Magnetic resonance imaging for diagnosing foot osteomyelitis: a meta-analysis

CRD summary
This review found that magnetic resonance imaging can be used to rule in or rule out foot osteomyelitis and is superior to technetium 99m bone scanning, plane radiography and white blood cell studies. The authors' conclusions appear to be supported by the review, but the inclusion of studies with ill-defined reference standards and other methodological problems weakens the strength of the evidence.

Authors' objectives
To evaluate the accuracy of magnetic resonance imaging (MRI) for osteomyelitis of the foot, and to compare its performance with technetium (Tc) 99m bone scanning, plain radiography and white blood cell studies.

Searching
MEDLINE and EMBASE were searched from inception to June 2006 for English language articles. The bibliographies of included studies were screened for additional relevant studies and specialists were contacted to recommend citations.

Study selection
Study designs of evaluations included in the review
Studies were only included if at least one site with the disease and one without were identified by the reference standard.

Specific interventions included in the review
Studies of MRI were eligible for inclusion. The majority of studies considered a lesion in the bone was positive on MRI if it showed focally decreased marrow signal intensity in T1-weighted images and a focally increased signal intensity in fat-suppressed T2-weighted or short tau inversion recovery images. Some studies also evaluated other signs known as secondary signs; these included cortical disruption, adjacent cutaneous ulcer, soft tissue mass, presence of a sinus tract, and adjacent soft tissue inflammation or oedema. The review also compared MRI with Tc 99m bone scanning, plain radiography and white blood cell studies in studies that directly compared the modalities.

Reference standard test against which the new test was compared
No specific inclusion criteria relating to the reference standard were specified. The reference standards used in the primary studies included biopsy; some studies did not specify a reference standard.

Participants included in the review
Studies of patients suspected of having osteomyelitis of the foot or ankle, or who had foot infection, were eligible for inclusion. At least 80% of the patients had to be aged 16 years or over to be included. In the included studies, the mean age ranged from 46 to 66 years and the prevalence of diabetes ranged from 70 to 100%. One study that included patients with suspected osteomyelitis in or around a Charcot joint was excluded.

Outcomes assessed in the review
Studies had to report sufficient data to construct a 2x2 table about discrete foot and ankle cases.

How were decisions on the relevance of primary studies made?
Two reviewers independently assessed studies for inclusion. A third reviewer resolved any disagreements.

Assessment of study quality
Two reviewers independently extracted information on blinding, the type of reference standard used and the frequency with which a bone biopsy-based reference standard was used. The review also reported on the methods used to select patients and the reporting of reasons for suspecting osteomyelitis.
Data extraction
Two reviewers independently extracted 2x2 data on MRI performance using a standardised data extraction form. Data were also extracted on the diagnostic performance of bone scanning, plain radiography and white blood cell studies if a 2x2 table could be derived from a study that was already included based on its MRI data. The sensitivity, specificity and diagnostic odds ratios (DORs) were calculated from the 2x2 table data.

Methods of synthesis
How were the studies combined?
A summary receiver operating characteristic (SROC) curve analysis was used to pool studies evaluating MRI, according to the methods of Moses and Littenberg. The SROC method was also used to compare the accuracy of the three other imaging tests with that of MRI. Only studies in which all (or nearly all) patients underwent both diagnostic tests being compared were included in this analysis.

How were differences between studies investigated?
The SROC analysis was repeated in the 13 subsets that represented different study populations, or the presence or absence of design flaws. Only some subsets were specified in the paper; full details were reported as being available from the authors.

Results of the review
Sixteen studies (617 sites, 485 patients) were included.

Nine studies were prospective and six of these included consecutive patients. The MRI assessors were blinded in 7 studies. Most studies did not report the reasons for suspecting osteomyelitis. Few studies used biopsy to confirm the diagnosis.

The prevalence of osteomyelitis ranged from 32 to 89%.

For MRI, the sensitivity ranged from 77 to 100% and the specificity from 40 to 100%. The pooled DOR was 42.1 (95% confidence interval, CI: 14.8, 119.9). There was no evidence of differences in MRI performance according to the various subgroup analyses performed.

Studies that did not use bone histological analysis as the reference standard tended to have higher performance (DOR 67.4, 95% CI: 18.3, 248.0).

The comparison of MRI with Tc 99m bone scanning (7 studies) showed that MRI was more accurate: DOR 149.9 (95% CI: 54.6, 411.3) compared with 3.6 (95% CI: 1.0, 13.3) for bone scanning.

The comparison of MRI with radiography (9 studies) also showed that MRI was more accurate: DOR 81.5 (95% CI: 14.2, 466.1) compared with 3.3 (95% CI: 2.2, 5.0) for radiography.

The comparison of MRI with white blood cell study (3 studies) also showed that MRI was more accurate: DOR 120.3 (95% CI: 61.8, 234.3) compared with 3.4 (95% CI: 0.2, 62.2) for white blood cell study.

SROC plots for all comparisons were shown. These supported the results found in terms of DORs, with all MRI studies and SROC curves considerably more towards the upper left hand corner of the plot than those for the other techniques.

Authors' conclusions
MRI can be used to rule in or rule out the diagnosis of osteomyelitis of the foot and ankle. It is superior to Tc 99m bone scanning, plane radiography and white blood cell studies.

CRD commentary
This clearly reported review addressed a defined review question that was supported by explicit inclusion criteria for
the intervention, participants and outcome; inclusion criteria were not specified for the reference standard and there were few limitations on study design, which had the potential to result in the inclusion of studies with considerable variation in study quality. The literature search was limited to two electronic database and contact with experts, only English language studies were included, and it was not clear if unpublished studies were eligible. It may therefore be subject to language and publication bias. Details of the review process, which included appropriate steps to minimise bias, were reported. A limited quality assessment was carried out; an assessment of other relevant items would have been beneficial.

The methods used to pool the results were appropriate and the presentation of SROC plots aided interpretation of the results. The authors’ conclusions appear to be supported by the results presented. However, the inclusion of several studies with ill-defined reference standards and other methodological problems weakens the strength of the evidence.

**Implications of the review for practice and research**

Practice: The authors stated that MRI is a robust test to both confirm and exclude a diagnosis of osteomyelitis of the foot, and that the use of Tc 99m bone scanning in the diagnosis of osteomyelitis of the foot should diminish.

Research: The authors stated the need for a study that formally evaluates serial plain radiography versus early MRI to clarify the place for MRI in the diagnostic algorithm of osteomyelitis. Such a study could also include a cost-effectiveness analysis.

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