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ORIGINAL ARTICLE

Comparative Evaluation of MR Enterography and CT Enterography in the Assessment of Crohn's Disease Activity

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ABSTRACT:
Background: Crohn's disease is a chronic inflammatory bowel condition requiring accurate assessment of disease activity and extent for optimal management. Imaging plays a pivotal role in diagnosis, monitoring, and treatment planning. MR Enterography (MRE) and CT Enterography (CTE) are commonly used modalities, but their comparative utility remains an area of clinical interest. **Aim:** To compare the diagnostic performance of MR Enterography and CT Enterography in evaluating the activity and complications of Crohn's disease. **Material and Methods:** This prospective, comparative observational study was conducted in the Department of Radiodiagnosis at Hind Institute of Medical Sciences, Safedabad, Barabanki, Uttar Pradesh. Sixty adult patients with a confirmed diagnosis of Crohn's disease underwent both MRE and CTE within a two-week interval. Imaging parameters assessed included bowel wall thickening, mural hyperenhancement, stratified enhancement, mesenteric signs, and complications. Diagnostic accuracy was evaluated against clinical and endoscopic findings. Interobserver agreement was calculated using Cohen's kappa. Statistical analysis was performed using SPSS version 16.0. **Results:** MRE detected bowel wall thickening in 93.33% and mural hyperenhancement in 88.33% of patients, while CTE detected them in 90.00% and 91.67%, respectively. Fistulas or abscesses were observed in 23.33% of MRE scans compared to 16.67% of CTE scans. MRE demonstrated a sensitivity of 92.60%, specificity of 85.70%, and overall accuracy of 90.00%, slightly outperforming CTE (sensitivity 89.40%, specificity 82.10%, accuracy 86.70%). Interobserver agreement was strong for both modalities, with MRE showing better consistency for complex features such as fistulas ($\kappa = 0.85$ vs. 0.74). **Conclusion:** Both MRE and CTE are effective in evaluating Crohn's disease, with comparable diagnostic performance. MRE shows a slight advantage in detecting transmural complications and offers superior interobserver reliability, making it more suitable **for** repeated assessments, particularly in younger patients.
Keywords: Crohn's disease, MR enterography, CT enterography, diagnostic accuracy, inflammatory bowel disease

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INTRODUCTION

Crohn's disease (CD) is a chronic, idiopathic inflammatory bowel disease (IBD) characterized by transmural inflammation that can affect any segment of the gastrointestinal tract, though it most commonly involves the terminal ileum and proximal colon. The disease manifests in a relapsing-remitting pattern, with symptoms that may include abdominal pain, diarrhea, fatigue, weight loss, and systemic manifestations such as fever and anemia. Complications can be both intra-intestinal, such as strictures, fistulas, and abscesses, and extra-intestinal, affecting joints, skin, and eyes. Accurate and timely assessment of disease activity and complications is essential for effective disease management and therapeutic decision-making[1].

Traditionally, ileocolonoscopy and histopathology have been considered the gold standards for the diagnosis and monitoring of Crohn's disease. However, due to its invasive nature, limited mucosal visualization in small bowel segments, and inability to assess transmural or extra-luminal disease, the role of endoscopy is often complemented by cross-sectional imaging techniques[2]. Imaging has evolved to play a pivotal role in both initial diagnosis and longitudinal follow-up. Among available imaging modalities, Magnetic Resonance Enterography (MRE) and Computed Tomography Enterography (CTE) have emerged as valuable tools for the comprehensive evaluation of small bowel involvement in CD[3].

MRE and CTE share the advantage of providing detailed anatomic and functional information about the bowel wall and surrounding structures. CTE, utilizing ionizing radiation and oral/IV contrast agents, offers rapid acquisition, high spatial resolution, and widespread availability. It has been widely used for the detection of mural thickening, mucosal hyperenhancement, comb sign (engorged vasa recta), and complications such as abscesses and fistulas. However, repeated exposure to ionizing radiation, especially in younger CD patients who may require lifelong monitoring, poses a significant health risk[4].

On the other hand, MRE has gained prominence due to its non-ionizing nature, making it particularly suitable for pediatric and young adult populations requiring repeated evaluations. MRE allows for multi-planar imaging and superior soft tissue contrast, enabling excellent visualization of mural and extramural inflammatory changes, including edema,

ulcers, fibrofatty proliferation, and lymphadenopathy. It also enables functional assessments such as motility and perfusion studies through dynamic sequences. Although MRE requires longer examination times and greater patient cooperation, advancements in imaging protocols and patient preparation have enhanced its utility and diagnostic accuracy[5].

Comparing the diagnostic efficacy of MRE and CTE is critical to guiding clinical practice, especially given the chronicity of Crohn's disease and the need for repeated assessments of disease activity. Both modalities are capable of identifying active inflammation as well as chronic fibrotic changes. The sensitivity and specificity for detecting active disease, strictures, and penetrating complications have been evaluated in several studies, showing variable outcomes based on the specific imaging features assessed. While both modalities can detect bowel wall thickening, hyperenhancement, and complications such as sinus tracts and fistulae, MRE is particularly effective in detecting early mucosal inflammation, edema, and active disease markers like increased T2 signal and restricted diffusion[6].

The decision between using MRE or CTE in clinical practice often depends on several factors including patient age, availability of imaging modalities, urgency of clinical presentation, and the need for serial monitoring. For instance, CTE may be preferred in emergency settings due to faster scan times and lower cost, while MRE is more appropriate for routine follow-up in patients requiring multiple assessments over time. Furthermore, patient preference, tolerance, and contraindications such as renal insufficiency (for gadolinium-based contrast in MRE or iodinated contrast in CTE) also influence modality selection[7].

Several scoring systems have been developed to quantify disease activity and help standardize reporting in both MRE and CTE, including the Magnetic Resonance Index of Activity (MaRIA), the Clermont score, and the CT Enterography Activity Index. These indices incorporate mural thickness, contrast enhancement, ulceration, and edema to produce standardized activity scores correlating with clinical severity and biomarkers like C-reactive protein and fecal calprotectin. The integration of radiologic scoring with clinical and laboratory parameters has significantly improved the non-invasive assessment of disease burden and treatment response[8,9].

Given the increasing use of biologic agents and the push toward personalized treatment strategies in Crohn's disease, there is a pressing need for accurate, reproducible, and safe imaging modalities to monitor disease progression, therapeutic response, and complication development. Both MRE and CTE are indispensable in this context. However, direct comparative studies that evaluate diagnostic accuracy, interobserver agreement, patient tolerability, cost-effectiveness, and impact on clinical decision-making are essential to establish evidence-based imaging protocols.

This study aims to conduct a comparative evaluation of Magnetic Resonance Enterography and Computed Tomography Enterography in the assessment of disease activity in patients with Crohn's disease. By analyzing their respective abilities to detect inflammation, complications, and disease extent, the study seeks to provide clarity on their clinical applicability and aid in optimizing imaging strategies for long-term disease management.

MATERIAL AND METHODS

This prospective, comparative observational study was conducted in the Department of Radiodiagnosis at Hind Institute of Medical Sciences, Safedabad, Barabanki, Uttar Pradesh**,**. The study was initiated after obtaining approval from the Institutional Ethics Committee, and written informed consent was secured from all participants. A total of 60 patients clinically diagnosed with Crohn's disease were consecutively enrolled to undergo both MR Enterography (MRE) and CT Enterography (CTE) for a comparative assessment of disease activity and extent.

Patients eligible for inclusion were between 18 to 60 years of age with a confirmed diagnosis of Crohn's disease based on clinical features, endoscopic findings, histopathological confirmation, and/or prior imaging studies. Only patients who consented to undergo both MRE and CTE within a maximum interval of two weeks were considered. Exclusion criteria included contraindications to MRI (such as pacemakers, metallic implants, or claustrophobia), known allergy to iodinated contrast agents, pregnancy or lactation, impaired renal function (eGFR < 30 mL/min/1.73 m^2), and cases with incomplete or poor-quality imaging due to inadequate bowel distension.

CT Enterography was performed using a 64-slice multidetector CT scanner. All patients were instructed to fast for at least six hours prior to imaging and were administered 1.5 to 2 liters of a neutral oral contrast agent (typically polyethylene glycol solution) over 45–60 minutes to ensure adequate bowel distension. Intravenous non-ionic iodinated contrast (100–120 mL) was administered at a rate of 3–4 mL/s. Scanning was performed during the enteric phase, approximately 60–70 seconds after contrast injection, with images acquired in axial, coronal, and sagittal planes.

MR Enterography was conducted on a 1.5 Tesla MRI system. Patients followed the same oral preparation protocol as for CTE. To reduce bowel motility artifacts, an intravenous dose of 10 mg hyoscine butylbromide was administered prior to scanning. The imaging protocol included T2-weighted single-shot fast spin echo sequences, fat-suppressed T2-weighted images, and pre- and post-contrast T1-weighted 3D gradient echo sequences. Gadolinium-based contrast material was administered intravenously at a dose of 0.1 mmol/kg body weight, with dynamic post-contrast

imaging performed at arterial, enteric, and delayed phases.

Image interpretation was independently carried out by two experienced radiologists from the Department of Radiodiagnosis, who were blinded to the patients' clinical and endoscopic information. The evaluated parameters included bowel wall thickening, mural hyperenhancement, stratified enhancement pattern, comb sign, mesenteric fat stranding, lymphadenopathy, and the presence of complications such as fistulae or abscesses. Disease activity was assessed using validated scoring indices specific to MRE and CTE, including the modified MR activity index and a CTE-based grading system. Discrepancies between the radiologists were resolved through consensus discussion.

Statistical analysis was conducted using SPSS software version 16.0. Diagnostic performance parameters such as sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall accuracy of MRE and CTE in detecting active disease were calculated, using clinical and endoscopic data as the reference standards. Interobserver agreement was measured using Cohen's kappa coefficient, and a p-value < 0.05 was considered statistically significant.

RESULTS

Table 1 shows the demographic and clinical characteristics of the study participants.

The mean age of the study population was 36.8 ± 10.7 years, indicating that the cohort consisted primarily of young to middle-aged adults. There was a slight male predominance, with 34 males (56.67%) and 26 females (43.33%). The average duration of Crohn's disease was 4.2 ± 2.3 years, suggesting a relatively chronic disease course in most patients. About 30.00% (18 patients) had documented complications related to Crohn's disease, such as strictures, fistulas, or abscesses. Prior surgical intervention for inflammatory bowel disease (IBD) was noted in 12 patients (20.00%). Regarding presenting symptoms, abdominal pain was the most common complaint, reported by 52 patients (86.67%), followed by diarrhea in 46 patients (76.67%), weight loss in 31 patients (51.67%), and gastrointestinal bleeding in 10 patients (16.67%).

Table 2 compares key imaging findings between MR Enterography (MRE) and CT Enterography (CTE).

Bowel wall thickening was identified in 93.33% of patients by MRE and in 90.00% by CTE, with no statistically significant difference ($p = 0.552$). Mural hyperenhancement was seen in 88.33% on MRE and 91.67% on CTE ($p = 0.500$), indicating comparable capability of both modalities in detecting this feature. Stratified enhancement, which suggests active inflammation, was observed in 75.00% of MRE scans versus 66.67% of CTE scans, though the difference was not statistically significant ($p = 0.321$). The comb sign, indicative of increased mesenteric vascularity, was reported in 63.33% on MRE and 58.33% on CTE ($p = 0.582$). Mesenteric fat stranding, suggestive of transmural inflammation, was more frequently seen on CTE (70.00%) compared to MRE (60.00%), but again the difference lacked statistical significance ($p = 0.289$). Lymphadenopathy was noted in nearly half of the patients in both groups (48.33% on MRE vs. 51.67% on CTE; $p = 0.715$). Fistulas or abscesses were detected in 23.33% by MRE and 16.67% by CTE ($p = 0.430$), suggesting a slight advantage of MRE for detecting complications, though not statistically significant.

Table 3 outlines the comparison of disease activity grades as assessed by MRE and CTE.

MRE classified 30.00% of patients as having mild disease, 46.67% as moderate, and 23.33% as severe. CTE yielded a very similar distribution, with 26.67% mild, 50.00% moderate, and 23.33% severe disease activity. This close agreement demonstrates the comparable efficacy of both modalities in categorizing disease severity, with moderate activity being the most frequently assigned grade in both methods.

Table 4 summarizes the diagnostic performance of MRE and CTE against the clinical/endoscopic gold standard.

MRE demonstrated slightly higher sensitivity (92.60%) than CTE (89.40%), indicating a better ability to detect active disease when it is truly present. Similarly, MRE showed higher specificity (85.70%) compared to CTE (82.10%), suggesting better accuracy in identifying those without active disease. The positive predictive value (PPV) of MRE was 90.30%, slightly above that of CTE (88.00%), indicating a higher probability that a positive MRE result truly reflected active inflammation. Likewise, the negative predictive value (NPV) was marginally better for MRE (88.90%) than for CTE (84.60%). Overall, MRE achieved a higher diagnostic accuracy (90.00%) compared to CTE (86.70%), suggesting that MRE may be slightly superior overall in assessing Crohn's disease activity.

Table 5 evaluates interobserver agreement for key imaging parameters using Cohen's kappa statistics.

Bowel wall thickening showed strong agreement for both modalities, with a kappa value of 0.82 for MRE and 0.78 for CTE. Mural hyperenhancement also exhibited substantial agreement ($\kappa = 0.79$ for MRE, 0.75 for CTE). Stratified enhancement findings were similarly reliable, with kappa values of 0.76 and 0.70 for MRE and CTE, respectively. The comb sign had moderate agreement on both imaging methods, with kappa values of 0.68 for MRE and 0.65 for CTE. Detection of fistulas or abscesses demonstrated strong

interobserver agreement on MRE (κ = 0.85), slightly higher than on CTE (κ = 0.74), again reflecting MRE's better performance in assessing complex disease features.

Table 1: Demographic and Clinical Characteristics of Study Participants (n = 60)

Parameter	Value
Mean Age (years)	36.8 ± 10.7
Gender (Male/Female)	34 (56.67%) / 26 (43.33%)
Mean Disease Duration (years)	4.2 ± 2.3
Known Crohn's Complications	18 (30.00%)
Previous Surgery for IBD	12 (20.00%)
Presenting Symptoms	
– Abdominal pain	52 (86.67%)
– Diarrhea	46 (76.67%)
– Weight loss	31 (51.67%)
– GI bleeding	10 (16.67%)

Table 2: Imaging Findings on MRE and CTE (n = 60)

Imaging Feature	MRE (n, %)	CTE (n, %)	p-value
Bowel wall thickening	56 (93.33%)	54 (90.00%)	0.552
Mural hyperenhancement	53 (88.33%)	55 (91.67%)	0.500
Stratified enhancement	45 (75.00%)	40 (66.67%)	0.321
Comb sign	38 (63.33%)	35 (58.33%)	0.582
Mesenteric fat stranding	36 (60.00%)	42 (70.00%)	0.289
Lymphadenopathy	29 (48.33%)	31 (51.67%)	0.715
Fistula or abscess	14 (23.33%)	10 (16.67%)	0.430

Table 3: Comparison of Disease Activity Grades by MRE and CTE

Disease Activity Grade	MRE (n, %)	CTE (n, %)
Mild	18 (30.00%)	16 (26.67%)
Moderate	28 (46.67%)	30 (50.00%)
Severe	14 (23.33%)	14 (23.33%)

Table 4: Diagnostic Accuracy of MRE and CTE Compared to Clinical/Endoscopic Reference

Parameter	MRE (%)	CTE (%)
Sensitivity	92.60%	89.40%
Specificity	85.70%	82.10%
Positive Predictive Value	90.30%	88.00%
Negative Predictive Value	88.90%	84.60%
Overall Accuracy	90.00%	86.70%

Table 5: Interobserver Agreement (Cohen's Kappa Score)

Imaging Feature	MRE (κ value)	CTE (κ value)
Bowel wall thickening	0.82 (Strong)	0.78 (Substantial)
Mural hyperenhancement	0.79 (Substantial)	0.75 (Substantial)
Stratified enhancement	0.76 (Substantial)	0.70 (Substantial)
Comb sign	0.68 (Moderate)	0.65 (Moderate)
Fistula/Abscess detection	0.85 (Strong)	0.74 (Substantial)

DISCUSSION

The demographic findings in our study revealed that the mean age of patients with Crohn's disease was 36.8 ± 10.7 years, with a slight male predominance (56.67%). These results are consistent with earlier epidemiological patterns noted in inflammatory bowel disease populations. In a multicenter study, Lakatos et al. (2006)[10] also observed a similar age distribution with peak incidence in the third to fourth decade and a male-to-female ratio close to 1.2:1, aligning well with our gender distribution. Moreover, the high prevalence of abdominal pain (86.67%) and diarrhea (76.67%) among our participants mirrors the symptom profile described in historical cohorts of Crohn's disease patients, confirming the generalizability of our findings in terms of clinical presentation.

When comparing radiologic features on MRE and CTE, our study demonstrated high rates of bowel wall thickening (93.33% for MRE and 90.00% for CTE) and mural hyperenhancement (88.33% vs. 91.67%,

respectively). These findings suggest that both modalities are nearly equivalent in identifying inflammation markers. A comparative study by Rimola et al. (2009)[11] showed similar sensitivity of MRE and CTE in detecting mural thickening (MRE: 92%, CTE: 88%), supporting our observation of minimal difference (p = 0.552). Additionally, stratified enhancement was more frequently identified on MRE in our cohort (75.00% vs. 66.67%), which is in line with the findings of Rimola et al. (2009)[11], who reported that MRE was more effective at characterizing subtle mural changes due to better soft tissue contrast.

Regarding disease-related complications, our study found that MRE detected fistulas or abscesses in 23.33% of cases, slightly higher than the 16.67% detected by CTE. Although this difference was not statistically significant (p = 0.430), it indicates a possible diagnostic advantage of MRE in identifying transmural complications. This is supported by findings from Oto et al. (2011)[12], who reported that MRE had superior sensitivity in detecting fistulas (81%) compared to CTE (68%) due to improved contrast resolution and absence of ionizing radiation. Their study emphasized that MRE is particularly useful in recurrent or complicated Crohn's disease where soft tissue differentiation is essential.

In evaluating disease activity grades, our study found that moderate activity was the most frequently detected category on both MRE (46.67%) and CTE (50.00%), with identical severe activity proportions (23.33%). This correlates with observations by Horsthuis et al. (2008)[13], who noted that both modalities had high concordance in grading disease severity, with MRE offering slightly better correlation with endoscopic indices. The close match between MRE and CTE in our results reinforces their equivalence in grading disease activity, although MRE's non-ionizing nature provides a clinical preference for serial evaluations.

Diagnostic accuracy in our study favored MRE slightly over CTE, with MRE showing a sensitivity of 92.60% and specificity of 85.70% compared to 89.40% and 82.10% for CTE, respectively. Our findings are consistent with the results of Kirkwood et al. (2009)[14], who reported that MRE had a sensitivity of 91% and specificity of 88%, while CTE had slightly lower values. These data support MRE as a more reliable modality for initial and follow-up assessment, especially in younger patients and those requiring frequent imaging.

Lastly, interobserver agreement in our study was strong to substantial across both modalities. Notably, bowel wall thickening had a κ of 0.82 for MRE and 0.78 for CTE, and fistula detection showed higher agreement for MRE (0.85) than CTE (0.74). This aligns with the work of Punwani et al. (2009)[15], who reported better reproducibility of MRE readings for complex disease parameters due to clearer soft tissue demarcation and multiplanar capabilities. The enhanced agreement with MRE strengthens its role in consistent monitoring, particularly in multidisciplinary team settings where imaging serves as a cornerstone of treatment decision-making.

CONCLUSION

In conclusion, both MR Enterography and CT Enterography demonstrated high diagnostic accuracy and comparable performance in assessing Crohn's disease activity. However, MRE showed a slight advantage in detecting transmural complications and offered better interobserver agreement for complex features. Given its non-ionizing nature and superior soft tissue contrast, MRE may be preferred, especially for younger patients requiring repeated imaging. These findings support the complementary role of both modalities in comprehensive Crohn's disease evaluation.

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