The Incidental Splenic Mass at CT: Does It Need Further Work-up? An Observational Study[1]

Bettina Siewert, MD
Noam Z. Millo, MD
Kamaldeep Sahi, MD
Robert G. Sheiman, MD
Olga R. Brook, MD
Maryellen R. M. Sun, MD
Robert A. Kane, MD

Purpose: To evaluate whether an incidentally noted splenic mass at abdominal computed tomography (CT) requires further imaging work-up.

Materials and Methods: In this institutional review board–approved HIPAA-compliant retrospective study, a search of a CT database was performed for patients with splenic masses at CT examinations of the abdomen and chest from 2002 to 2008. Patients were divided into three groups: group 1, patients with a history of malignancy; group 2, patients with symptoms such as weight loss, fever, or pain related to the left upper quadrant and epigastrium; and group 3, patients with incidental findings. Patients' CT scans, follow-up examinations, and electronic medical records were reviewed. Final diagnoses of the causes of the masses were confirmed with imaging follow-up (83.9%), clinical follow-up (13.7%), and pathologic examination (2.4%).

Results: This study included 379 patients, 214 (56.5%) women and 165 (43.5%) men, with a mean age ± standard deviation of 59.3 years ± 15.3 (range, 21–97 years). There were 145 (38.3%) patients in the malignancy group, 29 (7.6%) patients in the symptomatic group, and 205 (54.1%) patients in the incidental group. The incidence of malignant splenic masses was 49 of 145 (33.8%) in the malignancy group, eight of 29 (27.6%) in the symptomatic group, and two of 205 (1.0%) in the incidental group ($P < .0001$). The incidental group consisted of new diagnoses of lymphoma in one (50%) patient and metastases from ovarian carcinoma in one (50%) patient. Malignant splenic masses in the incidental group were not indeterminate, because synchronous tumors in other organs were diagnostic of malignancy.

Conclusion: In an incidental splenic mass, the likelihood of malignancy is very low (1.0%). Therefore, follow-up of incidental splenic masses may not be indicated.

[1] From the Department of Radiology, Beth Israel Deaconess Medical Center, 330 Brookline Ave, Boston, MA 02115.
From the 2015 RSNA Annual Meeting. Received February 5, 2017; revision requested March 31; revision received September 6; accepted September 25; final version accepted November 14. **Address correspondence to** B.S. (e-mail: *bsiewert@bidmc.harvard.edu*).

Incidental masses at computed tomography (CT) of the abdomen and pelvis are very common, reported in 35%–56% of trauma patients who undergo CT (1,2). Such incidental findings include masses in the spleen, which have been reported as incidental findings in greater than 14% of autopsies (3), and most commonly represent hemangiomas, cysts, hamartomas, lymphangiomas, or granulomas. Incidental findings are defined as abnormalities that are not related to the patient's presenting illness, which, in the context of the spleen, would mean that the patient had no history of malignancy, no constitutional symptoms including fever and weight loss, and no symptoms related to the epigastrium or left upper quadrant of the abdomen.

The widespread use of cross-sectional imaging as an integral part of the diagnostic evaluation of patients with a variety of symptoms and concerns and the high spatial and contrast resolution of modern CT scanners have resulted in a marked increase in the number of such incidental findings (4). While the majority of these "incidentalomas" are benign, the possibility of incidental detection of a clinically important abnormality is real and occurs frequently in other organs, such as detection of a small renal cell carcinoma or an early lung cancer. Consequently, a decision must be made about whether, when, and how to work up an incidentally detected mass.

Ever-increasing pressure to control the cost of health care raises concerns regarding the fiscal burden of additional evaluation for all incidentalomas (4), particularly if the added value from additional imaging is questionable. Further concerns have been raised regarding unnecessary radiation, patient anxiety, and even patient injury resulting from the work-up of incidental findings through image-guided biopsy (5) or splenectomy (6), including death from treatment of incidental abnormalities (7).

The initial "white paper" from the American College of Radiology (ACR) incidental findings committee recommends further evaluation and/or follow-up imaging for all incidental splenic masses greater than 1 cm that do not have clearly benign features at imaging at the time of detection (4). The majority of such solid splenic nodules and masses are benign, with hemangioma being the most frequent diagnosis (8,9). However, CT imaging characteristics of benign and malignant splenic masses often overlap, making definitive differentiation difficult (8,10). In addition, many CT examinations of the abdomen and pelvis are performed with intravenous contrast media only, which makes differentiation of enhancing nodules and masses from complex, proteinaceous, and/or hemorrhagic cysts impossible. Therefore, many patients require follow-up per ACR guidelines. While the ACR white paper represents a consensus opinion of experts in the field, the follow-up recommendations for splenic masses are based on personal experience of the expert panel, and the panel acknowledged that there were not enough scientific data on which to base this decision. The purpose of our study was, therefore, to evaluate whether an incidentally noted splenic mass at abdominal CT requires further imaging work-up.

Implication for Patient Care

- Follow-up of splenic masses incidentally detected at CT (ie, in patients with no evidence of previous or newly diagnosed malignancy and no systemic symptoms or localized pain) does not appear to be indicated.

Materials and Methods

Our retrospective study was Health Insurance Portability and Accountability Act–compliant and was approved by our institutional review board with a waiver of informed consent. We performed a search of our picture archiving and communications system database for patients diagnosed with a splenic mass or masses from throughout our institution (emergency oncology departments, inpatients and outpatients) performed during a 6-year time period (January 2002 to December 2008) in a large academic tertiary care center radiology department. This time period was specifically chosen to allow for sufficient clinical follow-up to establish benignity or malignancy of a mass. The search was consecutive, and CT reports were searched by using the keyword "spleen/splenic" plus one of the following terms: mass, lesion, nodule, abnormality, abscess, cyst, hemangioma, hamartoma, infarct, metastasis, lymphoma, sclerosing angiomatoid nodular transformation (SANT), and angiosarcoma. The inclusion criterion was the availability of adequate follow-up (imaging follow-up of 2 years, or clinical follow-up of 5 years for benign masses). Masses that represented splenic infarcts and calcified granulomas and those that could not be confirmed at image review were excluded from the study.

Examinations were performed with a variety of CT scanners from different vendors (GE, Fairfield, Conn; Siemens, Malvern, Pa; Toshiba, Glenn Mills, Pa) with one to 64 detectors. Because of the retrospective nature of our study and varied examination indications, CT protocols varied and included both intravenous contrast material–enhanced and unenhanced examinations. Where applicable, ioversol 320 (Optiray; Mallinckrodt, St Louis, Mo) was used as the intravenous contrast agent. The amount of administered contrast material varied according to patient weight:

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Abbreviations:
ACR = American College of Radiology
ROI = region of interest
SANT = sclerosing angiomatoid nodular transformation

Author contributions:
Guarantors of integrity of entire study, B.S., N.Z.M., K.S., R.A.K.; study concepts/study design or data acquisition or data analysis/interpretation, all authors; manuscript drafting or manuscript revision for important intellectual content, all authors; approval of final version of submitted manuscript, all authors; agrees to ensure any questions related to the work are appropriately resolved, all authors; literature research, B.S., N.Z.M., K.S., O.R.B., R.A.K.; clinical studies, B.S., K.S., R.G.S., O.R.B., M.R.M.S.; statistical analysis, B.S., N.Z.M.; and manuscript editing, all authors

Conflicts of interest are listed at the end of this article.

120 mL of contrast material for patients who weighed less than or equal to 120 lbs and 150 mL of contrast material for those who weighed more than 120 lbs. Injection rates ranged from 2 mL/sec for general examination of the abdomen to 5 mL/sec for CT angiography. Depending on the protocol, bolus tracking was used to allow for optimal contrast opacification with contrast-enhanced CT or a fixed 75-second delay for routine imaging in the portal-venous phase. Section thickness for all CT examinations was 2–5 mm.

Retrospective review was performed of the initial CT examination that demonstrated the splenic mass or masses and any subsequent relevant follow-up examinations performed during the time period of 2002–2013. Subsequent follow-up examinations, CT and related imaging reports, and electronic medical records were reviewed by three investigators: (N.M. and K.S., who were undergoing abdominal imaging fellowship training, and B.S., with 19 years of experience in abdominal imaging). CT image analysis was performed blinded with respect to patient outcome before review of each patient's medical record. The following CT findings were recorded: size of the mass or masses at initial and follow-up imaging, number of splenic masses, and presence or absence of enhancement on images of patients who were administered intravenous contrast material.

Mass size was remeasured in two perpendicular planes on axial images including the largest axial dimension. Measurements incorporated the entire mass, inclusive of solid components and components believed to be cystic. Annual growth rate of the largest mass in the initial examination was calculated by measuring the largest diameter at follow-up imaging minus the largest diameter at the initial examination and then dividing the result by the number of years between follow-up examinations.

If multiple masses were present, with a similar appearance at initial CT, the largest mass was followed up. When multiple dissimilar masses were present in the spleen at initial CT, the mass with the most complex imaging features was followed up (ie, if a solid and a cystic mass were present, the solid mass was evaluated).

For all masses greater than 1 cm in maximum dimension, a region of interest (ROI) analysis was performed by placing circular ROIs centrally on unenhanced and contrast-enhanced acquisitions when available. A mass was considered a cyst if it was uniform in appearance and demonstrated attenuation measurements of less than or equal to 20 HU, was well circumscribed, and, where applicable, did not demonstrate enhancement with intravenous contrast material (11). For all other masses, the presence or absence of contrast enhancement was recorded when applicable, with enhancement defined as an increase of greater than or equal to 20 HU between unenhanced and contrast-enhanced acquisitions. Masses were categorized as indeterminate if attenuation measurements on unenhanced images were greater than 20 HU, and contrast-enhanced images were not available. Masses were classified as hematomas if they fulfilled previously published criteria (1,12), which included attenuation measurements greater than 50 HU on an unenhanced image that showed no enhancement; these were excluded from our study. Peripheral, wedge-shaped, low-attenuating masses were defined as infarcts (13) and were excluded from our study. Calcified granulomas were also excluded.

Electronic medical records were independently and blindly reviewed for the indication for the initial CT examination and for any documentation of malignancy in the clinical and pathologic notes predating the time of the initial CT. Patients were stratified into three groups according to clinical history and presentation as follows: group 1 (malignancy), patients with a history of prior malignancy or currently undergoing treatment of a known malignancy; group 2 (symptomatic), no history of malignancy, but constitutional symptoms including weight loss, fever, or pain related to the left upper quadrant and epigastrium; and group 3 (incidental), no history of malignancy, no constitutional symptoms such as fever and weight loss, and no symptoms related to the epigastrium or left upper quadrant of the abdomen.

Final diagnosis of splenic masses was established by review of electronic medical records postdating the time of initial CT and correlation with either histopathologic results (obtained by means of surgical resection or percutaneous image-guided biopsy where applicable), imaging and clinical follow up, or clinical follow-up only in those patients for whom additional imaging was not performed or available. Clinical follow-up included review of physical examination and/or any clinical notes commenting on overall well-being of the patient. The initial determination was made by N.M. and K.S.; if a discordance with the CT report and electronic medical records was noted, the determination was then made in consensus with B.S.

For patients in the incidental and symptomatic groups, a mass was considered benign at follow-up imaging if it was stable or decreased in size or showed minimal annual growth of less than or equal to 2 mm per year (14) at follow-up imaging (CT, magnetic resonance [MR] imaging, ultrasonography [US], or fluorodeoxyglucose positron emission tomography [PET]/CT) throughout at least 2 years. In these groups, when only clinical follow-up was available, we required *(a)* a 5-year period without evidence of any malignancy for the splenic mass to be considered benign and *(b)* a persistent lack of symptoms in those with incidental masses and no change in or resolution of constitutional symptoms in those classified as symptomatic. Please note that patients who did not undergo imaging follow-up showing stability of the splenic mass for greater than or equal to 2 years or clinical follow-up notes greater than or equal to 5 years in our electronic medical records were excluded from our study. When none of these criteria were met, the splenic mass was considered malignant. In patients with a history of malignancy, a mass was considered malignant if it demonstrated an interval increase in the largest diameter of at least 10%

Figure 1

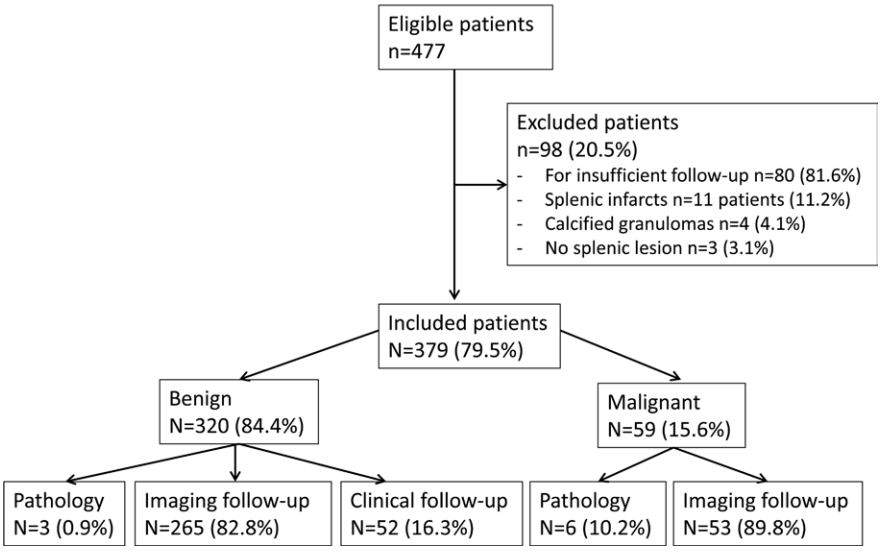


Figure 1: Consolidated Standards of Reporting Trials, or CONSORT, flowchart shows eligibility criteria and resulting number of study patients.

(15), was new in comparison with prior imaging, or demonstrated a size decrease after chemotherapy. In this group, a mass was considered benign if it was stable in size.

Statistical analysis was performed by using the χ^2 test and the Student *t* test. The χ^2 test was used to compare the frequency of solitary masses between benign and malignant masses, the frequency of malignant splenic masses between the incidental group and the malignancy group and the incidental group and the symptomatic group. The Student *t* test was used to compare the baseline diameter and size increase between benign and malignant masses. Ninety-five percent confidence intervals of the proportions were calculated. Statistical analysis was performed by using software (MatLab; MathWorks, Natick, Mass). A *P* value of .05 was considered to indicate a significant difference.

Results

During the time of our study (January 2002 to December 2008), we identified 477 consecutive patients who met our search criteria for an incidental splenic mass at CT (Fig 1). Ninety-eight (20.5%) patients were excluded: 80 (81.6%) because of absent clinical and/or imaging follow-up for the duration required to categorize the splenic mass, 11 (11.2%) for masses consistent with splenic infarcts, four (4.1%) for demonstrated calcified granulomas at image review, and three (3.1%) because no splenic mass could be identified at image review by three reviewers. The final study group included 379 patients: 214 (56.5%) women and 165 (43.5%) men (mean age ± standard deviation, 59.3 years ± 15.3 [range, 21–97 years]). CT examinations were performed with and without intravenous contrast material (*n* = 171, 45.1%), with intravenous contrast material only (*n* = 173, 45.6%), and without intravenous contrast material (*n* = 35, 9.2%). The distribution of unenhanced and intravenous contrast–enhanced examinations between study groups was as follows: For the group with a history of malignancy (*n* = 145), there were 135 (93.1%) intravenous contrast–enhanced examinations and 10 (6.9%) unenhanced examinations, for the symptomatic group (*n* = 29), there were 26 (89.7%) intravenous contrast–enhanced examinations and three (10.3%) unenhanced examinations, for the incidental group (*n* = 205), there were 183 (89.3%) intravenous contrast–enhanced examinations and 22 (10.7%) unenhanced examinations (*P* = .26). During the study period, a total of 236925 CT examinations of the abdomen were performed, of which 477 (0.2%) examinations had formal reports indicating least one splenic mass. The number of splenic masses per patient was as follows: one mass in 337 (88.9%) patients, two masses in 24 (6.3%) patients, three masses in four (1.1%) patients, four (1.1%) masses in four patients, five masses in two (0.5%) patients, and greater than five masses in eight (2.1%) patients (median, one mass).

Final Diagnoses

Final diagnoses were established at pathologic evaluation in nine of 379 (2.4%) patients (splenectomy [*n* = 6, 1.6%], CT-guided spleen biopsy [*n* = 2, 0.5%], and surgical cyst resection [*n* = 1; 0.3%]); at imaging follow-up in 318 of 379 (83.9%) patients (CT, *n* = 279; MR imaging, *n* = 21; US, *n* = 18), and by clinical follow-up in 52 (13.7%) patients. In 279 of 318 patients with imaging follow-up (87.7%), the follow-up was with CT. Follow-up for benign and malignant masses is listed in Table 1. The imaging follow-up interval (for benign and malignant masses) varied from 1 to 171 months, with a median follow-up interval of 56 months (interquartile range: 28–85 months). Final diagnoses are summarized in Table 1. In 320 of 379 patients (84.4%), splenic masses were benign. Of 379 masses, 59 (15.6%) were malignant. Thirty-seven of 59 (62.7%) represented metastatic disease in patients with either a newly diagnosed primary or a history of cancer. Twenty-two of 59 (37.3%) represented lymphoma in patients with a history of lymphoma or other CT findings suspicious for a new diagnosis of lymphoma. Of 320, 295 (92.2%) benign masses were solitary, in comparison with 41 of 59 (69.5%) malignant masses ($P < .001$). The mean largest baseline diameter of benign masses was 21.2 mm ± 18.9 (median, 13 mm; interquartile range, 9–23 mm; range, 3–113 mm), compared with 30.5 mm ± 25.9 for malignant masses (median, 21 mm; interquartile range, 16–33 mm; range, 8–108 mm) (*P* = .0014). Of the

Table 1

Final Diagnosis of Splenic Masses

Final Diagnosis	Total No. of Masses (n = 379)	No. of Masses according to Group		
		History of Malignancy (n = 145)	Symptomatic (n = 29)	Incidental (n = 205)
Indeterminate benign mass	264 (69.7)	85 (58.6)	14 (48.3)	165 (80.5)
Cyst*	54 (14.2)	11 (7.6)	7 (24.1)	36 (17.6)
Metastasis	37 (9.8)	36 (24.8)	0 (0)	1 (0.5)
Lymphoma†	22 (5.8)	13 (9.0)	8 (27.6)	1 (0.5)
SANT‡	2 (0.5)	0	0	2 (1.0)

Note.—Data are number of patients, with percentages in parentheses. SANT = sclerosing angiomatoid nodular transformation.

* Final diagnosis established at partial cyst resection (n = 1).

† Final diagnosis established at splenectomy (n = 4) and core biopsy of spleen (n = 2).

‡ Final diagnosis established at splenectomy (n = 2).

Table 2

Size Characteristics of Benign and Malignant Masses at Follow-up Imaging

Result	Benign (n = 292)	Malignant (n = 56)
Resolved*	6 (2.1)	9 (16.1)
Decreased*	64 (21.9)	17 (30.4)
Stable	176 (60.3)	0 (0)
Increased	46 (15.8)	21 (37.5)
Increased in size and number	0 (0)	9 (16.1)

Note.—Data are number of patients, with percentages in parentheses. n = 348

* For malignant masses, patients were undergoing chemotherapy.

379 masses, 87 (23.0%) were less than 1 cm in size, and 292 of 379 masses were greater than or equal to 1 cm in size (77.0%). Two hundred thirty eight of 292 (81.5%) masses greater than or equal to 1 cm were not cystic.

Follow-up imaging was available for 348 of 379 (91.8%) patients. In 318 of 348 patients, imaging follow-up was used to establish the final diagnosis. In 30 of 348 patients, imaging follow-up was available, but was performed within less than 24 months, a time period too short to establish a final diagnosis; therefore, clinical follow-up of greater than or equal to 5 years was used to establish a final diagnosis. No discrepancies were found between follow-up imaging results that met criteria for a benign splenic mass and subsequent clinical follow-up results for an individual patient. At follow-up imaging (Table 2), most benign masses (176 of 292 [60.3%]) were stable, and 70 of 292 (24.0%) were either decreased in size or completely resolved. However, 46 of 292 (15.7%) benign masses increased in size and included cysts (n = 8, 17.4%), indeterminate masses (n = 36, 78.3%), and SANT (n = 2, 4.3%). Imaging follow-up in the group with malignant splenic masses ranged from 1 month to 156 months, with a median of 14 months. At follow-up imaging, malignant masses increased (30 of 56, 53.6%) or decreased (26 of 56, 46.4%) in size in patients who underwent treatment. The overall increase in size in benign masses ranged from 2 mm to 80 mm (mean, 10.8 mm ± 12.0; increase in size in the malignant masses ranged from 2 mm to 63 mm (mean, 24.0 mm ± 16.2 [P = .00028]).

There were 145 of 379 (38.3%) patients in the malignancy group, 29 of 379 (7.6%) patients in the symptomatic group, and 205 of 379 (54.1%) patients in the incidental group. The incidence of malignant splenic masses was 49 of 145 (33.8%) in the malignancy group (95% confidence interval: 21%, 37%), eight of 29 (27.6%) in the symptomatic group (95% confidence interval: 13%, 47%), and two of 205 (1.0%) in the incidental group (95% confidence interval: 0.2%, 3.9%; [$P < .0001$, comparing the incidental group with the malignancy group and with the symptomatic group]) (Fig 2).

Patients with History of Malignancy

One hundred forty-five patients had a history of malignancy consisting of the following tumors: gastrointestinal tract (n = 26), lymphoma or leukemia (n = 25), breast (n = 21), melanoma (n = 15), lung (n = 14), other (endometrial, carcinoid, squamous cell carcinoma, liposarcoma, bladder, mesothelioma, testicular [n = 14]), hepatobiliary or pancreatic (n = 11), renal cell carcinoma (n = 9), ovarian (n = 6), and prostate (n = 4). Two patients had a history of both lymphoma and breast cancer, and these are included in the group of patients with lymphoma. Of the 49 patients in this group found to have malignant splenic masses, the distribution of primary malignancies was as follows: lymphoma (n = 13), melanoma (n = 11), gastrointestinal tract (n = 6), lung (n = 4), other (endometrial, carcinoid and squamous cell carcinoma [n = 4]), breast (n = 4), ovarian (n = 3), hepatobiliary (n = 2), and renal (n = 2) (Fig 3).

The frequency of splenic involvement with metastatic disease was as follows: melanoma, 73% (11 of 15); lymphoma, 52% (13 of 25; one patient

Figure 2

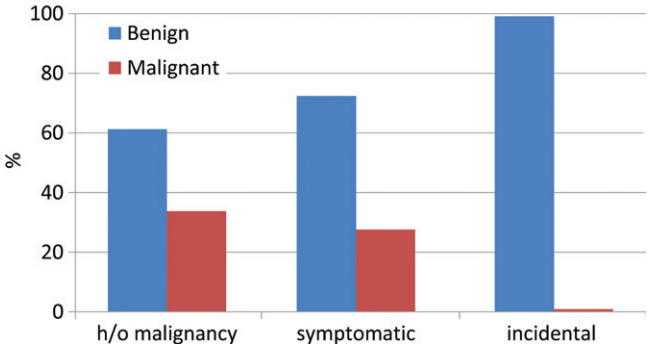


Figure 2: Bar graph shows distribution of benign and malignant masses per study group. *h/o* = history of.

Figure 3

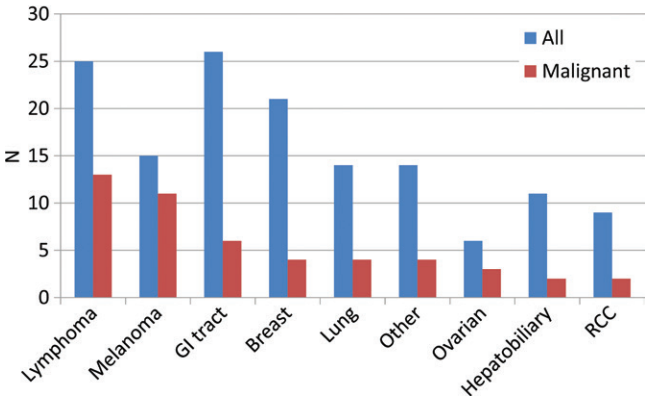


Figure 3: Bar graph shows splenic masses in patients with history of malignancy according to type of cancer. *GI* = gastrointestinal, *RCC* = renal cell carcinoma.

also had breast cancer); ovarian carcinoma, 50% (three of six); lung, 29% (four of 14); gastrointestinal tract, 23% (six of 26); renal cell carcinoma, 22% (two of nine); hepatobiliary or pancreatic, 18% (two of 11); breast, 19% (four of 21); and other, 29% (four of 14). No metastases were seen in patients with prostate cancer.

All patients (36 of 36, 100%) with metastatic masses (other than lymphoma) in the spleen had concomitant metastatic disease in other organs based on imaging results. The number of additional organs involved when splenic metastases were present was as follows: none (n = 0), one other organ (n = 6), two other organs (n = 22), three other organs (n = 6), and four other organs (n = 2). In other words, in 30 of 36 (83.3%) patients with splenic metastases, at least two other organs harbored metastases, making the spleen the third most likely organ to be involved. In only six of 36 (16.7%) patients with splenic metastases was the spleen and only one other organ involved. In no patient was the spleen the sole site of metastatic disease.

Symptomatic Patients

Twenty-nine of 379 (7.6%) patients had no history of malignancy, but presented with constitutional symptoms or symptoms related to the left upper quadrant and were found to have splenic masses. In eight of 29 (27.6%) patients, the splenic masses proved to be malignant, with the final diagnosis of lymphoma in all eight (Fig 4). Six of eight (75%) patients had concomitant extensive lymphadenopathy involving one to three of the following lymph node stations: the retroperitoneum (n = 3), inguinal (n = 2), perisplenic (n = 2), porta hepatis (n = 2), peripancreatic (n = 1), celiac axis (n = 1), and portocaval (n = 1). Confirmation of lymphoma was made by means of splenectomy (n = 4), response to chemotherapy (n = 3), and CT-guided biopsy (n = 1). In two of eight (25%) patients, the spleen was the only organ involved (Fig 5).

Patients with Incidental Splenic Masses

Two hundred five of 379 (54.1%) patients with splenic masses had no history of malignancy and no fever, weight loss, or symptoms related to the left upper quadrant or epigastrium. The splenic masses were, therefore, considered incidental. Two of 205 (1.0%) masses were determined to be malignant (the clinical indication for these two CT examinations were hematuria and abdominal pain with vomiting). One malignant mass consisted of a new diagnosis of lymphoma in a patient with perisplenic lymphadenopathy (Fig 6). The other patient had a new diagnosis of metastatic ovarian carcinoma with metastases simultaneously found in the pleura, omentum, inguinal nodes, and subcutaneous soft tissues (Fig 7). In these patients, both diagnoses (ie, lymphoma and ovarian cancer) were established prospectively on the basis of their CT examinations and were confirmed at splenectomy and exploratory laparoscopy with total hysterectomy, bilateral salpingo-oophorectomy, and tumor debulking. One patient with a solid mass showed a rapid increase in mass size and a second patient had a new large mass and underwent splenectomy. These were both found to represent SANT at histopathologic evaluation (Fig 8), a rare, benign vascular neoplasm.

Discussion

The clinical importance of splenic masses noted at CT examination of the abdomen in patients without a history of malignancy is unknown (16), to our knowledge, and the ACR white paper, published in 2013, therefore, recommends follow-up for all noncystic splenic masses larger than 1 cm (4). We conclude from our study that characterization and follow-up of an incidentally noted splenic mass at CT in a patient with no history of malignancy and with no constitutional symptoms or left upper-quadrant pain is not indicated, regardless of mass size.

Malignant masses were identified in only 1.0% (two of 205) of incidental splenic masses in our study. Even when we excluded masses that meet criteria for cysts from this group, these two patients represented only 1.1%

Figure 4

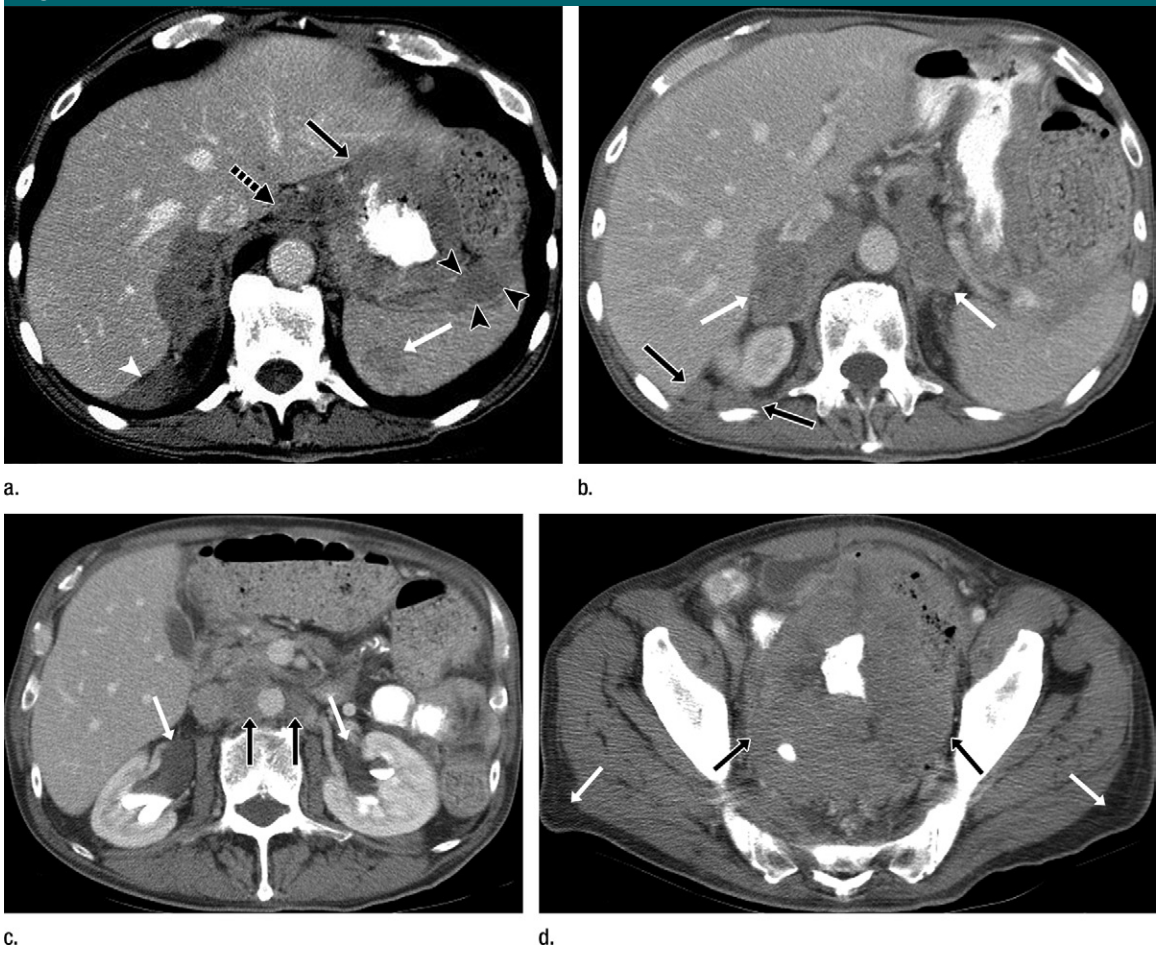


Figure 4: Images in a 78-year-old man who presented with diarrhea and weight loss. Axial CT images of abdomen and pelvis acquired with oral and intravenous contrast material raised concern for new diagnosis of lymphoma because of **(a)** hypoattenuating mass in spleen (white arrow), extensive thickening of stomach wall (black arrow), and soft-tissue masses adjacent to left hepatic lobe (dashed black arrow), posterior to right hepatic lobe (white arrowhead), and adjacent to spleen (black arrowheads); **(b)** masses in adrenals (white arrows) and soft-tissue nodules posterior to right kidney (black arrows); **(c)** retroperitoneal lymphadenopathy (black arrows); and **(d)** large pelvic mass from extensive bowel wall thickening (black arrows). Pelvic mass caused bilateral hydronephrosis (white arrows in **c**) from compression of distal ureters. Diffuse anasarca (white arrows in **d**) is noted.

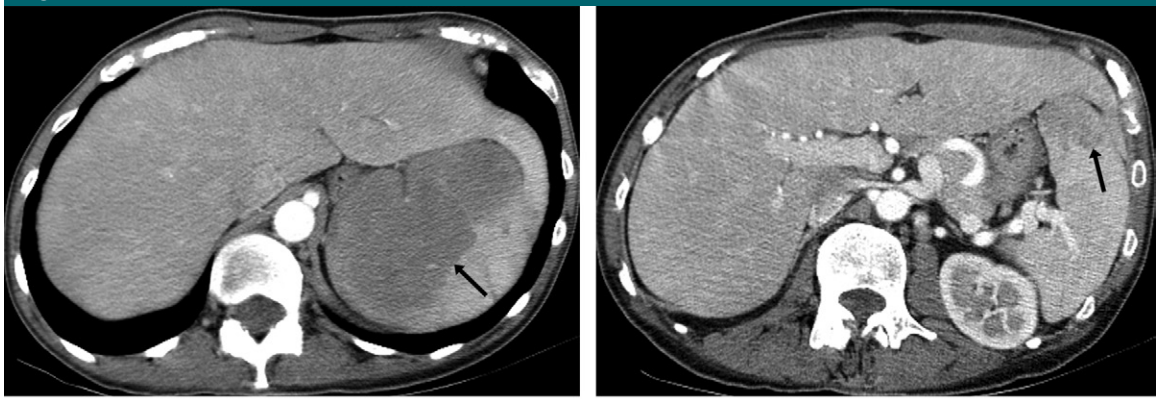
(two of 169) of this patient group. Also in both of these patients, the splenic masses were neither isolated nor indeterminate findings, because CT demonstrated disease in other locations, leading to the prospective diagnosis of a malignant splenic mass. Therefore, with an isolated incidental splenic nodule or mass, follow-up or further work-up does not seem to be indicated.

Malignant, isolated splenic masses can occur but are extremely rare. While lymphoma and angiosarcoma (17) can present this way, the latter is very rare. In our study, isolated malignant masses were only found in 0.6% (2 of 337) of isolated splenic masses and were only seen in the group of patients with constitutional symptoms. This further supports our claim that the isolated and incidentally found splenic mass is of unlikely clinical significance, regardless of its appearance.

Our findings regarding the importance of incidental masses in the spleen are in concordance with work by Song et al (18) on incidental adrenal nodules and masses detected at CT (18). In this study, all of 1049 incidentally noted adrenal nodules and masses in patients with no history of malignancy were found to be benign. The authors concluded similarly that follow-up is not necessary, even if the adrenal findings are indeterminate with the use of CT criteria.

The ACR white paper currently recommends follow-up for all noncystic splenic masses greater than 1 cm that do not have clearly benign features at imaging at the time of detection (4). These guidelines would have led to follow-up imaging or MR imaging evaluation of 151 of 266 (56.8%) masses larger than 1 cm in our series. Thut et al (19) recently suggested further

Figure 5



a. b.

Figure 5: Images in a 49-year-old woman with fever and malaise. Axial CT images of the abdomen and pelvis with intravenous contrast material raised concern for new diagnosis of lymphoma. **(a)** Large mass (arrow) involves superior aspect of spleen. **(b)** Second smaller mass (arrow) is noted at inferior aspect of spleen. Lymphoma was confirmed at splenectomy.

Figure 6

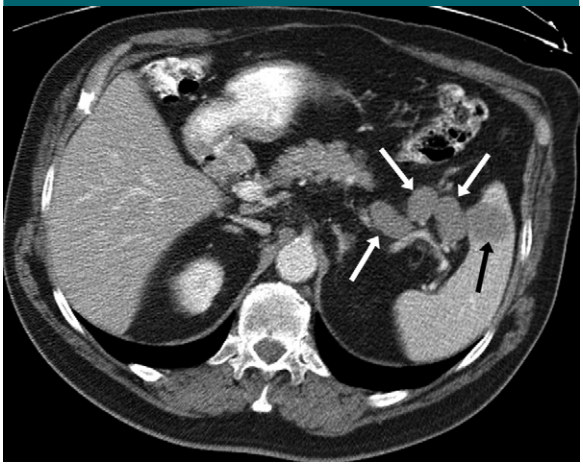


Figure 6: Images in a 78-year-old man who presented with hematuria and no constitutional symptoms or left upper quadrant pain. Axial CT image of abdomen acquired with oral and intravenous contrast material demonstrates splenic mass (black arrow) and perisplenic lymphadenopathy (white arrows), raising concern for lymphoma. This was confirmed at splenectomy.

MR imaging evaluation of all complex/solid splenic masses, while other authors have proposed image-guided biopsy in certain clinical scenarios with nonspecific imaging features (20). Such a practice would increase health care costs and potentially expose patients to increased morbidity and mortality (7). An example of patient morbidity resulting from such a follow-up recommendation is illustrated by one patient in our incidental group: follow-up was recommended for an incidental splenic mass detected at CT urography performed for hematuria. Follow-up CT demonstrated interval growth at a rate faster than that expected of hemangiomas (14), which led to splenectomy. Pathologic evaluation demonstrated SANT, a benign tumor (21). Patients with SANT are only rarely symptomatic (three of nine, 37%) with abdominal pain, splenomegaly, or anemia. Symptoms occur when lesions enlarge and cause mass effect: stretching the splenic capsule. Our findings challenge the ACR recommendation for patients in whom a splenic mass is truly incidental. Further confirmation of our findings in a multicenter study incorporating a larger series of patients would be helpful to validate this approach.

A different approach for the work-up of splenic masses is warranted in patients with constitutional symptoms, because eight of 29 (27.6%) splenic masses in patients with such symptoms were found to be malignant in our series, all of which were confirmed to be lymphoma. In 75% of these cases, lymphadenopathy was identified at multiple other sites, and the diagnosis of lymphoma was made prospectively. In 25% of patients with a new diagnosis of lymphoma and constitutional symptoms, the spleen was the only organ involved with lymphoma. In both patients, these were large, solid splenic masses (7 cm and 10 cm), with an appearance highly suspicious for cancer. Therefore, in patients with constitutional symptoms and isolated, indeterminate, or enhancing splenic masses, the possibility that such a mass is malignant is small (6.9%) but not negligible. MR imaging can be used to differentiate benign from malignant masses in 72% (10 of 14) of cases (22), and Metser et al (23) demonstrated even better results

Figure 7

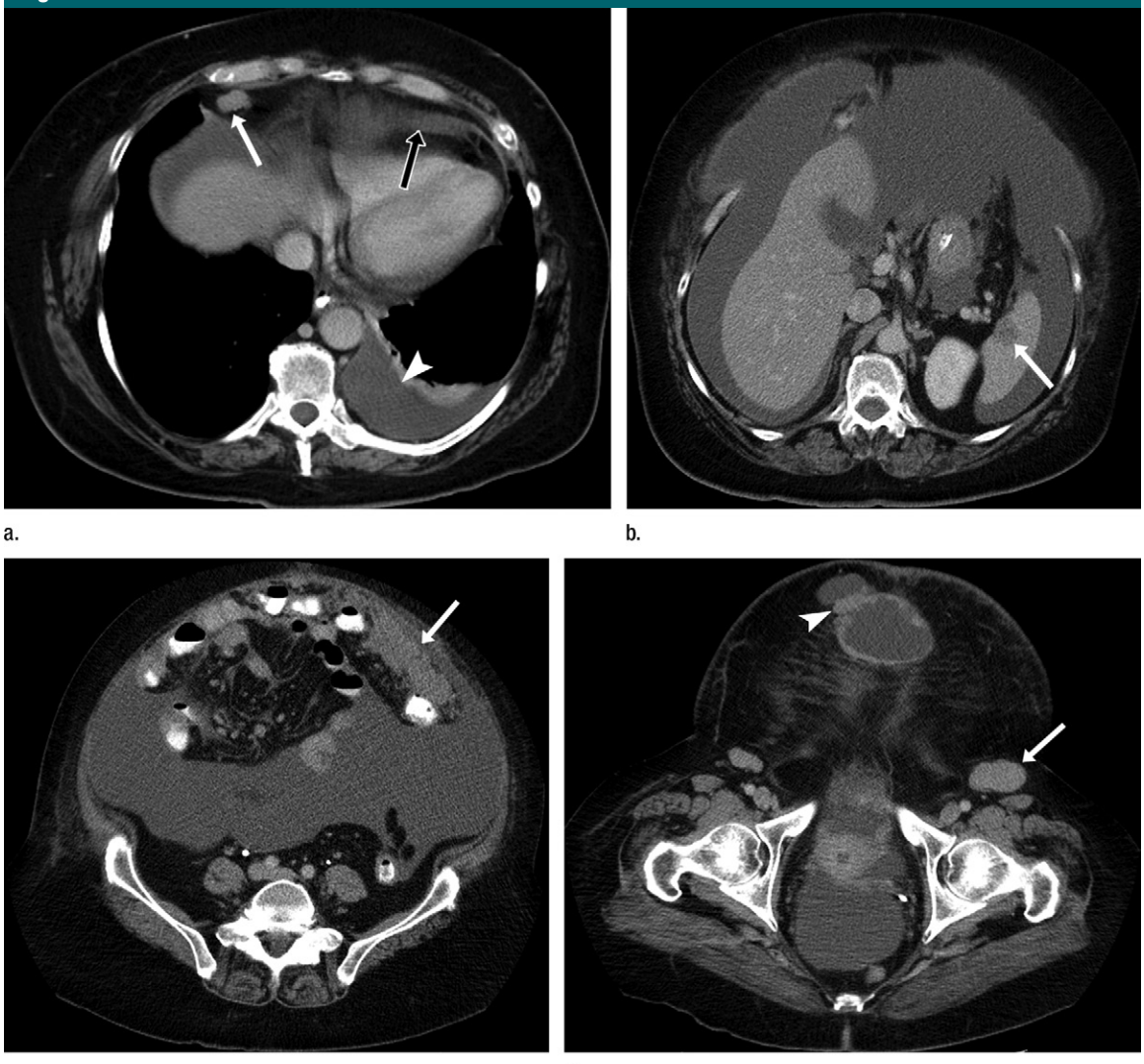
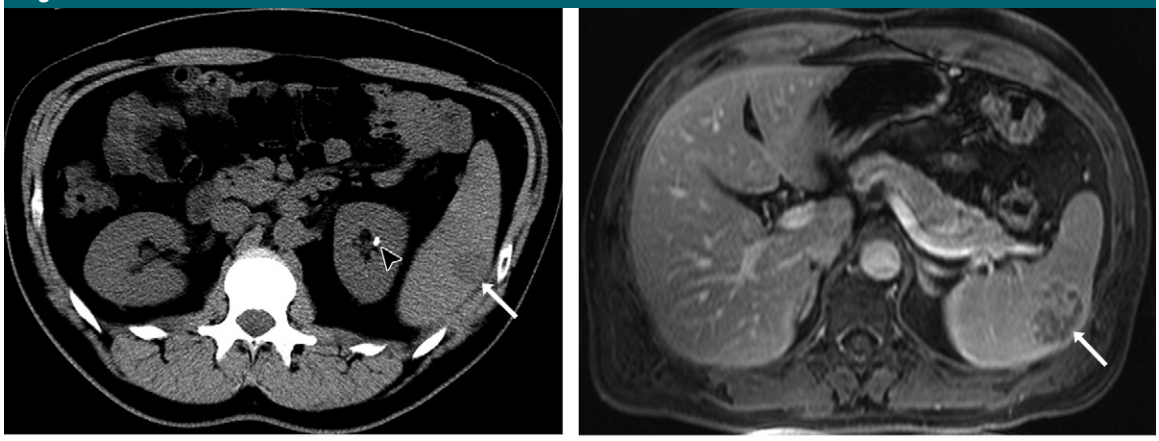


Figure 7: Images in a 72-year-old woman with abdominal pain and vomiting, no constitutional symptoms, and no left upper quadrant pain. Axial CT images of abdomen and pelvis with oral and intravenous contrast material raised concern for malignancy: **(a)** epiphrenic lymphadenopathy (white arrow), pericardial effusion (black arrow), and left pleural effusion (arrowhead); **(b)** splenic mass (arrow) and extensive ascites; **(c)** omental caking (arrow); and **(d)** peritoneal implants (arrowhead) and inguinal lymphadenopathy (arrow). Diagnosis of ovarian cancer was surgically confirmed.

for PET/CT, with sensitivity and specificity of 100% for malignant and 100% and 80% for benign masses, with a negative predictive value of 100%. These authors suggest that further evaluation with MR imaging or PET/CT should be considered as the next step in diagnosis. Although we agree with this approach in patients with constitutional symptoms or a history of malignancy, most patients in the study group of Dhyani et al (22) belonged to one of these groups, and we do not believe it is warranted in asymptomatic patients with incidental findings.

In our series, even in patients with a history of malignancy, only 33.8% of splenic masses represented metastases, which is a result that is in agreement with those of other studies (24). The majority of these malignant masses were from metastatic disease (73.5%), in which the primary tumors consisted of melanoma, lung, breast, ovarian, hepatobiliary, gastrointestinal tract, and renal carcinoma, in concordance with results of a recent meta-analysis (25). In addition, all patients with metastatic disease to the spleen always had more than one site of disease in the abdomen and pelvis (ie, the spleen was never the only organ involved in metastases). In most patients (30 of 36; 83.3%), at least two other organs

Figure 8



a. b.

Figure 8: Images in a 43-year-old man for evaluation of renal calculi. **(a)** Unenhanced axial CT image demonstrates renal calculus (arrowhead) and splenic mass (arrow). MR imaging was recommended for follow-up of splenic mass and was performed 7 months later. **(b)** Intravenous gadolinium-enhanced volumetric interpolated breath-hold examination, or VIBE, delayed-phase image demonstrates heterogeneous enhancement in mass. Because of rapid increase in size (1 cm over 7 months, from 2.6 to 3.6 cm), patient underwent splenectomy, which revealed a sclerosing angiomatoid nodular transformation.

harbored metastases, and in only six of 36 patients with splenic metastases (16.7%) was the spleen and one other abdominal or pelvic organ involved. This was concordant with results in the reported literature (12).

A limitation of our study was the infrequent availability of pathologic diagnosis (nine of 379 cases, 2.4%). The etiology of our indeterminate benign masses is therefore unclear, although hemangiomas and hamartomas are expected to be represented in this group (26,27). However, size stability over two years as indicative of benignity has also been used as a criterion by other investigators (22) and is used and accepted for incidentally discovered masses in other anatomic sites (28).

The absence of pathologic proof is even more complicated for patients with a history of malignancy in whom the definitive histologic diagnosis of a focal splenic mass is seldom obtained but rather assumed to be malignant on the basis of an increase in size over time or a size decrease in response to chemotherapy (29). We considered any solid mass in the malignancy group that increased in size as malignant. However, assuming a size increase implies malignancy may be inaccurate. Authors of a study on hepatic hemangiomas found that 40% of hemangiomas increased in a linear fashion at a rate of up to 2 mm per year (14). In our series, 18 of 165 (10.9%) benign, enhancing masses demonstrated a similar size increase. Two indeterminate masses demonstrated more than 2 mm of annual growth and were therefore resected. Pathologic evaluation revealed a diagnosis of SANT, a benign tumor, further indicating that interval growth of a splenic mass of greater than 2 mm per year need not indicate a malignant origin. Therefore, if anything, our lack of pathologic proof may have allowed overestimation of the incidence of a malignant splenic mass in the group of patients with known malignancy. This possible overestimation is compounded by our use of decrease in size after systemic chemotherapy as an indicator of malignancy in this patient group: decrease in size was noted in 21.9% of benign masses in our series, with 2.1% of benign masses resolving completely.

Other limitations due to the retrospective nature of our study were the variability in CT scanners and imaging protocols and the use of different imaging modalities for follow-up. This creates inherent differences in mass conspicuity and spatial resolution and could be problematic in the evaluation of enhancement characteristics. However, 279 of 318 (87.4%) follow-up imaging examinations were also performed with CT, minimizing this problem somewhat. In addition, our study was focused on assessing size stability. Finally, comparison of mass size among modalities and between examinations obtained with different CT scanners is accepted in daily clinical practice; therefore, we feel that these results are relevant to general practice. A third limitation may be a lower incidence of splenic masses in our population due to our search of reports for splenic masses rather than performing image analysis, which may have resulted in identification of more masses. As CT examinations were performed over a long time interval, some examinations had been performed with older technology, and more modern equipment and protocols probably would have increased the yield for incidental splenic findings.

We point out that although infectious processes such as microabscesses may represent another class of incidental masses, we did not encounter any infectious splenic processes in our study population of 379 masses. A

concern for an infectious cause must be raised in patients who are symptomatic and/or immunocompromised. We suggest that immunocompromised patients (even in the absence of symptoms) be considered part of the symptomatic group, who would require further work-up of splenic masses.

The implementation of our follow-up recommendations will require diligence by the radiologist to carefully review a patient's electronic medical record for a history of malignancy to ensure that such history was not omitted from the indication for the examination. This may prove challenging at institutions where the radiologist does not have easy access to an electronic medical record, although general follow-up recommendations could be developed for high-risk (constitutional symptoms and history of malignancy) and low-risk (truly incidental) groups, as has been achieved for the Fleischner recommendations for lung nodules (28).

In conclusion, in patients with an incidental splenic mass identified at imaging and with the absence of a history of malignancy, fever, weight loss, or pain in the left upper quadrant or epigastrium, such masses are highly likely to be benign regardless of their appearance. Additional imaging or follow-up is not warranted, even if the mass does not show the appearance of a simple cyst. Further work-up is only needed if the splenic mass is seen in conjunction with other findings worrisome for malignancy. In patients with known malignancy or with constitutional symptoms and/or pain localized to the left upper quadrant or epigastrium, although most masses will also be benign, such patients require further assessment.

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