimates of reported ankle sprains in the general population are scarce. In the nineties, approximately 300 ankle sprains per 10 000 inhabitants per year were reported in the UK, in France and in the Netherlands.[2–4] There is, unfortunately, a lack of data on incidence rates in primary care settings.

A diagnostic based on radiographs

The likelihood of a fracture in an ankle injury varies from 1–4% in general practice to 15% in emergency departments.[5] Despite this relatively low probability, most patients undergo radiography.[1] To decrease the number of unnecessary radiographs, the Ottawa Hospital Research

CONTACT Pascale Jonckheer pascale.jonckheer@kce.fgov.be Belgian Health Care Knowledge Centre, KCE, Doorbuilding, Boulevard du Jardin Botanique 55, 1000 Bruxelles, Belgium

Institute published a set of guidelines 'The Ottawa ankle rules' in 1992 to assist physicians in deciding whether radiography is needed after ankle injury.[6]

Since 1992, countries like Belgium, the Netherlands and the United States have included the Ottawa ankle rules in their guidelines.[7–9] All these guidelines based their recommendations on the 2003 systematic review meta-analysis of Bachmann and colleagues.[1]

More than ten years later, one can wonder whether new evidence is available and if the recommendations should be changed. Moreover, several questions have been raised about the utility of other imaging techniques such as ultrasound, magnetic resonance imaging (MRI) or CT-scans.

We conducted a systematic review to answer the following question: what is the most accurate method to assess the fracture risk after an ankle sprain in adults?

Methods

Search strategy

An electronic search for systematic reviews, meta-analyses and primary studies was performed in the Cochrane Database of systematic reviews, Medline, Embase, Pedro search database, CINAHL and Medion. A combination of a set of key terms was used combining three groups of words with 'OR' inside the groups and 'AND' between the groups:

- Pathology: ankle sprain, OR ankle injury, OR ankle trauma;
- Field of search (intervention): diagnosis. In Medline, a broad filter was used in order not to miss any articles about the Ottawa ankle rules. In Embase, the search was built on specific Emtree terms.
- Type of reference (study design) included: (systematic) reviews, OR meta-analyses, OR guidelines, OR RCT's, OR diagnostic trials, OR controlled clinical trials.

We also looked for guidelines as sources of systematic reviews and additional studies using the guidelines search engines of G-I-N, NICE, SIGN, National Guideline Clearinghouse, and New Zealand. The electronic search for systematic reviews, meta-analyses and guidelines covered the period from 1 January 2000 to 6 December 2011. The languages were Dutch, English, German and French. More details are available online at https://kce.fgov.be/sites/default/files/page_documents/KCE_197C_2011-02-GCP_Ankle%20sprain_0.pdf

Inclusion and exclusion criteria

To be included papers had to cover acute inversion sprain in adults. Age younger than 16 years, tendinopathy, acute and chronic non-traumatic ankle pain, chronic ankle instability and any other ankle trauma were reasons for exclusion. The inclusion and exclusion criteria according to the PICO framework (population, intervention, comparator, outcome) are available in Table 1.

Selection of studies (Figure 1)

Study selection was conducted by two groups of two researchers (TW & PR and RDR & PR), first on the title and abstract and subsequently on the full-text basis. Manual searching of additional articles was based on the reference lists of all selected studies and guidelines. The search identified 2536 titles from which 57 were retrieved for full text evaluation. Four guidelines were also identified.

Quality appraisal

The quality appraisal was performed by three researchers (TW, RDR, PR) using specific checklists (AMSTAR, Dutch Cochrane tool for assessing risk of bias, QUADAS and AGREE II) and was double-checked by another group of researchers (KH, LS, PJ). In case of disagreement, consensus was achieved through discussion.

Table 1. Inclusion and exclusion criteria according to the PICO framework (population, intervention, comparator, outcome).

PICO	Inclusion criteria	Exclusion criteria
Population	Adults and youngsters (16 years and over) Inversion sprain (including acute inversion sprain among patients with chronic ankle instability)	Children (age younger than 16) Tendinopathy Acute and chronic non traumatic ankle pain Chronic ankle instability Other ankle trauma
Intervention	Anamnesis Clinical examination: physical examination and functional assessment (including Ottawa rules) Imaging (X-ray, ultrasonography, magnetic resonance imaging, computed tomography)	
Comparator	Reference diagnostic evaluation versus other diagnostic evaluation.	
Outcome	Diagnostic accuracy of procedures (e.g. false positive, false negative, sensitivity, specificity, positive and negative predictive values).	

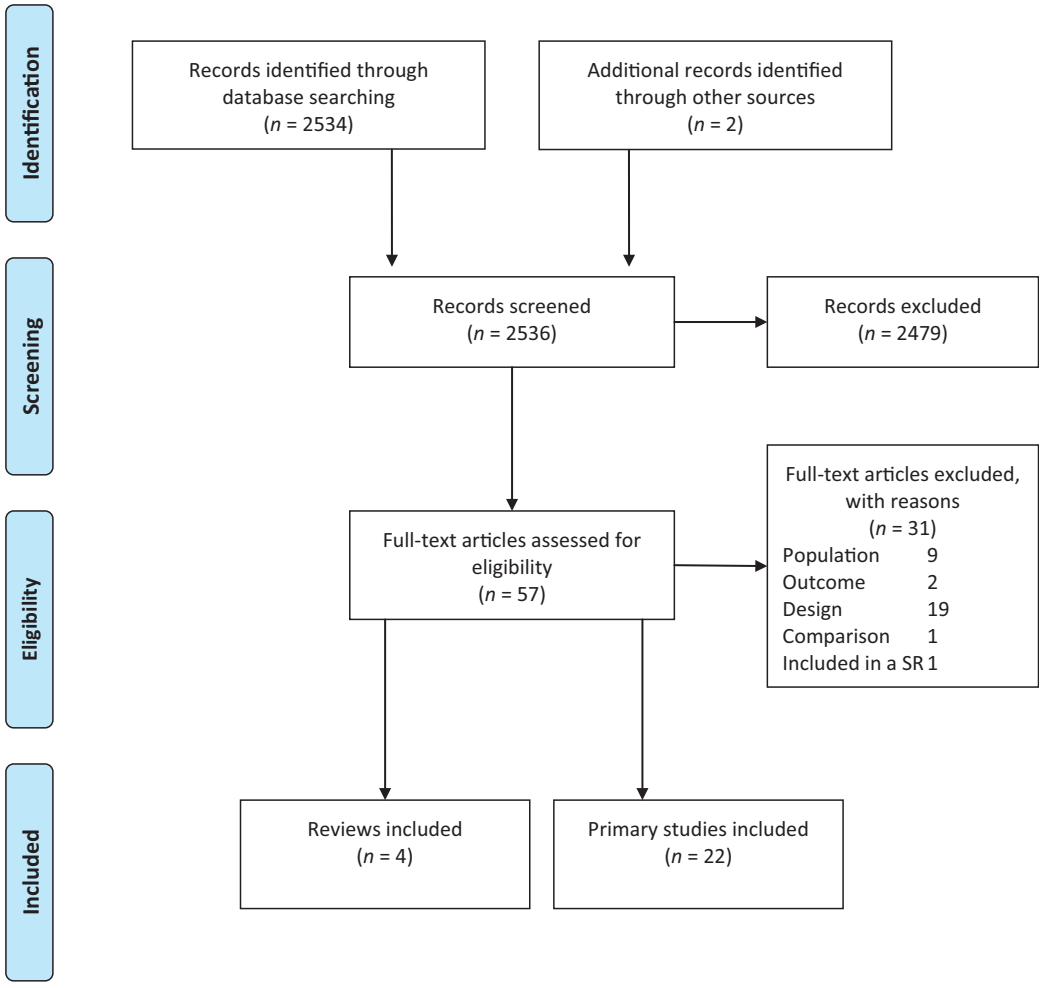

Figure 1. Flow chart on study selection for diagnosis of ankle sprain.

Data analysis

Two groups of independent reviewers (TW & PR and RDR & PR) extracted the data, using a standard KCE template for evidence tables. The tables encompassed a description of the study type, its objective, the PICO, the results and the level of evidence.

The analysis followed a hierarchical approach:

(1) Extraction of the data from the systematic reviews and meta-analyses.
(2) Search for the most recent primary studies to update the evidence found in the previous step (randomized and prospective controlled trials).

Results

Four guidelines and 26 publications were selected (four systematic reviews and 22 primary studies.[1,4,7,10–15,36] Among them, three systematic reviews were excluded because of their low quality and one article because it was a summary of a retained guideline.[12–14,20] The final selection contains one systematic review and 21 primary studies.[1,15–19,21–36] A description of these studies is available in Tables 2 and 3. The paucity of data and their heterogeneity prevented us from conducting a meta-analysis.

Among the 21 primary studies, 16 are from a European country (seven from the Netherlands) and only two are RCTs.

Ottawa ankle rules

Many trials evaluate the validity of the Ottawa ankle rules (OAR) for excluding fractures of the ankle in patients with an ankle sprain:

- The meta-analysis of Bachmann, with a moderate risk of bias, summarizes the accuracy of the OAR from 1990 to 2002.[1] The authors selected 27 studies describing 15 581 patients. The results show that pooled sensitivities, and the median of non-pooled

Table 2. Description of included systematic review.

Reference	Included studies	Patient	Intervention	Comparator	Outcome	Risk of bias
[1]	27 RCTs (pooled for analysis): 1. Aginaga, 1999 2. Auleley, 1998 3. Kerr, 1994 4. Lucchesi, 1995 5. Mann, 1998 6. Papacostas, 2001 7. Perry, 1999 8. Singh-Ranger and Marathias, 1999 9. Stiell, 1992 10. Stiell, 1993 11. Stiell, 1994 12. Yuen, 2001 13. Chandra and Schafmayer, 2001 14. Garces, 2001 15. Glas, 2002 16. Keogh, 1998 17. Leddy, 1998 18. McBride, 1997 19. Pigman, 1994 20. Salt and Clancy, 1997 21. Tay, 1999 22. Verma, 1996 23. Boutis, 2001 24. Chande, 1995 25. Karpas, 2002 26. Libetta, 1999 27. Plint, 1999	Adults and children (separated into two groups) and included if within one week after an acute ankle sprain.	Ottawa ankle rules three subgroups: Assessment of the ankle. Assessment of the mid-foot. Assessment of the ankle and the mid-foot combined.	Radiography as reference standard but not all included studies used radiography.	Sensitivity, specificity, likelihood ratios and/or standard errors.	Moderate risk of bias. Quality assessment of the primary studies not included. Publication bias not assessed

Last date search: 2002

specificities are 98% (95% CI: 96–99) and 40% (95% CI: 28–48), respectively for the assessment of the ankle.

- Eight studies published after the meta-analysis assess the validity of the OAR.[17,18,22,25,28, 29,33,36] Most of them are prospective studies, with low to moderate risk of bias. Many studies use X-rays as a reference but some also use clinical evaluation.[28,29,36] Clinical heterogeneity is noted between the studies in terms of setting (emergency department and primary care), patient characteristics (sometimes children are included), timing of OAR application (within 48 h to 10 days), type of provider (not only physicians) and characteristics of the test itself (OAR versus Buffalo malleolar rules). As the difference between Buffalo malleolar rule and OAR is minor (a change in the original area of palpation from the posterior borders of the malleoli to the midcrests of the malleoli, away from the ligament attachments), both tests are further considered as one. These studies show sensitivities and specificities of OAR ranging from 92–100% and from 16–51% respectively (Table 4). Three studies showed a sensitivity lower than 100%.[22,25,28] In each study, the number of missed fractures were very low, and they were considered of little clinical significance.
- A difference in specificity is quoted by some authors between specifically trained and non-trained professionals.[17,28,33]
- The aim of the OAR is to avoid unnecessary X-rays; but estimates on the reduction of radiographs vary broadly, ranging from 13% to more than 40%.[17,33,36]
- It is difficult to specify the best timing for the OAR in the management of acute ankle sprain because most studies [17,18,22,25,28,29,33,36] consider the application of the OAR within 7–10 days after the ankle injury. One meta-analysis showed higher sensitivities when the OAR were applied within 48 h than later after injury but no recent study confirms this result.[1]
- One study compared the patients' self-assessment when applying the OAR with the evaluation by the clinician and concluded that no evidence promotes this approach.[15]

Rules derived from OAR or additional tests to OAR

Several rules and diagnostic processes have been developed to improve the specificity of the OAR and to assist clinicians in the decisions on whether or not to perform an X-ray. Five studies were identified in recent literature on this topic (Table 5).[23,24,26,31,35]

- An additional vibrating tuning fork test in patients with positive OAR test may lead to a marked reduction in ankle radiographs. The specificity

Table 3. Description of included primary studies.

Reference	Study type, Country	Patient	Intervention	Comparator	Outcome	Risk of bias
[15]	Prospective study, U.K.	>15 years old patients in an emergency department (ED) within 48 hours after an ankle injury. $n = 50$	Patients self-assessment with OAR	OAR by an ED (+ radiography if appropriate)	Interobserver agreement	Low risk of bias Not all patients received a radiography as gold standard.
[16]	Prospective study, Austria	Athletically active patients (18-45 years old) within 7 days after inversion ankle trauma. $n = 60$	MRI (0.5 T units)	Lateral stress radiography (talar tilt test) + lesion observed during surgery repair in 15 patients	Sensitivity, specificity, agreement between MRI and stress radiography	High risk of bias Specific population; Intraoperative findings in a subgroup of 15 patients
[17]	Prospective cohort study, Australia	≥18 years old patients in ED within 10 days after ankle or foot injury $n = 366$	OAR by junior and senior physicians	Radiography (irrespective of OAR results)	Sensitivity specificity, predictive values	Low risk of bias
[18]	Prospective cohort study, Switzerland	≥18 years old patients in ED within 10 days after ankle trauma. $n = 359$	OAR by surgeons and non-surgeons	Radiography	Sensitivity and specificity	Moderate risk of bias No registry of OAR results in 42 cases
[19]	Prospective cohort study, U.K.	>16 year old patients with positive OAR in ED $n = 110$	Ultrasound scan (USS)	Radiography	Sensitivity, specificity, predictive values and likelihood ratio.	Moderate risk of bias
[22]	Prospective cohort study, The Netherlands	18–65 years old patients in ED within 48 hours after injury. $n = 106$	OAR/OFR by both a trained emergency nurse and a junior doctor	Radiography	Sensitivity, specificity, predictive values. Interobserver agreement.	Low risk of bias
[21]	Randomized controlled trial, The Netherlands	18–65 years old patients in ED. $n = 512$ 263 patients assessed by a trained emergency nurse and 249 by a junior doctor.	OAR/OFR by emergency nurse (+ Radiography)	OAR/OFR by junior doctor (+ Radiography)	Sensitivity, specificity, positive and negative predictive values.	Low risk of bias Radiography after 1 week of all injuries not radiographed earlier.
[23]	Prospective cohort study, U.K.	>12 years old patients with positive OAR in ED $n = 50$	Vibrating tuning fork (C° 128 Hz) test.	Radiography	Sensitivity, specificity and likelihood.	Low risk of bias.
[24]	Prospective cohort study, Switzerland	Adults patients in ED $n = 354$	Bernese ankles rules (clinical examination based on 3 consecutive steps: indirect fibular stress, direct medial malleolar stress and compression stress of the mid- and hindfoot)	Radiography	Sensitivity and specificity.	Low risk of bias. Lack of information about the included population
[25]	Prospective cohort study, U.S.A.	≥18 years old patients in ED within 1 week after the injury. $n = 103$	OAR by nurse or by physicians	Radiography (except for 6 patients who had not radiography but a structural telephone interview)	Sensitivity, specificity, predictive values. Interobserver agreement.	Moderate risk of bias.
[26]	Prospective cohort study, The Netherlands	≥18 years old patients in ED within 5 days after ankle injury $n = 647$	For each case: • history taking and physical examination • OAR • Leiden ankle rules By junior surgical and orthopedic residents	Radiography	Specificity, sensitivity and AUC.	Low risk of bias.
[27]	Prospective cohort study, France	18-55 years old patients in ED within 48 hours after ankle sprains $n = 110$	Ultrasonography to detect talocrural joint effusion	MRI if positive ultrasound test (within the next 8 days). No comparison if no effusion	Prevalence of joint effusion (by ultrasound) and cause of the effusion (by MRI)	Moderate risk of bias. Lack of a comparison with a golden standard. No conclusions when no effusion.
[28]	Intervention study, Denmark	All ages patients admitted to the ED with an acute blunt ankle or midfoot injury $n = 882$ patients control group	OAR by junior doctors (+ Radiography if required)	Clinical evaluation without OAR by the same junior doctors (+ Radiography if required)	Specificity, sensitivity	High risk of bias. Intervention and control groups were different populations; no standard reference.

(continued)

Table 3. Continued

Reference	Study type, Country	Patient	Intervention	Comparator	Outcome	Risk of bias
		$n = 1\,014$ intervention group				
[29]	Prospective cohort study, U.S.A.	All ages patients in a university sports medicine walk-in clinic within 10 days after an ankle/ mid-foot injury. $n = 217$	Modified OAR (Buffalo rules)	Radiography if positive OAR; telephone follow-up in the patients without radiography	Specificity and sensitivity, Cost-saving	Moderate risk of bias no golden standard in all cases; 11% of the patients were children (≤ 17 years).
[30]	Randomized controlled trial, The Netherlands	All ages patients referred by traumatologist, orthopedic surgeon, or emergency physician, within 7 days after ankle injury. $n = 197$ 97 patients assessed by a combination X-ray + MRI and 100 by X-ray only.	Radiography and MRI (0.2 T) performed immediately after radiography.	Radiography	Prediction of need for treatment	High risk of bias No criteria explaining why patients needed radiography Decision to treat based on physician only
[31]	Prospective cohort study, The Netherlands	$\geq$18 years old patients in ED within 5 days after ankle injury $n = 647$	OAR, Leiden Ankle Rules and Utrecht Ankle Rules	Radiography	Sensitivity, specificity, reduction of radiography, ROC curves and area under ROC curves	Low risk of bias
[32]	Case-control study, Germany	Adults patients a clinic in a clinic within 48 hours after ankle injury $n = 45$ Healthy control group $n = 38$	Assessment of anterior drawer test using the ankle meter	Stress radiography	ATD measurement in both group Correlation between ATD measurement and stress radiography Influence of pain	Moderate risk of bias
[33]	Prospective cohort study, U.S.A.	Military academy cadets (18-25 years old) at walk-in clinic within 10 days after ankle or midfoot injury $n = 156$	Modified OAR (Buffalo rule)	Radiography,	Sensitivity, specificity, predictive values Interobserver agreement	Moderate risk of bias Specific population
[34]	Prospective cohort study, The Netherlands	18 - 40 years old patients in ED within 2 days after inversion injury. $n = 160$	Physical examination within 48h after trauma; Arthrogram within 48h after trauma Delayed examination 5 days later; Stress radiography 5 days after trauma US for 74 consecutive patients	Intraoperative findings for 135 patients Clinical diagnosis at follow up at 6 month for the non-operatively treated group (25 patients).	Specificity and sensitivity	Moderate risk of bias
[35]	Prospective cohort study, The Netherlands	$\geq$15 year old patients in ED within 10 days after ankle trauma $n = 514$	Leiden ankle scoring system Radiography in case Leiden score $\geq$8 ($n = 81$)	No comparison, but telephone follow-up at six weeks	Specificity, sensitivity and reduction in the amount of radiographies	High risk of bias Lack of systematic golden standard test (radiography).
[36]	Prospective cohort study, New Zealand	$\geq$18 years old in an after-hours medical centre within 10 days after ankle or midfoot injury $n = 216$	Clinical examination by GP (+ radiography or phone call follow-up according to the GP management)	Retrospectively applied OAR	Survey, sensitivity , specificity, predictive value and reduction of radiography	High risk of bias Lack of systematic gold standard test (radiography).

ED, emergency department.

reached 95% if the tuning fork is applied on the distal fibula shaft compared to 61% on the tip of the lateral malleolus without any reduction in the sensitivity (both 100%).[23]

- The Bernese ankle rules (Box 1a) applied instead of the Ottawa ankle rules show a sensitivity of 100% and a specificity of 91% that could lead, if it is confirmed, to a reduction of false positive results and of unnecessary radiographs compared with OAR rules.[24]
- The Leiden and the Utrecht ankle rules (Box 1b) appear to have higher specificities and lower sensitivities than the OAR.[26,31,35]

Table 4. Diagnostic indicators performance of the OAR in identifying fracture.

Reference	Setting	*n*	Missed fractures	Total fractures	Sensitivity % (95%CI)	Specificity % (95%CI)	Positive predictive value % (95%CI)	Negative predictive value % (95%CI)	Risk of bias
[17]	ED (urban teaching hospital), junior or senior physicians trained to use OAR	265	0	43	100 (92–100)	16 (11–21)	19 (14–24)	100 (90–100)	Low
[18]	ED (district hospital), surgeons or physicians in training to become general practitioners or medical students, all informed about OAR	251	0	33	100 (89–100)	21 (16–27)	-	-	Moderate
	• Surgeons				100 (77–100)	32 (20–46)			
	• Non-surgeons				100 (82–100)	17 (11–23)			
[22]	ED (urban university teaching), specialized emergency nurses (SEN) trained in ankle injuries and junior emergency physicians	106[a]		14					Low
	• SEN		1 (avulsion chip of the talus)		93 (64–100)	49 (38–60)	22 (13–35)	98 (87–100)	
	• Junior physicians		1 (avulsion chip of the medial malleolus (deltoid) ligament		93 (64–100)	39 (29–50)	19 (11–31)	97 (84–100)	
[25]	ED (suburban teaching), emergency nurses and emergency physicians, both trained in OAR	103		27					Moderate
	• Emergency nurses		1 (nondisplaced lateral malleolar fracture)		92	36	32	90	
	• Emergency physicians		1 (small avulsion of the talus bone)		92	47	38	94	
[28]	ED (rural hospital), junior or senior doctors with OAR training provided to new junior doctors	1014[b]	2 (undislocated fracture of the 5th metatarsal; avulsion of the lateral malleolus		99	51	-	-	High
[29]	Sports medicine center, primary care sports medicine physician or nurse practitioners, all instructed about OAR	193[b,c]	0	17	100 (78–100)	45 (43–46)	-	-	Moderate
[33]	Orthopaedic walk-in clinic, physical therapists and orthopaedic surgeons	157[c,d]		6					Moderate
	• Physical therapists		0		100 (93–100)	40 (32–48)	6 (2–10)	100 (93–100)	
	• Orthopaedic surgeons		0		100 (93–100)	46 (38–54)	7 (3–11)	100 (93–100)	
[36]	Primary care setting(after-hours medical centre), OAR analysed retrospectively	196	0	13[e]	100 (75–100)	47 (41–55)	12 (7–19)	-	High

ED, emergency department.
[a]Within 48 h of the injury.
[b]Children included.
[c]OAR modified (Buffalo rules).
[d]Military cadets 18–25 years old.
[e]After exclusion of four clinically insignificant fractures.

Table 5. Diagnostic indicators performance of different tests in identifying fracture.

Ref.	Tests	*n*	Missed fractures *n*	Total fractures *n*	Sensitivity % (95% CI)	Specificity % (95% CI)	Risk of bias
[23]	Tuning fork test applied on the tip of the lateral malleolus in patients with positive OAR	49	0	5	100 (46–100)	61 (46–75)	Low
[23]	Tuning fork test applied on the distal fibula shaft in patients with positive OAR	49	0	5	100 (46–100)	95 (83–99)	Low
[24]	Bernese ankle rules	354	0	28	100	91	Low
[31]	Utrecht ankle rules	647	17	41[a]	59 (42–74)	84 (81–87)	
[26,31]	Leiden ankle rules	647	5	41[a]	88 (74–96)	57 (53–61)	Low
[35]	Leiden ankle rules	514	5	29	83 (69–94)	88 (85–91)	High
[19]	Ultrasound in patients with positive OAR	110	1	11[b]	91 (66–98)	91 (88–92)	Low

[a]After exclusion of 33 clinically insignificant fractures.
[b]After exclusion of four clinically insignificant fractures.

Box 1 Detailed explanations concerning certain tests.

(a) The Bernese ankle rules consist of three consecutive steps avoiding palpation on the injured region: indirect fibular stress (10 cm proximally to the fibular tip), direct medial malleolar stress, and compression stress of the mid- and hind foot (talus + calcaneus). Indirect forces are applied to the injured region by the flat of the hand or the whole area of the thumb (medial malleolus) instead of the fingertip.
(b) The Leiden ankle rule uses a score derived from 13 weighted variables ordered in seven rows. It was developed on the basis of published likelihood ratios and personal experience of the investigators. The Utrecht ankle rules consist of 16 variables derived from the Leiden ankle rules and subsequently modified on the basis of the personal preferences of the researchers.
(c) After the first missed fracture, the protocol was changed to scan the posterior edge and 10 cm above each malleoli (instead of 6 cm).

Imaging

This section focuses on the utility of imaging for excluding a fracture in the acute phase of the diagnosis. The diagnostic process needed in the presence of persistent symptoms, several days after an ankle injury, is not considered.

- One study assessed whether the use of ultrasonography can detect foot and ankle fractures in patients with positive OAR. The results indicate that if ultrasonography (Box 1c) is employed prior to X-ray in OAR positive patients, the number of radiographs will decrease by approximately 80%. Two other studies focused on the role of ultrasound for evaluating the severity of the ligament tear and were inconclusive for our search question.[19,27,34]
- Concerning the magnetic resonance imaging, the two selected studies compared MRI with X-ray in the detection of the severity of the lesion and provided inconclusive results.[16,30] No studies were identified on the role of computed tomography in the assessment of fracture risk after ankle sprain.

Discussion

The present study offers an overview of the current evidence on the evaluation of risk fracture after an ankle sprain, a common reason for an encounter in general practice. To our knowledge, no recent systematic review has been published on this topic despite the high prevalence of this kind of injury and the relatively old references used to develop current guidelines. One recent guideline was published by the Royal Society for Physical Therapy [40] and lead to similar conclusions to those of our review.

Main findings

The high sensitivity of the Ottawa ankle rules, previously underlined by the systematic review of Bachmann,[1] is confirmed by recent studies: when the test is negative, a fracture can always almost be excluded. Only three studies reported sensitivity below 100% and the missed fractures were considered of little clinical significance. Moreover, as the OAR recommends repeating the clinical examination after a few days to ascertain the severity of the ankle sprain, this should allow identification of a missed fracture. The relative low specificity of the OAR remains a problem, leading to unnecessary X-rays. The benefit is poorly demonstrated for other tests as Leiden and Utrecht ankle rules, or needs to be confirmed for the Bernese ankle rules, although the first results are very encouraging. In patients with positive OAR, an additional step could increase the specificity. Two methods are promising but need further confirmation: the tuning fork test applied on the distal fibula shaft, and the

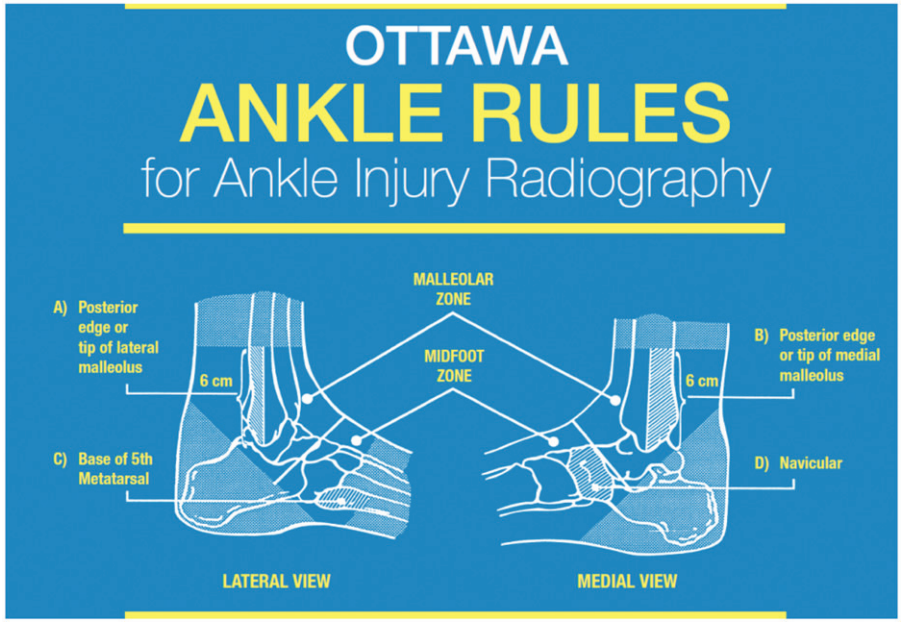

Figure 2. Ottawa ankle rules: Areas of palpation. Source: Ottawa Hospital Research Institute (http://www.ohri.ca/). Reprinted with permission of Ian Stiell of the Ottawa Hospital Research Institute.

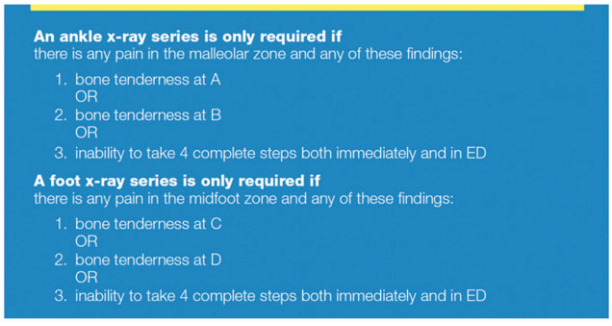

Figure 3. Ottawa ankle rules: Criteria for X-ray series requirements.

ultrasound. There is no evidence to support the use of CT-scan or MRI.

Strengths and limitations

The main strength of this review is the sound methodology followed to identify the best available evidence as well as the tools used for its validation (i.e. GRADE). A limitation of this review is the great heterogeneity between the studies concerning the Ottawa ankle rules preventing the performance of a meta-analysis, even if the main conclusions of the studies are similar. The pragmatic approach chosen to select a good quality systematic review as the starting point of this review and then update the evidence with primary studies published after the systematic review could represent another limitation.

Future direction

The paucity of high-quality evidence should lead to further research. The place of the tuning fork test and the ultrasound in addition to the OAR deserves to be assessed according to well design studies. The higher specificity of the Bernese ankle rules than the OAR in the assessment of ankle fracture risk also needs to be confirmed. It is, therefore, a broad domain that requires further exploration.

Research on the reasons why X-rays are still performed so often in spite of the very low probability of a fracture is also necessary. Some medical conditions of patients are known to hamper the applicability of the OAR as neurologic deficits, polytrauma, bone disease, pregnancy. The individual patient's expression of pain can also influence the OAR performance. For example, a vivid expression of pain could result in higher false positive rates whilst stoicism could lead to higher false negative rates. It is important to take this aspect into account.

Fear of possible medico-legal consequences, insurance issues (e.g. sports accidents) or patient demands seem to be factors that jeopardize the applicability of the Ottawa ankle rules.[5,41] To improve the implementation of OAR in clinical practice, some propositions can be formulated, including leaflets and campaigns on unnecessary use of X-rays after a well-performed examination targeted to patients, or specific training programmes for health professionals. Furthermore, results of the OAR examination could be systematically

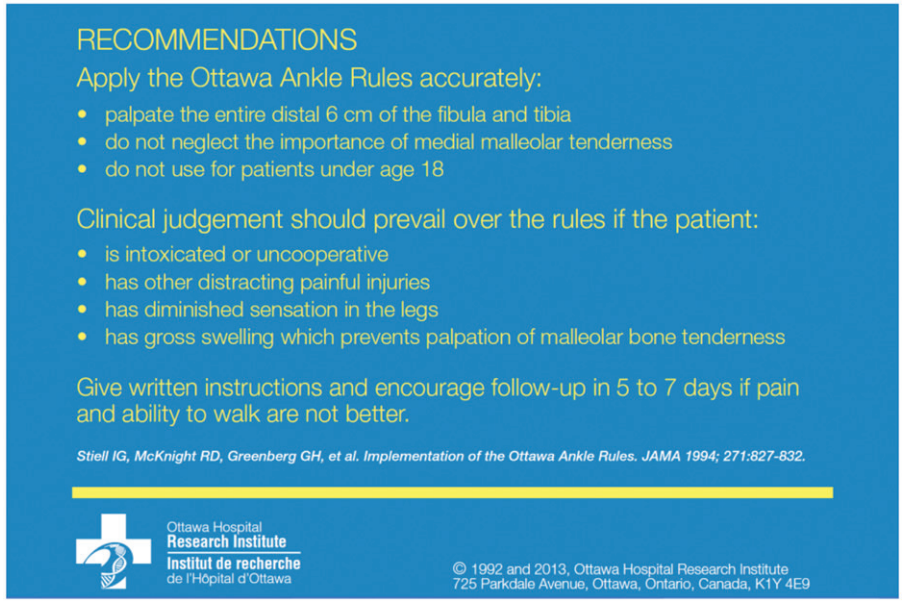

Figure 4. Ottawa ankle rules: Recommendations for use.

registered in the patient medical record and a second examination for patients, if pain and walking ability do not improve after several days, should be proposed during the first consultation.

Conclusion

The present study confirms the central role of OAR as a first step towards the diagnosis of ankle sprain since this test allows selection of patients eligible for X-ray. Although a promising alternative test (the Bernese ankle rules) or additional tests (the tuning fork test and the ultrasound) to increase the OAR specificity are available, their added value should be confirmed.

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Declaration of interest

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

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