Hepatobiliary Scintigraphy – Reporting Document

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Part A – Cholescintigraphy

Chapter 1: Introduction

The liver is one of the most frequently imaged organs in the body, using ultrasound, CT, MRI, or scintigraphy. The first three imaging techniques depend upon morphological changes to detect disease, whereas scintigraphy uses functional changes to detect liver pathology. Since physiological changes usually precede morphological alterations by several weeks or months, there is great potential for early diagnosis by scintigraphy.

Hepatobiliary diseases are quite common, and they often present clinically with dramatic suddenness requiring immediate diagnosis and therapy (e.g. acute cholecystitis). Hepatobiliary scintigraphy using Technetium-99m HIDA agents fulfils the requirement for a rapid diagnosis. Hepatic uptake of Tc-99m-HIDA agents varies from 82.5-98.1%. Hepatic uptake of Tc-99m-disofenin is 89% and Tc-99m mebrofenin is 98%. Hepatobiliary scintigraphy (including planar imaging, SPECT, or hybrid imaging such as SPECT/CT) after injection of Technetium-99m HIDA agents evaluates hepatocellular function and the biliary system by tracing the production and flow of bile in the liver, and its passage through the biliary system into the small intestine. Sequential (or dynamic) images of the liver, biliary tree and gut are obtained. Computer acquisition and analysis, including pharmacologic interventions, are used according to varying indications and an individual patient's needs.

Chapter 2: Indications

1. Functional biliary pain syndrome in adults.
2. Functional biliary pain syndrome in pediatrics.
3. Acute cholecystitis.
4. Biliary system patency.
5. Bile leak.
6. Neonatal hyperbilirubinemia (Biliary atresia vs Neonatal hepatitis syndrome).
7. Assessment of biliary enteric bypass (Kasai procedure).
8. Assessment of liver transplant.
9. Afferent loop syndrome.
10. Assessment of choledochal cysts.
11. Calculation of gallbladder ejection fraction (GBEF).
12. Functional assessment of the liver before partial hepatectomy
13. Demonstration of anomalous liver lobulation.
14. Enterogastric (duodenogastric) reflux assessment
15. Oesophageal bile reflux after gastrectomy
16. Sphincter of Oddi dysfunction

iii. Results of recent liver bilirubin and liver enzyme levels.

iv. Previous treatment history - e.g. Cholecystectomy, hepatectomy, liver transplant, choledocholithotomy, choledochoenterostomy.

v. Relevant symptoms (jaundice, abdominal pain, fever).

vi. Previous imaging findings (for comparison/ correlation).

vii. Relevant co-morbidities (Allergies and Renal failure)

Chapter 3: Essentials of Reporting:

3.1 Date, time and Type of Study

3.2 Patient Demographics:

Full name, Hospital ID, Age, Gender

3.3 Clinical details:

i. Indications for imaging study; e.g., suspected acute cholecystitis, common bile duct obstruction, or a bile leak, Gall bladder dysfunction, Biliary atresia, Bile leak etc.

ii. It is useful to include the patient's medications in this part of the historical review, especially the last dose of potentially interfering medications. The last oral food intake is also useful to record.

3.4 Procedure Details:

i. Radiopharmaceutical:

ii. Dose: MBq / mCi

iii. Site and route of Injection:

iv. Duration between time of injection to Imaging: _____ minutes

v. The duration of imaging and whether special (sitting/standing) or delayed views were obtained

vi. Regions Scanned:

vii. Scanner used:

viii. Usage of pharmacological pretreatment (Phenobarbitone)

ix. Usage of Pharmacological (Sinclaide/ Morphine sulphate) or

physiological (Fatty meal) intervention.

x. Presence of any surgical drainage tube.

xi. Any allergic/ adverse events encountered during the study period.

3.5 Findings:

i. Quality: Check whether the quality of scan is adequate and interpretable. Suspected radiopharmaceutical impurity or various artefacts such as motion, dose extravasation if any, should be reported.

ii. Identification of scan: by recognizing physiological tracer distribution. Include the appearance of the liver, intrahepatic ducts, common bile duct, the presence and time of tracer appearance in the gallbladder or small bowel.

iii. Qualitative description (good, fair, reduced, poor) of radiotracer distribution in the liver should be mentioned with presence of any inhomogeneity, abnormal hot or cold areas. Prolonged retention of blood pool activity in the cardiac region should be noted.

iv. Mention abnormal delay in the appearance of radiotracer into the liver, intrahepatic ducts, common bile duct, gall bladder and small intestine.

v. Effect of any pharmacological or physiological intervention on Gall bladder and biliary duct excretion should be mentioned.

vi. The result of any quantification like GBEF, if performed, should be recorded in the report.

vii. Presence of any unusual activity (e.g., bile leak or enterogastric reflux) should be mentioned. Presence of tracer activity in surgical drains/bags should be documented.

3.6 Conclusion:

i. The conclusion should be concise and as precise as possible.

ii. It should address the clinical question, should provide a differential diagnosis, and should make recommendations, if appropriate.

iii. Any urgent or unexpected findings should be directly communicated to the referring physician, and this communication should be documented in the report.

Chapter 4: Pitfalls

Following Pitfalls/ sources of errors should be identified before, during or after performing the Hepatobiliary Scintigraphy and should be mentioned in the report:

4.1 False-Positive Results:

The causes of a false-positive study for acute cholecystitis (gallbladder non-visualization in the absence of acute cholecystitis) include:

i. Insufficient fasting (less than 4 h)
ii. Prolonged fasting (>24 h), especially total parenteral nutrition
iii. Severe hepatocellular disease
iv. High-grade common bile duct obstruction
v. Severe inter-current illness
vi. Pancreatitis (rare)
vii. Rapid biliary-to-bowel transit (insufficient tracer activity remaining in the liver for delayed imaging)
viii. Severe chronic cholecystitis
ix. Previous cholecystectomy\

4.2 False-Negative Results:

The causes of a false-negative study for acute cholecystitis (gallbladder visualization in the presence of acute cholecystitis) are rare but include:

i. A bowel loop simulating gallbladder (Drinking 100–200 mL water may remove the radiopharmaceutical from the duodenum and allow differentiation of gallbladder from bowel. Review of dynamic images in a cine display may also be helpful. A right lateral view should be obtained to better distinguish activity in the duodenum from that of the gallbladder.)
ii. Acute acalculous cholecystitis
iii. The presence of the dilated-cystic-duct sign simulating gallbladder

iv. A bile leak due to gallbladder perforation
v. Congenital anomalies simulating the gallbladder
vi. Activity in the kidneys simulating the gallbladder or small bowel (may be clarified by a lateral image)

Chapter 5: Cholescintigraphy Reporting – Examples

12.1 Case-1:

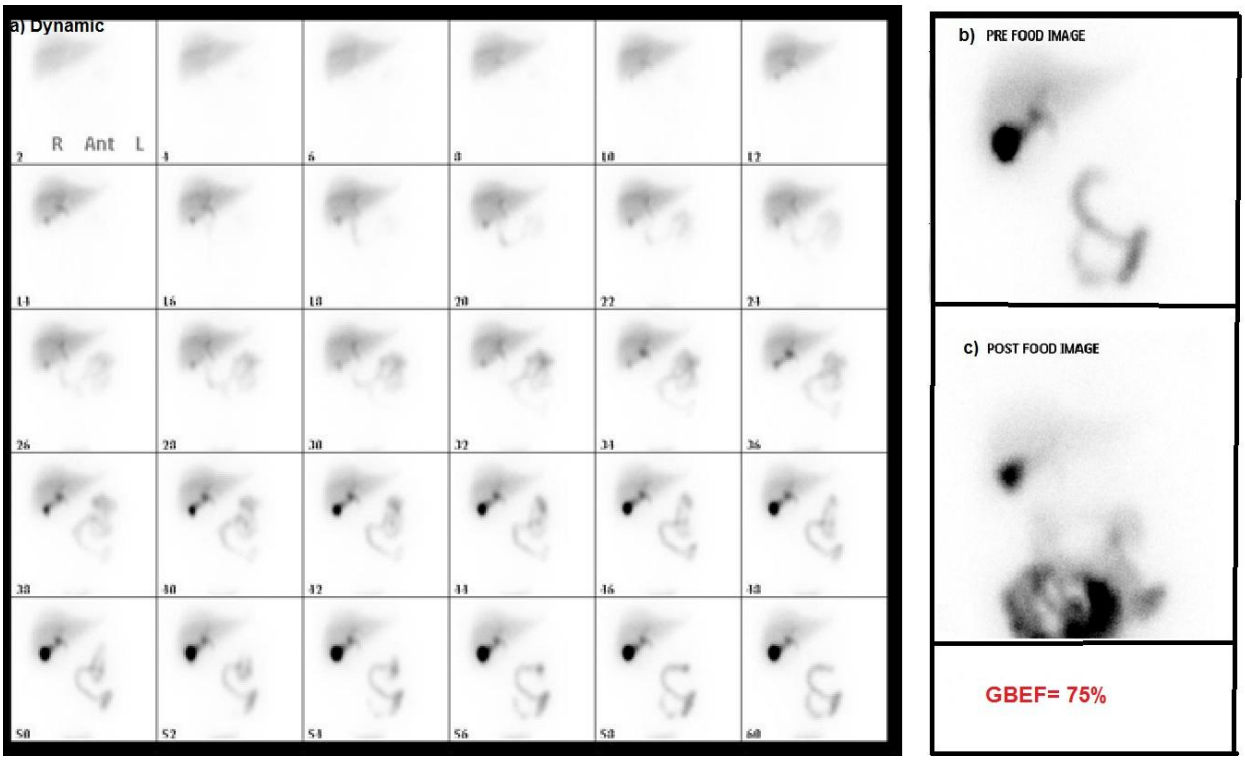

Figure 1: A 35-year-old female complaining of retrosternal/ epigastric pain and fat intolerance, referred for the evaluation for the Gall Bladder function. a) Dynamic images (2 min/frame) b) Delayed Pre and c) post food static images show prompt and uniform tracer uptake in the liver and within 45 mins activity is seen in the biliary tract, gall bladder and the bowel. Visually, the images show significant emptying of the gall bladder after fatty meal, and the ejection fraction was calculated to be 75% (normal value is 30-35%). No abnormal tracer localization seen. Findings are negative for Gall bladder dyskinesia/dysfunction.

12.2 Case-2:

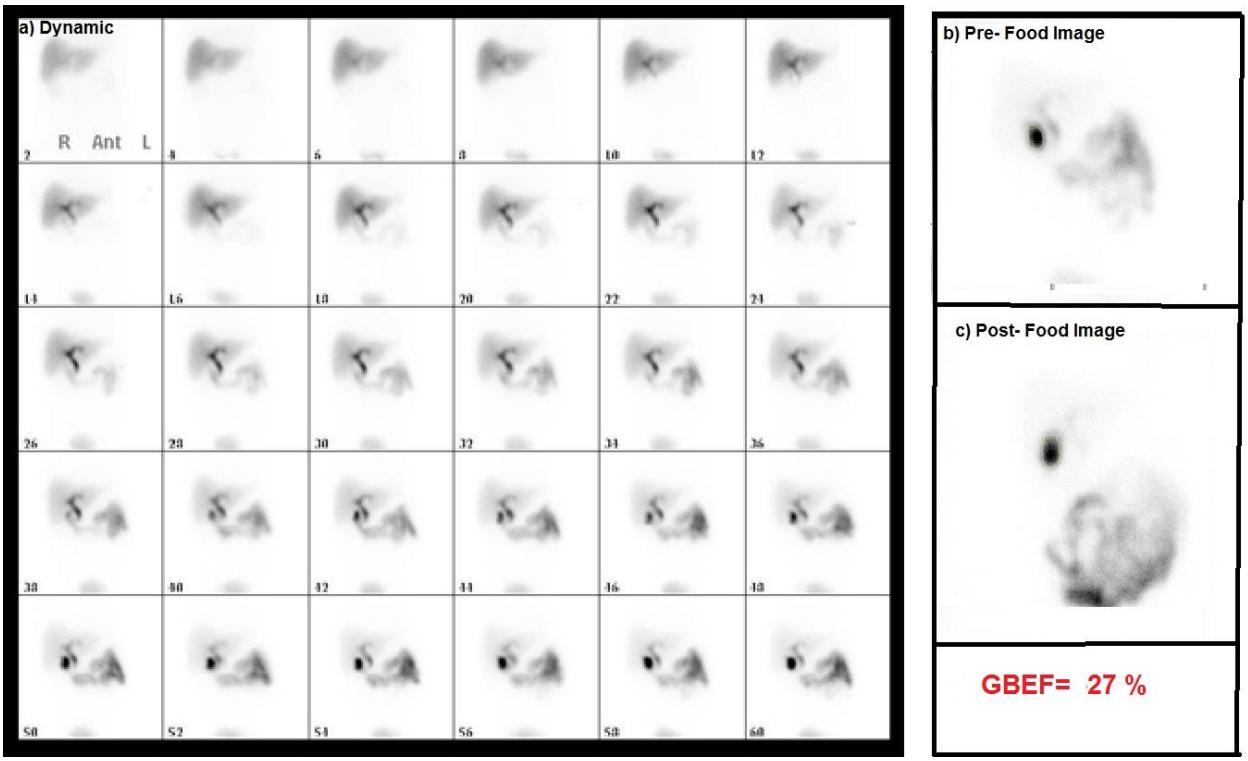

Figure 2: A 69-year-old male with H/o Upper abdominal pain since 01 year. U/S studies showed increased wall thickness with multiple stones inside gall bladder. a) Dynamic images (2 min/frame) images show prompt and uniform uptake in the liver and within 45 mins activity is seen in the biliary tract, gall bladder and the bowel. b) Delayed Pre and c) post food static were acquired after administration of fatty meal and the gall bladder ejection fraction was calculated. Visually, the images do not show significant emptying of the gall bladder after fatty meal, and the ejection fraction was calculated to be 27% (normal value is 30-35%). These findings are consistent with chronic cholecystitis.

12.3 Case-3:

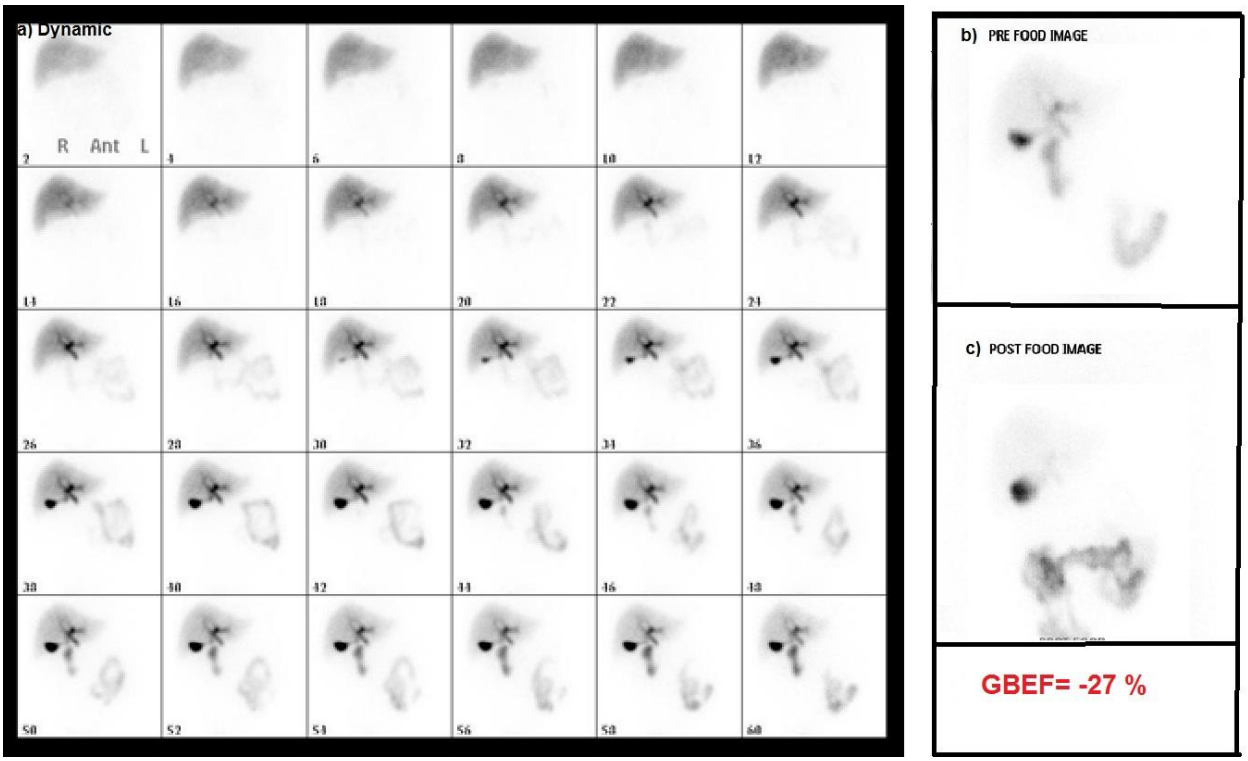

Figure 3: A 66-year-old male known diabetic, hypertensive, dyslipidemic patient presented in emergency with H/o Right upper abdominal pain and constipation since 4-5 days. Pain radiates toward Right side of back and upper back. U/S - normal GB, liver and pancreas with no stones in GB. Referred for HIDA to rule out acalculous cholecystitis. a) Dynamic images (2 min/frame) show prompt and uniform uptake in the liver and within 60 mins activity is seen in the biliary tract, gall bladder and the bowel. b) Pre and c) post food static images were acquired before and after administration of fatty meal and the gall bladder ejection fraction was calculated. Visually, the images do not show emptying of the gall bladder and persistently increased radiotracer uptake in post meal image. The ejection fraction was calculated to be 27% (normal value is 30-35%). These findings might suggest chronic cholecystitis or acalculous cholecystitis.

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12.4 Case-4:

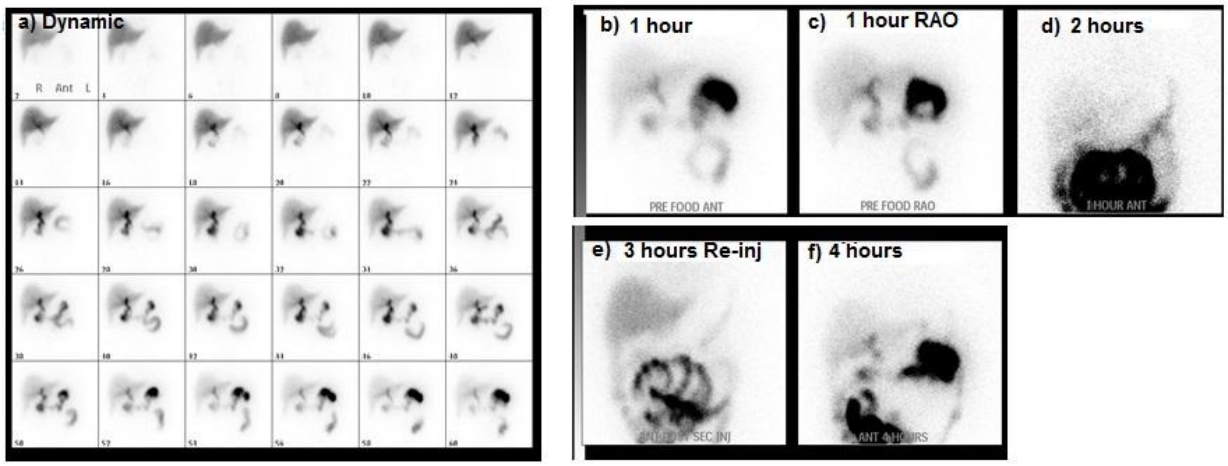

Figure 4: A 28-year-old male obese patient with H/o epigastric pain of recent onset. U/s studies 10 days before showing thick walled gall bladder with evidence of stones, possibility of cholecystitis. a) Dynamic images (2 min/frame) show prompt and uniform uptake in the liver and within 60 mins activity is seen in the biliary tract and the bowel. No activity is seen in the gall bladder. Delayed images for up to 3–4 h obtained to look for the filling of gall bladder. Radiotracer reinjected to avoid tracer washout. Delayed 1 hour (b, c), 2 hours (d), Re-injection 3 hours (e) till 4 hours (f) static images also do not show any activity in the gall bladder, confirming the diagnosis of acute cholecystitis.

12.5 Case-5:

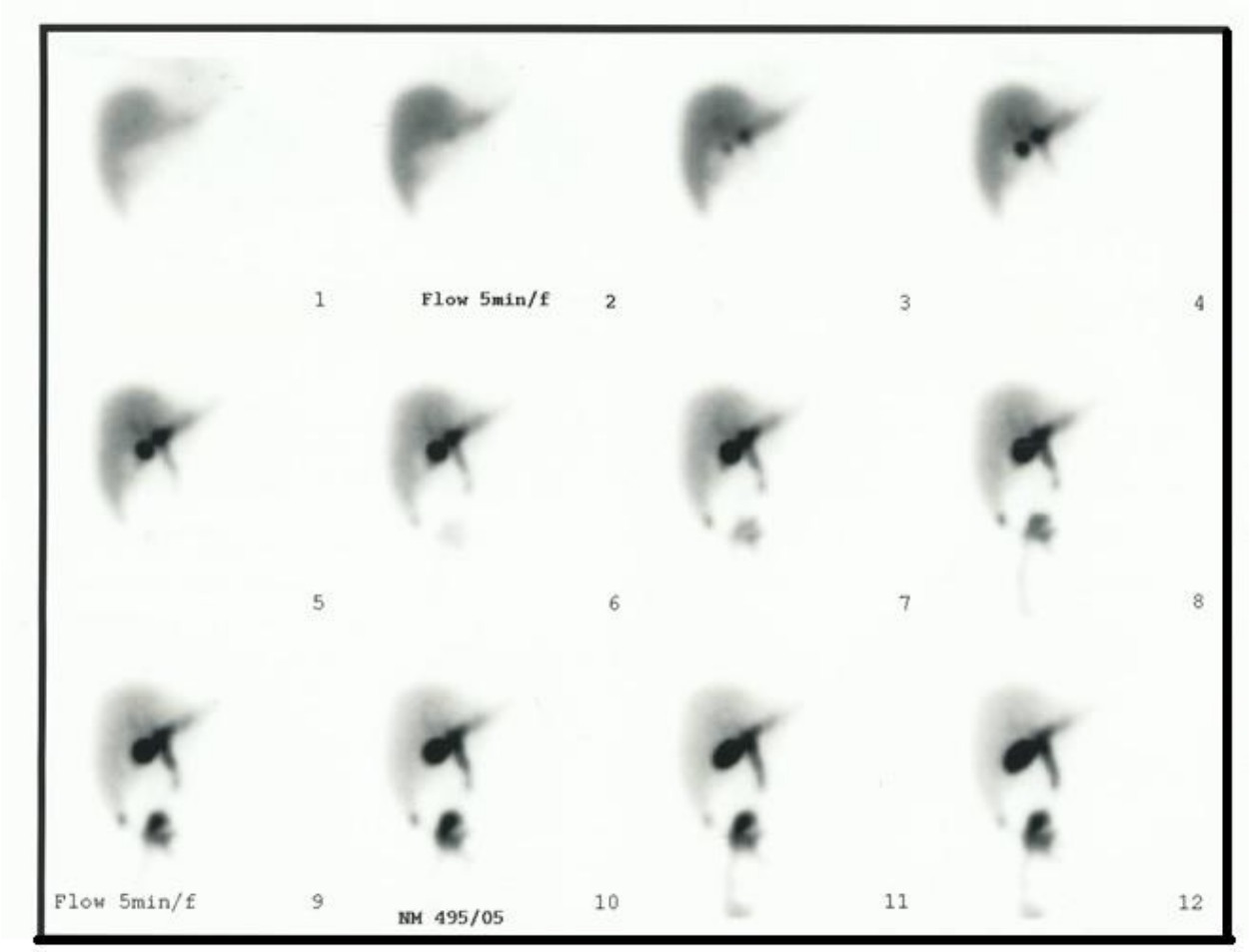

Figure 5: A 57-year-old Male with H/o Post Lap Cholecystectomy complaining of abdominal pain and fever. U/S studies showing small fluid collection over right hepatorenal region. Dynamic images (5 min/frame) show prompt and uniform uptake in the liver and within 60 mins activity is seen in the biliary tract, and the bowel. Gall bladder not visualized due to cholecystectomy. A focus of increasing activity seen on the inferior pole of the right lobe of liver, consistent with bile leak after recent cholecystectomy.

12.6 Case-6:

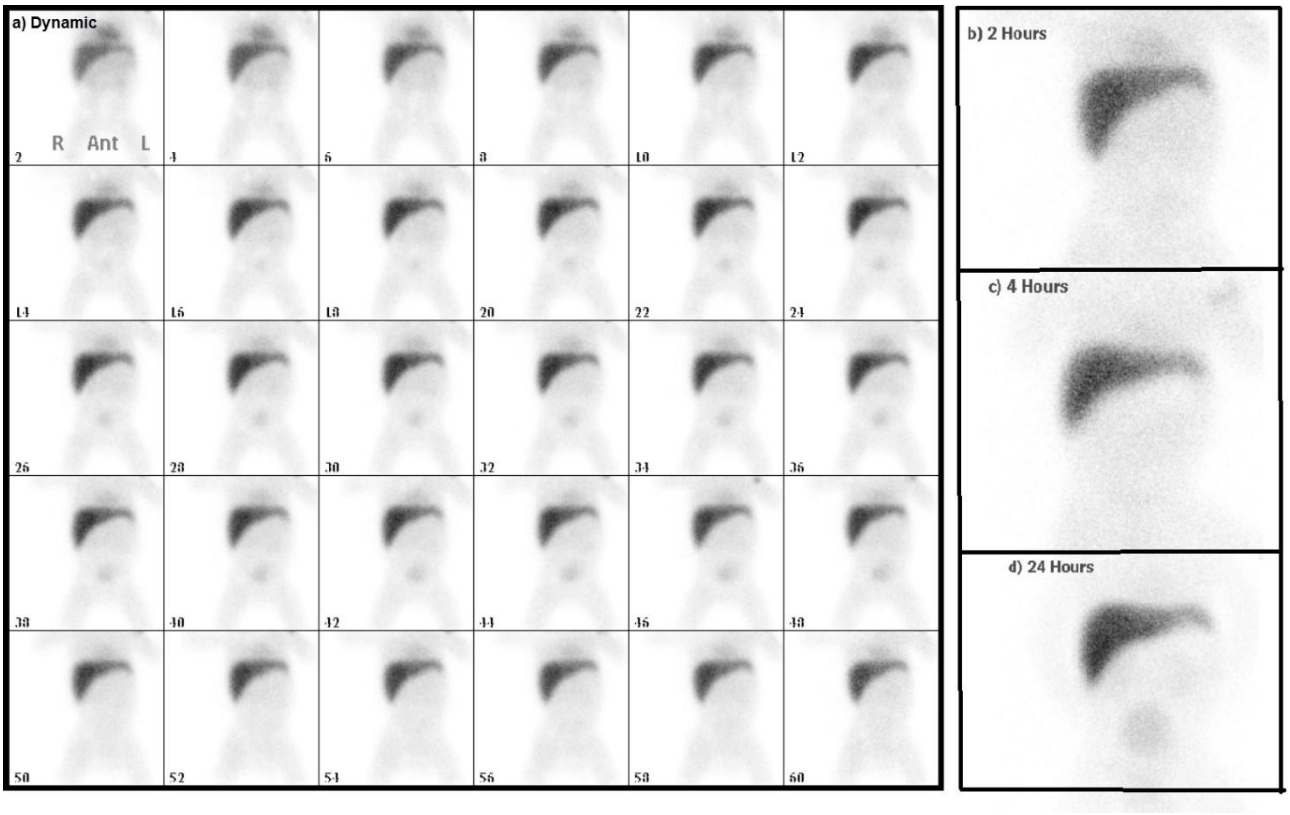

Figure 6: A 2-month-old baby girl brought to emergency by parents with the complaint of having prolonged and progressive yellowish discoloration of the skin and clay colored stools since 2nd day of birth. Liver function consistent with direct hyperbilirubinemia and US showing echogenic structure in close to the portal vein of possible triangular cord sign of thickness measuring 2.3 mm in size, consistent with biliary atresia. Referred for HIDA scan for further evaluation after appropriate pre-treatment with phenobartitone. a) Dynamic images (2 min/frame) show prompt, uniform and good uptake in the liver and within 60 mins, no activity is seen in the biliary tract, gall bladder and the bowel. Delayed images at b) 2 hours c) hours and d) 24 h do not show any evidence of bile entry into the small intestine. Kidneys visualized as an alternate route of excretion. These findings are likely due to biliary atresia.

References:

1. Tulchinsky M, Ciak BW, Delbeke D, et al. SNM practice guideline for hepatobiliary scintigraphy 4.0. *J Nucl Med Technol.* 2010;38:210e8.

2. Ziessman HA, O'Malley JP, Thrall JH, editors. Nuclear medicine: the requisites. 3rd ed. Philadelphia, PA: Mosby Elsevier; 2006.

3. Zeissman HA. Nuclear medicine hepatobiliary imaging. *Clin Gastroenterol Hepatol* 2010;8:111e6.

4. Krishnamurthy G, Krishnamurthy S. extended application of 99mTC mebrofenini cholecystography with cholecystokinin in the evaluation of abdominal pain of hepatobiliary and gastrointestinal origin. NMC 2010:31; 346-354.

5. Ziessman HA. Hepatobiliary scintigraphy in 2014. *J Nucl Med* 2014; 42:249–259.

6. Pakarinen MP, Rintala RJ. Surgery of biliary atresia. *Scand J Surg.* 2011;100:49e53.

7. Yue KT, Lin KP, Whatt AGS. Imaging postoperative bile leaks and assessing integrity of biliary-enteric anastomoses with fusion HIDA SPECT/CT scintigraphy. *Clin Nucl Med.* 2010; 35:875–878.

Part B – Liver and Spleen Scintigraphy

Chapter 6: Introduction

Liver and spleen imaging is performed after the injection of a ^{99m}Tc-labeled colloid which localize in the reticuloendothelial cells of liver and spleen or via ^{99m}Tc-labeled blood pool imaging of the liver and/or spleen, or by injecting ^{99m}Tc-labeled macroagregated albumin (MAA) in the precapillary arterioles of the liver when injected through an arterial catheter into the hepatic artery. Splenic imaging is also performed after the injection of ^{99m}Tc - labelled heat-damaged red blood cells.

Chapter 7: Indications

7.1 ^{99m}Tc-labelled colloid Liver and Spleen Imaging:

Liver–spleen imaging is performed after the injection of a ^{99m}Tc-labeled colloid that has been rapidly phagocytized by the reticuloendothelial cells of the liver, spleen, and bone marrow. The indications for liver and spleen scintigraphy include:

- Assessing the size, shape, and position of the liver and spleen.
- Detecting and monitoring masses of the liver and/or spleen.
- For suspected focal nodular hyperplasia of the liver. These lesions often have normal or increased uptake on colloid imaging.
- Evaluating hepatic function in acute or chronic liver disease.

7.2 ^{99m}Tc-labelled blood pool Liver Imaging:

Liver blood pool imaging is performed after the injection of ^{99m}Tc-labeled red blood cells and is indicated for:

- Detection of cavernous hemangiomas of the liver.

7.3 ^{99m}Tc-labelled MAA Liver perfusion Imaging:

Hepatic perfusion studies are performed after the injection of 99mTc- macroagregated albumin (MAA) through a hepatic artery catheter and is indicated for:

- Confirming the patency of hepatic arterial perfusion catheters to determine that intra-arterially administered

agents are delivered optimally

- Evaluating the pattern of blood flow via these catheters, including aberrant perfusion and shunting

7.4 ^{99m}Tc-labelled Heat-Damaged RBCs Spleen Imaging:

Splenic imaging is performed after the injection of ^{99m}Tc - labelled heat-damaged red blood cells. Damaged red blood cells are taken up selectively by functioning splenic tissue. Main indications are

1. Identifying functioning splenic tissue in patients treated with splenectomy for thrombocytopenia.
2. Evaluating suspected functional asplenia and for characterizing an incidentally noted mass as functional splenic tissue
3. In children to rule out congenital asplenia or polysplenia

Chapter 8: Pharmaceuticals

Radiopharmaceuticals used of Liver and Spleen scintigraphy are summarized in Table 1.

Table 1: Liver and spleen imaging radiopharmaceuticals used and dosages

Radiopharmaceutical	Administered Activity MBq /kg (mCi/kg)
^{99m}**Tc-colloid Sulphur colloid** (particles average in size from 0.1 to 1.0 µm)	1.5–2.2 (0.04–0.06)
^{99m}**Tc-labeled RBCs (Labelling technique: In vivo, modified In vivo and In Vitro)**	7.0–11.0 (0.2–0.3)
^{99m}**Tc- macroaggregated albumin (MAA)** (particles average in size from 10 to 90 µm)	1.5–2.2 (0.04–0.06)
^{99m}**Tc -labelled heat-damaged RBCs** (Labelled RBCs heated for 15 minutes in a preheated water bath at 49.0 to 50.0 degrees C	0.7–1.5 (0.02–0.04)

Chapter 9: Imaging Protocols

9.1 Clinical Details:

History

- Written or electronic request for liver and spleen scintigraphy should be documented in the report showing sufficient information to demonstrate the medical necessity of the examination and query/ concern of the physician.
- Signs and symptoms
- Relevant history (including known diagnoses. Any additional information regarding the specific reason for the examination or a provisional diagnosis would be helpful.

Physical Examination

Abdominal Examination is important for Liver size marker and a costal margin marker are needed for measuring liver and spleen size and for identifying anatomical landmarks.

Investigation

Any relevant investigation for correlation (Ultrasound, CT scan) should be made available. All prior liver and spleen scintigraphy results should be available for comparison.

9.2 Protocol Summary

Camera	Large field of view gamma
Collimator	Low energy, High resolution, parallel hole
Patient Position	Supine, properly aligned anterior abdominal imaging
^{99m}Tc-labeled colloid Liver and Spleen Imaging	
Images and Computer set up	Inject ^{99m}Tc sulfur colloid intravenously Start imaging 20 minutes after injection
	Planar Imaging • 750-100 k count images in multiple projections (anterior, upright and supine, posterior, right and left lateral, anterior and posterior oblique). • Additional Anterior supine image lead marker of known length to identify the right inferior costal margin and xiphoid process.

	• SPECT or SPECT/CT: a 128 x 128 matrix with a 3-degree angle of sampling for dual detector or 6-degree angle of sampling for single detector
^{99m}Tc -labelled RBC Blood Pool Hepatic Imaging	
Images and Computer set up	***Planar Imaging*** • Blood flow: 1-second frames for 60 seconds on computer and 2-second film images. • Immediate images: 750k to 1000k count planar image in same projection and other views as necessary as well. 3. Delayed images: 750k to 1000k count planar static images 1 to 2 hours after injection in multiple projections (anterior, upright and supine, posterior, right and left lateral, anterior and posterior oblique)
	• SPECT or SPECT/CT: same parameters as Colloid Imaging
^{99m}Tc-labelled MAA albumin Liver perfusion Imaging:	
Images and Computer set up	• Intra-arterial catheter must be positioned in the hepatic artery or its branches. • Infuse ^{99m}Tc MAA in a small volume (0.5-1 mL) very slowly (<1 mL/min) at a measured rate through the catheter
	Planar Imaging • Immediate images: Imaging is performed immediately after the infusion of the agent with same parameters as Colloid Imaging • Images of the lung are required to identify intrahepatic arteriovenous fistulas • Draw region of interest for the lung, for the liver, and for thigh background. Calculate ***Percent shunt to lung*** = Lung (geometric mean) / Lung + Liver (geometric mean), all corrected for background.
	• SPECT or SPECT/CT: same parameters as Colloid Imaging
^{99m}Tc-labelled Heat-Damaged RBCs Spleen Imaging:	
Images and Computer set up	• The radiopharmaceutical, ^{99m}Tc heat-damaged RBCs, is administered intravenously
	Planar Imaging • Delayed images: Imaging is performed 30-120 minutes after the injection. Same parameters as Colloid Imaging • Images of the chest are If the patient has had prior trauma that might have ruptured the diaphragm • If ectopic splenic tissue is in question, the abdomen and pelvis should be imaged.
	• SPECT or SPECT/CT: same parameters as Colloid Imaging

Chapter 10: Image Interpretation and Reporting:

10.1 ^{99m}Tc- colloid Liver–spleen imaging

Findings and interpretation criteria:

- Most focal lesions in the liver will have less activity than the liver.
- Focal nodular hyperplasia may have activity equal to or greater than the surrounding liver in about 50% of patients. Finding normal activity or increased activity in a lesion is very suggestive of focal nodular hyperplasia.
- A relative radiocolloid "shift" (increased radionuclide deposition in the spleen and bone marrow relative to liver) may occur in hepatic dysfunction but also may be seen with portal hypertension, hypersplenism, marrow active anemia as response to chemotherapy, and in some patients with malignant melanoma.

Reporting

- The size and shape of the liver and spleen and the relative amount of activity in the liver, spleen, and bone marrow should be noted.

10.2 ^{99m}Tc-labelled RBC hepatic blood pool imaging

Findings and interpretation criteria:

- Decreased or normal blood flow with finding of markedly increased blood pool activity within a lesion is pathognomonic of a cavernous hemangioma of the liver.
- Rarely, other tumors of the liver (e.g., angiosarcomas) have been reported to have increased blood pool on delayed images. However, they can usually be differentiated from cavernous hemangiomas by the fact that they also have increased blood flow.
- Cavernous hemangiomas that are 3 cm or greater in size almost always demonstrate markedly increased blood pool even on planar images.

- SPECT or SPECT-CT imaging is also helpful with lesions < 3 cm or when there are multiple lesions in the liver and facilitates comparison with CT and MR imaging

Reporting

- The report should include the results of other imaging studies when they are available.
- When multiple lesions have been noted on other imaging studies, the presence or absence of increased blood pool should be reported on a lesion-by-lesion basis, when possible.

10.3 ^{99m}Tc-MAA hepatic perfusion imaging

Findings and interpretation criteria:

- The images should be assessed for the presence of extrahepatic accumulation of activity (e.g. stomach, pancreas, spleen). The extrahepatic activity indicates that the catheter is not optimally positioned.
- Some lung activity may be seen with a properly positioned catheter as a result of arteriovenous fistulas in the liver. Significant lung uptake (>20% lung shunt) is an contraindication for administration of therapeutic radiolabelled microspheres.

Reporting

- The approximate rate (mL/min) of the injection of the radiopharmaceutical should be included in the report.
- The presence of any extra hepatic activity should be noted.
- When indicated, the percentage of the activity in the lung should be reported. Percent shunt to lung should be calculated and be mentioned in the report.

10.4 Splenic imaging

Findings and interpretation criteria:

- Functional ectopic splenic tissue is preferentially visualized when heat damaged blood cells are used.

Reporting

- The time between injection and imaging should be reported,
- The number, approximate size, and location of any functioning splenic tissue should be described in the report.

Conclusion/ Impression/ Recommendation

- Summary of key findings should be mentioned in this section
- Differential diagnoses should be given in the light of patient's

clinical condition and results of other diagnostic modalities

- Further work up may be recommended if there is need of other investigations like US, CT, MRI or biopsy

Chapter 11: Pitfalls and Artefacts

- Anatomic variations
- Respiratory motion
- Colloid size: Small particles preferentially go to the bone marrow and large particles preferentially go to the spleen.
- Artefacts resulting from radiation therapy
- Breast attenuation artefact
- Blood Pool Imaging: Ineffective RBC labelling
- Hepatic perfusion Imaging: Improper positioning of the catheter
- Splenic imaging: Degree of damage to the red blood cells

Chapter 12: Liver-Spleen Scintigraphy Reporting – Examples

12.1 Case 1: Normal liver and spleen scan.

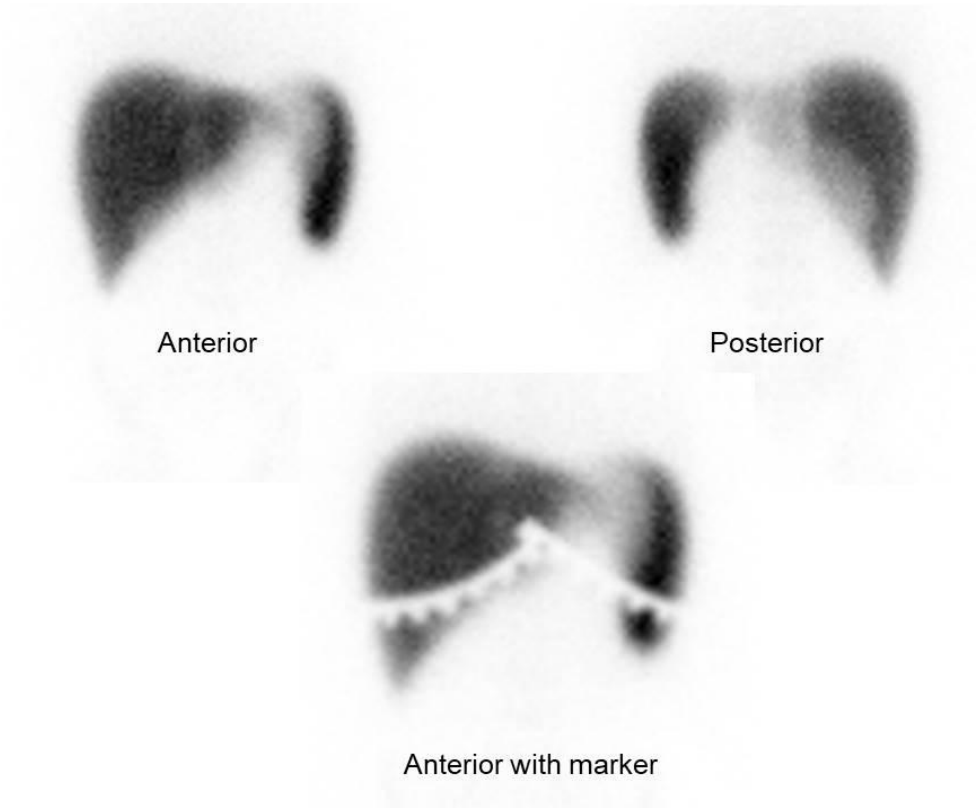

Figure 1 ^{99m}Tc- Sulphur colloid liver-spleen scintigraphy show normal size and shape of liver with homogeneous tracer uptake

Clinical Details: 10-year-old male is a case of thalassemia major and splenomegaly. Referred to assess splenic function.

Findings: ^{99m}Tc - Sulphur colloid liver-spleen scintigraphy show normal size and shape of liver with homogeneous tracer uptake. No focal abnormality seen in liver. The spleen shows normal size and shape with homogenous tracer uptake. No focal abnormality seen in the spleen. No colloid shift in spleen or bone marrow

Impression: Normal liver and spleen scan.

12.2 Case 2: Case of Splenosis

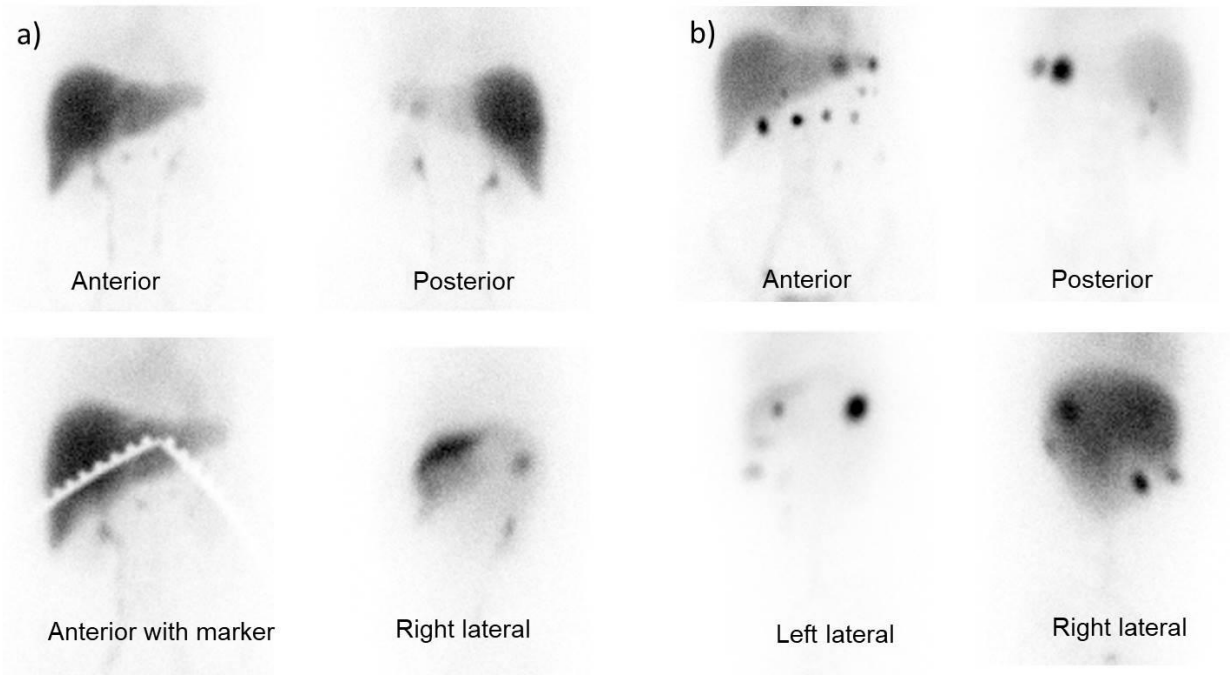

Figure 2 a) ^{99m}Tc- Sulphur colloid liver-spleen scintigraphy b) ^{99m}Tc-Denatured RBCs In-vitro labelled scintigraphy

Clinical Details: 34-years old female is a known case of lymphoma on follow-up. Recent PET-CT shows multiple hypodense lesions are seen within the abdominal cavity with no hypermetabolic activity. Patient has history of splenectomy after car accident at age of 6 years due to rupture spleen.

Findings: ^{99m}Tc- Sulphur colloid liver-spleen scintigraphy show no functional parenchymal tissue is seen in the splenic area, while homogeneous tracer uptake in the liver with no focal abnormality seen in liver. Few foci of mildly increased tracrt activity are noted in upper abdomen. b) ^{99m}Tc Denatured RBCs In-vitro labelled scintigraphy show multiple focal areas of increased tracer are noted in the abdomen. Focal area of increase tracer uptake is also seen at right pelvic region

Impression: Findings are consistent with multiple active splenic tissues in the abdomen and pelvis due to splenosis.

12.3 Case 3: Case of Polysplenia

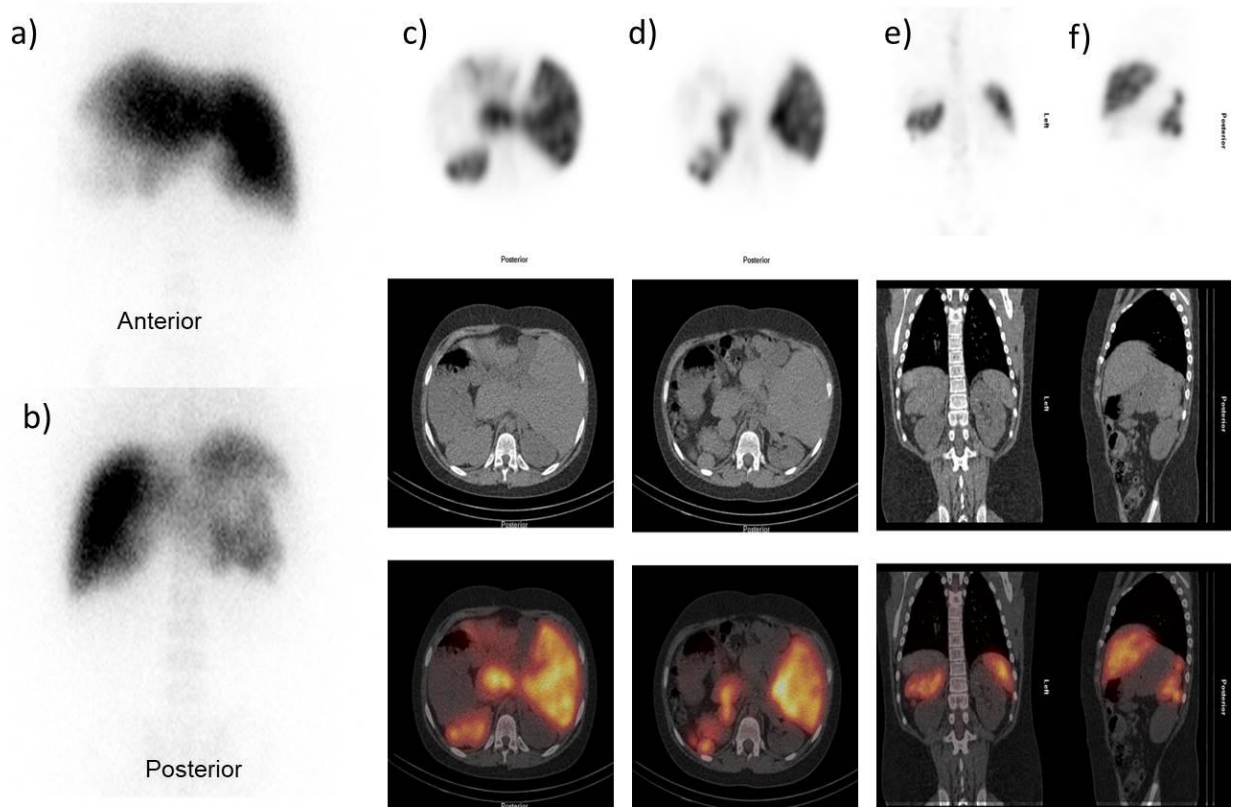

Figure 3 ^{99m}Tc- Sulphur colloid liver-spleen scan a) Anterior b) Posterior view c-f) SPECT-CT

Clinical Details: 8-years girl has situs inversus referred for evaluation of non-functional spleen or asplenia.

Findings: ^{99m}Tc - Sulphur colloid liver-spleen images show situs inversus. There is lobulated functional splenic tissue is present in the upper abdomen posteriorly at D9-D12 vertebrae level, approximately 66mm in dimension. Multiple small rounded soft densities are also noted at superior and inferior border of spleen with increase tracer uptake (splenules).

Impression: Findings are consistent multiple functional splenic tissue (polysplenia) at right side.

12.4 Case 4: Normal Hepatic Blood Pool Imaging

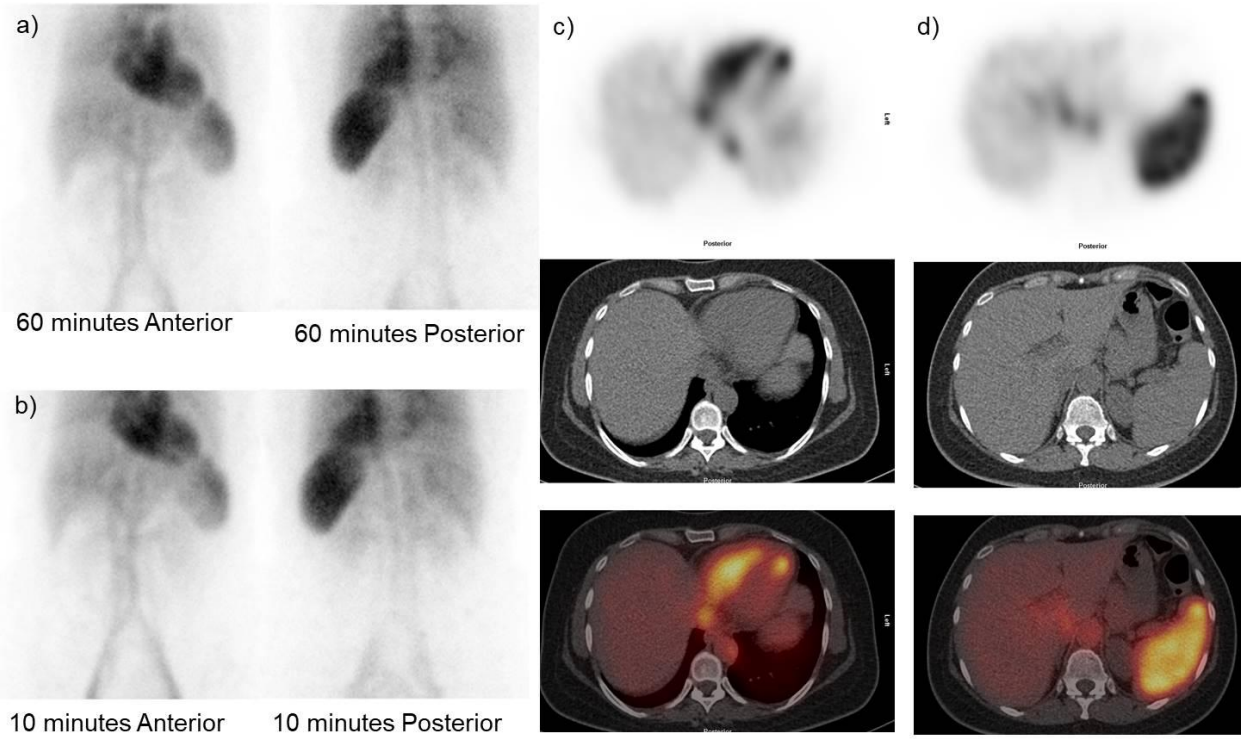

Figure 4: ^{99m}Tc **labeled** RBC Scan of the Liver a-b) 60 and 10minutes static images c-d) SPECT/CT images

Clinical Details: A 50 years old female has breast cancer. Recent CT scan showed small liver lesion at right lobe of liver. Patient was referred for RBCs labeled scan to rule out hepatic hemangioma.

Findings: The static and SPECT/CT image showed physiological radiotracer distribution with no focal abnormality seen in the liver. There is no evidence of any increased blood pool at the sites of lesions noted on CT scan.

Impression: Normal Hepatic blood pool imaging. No scintigraphic evidence of vascular hepatic lesion (Hemangioma).

12.5 Case 5: Hepatic Blood Pool Imaging positive for Haemangioma

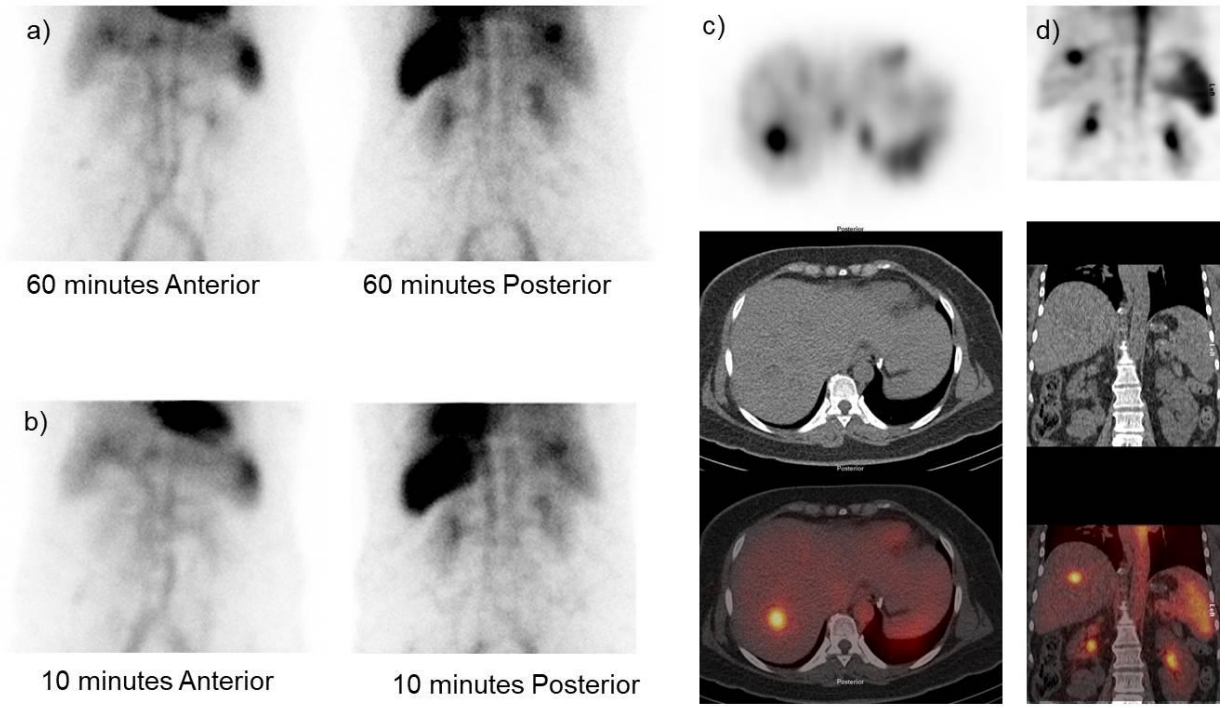

Figure 5: ^{99m}Tc **labeled** RBC Scan of the Liver a-b) 60 and 10 minutes static images c-d) SPECT/CT images

Clinical Details: 52-year-old lady, presented with focal hypodense hepatic lesion in the right lobe of liver on CT scan. Patient was referred for RBCs labelled scan to rule out hepatic hemangioma.

Findings: The static and SPECT/CT images show image shows focal area of mildly increased radiotracer uptake area at right lobe of liver on early images that show further filling on the delayed images in segment VII of the liver, corresponding CT show hypodense lesion measuring about 3 x2x2.7 cm.

Impression: Positive for scintigraphic evidence of single hepatic vascular lesion (Haemangioma) at segment VII.

12.6 Case 6: Hepatic Blood Pool Imaging positive for Multiple Haemangioma

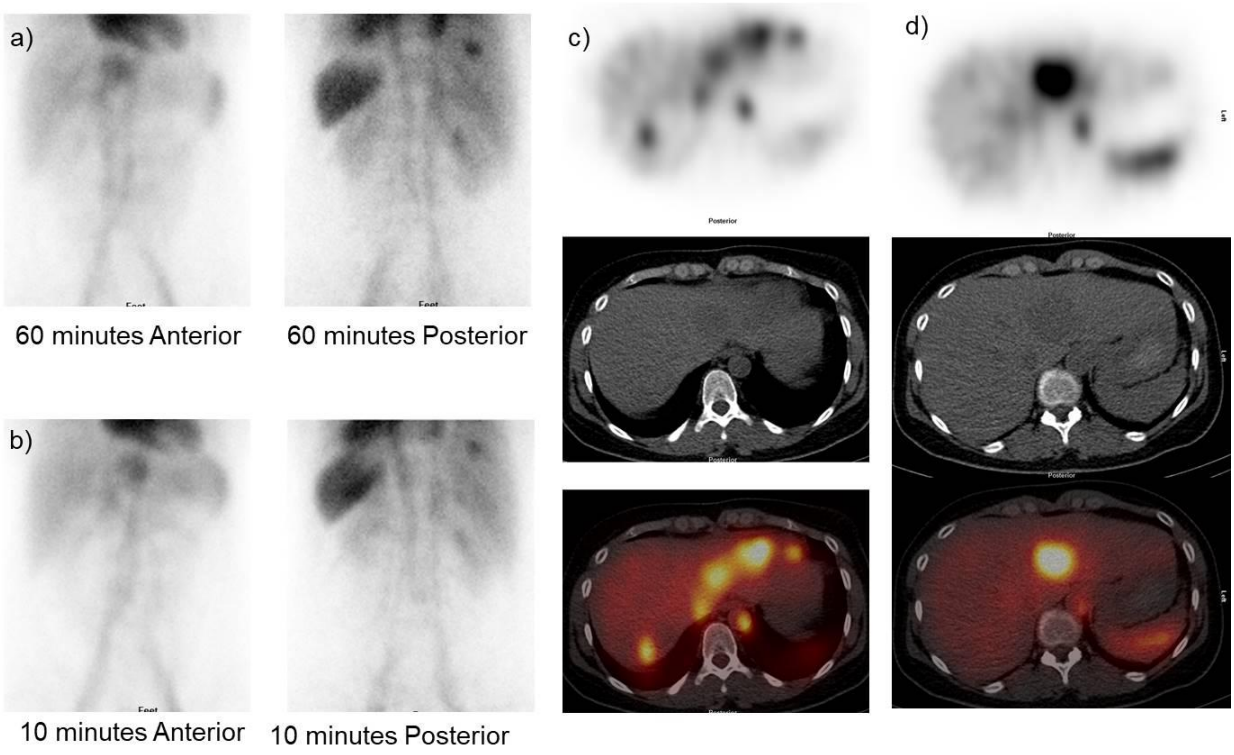

Figure 6: ^{99m}Tc RBCs Labelled Scan of the Liver a-b) 60 and 10minutes static images c-d) SPECT/CT images

Clinical Details: A 40-year-old female, known case of papillary thyroid cancer with cervical lymphadenopathy, accidentally found to have multiple hypodense hepatic lesions on CT abdomen. The RBCs labelled scan to rule out hepatic haemangioma.

Findings: The static and SPECT/CT images show image shows two focal areas of mildly increased radiotracer uptake area at right lobe of liver on early images that show further filling and on the delayed images. SPECT-CT show hypodense lesion at segment IVa measuring 3.3x 3.4x 3.6 cm, another small subcentimeter hypodense lesion is seen at segment VII with corresponding increase tracer uptake on fused images.

Impression: Positive for scintigraphic evidence of multiple hepatic vascular lesions (haemangioma) at segment IV and VII.

12.7 Case 7: Hepatic Perfusion Imaging: Case of an appropriate candidate for Y-90 Radioembolisation

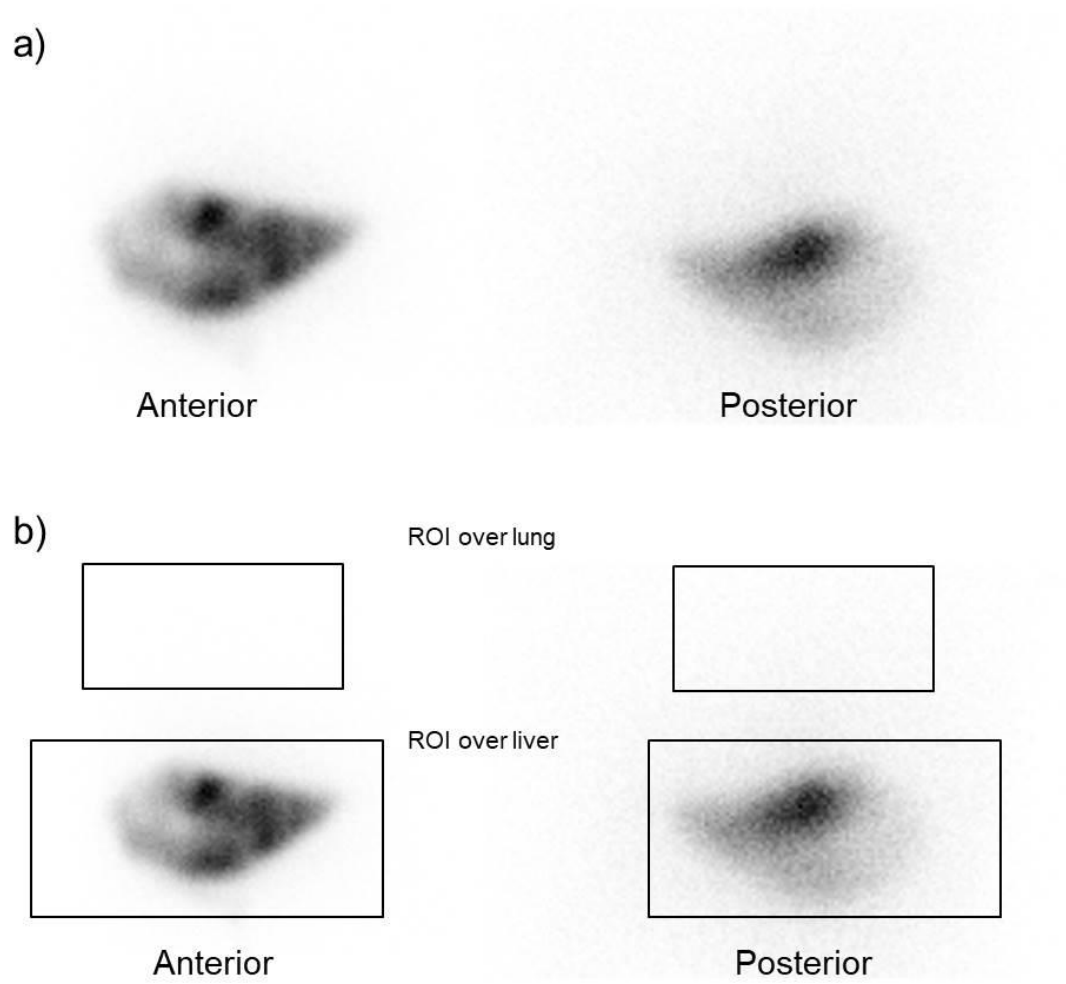

Figure 7: ^{99m}Tc MAA hepatic Perfusion study. a) 30 minutes post intra-arterial radiotracer Anterior and posterior abdominal static images b) ROI over lung and liver for shunt quantification.

Clinical Details: A 69-year-old male patient who is a known case of colorectal cancer with liver metastases. Patient is referred for Y-90 Therasphere Radioembolisation therapy.

Procedure: Patient had angiographic procedure to delineate the liver vessel anatomy. The tumor hypervascualrity was seen at the left hepatic lobe region. Hepatic angiography was done and 4.3 mCi of ^{99m}Tc MAA in a 1 ml volume injected intra arterially at rate of <1 mL/min into the left hepatic artery through the hepatic stent.

Findings: Anterior and posterior static images showing localization of Tc99m MAA within the left liver lobe. No extra-hepatic gastrointestinal accumulation was noted.

Regions of interest (ROI) were placed on the lungs and liver, utilizing the geometric mean method (Geometric mean of liver is 640072 counts; Geometric mean of the lung is 29766 counts.) the lung shunt fraction 4%.

Impression: Hepatic Perfusion mapping for Y-90 radioembolization show scintigraphic activity in liver lesion at left lobe of liver with lung shunt fraction of 4%.

Patient is a candidate of radio-embolization.