ORIGINAL ARTICLES

Ultrasonographic findings and differentiation of benign and malignant focal splenic lesions

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Abstract

The purpose of this study was to analyse the sonographic findings of focal splenic lesions with an attempt to differentiate benign lesions from malignancies. The sonographic findings of 53 cases of verified focal splenic lesions, excluding post-traumatic haematomas and phleboliths, were retrospectively analysed. Of the 53 cases, 30 cases (57%) were benign and 23 cases (43%) were malignant. The malignancies included lymphoma (n=13), metastases (n=10); while the benign lesions included cysts (n=17), infarcts (n=3), and abscesses (n=5), and one case each of haemangioma, hamartoma, spontaneous rupture, tuberculosis, and lymphangioma. Significant differences were noted between the benign and malignant groups with respect to the presence of solitary lesions ($p<0.0001$), anechoic mass ($p<0.0001$), lesions with highly echogenic foci due to gas or calcification ($p = 0.0303$), hyperechoic/mixed echoic lesions ($p<0.0001$), presence of extrasplenic abdominal masses ($p<0.0001$), and nodules with the target sign ($p<0.0001$). Solitary lesions, anechoic mass, and lesions with highly echogenic foci due to gas or calcification each had a positive predictive value of 85%, 100%, and 100%, respectively, for the lesions to be benign. The multifocal/diffuse lesions, presence of extrasplenic abdominal masses, hyperechoic/mixed echoic lesions, and nodules with the target sign each had a positive predictive value of 70%, 100%, 70%, and 100%, respectively, for the lesions to be malignant. In summary, focal lesions with anechoic pattern or echogenic foci due to gas or calcification are suggestive signs of benign process. The sonographic observations of multifocal or diffuse solid lesions, especially those associated with target sign or extrasplenic abdominal masses are suggestive of malignancy.

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Keywords: spleen; splenic mass; ultrasonography

Focal lesions in the spleen are rare as compared with those in other solid viscera. The focal masses can be delineated by ultrasonography, computed tomography, radionuclide studies, and magnetic resonance imaging.^{1–4} Reports of a large series regarding focal splenic lesions by

cross sectional imaging and ultrasonography are rare.^{1–3 5–8}

Clinical and laboratory findings of a focal splenic lesion are non-specific, and its accurate diagnosis with radiological studies is difficult.^{2 3} Image guided fine needle aspiration cytology or colour Doppler imaging may sometimes aid in the accurate diagnosis.^{9 10} However, fine needle aspiration cytology is considered an invasive procedure.

Demonstration of the focal mass and the internal architecture of the lesions is essential in making an accurate diagnosis. The malignant lesions are more likely to be multifocal due to metastases or tend to be diffuse and ill defined due to rapid growth. A benign lesion such as a cyst usually exhibits a mass with fluid content, a well defined and smooth outline, and without solid components. A soft tissue lesion associated with calcification usually indicates that the disease has been a long term process, and it is more likely to be benign. The gas in parenchyma of solid organs is usually originated from bacterial infection or arterial embolisation, and is also an indicator of benign disease. Ultrasonography has the capability of delineating these distinct characteristics of malignant and benign lesions, thus, it may provide diagnostic values in making accurate differentiation between benign and malignant splenic lesions. To our knowledge, there have been no reports dealing with the differentiation by ultrasonography in the literature.

This paper describes the sonographic findings of various focal splenic lesions, with an attempt to differentiate benign from malignant lesions. The final diagnosis of each lesion was determined by pathological examination, and/or combination of serial imaging studies and clinical data. All malignant and benign lesions were pooled separately. The discriminative power of the echo pattern of the focal splenic lesion as well as the anatomic features including splenomegaly, focal pattern, and extrasplenic abdominal neoplasms in differentiating benign from malignant lesions were assessed.

Patients and methods

Sixty verified patients with focal splenic lesions, excluding phleboliths or post-traumatic haematoma, were studied by both ultrasonography and computed tomography during a period of eight and a half years. The 53 cases (88%) detected by ultrasonography formed the baseline of the study. The subjects

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Table 1 Summary of 53 cases of focal splenic lesions detected by ultrasound

Final diagnosis	No (%) of cases	Gender or M:F	Age (mean)	Splenomegaly	Solitary	Sonographic diagnoses (No of cases)	Computed tomography diagnoses (No of cases)	Methods of confirmation (No of cases)
Malignant								
Lymphoma	23 (43)	21:2	27-73 (49.9)	15	4	Malignancy or lymphoma (8)	Malignancy or lymphoma (8)	Splenectomy (3), biopsy from other sites and imaging studies (10)
	13 (25)	12:1	27-73 (45.7)	10	3	Infiltrative tumours (2)	Malignancy or lymphoma (2)	
						Lymphoma (1)	Haematopoietic disorders (1)	
						Splenic tumours (1)	Parenchymal lesion (1)	
						Lymphoma (1)	Abscess (1)	
Metastases	10 (19)	9:1	43-73 (55.4)	5	1	Malignancy or metastases (8)	Metastases (8)	Surgical pathology from primaries and imaging studies (9), splenectomy (1)
						Malignancy (1)	Sarcoma (1)	
						Metastases (1)	Parenchymal lesion (1)	
Benign								
Cysts	30 (57)	16:14	4-76 (51.5)	18	22	Splenic cyst (11)	Splenic cyst (11)	Serial sonography and clinical data (11)
Primary	17 (32)	8:9	18-76 (55.4)	8	13	Complicated cyst (2)	Traumatic pseudocyst (2)	Imaging findings and clinical data (2)
Pseudocyst	11 (21)	2:9	47-76 (64.7)	4	10	Pancreatic pseudocyst (2)	Pancreatic pseudocyst (2)	Imaging findings and clinical data (2)
	4 (7)	4:0	29-52 (40)	3	1	Splenic cyst	Splenic cyst	Splenectomy and pathology
Epidermoid	1 (2)	M	18	0	1	Complicated cyst	Cyst with debris or infection	Computed tomography, clinical data (3)
Haemorrhagic	1 (2)	M	39	1	1	Consistent with infarcts (3)	Infarcts (3)	Surgery (4), aspiration (1), culture (5), clinical data (5)
Infarct	3 (5.7)	1:2	17-66 (35)	4	3	Abscess (5)	Abscess (5)	Splenectomy and pathology
Abscess	5 (9.3)	3:2	55-67 (63.2)	3	4			Splenectomy and pathology
Hamartoma	1 (2)	M	38	0	1	Haemangioma	Haemangioma	Splenectomy and pathology
Spontaneous rupture	1 (2)	M	52	1	0	Splenic mass	Splenic tumour	Splenectomy and pathology
Tuberculosis	1 (2)	M	48	0	1	Splenic abscess	Splenic granuloma	Splenectomy and pathology
Lymphangioma	1 (2)	F	24	1	0	Metastases	Metastases	Splenectomy and pathology
Haemangioma	1 (2)	M	4	1	0	Lymphoma	Haematopoietic disorder	Splenectomy and pathology
Total	53 (100)	37:16	4-76	33	26			

included 52 adults (17-76 years, mean 51.7), 36 males and 16 females, as well as a 4 year old boy. The abdomen was scanned by a real time ultrasound scanner using a 3.5 or 5 MHZ transducer. Computed tomography of the abdomen was performed with and without intravenous administration of contrast medium. Splenic angiography was performed in five cases. The interval between the ultrasonography and subsequent computed tomography ranged from six hours to eight days. The clinical data and the imaging findings of ultrasonography and computed tomography were recorded.

The anatomical features and the echo patterns detected by ultrasonography were analysed in this study. The anatomic features including the presence of splenomegaly, the focal pattern (solitary versus multifocal or diffuse patterns), the extrasplenic neoplasms in the abdomen were reviewed and analysed. The echo patterns were categorised into anechoic mass without calcification, hypoechoic, hyperechoic or mixed, target-like, complex, and lesions with high echoes and shadowing due to gas and calcification. The ultrasonography findings were read by three radiologists (YLW, YCC, KWL), and the final lesion classifications were determined by consensus. For every lesion, four features were recorded: the splenomegaly, the focal pattern (solitary versus multifocal/diffuse), the extrasplenic abdominal masses, and the ultrasonography echo pattern.

The summary of the 53 subjects and the final diagnoses of the lesions are listed in table 1. The final diagnoses of these lesions were determined based on a series of imaging studies and clinical data in 37 cases, splenectomy and pathology in 15 cases, and on aspiration and culture of the bacteria in one. The aforementioned 37 cases included 10 cases of lymphoma and nine cases of metastases in which the histopathology specimens were obtained from sites outside the spleen. In one patient, the primary site of the splenic metastases could not be identified even after surgical laparotomy and splenectomy. Among the 17 cases of splenic cyst, 11 were incidentally found and a tentative diagnosis of primary cyst was made. The 11 patients with primary cysts had sonographic follow up ranging from 3-19 months (mean 9.5 months). No evidence of malignancy or solid mass was found within the cysts in the subsequent ultrasonography.

The infective bacteria in five cases of splenic abscess included *Escherichia coli* in two cases, and *Salmonella choleraesuis*, *Bacteroides fragilis*, and *Pseudomonas aeruginosa* in one case each.

The malignant lesions were pooled, as were the benign lesions. The percentages of benign or malignant lesions displaying each of the above mentioned ultrasonography feature were recorded. The discriminative capability of each feature between malignant and benign groups was assessed. Differences between the benign and malignant groups were tested using the Fisher's exact test. A p value of ≤ 0.05 was considered statistically significant.

Figure 1 Sonogram shows splenic lymphoma presenting as hypoechoic nodules (arrows) and nodules with a target sign (arrowheads).

Results

LYMPHOMAS

Of the 13 cases with lymphoma, a diffusely heterogeneous pattern with mixed echogeneity was found in three, nodules with target sign in two (fig 1), and were hypoechoic in seven (fig 2). In one case the lesion appeared complex, which was caused by chemotherapy. Tumours were observed elsewhere in the abdomen by ultrasonography in nine (69%) and by computed tomography in 10 (77%) of the 13 patients (fig 2).

METASTASES

Among 10 cases of splenic metastases, the lesions were hyperechoic in four patients, two with primary colon cancer, one with nasopharyngeal carcinoma, and the other with gastric cancer (fig 3). Nodules in a patient with lung cancer exhibited a target sign. Deposits in a patient with nasopharyngeal carcinoma after chemotherapy were complex. Lesions in the remaining four cases were hypoechoic, including one case each with primary melanoma, lung cancer, oesophageal cancer, and an unknown cancer (fig 4). In 70% of the patients,

Figure 2 Coronal sonogram of the left upper abdomen shows splenomegaly with discrete hypoechoic nodules in the spleen and enlarged para-aortic nodes (white arrowheads) due to lymphoma.

metastases were also seen elsewhere in the abdomen on sonograms.

CYSTS

The 17 cases of cysts included 11 primary cysts, two post-traumatic pseudocysts, two pancreatic pseudocysts, one epidermoid cyst, and one haemorrhagic cyst (fig 5). Calcification was found in three of 11 primary cysts. The primary cysts in 10 cases were unilocular and ranged from 1.5–4.7 cm in diameter (mean 3 cm); three had incomplete septa, including one associated with punctate calcifications.

INFARCTS, ABSCESSSES, AND OTHERS

The infarcts in three cases were hypoechoic and wedge shaped at the periphery (fig 6). Two abscesses were hyperechoic and cast a dirty shadow due to the presence of gas (fig 7). The echo pattern in other three abscesses demonstrated hypoechoic, hyperechoic, and a complex pattern in one case each. The lesion in one case each of hamartoma, tuberculosis, and lymphangioma appeared hypoechoic. The lesion caused by spontaneous splenic rupture and a haemangioma with necrosis and infarcts showed a diffusely mixed echo pattern on sonograms.

STATISTICAL STUDIES

The ultrasonography findings of benign and malignant lesions are summarised in table 2. There were no significant differences between the benign and malignant groups with respect to the presence of splenomegaly and complex nodules. However, there were significant differ-

Figure 3 A case of recurrent gastric cancer in a 73 year old man with cancerous peritonitis and metastases in the pelvis and spleen. Sonogram of the spleen shows a metastatic hyperechoic nodule (arrowheads).

ences between the benign and malignant groups with respect to the presence of focal pattern ($p < 0.0001$), presence of neoplasms elsewhere in the abdomen ($p < 0.0001$), ane-

Figure 4 A case of metastatic adenocarcinoma of unknown origin proved by surgery and pathology. (A) Sonogram shows a huge heterogeneously hypoechoic mass (arrowheads) in the spleen and (B) computed tomography reveals the splenic mass is heterogeneous.

Figure 5 A case of haemorrhagic cyst in a 39 year old man proved by surgery and pathology. Sonogram of the spleen shows a cyst with internal echoes and subtle fluid-fluid layering (arrowheads) due to haemorrhage.

choic mass ($p < 0.0001$), hyperechoic/mixed echoic lesions ($p < 0.0001$), nodules with target sign ($p < 0.0001$), and lesions with highly echogenic foci due to gas or calcification ($p = 0.0303$). The solitary lesion, anechoic mass, and lesions with highly echogenic foci due to gas or calcification each had a positive predictive value of 85%, 100%, and 100%, respectively, for the lesions to be benign. The multifocal/diffuse lesions, presence of neoplasms elsewhere in the abdomen, hyperechoic/mixed echoic lesions, and nodules with a target sign each had a positive predictive value of 70%, 100%, 70%, and 100%, respectively, for the lesions to be malignant.

Discussion

In this study, 53 (88%) of 60 cases of focal lesions evident on computed tomography could be seen by ultrasonography. The lesions undetected were three infarcts, two metastatic deposits, one cyst, and one lymphoma. All undetected lesions were either isoechoic, located beneath the diaphragm, or at the surface of the spleen. Infarcts were the most common lesions undetected by ultrasonography. Intravenous administration of contrast medium on computed tomography made the infarcts conspicuous.

FOCAL PATTERN

In our series, multifocal or diffuse solid lesions occurred more often in malignant processes with a frequency of 83%. However, benign diseases such as infarcts, abscesses, and pseudocysts could also be multifocal, therefore other criteria should be used for further differentiation.

EXTRASPLENIC ABDOMINAL MASSES

The findings of abdominal neoplasms outside the spleen occurred exclusively in the malignant group. In patients with lymphoma, extrasplenic abdominal masses were found in 69% and 77% of our cases by ultrasonography and computed tomography, respectively, and in 100% of 43 cases in other series.⁶ In cases of widespread metastases, splenic involvement is noted at necropsy by a frequency of 50%,¹¹ and the deposits were grossly visible in 67% of patients.¹² Metastases confined to the spleen are rare.^{8, 12} In our series of metastases, the finding of extrasplenic abdominal masses in 75% of cases by computed tomography and in 70% of patients by ultrasonography is in agreement with the figure of 81% reported in other series.⁸ Cancer from various organs may metastasise to the spleen.^{1, 2, 8, 11-14}

HYPERECHOIC, HYPOECHOIC, AND COMPLEX PATTERNS

The splenic deposits in this series from nasopharyngeal carcinoma, colon, or gastric cancer were hyperechoic. Benign lesions exhibiting hyperechoic include haemangioma, splenoma, Gamna-Gandy bodies, Gaucher's disease, old infarcts, haematoma, abscess, and extramedullary haematopoiesis.^{2, 15-21} From the current study and previous reports, up to 44% of benign and 48%–93% of malignant lesions

were reported to be hypoechoic.⁶ Therefore, we suggest that focal splenic lesions should not be differentiated as benign or malignant merely on

Figure 6 Sonogram shows a characteristic wedge shaped hypoechoic lesion (arrowheads) at the periphery of the spleen due to infarct.

Figure 7 (A) Sonogram of the spleen shows a splenic abscess with high echoes (arrow) due to presence of gas bubbles and (B) computed tomography confirms the abscess (arrowheads) with gas content.

Learning points

- The ratio of benign versus malignant focal splenic lesions is 1.3. The common malignant lesions are lymphoma and metastases.
- The common primaries of the metastases arise from the breast, lung, ovary, stomach, skin, prostate, colon, liver, and pancreas in decreasing order of frequency. Around 70%–81% of patients with splenic malignancy have concurrent neoplasms elsewhere in the abdomen.
- Splenic cyst is the most common benign lesion. The other benign lesions include infarcts, haemangioma, lymphangioma, hamartoma, abscess, granulomatous disease or tuberculosis, fungus infection or candidiasis, Gaucher's disease, inflammatory pseudotumour, *Pneumocystis carinii* infection, and extramedullary haematopoiesis.
- Ultrasonography can detect 88% of the focal splenic lesions evident on computed tomography. Infarcts are the most common lesions overlooked by ultrasound.
- The presence of solitary lesion, anechoic mass, and lesions with highly echogenic foci due to gas or calcification are suggestive sign of benign process and each has a positive predictive value of 85%, 100%, and 100%, respectively.
- The hyperechoic/mixed echoic lesions, multifocal/diffuse lesions, presence of neoplasms elsewhere in the abdomen, and nodules with the target sign are suggestive of malignancy and each has a positive predictive value of 70%, 70%, 100%, and 100%, respectively.

the bases of low or high echogeneity. A complex echo pattern was encountered in one case each of abscess, nasopharyngeal carcinoma, and lymphoma after chemotherapy in our patients. Complex lesions have been described in malignant^{22–23} and benign cases,^{1–15–16–18–24} thus not capable of providing useful information for differential diagnosis.

TARGET-LIKE PATTERN

Target lesions were observed in 15.4% of our lymphoma patients and in 10% of cases with metastases. Most splenic target nodules represented metastases,^{2–5–7–8–25} although splenic candidiasis with a “wheels within wheels” appearance in its early course may later evolve to a target-like appearance.¹⁴ It is believed that the target-like appearance may represent histologically an area of central necrosis surrounded by zones of viable tumour cells and/or compressed or atrophic parenchyma.²⁶

CALCIFICATION AND GAS

In this study, calcification was observed in three cases of splenic cyst and in one case of tuberculosis. In a literature review, almost all

Table 2 Ultrasonographic findings of benign versus malignant focal splenic lesions

	Benign (%) (n=30)	Malignant (%) (n=23)	p Value
Splenomegaly	18 (60)	15 (65.2)	0.779
Solitary (v multifocal/diffuse)	22 (73.3)	4 (17.4)	<0.0001
Neoplasms elsewhere in the abdomen	0	16 (69.6)	<0.0001
Echo pattern of lesions in 53 cases			
Anechoic mass without calcification	14 (46.7)	0	<0.0001
Hypoechoic	6 (20)	11 (47.8)	0.0637
Hyperechoic or mixed	3 (10)	7 (30.4)	<0.0001
Target-like	0	3 (13.1)	<0.0001
Complex	1 (3.3)	2 (8.7)	0.573
Lesions with high echoes and shadowing due to gas (2 cases) and calcification (4 cases)	6 (20)	0	0.0303

calcification occurs in benign lesions, these include hamartoma, tuberculosis, histoplasmosis, phleboliths, infarction, haemangioma, true/false cysts, *Pneumocystis carinii* infection, and inflammatory pseudotumour.^{2 15-17 22 27-32} In a series of 172 patients, 13 cases of splenic calcification and two cases of non-parasitic calcified cysts were found, and all were proved to be benign.² Calcification is extremely rare in malignant splenic lesions. There were only two cases of metastatic deposits from ovarian cancer ever being reported to exhibit calcification.^{23 33} The sonographic demonstration of gas content in splenic abscess, which happened in two of our five cases, has been described previously.¹⁸ Splenic gas may also be found after splenic embolisation.³⁴

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