Liver/Spleen Scan

RADIOPHARMACY

Radionuclide
- $^{99m}\text{Tc}$ $t_{1/2}$: 6 hours
  Energies: 140 keV
  Type: $\beta$, $\gamma$, generator

Radiopharmaceutical
- $^{99m}\text{Tc}$-SC (sulfur colloid)

Localization
- Phagocytosis by reticular cells of liver, spleen, bone marrow, and lungs. Complete clearance by reticuloendothelial system (RES) by liver (80–90%), spleen (5–10%), and bone marrow. Localization is flow dependent and requires functional integrity of RES cells. Particle size 0.3–1.0 µm. Clearance from blood stream $t_{1/2} = 2–3$ minutes.

Quality Control
- Chromatography, >90%; particle size, 0.1–1.0 µm; use within 6 hours

Adult Dose Range
- 2–7 mCi (74–259 MBq)

Method of Administration
- Intravenous (IV) injection or IV catheter and flush. Invert syringe before administering the dose to mix particles.

INDICATIONS

- Assessment of anatomy, size, and relative position of liver and spleen.
- Assessment of hepatomegaly, splenomegaly, splenic infarcts, accessory spleen or splenosis, or situs inversus.
- Assessment of benign mesenchymal (Kupffer cells) focal lesions (hemangioma, hamartoma) and hepatocellular focal nodular hyperplasia.
- Assessment of chronic liver or spleen disease including primary liver tumors and metastasis, jaundice, cirrhosis, hepatocellular disease, hepatitis, hepatic abscess, reticuloendothelial system function, or elevated blood work results.
- Detection and assessment of hepatic or splenic trauma.
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- Evaluation for liver disease, chronic anemia, leukemia or other blood disorders, thrombocytopenia, white blood cell (WBC) sequestration, tumors, abscesses, cysts, hemangiomas, hematomas, and trauma.
- Evaluation of hepatic infections, e.g., amoebic abscess, hydatid cyst, pyogenic abscess.
- Evaluation of relative splenic function by liver:spleen ratio.
- Evaluation for liver biopsy.
- Detection and assessment of congenital asplenia or polysplenia in children.
- Assessment of previous splenectomy.
- Detection and evaluation of splenic mass.
- Assessment of hepatic artery catheter patency and delivery.
- Evaluation of liver and/or spleen because of abnormal findings on related diagnostic scans.

CONTRAINDICATIONS

- Study should be performed before any iodinated or barium containing contrast agents. Particularly barium in the colon may result in artifactual defects with the liver and spleen.

PATIENT PREPARATION

- Identify the patient. Verify doctor’s order. Explain the procedure.
- If available, write concentrations of alanine amino transferase (ALT, a.k.a SGPT), aspartate amino transferase (AST, a.k.a SGOT), lactate dehydrogenase (LDH), and total bilirubin on history sheet.

EQUIPMENT

**Camera**
- Large field of view

**Collimator**
- Low energy, all purpose, or low energy, high resolution

**Computer Set-up**

**Flow**
- 1–3 sec/frame for 1 minute followed by immediate static blood pool (60 seconds or 500,000 counts)

**Static**
- 500,000–1 million counts

**Single Photon Emission Computed Tomography (SPECT)**
- 360° rotation, 128 × 128 matrix, 64 to 120 stops at 30 sec/stop

PROCEDURE (TIME: ~30–60 MINUTES)

- Place patient in supine position, camera anterior over lower thorax-abdomen.
- Flow: Position using point source on xiphoid process at top of camera field of view (FOV).
  - Inject, wait a couple of seconds, then start camera.
  - Take immediate blood pool image when flow is complete.
- Statics: Without flow, inject and wait 15 minutes. (Patients with liver dysfunction or portal hypertension may require 20–30 minutes before imaging.) Position liver and spleen in middle to upper left and right quadrants of FOV.
- Obtain images: Anterior with marker(s) over last costal margin for liver (and spleen if splenomegalgy indicated), anterior, RAO, RLAT, (RPO if protocol), posterior, LLAT, and LAO.
- Optional: Posterior with marker on spleen, anterior inspiration, and expiration (10 seconds each) to show viability of organs, and standing to reduce motion and improve resolution.
• SPECT: Center region of interest (ROI) in FOV. Set parameters and start camera. Contoured or noncircular.
• Processing may include centering liver and spleen, getting ROIs, and doing some combination of computer-generated regional ratios of spleen:liver, vertebrae:liver, and vertebrae:spleen uptakes (vertebrae ROI taken from center just below organs). Try Hanning filter, 0.8 cutoff, uniformity correction, 1–2 pixel thickness.

**Hepatic Artery Study**
• 1–3 mCi (37–111 MBq) 99mTc-MAA.
• Inject slowly through hepatic artery catheter or infusion pump (<1 mL/minute).
• Images: Immediate, anterior, posterior, and right lateral of liver. 500,000–1 million counts. Image lungs to identify intrahepatic arteriovenous fistulas.

**Splenic Study and Imaging**
• 1–3 mCi (37–111 MBq) 99mTc-heat-damaged red blood cells. This is accomplished by heating tagged RBCs for 20 minutes in a warm water bath at 49 to 50°C (120.2–122°F).
• Imaging: 30–120 minutes after injection. Anterior, posterior, and posterior oblique views, 300,000–750,000 counts. Image abdomen if ectopic splenic tissue is suspected. Image chest in cases of diaphragmatic rupture due to trauma. SPECT imaging may be requested.

**NORMAL RESULTS**
• Flow: Because liver is fed 75% by portal system, there should be ~6-second delay from aorta presenting to liver presenting. Liver will show dimly at first from aortic (hepatic artery) flush, then brightly from the portal venous system of the superior mesentery vein (small intestine) and splenic vein (including the stomach, large intestine, and pancreatic veins).
• Statics: Liver and spleen should have equal homogeneous distribution with little or no bone marrow uptake. A large patient with soft-tissue attenuation may present with hepatomegaly and slightly decreased uptake. Liver uptake is homogeneous, dominant right and smaller left lobe, variants are normal, e.g., Riedel’s lobe (long, thin right lobe), indentations from porta hepatis, rib margins, xiphoid, gallbladder, right kidney, suprahepatic veins, heart, and affected diaphragmatic configurations. Normal liver right lobe size is about 18 cm (anterior view) highest point to inferior tip. Splenic uptake is homogeneous and equal to or less than the liver. Normal splenic size is 10 cm not to exceed 13 cm (posterior view).
• Relative radiotracer uptake is 85% liver, 10% spleen, and 5% bone marrow.
• Hepatic artery study: Hepatic uptake. A small amount of lung uptake may be visible with a properly placed catheter due to arteriovenous fistulas in the liver.
• Splenic imaging: Uptake of tagged heat-damaged red blood cells in spleen.

**ABNORMAL RESULTS**
• Flow
  • Fast uptake: Tumors or hepatitis.
  • Increased uptake: Hepatomas, hemangiomas.
  • Slow uptake: Congestive heart failure, severe cirrhosis.
• Statics
  • Hepatomegaly: Fatty infiltration, chronic passive congestion, hepatitis, metastasis, diabetes, hemochromatosis, amyloidosis, lymphoma, leukemia, sarcoidosis, lipid storage disorders.
  • Splenomegaly: Leukemia, myelofibrosis, malaria, visceral leishmaniasis (e.g., Kala-azar, black fever, tropical).
  • Splenic dominance: Compromised liver function.
  • Splenic absence: Functional asplenia (sickle cell).
  • Bone marrow shifting (shunting): Hepatitis, cirrhosis, anemia, leukemia, infection, tumor, diabetes, chronic heart failure.
• Colloid shifting presents in marrow, spleen, lungs, and kidneys. These may be caused by severe liver dysfunction (especially cirrhosis), recent chemotherapy or malignant melanoma, and/or portal hypertension.
• Hot spots: Tumors, superior vena cava obstruction (lung cancer, quadrate lobe, arm injection), Budd-Chiari syndrome (hepatic vein thrombosis, caudate lobe), and focal nodular hyperplasia, hepatic cell adenomas (women on birth control).
• Cold spots: Metastatic tumors (primary), hepatomas, adenomas, abscess, cyst, infarction, hematoma, trauma, and hemangiomata, pseudotumor caused by cirrhosis.
• Patchy areas: Lacerations, liver diseases e.g., advanced (alcoholic or postnecrotic) cirrhosis.
• Pulmonary uptake: Hepatic cirrhosis, chronic obstructive pulmonary disease with superimposed infection, bacterial endotoxin, estrogen therapy, neoplasms, disseminated intravascular coagulopathy, mucopolysaccharidosis type II (Hunter’s syndrome), Histiocytosis X, faulty colloid preparation (excess aluminum), high serum aluminum level (antacids), children (normal minimal uptake), transplant recipients, pulmonary trauma.
• Accumulation in renal transplant indicates rejection of that organ.
• Hepatic artery study: Extrahepatic uptake, e.g., stomach, spleen, pancreas, lung. This indicates improper positioning of catheter. High concentrations in the lung may preclude the use of certain types of therapy.
• Splenic imaging: Little or no uptake of heat-damaged cells in spleen.

ARTIFACTS

• Tape marker to clothes or camera to prevent movement and distortion of holes in marker.
• For females, breasts may cause attenuation. Patient can hold them up out of FOV or they can be taped. Also, obese skin folds may cause attenuation; standing in front of camera will help eliminate these.
• Lung uptake caused by aluminum contamination of antacids or virilizing androgen therapy, iron preparations, magnesium preparations, niacin, or large colloid size and may indicate colloid clumping within radiopharmaceutical.
• Increased bone marrow shifting may be the result of nitrosoureas (alkylating agent in treatment of neoplasms), or colloid particles that are too small.
• Increased spleen uptake caused by nitrosoureas, recent halothane or methylcellulose.
• Decreased spleen uptake may result from chemotherapy, epinephrine, and antimalarials.
• Deep lesions may be missed.
• Deep respirations may blur images.
• Reversible rectangular area (usually liver) of decreased activity from radiation therapy.
• Surgery using anesthetic within 1 month can cause colloid shift from liver to spleen and contribute to decreased hepatic uptake of radiocolloid.
• Chemotherapy may cause irregular distribution, hepatomegaly, and/or shift to spleen and bone marrow.
• Splenic imaging: Amount of damaged RBCs will affect outcome of images.

PATIENT HISTORY
(or use complete patient history in reference section)
The patient should answer the following questions.

<table>
<thead>
<tr>
<th>Question</th>
<th>Y</th>
<th>N</th>
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</thead>
<tbody>
<tr>
<td>Do you have a history or family history of cancer?</td>
<td>Y</td>
<td>N</td>
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<tr>
<td>If so, what type and for how long?</td>
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<tr>
<td>Do you have a history of liver or spleen disease?</td>
<td>Y</td>
<td>N</td>
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<tr>
<td>(continued)</td>
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