

Magnetic resonance enteroclysis compared with conventional enteroclysis and computed tomography enteroclysis: a critically appraised topic

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Abstract

Recent advances in CT and MR technology, particularly the advent of multidetector CT (MDCT), the advent of rapidly changing gradients in industry standard MRI scanners, enabling ultrafast sequences, have led to an expansion in the role of cross sectional imaging in the investigation of small bowel disorders. We conducted an evidence-based review of MR enteroclysis (MRE) and how it performs in comparison to CT enteroclysis (CTE) and the gold standard of conventional enteroclysis (CE) for diagnosis of small bowel Crohn's disease and small bowel neoplasia. We used the standard 5 step evidence-based medicine method of ask, search, appraise, apply and evaluate. We found 3 relevant level 1B studies, and one level 3B study. No studies evaluating MRE in small bowel neoplasia were found. MRE does not perform as well as CE in evaluation of fine mucosal detail, but the additional extraluminal detail, and absence of ionising radiation enhances its overall performance. It was not possible to establish the relative diagnostic performances of MRE and CTE from existing literature. CTE does involve patient irradiation. For patients in whom jejunal intubation and enteroclysis is considered to evaluate the small bowel, MRE should be considered the first-line investigation, local resources and expertise permitting.

Key words: Evidence-based medicine/*methods/standards—*Radiology—Crohn disease/*diagnosis—Intestine, small/pathology/*radiography—Magnetic resonance imaging/*methods—Tomography, X-ray computed

Ask

- We wondered whether magnetic resonance enteroclysis (MRE) performs better than conventional enteroclysis (CE) or computed tomography enteroclysis (CTE) in the diagnosis of small bowel Crohn's disease and small bowel neoplasms.
- Before undertaking this review using evidenced-based methods, our opinion without explicit critical appraisal was that MRE would have poorer mucosal detail than CE, but would have better extramucosal detail, without the risk associated with ionizing radiation, thus adhering to the ALARA (As Low As Reasonably Achievable) principle.
- We constructed a standardized PICO question to search the available literature [1]: "In patients with suspected small bowel Crohn's disease or small bowel neoplasia, how does MRE compare to CE or CTE?"

Search

- Using the evidence pyramid as described by Haynes et al. [2], we did not find any secondary evidence of relevance, so proceeded to a search of the primary literature in the Medline database using the PubMed search engine [3]. We constructed a PubMed search based on our PICO question using MESH terms.
- Two separate patient groups were combined to include mucosal pathology terms and neoplasia terms, while confining the search to the small bowel.
- Limits were applied to include only articles referring to humans, published in English in the last 5 years.

- Table 1 outlines the PICO question as constructed with MESH terms.

Appraise

Using PubMed, and the above PICO search, 55 references were retrieved. Review of these abstracts revealed 3 Level 1B diagnostic studies as per Oxford CEBM levels of evidence [4]. Three relevant level 3B studies were identified; however, two of these were discarded in view of stronger available evidence. The third was included because it was the only direct comparison between CTE and MRE. Table 2 outlines the highest ranked articles and some important factors for appraisal of study validity using evidence-based methods [5, 6].

Level 1B Studies (3):

1. Gourtsoyiannis et al. [7] compared MRE and CE in 52 consecutive patients with known ($n = 25$) or suspected ($n = 27$) Crohn's disease. The comparison was performed in a double blind manner, with an acceptable reference standard of CE applied to all patients. Each study was assessed on the basis of severity and location of disease under headings of early minimal disease (fold thickening and distortion, superficial ulceration), transmural disease (deep ulcers, cobble-stoning, wall thickness, stenosis) and extra-intestinal disease (sinus tracts, fistulae, abscesses). Forty-nine diseased segments in 35 patients were detected. Looking specifically at fold thickness, MR detected 10 segments of 49 with fold thickening, but missed 6 segments seen on CE yielding a sensitivity of 62.5% and a specificity of 100%, with a PPV 1.0 and an NPV 0.846. For deep ulcers MR detected 17 of 19 segments with deep ulcers, with a sensitivity of 89.5% and specificity of 100%, giving a PPV 1.00 and NPV 93.8. MR identified 23 segments with stenosis where only 21 were identified with CE giving a sensitivity of 100% and specificity of 92.9%, with a PPV 0.92 and NPV 1.0. With regard to fistulae, MR detected three entero-enteric fistulae confirmed with CE and one entero-cutaneous fistula seen only by MR giving a sensitivity of 100% and a specificity 97.8% and PPV

0.75, NPV 1.0. Figure 1 shows a graph of conditional probabilities [5, 6] for detection of deep ulcers, as a representative marker of disease.

2. Masselli et al. [8] reported results of a cohort of 30 consecutive patients all of whom underwent MRE and CE. All MRE examinations were evaluated by two radiologists in consensus, blinded to the results of CE, evaluated by a third colleague. Specific pathological signs of Crohn's were evaluated independently of each other including ulcers (sensitivity and specificity of 82% and 100%, respectively), pseudopolyps (sensitivity and specificity of 87% and 100%, respectively), stenoses (sensitivity and specificity of 100% and 88%, respectively) and fistulae (sensitivity and specificity of 75% and 100%, respectively).
3. Darbari et al. [9] published a consecutive cohort series of 58 paediatric patients, which compared MRE to histology. This was done in a double blind manner compared to an acceptable gold standard for proof of disease, namely histology, and the authors reported false positives and false negatives. This enabled calculation of positive predictive value of 0.964 and a negative predictive value of 0.923 in the study population. The likelihood ratio for a positive test was 12.5 and 0.04 for a negative test, both reflecting excellent diagnostic performance of the test. The sensitivity and specificity were 0.96 (95%CI 0.896–1.033) and .92 (95% CI 0.778–1.068) respectively. A graph of conditional probabilities was constructed from these results (Fig. 2).

Level 3B Study (1):

The only study we found that compared directly MRE with CTE was published by Schmidt et al. [10]. This reported a cohort of 55 consecutive patients, all of whom underwent both CTE and MRE, but at different times. The proof of disease was based on the findings at CTE combined with histological, surgical, laboratory, and clinical follow-up data. This data was not available for each patient or group of patients, so accurate evaluation of reported sensitivity and specificity results could not be performed. A reproducible reference standard was not employed. Interobserver agreement between radiologists was evaluated by the use of the Kappa statistic. The

Table 1. PICO Literature search strategy table

Patients		Intervention		Comparison		Outcome
[<u>crohn</u> disease or intestine, small or intestine, small/pathology or intestinal mucosa/pathology] or [(intestine, small or intestine, small/pathology or intestinal mucosa/pathology) and neoplasms]	And	Magnetic resonance imaging	And	Tomography, spiral computed or tomography, X-ray computed or barium compounds/diagnostic use or barium sulfate/administration and dosage or barium sulfate/diagnostic use	And	Diagnosis

Table 2. Highest ranked studies with relevant measures of validity from the materials and methods sections of each study

Author	CEBM level of evidence	Independent blinded comparison with reference standard	Applicable spectrum of patients	Reference standard applied to all
Gourtsoyiannis et al. [7]	1B	Yes	Yes	Yes
Masselli et al. [8]	1B	Yes	Yes	Yes
Darbari et al. [9]	1B	Yes	Yes	yes
Schmidt et al. [10]	3B	No	Yes	No

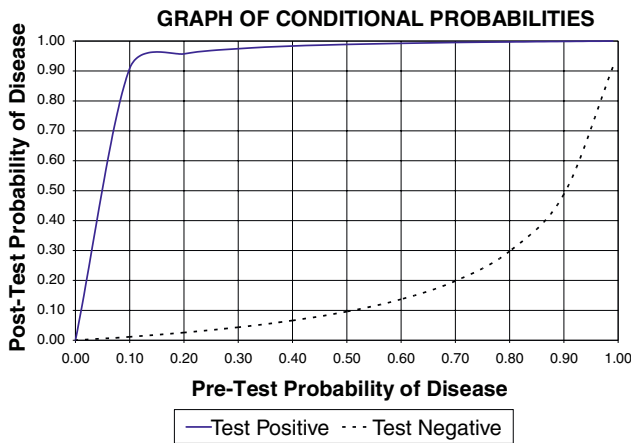


Fig. 1. Gourtsoyiannis et al; Graph of conditional probabilities [5, 6] for detection of deep ulcers on MRE.

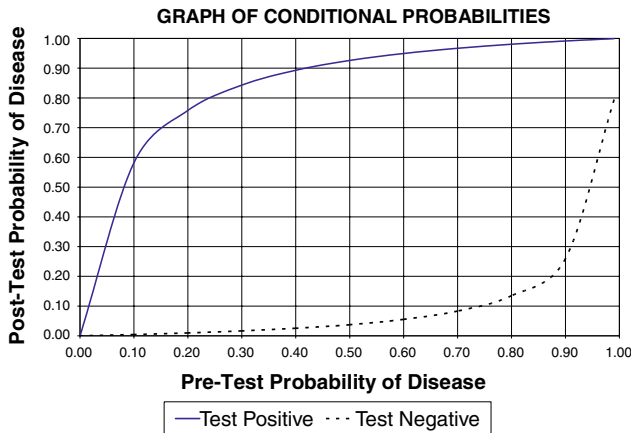


Fig. 2. Darbari et al.; Graph of conditional probabilities [5, 6] for diagnosis of Crohn's disease on MRE.

overall agreement was better for CTE than MRE (0.52 vs. 0.42).

Apply

There is no available high quality evidence for MRE in the diagnosis of small bowel neoplasia, which probably reflects the low incidence of small bowel malignancy [11]. For Crohn's disease, there are no strong studies comparing the diagnostic performance of MRE and CTE.

MRE compares very favourably to CE in overall diagnostic yield, but is inferior in detection of subtle mucosal detail. MRE has the added advantage of extramural detail, which is not provided by CE. Since MRE performs very well in detection of the major pathological signs of Crohn's disease, with the added advantage of extraluminal detail, it should be considered in patients suspected of having small bowel Crohn's disease who would historically be considered for CE, referred from the gastroenterology service, with appropriate clinical and laboratory workup having been undertaken. Application of the ALARA principle would dictate that where it performs as well as CE, it should be preferentially used in such circumstances because of the absence of ionizing radiation. The limitation in the detection of fine mucosal detail in practice will probably have limited impact in practice. The practical implications of MRE must also be considered, considering the pressure on MRI availability and capacity in most busy clinical radiology departments from many clinical specialities. The impact on the radiologist's time is not likely to be great for MRE compared to CE, co-ordination of fluoroscopy and MR schedules to facilitate transfer of the patient from fluoroscopy to MRI following jejunal intubation may be a greater challenge.

We conclude that in patients with suspected Crohn's disease for whom enteroclysis is being considered, MRE should be considered before CE where local resources and expertise permit.

Evaluate

It is unlikely that a robust study comparing MRE with CTE could be performed. This would entail the use of an acceptable reference standard, namely CE, which would then necessitate 3 examinations in each patient, two of which involve a significant radiation dose, and probably necessitating two jejunal intubations.

A future direction for the evaluation of MR imaging of the small intestine might include the assessment of MR enterography as a possible first line examination. In the same manner as small bowel follow through (SBFT) is logistically easier to implement than CE in many centres, an MR equivalent with contrast medium administered orally may be an acceptable first-line study for patients and radiologists alike.

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