

Radiologic Findings of Direct Splenic Invasion by Malignant Tumors of Adjacent Organs¹

Kyung Won Lee, M.D., Soo Young Chung, M.D., Ik Yang, M.D., Hong Dae Kim, M.D.,
Sang June Shin, M.D., Jung Eun Kim, M.D., Chul Min Park, M.D.²

Purpose: To evaluate the radiologic findings of direct invasion of the spleen by malignant tumors of adjacent organs.

Materials and Methods: We retrospectively reviewed the CT (n=6) and MR (n=3) images of six patients with direct invasion of the spleen by malignant tumor of left lower lung, stomach, colon, pancreas, left kidney, and left adrenal gland. We evaluated the tumor margin, attenuation or intensity, perisplenic fat infiltration, regional lymphnode enlargement, and invaded site of the spleen.

Results: Ill-defined masses were found in the spleen with central necrosis and infiltration into perisplenic fatty tissue in all six patients; left adrenal mass was present also in three patients. Regional lymphnode enlargement was found in four patients. The masses showed heterogenous low attenuation on CT. The invaded site was variable and corresponding to their anatomical connections to the spleen.

Conclusion: Direct invasion of the spleen by malignant tumors of adjacent organs showed ill-defined masses with central necrosis and were commonly associated with infiltration to perisplenic fatty tissue and adrenal invasion. The pattern and invaded site can be helpful to assess the primary cancer.

Index words : Spleen

Computed tomography (CT)

Magnetic resonance (MR)

The spleen, to the best of our knowledge, is an unusual site of distant metastasis or direct invasion by malignant tumors of adjacent organs (1). Computed tomography (CT) and magnetic resonance imaging (MRI) findings, therefore, have not been described sufficiently of direct invasion of the spleen (2 - 5). For better understanding the route of direct invasion, it is prerequisite to

emphasize the anatomic relation of the spleen with adjacent structures. In this study, we discuss CT and MRI findings of direct splenic invasion, and possible routes of invasion by malignant tumors of adjacent organs.

Materials and Methods

This study included six patients (5 men and 1 woman, 52 - 84 years old, mean age 65 years), who were diagnosed as direct splenic invasion by malignant tumor of adjacent organ from 1994 to 1999 in our hospital. Direct invasion was diagnosed pathologically (n=4) or radiologically (n=2). When splenic mass was contiguous to the primary cancer and showed irregular margin with

¹Department of Radiology, Hallym University College of Medicine

²Department of Radiology, Korea University College of Medicine

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Address reprint requests to : Kyung Won Lee, M.D., Department of Radiology, Kangnam Sacred Heart Hospital, Hallym University College of Medicine, 948-1 Daelim-dong, Youngdeungpo-gu, Seoul 150-071, Korea.

Tel. 82-2-829-5241 Fax. 82-2-832-1845 E-mail: lkwrad@hanmail.net

normal area of the spleen, direct invasion was diagnosed radiologically. The primary tumors were as follows: squamous cell carcinoma of the lung, poorly differentiated adenocarcinoma of the stomach, adenocarcinoma of the colon, well-differentiated ductal adenocarcinoma of the pancreatic tail, recurred renal cell carcinoma after left nephrectomy, and adrenal metastatic tumor from small cell carcinoma of the lung (Table 1). Surgery was done in two patients with colon cancer and pancreatic cancer, and fine needle biopsy in two patients with lung cancer and metastatic adrenal cancer. Tumor infiltration into spleen was confirmed on histologic specimen in the four patients. CT (Somatom DR; Siemens, Erlangen, Germany) was performed with conventional sequential scan with 8 mm slice thickness. CT images were obtained in six pa-

tients. CT scans were obtained with injection of intravenous contrast materials (Rayvist 300, Schering, Germany) at 2.5 mL/sec for a total volume of 100ml with a scanning delay of 45 - 50 seconds. MRI was performed with 1.0-T MRI (Magnetom Impact; Siemens, Erlangen, Germany) in three patients. MR examination included the acquisition of axial and sagittal T1-weighted spin-echo (TR/TE = 500 - 600/15) images and axial T2-weighted spin-echo (TR/TE = 3000/90) images with a breath hold. Enhanced axial, coronal and sagittal T1-weighted images were obtained following hand bolus administration of Gd-DTPA (Magnevist, Schering, Germany) at a dose of 0.16 mmol/kg.

We evaluated the margin of tumor, attenuation or intensity, and homogeneity of attenuation of tumor.

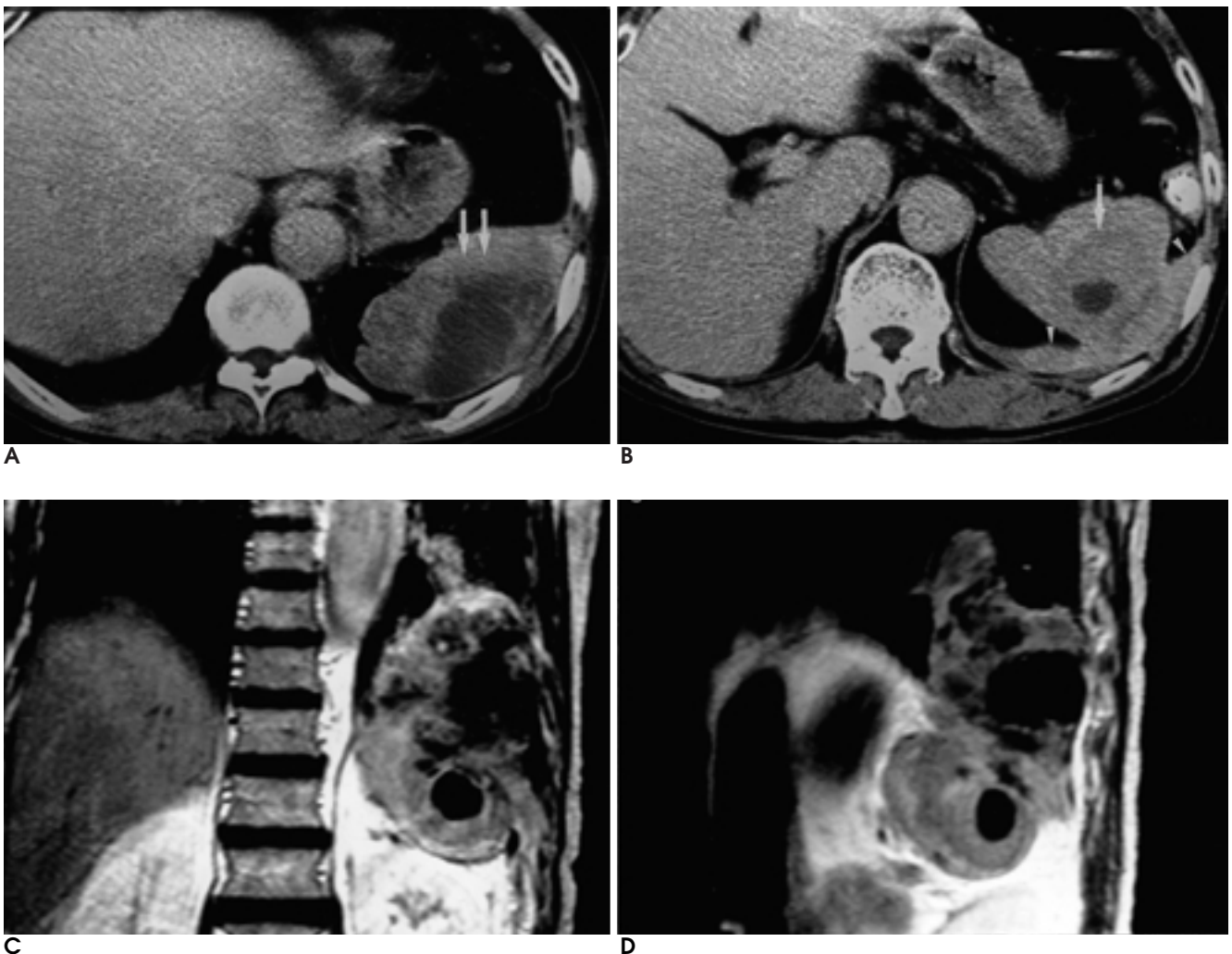


Fig. 1. An 84-year-old man with direct invasion of spleen by squamous cell carcinoma of the lung.
A. CT scan shows a mass with heterogenous low attenuation in lower lobe of left lung (arrows).
B. At 3 cm below A, ill-defined low attenuating mass (arrow) similar to the pulmonary mass is found in the spleen. The diaphragm adjacent to the mass is thickened irregularly (arrowheads).
C, D. The contiguity of the lung mass with splenic mass is demonstrated on Gd-enhanced coronal (**C**) and sagittal (**D**) T1-weighted images.

Tumor margin was classified as well-defined or ill-defined. When linear or nodular increased attenuation was found at perisplenic fat, we considered as perisplenic fat infiltration of the tumor. Regional lymphnode enlargement and invasion to adrenal gland were also evaluated. The invaded site of the spleen was categorized as superior or inferior, medial or lateral, and posterior or anterior. We correlated the invaded site with the primary cancer.

Results

All six patients showed ill-defined masses with heterogeneously low attenuation in the spleen on CT. Necrosis within the masses and infiltration into perisplenic fatty tissue were found in all cases. Splenic masses showed contiguity to the primary tumor of adjacent organ. Left adrenal mass was associated in three patients. Regional lymphnode enlargement was found in four patients.

The invaded site was postero-supero-lateral in lung cancer (Fig. 1), antero-supero-medial in stomach cancer, antero-infero-lateral in colon cancer, antero-medial

(splenic hilum) in renal cell carcinoma and ductal carcinoma of pancreatic tail, and postero-medial in metastatic adrenal cancer from the lung (Table 1). The invaded sites were corresponding to the ligament insertion sites of adjacent organs.

The masses showed low-signal intensity on T1-weighted image and heterogenous high-signal intensity on T2-weighted image, similar to other malignant tumors. Coronal and sagittal MR images provided a better evaluation of contiguity to the primary tumor (Fig. 1).

Discussion

The spleen is a rare site of primary cancer and a relatively uncommon site of metastases in spite of its large mass of lymphoid tissue and its filtering function of systemic blood flow (1, 6). In most cases, the spleen is displaced by adjacent tumor and direct invasion is rare (2).

In our series, all tumors of the spleen were presented as ill-defined masses with central necrosis. Infiltration into perisplenic fat and invasion to left adrenal gland

Table 1. Patient Characteristics and CT Findings of Direct Splenic invasion by Malignant Tumors of Adjacent Organs

No	Age	Sex	Primary Tumor	Invasion Site	Margin	attenuation	Fat-inf	Adrenal	Dx	Comment
1.	84	M	Lung Ca	post, sup, lat	ill	het, low	+	-	Bx	Squamous cell carcinoma
2.	62	M	Stomach Ca	ant, sup, med	ill	het, low	+	+	Rad	AdenoCa-pd
3.	62	M	Colon Ca	ant, inf, lat	ill	het, low	+	-	OP	AdenoCa
4.	65	F	Pancreas Ca	med (hilum)	ill	het, low	+	-	OP	AdenoCa-wd
5.	66	M	recurred RCC	inf, med (hilum)	ill	het, low	+	+	Rad	Renal cell carcinoma
6.	52	M	metastatic adrenal Ca	post, med	ill	het, low	+	+	Bx	Small cell lung cancer

Ca: cancer, ant: anterior, post: posterior, sup: superior, inf: inferior, med: medial, lat: lateral, het: heterogenous, Dx: diagnostic method, Bx: biopsy, OP: operation, Rad: radiologic diagnosis, pd: poorly differentiated, wd: well differentiated, meta: metastasis

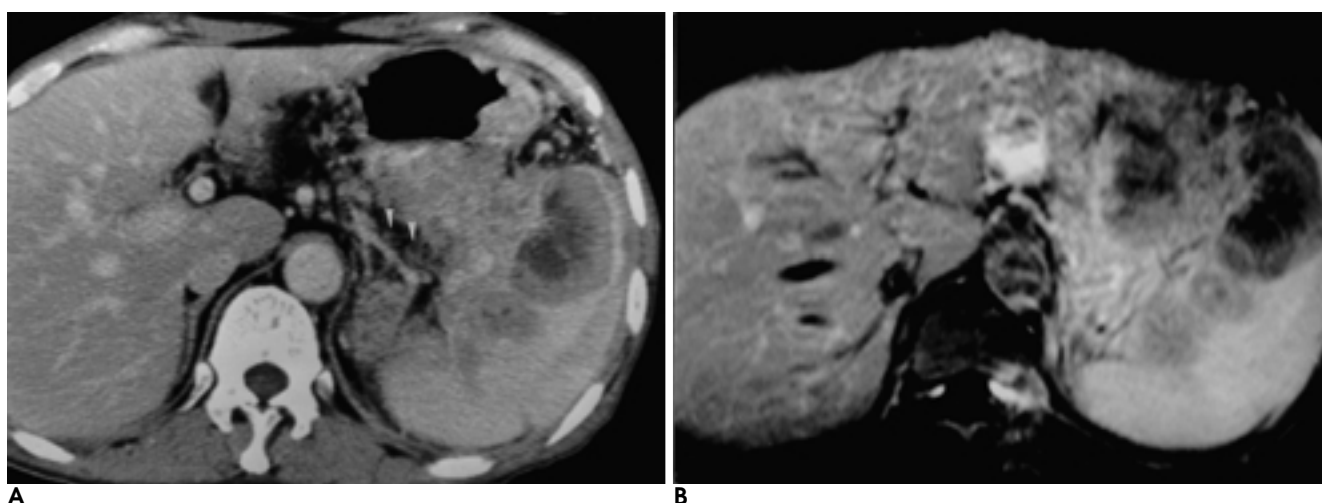


Fig. 2. A 62-year-old man with direct invasion by adenocarcinoma of the stomach.

A. CT scan shows a mass of heterogenous attenuation at posterior wall of the stomach. The mass extends to the spleen. Perisplenic fat infiltration is noted (arrowheads).

B. Fat suppression T1-weighted MR image shows a mass with ill-defined heterogenous low signal intensity.



Fig. 3. A 65-year-old woman with direct invasion of the splenic hilum by adenocarcinoma of the pancreatic tail. An ill-defined mass is found in the medial portion of the spleen. The mass has contiguity to the mass of pancreatic tail (arrowheads).

were associated frequently. Ill-defined splenic mass with contiguity to the primary tumor of adjacent organ can be useful findings to diagnose direct splenic invasion.

MRI of the spleen is limited by a number of factors: respiratory and cardiac motion due to its proximity to the diaphragm, bowel motion, and variations in morphologic appearance. However, rapid scanning techniques with a single breath hold and with the use of paramagnetic agents, such as Gd-DTPA, can provide significant improvements in lesion conspicuity (7). Coronal and sagittal MR images provided a better evaluation of three dimensional relationships to adjacent structures than CT scans (Fig. 1).

Knowledge on the anatomic relationships of the spleen to surrounding organs is needed to understand the route of direct invasion to the spleen by malignant tumor of adjacent organs and to interpret CT and MR images around the spleen. The spleen is connected to the stomach via the gastrosplenic ligament, to the pancreas and left kidney via the splenorenal ligament, to the splenic flexure of the colon via the splenocolic ligament, and to dorsal body wall via the phrenicolienal ligament (8, 10). The splenorenal ligament may persist as a short narrow strut that creates a small bare area over the medial margin of the spleen (11). Lung cancer of left lower lobe can extend to postero-superior portion of the spleen via the phrenicolienal ligament or via left hemidiaphragm itself (Fig. 1). Stomach cancer can invade ante-

rio-superio-medial portion of the spleen through the gastrosplenic ligament (5, 12) (Fig. 2). Colon cancer can invade inferior portion of the spleen via the splenocolic ligament. Pancreatic tail cancer (Fig. 3), renal cell carcinoma or adrenal malignant tumor can invade medial portion of the spleen via the splenorenal ligament and bare area (3, 5, 11).

Our study was limited by a small number of cases. The fact direct splenic invasion was diagnosed radiologically in two patients was another limitation.

Direct invasion of the spleen by malignant tumors of adjacent organs showed non-specific findings. However, ill-defined infiltrating mass in the spleen with contiguity to the primary tumor of adjacent organ can be diagnosed as direct invasion into spleen. The invaded site was variable according to the primary cancer and corresponding to the ligament insertion sites of the spleen. So, the evaluation of pattern and site of splenic invasion can be helpful to assess the primary cancer when the origin is uncertain.

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