

Splenic abnormalities: an overview on sectional images

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ABSTRACT

Spleen, an organ that produces and controls blood cells, is a major regulatory site of the immune system. However, it is not necessary for the preservation of the vital functions, a feature that made this structure overlooked by most of radiologists and clinicians. In this paper, a working knowledge about the differential diagnosis of the sectional imaging techniques were presented. Computed tomography provides the basic information about this organ and its neighboring structures. The addition of the iodinated contrast media helps to further demarcate its parenchymal lesions. Magnetic resonance imaging, by virtue of its superb soft tissue contrast and lesion characterization, is used for the splenic lesions in which differential diagnosis were not reached by computed tomography. Organ-specific contrast media will be an important adjunct to magnetic resonance imaging in the near future.

Key words: • spleen • tomography, X-ray, computed
• magnetic resonance imaging

Spleen is an organ affected by many various lesions. Percutaneous biopsy methods are rarely used for diagnosis in splenic lesions and biopsies are limited by fine needle aspiration. Although not specific alone, combined computed tomography (CT) and magnetic resonance (MR) imaging findings are compensatory and correct interpretation of the findings carry great importance in the diagnosis and characterization of the mentioned lesions.

Anatomy

Spleen is an intraperitoneal organ that has a smooth serosal surface. The contours of this organ have indentations of the neighboring structures and has a variable shape. Splenic sulci (Figure 1) and medial splenic bulging (Figure 2) are normal variances in shape that should not be confused with splenic pathologies. In many cases, the costodiaphragmatic recess may elongate to the most inferior end of the spleen and may cause diagnostic confusion in trauma cases (Figure 3). Although traditionally axial sections are used for the assessment of spleen, coronal sections have value in evaluation of splenic size and relationships with the neighboring structures (Figure 4). Spleen is evaluated by the sectional imaging parameters of the liver, which is also located in the same coronal and transverse sections. The CT density and MR signal intensity of the spleen are determined by the high blood content. Therefore the normal parenchyma may resemble neoplastic tissue (1, 2). In both methods, it is normal to observe a heterogeneous image in the first 60 seconds after injection of contrast secondary to differences in flow between the red and white pulps (Figure 1). Any heterogeneity after this period is considered pathologic (Figure 5) (2).

Congenital variations and anomalies

The main morphological anomalies of the spleen are mentioned in the above section. Congenital absence of the spleen is known as asplenia (Ivemark syndrome) and presence of more than one spleen is known as polysplenia syndrome. Both situations are quite rare and associated with multiple system and organ anomalies including the liver in the first place. Accessory spleen (Figure 6) and wandering spleen (Figure 7) are commonly encountered (3). Such variations are recognized through their same density or signal intensity with the spleen. Accessory spleen is mostly located in the hilum. Wandering spleen is due to the laxity of the splenic ligament and may present as a soft tissue mass in the abdomen (3).

Splenomegaly

The basic radiological finding in many diseases of the spleen is an increase in the size of the organ (Table). Although spleen shows a wide

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Figure 1. In early phase CT in transverse plane, variational sulci (arrows) reaching up to 2 cm in depth may be differentiated from the ill-defined lacerations (see also Figure 23) associated with perisplenic hematoma by their sharp contours. The heterogeneous enhancement observed in the parenchyma is a normal finding and results from the flow difference between the red and white pulps in the early arterial phase.

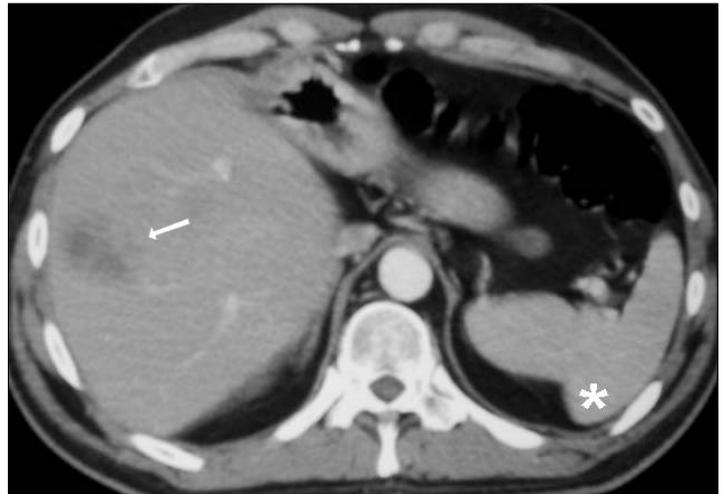


Figure 2. Medial splenic bulging (asterisk) in the late arterial phase CT in transverse plane. This variation representing the persistent fetal lobulation may be perceived as a mass lesion of the adjacent organs. Additionally, a metastatic lesion is visualized in the liver (arrow).



Figure 3. A transverse non-contrast enhanced CT section of a trauma case. In cases where the costodiaphragmatic recess extends to the inferior end of the spleen, effusions within the recess (arrows) may be confused with perisplenic effusions secondary to splenic lacerations.



Figure 4. Coronal post-contrast T1-weighted MR image in vascular equilibrium phase with fat saturation. Coronal plane provides the most appropriate slices that allow the assessment of the exact dimensions (double ended arrow) of the spleen in massive splenomegaly cases.

Table. Main causes of splenomegaly

Hematological disorders	Hemoglobinopathies, hereditary spherocytosis, primary neutropenia, thalassemia, myelofibrosis, polycythemia vera, thrombotic thrombocytopenic purpura, osteopetrosis, myelofibrosis
Congestive diseases	Cirrhosis, portal hypertension, splenic vein and portal vein thromboses, right sided heart failure, cystic fibrosis, acute splenic sequestration secondary to sickle cell anemia crisis
Storage diseases	Gaucher disease, Niemann-Pick disease, amyloidosis, hemosiderosis, hemochromatosis, diabetes mellitus, histiocytosis
Collagen vascular diseases	Systemic lupus erythematosus, rheumatoid arthritis, Felty syndrome
Neoplastic diseases	Cysts, hemangioma, lymphangioma, leiomyosarcoma, fibrosarcoma, lymphoma, leukemia, myeloma, metastases
Inflammatory diseases	Hepatitis, septicemia, bacterial endocarditis, infectious mononucleosis, tuberculosis, syphilis, histoplasmosis, brucellosis, malaria, leishmaniasis, kala-azar



Figure 5. Transverse CT image in portal venous phase shows the diffuse heterogeneity in the splenic parenchyma which is related to lymphoma infiltration.



Figure 6. Transverse contrast enhanced CT study in equilibrium phase demonstrates an isodense accessory spleen in the splenic hilum (*arrow*), which is the most common location for this variation.

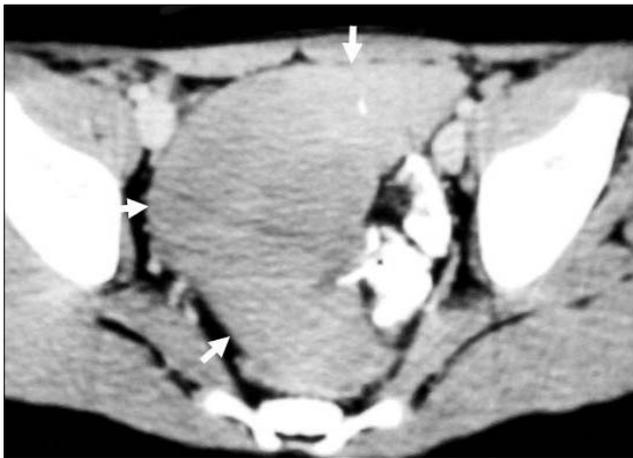


Figure 7. A wandering spleen (*arrows*) that fills the pelvis on the contrast enhanced CT study in transverse plane.



Figure 8. Transverse T2-weighted MR image demonstrating massive splenomegaly in Gaucher's disease. A hypointense nodule (*asterisk*) located centrally is seen. In some cases, infarcts associated with many nodules of various intensities and hypointense hemorrhagic areas (*arrow*) as in this case may be detected.



Figure 9. Transverse contrast enhanced equilibrium phase CT image of a thalassemia patient shows splenic enlargement, calcifications (*arrows*) and infarcted areas (*asterisk*).



Figure 10. Portal hypertension in the transverse images of the contrast enhanced abdominal CT scan in the equilibrium phase. Presence of splenorenal collaterals (*arrows*) is diagnostic for this disease.

range of variation regarding size, craniocaudal length of more than 15 cm and a spleen that is seen anterior to the mid-axillary line and/or contact with

the liver are considered abnormal. Another method that has proved valuable in the evaluation of splenic volume is multiplication of the lengths in all

three dimensions. This value, which grossly correlates linearly with the organ weight, ranges from 160 to 440 in healthy individuals (Figures 8-11) (4).



Figure 11. a, b. Transverse pre-contrast spin-echo (a) and gradient-echo (b) T1-weighted images of a patient with primary angiosarcoma show the “polka dot” appearance (arrows, a and b) on the splenomegalic background which are the radiologic equivalent of the Gamma-Gandy bodies and represent organized perifollicular and trabecular hemorrhagic areas.

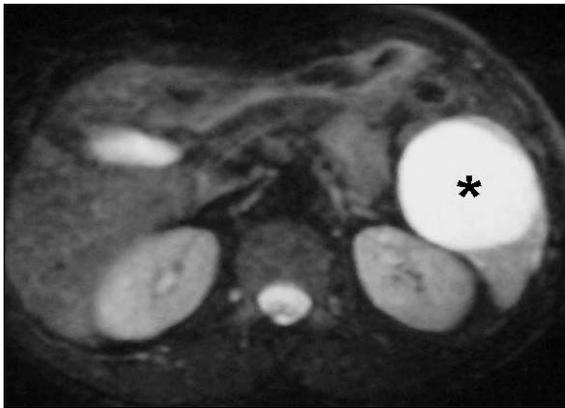


Figure 12. Transverse fat-saturated T2-weighted MR image reveals a well defined pseudocyst (asterisk) of high signal.



Figure 13. Hydatid cysts (asterisks) in the liver and spleen on the contrast enhanced abdominal CT study in transverse plane are seen. Cyst walls demonstrate focal contrast enhancement (arrows). This diagnosis should be considered in cases from endemic regions that present with multiple cysts.

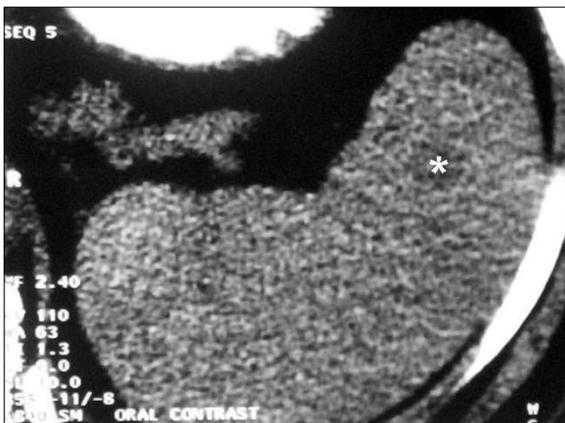


Figure 14. A hypodense nodular hemangioma (asterisk) in the lateral region of the spleen in a non-contrast abdominal CT study in transverse plane is seen.

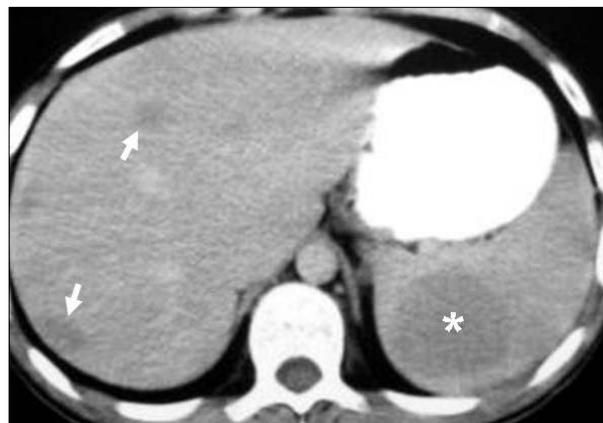


Figure 15. On transverse contrast enhanced abdominal CT study in equilibrium phase, there is a lesion (asterisk) indistinguishable from a pseudocyst radiologically. However, the presence of multiple similar lesions (arrows) in the liver and a history of lymphoma helped to establish the diagnosis of lymphoma metastasis. This is the two-year follow-up of the case in Figure 5.

Cystic lesions

Cysts are the most frequent benign lesions of the spleen. They develop mostly secondary to trauma, infections and infarction and are called pseu-

docysts (Figure 12). Hydatid cysts are often encountered in Middle Eastern countries including Turkey and may be diagnosed in some cases by contrast enhancement of the cyst walls and sep-

tations (Figure 13). A hypointense peripheral rim may be visualized around hydatid cysts on MR imaging studies. Hemangiomas (Figure 14), metastases (Figure 15) and abscesses (Figure 16)



Figure 16. On transverse contrast enhanced abdominal CT study of an immunosuppressed patient, two (arrows) out of multiple abscesses are detected. There is no peripheral contrast enhancement of the lesions.

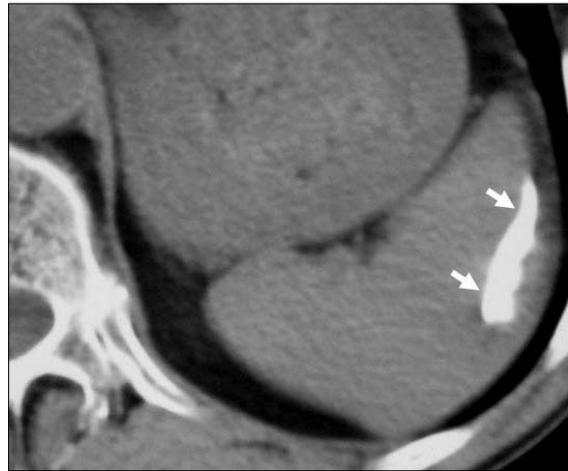


Figure 17. Hyperdense parenchymal calcification (arrows) secondary to tuberculosis is present on a transverse plane non-contrast enhanced abdominal CT image.

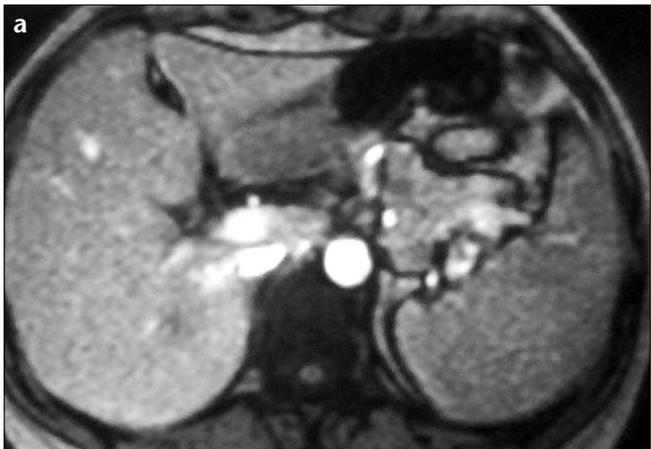


Figure 18. a, b. On transverse post-contrast early phase (a) T1-weighted MR image, a hemangioma is hardly distinguishable in the splenic parenchyma, but it becomes conspicuous (asterisk) due to contrast enhancement in the late phase (b).

are lesions that should be considered in the differential diagnoses of cystic lesions (2, 5).

Inflammatory diseases

Abscesses are more frequently encountered in the immunosuppressed cases which may be single or multiple and are typically focal, well-defined and low attenuated lesions on CT (Figure 16). Peripheral contrast enhancement is a typical, however not constant, feature. One of the typical findings of infection sequela is splenic parenchymal calcifications (3) (Figure 17).

Neoplastic diseases

Primary tumors are rarely encountered lesions of the spleen, where hemangioma is the most frequent benign tumor. This lesion has smooth con-

tours on CT with iso- to hypodense appearance (Figure 14). Capillary types enhance homogeneously unlike the cavernous types with heterogeneous enhancement. Hemangiomas demonstrate mostly nodular enhancement in the liver and circular enhancement in the spleen in the early phase (Figure 18) (5). Lymphangiomas present as homogeneous cystic multispaces in which MR signal features are determined by the proteinaceous content. Among the primary and secondary tumors of the spleen, lymphoma (Figures 5 and 15), metastases (Figures 19-21), angiosarcoma (Figure 11), leiomyosarcoma and fibrosarcoma may be mentioned (6). Presence of metastasis in the spleen is a rare occurrence, which usually is secondary to hematogenous spread in malignant melanoma (Figure 21), gynecologic malignancies, breast,

lung, and stomach cancers (Figure 20) (7, 8). Splenic metastases present as solid or cystic lesions which enhance homogeneously or non-homogeneously on CT. If necrotic or hemorrhagic changes occur, they are visualized as hyperintense nodules on T2 weighted MR imaging studies. In the absence of such changes, difficulties arise in the demonstration of metastases on MR imaging and differentiation from lymphoma. Lymphoma may be visualized as a solitary or multifocal mass, splenomegaly or diffuse infiltration (Figure 5) on CT. On MR imaging, differentiation of the normal parenchyma from infiltration proves difficult. Despite this, loss of normal heterogeneity in the early phase and presence of focal hypo-/hyperintense regions may help diagnosis in lymphoma surveillance cases (3, 7).

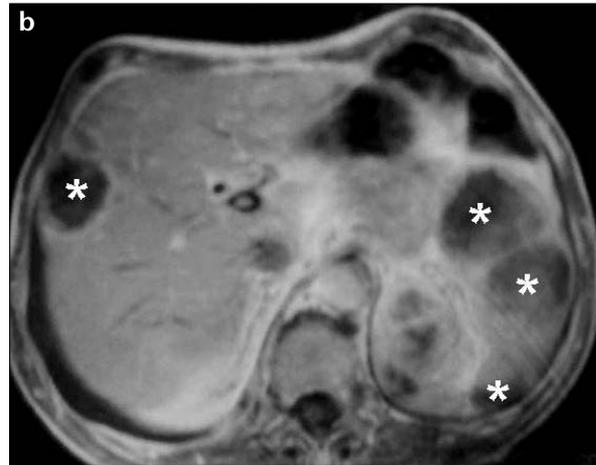


Figure 19. a, b. Transverse pre-contrast CT (a) and transverse post-contrast T1-weighted MR images (b) of a patient with metastatic larynx carcinoma show metastatic nodules (asterisks, a and b).



Figure 20. a, b. Transverse post-contrast CT (a) and T1-weighted MR images (b) of a patient with stomach cancer show necrotic metastases (asterisks, a and b). The air density (arrow, a) in the necrotic lesion is clearly visualized on the CT image.



Figure 21. Transverse CT image shows a few hypodense hepatic (asterisk) and many splenic metastatic nodules (arrows) in a malignant melanoma patient.

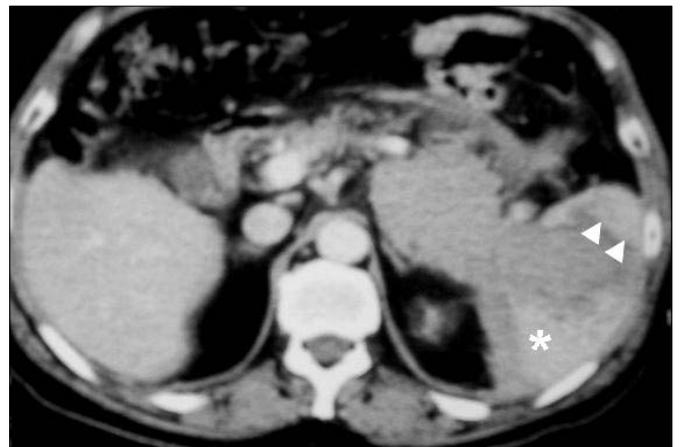


Figure 22. Grade III subcapsular (arrowheads) and intraparenchymal hematoma (asterisk) is demonstrated on a contrast enhanced CT scan in transverse plane.

Traumatic lesions

Spleen is the most commonly injured intraperitoneal organ in blunt abdominal trauma. Trauma may result in subcapsular and intraparenchymal

bleeding (Figure 22) and parenchymal rupture (laceration) (Figure 23) (9, 10). The management of findings differs in pediatric and adult patients. The hemodynamic status in children is more

important than the CT findings in choosing the appropriate management. In contrast, the high failure rate of the conservative management in adults and the high mortality and morbidity rates



Figure 23. Grade II laceration of 3 cm depth within the splenic parenchyma (arrows) is seen on equilibrium phase contrast enhanced CT scan in transverse plane.



Figure 24. Triangle shaped typical splenic infarct (arrows) in a lymphoma case is seen in the late arterial phase on a contrast enhanced CT scan in transverse plane.



Figure 25. A nodular infarction (asterisk) with ill defined contours in a patient with bleeding diathesis is shown on a post-contrast CT scan in transverse plane. Although not characteristic, this is the most frequently encountered finding in splenic infarcts.

of delayed surgery raised a necessity to classify the CT findings. The most frequently used classification is Mirvis et al.'s CT classification of blunt abdominal traumas (10). A superficial laceration or a subcapsular hematoma of less than 1 cm would be classified as grade I, a laceration of less than 3 cm depth resulting in a central or subcapsular hematoma would be grade II, a laceration more than 3 cm depth resulting in a central or subcapsular hematoma would be grade III and if there is laceration in more than three or more segments or if there is devascularization, this would be classified as grade IV (10, 11).

Vascular disease

Infarcts are the most important causes of focal splenic defects which may be caused by embolic, hematologic or splenic vascular diseases. The typical but infrequent image of the infarct is a triangle of well defined borders with the apex in the splenic hilus and the base in the splenic capsule (Figures 9 and 24). These lesions may also be visualized as circular, multinodular lesions with indistinct borders (Figure 25) (3, 7). Infarcts may completely heal within a month or may result in contour defects or pseudocysts.

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