The Role of Nuclear Medicine in Imaging of the Liver

CPD Workshop, Saturday 11th March 2017
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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
• \(^{99m}\text{Tc}\)–labelled tracers (T½ 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
99mTc-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 99mTc-Sulphur Colloid, which localize in the reticuloendothelial cells of the liver, spleen and bone marrow
**99mTc-Sulphur Colloid Liver & Spleen Scan**

- **Patient preparation**
  - Nil
  - History of previous surgeries
  - Results of previous imaging: abdominal US, MRI or CT

- **99mTc-Sulfur colloid**
  - Administered IV
  - 200MBq in adults
  - 1.87mSv = x-ray Lumbar spine series
  - 1.8mSv

- **Static imaging begins 15-20 minutes after injection**
  - ANT, POST, RAO, LAO, ANT with costal margin marker
  - SPECT/CT – 40 secs/image
$^{99m}\text{Tc}-\text{Sulphur Colloid Liver & Spleen Scan}$
99mTc-Sulphur Colloid Liver & Spleen Scan

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

US liver
Result = confirm cold area in segment 7 FNH. Inferior lesion also suggestive of FNH, and not haemangioma as thought on MRI.
**99mTc-Labeled Red Blood Cells - ? Haemangiomma**

- **Differentiate** hepatic haemangiomas and focal nodular hyperplasia from other liver lesions
- Utililise 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**
99mTc-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.
99mTc-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.
90Y-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

- 90Yttrium is a beta emitter, travels cm’s in tissue
99mTc-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
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
$^{99m}\text{Tc-MAA}$ Liver Perfusion Scan
$^{99m}$Tc-MAA Liver Perfusion Scan

UPTAKE RATIOS
LUNG = 8.92%
LIVER = 91.08%
$^{99m}$Tc-MAA Liver Perfusion Scan
90Y-SIR-Spheres SIRT Therapy

- **Selective Internal Radiation Therapy** SIR-Spheres®
  - Non-resectable malignant liver tumours
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  - **LAST CHANCE**

- $^{90}$Yttrium 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

Bremsstralung 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 its 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

• \(^{99m}\text{Tc-Disofenin (HIDA)}\)
  • Administered IV
  • 111MBq-185MBq in adults
  • 2.51mSv = slightly more than an axial CT head 2.1mSv

• 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
Hepatobiliary Imaging – Fatty meal

60 mins post fatty meal, 87.5% has been excreted = *normal ejection fraction*
Hepatobiliary Imaging – Chronic Cholecystitis

60 min post injection

120 min post injection
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
  - Pancreatitits
  - 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
THANK YOU