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MRI Manifestations of Gastrointestinal Lymphoma

C.-K. Chou,[1] L.-T. Chen,[2] R.-S. Sheu,[1] C. W. Yang,[1] M.-L. Wang,[1] T.-S. Jaw,[1] G.-C. Liu[1]

[1]Department of Radiology, Kaohsiung Medical College, No. 100, Shih-Chuan 1st Road, Kaohsiung, Taiwan, Republic of China
[2]Department of Internal Medicine, Kaohsiung Medical College, No. 100, Shih-Chuan 1st Road, Kaohsiung, Taiwan, Republic of China

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Abstract. The magnetic resonance (MR) images of 11 cases of gastrointestinal lymphoma are presented. The findings include irregularly thickened mucosal folds, irregular submucosal infiltration, annular constricting lesion, exophytic tumor growth, mesenteric masses, and mesenteric/retroperitoneal lymphadenopathy. The tumors were homogeneous and intermediate in signal intensity on T1-weighted images. Heterogeneously increased signal intensities were noted on T2-weighted images. There was mild to moderate enhancement after intravenous administration of gadolinium dimeglumine (Gd-DTPA). The submucosal tumor infiltration might be outlined between the strongly GD-DTPA-enhanced mucosa and the low-intensity muscular layer. In one case that received tumor resection, the pathological examination showed destruction of most parts of the muscular layer, and the MR images did not disclose the low-intensity muscular zone.

Key words: MR studies, gastrointestinal tract—Lymphoma, MR studies—Intestines, MR studies.

The radiographic findings of gastrointestinal tract involvement by lymphoma are widely familiar [1–3]. In conventional barium examinations, gastric lymphoma may be present as an intraluminal polypoid lesion, diffusely thickened rugae, or an infiltrating form. With small bowel involvement, the appearances include aneurysmal, constrictive, nodular, ulcerative, and sprue-like forms. Colonic lymphoma may show a focal polypoid mass, multiple small nodules, fold thickening, constrictive form, and a large ulcerative mass with fistula formation. The mesenteric form causes an extrinsic pressure effect to the bowel with or without mucosal change. Computed tomography (CT) can show intraluminal mass, rugal or fold thickening, irregular wall thickening, and extraluminal tumor growth. Furthermore, mesenteric or retroperitoneal lymphadenopathy, tumor extent, and other organ involvement can also be demonstrated. Magnetic resonance (MR) images of lymphoma involving the liver, spleen, lymph nodes, lung, bone, and intracranial central nervous system have been reported [4–8]. However, to our knowledge, the manifestations of gastrointestinal lymphoma on magnetic resonance imaging (MRI) have been limited. In this report, we present the MRI findings of lymphomatous involvement of different gastrointestinal segments in 11 cases. We introduced air antegradedly or retrogradedly into the alimentary tract to act as a contrast agent. Scopolamine butylbromide was injected to suppress bowel movement.

Correspondence to: C.-K. Chou

Patients and Methods

The patients included seven men and four women, aged from 3–66 years old, with a mean age of 43 years (Table 1). Nine cases were primary lymphoma and two cases were secondary involvement according to the criteria proposed by Dawson, Cornes, and Morson [9]. The involved segments were stomach (four cases), duodenum (four cases), jejunum (five cases), ileum (one case), colon (one case), and mesentery (two cases). The diagnoses were made by endoscopic biopsy, lymph node biopsy, laparotomy, or aspiration cytology. All cases were studied by conventional barium examinations. CT examination was performed in six cases.

In the MR examinations, air was introduced into the alimentary tract to act as a contrast agent. The methods of air introduction were antegrade (four cases) or retrograde (seven cases) which have been previously described [10, 11]. Briefly, the antegrade method used a nasogastric tube to introduce about 1000–2000 ml of air into the stomach after oral ingestion of 10 mg of metoclopramide. Retrograde insufflation was accomplished with about 1000–1500 ml of air into the rectum through a Foley catheter. In the case of a 3-year-old boy, only 250 ml of air was introduced retrogradely. Forty milligrams of scopolamine butylbromide was injected (20 mg intravenously and 20 mg intramuscularly, or 40 mg intramuscularly) to control bowel peristalsis

Table 1. Patient characteristics and MRI manifestations[a]

Case no.	Age/sex	Location of involvement	Barium study	MRI findings
1	37/F	S	Infiltrative form	Irregular wall thickening
2	54/M	S	Infiltrative form	Irregular wall thickening and mesenteric LAP
3	51/F	S + D + J	Infiltrative form in the stomach, constrictive form in the duodenum and jejunum	Marked, irregular wall thickening
4	56/F	S + D + J	Infiltrative form in the stomach, outgrowing tumors from the duodenum and the jejunium	Outgrowing masses from the duodenum and the jejunum, marked annular wall thickening in the gastric antrum
5	66/M	D	Constrictive form	Huge, circumferential wall thickening
6	31/F	D + J	Irregular thickening of mucosal folds	Mucosal fold thickening
7	49/M	J	Irregular thickening of mucosal folds	Mucosal fold thickening and mesenteric LAP
8	35/M	J + I	Irregular thickening of mucosal folds	Mucosal fold thickening
9	3/M	C	Constrictive form	Huge, circumferential wall thickening
10	62/M	MN	Extrinsic pressure effect to the colon without mucosal change	Huge extraluminal mass
11	27/M	MN	Extrinsic pressure effect to the small bowel with spiculation along the mesenteric border	Huge mesenteric mass

S, stomach; D, duodenum; J, jejunum; I, ileum; C, colon; LAP, lymphadenopathy; MN, mesentery
[a] Six cases were also studied by CT and the findings were similar to those of MRI

in both methods. Fasting for 12–18 h was employed to reduce intestinal contents.

The MR examination was performed on a 0.5T superconductive scanner (MR-MAX plus system, GE, Milwaukee, WI, USA). The parameters included spin-echo T1-weighted (TR/TE = 400–600/20–30 ms) coronal, sagittal, and axial images in all cases. Spin-echo T2-weighted axial images (TR/TE = 1600–2000/90 ms) were obtained in three cases. The slice thickness was 7–10 mm with a gap of 1–2 mm. The matrix size was 192 × 192 (coronal), 192 × 160 (axial), and 160 × 190 (sagittal). The number of signal excitations was two. Gadolinium dimeglumine (Gd-DTPA) (Magnevist, Schering AG, Germany) was administered in seven cases at a dosage of 0.1 mmol/kg.

Results

The MRI manifestations are summarized in Table 1. The stomach was involved in a submucosal infiltration pattern. Irregular wall thickening was apparent. The proper muscular layer was visible (Fig. 1). Intraluminal fungating or nodular patterns and enlarged rugal folds were not encountered in our limited cases.

In the small bowel, the involved duodenum presented with irregular mucosal fold thickening (Fig. 2), circumferential constricting lesion (Fig. 3), and outgrowing masses (Fig. 4). The small bowel showed thickening of the mucosal folds (Figs. 5 and 6) and irregular annular wall thickening (Fig. 7). The submucosal infiltration was outlined between the Gd-DTPA-enhanced high-intensity mucosa and hypointense proper muscular layer. The proper muscular layer was identified between the thickened mucosa–submucosa and the extramural fat. In some cases, this muscular layer was not visualized. However, only one case received tumor resection. The pathological examination showed destruction of most parts of the muscular layer and the MR images showed no low-intensity zone corresponding to the muscular layer (Fig. 4).

In the colon, only one case with a huge constrictive mass encasing the transverse colon was encountered (Fig. 8).

As to the mesenteric form, one case showed a large well-defined tumor in the right upper quadrant surrounded by air-filled bowel loops (Fig. 9). Another case

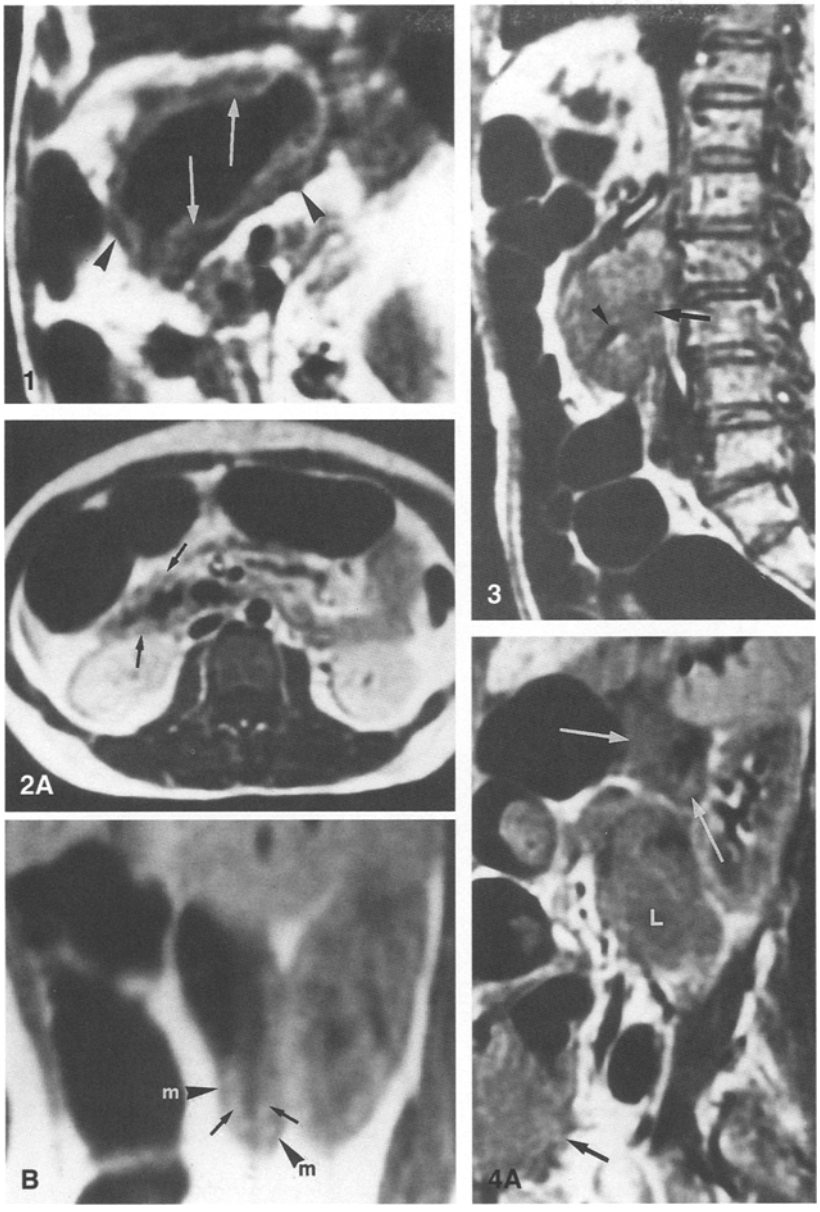
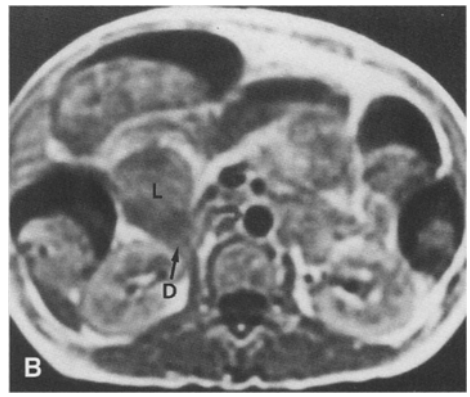


Fig. 1. A 37-year-old woman with gastric lymphoma. The spin-echo T1-weighted sagittal image shows thickening of the mucosa–submucosa (*arrows*). The proper muscular layer is identified (*arrowhead*).

Fig. 2. A 31-year-old woman with duodenal and jejunal lymphoma. **A** The Gd-DTPA-enhanced T1-weighted axial image shows circumferential wall thickening (*arrows*) of the second portion of the duodenum. **B** Nonenhanced T1-weighted sagittal image shows the mucosal fold thickening (*arrows*). *m*, proper muscular layer.

Fig. 3. A 66-year-old man with duodenal lymphoma. A huge circumferential mass (*arrow*) constricting the air-filled lumen (*arrowhead*) is noted on the T1-weighted sagittal image.

Fig. 4. A 56-year-old woman with lymphoma involving the stomach, duodenum, and jejunum. Spin-echo T1-weighted sagittal (**A**) and axial (**B**) images show a large tumor (*L*) has grown beyond the duodenum, (*D*). Pyloroduodenal thickening is noted (*white arrows*). There is a second exophytic tumor from the jejunum (*black arrow*). This patient received laparotomy for tumor resection and the pathological examination showed destruction of most parts of the proper muscular layer. No hypointense zone corresponding to the proper muscular layer is visualized in the MR images.



showed a huge mesenteric mass with encasement of the superior mesenteric artery (Fig. 10). Wall thickening due to intraperitoneal lymphomatous seedings was demonstrated in one case (Fig. 11). Mesenteric lymphadenopathy was present in two cases. These enlarged lymph nodes showed intense enhancement after Gd-DTPA administration (Fig. 12).

The signal intensity of gastrointestinal lymphoma was homogeneous and intermediate on T1-weighted images. On T2-weighted images, the tumor showed heterogeneous, increased signal intensities. After intravenous administration of Gd-DTPA, mild to moderate enhancement of the tumor was noted. These signal intensity changes were nonspecific and similar to the general characteristics of most other tumors.

Discussion

Gastrointestinal lymphoma originates from the lamina propria or submucosa. Depending upon the direction and extent of tumor infiltration, various appearances in conventional barium examinations and CT can be observed [1–3]. At first, gastrointestinal lymphoma has an extramucosal appearance with a smooth surface and an obtuse, smoothly tapered edge. If the lesion grows mainly toward the mucosa, a polypoid, nodular, or fungating form may appear. Irregularly thickened mucosal folds in the esophagus, stomach, small bowel, or colon may also occur. Surface ulceration is common. If submucosal infiltration is the major form of extension, an annular-constricting appearance with markedly thick-

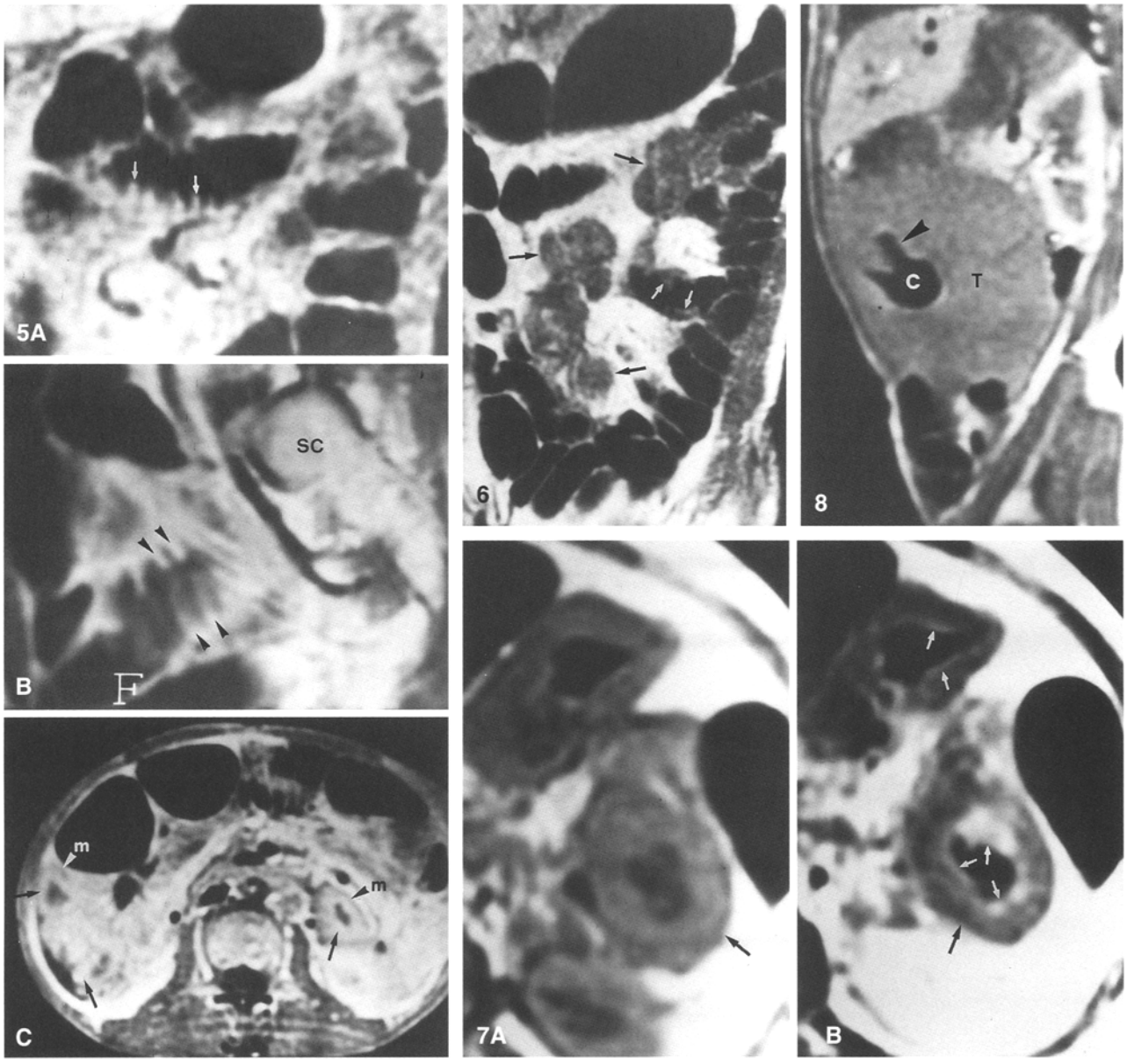


Fig. 5. Spin-echo T1-weighted coronal (**A**), sagittal (**B**), and axial (**C**) images of a 35-year-old man with jejunal and ileal lymphoma. The thickened folds are seen in profile (*white arrows*), en face (*arrowheads*), and in cross section (*black arrows*). *SC*, sacrum; *m*, proper muscular layer.

Fig. 6. A 49-year-old man with small bowel lymphoma. The coronal image shows thickened folds (*white arrows*) outlined by intraluminal air. The mesenteric lymph nodes (*black arrows*) were outstanding when compared to the surrounding air-filled bowel loops.

Fig. 7. Spin-echo T1-weighted (**A**) pre- and (**B**) post-gadolinium-enhanced axial images of a 51-year-old woman with gastric and jejunal lymphoma. The circumferential submucosal infiltrations show moderate enhancement after Gd-DTPA administration. However, the mucosa shows a much intenser enhancement (*white arrows*). The entire wall is then composed of three distinct layers: inner high-intensity mucosa, middle intermediate-intensity submucosal infiltration, and outer low-intensity proper muscular layer (*black arrow*).

Fig. 8. A 3-year-old boy with transverse colonic lymphoma. The spin-echo T1-weighted sagittal image shows a huge circumferential tumor (*T*) encasing the transverse colon (*C*). An excavating ulceration is indicated (*arrowhead*).

ened wall and separation of bowel loops may occur. The submucosal infiltration can grow into a huge circumferential mass and cause displacement of contiguous bowel loops. The mucosal ulceration may cause aneurysmal dilatation of the lumen. If the tumor extends through the proper muscular layer and grows mainly toward the outside, a large extraluminal tumor then occurs. Ulceration may extend from the mucosa deeply into the tumor. The mesenteric form, at first, causes an extrinsic pressure effect on the bowel. When

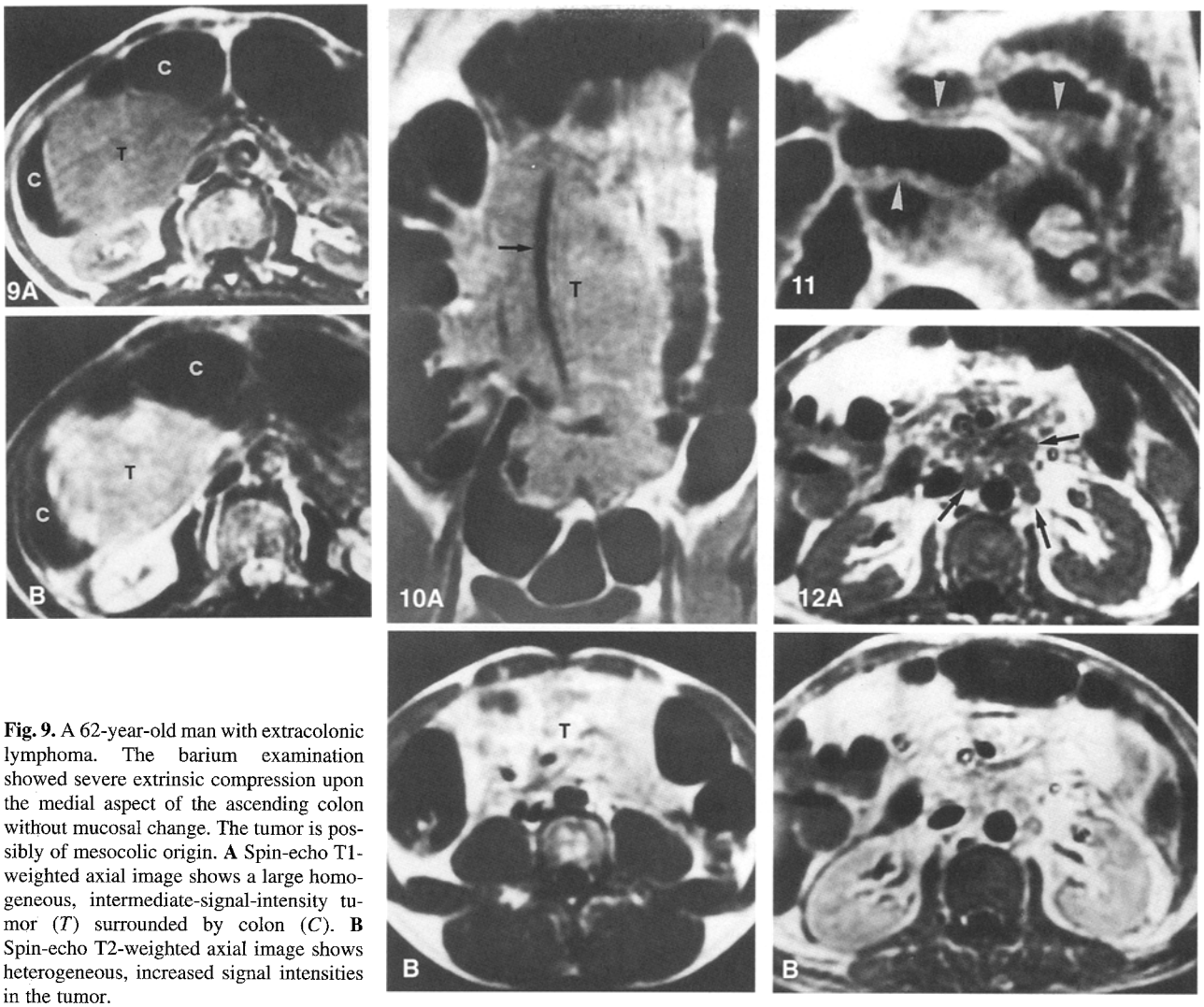


Fig. 9. A 62-year-old man with extracolonic lymphoma. The barium examination showed severe extrinsic compression upon the medial aspect of the ascending colon without mucosal change. The tumor is possibly of mesocolic origin. **A** Spin-echo T1-weighted axial image shows a large homogeneous, intermediate-signal-intensity tumor (*T*) surrounded by colon (*C*). **B** Spin-echo T2-weighted axial image shows heterogeneous, increased signal intensities in the tumor.

Fig. 10. A Spin-echo T1-weighted coronal image shows a huge mesenteric lymphoma (*T*) with encasement of the superior mesenteric artery (*arrow*) in a 27-year-old man. **B** Spin-echo T1-weighted axial image. After intravenous administration of Gd-DTPA, this tumor shows heterogeneous enhancement.

Fig. 11. A case of intraperitoneal lymphomatous seedings proved during laparotomy. The spin-echo T1-weighted coronal image shows wall thickenings (*arrowheads*) in the air-distended bowel loops.

Fig. 12. A Pre- and (**B**) post-Gd-DTPA spin-echo T1-weighted axial images of a 54-year-old man with gastric lymphoma. The multiple mesenteric lymph nodes (*arrows*) show intense enhancement and have become less distinguishable from surrounding fat after Gd-DTPA administration.

it further invades the bowel wall, a spiculated appearance along the mesenteric side of the small bowel may occur. CT can show intraluminal tumor, irregular fold or wall thickenings, exophytic tumor growth, mesenteric mass, lymphadenopathy, and other organ involvement.

In our limited number of cases, submucosal infiltration was the most common pattern (six cases). After intravenous administration of Gd-DTPA, the mucosa was strongly enhanced. The wall was then composed of three zones: high-intensity mucosa, intermediate-intensity submucosal tumor infiltration, and a low-intensity proper muscular layer. This three-zone appearance may be useful in differentiating a submucosal tumor from a mucosal one (Fig. 7). The proper muscular layer was outlined between the thickened, infiltrated mucosa–submucosa and mesenteric fat. When this low-intensity muscular layer was not visualized, destruction of this layer by tumor infiltration might have occurred (Fig. 4). Whether these findings have any clinical significance is to be determined. The excavating ulcerations in large mural masses were filled with air (Fig. 8). However, superficial ulcerations were not demonstrable on MRI. Irregular mucosal fold thick-

enings were delineated by intraluminal air in three cases. Two large, mainly exoenteric tumors were encountered in one case.

Conventional barium studies can show the mucosal changes very clearly. However, they cannot show the extraluminal extent of tumor involvement as well as CT. In our cases, MRI successfully showed irregular mucosal fold thickenings, various extent of submucosal infiltration-induced wall thickenings, exophytic tumor growth, mesenteric tumors, and lymphadenopathy. Adequate distention of the alimentary tract by air was an important factor for demonstration of these lesions.

So far, conventional barium examination is the study of choice for the detection of lymphomatous involvement of the gastrointestinal tract. CT, in addition to the detection of gastrointestinal tract abnormalities, offers further information about extraluminal tumor extent, mesenteric or retroperitoneal lymphadenopathy, and other organ involvement. In this report, we have shown the potential of MRI in demonstrating this involvement. Its role in this aspect requires further evaluation.

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