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CASE REPORT

Magnetic resonance enterography findings of chronic radiation enteritis

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Abstract

The diagnosis of chronic radiation enteritis (CRE) is considerably challenging both for clinicians and radiologists. The aim of this study was to evaluate the role of magnetic resonance enterography (MRE) in the diagnosis of CRE. To the best of our knowledge, there are no reports on the role of MRE in the diagnosis of CRE specifically. In this report, we present MRE findings of 4 patients with CRE. The most important factors in CRE diagnosis are the clinical findings and medical history, but focal abnormal bowel loop in the region of a known radiation field is the most important information. This abnormal loop is generally located in the distal ileum as present in our patients. Other associated findings helpful for the diagnosis are small bowel thickening, contrast material enhancement in a long segment, mesenteric stranding and luminal narrowing. MRE can be sufficient and useful in the diagnosis of CRE and for treatment planning, especially in patients with significant comorbidities who have had radiotherapy in the past. Adding MRE into the diagnostic algorithm can be helpful in post-radiotherapy patients with acute/subacute gastrointestinal symptoms.

Keywords: *Chronic radiation enteritis; enterography; radiotherapy; small bowel imaging; MRI; oral contrast.*

Introduction

The increased rate of cancer diagnosis has recently resulted in an increase in the number of patients having radiotherapy and an increase in the incidence of its resultant complications, one of which is radiation enteritis (acute or chronic)[1]. Acute radiation enteritis (ARE) manifests with rapidly developing gastrointestinal symptoms just after the radiotherapy, which is generally regressive within 3 months after completion of radiotherapy. Although the clinical diagnosis of ARE is not difficult, the diagnosis and management of chronic radiation enteritis (CRE) is considerably more difficult both for clinicians and radiologists[1]. CRE, which is the focus of this article, develops between 6 months and 7 years after radiotherapy[2]. CRE is reported to occur in 20% of abdominopelvic radiotherapy patients; however, its actual prevalence is thought to be much more than the reported 20%[1,2].

Only a few decades ago, conventional enteroclysis (CE) was the most commonly used imaging method for the diagnosis of CRE or related low-grade intestinal obstruction[2,3]. Plain radiographic scans, ultrasonography (US), computed tomography (CT) and/or magnetic resonance imaging (MRI) are now more frequently used but reported to be insufficient under several circumstances for diagnosis[3]. CT or MR enteroclysis involve a similar technique such as CE, in terms of the need for nasojejunal intubation (NI), and are difficult techniques to perform in patients with suspected CRE, most of whom are generally adynamic and weak with decreased appetite and significant comorbidities (e.g. cardiovascular problems and a history of vomiting)[3]. In addition, radiation exposure both for radiologists/patients during

NI and the long procedure time limit daily routine clinical usage[4].

To prevent these disadvantages of CT and MR enteroclysis, new techniques such as CT or magnetic resonance enterography (MRE), which only include CT or MR image acquisition with oral contrast agent administration without the need for NI have been developed.

Despite its benefits, CT enterography (CTE) has some disadvantages such as radiation exposure, nephrotoxicity and possible allergic effects of the intravenous CT contrast[5]. On the other hand, MRE can potentially avoid these disadvantages of CTE, specifically for patients with CRE. In this clinical report, we present the MRE findings of 4 patients with CRE for whom other diagnostic imaging modalities (CT, MRI, or endoscopy) were inadequate to accurately diagnose CRE. To the best of our knowledge, this is the first report in the literature to document the use of MRE for the diagnosis of CRE.

Materials and methods

Between January 2006 and March 2010 in 2 different centers, MRE studies of 86 patients with a prediagnosis of low-grade ileus were randomly evaluated by 2 experienced radiologists and an experienced oncologist. Patients without a history of radiotherapy (77 patients) were excluded from the analysis. Of these 86 patients, 9 had radiotherapy in the lower abdominal area and the clinical and radiologic data of these 9 patients were analyzed using the Hospital Information System and Picture Archiving and Communications System (PACS). Two patients were excluded as their MRE images could not be evaluated because they were unable to hold breath during MRI or were intolerant to oral contrast agent. Three patients with unproven CRE (clinically or pathologically) were also excluded. There were no other patients (examined by MRE) with a history of radiotherapy and abdominal symptoms in our archives. The final study population included 4 patients with CRE (3 women, 1 man; mean age 56 years; range 31–83 years).

Oral contrast agent and patient preparation

All of the patients gave informed consent before imaging. Patients were asked to fast the night before the examination, and bowel enema was not given for intestinal preparation. Oral contrast agent solution (1500 ml) was administered for intestinal distention. The oral contrast solution was prepared as follows: 10 g of methylcellulose was mixed and homogenized in approximately 400 ml of boiled water at 90°C by using a mixer. Then, 225 ml of low concentration barium (4.9%) and sorbitol-containing solution (E-Z-CAT, E-Z-EM, Inc, Quebec, Canada) at room temperature were added to this suspension. The mixture was put into a 1500-ml bottle and the rest of the bottle was filled with cold water. Because the solution had no fungo-static activity, it was kept in a refrigerator if not used immediately. The reason for adding low concentration barium to the oral contrast material was to enable an evaluation of the patient with CTE without any need to administer any other oral contrast agent in case MRE could not be performed optimally. This approach was applied to all MRE cases.

Oral contrast agent was ingested over a 40–50 min period, as permitted by the patient's tolerance and cooperation. After drinking the solution, 20 mg of hyoscine-*N*-butyl bromide (Buscopan, Boehringer Ingelheim, Germany) was given intravenously to suppress bowel spasms and motion, and the patients were then taken to the MRI suite.

MRE technique

All MRE studies were performed using a 1.5-Tesla scanner (Magnetom Vision Plus, Siemens Medical Solutions, Germany) by using a 4-channel phased-array body coil in the supine position. After acquiring three-plane scout images, two-dimensional T2-weighted (T2W) and precontrast T1-weighted (T1W) images were obtained using the following protocol: axial and coronal planes heavily T2W steady state free precession (also called TruFISP sequence) (repetition time (TR)/echo time (TE) 4.8/2.3 ms, flip angle 70°, matrix 512×56, field of view (FOV) 388×88 mm, slice thickness 7.8 mm, number of slices 6); half-Fourier acquisition single-shot turbo spin-echo (HASTE) with and without fat saturation (TR/TE 95/11.9 ms, FOV 388×388 mm, slice thickness 3.6 mm, number of slices 21, matrix 512×96), and T1W gradient-echo (FLASH) with fat saturation (TR/TE 160/2.3 ms, number of slices 20, slice thickness 7.4 mm, FOV 388×388 mm, matrix 512×172) sequences were obtained. After intravenous administration of gadoterate-meglumine (0.1 mmol/kg; Dotarem, Guerbet, France), T1W sequences were repeated with same parameters in arterial, portal and delayed phases. The MR acquisition time ranged from 20 to 25 min per patient. All T1W and T2W images were obtained with the breath-hold technique.

MRE evaluation

On MRE images, the presence of thickened small bowel wall (>3 mm) and mural contrast material enhancement were positive criteria for bowel segments affected by CRE. If the caliber of the small bowel was greater than 3 cm on T2W MR images, it was reported as small bowel dilatation and ileus, which were again accepted as positive signs for CRE. In addition, the transition zone between the normal and affected bowel segment was investigated, and the distance between the transition zone and the ileocecal valve was identified.

Figure 1 **Case 1. Coronal fat-saturated T2W HASTE image shows distal ileal wall thickening and luminal narrowing (arrows).**

Case presentations

Case 1

A 47-year-old man with diabetes mellitus was admitted with dyspepsia, abdominal pain, nausea, and vomiting for the last 3 days. He had a Whipple procedure 8 months previously for carcinoma of the ampulla of Vater, followed by radiotherapy. Physical examination and laboratory findings were within normal ranges. His colonoscopy, upper gastrointestinal endoscopy, plain roentgenogram and abdominal US examinations were also normal. An MRE was planned for further assessment.

MRE showed moderate dilatation in the jejunal and proximal ileal loops. Thickened, narrowed terminal ileum and perimesenteric stranding were evident (Fig. 1). Contrast material enhancement was seen in the walls of this segment and the surrounding mesenteric adipose tissue. In addition, postoperative changes were present at the operation site.

The patient underwent surgery as a result of these findings and approximately 25 cm of a distal ileum segment and surrounding mesenteric adipose tissue were removed. Macroscopic examination demonstrated partial blunting of the mucosal pilli and edema. Histopathologic examination revealed multiple ulcerations in the intestinal mucosa with mononuclear polymorphonuclear leukocyte infiltration and inflammatory changes. Fibrosis, edema and dilated congestive vessels were seen in the mucosa and submucosa. Wide necrosis was present in the serosa of the terminal ileum and in the surrounding adipose tissue. In addition, ulceration and related fibrinous exudates, granulation characterized by mononuclear inflammatory cell infiltration and capillary hypervascularity were detected. These pathologic findings were consistent with radiation enteritis of the ileum.

The postoperative course was uneventful and patient was discharged on the seventh postoperative day. His 4-week control follow-up was complaint free.

Case 2

A 64-year-old woman was admitted to the emergency room with bilious vomiting, weight loss and abdominal pain ongoing for 2 months. She had undergone total abdominal hysterectomy and bilateral salpingo-oophorectomy (TAH+BSO) 2 years previously for villoglandular adenocarcinoma of the cervix. Eighteen months after the surgery, she had chemotherapy, radiotherapy and brachytherapy for a relapse.

On physical examination, there was abdominal distention without rebound, tenderness and decrease in respiratory sounds of the left lung basal segment. The only positive laboratory finding was a moderate increase in blood urea and creatinine. Abdominal US examination was normal, whereas CT examination was suboptimal because of the dense artifacts secondary to the barium residue from prior fluoroscopic examination, and intravenous contrast material could not be administered due to abnormal kidney function of the patient (Fig. 2). MRE was performed for further evaluation.

Luminal narrowing affecting a 30-cm segment of the distal ileum, as well as wall thickening and abnormal contrast material enhancement were seen on MRE (Fig. 2). The remaining bowel segments were normal. The patient underwent laparotomy as a result of these MRE findings. At laparotomy, there were multiple adhesions secondary to previous surgery. End ileostomy and bridectomy was done. Pathologic examination revealed findings consistent with radiotherapy-induced fibrosis and edema in the distal ileum. The postoperative course was uneventful except for an incision site infection treated with antibiotics and patient was discharged on the 20th postoperative day. She was symptom free at 3-month follow-up.

Case 3

An 83-year-old woman, who had undergone TAH+BSO and radiotherapy for endometrial carcinoma 7 years previously, presented with nausea, anorexia, vomiting and weight loss (5 kg/2 months). Her complaints had become aggravated in the last 15 days and she had started to experience constipation recently. Physical

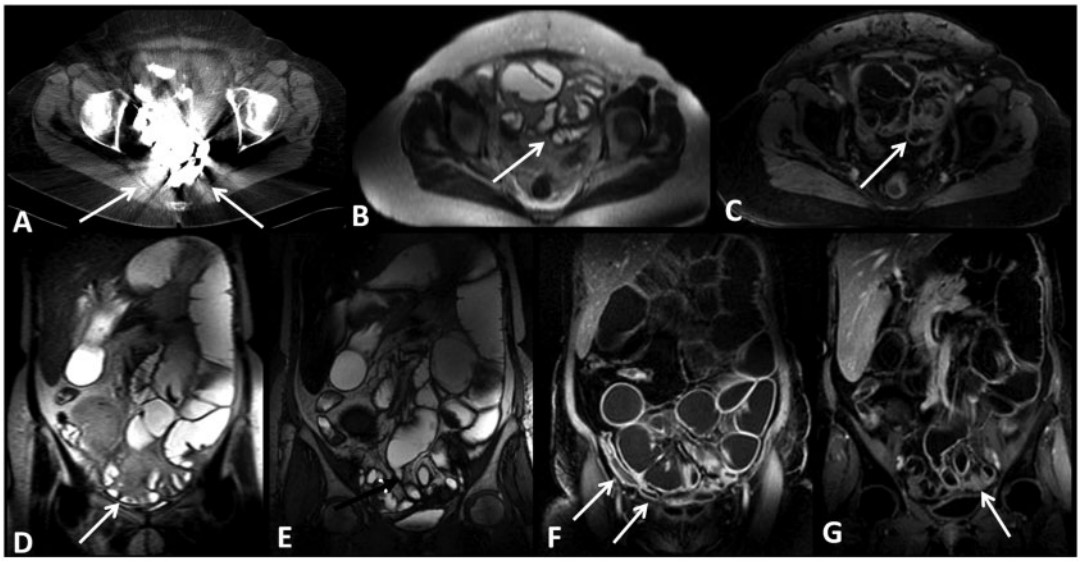

Figure 2 **Case 2. Axial CT image demonstrates significant streak artifacts secondary to barium residues from previous lower gastrointestinal series (arrows, A). Axial HASTE image demonstrates wall thickening, luminal narrowing of a long segment of distal ileum (arrow, B). Axial post-contrast T1W image demonstrates contrast material enhancement in the bowel walls of narrowed distal ileum (arrow, C). Coronal HASTE image demonstrates dilatation of the jejunum and luminal narrowing in the distal ileum (arrow, D). Coronal TruFISP image demonstrates the transition zone (black arrow, E). Coronal post-contrast fat-saturated T1W MR images demonstrate contrast material enhanced bowel walls and luminal narrowing (arrows) in the distal ileum (F,G).**

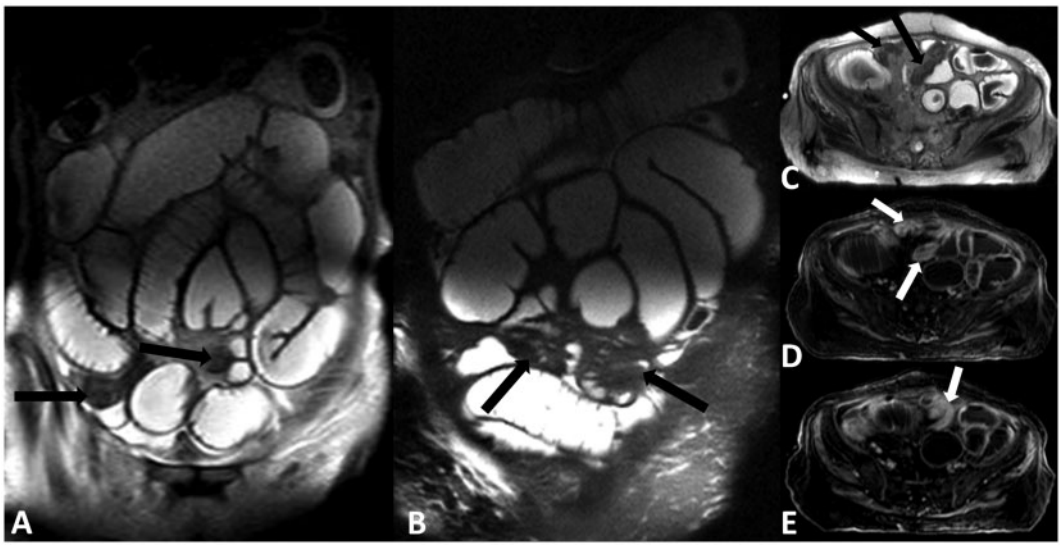

Figure 3 **Case 3. Coronal (A,B) and axial (C) fat-saturated HASTE images of the patient demonstrate proximal small bowel dilation and long segment thick-walled small bowel stricture (distal ileum) with luminal narrowing (black arrows). Axial post-contrast fat-saturated T1W MR images show thick-walled and narrowed small bowels with enhancing mucosa (white arrows in D and E). Imaging findings are consistent with chronic radiation enteritis.**

examination revealed abdominal discomfort. Anemia and moderate increase in blood levels of urea and creatinine were present on blood laboratory examination. Gastroscopy and colonoscopy were negative.

Abdominal radiography revealed air-fluid levels in the jejunum. Abdominal US was negative except for hepatosteatosis. CT was not done due to increased blood urea and creatinine values. MRE demonstrated luminal narrowing and pathologic enhancement in the distal ileum (Fig. 3), which was consistent with CRE.

Surgery was planned but had to be postponed because of her comorbidities. After supportive treatment she had

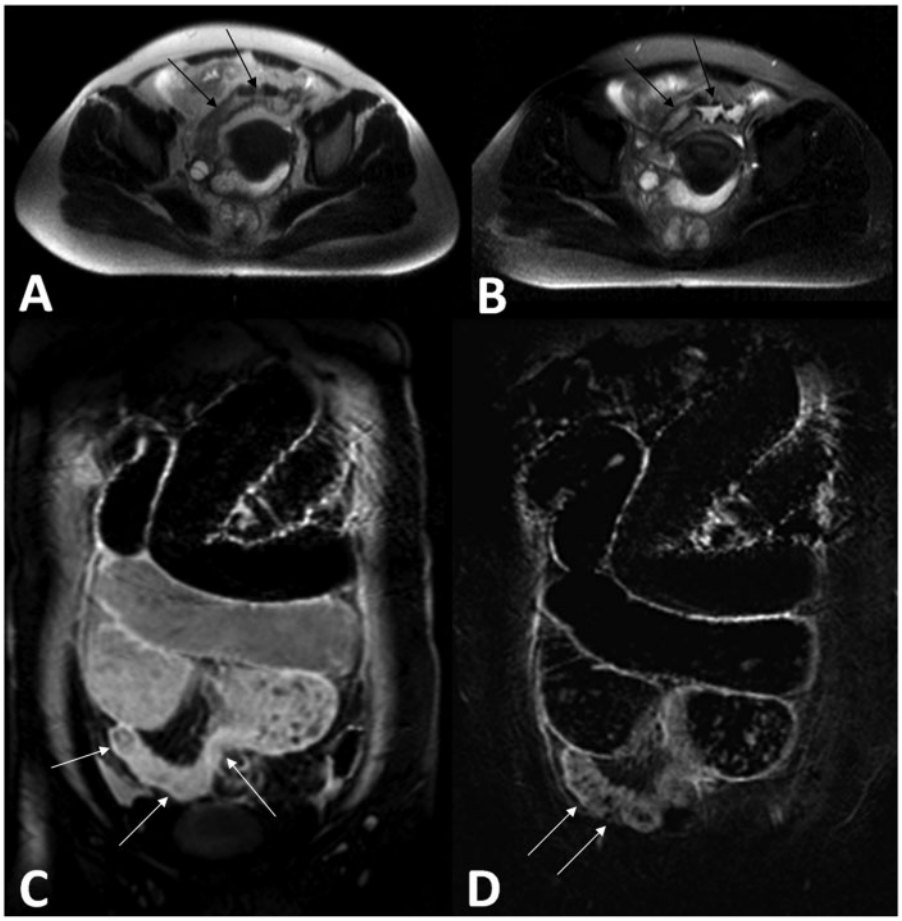

Figure 4 **Case 4. Axial non-fat-saturated (A) and fat-saturated (B) HASTE images of the patient demonstrate bowel wall thickening and luminal narrowing in the distal ileum (arrows in A and B). Coronal post-contrast T1W MRI with fat saturation (C) and subtracted (D) images show mesenteric stranding, luminal narrowing and contrast material enhanced mucosa in the terminal ileum (arrows).**

ileal resection and histopathology examination revealed changes related to radiation enteritis.

Case 4

A 31-year-old woman was admitted with sudden onset anorexia, dyspepsia, nausea and abdominal pain episode. Her past medical history included radiotherapy to the pelvic region for rectal cancer 2 years previously. Physical examination, blood laboratory, colonoscopic and upper endoscopic examinations were all within normal ranges. CTE was planned to exclude a possible small bowel obstruction before capsule endoscopy. However, MRE was primarily preferred instead of CTE because of her history of allergy to iodine-based contrast agents. MRE demonstrated wall thickening, luminal narrowing and wall enhancement in a 30–35 cm segment of the distal ileum also including the terminal ileum (Fig. 4). The patient underwent laparotomy and intra-operative findings were confirmatory for MRE. Histopathologic examination revealed mucosal ulceration, intestinal wall necrosis, telangiectatic vessel formation, and serosal adhesion formation consistent with CRE.

Discussion

CRE accounts for 0.8–13% of cases of intestinal obstruction in oncology patients and is related to significant morbidity and mortality[2]. CRE generally affects the distal ileum since this bowel segment is much more fixed than others; but theoretically it can affect all small bowel loops and the colon[1].

The diagnosis of CRE and differentiation of CRE from recurrent tumor is considerably challenging both for clinicians and radiologists and can require several diagnostic tests in daily routine practice, such as colonoscopy, enteroclysis (conventional, CT or MR enteroclysis), upper gastrointestinal tract endoscopy, capsule endoscopy or small bowel contrast studies[2,3]. Besides their utility, these tests have several disadvantages. For example, capsule endoscopy can cause complete luminal distension in the case of a stricture[6]. In addition, endoscopic studies

and CE fail to demonstrate all layers of the bowel wall and extra-intestinal pathologies[4,6]. Conventional, CT or MR enteroclysis require NI, which negatively effects patient compliance, and leads to additional radiation exposure[7].

In order to address these limitations, per oral CTE and MRE techniques are being developed[7]. Although enterographic methods are useful in evaluating the entire bowel wall and extra-intestinal pathologies, they may have their own disadvantages. For CTE, limitations included radiation exposure, the need for nephrotoxic intravenous contrast material, and the presence of remnant barium from previous studies obscuring image quality[5,8]. For MRE, the most important limitations are long image acquisition time and being more prone to motion artifacts[9]. In addition, gadolinium-based agents used during MRE can cause nephrogenic systemic fibrosis (NSF)[5]. In our institution, we prefer macro cyclic Gd chelates in patients at risk for NSF. On the other hand, high soft tissue resolution, multiphasic imaging (e.g. arterial, portal or delayed venous) without radiation exposure, and not being affected by previous barium studies or CT examinations are among the major advantages of MRE[4,9]. In addition, MRE has the ability to evaluate the jejunum in the early phase (15th min.) and colonic loops in the later phase (1st hour or later) after oral contrast agent administration[10].

The most important factors in CRE diagnosis are the clinical findings and medical history, but focal abnormal bowel loop in the region of a known radiation field is the most important information[1–3]. This abnormal loop is generally located in the distal ileum as present in our patients. Other associated findings helpful for the diagnosis are small bowel thickening, contrast material enhancement in a long segment, mesenteric stranding and luminal narrowing[3]. In the later stages, stenotic segments and ultimate small bowel obstruction can occur as a result of fibrosis[1]. Such findings were also present in our small cohort. In patients with a history of radiotherapy, colitis, proctitis or fistulae may be seen occasionally, and infiltrative processes, neoplasms and/or adhesions must be kept in mind for the differential diagnosis of CRE[1-3].

Conclusion

The incidence of CRE is increasing with the increasing number of patients undergoing radiotherapy for cancer treatment. The diagnosis of CRE is challenging and current techniques have several limitations. MRE can be sufficient and useful in the diagnosis of CRE and for treatment planning, especially in patients with significant comorbidities who have surgery and radiotherapy in their past medical history.

Conflict of interest

We declare that we have no conflict of interest.

Acknowledgments

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