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Vascular Contact With Soft Tissue: A Sign of Mesenteric Masses at Computed Tomography

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Abstract

Purpose—To evaluate prevalence of mesenteric vascular contact at routine computed tomography (CT) and evaluate its value for distinguishing missed mesenteric masses from adjacent bowel.

Materials and Methods—We identified 18 abdominopelvic CT scans of 9 patients in whom mesenteric masses were missed on the prospective CT reports. We recorded the long-axis diameter of the masses, time interval to eventual detection, and presence of vascular contact (fat plane obscuration) with a mesenteric vessel greater than 1 mm in diameter. We also retrospectively identified 129 consecutive abdominopelvic CT scans of nononcology patients and recorded all locations of vascular contact between a mesenteric vessel greater than 1 mm in diameter and adjacent bowel.

Results—In the 18 CT examinations where mesenteric masses were missed, the mean long-axis diameter was 2.9 cm, and time between the initial CT scan and first discovery was 12 months. Mesenteric vessels contacted the masses in 17 (94%) of 18 scans. In the 129 nononcology patients, vascular contact was rarely seen with bowel distal to the proximal jejunum (6 had vascular contact with distal jejunum, 5 with ileum, and 0 with colon). However, the third and fourth duodenal portions showed vascular contact with the superior mesenteric vessels in 36 (28%) and 12 patients (9.4%), respectively, and with the inferior mesenteric vessels in 58 patients (48%).

Conclusions—At CT, mesenteric vessels greater than 1 mm in diameter rarely contact bowel other than the duodenum and proximal jejunum; however, they often contact mesenteric masses. At CT scan review, inspection of the mesenteric vessels may facilitate mesenteric mass identification.

Keywords

small bowel; CT imaging; gastrointestinal radiology; lymph nodes; cancer

Accurate and timely identification of metastases is critical for oncological patient management. Computed tomography (CT) is the most common imaging modality used for monitoring neoplastic disease in the abdomen and pelvis. Several reports have evaluated the frequency and findings of mesenteric lymphadenopathy in patients with¹ and without malignancy² and have reported a high sensitivity of CT for the detection of extravisceral masses.³

However, the mesentery remains a challenge for radiological evaluation because of its mobility and tendency to change configuration from scan to scan. Also, many institutions now use isoattenuation oral contrast agents such as water or sorbitol rather than high attenuation contrast material for bowel distension,⁴ and this practice may decrease the conspicuity of mesenteric masses against the background of similar-attenuation bowel. In our experience in an academic regional oncology referral center, we found several cases of mesenteric masses that were repeatedly missed at abdominopelvic CT despite the studies being read by abdominal imaging specialists. These masses were subsequently identified on follow-up examination when the masses grew in size.

In the missed cases that we preliminarily identified, we noticed obscuration of the fat plane (vascular contact) between the missed mesenteric masses and visible mesenteric vessels on transverse CT images. We are not aware of a prior study assessing the value of finding contact between mesenteric vessels and soft tissue at CT for finding mesenteric masses nor of the frequency with which normal bowel contacts mesenteric vessels at CT. Therefore, we performed this retrospective descriptive study to evaluate the value of mesenteric vascular contact as a CT sign for the distinction of missed mesenteric masses from adjacent bowel.

MATERIALS AND METHODS

Subjects

This was a retrospective single-institution study approved by our Committee on Human Research and compliant with requirements of the Health Insurance Portability and Accountability Act. Patient consent was not required. There were 2 groups of subjects. The first group of patients was composed of 9 patients (6 men and 3 women; mean age, 53 years) in whom mesenteric masses were missed at CT scan. These patients were identified by 2 authors (B.M.Y., F.V.C.) during the course of daily clinical activity and consisted of patients in whom mesenteric masses were found at a subsequent CT scan (6 patients), subsequent positron emission tomography (PET) scan (1 patient), on second-opinion review of the CT scan (1 patient), or surgery for bowel obstruction (1 patient), yet in whom the prior CT scan reports did not describe the presence of a mesenteric mass. For these 9 patients, a total of 18 CT scans were identified where the report missed the finding of a mesenteric mass and where a mesenteric mass was, in retrospect, present. All 18 CT scans with missed mesenteric metastases had been read prospectively between January 2001 and July 2005 by attending faculty with subspecialty training in abdominal imaging using a picture archive and computer system (PACS) workstation (Impax; Agfa, Mortsel, Belgium). All radiological reports were then reviewed to determine whether, at the time of each CT scan, the mesenteric mass would have been the only radiological finding of malignancy or of tumor recurrence. The time interval between each CT scan and first discovery of the mesenteric mass was recorded. Our institution is an academic center with a busy oncology practice that routinely performs 50 abdominopelvic CT cases per day.

The second group (control group) consisted of 129 consecutive abdominopelvic CT scans of adults without known nor suspected malignancy in whom lymphadenopathy was not noted. This group was identified by a computerized search of our radiology departmental information system (IDXrad, software version 9.7.1; IDX Systems Corporation, Burlington, Vt) between October 8 and 13, 2005, for CT scans obtained using 5-mm slice thickness. We chose to include only patients imaged with 5-mm slice thickness because this is currently the slice thickness for our standard imaging protocol for general oncological patient surveillance. If multiple CT scans were obtained in the same patient, then only the first CT examination was evaluated. Note that initially 131 CT scans were identified, but 2 were discarded because of excessive motion artifact that obscured the mesenteric vessels. The final patient group included 71 women with a mean age of 53 years (range, 19–94 years) and 58 men with mean age of 54 years (range,

18–96 years). The indication for the CT scans was to evaluate for abdominal pain (n = 48), source of sepsis (n = 27), flank pain or hematuria (n = 26), intraabdominal bleed (n = 10), possible bowel obstruction (n = 4), liver disease (n = 4), or other nonmalignant intraabdominal processes (n = 10). None of the patients were identified with malignancy at CT nor at subsequent clinical follow-up up to 6 months later.

CT Technique

The 9 patients with missed mesenteric masses underwent a total of 24 CT scans (18 CT scans in which the masses were missed and 6 CT scans in which the masses were first discovered; in 1 patient, the mass was discovered on second-opinion review of the initial CT scan; in the other 2 patients, the mesenteric masses were first discovered at surgery or PET scan). These CT scans were performed on multidetector-row (n = 20, Lightspeed; General Electric Healthcare, Milwaukee, Wis) or single detector-row (n = 4, HiSpeed CT/I; General Electric Healthcare) scanners. For all CT examinations, 800 mL of oral diatrizoate meglumine (Hypaque; Nycomed Amersham, Princeton, NJ) was administered, and for 20 examinations, 150 mL of intravenous iohexol (Omnipaque 350; Nycomed Amersham) was given 70 to 80 seconds before scanning. Images were acquired with 5- (n = 20) or 7-mm (n = 2) slice thickness with instructions to maintain a breath-hold.

The CT scans for the 129 patients in the control group were performed on multidetector-row CT scanners (Light-speed; General Electric Healthcare). Oral contrast (800 mL of oral diatrizoate meglumine, Hypaque; Nycomed Amersham) was administered in 68 patients, and 97 patients received 150 mL of intravenous iohexol (Omnipaque 350; Nycomed Amersham) 80 seconds before scanning. For all patients, 5-mm thick contiguous slices were obtained through the abdomen and pelvis with instructions to maintain a breath-hold. Of the 32 patients who did not receive intravenous contrast material, 20 were scanned for possible nephrolithiasis, 8 were for possible retroperitoneal hemorrhage, and 4 had contraindications to intravenous contrast administration.

CT Interpretation

One attending radiologist with subspecialty experience in abdominal imaging (B.M.Y.) reviewed the axial CT scan images of the 9 patients with missed mesenteric masses using a PACS (Impax; Agfa) workstation. Multiplanar reformations were not obtained. Using all available medical records, the reader identified the missed mesenteric masses and recorded the long- and short-axis diameters of the lesions in the axial plane and the presence or absence of mesenteric vascular contact, which was defined as an obscured fat plane between the lesion and a mesenteric vessel greater than 1 mm in diameter. For lesions with mesenteric vascular contact, the reader recorded which mesenteric vessel (superior vs inferior mesenteric) was in contact with the lesion. Use of a PACS workstation readily allows tracking of large (>1 mm) mesenteric vessels, even in the absence of intravenous contrast.

The reader then reviewed the 129 CT scans of the “control group.” For these CT scans, the reader recorded the presence of mesenteric vascular contact with the bowel. Multiplanar reformations and thin-section images were not assessed. The vessels that were evaluated were the superior and inferior mesenteric veins and arteries as well as the tributaries and branches of these vessels that were 1 mm in diameter or larger. If mesenteric vascular contact was seen, the involved viscera was recorded as the third or fourth duodenal segments, proximal jejunum, distal jejunum, ileum, or colon.

Statistical Analysis

Data were analyzed descriptively using the Stata software package version 8.0 (Stata Corporation, College Station, Tex).

RESULTS

Table 1 summarizes the findings of the 9 patients (18 CT scans) where mesenteric masses were missed in the prospective CT report (Fig. 1, Fig. 2, Fig. 3, Fig. 4). In these scans, the mean size of the missed mesenteric masses was 2.9×2.3 cm (range, 1.0×1.0 to 5.1×4.3 cm), and the mean time between the initial CT scan and first discovery of the masses was 12 months (range, 2 days to 44 months). In 5 (56%) of 9 patients, the missed mesenteric mass would have been, at one point in time, the only radiological sign of tumor or tumor recurrence (Table 1). In all 9 patients, mesenteric vascular contact was seen with the missed mesenteric masses, and this sign was found in 17 (94%) of the 18 CT scans where the masses were not prospectively reported. In the CT scan where mesenteric vascular contact was not seen with the mesenteric mass, the mass was small (1.2-cm maximal diameter).

In the 129 nononcological patients, the frequency of mesenteric vascular contact with the bowel is summarized in Figure 5, and examples are shown in Figure 6 and Figure 7. Vascular contact was rarely seen with bowel distal to the proximal jejunum (6 patients had vascular contact with distal jejunum, 5 with ileum, and 0 with colon). However, vascular contact was commonly seen between the mesenteric vessels and the duodenum: the third and fourth duodenal portions showed vascular contact with the superior mesenteric vessels in 36 (28%) and 12 patients (9.4%), respectively, and with the inferior mesenteric vessels in 58 patients (48%).

DISCUSSION

Mesenteric masses can be the first sign of malignancy or of tumor recurrence, as shown in 5 of our patients, and our experience unfortunately demonstrates that large mesenteric masses can be repeatedly missed at serial CTs, even when the examinations are interpreted by subspecialty trained abdominal imagers who are familiar with the assessment of oncological patients and who read CT scans on a daily basis. To us, this was a surprising and humbling realization, and our results emphasize the need to remain vigilant in searching for mesenteric lesions. A benefit of our preliminary findings is that we identify a potentially helpful finding that may assist in the search for mesenteric masses: all of the patients with missed mesenteric masses showed contact between the masses and the mesenteric vasculature at CT. This finding may be of particular value for evaluating the mesentery of the colon and the mid and distal small bowel where mesenteric vascular contact with bowel is rare. A search pattern that includes tracing the major mesenteric vessels on axial images to identify areas of mesenteric vascular contact may be of particular value in the evaluation of high-risk patients with known or suspected malignancy and may allow more prompt intervention.

It must be stressed that the finding of mesenteric vascular contact is not in itself diagnostic for tumor because normal bowel can occasionally abut a mesenteric vessel. Rather, when interpreting CT scans with a concern for possible malignancy, the search pattern should include the tracing of mesenteric vessels to locate areas of vascular contact. Of course, because bowel may occasionally contact the mesenteric vessels, the reader must further inspect these foci to determine whether the mesenteric vessels abut a true mass or a bowel segment. Nevertheless, tracing of the mesenteric vessels may be helpful to improve detection of otherwise difficult-to-find mesenteric masses. Ambiguous cases may require multiplanar reformation of the CT images or follow-up examination. In our experience, tracing of vessels, even when intravenous contrast is not present (Fig. 2), can be readily performed on a PACS workstation by scrolling the images.

The finding of mesenteric metastases is important for medical and surgical management. Enlargement and encasement of the mesenteric vessels by enlarged lymph nodes is referred to as the “sandwich sign” and is thought to be suggestive of lymphoma.^{5,6} Also, the finding of

mesenteric lymphadenopathy in patients with focal colonic wall thickening favors the diagnosis of colon cancer rather than diverticulitis.⁷ Several studies have shown that the size of normal mesenteric lymph nodes at CT may range up to 5 mm in diameter in adults² and 8 mm in children⁸ and that such nodes may reside on either side of mesenteric branch vessels.⁶ However, the frequency and locations of mesenteric vascular contact with mesenteric masses or bowel at CT have not been previously described. We found that missed mesenteric masses are frequently in contact with mesenteric vasculature at CT (noted in 17 of the 18 CT scans where the masses were missed and 6 of the 6 scans where the masses were eventually identified). This finding held true even for the 2 patients with ovarian tumors, which were expected to have peritoneal implants rather than tumor enveloped within the mesenteric fat. This association between mesenteric masses and macroscopic blood vessels may reflect local potential for angiogenesis: tumors that grow larger may be more capable of blood vessel recruitment, or conversely, prominent blood vessels adjacent to tumor foci may allow more dramatic tumor growth. Other causes for mesenteric vascular contact with masses or bowel, such as the patient's body habitus or location of the mass on the peritoneum versus within the mesenteric fat or distance from the mesenteric root, are not answered by our initial data and will require further study.

Knowledge of findings that assist in mesenteric lesion detection at 5-mm slice thickness CT is of high clinical importance. Potentially, the use of PET⁹ or novel magnetic resonance contrast agents^{10,11} may allow for higher detection rates of mesenteric masses. However, some low-grade malignancies, such as carcinoid, may not show significant uptake of 18-FDG or may be poorly visualized at routine MRI because of mesenteric motion artifact, and neither modality has yet replaced routine CT scanning for oncological follow-up in most clinical practices. The need to recognize useful CT findings to detect mesenteric masses is further amplified by the increasing use of isoattenuation oral agents, such as oral water or sorbitol, rather than radiodense oral agents as a means to improve evaluation of the bowel wall at CT^{12,13} because this practice may reduce the conspicuity of mesenteric masses relative to similar-attenuation bowel. Some reports have shown that thin-section CT with multiplanar reformations may improve the detection of mesenteric lymph nodes,^{14,15} and the added value of tracing mesenteric vessels to identify mesenteric masses at multiplanar CT review will require further study. However, most imaging centers, including ours, have not been fortunate enough to upgrade all of their CT scanners to allow for thin-section multiplanar reformation, and 5-mm thick transverse section CT remains a widely used imaging method to assess for abdominal tumors in the United States.

It is important to note that our patient population is likely biased toward severe or clinically relevant disease because smaller or asymptomatic missed mesenteric masses were less likely to be discovered. Our patient sample is also likely biased toward patients in whom the mesenteric mass was the first sign of malignancy or tumor recurrence because the finding of a missed solitary mass is more likely to stir clinical consternation than would the finding of just another metastasis in the setting of widespread disease. Furthermore, because the patients with mesenteric masses were nonconsecutive, we were not able to determine the sensitivity of this sign for the detection of mesenteric masses. Nevertheless, our cases show that clinically relevant enlarging mesenteric masses may be associated with mesenteric vascular contact at CT and that assessment of the mesentery for this finding may be of value in the oncological patient population.

Our study has a number of limitations. First, all our patients with mesenteric masses had tumors, and none had inflammatory or infectious disease. Other mesenteric diseases, including retractile mesenteric panniculitis or tuberculosis^{16,17} might also result in mesenteric masses that contact mesenteric vessels. Further study in a wider scope of patients will be useful to determine the generalizability of finding contact with mesenteric vessels to identify mesenteric

masses. Second, our sample size of patients with missed mesenteric masses was small and nonconsecutive. Unfortunately, it is intrinsically difficult to identify consecutive patients with missed mesenteric masses because the identification of “missed” masses requires that the CT report not mention the mass, hence many missed masses would not be identified by a systematic search. However, our patient sample is of particular clinical importance because each mass was both missed at initial CT and was eventually proven to be malignant either by growth on subsequent imaging or at surgery. Third, our evaluation of anatomy in the 129 consecutive nononcological patients included only CT scans obtained with 5-mm slice thickness evaluated in the axial plane. The value of tracing mesenteric vessels to assess for mesenteric masses using multiplanar reformations or thinner slice thicknesses will require further study in the future. Nevertheless, 5-mm slice thickness is a commonly used CT technique in routine abdominopelvic imaging, and therefore, the assessment of mesenteric vessels will likely be useful for the evaluation of oncological patients in a broad range of institutions.

Nonwithstanding these limitations, we found that at CT, mesenteric vessels greater than 1 mm diameter rarely contact bowel segments other than the duodenum and proximal jejunum; however, they often contact mesenteric masses. At CT scan review, inspection of the mesenteric vessels may facilitate mesenteric mass identification.

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Figure 1.

Missed mesenteric mass in a 56-year-old man with melanoma. A, Initial CT examination shows contact between a branch of the superior mesenteric vein (arrowhead) and a 2.7-cm mesenteric metastasis (arrow) that was missed prospectively. Note how the mass resembles other segments of unopacified bowel. B, Eight months later, the mass (arrow) is larger and contacts the superior mesenteric vein (arrowhead) but again was not identified prospectively. The CT attenuation and texture of the mass again resembles that of adjacent unopacified bowel. C, Another 10 months later, the mass (arrow) was then recognized and showed contact with 2 mesenteric vessels (arrowheads). Incidentally, contact between a segment of dilated bowel with mural tumor infiltration (small arrow) and a prominent mesenteric vein (small arrowhead) is also seen.

Figure 2.

A 38-year-old woman with non-Hodgkin lymphoma and missed mesenteric mass. Oral contrast-enhanced CT scan without intravenous contrast shows a partially calcified mesenteric nodal mass (large arrow) that is similar in appearance to the adjacent oral contrast-enhanced small bowel (small arrows), except that the mass contacts a 2-mm superior mesenteric vein branch (arrowhead). No vessels larger than 1 mm in diameter were seen in contact with bowel.

Figure 3.

A 63-year-old man with missed carcinoid lymph node metastasis to the small bowel mesentery.

A, Intravenous contrast-enhanced CT shows a branch of the superior mesenteric vein (arrowhead) in contact with a lobulated soft tissue mass (arrow) that was not identified prospectively in the CT report. This mass is similar in CT attenuation to some segments of adjacent unopacified small bowel. B, Gross specimen shows the metastasis (arrow) in the mesentery (arrowheads). No vessels are visible on the mesenteric surface. C, Cross-section through the metastasis shows mesenteric veins (white arrowheads) within the mass (white arrow). Cross-section through the mesentery shows mesenteric vessels (black arrowheads) encased by mesenteric fat.

Figure 4.

A 23-year-old woman with ovarian yolk sac tumor metastasis missed at CT. A segment of jejunum (black arrow) contacts the mesenteric metastasis (white arrow), which in turn contacts a branch of the superior mesenteric vein (black arrowhead). However, the bowel itself does not show contact with large mesenteric vessels at CT.

Figure 5.

Bar graph showing prevalence of mesenteric vascular contact with bowel at abdominopelvic CT in 129 consecutive nononcological patients. Mesenteric vascular contact was rarely seen with segments of the distal jejunum, ileum, or colon at CT. Numbers in parentheses indicate the number of CT scans in which mesenteric vascular contact was seen with the given segment of bowel.

Figure 6. Oral and intravenous contrast-enhanced CT scan of a 49-year-old woman with abdominal pain. A branch of the superior mesenteric vein (arrow) is seen in contact with the third portion of the duodenum (arrowhead). The duodenum was the most common site of contact between the superior mesenteric vessels and bowel in our series.

Figure 7.

Oral and intravenous contrast-enhanced CT scan of a 44-year-old woman for possible abscess. The inferior mesenteric vein (small arrow) is seen in contact with the posterior aspect of the fourth portion of the duodenum (large arrow). The fourth portion of the duodenum was the most frequent site of contact between the inferior mesenteric vessels and bowel. A branch of the superior mesenteric vein (small arrowhead) is also seen in contact with the fourth portion of the duodenum and a segment of proximal jejunum (large arrowhead).

TABLE 1
Summary of Abdominopelvic CT Scan Findings Where Mesenteric Masses Were Missed at Prospective Evaluation

Patient Age, yrs	Malignancy	Time Before Discovery	Size of Mesenteric Mass, cm	Mesenteric Vascular Contact	Mesenteric Vessel Involved
38	Non-Hodgkin lymphoma	6 wk	3.0 × 2.5	Yes	Superior
57	Melanoma	Identified	3.4 × 2.9	Yes	Superior
		44 mo	1.0 × 1.0	Yes	Superior
		38 mo	1.2 × 0.9	No	—
		32 mo	1.5 × 1.5	Yes	Superior
		18 mo	2.9 × 2.8	Yes	Superior
71	Nonsmall cell lung	10 mo	4.8 × 3.1	Yes	Superior
		Identified	5.7 × 4.3	Yes	Superior
		9 mo [*]	1.9 × 1.3	Yes	Superior
		4 mo	3.1 × 1.8	Yes	Superior
		Identified	5.9 × 2.0	Yes	Superior
23	Ovarian yolk sac tumor	14 mo	2.5 × 1.8	Yes	Superior
		9 mo	2.7 × 2.5	Yes	Superior
		7 mo	2.8 × 2.7	Yes	Superior
		3 mo	3.2 × 2.6	Yes	Superior
		Identified	3.2 × 2.8	Yes	Superior
64	Colon	17 mo [*]	1.3 × 1.2	Yes	Superior
		8 mo [*]	2.9 × 2.2	Yes	Superior
		Identified	4.6 × 4.3	Yes	Superior
		2 d [*]	5.0 × 4.3 and 3.2 × 2.8	Yes for both	Superior for both
		Identified	5.0 × 4.3 and 3.2 × 2.8	Yes for both	Superior for both
56	Desmoid tumor (2 mesenteric masses missed)	4 mo [*]	3.0 × 2.2	Yes	Superior
63	Carcinoid	Identified [†]	3.3 × 2.5 [†]	NA [†]	—
38	Adenocarcinoma	2 mo [‡]	5.1 × 3.7	Yes	Superior
66	Ovarian	3 mo	1.0 × 1.2	Yes	Superior
		Identified [§]	§	NA [§]	—

* The mesenteric mass was the only site of recurrence at that time.

⁷Incidentally identified at surgery.

[#]Identified on second-opinion review.

[§]Identified at PET scan.

NA indicates not applicable.