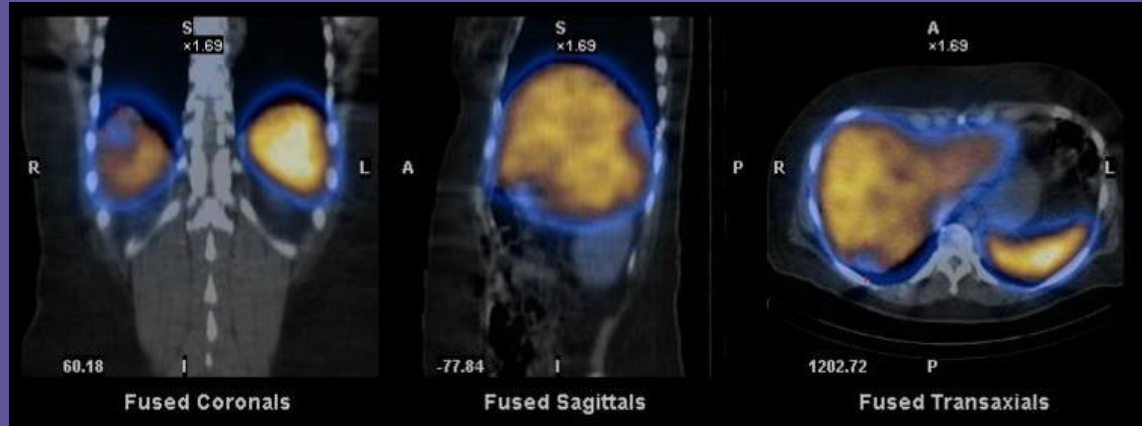


The Role of Nuclear Medicine in Imaging of the Liver



Introduction

- Nuclear Medicine provides functional imaging of organs and physiological systems
- Frequently used for *skeletal, myocardial, lung, endocrine, GU & GI imaging*
- One of the oldest examinations and most common = **liver & hepatobiliary imaging**
- ^{99m}Tc –labelled tracers ($T_{1/2}$ 6hours, 140KeV, gamma emitter)
- Gamma camera with SPECT/CT capabilities (fusion/hybrid imaging)



Hot lab & SPECT/CT Gamma Camera Set-up



Two Goals in NM Imaging of the Liver

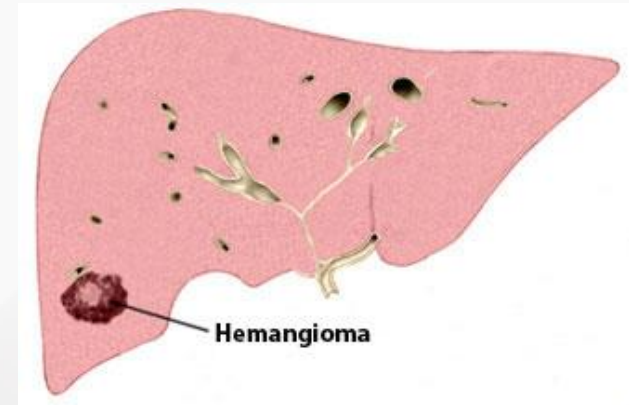
- **Liver-spleen imaging**

to gain images of hepatic &/or splenic tissue and to detect or characterise abnormalities

- *Sulphur colloid liver & spleen scan*
- *Red blood cell haemangioma scan*
- *Liver perfusion pre SIRT scan*

- **Hepatobiliary imaging**

to trace production and flow of bile, from liver through biliary system into the small intestine



^{99m}Tc -Sulphur Colloid Liver & Spleen Scan



- **Assess size, shape and position** of the liver and spleen
- **Detect, measure and monitor** masses of the liver &/or spleen
- **Identify** functioning splenic tissue
- **Evaluate** suspected functional asplenia
- **Differentiate** hepatic hemangiomas and focal nodular hyperplasia from other focal liver lesions
- **Assess** diffuse liver lesions, eg Cirrhosis & hepatitis

- Involves IV administration of ^{99m}Tc -Sulphur Colloid, which localize in the **reticuloendothelial cells** of the liver, spleen and bone marrow



^{99m}Tc -Sulphur Colloid Liver & Spleen Scan

- **Patient preparation**

- Nil
- History of previous surgeries
- Results of previous imaging abdominal US, MRI or CT

- **^{99m}Tc -Sulfur colloid**

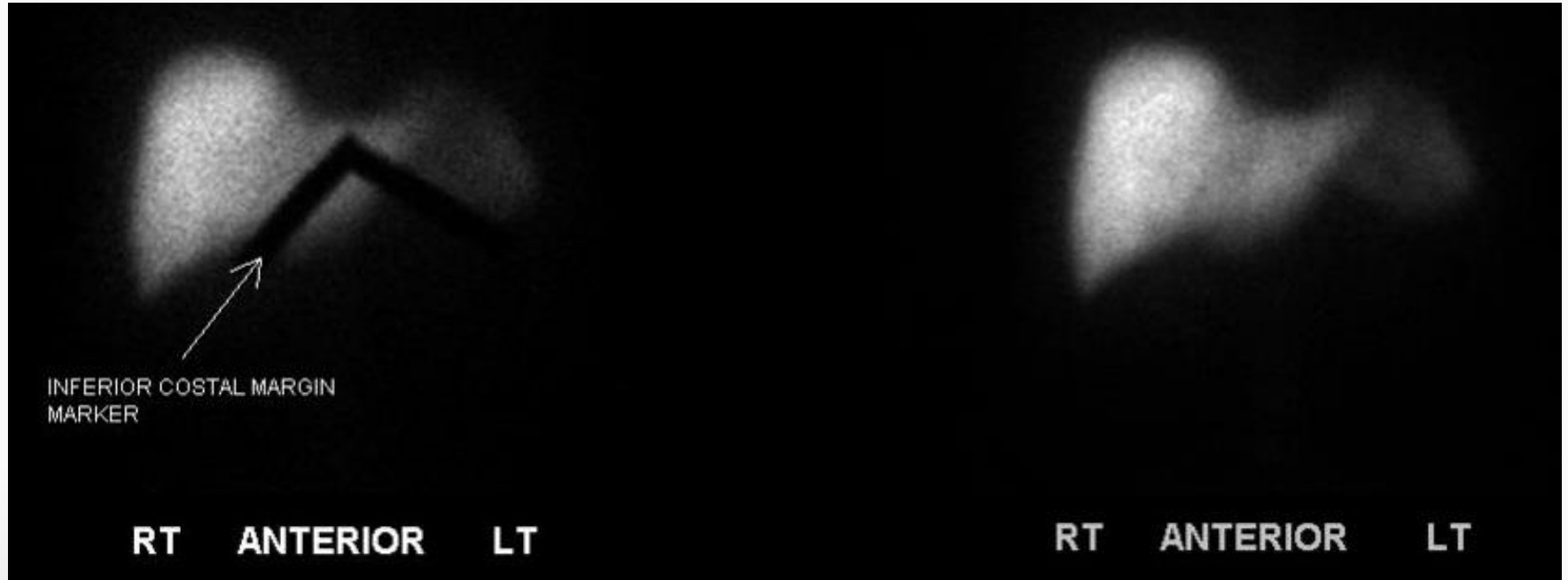
- Administered IV
- 200MBq in adults
- 1.87mSv = xray Lumbar spine series
1.8mSv
- <http://www.doseinfo-radar.com/RADARDoseRiskCalc.html>

- **Static imaging begins 15-20 minutes after injection**

- ANT, POST, RAO, LAO, ANT with costal margin marker
- SPECT/CT – 40 secs/image



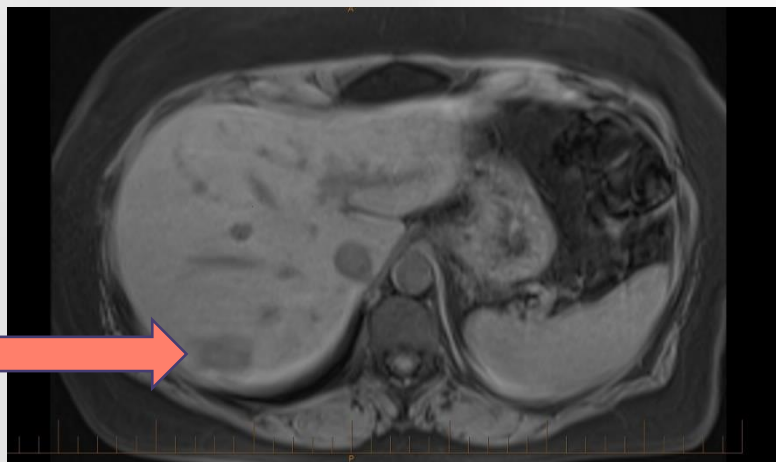
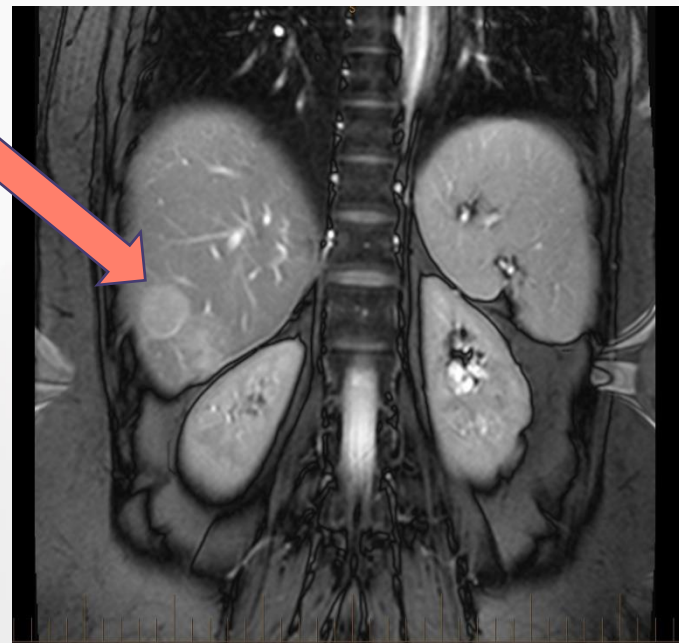
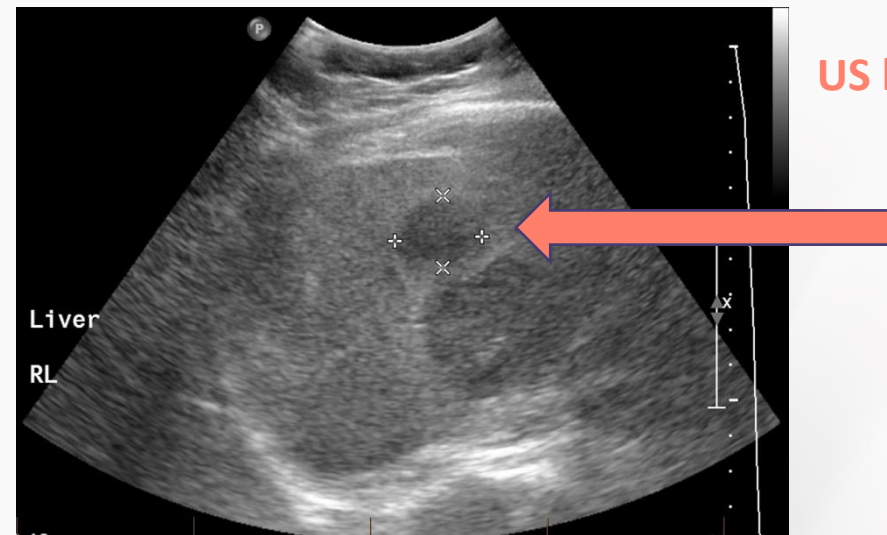
^{99m}Tc -Sulphur Colloid Liver & Spleen Scan



^{99m}Tc -Sulphur Colloid Liver & Spleen Scan

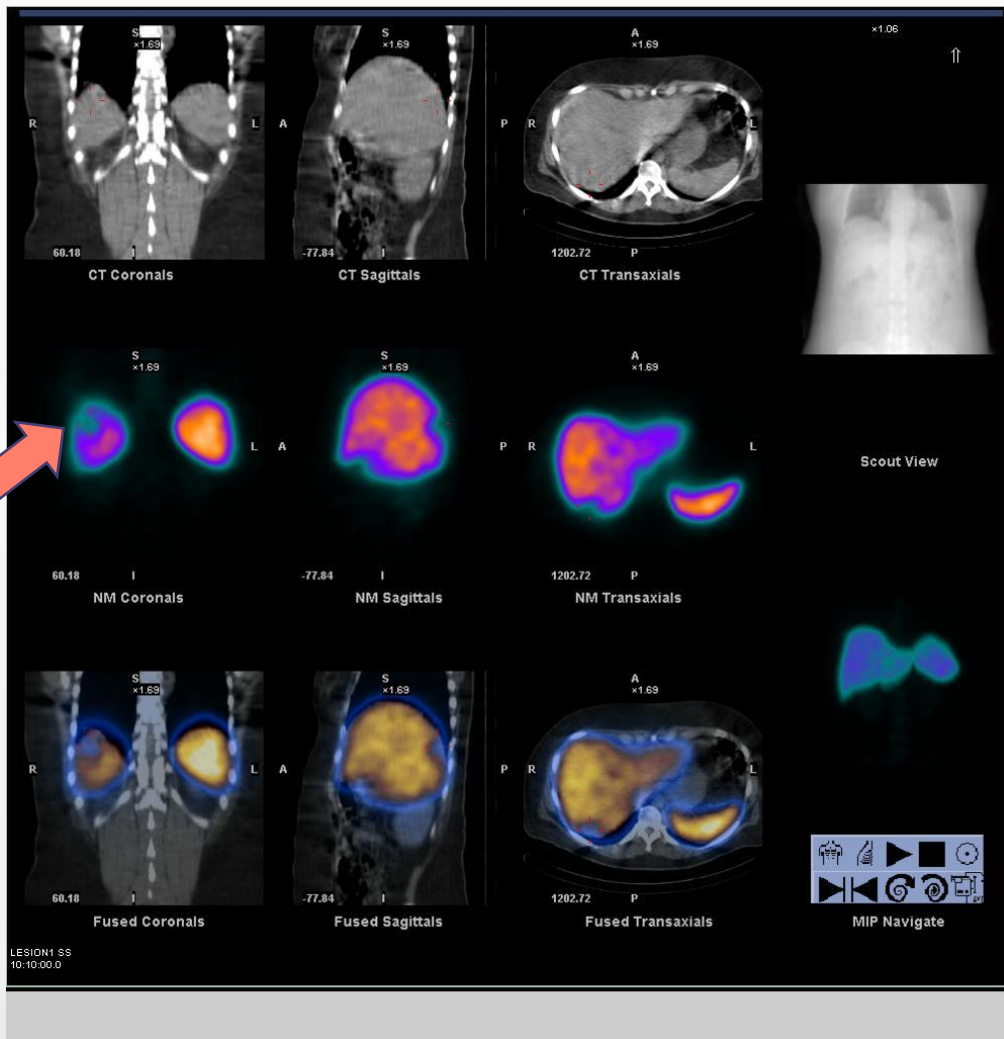
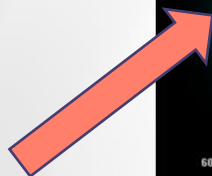
US liver

Enhanced MRI, T1 vibe Dixon, and
T2+FS Cor



^{99m}Tc -Sulphur Colloid Liver & Spleen Scan

Result = confirm cold area in segment 7 FNH.
Inferior lesion also suggestive of FNH, and not haemangioma as thought on MRI.



^{99m}Tc -Labeled Red Blood Cells - ? Haemangioma

- *Differentiate* hepatic haemangiomas and focal nodular hyperplasia from other liver lesions
- Utilise the *blood pool* of the liver
- Haemangiomas are conspicuous with ^{99m}Tc RBC imaging because of their relatively greater blood volume than that of surrounding liver parenchyma



2. ^{99m}Tc -Labeled Red Blood Cells - ? Haemangioma

- **Patient preparation**

- Nil
- History of previous surgeries, esp biliary and GI
- Results of previous imaging

- **^{99m}Tc -Labeled Red Blood Cells (RBC's)**

- Administered IV
- 840MBq in adults

 5.6mSv

- **Dynamic & static imaging**

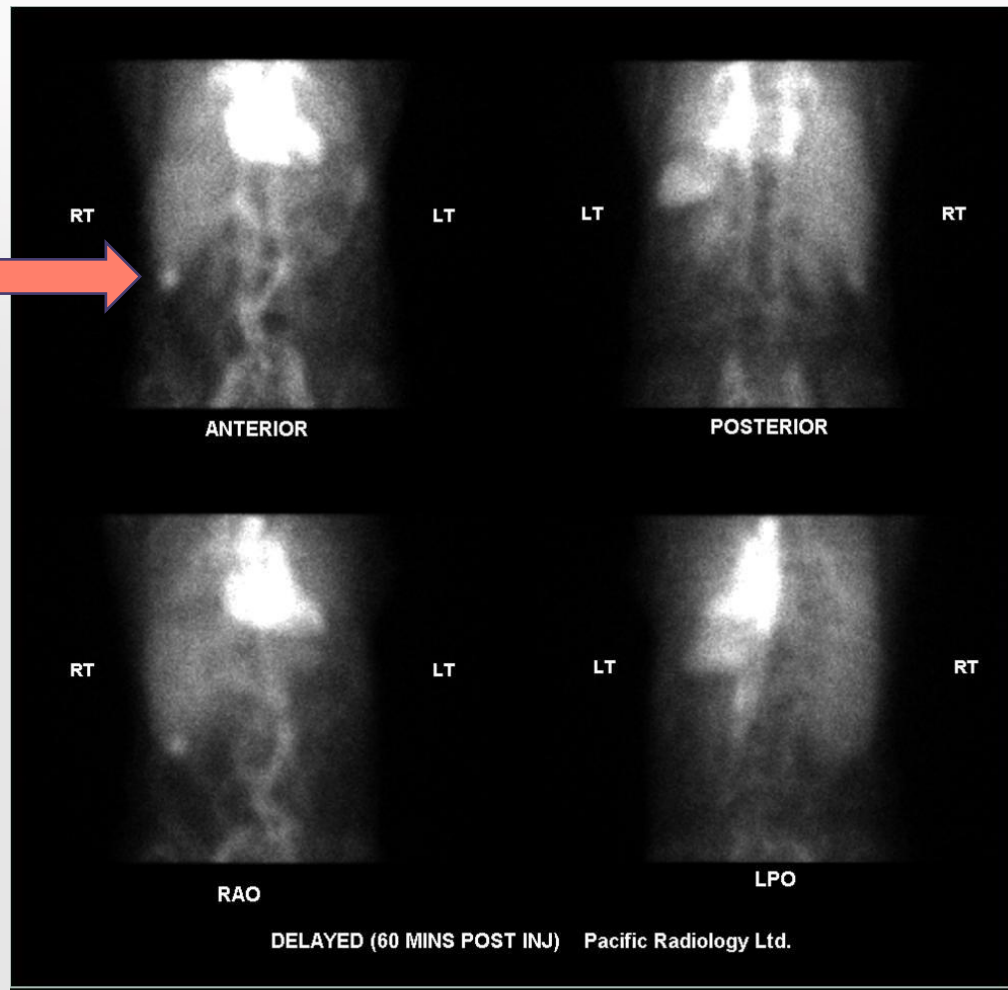
- Initial 60 sec dynamic (flow)
- Early ANT/POST static
- Delay of 2 hours then repeat statics and do a SPECT/CT

- <http://www.doseinfo-radar.com/RADARDoseRiskCalc.html>

^{99m}Tc -Labeled Red Blood Cells – Static Images

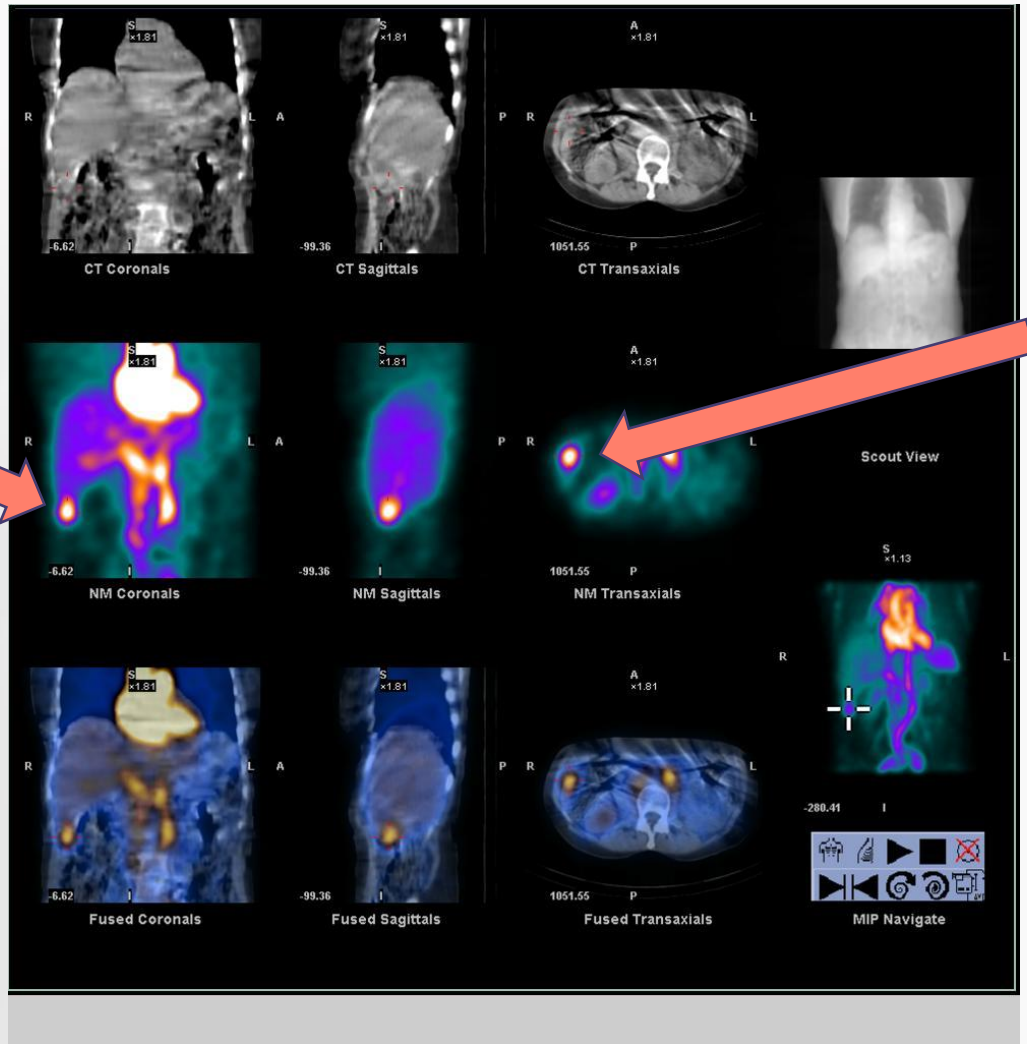


70 yr old female
= incidental finding mass in liver on CT abdomen when patient admitted to Emergency Dept. To rule out/confirm haemangioma.



^{99m}Tc -Labeled Red Blood Cells – SPECT/CT fused images

Result:- Lesion in inferior tip of the right lobe of liver, segment 6, shows increased uptake and retention of red cells, consistent with haemangioma. Good correlation on position obtained with SPECT/CT and the original CT.



^{90}Y -SIR-Spheres SIRT Therapy

- Selective Internal Radiation Therapy **SIR-Spheres®**
 - Non-resectable malignant liver tumours
 - Primary or secondary (HCC or CRC mets)
 - Failure of 1st or 2nd line chemotherapy
 - LAST CHANCE
- ^{90}Y ittrium is a beta emitter, travels cm's in tissue



^{99m}Tc -MAA Liver Perfusion Scan

- ***Confirm patency*** of hepatic arterial perfusion catheters and evaluate pattern of blood flow via these catheters
- Used to detect any extra hepatic shunting to the lungs or gastrointestinal tract
- Provides a simulation of the treatment & is used to identify the shunting of microspheres to the lungs or gastrointestinal tract

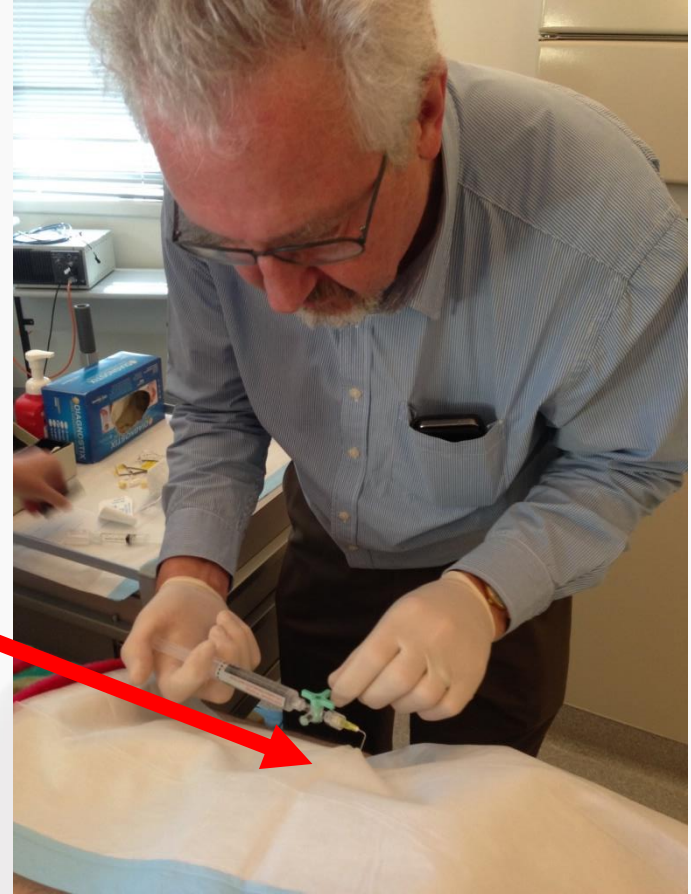


^{99m}Tc -MAA Liver Perfusion Scan

- Tc-99m MAA particles are larger than capillary size (range, 10-90 μm ; mean, 30-50 μm)
- Distribute according to blood flow, and are trapped on first pass in the arteriolar-capillary bed of the liver
- **The particles are approximately the same size as Y-90 SIR-Spheres[®] bearing microspheres and have a similar pattern of microspheres distribution**



^{99m}Tc -MAA Liver Perfusion Scan



^{99m}Tc -MAA Liver Perfusion Scan

UPTAKE RATIOS

LUNG = 8.92%

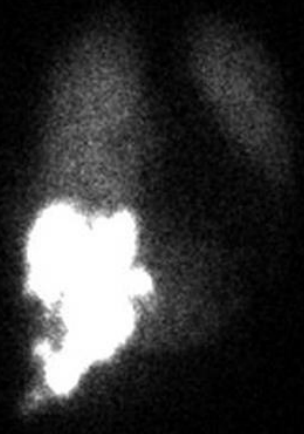
LIVER = 91.08%



ANTERIOR with ROI's

Rt

Lt



ANTERIOR

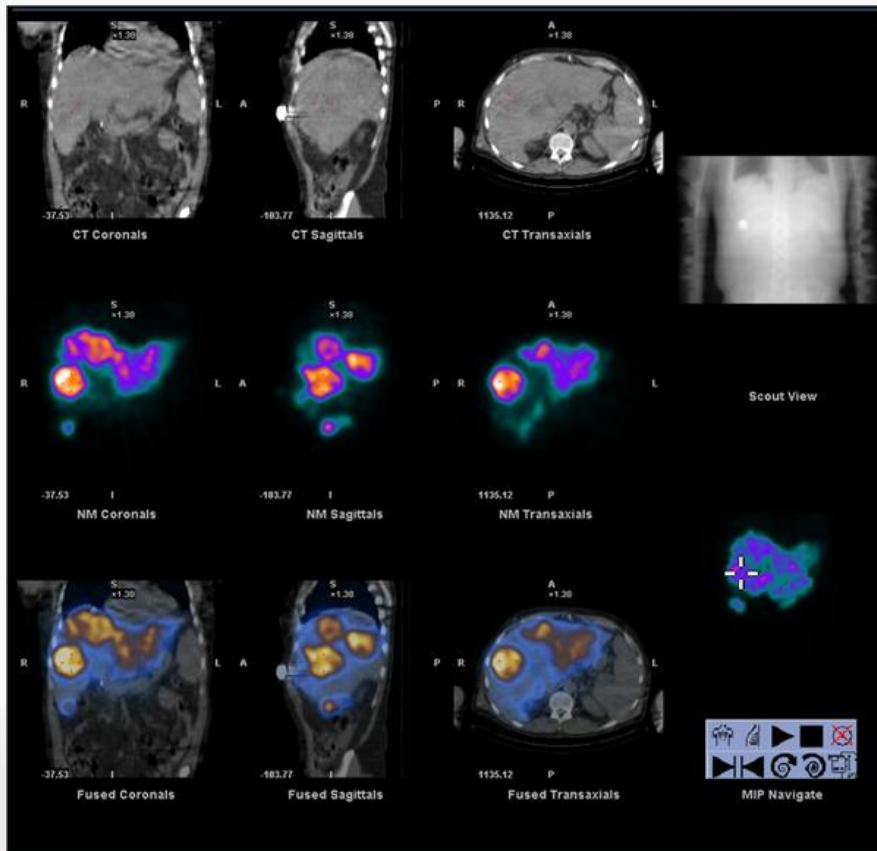


^{99m}Tc -MAA Liver Perfusion Scan

UPTAKE RATIOS

LUNG = 2.57%

LIVER = 97.43%



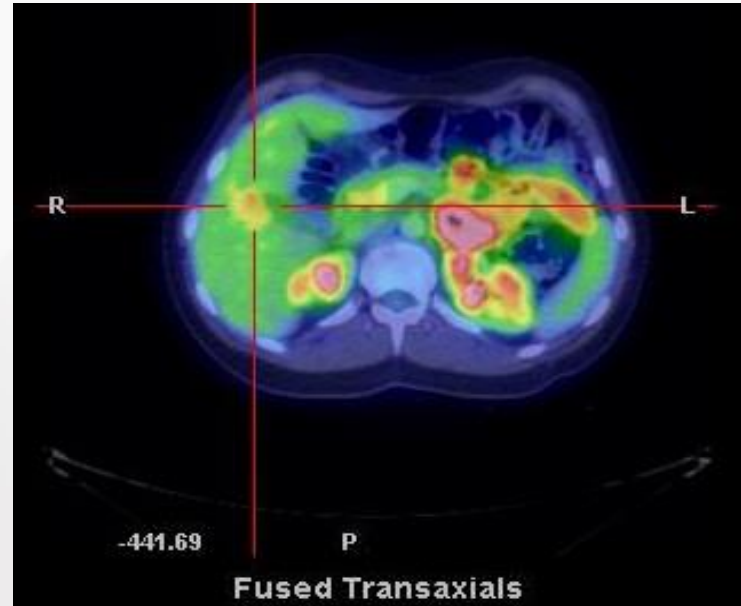
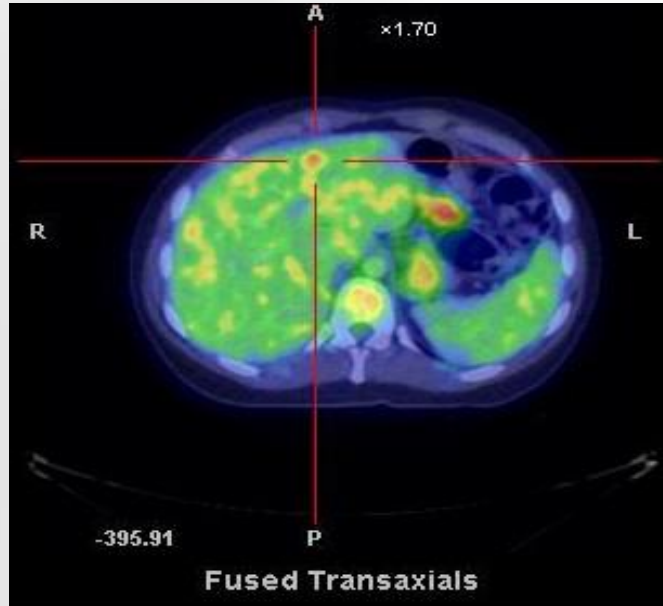
^{90}Y -SIR-Spheres SIRT Therapy

- Selective Internal Radiation Therapy **SIR-Spheres®**
 - Non-resectable malignant liver tumours
 - Primary or secondary (HCC or CRC mets)
 - Failure of 1st or 2nd line chemotherapy
 - LAST CHANCE
- ^{90}Y ittrium is a beta emitter, travels cm's in tissue
- Selective catheters into lobar branches
- Check placement with use of contrast
- Then give treatment

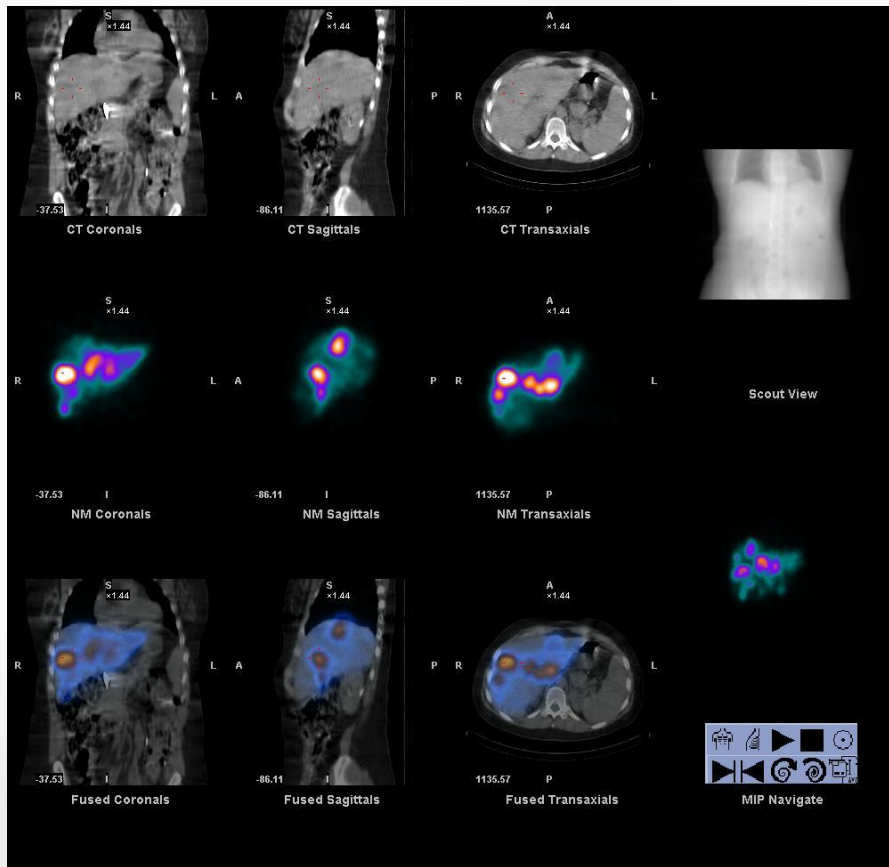


^{18}F -FDG PETCT scan

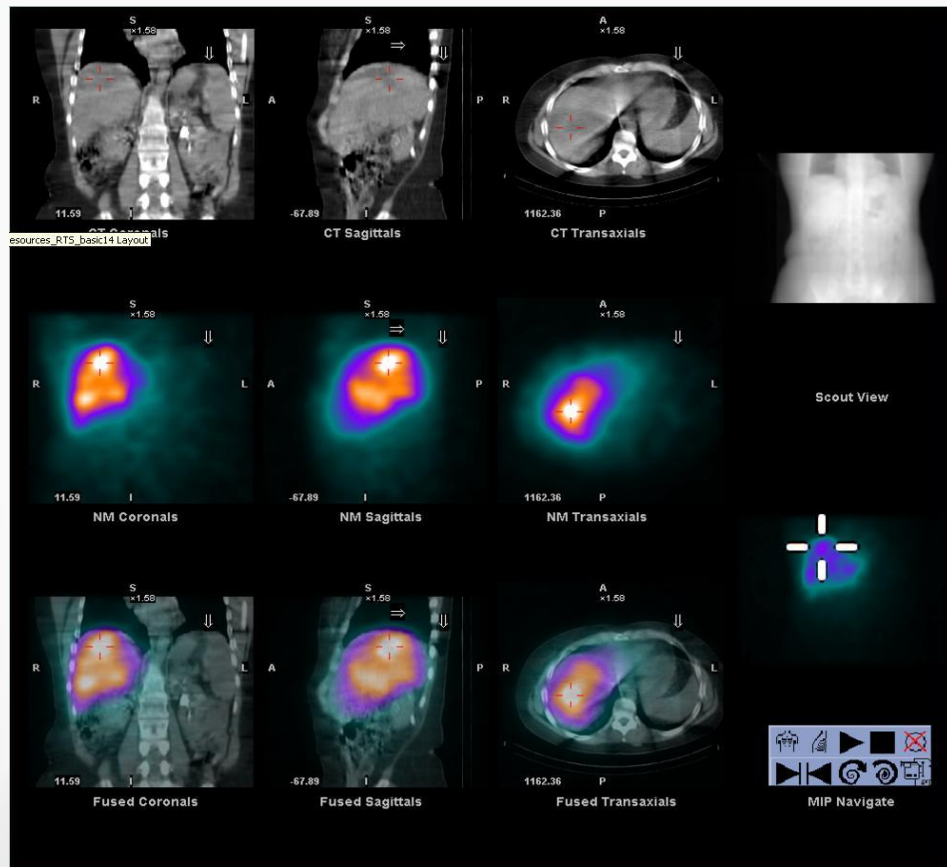
= 36 yr old female with metastatic colo-rectal cancer



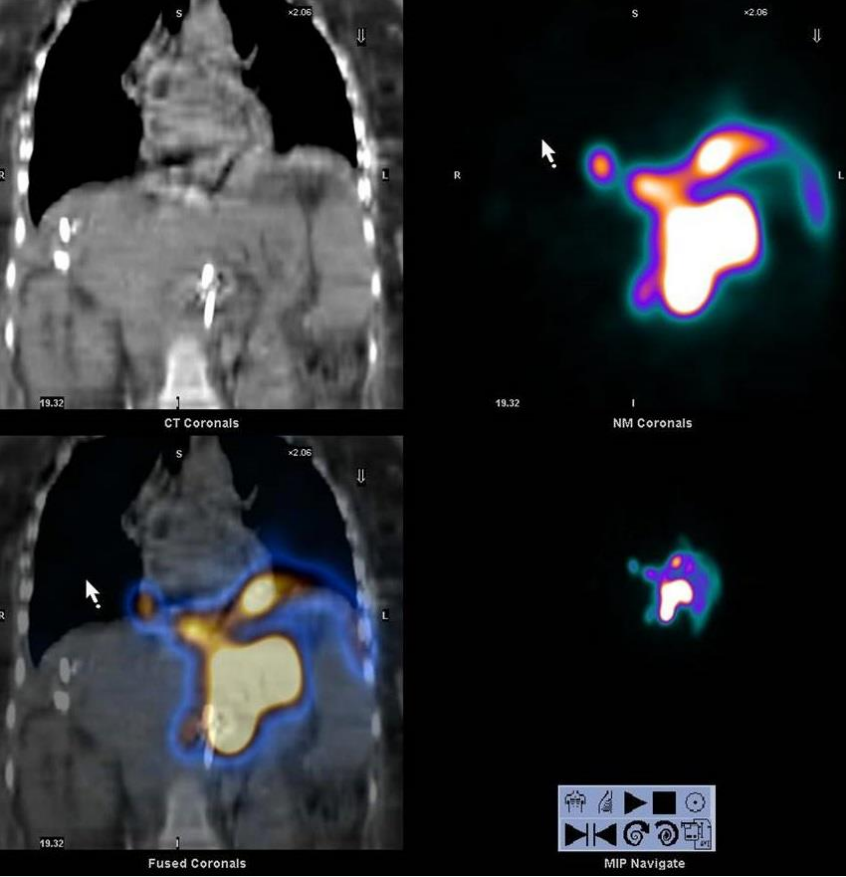
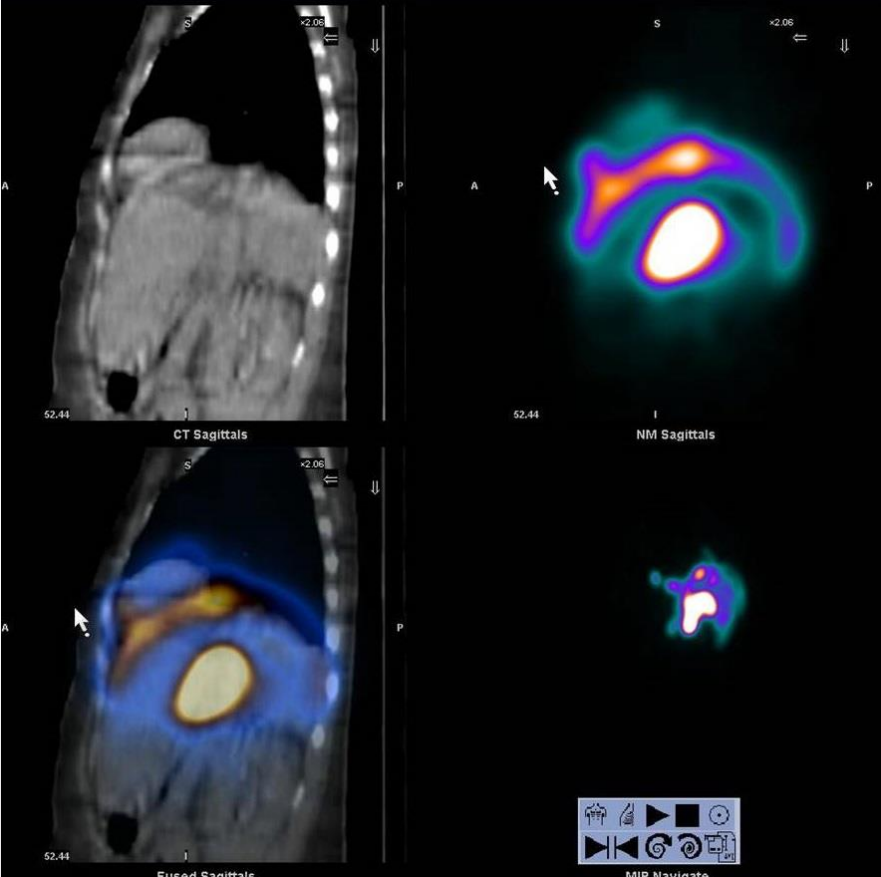
MAA liver perfusion scan



Bremsstrahlung scan

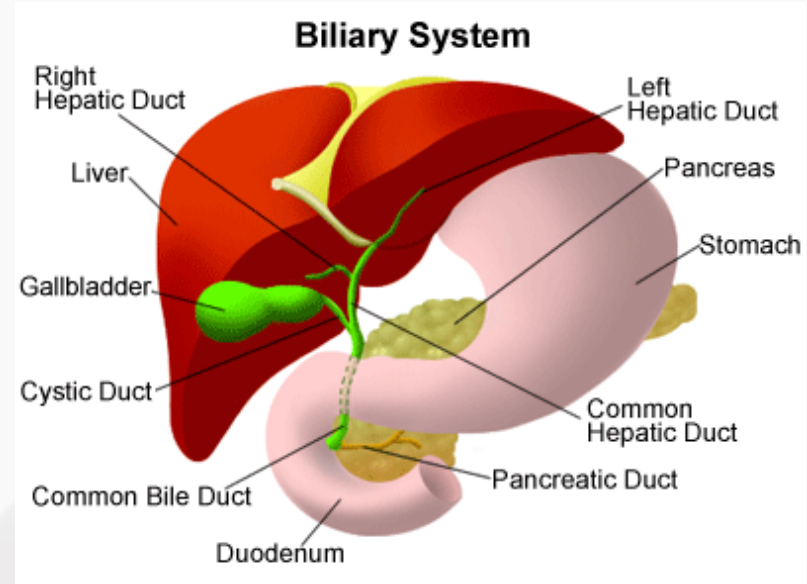


Failed catheter placement



Hepatobiliary Imaging - Definition

- To evaluate *hepatocellular function* and the biliary system by tracing the production and flow of bile from the formative phase in the liver, and it's passage through the biliary system into the small intestine



Hepatobiliary Imaging – Clinical Indications

- Functional biliary pain syndromes in adults and in paediatric patients
- Acute cholecystitis
- RUQ pain variants
- Biliary system patency
- Bile leakage
- Neonatal hyperbilirubinemia (biliary atresia vs neonatal hepatitis “syndrome”)
- Assessment post-surgery (biliary enteric bypass; bile reflux after gastrectomy)
- Calculation of gallbladder ejection fraction (GBEF)
- Sphincter of Oddi dysfunction



Hepatobiliary Imaging - Technique

• Patient preparation

- Nil by mouth 6 hours (fasting longer than 24 hours can cause GB not to fill within normally expected time)
- List of current medications
- History of previous surgeries, esp biliary and GI
- Results of previous GB or abdominal US

• ^{99m}Tc-Disofenin (HIDA)

- Administered IV
- 111MBq-185MBq in adults
- 2.51mSv = slightly more than an axial CT head 2.1mSv
- <http://www.doseinfo-radar.com/RADARDoseRiskCalc.html>

• Initial scan time 60 minutes

- +/- 2-4 hours post injection dependent on an individual patient's needs



Hepatobiliary Imaging – Imaging Technique

- **Pacific Radiology Wellington Protocol**

- Dynamic imaging (60 sec frames)

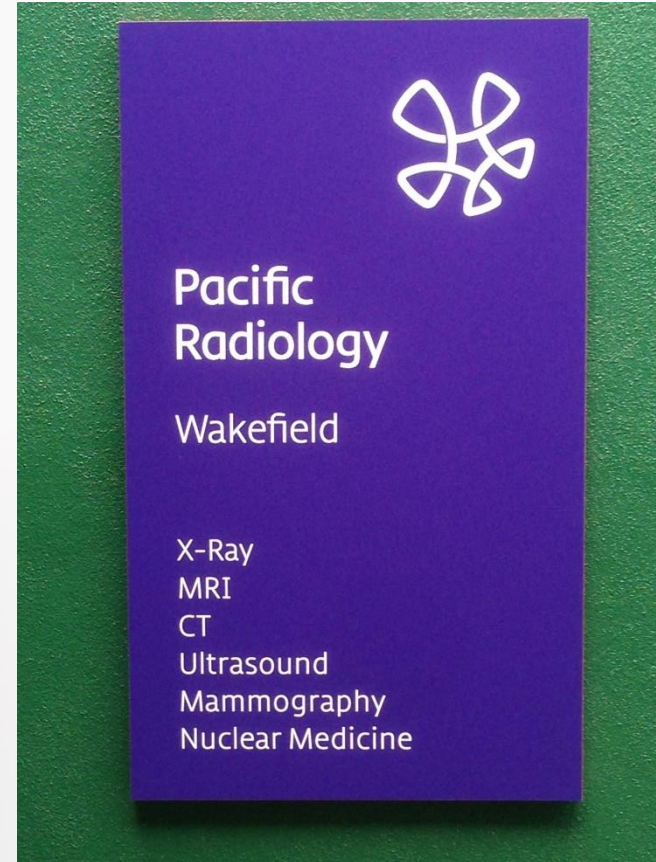
T0-60 minutes

- **If GB seen:**

- pre-meal image
- Fatty meal (3 x Mars bars = 9g fat)
- Post meal image 1 hr post meal

- **GB not seen within 60 minutes:**

- Delayed images up to 3-4 hours

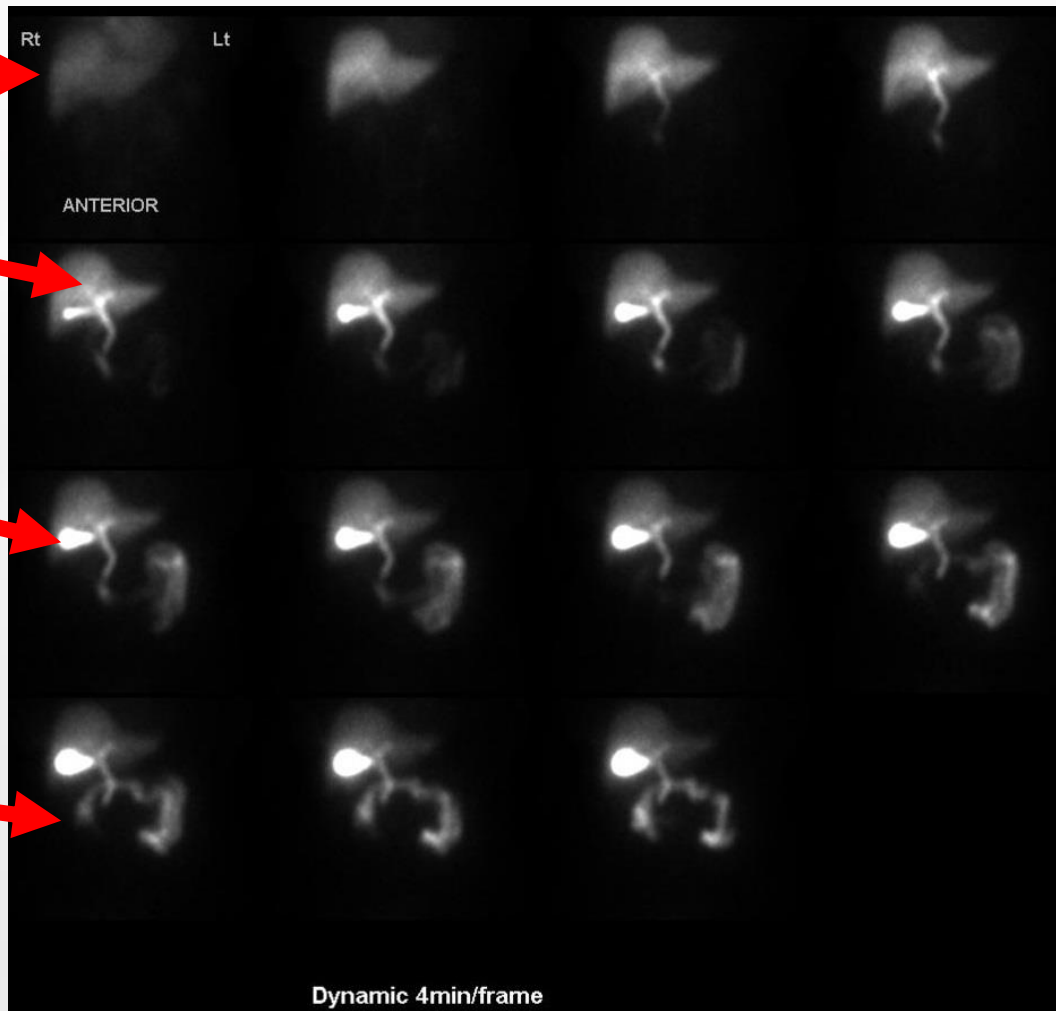


Liver parenchyma

Intra-hepatic ducts

Gall bladder

Upper small bowel

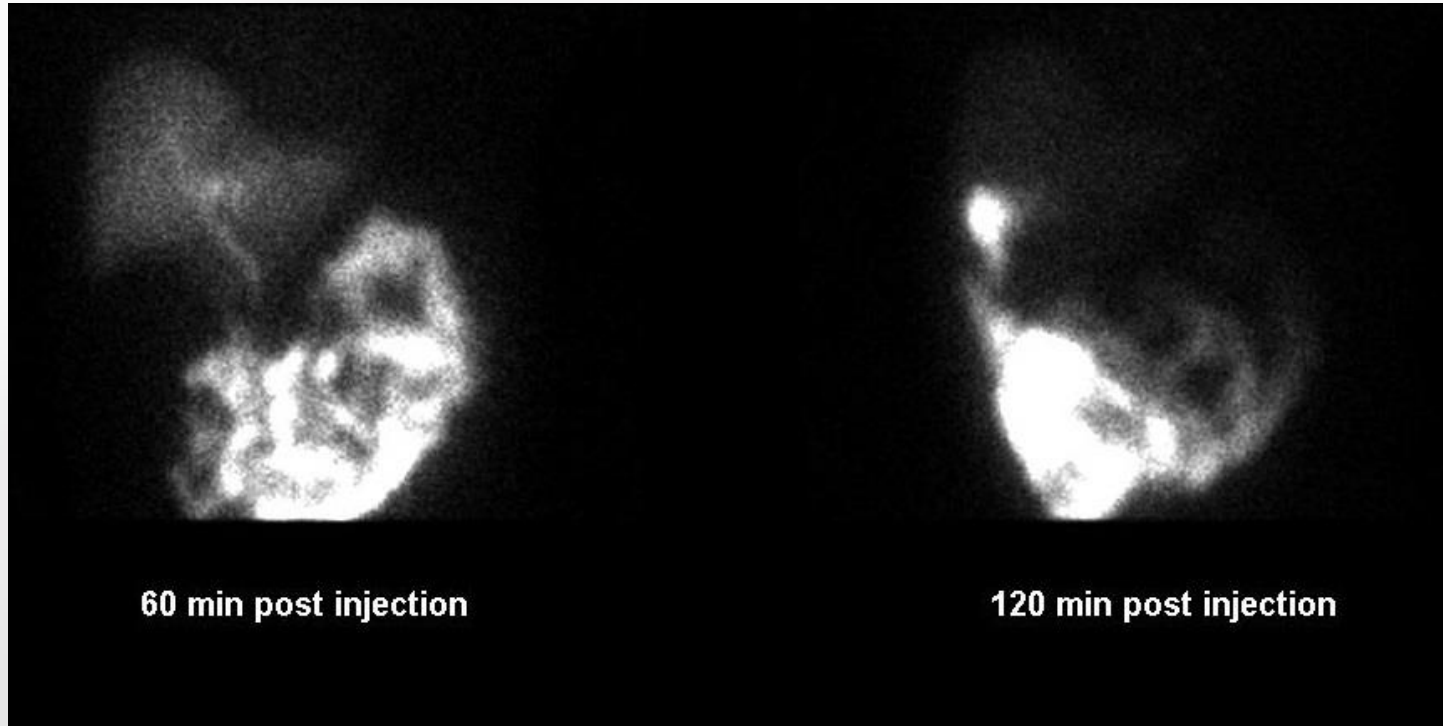


Hepatobiliary Imaging – Fatty meal

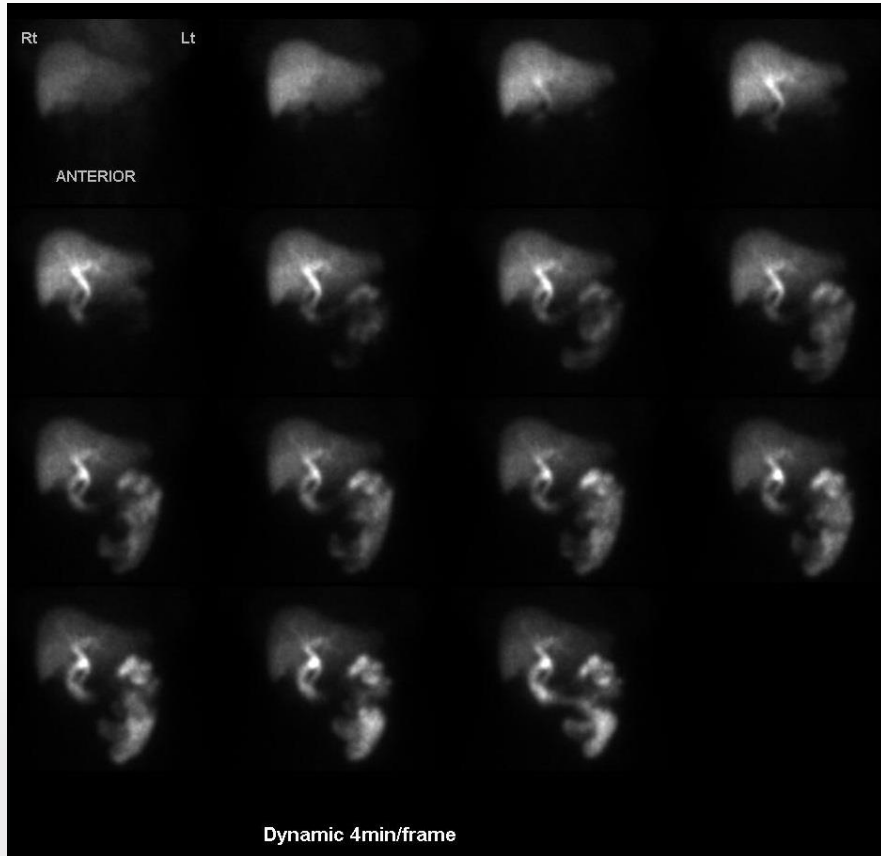
60 mins post fatty meal,
87.5% has been excreted
= *normal ejection fraction*



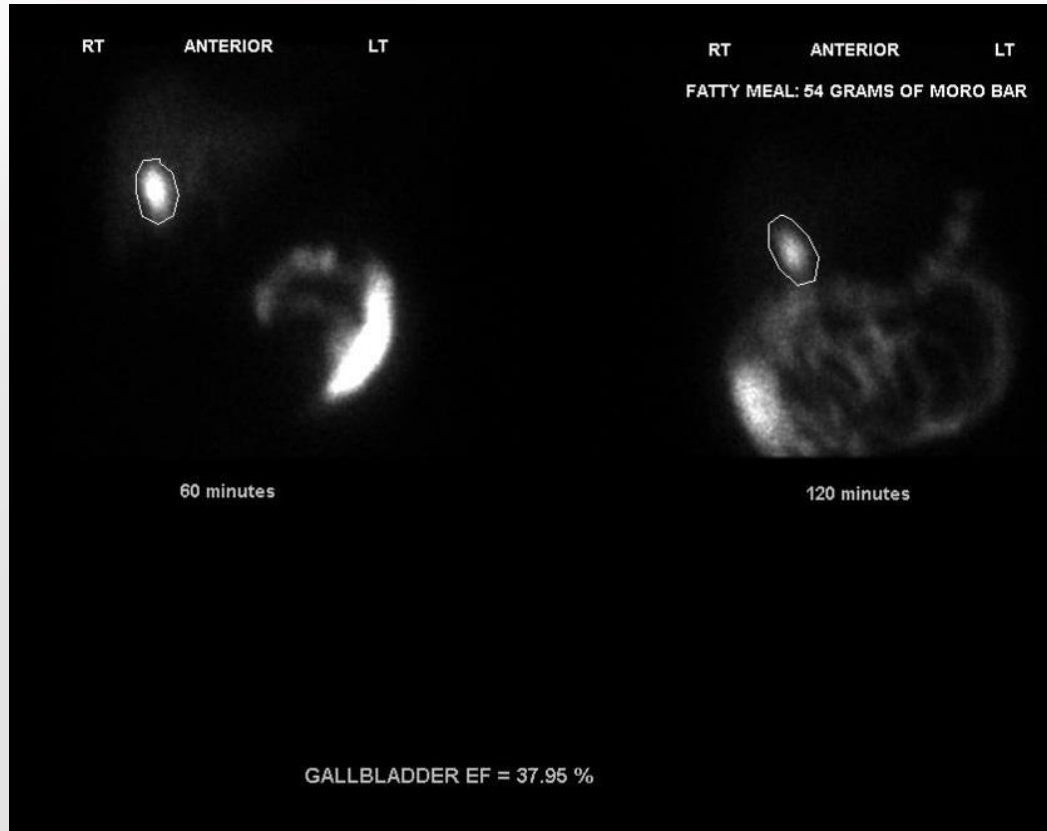
Hepatobiliary Imaging – Chronic Cholecystitis



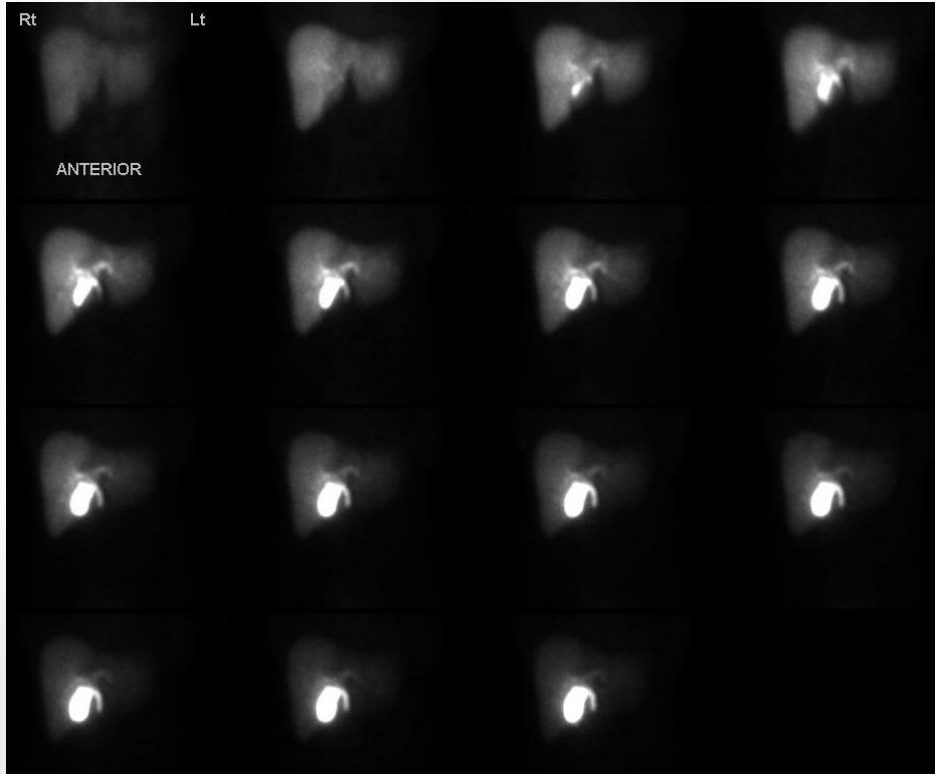
Hepatobiliary Imaging – Acute Cholecystitis



Hepatobiliary Imaging – reduced GBEF



Hepatobiliary Imaging – delayed biliary-to-bowel transit



Hepatobiliary Imaging – sources of error

• False-positive

- Insufficient fasting (<2-4h)
- Prolonged fasting (>24h)
- Severe hepatocellular disease
- High-grade CBD obstruction
- Severe intercurrent illness
- Pancreatitis
- Rapid biliary-to-bowel transit
- Severe chronic cholecystitis
- Previous cholecystectomy

• False-negative

- Bowel loop simulating gall bladder
- Acute acalculous cholecystitis
- Dilated-cystic-duct sign simulating gall bladder
- Bile leak due to GB perforation
- Congenital anomalies simulating GB
- Activity in kidneys simulating GB or small bowel



Conclusion

- Nuclear Medicine provides *functional imaging* alternative to investigating the liver
- *Compliments* the anatomical imaging provided by CT, MRI & US
- *Non-invasive*, yet time consuming
- Need good understanding of normal physiology to be able to interpret false positive and negative studies





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