

Preoperative evaluation by magnetic resonance imaging in patients with bowel obstruction

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Manuscript received July 27, 2001; revised manuscript December 18, 2001

Abstract

Background: Bowel obstruction is a problematic condition because the main clinical issue is to determine whether emergency laparotomy or observation with a long tube is required. The recent development of imaging diagnostic modalities such as magnetic resonance imaging (MRI) is thought to be promising to support therapeutic decisions in patients with bowel obstruction.

Methods: Twenty-seven patients with bowel obstruction who underwent laparotomy were evaluated by plain x-ray film, computed tomography (CT) scan, and MRI preoperatively with regard to the presence or absence of bowel obstruction, and the site and cause of bowel obstruction. Diagnostic accuracies were compared among these radiological modalities.

Results: The presence of bowel obstruction was detected in 22 (81.5%) of 27 patients by plain abdominal x-ray film, in 24 (92.3%) of 26 patients by CT scan, and in 25 (92.6%) of 27 patients by MRI. The sites of obstruction were consistent with surgical findings in 25 (92.6%) of 27 patients by MRI, and in 15 (57.7%) of 26 patients by CT scan. The causes of bowel obstruction were accurately diagnosed by MRI in 25 (92.6%) of 27 patients, and in 23 (88.5%) of 26 patients by CT scan.

Conclusions: MRI could identify the presence and the site and cause of bowel obstruction in most of the cases. MRI is assumed to be superior to CT scan in the preoperative diagnosis of bowel obstruction. © 2002 Excerpta Medica, Inc. All rights reserved.

Keywords: Magnetic resonance imaging; Small bowel obstruction; Strangulated bowel obstruction; Bowel obstruction

Small bowel obstruction (SBO) is a relatively common complication in patients who undergo abdominal surgery. In some of them, emergency surgical treatment is indicated. Diagnostic examinations such as abdominal x-ray film [1], enteroclysis [2,3], ultrasonography [4,5], and computed tomography (CT) [6–8] are performed in combination.

Recently, magnetic resonance imaging (MRI) has been developed as a promising tool because of its high resolution and multiplane observations [9–12]. However, the clinical use of this modality is still limited, and its feasibility in emergency situations awaits clarification. Therefore, we conducted this study to evaluate the usefulness of MRI in patients with SBO who underwent surgical treatment.

Patients and methods

Twenty-seven patients with SBO who underwent laparotomy from April 1999 to May 2001 were included in this study. These patients were evaluated by plain abdominal x-ray film, CT scan, and MRI. The MRI device used preoperatively was a Magnetom Vision (Siemens, Germany) 1.5 Tesla superconducted apparatus. Sequences obtained were axial turbo spin-echo T2-weighted images, coronal turbo spin-echo T2-weighted image, coronal turbo spin-echo STIR (short inversion time inversion recovery), and dynamic gadolinium enhancement (Magnevist; Nihon Schering, Osaka, Japan). The dose was 0.1 mmol/kg body weight by bolus intravenous administration, with TR/TE/TI of 7000/72 to 144/120 ms. The matrix size was 128 × 256, slice thickness was 7 mm, and interslice gap was 1.4 mm. Field of view (FOV) was 35 cm to about 40 cm, with the one-breath-hold technique. These procedures using the one-breath-hold technique required approximately 25 seconds.

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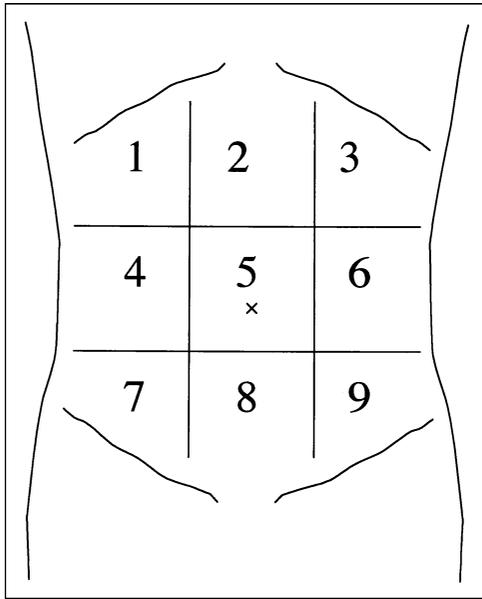


Fig. 1. Diagnosis of the location of bowel obstruction by dividing the abdomen into nine sections.

HASTE (half-Fourier acquisition single-shot turbo spin-echo) sequences and additional maximum intensity projection (MIP) image were also obtained in all cases. The whole procedure lasted approximately 20 minutes without any complications. Dynamic cine projection to observe dynamic bowel movement was performed in 8 cases. CT scan was obtained by Aquilion (Toshiba Medical System, Tokyo, Japan) or X Vigaor Laudator (Toshiba Medical System) with a patient in a supine position. Enhancement medium ([Iopamidol with an iodine concentration of 300 mg/mL] Iopamiron; Nihon Schering, Osaka, Japan) was administered intravenously. Plain abdominal x-ray film, CT scan, and MRI findings were interpreted retrospectively by one specialized radiologist (TT) with special reference to the presence or absence of bowel obstruction and the site and cause of bowel obstruction without knowing the operative findings.

The presence of bowel obstruction was suspected when the bowel diameter exceeded 2.5 cm, and bowel obstruction was diagnosed as present if a transition zone was recognized between the dilated and collapsed bowel. The obstruction site was defined by dividing the abdomen into nine sections as shown in Fig. 1. The cause of bowel obstruction was categorized as adhesion, neoplasm, or others, and if unclear, was reconfirmed by pathological examination. Informed consent was obtained from all patients before these examinations.

Results

Of 27 patients, 11 were men and 16 were women. The mean age was 62.4 years, with a range of 21 to 91 years.

Twenty-four patients (88.8%) had a previous history of abdominal operation.

The supine and upright plain abdominal x-ray film examination was performed in all 27 patients on the emergency admission day. Axial CT scan was performed in 26 of 27 patients at a mean of 2.5 days (range 4 hours to 13 days) after their admission. One pregnant woman did not undergo CT scan and was excluded from the analysis. All 27 patients underwent MRI at a mean of 4.5 days (range 4 to 21) after their admission. Abdominal x-ray film was taken before a long tube insertion in all patients, whereas MRI and CT scan were performed after a long tube insertion in 23 (85.2%) of 27 patients and in 17 (65.4%) of 26 patients, respectively. All patients were eventually treated by surgery, and 14 of them (51.8%) required bowel resection owing to bowel necrosis or partial bowel stenosis. The causes of bowel obstruction determined by surgery or pathologic examinations were neoplasm in 4 patients, and adhesion in the remaining 23 patients. Plain abdominal x-ray film revealed the presence of bowel obstruction in 22 (81.5%) of 27 patients. Air-fluid level was not apparent in the remaining 4 patients owing to the absence or paucity of air in the dilated bowel.

CT scan determined the presence of bowel obstruction in 24 (92.3%) of 26 patients. In 2 patients, the presence of bowel obstruction was overlooked by CT scan, because the transition zone was not apparent and bowel diameter was less than 2.5 cm. The sites of obstruction were correctly diagnosed by CT in 15 (57.7%) of 26 cases. In the remaining 11 patients, transition zone could not be determined. The cause of obstruction was correctly diagnosed by CT scan in 23 (88.5%) of 26 patients. In the remaining 3 patients, carcinomatous peritoneal dissemination could not be revealed by CT scan.

On MRI, the presence of bowel obstruction was determined in 25 (92.6%) of 27 patients. In the remaining 2 patients, MRI missed the presence of bowel obstruction owing to the same reasons as CT scan. The sites of obstruction were correctly diagnosed by MRI in 25 (92.6%) of 27 patients. In the remaining 2 patients, bowel diameter was less than 2.5 cm and the presence of bowel obstruction itself was overlooked.

The cause of obstruction was diagnosed correctly by MRI in 25 (92.6%) of 27 patients. In the remaining 1 patient each a small carcinoma causing bowel obstruction was not revealed by MRI or paralytic bowel obstruction was suspected because of enteritis even though the bowel was strangulated. In this study, strangulated bowel was encountered in 8 patients. Of these, 3 patients were diagnosed as having strangulation by dynamic cine MRI by detecting both bowel peristalsis and akinetic dilated closed loop (Fig. 2), which was helpful for surgeons to perform emergent surgery. In 2 of these 3 patients, bowel resection was avoided.

Regarding the cost of these examinations, the national or social insurances cover their fees. In our country, these

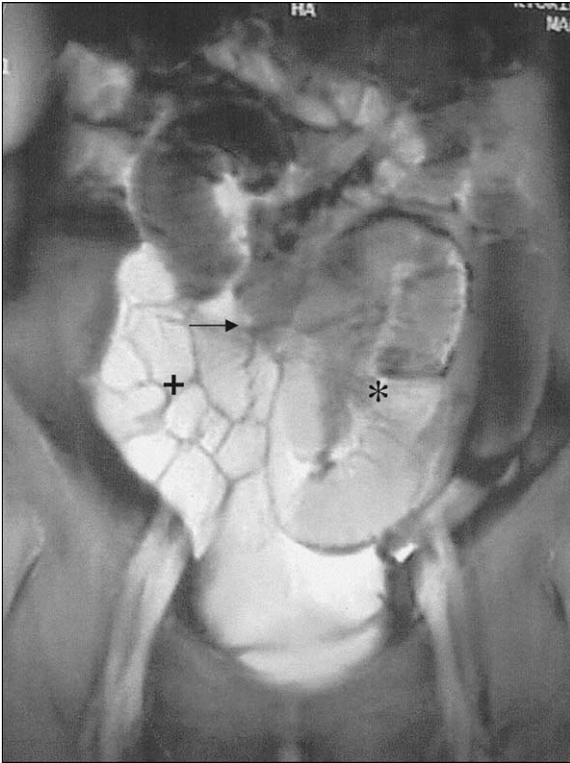


Fig. 2. Strangulated bowel obstruction (**arrow**) diagnosed by cine magnetic resonance imaging, showing akinetic closed bowel loop (*) and kinetic bowel (+).

figures represent a little difference depending on each individual patient and each insurance system. If the exchange rate is 100 Japanese yen to 1 US dollar, insurance coverage allows patient to pay about 6 US dollars for plain x-ray film examination, 30 to 70 US dollars for CT scan, and 50 to 80 US dollars for MRI, depending on the use of enhancement or contrast media. Although these costs are different among each country, it would be universally true that MRI and CT scan are expensive among abdominal examinations.

Comments

SBO is a relatively common complication in patients who undergo abdominal surgery [13]. In some of these patients, surgery is indicated for either strangulation or adhesion, as they respond poorly to conservative treatment. In urgent clinical settings, it is sometimes difficult for clinicians to decide to perform surgery or to continue conservative treatment. On plain x-ray film examinations, we encountered gasless abdomen in only 4 cases. It is no doubt that plain x-ray film examination should be performed if SBO is suspected. Sharke et al [1] reported that in patients with bowel obstruction on enteroclysis, 34% (15 of 44) had normal findings or nonspecific abnormalities in plain radiographs. Therefore, subsequent tests should be done, such as abdominal ultrasonography, CT scan, or enteroclysis after long tube decompression.

Abdominal ultrasonography is easy to perform and provides important information such as the presence of dilated bowel with or without folds, thickened bowel wall, intra-abdominal fluid collection, and the dynamic movement of the bowel. It is helpful to differentiate loops of bowel from a cystic mass in the abdomen or pelvis [4].

The presence of strangulation should be suspected when both an akinetic dilated loop and kinetic nondilated bowel is detected, with 90% sensitivity and 93% specificity [5]. However, the exact cause of obstruction is sometimes difficult to determine, and ultrasonographic examination itself is difficult when a patient is obese or massive intestinal gas is present. Furthermore, the interpretation of its findings is mainly dependent on the operator's experience. The small bowel itself is demonstrated by bowel contrast study, termed enteroclysis [14], small bowel enema [1] and detailed per-oral small bowel examination [15]. Enteroclysis is the most reliable examination to detect small bowel disease; however, it may not be suitable when bowel strangulation is suspected [16]. This technique has several disadvantages. The small bowel should be examined with barium suspension to obtain high resolution, which is sometimes dangerous when there is complete bowel obstruction. Furthermore, the presence of closed loops cannot be diagnosed with this technique. As Maglinte et al [16] reported, CT scan is more useful to examine patients with acute abdomen. Megibow et al [17] reported overall accuracy of 95% in the diagnosis of the presence of bowel dilatation, the cause of obstruction, and the presence of intra-abdominal fluid. Subsequently, CT scan was diagnostic when the patient presented with high-grade bowel obstruction with 81% accuracy, versus only 48% if the patient had low-grade bowel obstruction [18].

In the present study, both CT and MRI overlooked the presence of bowel obstruction in 2 patients, because bowel diameter was less than 2.5 cm. If the bowel does not distend, it is hard to detect by imaging studies. Compared with MRI, CT scan generally provides images only with axial slices, which is a potential limitation of this modality resulting in less accurate diagnosis in the sites of bowel obstruction. Initial reports of MRI [8,19,20] indicated that coronal and sagittal sections were more useful to identify the transition zone than routine axial images. Moreover, MRI showed that the dilated bowel with fluid is seen as high intensity on T2-weighted images. A recent refinement is the HASTE sequence [21,22]. By using this sequence, Regan et al. reported that small bowel obstruction was identified in 26 of 29 patients (90%), and the site and the cause of obstruction were accurately diagnosed in 19 (73%) and 13 patients (50%), respectively. The term "MR enteroclysis" as another new modality, using methylcellulose administration to detect small bowel disease, was introduced in the year 2000 [11,23]. However, when bowel obstruction is present, bowel fluid can be visualized as high intensity of intestinal fluid on T2-weighted images. When MIP images are obtained, the bowel is represented as a three-dimensional structure, and it

is easy to recognize the site of bowel obstruction without reconstructing the bowel structure mentally. Most of the patients in this study were treated with a long tube before MRI examination. Therefore, decompression of the bowel is thought to have affected the diagnostic imaging of MRI. Nonetheless, the site and cause of obstruction were accurately diagnosed in about 92% of patients. Furthermore, dynamic cine observation with coronal imaging could definitively differentiate strangulated and normal bowel, and with sagittal imaging on deep inhalation and exhalation it revealed the presence of adhesion between the bowel and the abdominal wall in these patients. The use of cine MRI could discriminate an akinetic distended loop from normal kinetic bowel, as does ultrasonography.

Magnetic resonance imaging is an all-in-one modality that includes all useful features of other examinations. Although MRI has some advantages such as schedule limitations and expensive costs, we feel that advantages of MRI can overcome its disadvantages. Lastly, MR examination should be performed by specialized radiologists, because SBO always presents as an emergency.

Conclusions

MRI could reveal the site and cause of small bowel obstruction in most of the cases, and is considered to be one of the most useful examinations in patients with small bowel obstruction. However, our retrospective study was not sufficient to clarify the clinical feasibility of MRI in patients with small bowel obstruction. A further prospective comparative study is needed.

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