Abdominal Manifestations of Extranodal Lymphoma: Spectrum of Imaging Findings

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OBJECTIVE. The purpose of this article is to illustrate the spectrum of appearances of extranodal lymphoma in the abdomen using cross-sectional imaging techniques.

CONCLUSION. Extranodal lymphoma in the abdomen can mimic other neoplastic or inflammatory conditions. Although a definitive diagnosis is possible only with biopsy, it is important to consider extranodal lymphoma in the presence of certain imaging appearances in the appropriate clinical setting for the correct diagnosis, accurate staging, and optimal management.

Extranodal lymphoma occurs in about 40% of patients with lymphoma and has been described in virtually every organ and tissue [1]. In decreasing order of frequency, the spleen, liver, gastrointestinal tract, pancreas, abdominal wall, genitourinary tract, adrenal, peritoneal cavity, and biliary tract are involved [2–5]. Extranodal disease is more common with non-Hodgkin’s lymphoma (NHL) than with Hodgkin’s lymphoma and is often intermediate- to high-grade [2, 3]. AIDS-related lymphoma and posttransplantation lymphoproliferative disorder (PTLD) are more likely to affect extranodal sites and are of higher grade [2, 4, 5]. Diffuse large B-cell lymphoma and follicular lymphoma are the dominant histologic subtypes in extranodal lymphoma. Mantle cell lymphoma, lymphoblastic lymphoma, Burkitt’s lymphoma, and mucosa-associated lymphoid tissue (MALT) lymphoma, however, are more likely to affect extranodal sites [2]. MALT lymphoma is a low-grade marginal zone B-cell lymphoma that is most commonly found in the stomach. It is closely associated with chronic inflammation, such as Helicobacter pylori gastritis, and has a clinically indolent course. Secondary involvement of extranodal tissues as part of generalized lymphoma is significantly more common than primary extranodal disease, in which there is a dominant extranodal component with no or minor nodal involvement. Splenic, hepatic, or diffuse involvement of one or more extranodal organs indicates a more advanced stage of disease. Extranodal involvement is in general a poor prognostic factor.

The protean imaging appearances of extranodal lymphoma in the abdomen can mimic other neoplastic or inflammatory conditions. Misinterpretation of the imaging findings can lead to delayed diagnosis and treatment, and incorrect staging may result in inappropriate treatment. In this article, we illustrate the appearances of extranodal lymphoma in the abdomen of immunocompetent and immunocompromised patients with current cross-sectional imaging techniques.

Imaging Techniques

MDCT is the principal imaging technique used for the evaluation of patients with lymphoma. However, evidence indicates that PET/CT is superior to CT in detecting extranodal disease in the abdomen, especially in the spleen and liver [1, 6]. The role of PET/CT in low-grade lymphoma such as MALT lymphoma is controversial. For the routine evaluation of abdominal lymphoma, no data are available at present on the effectiveness of MRI, and sonography has no role. Patients unsuitable for CT can be assessed with MRI. Sonography and MRI can be used for targeted characterization of indeterminate lesions identified at CT.

At our institution, routine abdominopelvic CT for the evaluation of lymphoma is usually performed after the patient has drunk 900 mL of 2.5% diluted sodium amidotrizoate and meglumine amidotrizoate (Gastrografin, Bayer HealthCare) 45–60 minutes before the...
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Liver and Spleen
The spleen and liver are involved in 20–40% and up to 15% of patients with lymphoma, respectively [1–3]. The patterns of involvement include diffuse infiltration (Fig. 1), with or without organomegaly, and focal nodules (Fig. 2). FDG PET/CT is more accurate than other cross-sectional techniques for the detection of diffuse hepatosplenic involvement [6]. Focal hepatosplenic lymphoma appears as circumscribed nodules that are hypoechoic, show no posterior acoustic enhancement on sonography, and are low-attenuation on contrast-enhanced CT. On MRI, the nodules may appear as hypo- or isointense compared with normal spleen or liver on T1-weighted images and as hyperintense on T2-weighted images, and may show reduced enhancement after the administration of gadolinium. Focal hepatosplenic lymphomas can be indistinguishable from metastases but are usually smaller and homogeneous and occur with extensive, bulky coalescent lymph nodes. Hepatosplenic fungal abscesses tend to be smaller and show heterogeneous enhancement compared with lymphoma.

Gastrointestinal Tract
Extranodal lymphoma in the gastrointestinal tract occurs in 10–30% of all patients with NHL [2, 7]. The stomach, small bowel, pharynx, large bowel, and esophagus are involved in decreasing order of frequency [7]. The patterns of gastric involvement include polyoid mass, diffuse or focal infiltration (Fig. 3), ulcerative lesion, or mucosal nodularity [8]. The patterns of small-bowel involvement include solitary or multiple nodules (Fig. 4), circumferential wall thickening with or without aneurysmal dilatation (Figs. 4 and 5), and direct extension from mesenteric nodes [7, 9]. The cecum and rectum are the most commonly involved parts of the large bowel. The patterns of large-bowel involvement include bulky polyoidal mass, infiltrative tumor (Fig. 6), and aneurysmal dilatation [7]. Bowel perforation is an uncommon complication of gastrointestinal lymphoma but is more likely with T-cell lymphoma, with PTLD, and after chemotherapy or radiation therapy [5, 7–9]. Bowel obstruction is uncommon at presentation despite significant lymphomatous infiltration of the bowel wall because of absent desmoplastic reaction [7, 9]. In contrast to gastrointestinal adenocarcinoma, lymphoma is more likely to involve multiple and longer segments of gut and is less likely to cause bowel obstruction [8].

Genitourinary Tract
Renal involvement occurs in 3–8% of patients with lymphoma; the kidney is the most commonly involved part of the genitourinary tract [10]. The patterns of renal involvement, in descending order of frequency, include multiple circumscribed masses (Figs. 7 and 8), direct infiltration from adjacent nodes, a solitary mass, an isolated perinephric mass (Fig. 9), and diffuse infiltration [10] (Fig. 10). Renal metastases can mimic renal lymphoma. Renal cell carcinomas can often be differentiated from renal lymphoma by their hypervascular enhancement pattern. Transitional cell carcinoma and severe pyelonephritis may mimic diffuse renal infiltration by lymphoma. Extensive bulky coalescent lymph nodes and absence of features of an infective process are supportive of the diagnosis of lymphoma. Predominant peripelvic or renal sinus involvement by lymphoma is uncommon [10, 11].

Despite peripelvic lymphoma encasing renal hilar structures, the vessels often remain patent, and there is often minimal nephropathy (Fig. 11). This helps to differentiate peripelvic lymphoma from transitional cell carcinoma or metastases. The ureter is often affected by involved retroperitoneal nodes, but primary involvement of the ureter by lymphoma is rare [12]. About 8% of patients with lymphoma have bladder involvement at autopsy [10, 13]. The patterns of bladder involvement include circumscribed solitary or multiple masses (Fig. 12) and diffuse infiltration [13]. Transitional cell carcinoma may mimic bladder lymphoma. Approximately 6% of patients with lymphoma have testicular involvement at autopsy [10]. Lymphoma is the most common testicular tumor in older men; bilateral involvement occurs in 38% of cases [1]. The patterns of testicular involvement include focal masses (Fig. 13) and diffuse infiltration with or without testicular enlargement [2].

Pancreas
The pancreas is involved in about 30% of cases of NHL, usually from contiguous nodal infiltration [14]. The patterns of involvement include a circumscribed mass (Figs. 14 and 15) and diffuse glandular enlargement mimicking acute pancreatitis [14]. Although bile duct obstruction may occur with pancreatic lymphoma, moderate to severe dilatation of the main pancreatic duct despite a bulky tumor is uncommon. Vascular invasion, pancreatic atrophy distal to the tumor, and tumor calcification and necrosis are unusual.

examination. One hundred milliliters of 370 mg I/mL of iopromide (Ultravist 370, Bayer HealthCare) is administered IV at a rate of 2.5 mL/s. CT is performed after a 75-second delay. For 16- and 64-MDCT scanners, 0.75- and 0.6-mm detectors are used, respectively, with 120-kVp and 150–180 mAs. In suspected gastric or enteric involvement, CT is performed after the patient has drunk 1,000–1,500 mL of water or 2% sorbitol. In suspected colonic involvement, CT is performed after the administration of 500–1,000 mL of water or 2.5% diluted sodium amidotrizoate and meglumine amidotrizoate (Gastrografin) as rectal contrast medium.

Routine PET/CT for the evaluation of lymphoma is performed after an IV injection of 370 MBq of 18F-FDG that is administered 45–60 minutes before the scan. A low-dose CT acquisition is first performed (120 kVp, average of 64 mAs) from the skull base to the mid thigh, without IV or oral contrast material and no specific breath-holding instructions. A PET emission scan is immediately performed after the CT acquisition over the same range as CT, without changing the patient’s position. Images are reconstructed with a 16-subset, two-iteration algorithm, 256 × 256 matrix, and a CT-based attenuation coefficient. In suspected gastric or enteric involvement, the study is performed after the patient has ingested 1,000–1,500 mL of water or 2% sorbitol. If colonic involvement is suspected, the study is performed after the patient has drunk 1,000–1,500 mL of water or 2% sorbitol. In suspected colonic involvement, CT is performed after the administration of 500–1,000 mL of water or 2.5% diluted sodium amidotrizoate and meglumine amidotrizoate (Gastrografin) as rectal contrast medium.

At our institution, abdominopelvic MRI examination includes bulky polypoidal mass, infiltrative mass, an isolated perinephric mass (Fig. 9), and direct extension from mesenteric nodes at autopsy [10, 13]. The patterns of bladder involvement include circumscribed solitary or multiple masses (Fig. 12) and diffuse infiltration [13]. Transitional cell carcinoma may mimic bladder lymphoma. Approximately 6% of patients with lymphoma have testicular involvement at autopsy [10]. Lymphoma is the most common testicular tumor in older men; bilateral involvement occurs in 38% of cases [1]. The patterns of testicular involvement include focal masses (Fig. 13) and diffuse infiltration with or without testicular enlargement [2].

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at initial presentation [14]. These features can help to differentiate pancreatic lymphoma from adenocarcinoma.

**Adrenal Gland**

The adrenal gland is involved in about 4% of cases of NHL [1, 15]. Bilateral adrenal involvement occurs in approximately 50% of these cases. The patterns of involvement include a rounded circumscribed homogeneous mass (Fig. 16) and an enlarged adrenal gland that maintains its normal shape [15].

**Biliary Tract**

Lymphomatous involvement of the biliary tree is rare. The patterns of involvement of the gallbladder include an intraluminal polypoidal mass, a large mass replacing the gallbladder, and diffuse mural thickening [16] (Fig. 17). The patterns of involvement of the bile ducts include a biliary stricture mimicking cholangiocarcinoma and a focal mass [17].

**Peritoneum and Peritoneal Reflections**

Peritoneal lymphomatosis is a rare clinical presentation that is often associated with high-grade primary gastrointestinal NHL and is radiologically indistinguishable from peritoneal carcinomatosis [18]. The patterns of involvement include discrete nodules, a diffuse infiltrative mass, and ascites (Fig. 18). Exudative ascites from peritoneal lymphomatosis shows high attenuation because of the increased proteinaceous content [18]. Loculated high-attenuation ascites and smooth peritoneal enhancement are more characteristic of tuberculous peritonitis. Diffuse lymphomatous infiltration of the mesentery produces a stellate appearance of the mesentery and causes fixation of the small-bowel loops (Fig. 18).

**Abdominal Wall**

Lymphoma may involve the abdominal wall by direct extension from bone or may occur separately in the muscle, subcutaneous fat, or skin from hematogenous spread (Fig. 19).

**Conclusion**

The wide spectrum of imaging appearances of extranodal lymphoma in the abdomen presented in this article should serve to alert the radiologist to consider its diagnosis in patients with or without a history of lymphoma in the presence of supportive collective imaging findings and suggestive clinical features. Although a definitive diagnosis of extranodal lymphoma is possible only with biopsy, certain findings (e.g., a bulky tumor of the gastrointestinal tract involving multiple segments with aneurysmal dilatation or without bowel obstruction; a bulky, homogeneous, noncalcified pancreatic mass without significant dilatation of the main pancreatic duct; or a peripelvic renal mass without significant hydronephrosis) together with extensive bulky coalescent lymph nodes and absent features of an infective process are strongly suggestive of the diagnosis.

**References**

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Fig. 1—52-year-old woman with large B-cell lymphoma involving spleen. Axial fused PET/CT image shows diffuse increased 18F-FDG uptake in normal-sized spleen (arrow), indicating splenic involvement.

Fig. 2—74-year-old woman with biopsy-proven large B-cell lymphoma involving liver and spleen.
A. Longitudinal sonogram of right lobe of liver shows multiple hypoechoic nodules (arrowheads).
B. Axial contrast-enhanced CT image shows multiple circumscribed low-attenuation nodules in liver and spleen (arrowheads).

Fig. 3—62-year-old man with biopsy-proven large B-cell lymphoma involving stomach.
A. Axial contrast-enhanced CT image shows focally infiltrative tumor involving body of stomach (arrow).
B. Corresponding axial fused PET/CT image shows 18F-FDG-avid tumor (arrow).
Fig. 4—52-year-old man with mantle cell lymphoma involving small bowel. Coronal contrast-enhanced CT image shows nodular masses in proximal small bowel (arrowheads) and marked mural thickening of distal ileum (large arrow). Note mesenteric nodes (M) and right inguinal node (small arrow).

Fig. 5—62-year-old man with follicular lymphoma of small bowel. Axial contrast-enhanced CT image shows circumferential thickening and aneurysmal dilatation of segment of distal ileum (arrows).

Fig. 6—73-year-old man with biopsy-proven large B-cell lymphoma involving small and large bowel. Coronal contrast-enhanced CT image shows bulky infiltrative tumor (arrows) involving distal ileum (I), cecum (C), and ascending colon (A). No small-bowel dilatation is seen proximal to tumor.

Fig. 7—37-year-old man with T-cell lymphoblastic lymphoma involving kidneys. 
A, Axial contrast-enhanced CT image shows multiple bilateral, circumscribed low-attenuation renal masses.
B, Longitudinal sonogram of right kidney shows multiple hypoechoic masses (arrowheads). Similar hypoechoic masses were seen in left kidney (not shown). These lymphomatous deposits resolved after chemotherapy.
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Fig. 8—63-year-old woman with newly diagnosed large B-cell lymphoma involving kidneys. Axial fused PET/CT image shows bilateral 18F-FDG-avid renal lymphomatous deposits (arrows).

Fig. 9—60-year-old man with biopsy-proven perinephric mucosa-associated lymphoid tissue lymphoma. Coronal contrast-enhanced CT image shows soft-tissue perinephric mass that partially encases lower left kidney without frank renal invasion (arrowheads).

Fig. 10—61-year-old woman with biopsy-proven large B-cell lymphoma involving kidney. Coronal contrast-enhanced CT image shows left renomegaly and complete replacement of kidney by lymphoma (arrowheads).
Fig. 11—73-year-old man with biopsy-proven peripelvic follicular lymphoma of kidney.

A, Axial contrast-enhanced prone CT image shows soft-tissue mass encasing left renal hilum (arrow). Left renal hilar vessels are patent. No hydronephrosis is seen. Note calyceal diverticulum with dependent calculi (arrowhead).

B–D, Axial fat-suppressed T2-weighted fast spin-echo (B), axial T1-weighted fast spin-echo (C), and axial gadolinium-enhanced fat-suppressed T1-weighted fast spin-echo (D) images show T2 hyperintense and T1 hypointense mass that mildly enhances with IV gadolinium (arrow). Arrowheads indicate calyceal diverticulum with dependent calculi.

E, Axial fused PET/CT image shows 18F-FDG-avid tumor (arrow).
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**Fig. 12**—55-year-old woman with biopsy-proven mucosa-associated lymphoid tissue lymphoma involving bladder. **A**, Axial contrast-enhanced CT image shows polypoid soft-tissue mass arising from right lateral wall of bladder (arrow). **B**, Corresponding axial fused PET/CT image shows moderate $^{18}$F-FDG activity in tumor (arrow) compared with “hot” urine.

**Fig. 13**—70-year-old man with histologically proven large B-cell lymphoma involving testes. Longitudinal sonogram shows large, hypoechoic, circumscribed mass in left testis (arrowheads). Multiple smaller but similar masses were seen in right testis (not shown). Histopathology of resected left testis revealed large B-cell lymphoma.

**Fig. 14**—59-year-old man with large B-cell lymphoma involving pancreas. Axial contrast-enhanced CT image shows two low-attenuation tumor nodules in pancreatic body (arrowheads).

**Fig. 15**—72-year-old woman with large B-cell lymphoma involving pancreas. Axial fused PET/CT image shows $^{18}$F-FDG-avid pancreatic body lymphomatous deposit (arrowhead).

**Fig. 16**—55-year-old woman with large B-cell lymphoma involving adrenals. Axial contrast-enhanced CT image shows rounded large bilateral adrenal tumors (arrows).
Fig. 17—61-year-old woman with histologically proven primary mucosa-associated lymphoid tissue lymphoma in gallbladder. A, Longitudinal sonogram shows diffuse, asymmetric mural thickening of gallbladder (arrowheads). B, Axial contrast-enhanced CT image shows homogeneous soft-tissue thickening of wall of gallbladder (arrowheads) without tumoral invasion of adjacent liver.

Fig. 18—57-year-old woman with peritoneal lymphomatosis. (Courtesy of Henderson R, Los Angeles, CA) A, Axial unenhanced CT image shows ascites that is similar in attenuation to adjacent muscle. Linear bands of soft-tissue attenuation run through mesenteric fat, indicating tumor infiltration (arrowheads) that causes tethering of small bowel. B, Corresponding axial fused PET/CT image shows ascites and mesenteric tumor that are intensely 18F-FDG-avid.

Fig. 19—54-year-old man with diffuse large B-cell lymphoma involving retroperitoneum, abdominal wall, and lumbar spine. A, Axial T2-weighted fast spin-echo image shows large right-sided retroperitoneal mass (arrows) that infiltrates paravertebral muscle (M), causes adjacent L1 vertebral destruction (arrowhead), and extends into epidural space to displace cauda equina. Right kidney (K) is anteriorly displaced. B, Axial fused PET/CT image at L3–L4 disk level 1 year after initial treatment shows multiple new 18F-FDG-avid subcutaneous tumor nodules (arrowheads).

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