Diagnostic value of whole-body magnetic resonance imaging for bone metastases: systematic review and meta-analysis


CRD summary
This review concluded that whole-body magnetic resonance imaging (MRI) was an accurate, cost-effective tool for detecting bone metastases and that whole-body MRI without diffusion-weighted imaging may improve specificity. Poor reporting, weaknesses in the analyses, small number and size of studies and lack of cost-effectiveness data mean that these conclusions are unlikely to be reliable.

Authors’ objectives
To assess the diagnostic performance of whole-body magnetic resonance imaging (MRI) for the detection of bone metastases.

Searching
MEDLINE and EMBASE were searched from January 1995 to September 2010 and search terms were reported. CANCERLIT and The Cochrane Library were also searched. The bibliographies of included studies were also screened for additional articles. Only studies published in English were eligible for inclusion.

Study selection
Eligible studies used whole-body MRI to assess patients with suspected or previously diagnosed skeletal metastases, where histopathology and/or clinical follow-up for a minimum of six months were used as the reference standard to confirm diagnosis. Studies were required to include at least 10 participants and to report sufficient data to populate per patient 2x2 contingency tables (numbers of true positive, false negative, false positive and true negative test results).

The authors of abstracts and studies that did not report sufficient data were contacted to request additional information.

Where reported, the average age of study participants ranged from 53 to 72 years and the proportion of male participants ranged from 2% to 70%. The majority of included studies used whole-body MRI with diffusion-weighted imaging and scan times ranged from 30 to 76 minutes.

Two reviewers independently assessed studies for inclusion and any disagreements were resolved by consensus.

Assessment of study quality
Two reviewers independently assessed study quality using the QUADAS tool; any disagreements were resolved by consensus.

Data extraction
Data were extracted to populate 2x2 contingency tables on the performance of whole-body MRI in detecting bone metastases. These data were used to calculate sensitivity and specificity with 95% confidence intervals (CIs).

Two reviewers independently extracted data; any disagreements were resolved by consensus.

Methods of synthesis
Pooled estimates of sensitivity, specificity and diagnostic odds ratio (DOR), with 95% confidence intervals were calculated using a random-effects model. A summary receiver operating characteristic curve was estimated using the Moses and Littenberg model and the Q* index (the point on the curve where sensitivity and specificity are equal) was calculated.

Between study heterogeneity was assessed using the X² test. Threshold effect was assessed and other sources of heterogeneity were explored using meta-regression analysis; variables included publication year, study design, sample size, individual items of the QUADAS assessment, use of diffusion-weighted imaging, and histopathological confirmation of whole-body MRI positive results. Publication bias was assessed using funnel plots. Subgroup analyses
were also reported for study design (prospective and retrospective), use of diffusion-weighted imaging, and histopathological confirmation.

**Results of the review**

Eleven studies, with a total of 495 participants, were included in the review. Five studies reported prospective, consecutive recruitment of participants; the remaining six studies were retrospective database reviews. No further results of the QUADAS assessment were reported.

The pooled estimate of the sensitivity of whole-body MRI for the detection of bone metastases was 89.9% (95% CI 84.5% to 93.9%) and the pooled estimate of specificity was 91.8% (95% CI 88.2% to 94.6%). The pooled estimate of DOR was 105.58 (95% CI 27.86 to 400.07). There was significant between study heterogeneity in all estimates. The Q* index derived from the summary receiver operating characteristic curve was 89.9%.

There was no evidence of threshold effect. Full results of the meta-regression analysis were not reported, but the variable reported as 'most important' (diffusion-weighted imaging) was not statistically significant. Subgroup analyses indicated that specificity, DOR and Q* index were significantly lower in studies using whole-body MRI with diffusion-weighted imaging than in those without diffusion-weighted imaging; there were no other significant differences.

There was no evidence of publication bias.

**Authors' conclusions**

Whole-body MRI was an accurate, cost-effective tool for detecting bone metastases. Whole-body MRI without diffusion-weighted imaging may improve the specificity. Diffusion-weighted imaging appears to be a sensitive but rather unspecific modality for the detection of bone metastatic disease.

**CRD commentary**

The review stated a clear research objective and reported inclusion criteria. A number of sources were searched for relevant studies but the restriction to studies published in English raised the possibility of language and publication biases. A test for publication bias was reported, but these tests were unreliable for reviews of test accuracy studies. The review process included measures to minimise error and/or bias and the authors reported assessing the methodological quality of included studies. Quality assessment results were not reported and it was therefore not possible to assess the reliability of the data included in the review. There was minimal reporting of the characteristics of participants in included studies (for example, the location of primary cancers was not reported) which made it difficult to assess the generalisability of findings.

Generating pooled estimates of test performance, given the presence of significant, unexplained, between study heterogeneity may not have been appropriate. Results of the meta-regression analysis were not fully reported, though given the small number of included studies and their small sample size, the results of meta-regression and subgroup analyses were unlikely to be reliable. The authors' conclusions refer to cost-effectiveness without presenting any cost-effectiveness data. Limitations in the reporting and analytical methods mean that the results of this review should be interpreted cautiously.

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

**Practice:** The authors did not specify any recommendations for clinical practice.

**Research:** The authors stated that high-quality prospective studies of whole-body MRI for the detection of bone metastases still need to be conducted.

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