

Learning outcomes

- Review pathophysiology of gallbladder dysfunction and sphincter of Oddi dysfunction.
- Describe the role of non-invasive imaging in the diagnosis of functional biliary disorders.
- Understand technical specifications and performance of biliary tract scintigraphy.
- Identify normal and pathological findings on cholescintigraphy.
- Correlate non-invasive imaging findings with clinical management of patients.

Background

- Functional disorders of the biliary tract cause significant upper abdominal pain which may be severely debilitating for patients.
- Standard anatomical imaging techniques are of limited value in the diagnosis of these conditions.
- Cholescintigraphy is a valuable imaging modality in confirming Gallbladder Dysfunction and Sphincter of Oddi Dysfunction (SOD).
- This provides diagnostic certainty for the patient, and facilitates definitive management options.

Background

- Bile produced by hepatocytes is required for digestion and absorption of fat within the duodenum and small bowel.
- Following ingestion of fatty food, gallbladder contraction and sphincter of Oddi relaxation facilitate emptying of bile into small bowel.
- The sphincter of Oddi also affects transport of pancreatic secretions into small bowel.
- Food passing into the proximal duodenum stimulates hormonal secretion of cholecystokinin and secretin, which facilitate gallbladder emptying and sphincter of Oddi relaxation.

Gallbladder dysfunction

- Insufficient emptying of the gallbladder is characterised by biliary type symptoms.
- Gallbladder dysfunction is clinically suspected when patients experience recurrent episodes of right upper quadrant pain, but without evidence of gallbladder calculi on ultrasound imaging or MRCP.
- A gallbladder ejection fraction below 35% during dynamic scintigraphy indicates GB dysfunction.
- Laparoscopic cholecystectomy has been shown to provide symptom control for some patients with acalculous gallbladder disease.

Sphincter of Oddi dysfunction

- Epigastric or right upper quadrant pain.
- Subdivided into biliary and pancreatic types.
- May occur as post-cholecystectomy pain syndrome.
- Recurrent episodes of acute pancreatitis are another possible clinical presentation.
- Scintigraphy with Tc99m HIDA may confirm diagnosis before proceeding to invasive studies.

Sphincter of Oddi dysfunction

- It is subdivided into:
- Type I disease (biliary-type pain with abnormal liver function tests, common bile duct dilatation, delayed ERCP contrast drainage)
- Type II (biliary pain with at least one other feature)
- Type III (biliary pain alone)
- During cholescintigraphy, patients with SOD have delayed passage of isotope from biliary tract into small bowel.
- Symptomatic relief may be provided by endoscopic sphincterotomy in patients with SOD.

Procedure details

- Dynamic cholescintigraphic imaging is performed with intravenous administration of Technetium 99m hepatobiliary iminodiacetic acid (HIDA).
- The tracer molecule is absorbed by hepatocytes and rapidly excreted into the biliary tract.
- The typical dose of isotope administered is 150 MBq, giving an effective dose of 2.4 mSv.
- Patient preparation involves fasting for 4 hours prior to the scan.

Procedure details

- Dynamic imaging is performed in supine position for 1 hour following administration of the radiopharmaceutical to ensure adequate gallbladder filling (1 frame per minute).
- A further 1 hour period of dynamic imaging is performed after stimulation of gallbladder contraction.
- Stimulation is created by giving the patient a fatty meal, or intravenous administration of a cholecystokinin (CCK) analogue. At our centre, patients are given a scone with butter.

Image post-processing

- Reprocessed images with summation of frames at 10 minute interval are shown below during the first hour after IV administration of HIDA.
- Following initial perfusion of hepatocytes, there is rapid excretion of isotope into the biliary system and early filling of the gallbladder.

Normal HIDA uptake scan, with hepatocyte perfusion, excretion into biliary system and early GB filling

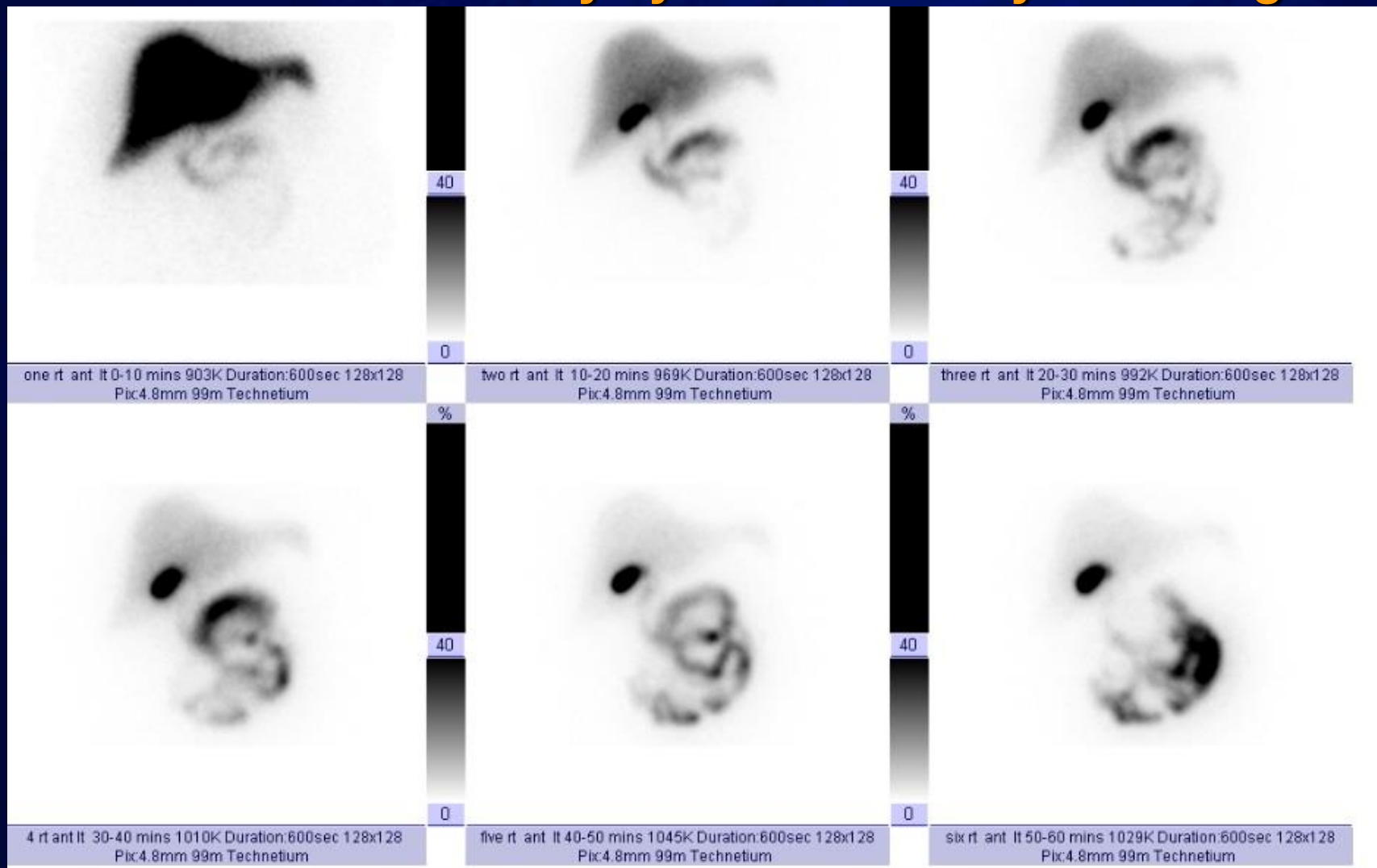
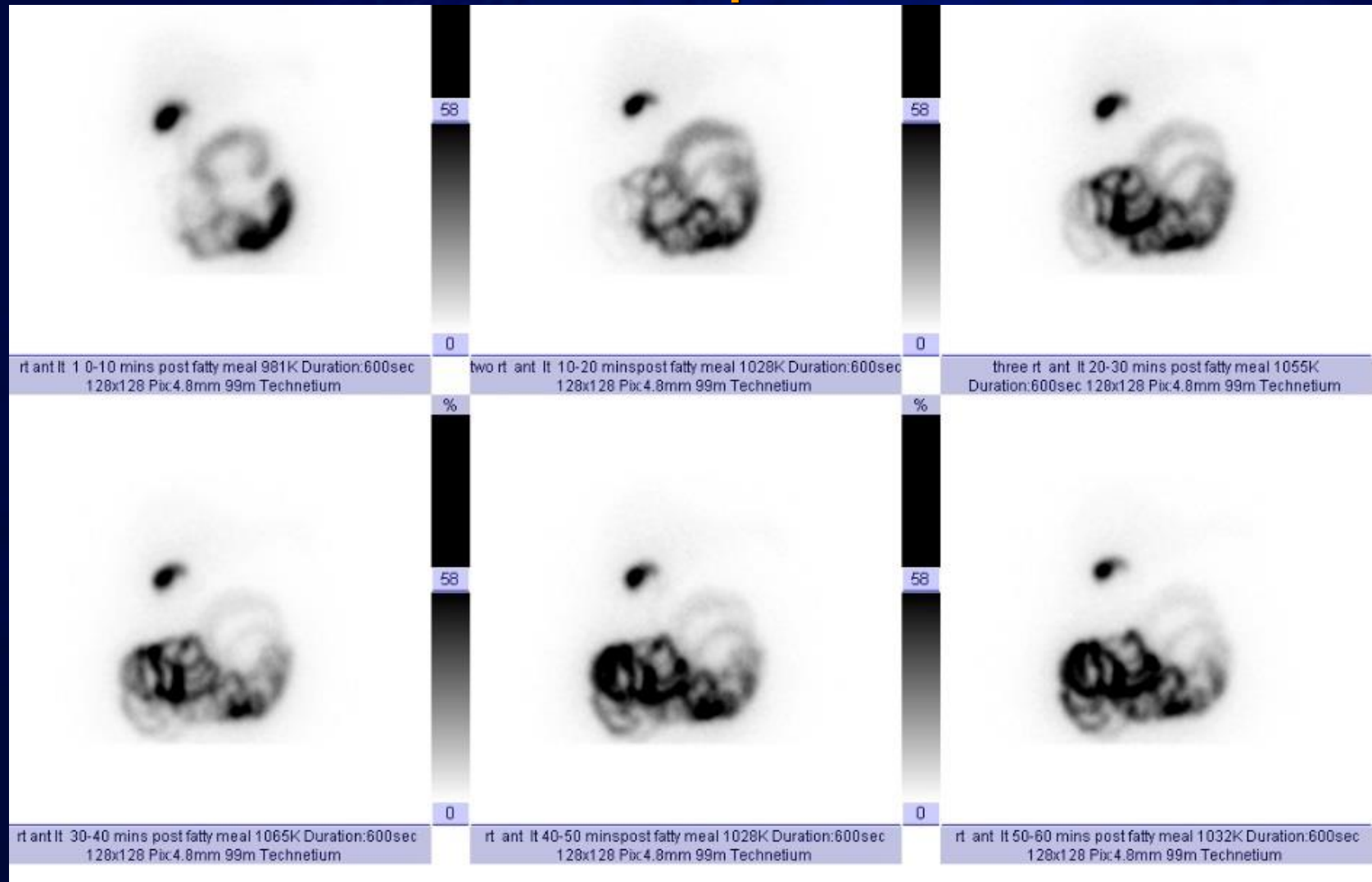


Image post-processing

- In the assessment of Gallbladder dysfunction, a region of interest is placed over the gallbladder on each frame following stimulation by fatty meal or CCK analogue.
- An emptying curve is plotted from the data, with calculation of GB ejection fraction. The curve below shows normal gallbladder function following stimulation.

Normal gallbladder emptying after fatty meal stimulation, with excretion of isotope into small bowel



Normal gallbladder emptying curve after stimulation

		Parameter	99m Technetium
Bkgd Correction	On	Ejection Fraction	65 %
Decay Correction	On	EF interval begin	0 mins
		EF interval end	59 mins
		T Max	1 mins
		T Min	54 mins

Series Description: stim hepatobiliary

Series Date: 15/12/2017

Series Time: 12:02:15

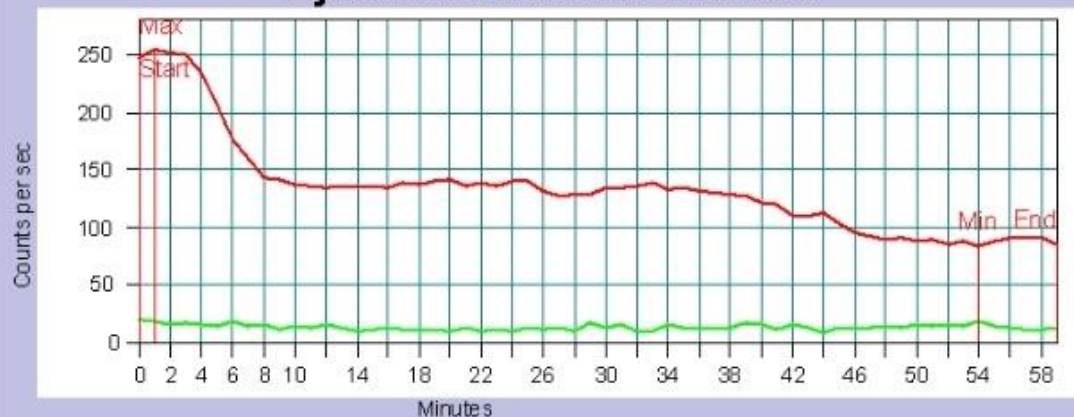
Radiopharmaceutical 1: 0.0 MBq (0.00 mCi) E-BUTYL-IDA

Energy Window Group 1: 99m Technetium

stim hepatobiliary [Composite] 15/12/2017



Ejection Fraction Curves



Gallbladder Dysfunction findings

- This is the graph obtained for a patient with gallbladder dysfunction.
- Following stimulation, the gallbladder ejection fraction is 13%, well below the normal range of >35%.
- An ejection fraction of 30-35% is equivocal for Gallbladder dysfunction.

Gallbladder Dysfunction emptying curve after stimulation

		Parameter	99m Technetium
Bkgd Correction	On	Ejection Fraction	13 %
Decay Correction	On	EF interval begin	3 mins
		EF interval end	58 mins
		T Max	3 mins
		T Min	58 mins

Series Description: stim hepatobiliary

Series Date: 30/09/2016

Series Time: 11:03:03

Radiopharmaceutical 1: 0.0 MBq (0.00 mCi) E-BUTYL-IDA

Energy Window Group 1: 99m Technetium

stim hepatobiliary [Composite] 30/09/2016



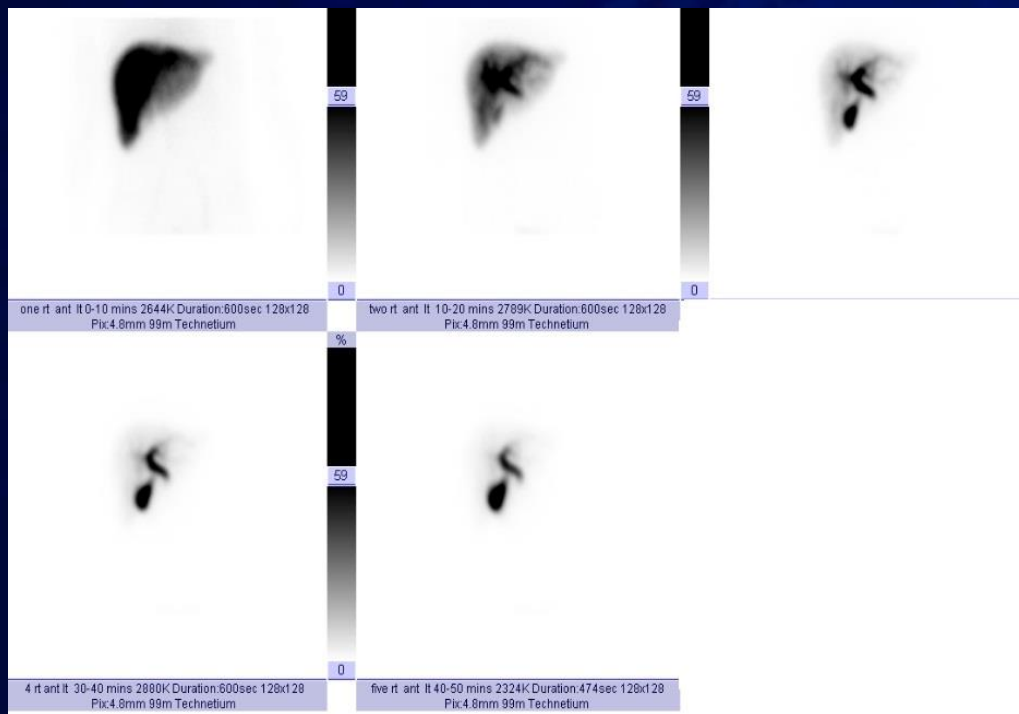
Ejection Fraction Curves



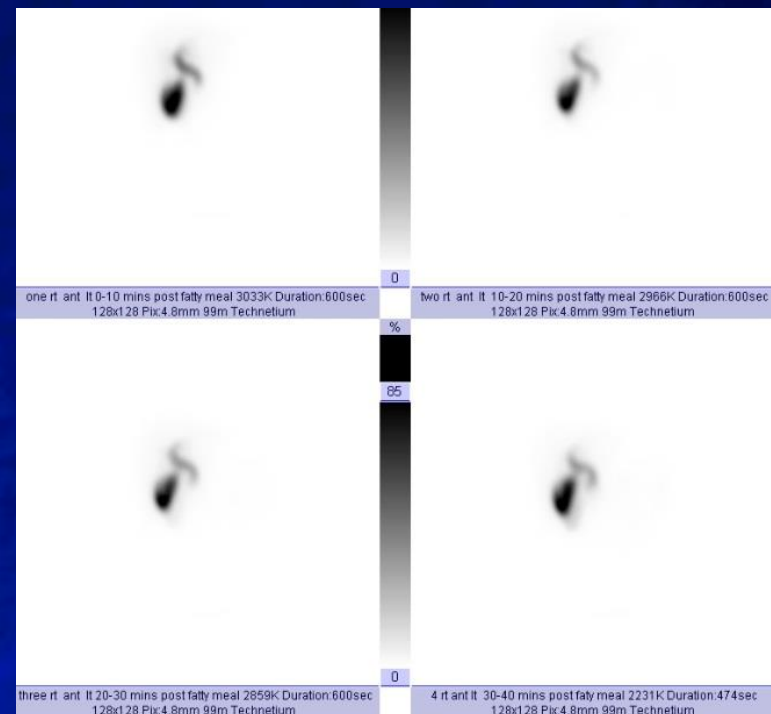
Concurrent Gallbladder dysfunction and Sphincter of Oddi dysfunction

- The 10 minute summated images below demonstrate the findings in a patient with concurrent gallbladder dysfunction and sphincter of Oddi dysfunction.
- There is early filling of the gallbladder but no excretion of isotope into small bowel.
- Following fatty meal stimulation, there is no significant gallbladder emptying or excretion into small bowel.

Concurrent Gallbladder Dysfunction and Sphincter of Oddi Dysfunction



Following IV administration of HIDA, early filling of gallbladder and accumulation of isotope in common bile duct



Following fatty meal stimulation, no gallbladder emptying and persistent isotope accumulation in common bile duct

Concurrent Gallbladder Dysfunction and Sphincter of Oddi Dysfunction post stimulation curve. Mild undulation of curve due to reflux of bile from dilated ductal system into gallbladder

Bkgd Correction	On	Parameter	99m Technetium
Decay Correction	On	Ejection Fraction	1 %
		EF interval begin	8 mins
		EF interval end	36 mins
		T Max	8 mins
		T Min	37 mins

Series Description: stim hepatobiliary

Series Date: 23/10/2015

Series Time: 12:27:10

Radiopharmaceutical 1: 0.0 MBq (0.00 mCi) E-BUTYL-IDA

Energy Window Group 1: 99m Technetium

stim hepatobiliary [Composite] 23/10/2015



Ejection Fraction Curves



Sphincter of Oddi Dysfunction in post cholecystectomy patient

- Progressive accumulation of isotope within the intrahepatic and extrahepatic biliary ductal system.
- Significant biliary ductal dilatation occurs as no gallbladder reservoir function to prevent increased intra-ductal pressure.
- Greater risk of liver dysfunction and pancreatitis.

Cholescintigraphy at our institution

- In the past 7 years, 74 adult patients have had HIDA imaging performed for investigation of functional biliary disorders.
- 92% of patients were referred for suspected Gallbladder dysfunction, with 8% referred for suspected sphincter of Oddi dysfunction.
- Female patients comprised 78% of all patients undergoing cholescintigraphy.

Cholescintigraphy findings

GALLBLADDER DYSFUNCTION	Number of patients	Percentage of patients
GB dysfunction	42	61%
Normal	18	26%
Equivocal	9	13%

SPHINCTER OF ODDI DYSFUNCTION	Number of patients	Percentage of patients
SOD dysfunction	1	20%
Normal	4	80%
Equivocal	0	0%

Outcomes for patients with confirmed Gallbladder Dysfunction on scintigraphy

	Number of patients	Percentage of patients
Cholecystectomy performed	19	45%
On waiting list for cholecystectomy	6	14%
Co-morbidities, surgery not possible	12	29%
No data available	5	12%

- Following laparoscopic cholecystectomy,
 - 53% of patients experienced resolution of symptoms
 - 5% of patients had persistent symptoms
 - 42% of patients had no follow up data available (which suggests not requiring follow up due to resolution)

Conclusions

- Cholescintigraphy is a valuable tool to investigate suspected functional disorders of the biliary tract.
- It is a non-invasive test which effectively triages patients, and increases diagnostic certainty before progressing to surgical/invasive management.
- Most adult patients referred for functional biliary imaging had suspected Gallbladder Dysfunction.
- Most patients with confirmed Gallbladder Dysfunction on scintigraphy were referred for cholecystectomy, unless surgery contraindicated due to co-morbidities such as obesity.

References

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- Behar J, Corazziari E, Guelrud M et al. Functional gallbladder and sphincter of oddi disorders. *Gastroenterology* 2006;130(5):1498-509
- Funch-Jensen P, Drewes AM, Madacsy L. Evaluation of the biliary tract in patients with functional biliary symptoms. *World J Gastroenterol* 2006;12(18):2839-2845

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