



Role of MR Enterography (MRE) in Small Bowel Diseases

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Abstract

Introduction: Over recent years there have been significant advances in radiological techniques to better define small bowel lesions. Lack of ionising radiation, superior soft-tissue contrast resolution, capability of dynamic contrast enhanced imaging and capability of cine imaging to assess peristalsis makes MRE potential ideal imaging modality to assess small bowel pathologies.

Objective: The purpose of this article is to describe the role of MRE in diagnosis of small bowel diseases and guiding the course of management in patients of small bowel diseases.

Materials and Methods: MRE was performed on 30 patients who presented to outpatient department of surgery and general medicine with abdominal complaints. The level of agreement (%) of MR diagnosis with reference to a gold standard (histopathology, Fine Needle Aspiration Cytology, response to treatment) was calculated. The number and proportion of patients among whom the operating surgeons changed their course of management (that might have adopted in the absence of MR diagnosis) was calculated.

Observations: Four of 30 patients had Crohn's disease (CD) on MRE. Ten (33.3%) of the 30 patients who underwent MRE were operated. Adhesive bands (2.7%) was the most common operative finding. Histopathological examination was done in 43.4% of patients where CD (16.7%) was the most common diagnosis. Course of management changed in 56.7% of patients after MRE. There was 100% agreement between MR diagnosis and histopathology in all the cases except CD where there was 80% agreement.

Conclusions: MRE has high diagnostic accuracy comparable with histopathological diagnosis except in CD where diagnostic accuracy was 80%. MRE is very useful tool for clinician and surgeon in deciding the optimal course of management.

Keywords: MR enterography, small intestine, Crohn's disease.

INTRODUCTION

Imaging of small bowel has been a challenging area due to its anatomy, location and relative tortuosity. Small bowel barium study has a limited

role in the diagnosis of acute small bowel obstruction, ileus and in the assessment of extraluminal disease. Ultrasound is reliant on operator's skill¹. Although computed tomography

enterography can obtain high-resolution images of the small bowel, there is high radiation exposure. Several small bowel disease processes such as Crohn's disease (CD) and the polyposis syndromes occur in younger patients who may require frequent imaging for surveillance. Therefore, the cumulative amount of lifetime radiation exposure from repeated CT scans for these patients is significant and imaging that can be performed without ionizing radiation would be beneficial in this population. MRI is the answer to this problem and should be used in patients requiring surveillance, in pregnant patients and in children. Although CT and MR enteroclysis provide better bowel distension, there is patient discomfort associated with nasojejunal tube placement. The logistics of performing CT and MRI when the fluoroscopic suite is far from the scanning area is inconvenient. Magnetic Resonance Enterography (MRE) has several advantages including lack of ionizing radiation, superior soft-tissue contrast resolution, capability of dynamic contrast enhanced imaging and capability of cine imaging to assess peristalsis². Early studies have shown that diffusion-weighted imaging of the small bowel can provide quantitative measures of inflammation and tumor

allowing differentiation from normal segments⁵. The purpose of this article is to describe the role of MRE in diagnosis of small bowel diseases and guiding the course of management in such patients.

MATERIALS AND METHODS

We conducted this study in the Department of Radio-Diagnosis, Indira Gandhi Medical College and Hospital, Shimla from July 2015 through June 2016. Patients were kept overnight fasting prior to MRE. PEGLEC solution was prepared by dissolving 137.15g in 2 litres of water out of which 1.4 litre was given according to following schedule:

- 400 ml , 45 minutes before scanning.
- 400ml ,30 minutes before scanning.
- 400 ml ,15 minutes prior to scan.
- 200 ml on scanning table.

To reduce peristalsis induced motion artifacts, 10 mg of Hyoscine butylbromide was given intravenously prior to scanning and another 10 mg before administration of contrast. MR images were obtained on a 1.5T Avanto system (Siemens, Erlangen, Germany) by using two six channel phased array body coil. Following sequences were used.

Image plane and sequence	Repetition time (msec)	Echo TIME (msec)	Flip angle	Section Thickness (mm)	Intersection Gap (mm)	Matrix	Field Of View (mm)
True FISP Axial	3.75	1.56	70	6	0	141256	380
True FISP Coronal	3.68	1.47	70	4	0	192257	380
T2 HASTE Axial	1600	92	180	6	0	163256	380
T2 HASTE Coronal	1200	86	170	4	0	205256	380
3D VIBE	4.66	2.05	10	3	0	138256	360
DIXON	7.08	2.39	10	3.5	0	144256	360
Diffusion Weighted Imaging	3500	72		6	0	128192	285
T1 Fat Sat Post contrast	510	8.5	150	4	0	138256	240

FISP = fast imaging with steady-state precession

VIBE = volumetric interpolated breath-hold examination

HASTE half-Fourier single-shot spin echo

0.1 mmole /kg body weight of Gadoterate Meglumine was injected by power injector at a rate of 2mL/sec .Arterial phase MR imaging was initiated 15sec after contrast administration and venous phase MR imaging was performed with a fixed image delay of 50 seconds . Late venous phase was initiated 85s after contrast agent injection.

Image interpretation

MR images were reviewed by one radiologist. Small bowel was considered adequately distended when it was at least 1.5cm in caliber. Wall thickness more than 3 mm in a well distended gut loop was considered abnormal. It was described as symmetrical or asymmetrical wall thickness. Length of abnormal wall thickening was divided as focal (<5 cm), segmental (6-40 cm) or diffuse (>40 cm) involvement. Pattern of enhancement was described as homogenous, heterogenous or minimal or intense enhancement. Pericecal and mesenteric lymph nodes were defined as abnormal if short axis diameter of lymph nodes was more than 1 cm. Mesenteric and paracolic fat was considered as normal or abnormal with minimal, moderate or marked haziness and stranding.

STATISTICAL ANALYSIS

Univariate analysis was performed to describe the clinical, pathological and radiological features of patients. The level of agreement (%) of MR diagnosis with reference to a gold standard (histopathology, FNAC, response to treatment) was calculated. The number and proportion of patients among whom the operating surgeons and physicians changed their course of management (that might have adopted in the absence of MR diagnosis) was calculated. Epi Info version 7.0.9 for windows was used for data analysis.

OBSERVATIONS

We performed MRE on 30 patients who presented to outpatient department of surgery and general medicine with abdominal complaints. Of these 18(60.0%) were female. The age of study participants ranged from 13 to 75 years with the

mean (\pm s.d.) of 46.4(\pm 20.4) years. Majority (90.0%) of the patients presented with chronic pain abdomen and in 2/3rd of the patients clinical diagnosis of partial intestinal obstruction was made. Fifty percent of patients had adequate luminal distension between 1.6 to 2 cm on MRE. Normal wall thickness was seen in 56.7% of patients and 11% of patients showed asymmetrical wall thickness. Homogenous enhancement was seen in 70% of patients. Focal involvement of bowel was seen in 43.3% of patients. Distal involvement of small bowel was seen in 43.3% of patients. Forty percent of patients on MRE were normal. Four were diagnosed as CD and later proved on histopathology. Ten (33.3%) patients who underwent MRE were operated. Adhesive bands (2.7%) (2) was the most common operative finding. These patients had past history of surgery. Histopathological examination was done in 43.4% of patients (13) where CD (16.7%) was the most common diagnosis. There were two patients each of adenocarcinoma colon, gastrointestinal stromal tumour and adhesive bands. There was one patient each of Peutz Jeghers polyp, ulcerative colitis, paralytic ileus, mesenteric ischemia and mesenteric haematoma. There was 100% agreement in the diagnosis like Peutz Jeghers polyp, ulcerative colitis, gastrointestinal stromal tumour, adenocarcinoma, adhesion bands on MRE and histopathology however in CD the HPE agreement was seen in 80% of cases. Course of management changed in 56.7% of patients after MRE.

Table 1: Individual case findings (clinical, MRI, HPE/FNAC and Final diagnosis)

S.N.	Clinical diagnosis	MRI report	Confirmed by HPE/Clinical follow up/Surgery/colonoscopy	Final Diagnosis
1	PSBO ¹	Normal study	Follow up	Normal study
2	Kochs abdomen	Polypoidal lesion in the second part of duodenum	Endoscopy	Peutz zegher syndrome
3	PSBO	Jejunal adenocarcinoma	Histopathological examination	Metastatic Adenocarcinoma
4	PSBO	New growth in ascending colon with intestinal obstruction	Histopathological examination	Adenocarcinoma colon
5	PSBO	Crohn's disease	Histopathological examination	Crohn's disease
6	IBD ²	Gastrointestinal stromal tumour ileum	Histopathological examination	Gastrointestinal stromal tumour
7	Kochs abdomen	Gastrointestinal stromal tumour jejunum	Histopathological examination	Gastrointestinal stromal tumour
8	IBD	Ulcerative colitis	Histopathological examination	Ulcerative colitis
9	PSBO	Normal study	Follow up	Normal study
10	PSBO	Normal study	Follow up	Normal study
11	PSBO	Crohn's disease	Histopathological examination	Crohn's disease
12	IBD	Crohn's disease	Histopathological examination	Crohn's disease
13	IBD	New growth ascending colon	Histopathological examination	Adenocarcinoma colon
14	PSBO	Normal study	Follow up	Normal study
15	PSBO	Adhesive band in terminal ileum	Operated	Adhesive band in terminal ileum
16	IBD	Intestinal tuberculosis	Follow up	Tuberculosis
17	IBD	Crohn's Disease	Histopathological examination	Crohn's Disease
18	PSBO	Paralytic ileus	Follow up	Paralytic ileus
19	PSBO	Normal study	Follow up	Normal study
20	PSBO	Mesentric venous ischemia	Operated	Mesentric venous ischemia
21	IBD	Normal study	Histopathological examination	Normal study
22	PSBO	Subacute haematoma in relation to gastrosplenic region	Fine Needle Aspiration Cytology	Subacute haematoma in relation to gastrosplenic region
23	PSBO	Adhesive band terminal ileum	Histopathological examination	Benign cystic lesion
24	PSBO	Normal study	Follow up	Normal study
25	PSBO	Normal study	Follow up	Normal study
26	PSBO	Inflammatory pathology jejunal loops	Histopathological examination	Metastatic deposits
27	PSBO	Intestinal tuberculosis	Histopathological examination	Metastatic deposits
28	PSBO	Normal study	Follow up	Normal study
29	IBD	Normal study	Follow up	Normal study
30	PSBO	Minimal ascites with bilateral pleural effusion	Follow up	Minimal ascites with bilateral pleural effusion

¹PSBO Partial small bowel obstruction

²IBD Inflammatory bowel disease

Table 2: Comparison of MR Enterography diagnosis and histopathological diagnosis (n=14).

	HPE diagnosis	MR Enterography (MRE) diagnosis	% Agreement	Remarks
Crohn's disease	5	4	80.0	One case found normal on MRE
GIST	2	2	100.0	-
Metastatic tumour deposits	2	NA	NA	Biopsy material taken from mesenteric deposits. One case diagnosed as ileocacal TB and the other one as Jejunal Adenocarcinoma on MRE
Adenocarcinoma colon	2	2	100.0	-
Peutz Zeghers polyp	1	1	100.0	-
Ulcerative colitis	1	1	100.0	-
Haemorrhagic aspirate	1	1	100.0	-

Figure 1

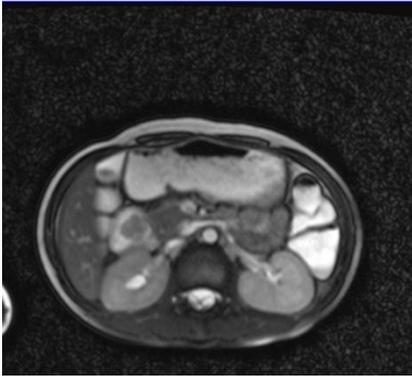


Figure 2

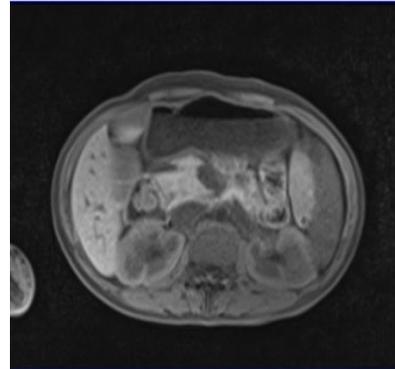


Figure 3

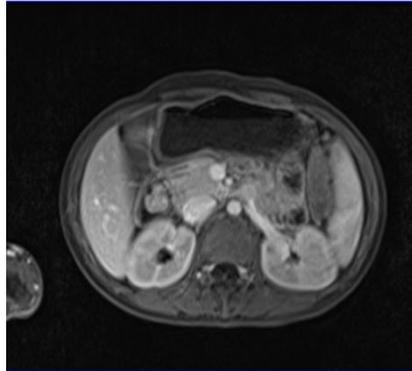
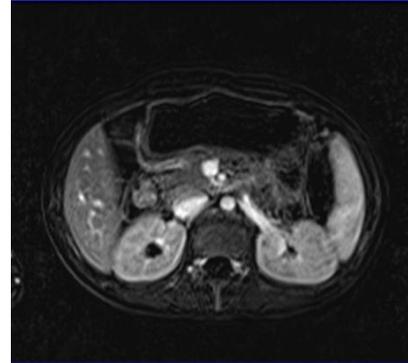


Figure 4



15 year old female with Peutz Zeghers syndrome. Axial TRUF1 (Fig 1) shows hypointense polypoidal mass projecting into the lumen of second part of duodenum. Axial T1 images (Fig 2) shows hyperintense polypoidal mass projecting into second part of duodenum. On postcontrast images (Fig 3) this mass shows heterogenous enhancement. Subtraction images (Fig 4) show hyperintense mass.

Figure 5

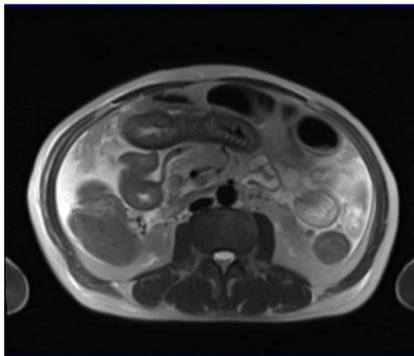


Figure 6

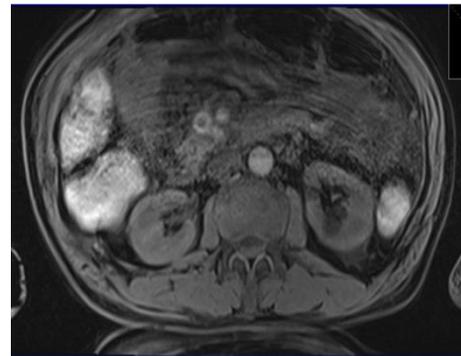


Figure 7

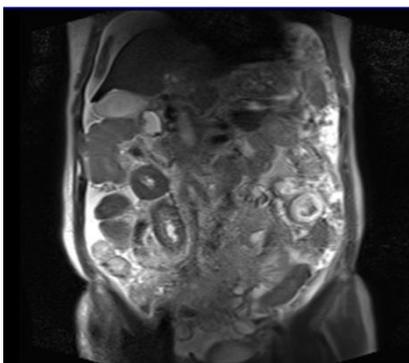
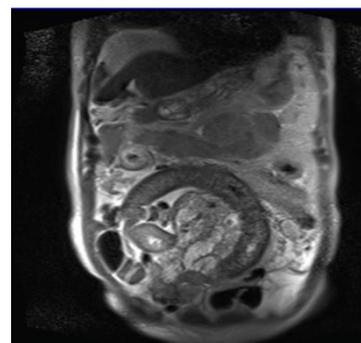


Figure 8



CASE

67 year old patient with superior mesenteric vein thrombosis with symmetrical gut thickening (non contrast study due to deranged renal function tests). Axial HASTE (Fig 1) shows loss of signal void in superior mesenteric vein with normal superior mesenteric artery with circumferential symmetrical wall thickening of jejunal loops. Axial FLASH (Fig 2) images show intraluminal filling defect in superior mesenteric vein. Coronal HASTE (Fig 3 & 4) shows circumferential symmetrical wall thickening of jejunal loops with ascites and loss of flow void in superior mesenteric vein (Fig 3).

DISCUSSION

We gave 1400 ml of oral PEGLEC solution to all patients in divided doses and observed that patient tolerated the dose well without any discomfort and complaints. Also there was optimal distension in all the cases which was more than 1.5cms resulting in good image interpretation. Administration of two doses of buscopan before the start of imaging and contrast respectively proved to be advantageous as no motion artifacts were seen in our study. Sinha et al⁹ observed that in divided dose preparation, 96.6% and in single dose preparation, 87.9% diagnostic distension of bowel was obtained hence concluding that bowel distension was better with divided dose preparation. There is significant variation in the amount of oral contrast for MRE. Young⁸ et al used 2000ml of total oral contrast out of which 1500 ml was given during the first 10 min with an additional 500 ml just prior to scanning. Launstein et al¹⁰ used 1500 ml of oral contrast ingested over a period of 45 min. They were able to achieve optimal bowel distension with minimum side effects.

Three post contrast phases were acquired by us in all cases. This helped in picking thrombus in superior mesenteric vein with long segment ischemic changes in small bowel in one case. Till date in literature acquisition of only one post

contrast sequence is mentioned which can miss the arterial and venous pathologies.

MRI has a disadvantage of limited field of view in axial scanning hence region of interest was selected by looking at pathology in T1, and T2 weighted sequences before acquiring post contrast images.

Our study has four cases of CD. In all the four cases, there was short segment focal asymmetrical thickening with heterogenous enhancement seen in the ileocaecal region. One case had additional finding of stricture in transverse colon. Dinter¹¹ et al found that caecum was the most common site of involvement followed by terminal ileum in CD. There was 80% agreement between colonoscopy and MRE in diagnosis of CD in our study which goes hand in hand with Grand et al¹² who also found 85% sensitivity in Crohns disease. One case of tuberculosis of the ileocaecal region showed short segment asymmetrical thickening having homogenous enhancement. Patient improved with antitubercular treatment. Boudiaf¹⁹ et al found that ileocaecal region was the most common site of involvement in abdominal tuberculosis. Kalra²⁰ et al described homogenous enhancement in 91% cases and focal involvement in 65% cases of ileocaecal tuberculosis

Two cases of GIST in our study had a mean diameter of 8 cm with exophytic component and well defined margins. One tumour showed heterogenous enhancement while the other had central cystic areas with air fluid level. No lymphadenopathy was seen in both the cases. Burkill¹³ et al. reported a mean diameter of 13 cm with well defined margins in about two-thirds of the cases of GIST. Marla¹⁴ et al. found that all tumors in their study were predominantly exophytic. Lee et al.¹⁵ found GIST to be well-defined tumors with homogenous enhancement, while Levy et al.¹⁶ found large heterogeneously enhancing masses due to areas of necrosis or cystic degeneration. Lymph node metastases are uncommon.

We correctly diagnosed site and cause in two cases of subacute intestinal obstruction. Both showed transition point in distal ileum without any other pathology. Both had a prior history of surgery, so the diagnosis of adhesion bands leading to small intestinal obstruction was made, which was confirmed on surgery. Matsuoka et al¹⁷ showed 92.6% sensitivity¹⁷ in diagnosing site and cause of bowel obstruction.

We reviewed one case of Peutz Jeghers syndrome which showed polyp of size 1.5 cm in duodenum. However, smaller polyps seen on endoscopy in posterior wall of antrum of stomach were not appreciated as only supine imaging was done in our study which resulted in masking of the small polyps in the oral contrast of the stomach. Maccioni¹⁸ et al found concordance between MRE and endoscopy in Peutz Jeghers as 72.6% for polyps <15 mm, 93% for polyps >15 mm. He performed both supine and prone imaging in all these cases to detect small polyps and concluded that MRE is less sensitive for identification of smaller polyps (<15 mm).

One case of mesenteric haematoma showed a well defined lobulated mass in gastrosplenic region which was heterogeneously hyperintense on both T1 and T2 weighted images and showed areas of diffusion restriction. There was no enhancement on postcontrast images. The patient was taking diclofenac for more than one year for joint pains. Gomez²¹ et al described two rare cases of mesenteric haematoma where the diagnosis was not obvious on CT scan. However hyper-intensity on T1 weighted images helped in confirmation of diagnosis of mesenteric haematoma.

CONCLUSIONS

MRE has 100% diagnostic accuracy in small bowel pathologies except in CD where diagnostic accuracy was 80%. It proved to be very useful tool for clinician and surgeon in deciding the optimal course of management.

LIMITATIONS

- Small sample size of intestinal obstruction cases. Most cases present in emergency when MRI is not available.
- Histopathological examination could not be done in all cases as all cases were not operated and it was not feasible to have biopsy material in many (nonsurgical) cases.
- Both CT and MRE could not be done in all cases due to ethical and economical concerns.

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