BRITISH NUCLEAR MEDICINE SOCIETY

Clinical Guideline for Hepatobiliary Scintigraphy

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Contents:

This guideline must be read in conjunction with the BNMS Generic guidelines.

1. Purpose

The purpose of this guideline is to assist specialists in Nuclear Medicine and Radionuclide Radiology in recommending, performing, interpreting and reporting the results of hepatobiliary scintigraphy. This guideline may also be used to help individual departments formulate their own local protocols. This does not however aim to be prescriptive regarding technical aspects of individual camera acquisitions, which need to be developed in conjunction with the local medical physics expert.

2. Background

Hepatobiliary scintigraphy is a technique established in the 1980s. Tracers use a similar physiological pathway to bile and hence are used to assess hepatocyte function and bile flow. Mebrofenin (HIDA) has high extraction efficiency and can be labeled with Technetium, hence it has become the tracer of choice.

3. Conditions which are commonly investigated using hepatobiliary scintigraphy include:

1. Functional biliary pain syndromes in adults
2. Functional biliary pain syndromes in paediatric
patients
3. Acute cholecystitis – uncommon indication in UK.
5. Biliary system patency
6. Bile leakage
7. Neonatal hyperbilirubinemia (biliary atresia vs. Neonatal hepatitis “syndrome”)
8. Assessment of biliary enteric bypass (e.g., Kasai procedure)
9. Assessment of liver transplant
11. Assessment of choledochal cysts
12. Calculation of gallbladder ejection fraction (GBEF)
13. Functional assessment of the liver before partial hepatectomy
14. Demonstration of anomalous liver lobulation
15. Enterogastric (duodenogastric) reflux assessment
16. Oesophageal bile reflux after gastrectomy
17. Biliary dyskinesia and Sphincter of Oddi dysfunction
18. Liver transplant functional volume assessment

4. Contraindications

a. Absolute – Pregnancy is a contraindication in most clinical situations

b. Relative - A theoretic possibility of allergic reactions should be considered in patients who receive multiple doses of hepatobiliary compound. Breastfeeding is not an absolute contraindication (See ARSAC) notes but clinicians should assess indication and may wish to delay the examination.

5. Radiopharmaceuticals and dose

^{99m}Tc-Br-IDA (choledíam) (Tri-bromo Iminodiacetic Acid) mebrofenin known as HIDA

ARSAC DRL Adults: 150 MBq.

Children: Reduce in proportion to weight in accordance with ARSAC advice. The minimum child dose being 20 MBq

6. Radiation exposure

The effective dose from ^{99m}Tc-Br-IDA (choledíam) (Tri-bromo Iminodiacetic Acid) mebrofenin is 2mSv

7. Patient preparation

Adult patient should fast for a minimum of 2 and preferably 6 h before administration of the radiopharmaceutical. Children should be instructed to fast for 2–4 h, whereas infants need to fast for only 2 h before radiotracer injection. This allows timely visualisation of the gallbladder. In infants clear liquids are allowed if medically necessary. However, fasting for longer than 24 h (including those on total parenteral nutrition), can cause the gallbladder not to fill with radiotracer within the normally expected time frame. In these cases the patient may be pre-treated with sincalide, as described below. Disregard of the above guidelines may result in a false-positive nonvisualization of the gallbladder.

8. Imaging Procedure

Standardised protocols are required to ensure the highest quality images are acquired; the technical details of image acquisition need to be established by departments on individual cameras following collaboration with the local medical physics expert - the parameters given here are for demonstrative purposes only. The study should be tailored to the individual patient and the differential diagnosis.

A large field of view gamma camera with a low energy all purpose or high-resolution collimator is recommended. SPECT and SPECT CT may be useful particularly for biliary leak and liver remnant volume assessment prior to hepatectomy. Illustrative suitable imaging parameters are given in table 1.

Gamma-Camera				
Acquisition Protocol	**Image Acquisition**			
Hepatic – **Hida Adult / Hida Child**	**Adult**	**Dynamic** **Anterior**	Collimator	LEHR
			Energy Photopeak	140 KeV with 15% energy window
			Matrix	128 x 128 (Pixel size 4.4)
			Frames/ Second	60 x 1 min frames (90 minutes with stimulation)
			Zoom	1.0 to 1.5 zoom as appropriate
	Paediatric	**Dynamic** **Anterior**	Collimator	LEHR
			Energy Photopeak	140 KeV with 15% energy window
			Matrix	128 x 128
			Frames/ Second	30 x 1 min frames
			Zoom	1.0 to 2.0 zoom as appropriate

	Marker	**Static Anterior following dynamic acquisition**	Collimator	LEHR
			Energy Photopeak	122 keV with 20 % energy window for Co marker, Tc windows as above for Tc marker
			Matrix	128 x 128
			Scan Time	60 s
			Zoom	same as dynamic acquisition
	Additional views	**Static** Anterior images at 1, 2, 3 and 24 hours as required.	Collimator	LEHR
			Energy Photo peak	140 keeve with 15% energy window
			Matrix	128 x 128
			Scan Time	120 s
			Zoom	1.45 or as appropriate
Comments	Mark Xiphi-sternum (XS) and right costal margin (RCM) at 60 minutes, together with all drainage sites and all drain-bags.			
	SPECT		Collimator	LEHR

Hida SPECT CT			Energy Photo peak	140 keV with 15 % energy window plus lower scatter correction window of 15 % (optional)
			Orbit	Non circular
			No of views	32
			Time /Projection	20 s
			Rotation	180°
			Matrix	128 x 128
			Zoom	1.0
	Acquisition	**CT (for attenuation correction)**	Ref. mAs	15
			KV	130
			Slice Thickness	5 mm (16 × 1.2)
			Rot Time	0.6
			Pitch	0.8
	Reconstruction		FOV	500 mm
			slice	5 mm

			Recon increment	5 mm
			FOV	500 mm
			slice	1.5 mm
			Recon increment	1.2 mm
Processing	Display statics and dynamics using local departmental Display and Scale.			

Processing

Hepatocellular function may be assessed by deconvolution analysis if software is available. ROI are drawn over liver and heart to derive the hepatic extraction fraction. The biliary excretion half-life can also be derived.

Adjustments

1. Bile leak – SPECT and SPECT CT may be useful. Any drainage bags must be imaged. Delayed imaging up to 24 hours is suggested if no leak identified earlier.

2. Stimulated HIDA for assessment of biliary dyskinesia

Biliary dyskinesia consists of two different disease entities. Sphincter of Oddi spasm (SOS) occurs at the distal end of the common bile duct (CBD) while cystic duct syndrome (CDS) occurs at the gallbladder. Both conditions are characterized by a paradoxical response in which the sphincter of Oddi and cystic duct contract and impede bile flow instead of undergoing the normal dilatation when physiological doses of cholecystokinin (CCK) are infused. Quantitative cholescintigraphy can differentiate SOS from CDS. The therapies for

these disorders include sphincterotomy or antispasmodics for SOS and cholecystectomy for CDS

Theory

In SOS, CCK infusion results in contraction of the sphincter with reflux of bile proximally. The gallbladder empties bile normally and the gallbladder ejection fraction (EF) is normal. In CDS, CCK infusion results in cystic duct contraction and bile is unable to flow out of the gallbladder and the gallbladder EF is low and no reflux of bile is seen. Morphine causes functional obstruction of the CBD and sphincter of Oddi spasm and may accentuate functional abnormalities in patients with SOS.

Table 2. Table of infusions (Ref 1)

Expected GBEF for Tested Techniques

Sincalide dose (μg/kg)	Time of infusion (min)	Mean GBEF ± SD (%)	GBEF range (%)	No. of healthy individuals studied
0.04	3	43 ± 26	15–88	12
0.02	3	35 ± 17	17–59	6
0.02	3	56 ± 27	0–100	23
0.01	3	46 ± 20	12–74	20
0.01	10	76 ± 16	37–96	13
0.02	15	76 ± 22	32–98	15
0.02	15	57 ± 29	22–98	60
0.01	30	64 ± 20	26–95	14
0.02	30	70 ± 22	17–97	23
0.02	30	71 ± 25	8–99	60
0.015	45	75 ± 12	>40†	40
0.01	60	68 ± 16	15–88	20
0.02	60	84 ± 16	38–100	60

*Subjects were prescreened with a 3-min sincalide stimulation, and those with GBEF < 35% were excluded.
†95% confidence limits.

CCK can also be given post cholecystectomy.

Fatty meal:

Following injection of HIDA dynamicimaging is commenced. When gall bladder is fully visualized at about 30 minutes patient is given a fatty meal (erect) imaging is continued for at least 30 minutes after the fatty meal. If the patient has had cholecystectomy, fatty meal may be given 15 minutes prior to HIDA dynamic imaging.

Fatty meal can also be given post cholecystectomy.

Morphine stimulation test:

In post cholecystectomy patients with suspected SOS, 0.02ug/kg IV morphine is administered slowly over 3 min period pre HIDA and dynamic imaging is started immediately for 60 minutes.

Baseline HIDA study with no morphine stimulation may be required to assess the degree of partial obstruction from morphine to differentiate patients with SOS from normal function. The liver excretion curves are obtained using whole liver ROIs. There is considerable delay with SOD, demonstrated by 45 and 60-minute total liver retention/excretion changes. Morphine stimulation can also be performed in patients with suspected SOS without cholecystectomy.

Sources of error

False positive for acute cholecystitis (non-visualisation of gallbladder):

Insufficient fasting; prolonged fasting>24hour; severe hepatocellular disease; pancreatitis, rapid biliary to bowel transit; severe chronic cholecystitis; previous cholecystectomy.

False negative for cholecystitis:

Bowel loop activity mistaken for gallbladder; acute acalculous cholecystitis; dilated cystic duct sign; bile leak; congenital anomalies mimicking the gallbladder.

9. Patient After Care

No specific precautions. Warn against handling machinery and driving post morphine until drowsiness resolves. Sincalide rarely can provoke severe abdominal pain and vomiting requiring treatment.

10. Reporting

Nuclear medicine images should only be reported by ARSAC certificate holders or those delegated by them to perform this role.

Accurate image interpretation depends on sound knowledge and extensive experience of the normal range of tracer distribution to help distinguish significant pathology from normal or trivial pathology.

Review of relevant imaging is advised with attention to details of previous surgical history, which can result in altered anatomy. The report should include the clinical indication, description of radiopharmaceutical administered any other dugs administered e.g. sincalide and potential technical limitations. Details of findings include appearance of the liver, intra and extra hepatic ducts, the presence and time of tracer appearing in gallbladder/ small bowel and liver clearance. If quantification has been performed, it should be recorded in the report.

11. References

1. Tulchinsky M, Ciak B, Delbeke et al. SNM Practice guidelines for hepatobiliary scinitigraphy 4.0

   JNM, 2010; 38: 210-218

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

3. Zeismman H, Tuclchinsky, Lavely W et al., Sincalide stimulated cholescintigraphy: A multicenter study to assess optimal infusion methodology and normal gall bladder ejection fractions. J Nuc Med 2010; 51; 277-281

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