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Case Report

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Integrated Ultrasound in Management of Sepsis: Case Report

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Abstract

We describe a 42-year-old woman who presented with fever, sore throat, exertional dyspnea and fatigue then developed sever sepsis and endocarditis, caused by *Staphylococcus aureus*. Here we describe the importance of Thoracoabdominal sonography to evaluate hemodynamic instability, fluid status, therapeutic response and fast diagnosis of the septic source. It is well-known that some source of sepsis detected by ultrasound can lead to urgent surgery, like our patient who underwent urgent splenectomy due to hematoma/abscess formation and urgent prosthetic heart valve replacement which both were diagnosed by ultrasound methods. Ultrasound can provide important information which can influence the management to improve patient's outcome.

Keywords

Sepsis, Ultrasonography, Endocarditis, Septicemia, Prosthetic heart valve

Case Report

We present a 42 years old housewife woman who admitted to our hospital with one-week history of high-grade fever, sore throat, exertional dyspnea, fatigue and weakness under antibiotic therapy with amoxicillin-clavulanic acid. Past medical history and family history were both negative except exertional dyspnea which was started 3 months before hospitalization. The patient denied any use of tobacco or alcohol. Upon arrival she presented with mental confusion (GCS 14), tachypnea (RR: 30 breath/minute), tachycardia (HR: 114 beat/min), (BP: 140/70, MAP 93 mmHg), purulent gingivitis, diastolic murmur (2/6) in aortic area, TC 37° and 94% of blood oxygen saturation, diffuse abdominal tenderness without positive rebound sign. Also, a small red raised, painful cutaneous lesions, surmounted by central necrosis (10 mm) was seen in right external malleolus. The blood exam of the first day showed Neutrophilic leukocytosis, high CRP (C-reactive protein), high ESR (erythrocyte sedimentation rate), hyperbilirubinemia and severe anemia with thrombocytopenia. ABG (arterial blood gas) analysis showed pa CO_2: 32 mmHg, pa O_2: 75 mmHg, pH 7.40 as below in (Table 1). In the admission the chest X-Ray, thoracic CT scan and ECG were all normal, but abdominal CT scan showed splenomegaly (175 mm) and gallstones of 35 mm. In the second day of recovery, abdominal ultrasound confirmed the splenomegaly (Figure 1) and Cholelithiasis (Figure 2), inferior vena cava diameter was 18 mm (Figure 3) with decreased collapsibility index, which suggested right atrium pressure less than 10-15 mmHg, left ventricular enlargement (Figure 4), reduction of cardiac systolic function (EF 45%), septal hypokinesia, mod-severe aortic valve insufficiency (Figure 5). In table 2, we report the second day blood exam.

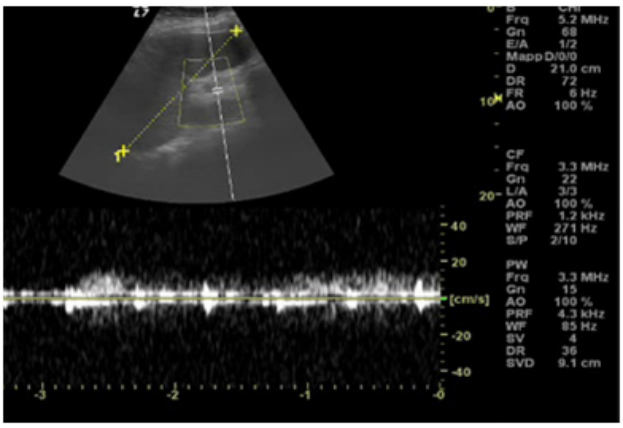

Figure 1: Splenomegaly.

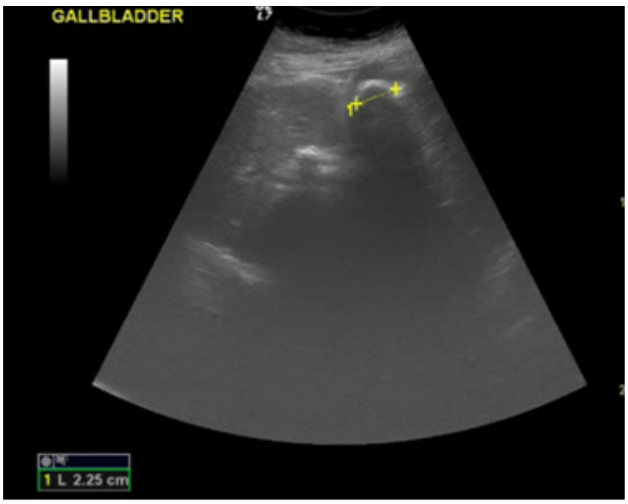

Figure 2: Cholelithiasis.

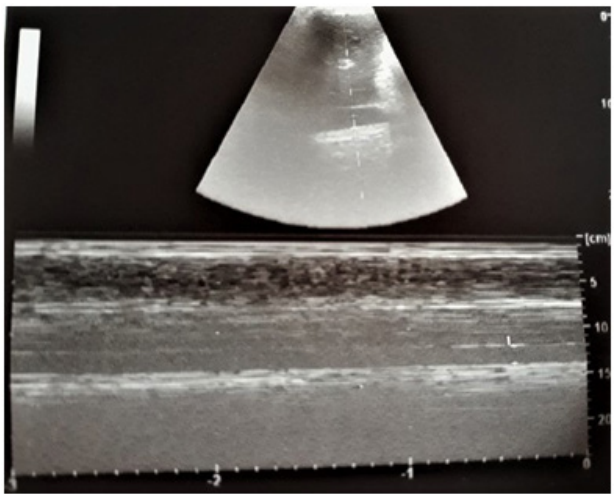

Figure 3: Inferior vena cava diameter.

Using quick sequential organ failure score (qSOFA)—which is based on rapidly assessable vital parameters, including respiratory rate, mental status, and systolic blood pressure and the Sequential Organ Failure Assessment (SOFA) score, fallowed us to rapid diagnosis of sepsis. Our patient's qSOFA score was 2 points, and SOFA score calculated was 8 score

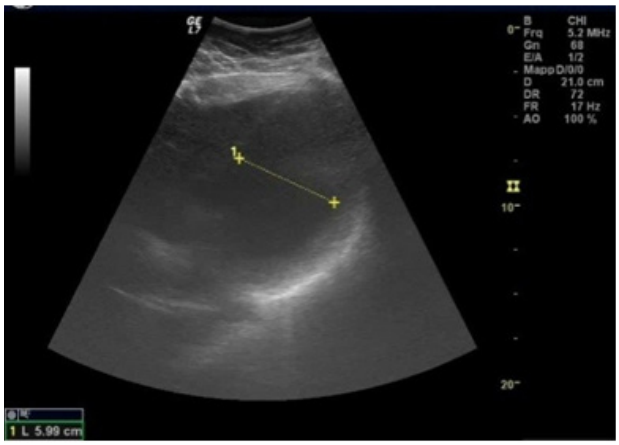

Figure 4: Echocardiogram, left ventricular enlargement.

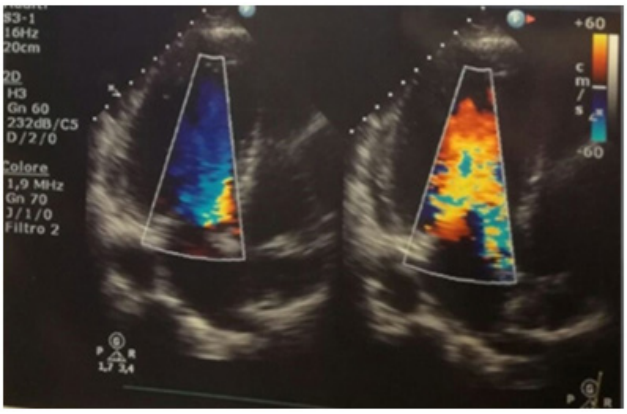

Figure 5: Aortic valve insufficiency.

Table 1: First day blood exam.

Hb	6.6 G % MCV 55 FL
WBC	16,060 mmc/PMN 13,530
PLT	61000/mmc
AST	104 UI/L (nv<54)
ALT	77 UI/L (nv <41)
CPK	200 UI/L (nv<140)
LDH	1437 UI/L (nv<500)
LAC (Hemogas)	1.7 mmol/L
Creatinina	2.8 mg%
BIL	5.6 mg %
CRP	338 mg%
APTT	37 "
Protrombin Activation	96%
Fibrinogen	429 mg%
Procalcitonina	7.6 ng/ml (nv<0,05)

as below in (Table 3). According to International Guidelines for Management of Severe Sepsis and Septic Shock, within the first hour of sepsis recognition, we started fluid therapy with normal saline and effective intravenous antibiotics. In

this point of time, blood culture was done and due to severe anemia, 2 unit of pack cell was transfused. Occult blood test was negative, and esophagogastroduodenoscopy only demonstrated a peptic ulcer with scar tissue.

Table 2: Second day blood exam.

Ferritin	335 ng/dl
WBC	18900/mmc
PLT	37000/mmc
Hemoglobin electrophoresis	HbA2 2.2%
	HbF 0%
Alkalin Phosphatase	200 U/L (nv 32-92)
Haptoglobin	319 mg% (normal range 30-200)
PRO-BNP	5548 pg/ml (nv 0-125)

Table 3: Sofa score.

Sequential Organ Failure Assessment (SOFA)	
Cardiovascular system (no Hypotension PA: 140/70 mmHg)	0
Kidney (Creatinine: 2.8 mg/dl)	2
Coagulation (platelet: 61000 mmc)	2
Liver (bilirubin: 5.6 mg%)	2
Respiratory system (PaO_2/FiO_2)	1
Nervous system (GCS 14)	1

Whiles in the fourth day of recovery, the clinical sign and laboratory exams was improving with significant reduction of procalcitonin level from 7.6 ng/ml to 0.13 ng/ml, she complained of oral cavity pain due to purulent gingivitis. The presence of asymmetric lower limb edema with small painful swelling of external malleolus with central necrosis directed us to use femoro-popliteal eco-color Doppler to exclude Deep vein thrombosis (DVP). Bilateral normal venous flow with normal compression indicated the absence of DVT (Figure 6)

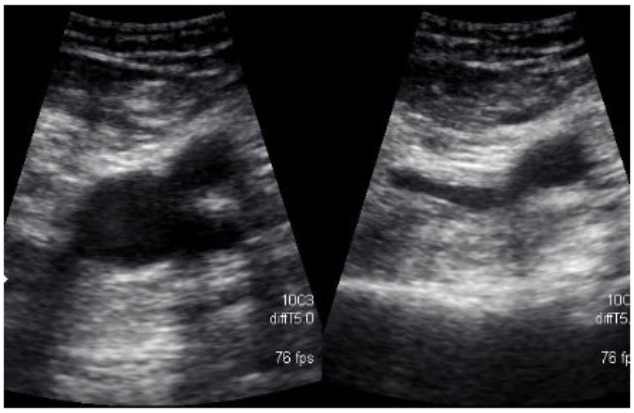

Figure 6: Femoral artery and vein.

Blood culture result was positive for staphylococcus aureus, sensible to antibiotics which were started as empiric therapy. As regard to Duke's criteria the diagnosis of endocarditis was done, given that she had 2 major criteria (positive blood culture and new onset of diastolic aortic murmur) and 3 minor criteria such as vascular phenomena (splinter hemorrhages), immunologic phenomena (Osler's nodes of right malleus) and fever. She underwent another echocardiogram which was negative for vegetation, so transesophageal echocardiography was programmed.

After seven days she suddenly manifested high fever and malaise with left upper abdominal pain and positive Kehr's sign. Abdominal ultrasound evidenced one subcapsular, rounded, anechogenic lesion in the lower pole of the spleen of 23 mm with fluid components and well-defined margin. Another ill-defined margin lesion was seen in the upper pole of spleen of max 80 mm with dyshomogeneous aspect due to complex fluid and solid components, without any vascularization in Doppler. The US helped us to suspect the diagnosis of splenic hematomas/abscess formation related to septic embolism. The dimension, rapid onset of subcapsular lesion, without any specific posterior acoustic effect, led us to suspect the hematomas/abscess formation with high risk of rupture (Figures 7-9).

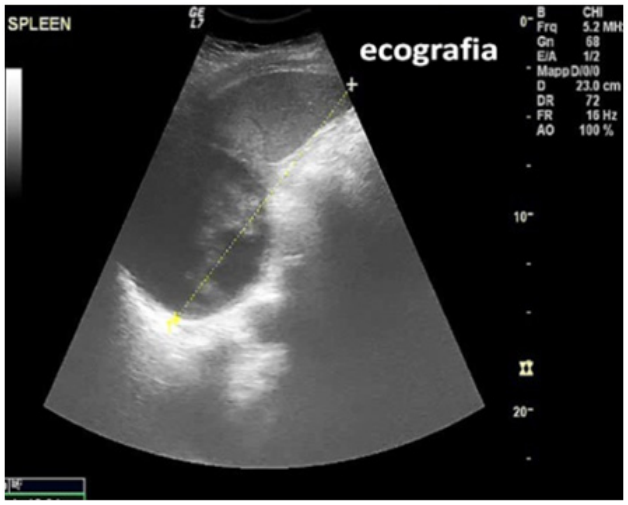

Figure 7: Splenic hematomas.

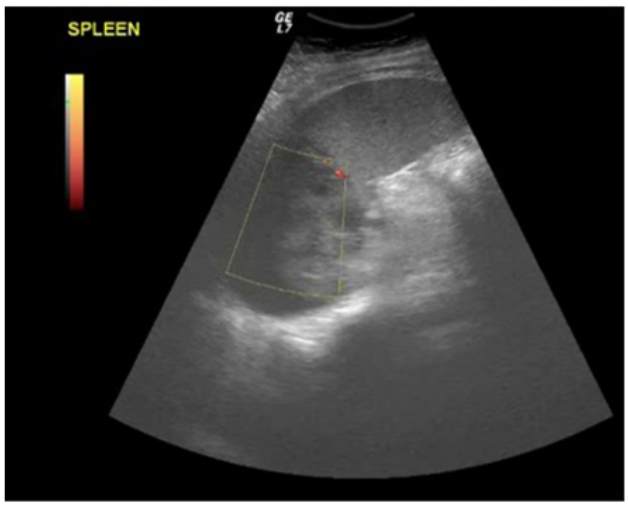

Figure 8: Splenic hematomas (color-Doppler).

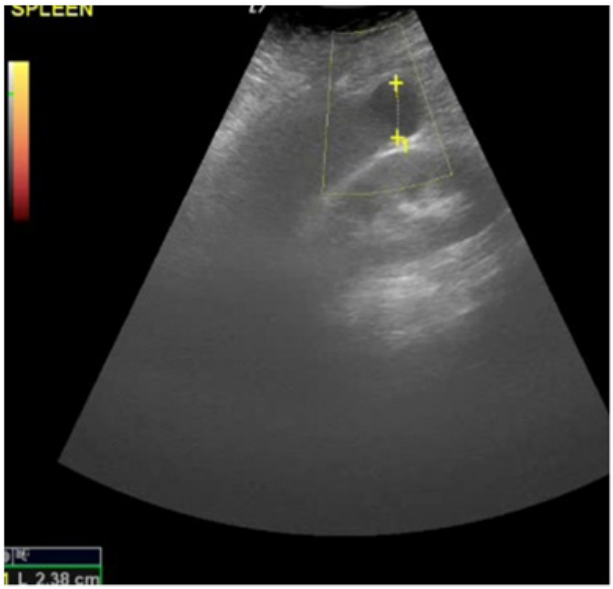

Figure 9: Splenic hematomas.

Abdominal CT scan with and without contrast demonstrated the presence of multiple, small, fluid-superfluid splenic lesions of maximum 89 mm which were hypodence in basal and hypointense in contrast phase (confirmed the diagnosis which was yet made by US), and cholecystelitiasis (Figure 10).

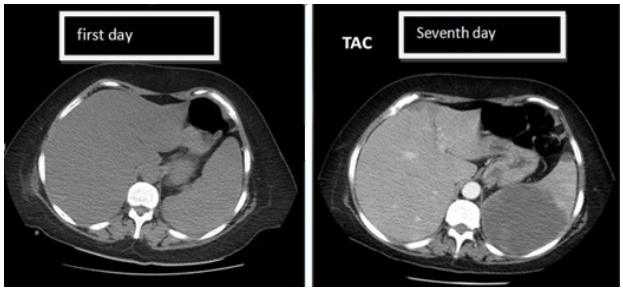

Figure 10: CT scan.

Urgent splenectomy was done, the splenic mass was filled up with blood and pus formation, so it was splenic hematomas with abscess formation. Macroscopic histological report: "spleen with lacerated capsule due to large yellowish necrotic area of 100 mm". Microscopic histological report: "necrotizing hemorrhagic type of inflammatory process with abscess formation". After the intervention because of hemodynamic instability she was transferred to the ICU. After some days because of acute high troponin level and ECG sign of subendocardial ischemia probably due to sever aortic insufficiency in endocarditis state she was recovered firstly in cardiology and then in Cardiac Surgery department, where urgent prosthetic heart valve replacement was done.

Discussion

Since 1985, ultrasonography has been recommended for developing countries by the World Health Organization (WHO) [1, 2]. Nowadays, should be considered as front-line tool in managing of critical patients. We suggest the using of thoraco-abdominal ultrasound in emergency department to evaluate the heart chambers size, their contractility and valvular function, the caliber of inferior vena cava with its collapsibility index and try to recognize the source of sepsis. All this together can aid to us to make treatment decision and reduce the medical errors.

In a small Prospective observational study, carried out by Hamid Shokoohi and his group [3], ultrasound dramatically changed the diagnosis and identified pathology that required a complete shift of management and immediate interventions.

Use of echocardiography in sepsis state

In critical state, 2D and M-mode echocardiography is able to identify different types of shock, such as cardiogenic, hypovolemic, obstructive, and vasoplegic type. Echocardiography is used to

1. Assessment of contractility and volume status: Hyperdynamic heart and collapsed IVC are sign of hypovolemic shock.

2. Assessment of left ventricular contractility: Depressed LV contractility can be a sign of coronary artery disease, septic myocardial dysfunction (which is one of the important features of sepsis), fulminant myocarditis and cardiomyopathy.

3. Estimate right ventricle size and function: Dilated akinetic right ventricle is suggestive for infarction or pulmonary embolism.

Ultrasonography used to assess fluid responsiveness

Estimation of right atrial (RA) pressure even called as central venous pressure (CVP) used for fluid management. As see below using collapsing rate which is calculated by (max diameter of IVC – min diameters of IVC in cm/max diameters of IVC in CM x 100) is an indicator for Volume status (Table 4).

Table 4: Diameters of IVC.

IVC size (cm)	Collapsing rate (%)	RAP (Right Atrium Pressure)
<1.5 cm	100% collapsed	0-5 mmHg
1.5-2.5 cm	>50% collapsed	5-10 mmHg
1.5-2.5 cm	<50% collapsed	10-15 mmHg
>2.5 cm	<50% collapsed	15-20 mmHg
>2.5 cm	No change	>20 mmHg

Ultrasonic features in splenic lesions

Here, we briefly describe the ultrasonic features of various splenic lesions then we describe with more details the splenic hematomas and abscess. The ratio of benign versus malignant focal splenic lesions is 1 to 3. The most common malignant lesions are lymphoma and metastases. Ultrasonography can detect 88% of the focal splenic lesions evident on computed tomography. The presence of solitary lesion, anechoic mass, and lesions with highly echogenic foci due to gas or calcification are suggestive sign of benign process.

Accessory spleen

Accessory spleen is a homogenous rounded formation near the hilum, of dimensions often about 1 cm and an echogenicity identical to the main adjacent spleen. In some cases, there is a parenchymal bridge between the main spleen and the accessory spleen (Figure 11).

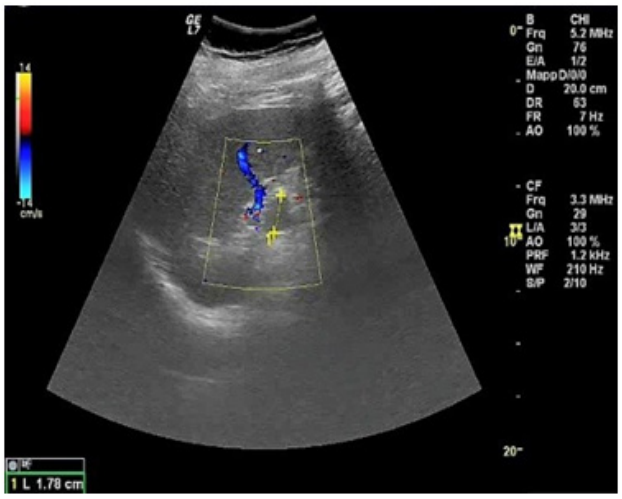

Figure 11: Accessory spleen.

Spleen cyst

Rarely seen, much less common than kidney, liver, or ovaria cyst. Splenic cyst formation could be: congenital, parasitic, neoplastic, post-traumatic (Figure 12), degenerative or inflammatory. Ultrasonic characters: round intra-parenchymal anechogenic well-defined regular contours formation with posterior echo enhancement [4].

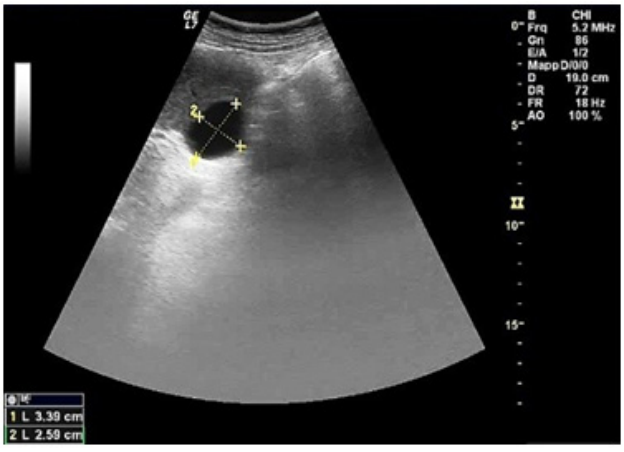

Figure 12: Post-traumatic cyst.

Splenic infarction

The incidence is 9.7%, caused by occlusion of the splenic artery or vein thrombosis of the splenicsinusoid's artery. Normally causes pain of varying intensity in the left upper quadrant and low-grade fever. US typically show a peripheral hypo-echogenicity triangular area with its apex toward the splenic hilum and base facing the splenic capsule. color Doppler show an area with no blood supply region. (Figure 13)

Figure 13: Scar of splenic infarction.

Splenic metastasis

It is not a common finding. The most frequent metastases arise from lymphoma and melanoma, followed by carcinoma of the ovary, breast, lung, and stomach in decreasing order of frequency [5]. Target lesions with a hypoechoic halo suggest metastasis (Figure 14).

Figure 14: Splenic metastasis.

Splenic abscess

Splenic abscess a rare complication of systemic infection, but when present may be associated with bacterial endocarditis [6]. In, 564 patients with infective endocarditis, only 5% developed a splenic abscess [7]. Due to its nonspecific signs and symptoms, the diagnosis is easily missed or delayed. Treatment is almost always surgical resection of the abscess or percutaneous ultrasound-guided drainage. Although splenic abscess is rare, there is a high mortality if diagnosis and treatment are delayed. Fine-needle aspiration is useful when

an abscess is suspected to confirm the diagnosis. (Figure 15)

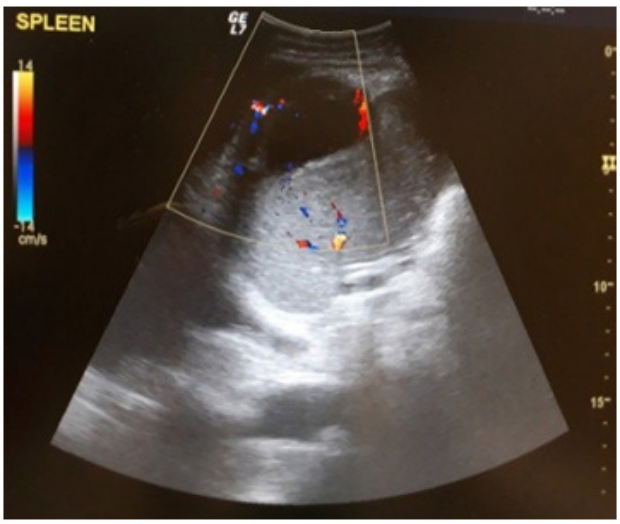

Figure 15: Splenic abscess.

The risk factors of developing splenic abscess: bacteremia is the most important risk factor, especially endocarditis is associated with splenic abscess.

Splenic trauma, Felty syndrome, amyloidosis, hemoglobinopathies, immunosuppression particularly human immunodeficiency virus (HIV) infection, diabetes mellitus, cancer, chemotherapy and immunosuppressive therapy all can increase the risk of splenic abscess.

Sonographic diagnosis [4]

Hypo- or iso-echoic lesions, often solitary and larger than 2–3 cm in diameter, with irregular and thick walls, sometimes ill-defined due to subcapsular extension and collections of extracapsular fluid, hyper-echogenicity spots because of gas formation with reverberation artifacts. Color Doppler examination show hypervascularity only in the thick wall. Wheel within a wheel appearance suggest for fungus, Pneumocystis carinii or Bartonella infection [8]. Percutaneous drainage of a single abscess and splenectomy for multiple abscesses are recommended.

At CEUS, there is no uptake of contrast agent in the larger abscesses at any stage.

Spleen hematomas

Spleen hematomas are seen mostly after blunt trauma. Subcapsular hematoma is seen when the capsule remains intact. The spleen, liver, and kidney are the three intraperitoneal organs most commonly injured by blunt trauma. If the capsule of the injured spleen remains intact, an intraparenchymal or subcapsular hematoma may result. Echogenicity of a hematoma depends on the stage at which the scan was performed. Fresh blood is liquid and initially seen as anechogenic formation but over the course of several days becomes more echogenic and thus more difficult to identify (Figure 8). Free fluid in the left upper quadrant is strongly suggestive of splenic injury, which must be excluded in such a case [9]. Less frequently, a splenic laceration or rupture is identified as a blood-filled cleft with capsular rupture.

Conclusion

Our case presentation demonstrates the role of ultrasound in initial evaluation of sepsis, early source identification and cardiac evaluation. Information derived from ultrasound can influence the management to improve patient's outcome.

Disclosure Statement

None of the authors have any conflict of interest pertaining to this publication, and none have any competing interests to declare.

Statement of Ethics

Consent declaration

Informed consent was obtained from the patient for publication of this case report.

Ethical approval

This article does not contain any studies with human participants or animals performed by any of the authors.

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