Inflammatory bowel disease diagnosed with US, MR, scintigraphy, and CT: meta-analysis of prospective studies
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CRD summary
This review compared the accuracy of ultrasound, magnetic resonance imaging, scintigraphy and computed tomography for the diagnosis of inflammatory bowel disease. Overall, the review was well conducted and the authors’ conclusion, that diagnostic performance was similar across imaging modalities, reflected the available data and is likely to be reliable.

Authors' objectives
To compare the accuracies of ultrasound, magnetic resonance imaging (MRI), scintigraphy, computed tomography (CT), and positron emission tomography (PET) in the diagnosis of inflammatory bowel disease.

Searching
MEDLINE, EMBASE, CINAHL and the Cochrane Library were searched (January 1993 to February 2006). No language or patient age restrictions were applied. Search strategies were reported in an on-line appendix. The bibliographies of included studies and review articles were screened for additional studies. Studies published as abstracts only were excluded.

Study selection
Prospective studies of ultrasound, MRI (field strength more than 0.5T), scintigraphy, CT, or PET, used to diagnosis inflammatory bowel disease in 15 or more patients, were eligible for inclusion. Study populations could comprise: patients with suspected inflammatory bowel disease; patients with both suspected inflammatory bowel disease and patients with confirmed inflammatory bowel disease; or patients with known inflammatory bowel disease and suspected recurrence. Included studies were required to confirm diagnosis using the following reference standards: histopathological, ileocolonoscopic and/or intraoperative findings for examination of the colon and terminal ileum; histopathological, small-bowel barium examination; and/or intraoperative findings for examination of the small bowel. The criteria for a positive diagnostic test and data to populate 2x2 contingency tables had to be reported in eligible studies.

Included participants ranged in age from two to 86 years. Of the 33 included studies, the review included 10 studies in which all patients were known to have Crohn's disease and one study in which all patients were known to have ulcerative colitis. Criteria used for imaging diagnosis were inconsistent; wall thickening was considered a positive criterion in all but one of the cross-sectional studies (ultrasound, MRI, CT), but thickness cut-off values varied.

Initial screening of titles and abstracts was undertaken by one reviewer. Full inclusion criteria were applied to retrieved articles by two reviewers and disagreements were resolved by consensus.

Assessment of study quality
The following criteria were assessed: blinded interpretation of test results; clear description of diagnostic criteria; adequate description of the reference standard examination; time delay between index test and reference standard.

Two reviewers independently assessed study quality using criteria based on the QUADAS (Quality Assessment of Diagnostic Accuracy Studies) tool and disagreements were resolved by consensus.

Data extraction
Details of the imaging technique, the imaging criteria for a positive diagnosis of inflammatory bowel disease, the reference standard used to confirm diagnosis, and data to populate 2x2 contingency tables, were extracted for each study. These data were used to calculate sensitivity and specificity per patient and/or per segment.
Two reviewers independently extracted data and disagreements were resolved by consensus.

**Methods of synthesis**
Summary estimates of sensitivity and specificity were calculated using a random-effects and/or fixed-effect bivariate model.

Where sufficient data were available, possible causes of heterogeneity in accuracy were explored using subgroup analyses on per patient data for disease type (Crohn's disease, ulcerative colitis, both), patient age (less than 18 yrs, adult), disease location (small bowel, colon, both), and imaging criteria used to define disease.

The z test for unpaired groups was used to assess differences between imaging modalities and subgroups.

**Results of the review**
Thirty-three studies, with a total of 1,735 participants (sample size 15 to 440), were included in the review. No studies of PET were identified. Seventeen studies did not report whether test results were interpreted blind to other clinical information. Seven studies did not report whether imaging tests were interpreted without knowledge of the reference standard results. Eleven studies did not report whether reference standards were interpreted without knowledge of imaging test results. Verification of imaging tests was complete in all but seven studies.

**Sensitivity and specificity estimates**: Overall sensitivity estimates, per patient, were not significantly different between imaging modalities: ultrasound 89.7% (11 studies); MRI 93.0% (11 studies); scintigraphy 87.8% (9 studies); and CT 84.3% (7 studies). Overall specificity estimates, per patient, were 95.6% for ultrasound, 92.8% for MRI, 84.5% for scintigraphy, and 95.1% for CT; specificity for ultrasound was significantly higher than that for scintigraphy (p=0.009). Confidence intervals were not reported in the text, but illustrated in supplemental figures were available online (see URL for Additional Data field). Sensitivity estimates per bowel segment were lower for all imaging modalities (67.4 to 77.3%) and specificity estimates were similar (90.2 to 94.0%). CT was significantly less sensitive and specific than scintigraphy (p=0.006) and MRI (p=0.037).

**Subgroup analyses**: There were no significant differences in the performance of MRI by disease location. MRI appeared more sensitive in adult patients (p=0.042) and more specific in paediatric patients (p=0.024). The sensitivity of MRI enterography was significantly lower than that of MRI enteroclysis (p=0.046). The specificity of ultrasound was significantly lower when only the small bowel was examined than when both small bowel and colon were examined (p<0.001), and sensitivities decreased with increasing wall thickness cut-off values.

**Authors' conclusions**
No significant differences in diagnostic accuracy between imaging techniques were observed.

**CRD commentary**
The review assessed a clearly stated research question and reported a comprehensive and appropriate set of inclusion criteria. The search strategy examined a number of sources and was not restricted by language. However, the exclusion of unpublished studies left open the possibility of publication bias. The methodological quality of included studies was assessed and the findings included in the authors’ interpretation of results. Measures were taken during the review process (except when screening titles and abstracts for inclusion) to reduce error and bias. Details of the included studies were adequately reported and the meta-analyses conducted were appropriate to the data. Interpretation of the results would have been aided by reporting (in the article text) of confidence intervals around pooled estimates of accuracy, particularly in the light of generally small sample sizes (three-quarters of the included studies had less than 50 participants). Overall, the authors’ conclusion, that the imaging modalities had similar diagnostic accuracy, reflected the available data and is likely to be reliable.

**Implications of the review for practice and research**
**Practice**: The authors stated that, because patients with inflammatory bowel disease often need frequent re-evaluation, an imaging modality that does not involve the use of ionizing radiation (ultrasound or MRI) is preferable.
**Research:** The authors stated that future studies should focus on standardization of bowel preparation, imaging technique and diagnostic criteria, and should include larger numbers of patients.

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