Liver Scan Biliary with Ejection Fraction Measurement

Primary Indications: In patients with chronic abdominal pain, hepatobiliary imaging with gallbladder ejection fraction measurement is indicated as an adjunct in the diagnosis of biliary dyskinesia or chronic cholecystitis.

Rationale: Tc-99m iminodiacetic acid (IDA) derivatives are normally rapidly taken up by hepatocytes and excreted unconjugated into the biliary tree. The gallbladder is normally seen within 30 minutes of injection and the small bowel is seen within 60 minutes. Chronic right upper quadrant pain may be caused by biliary dyskinesia or chronic cholecystitis. In these conditions, the gallbladder usually fills with the radiopharmaceutical. Once the gallbladder fills, the patient can be given a cholecystokinin analogue (sincalide) or a fatty meal to see if the gallbladder contracts normally. Normal filling and contraction of the gallbladder make biliary dyskinesia and chronic cholecystitis unlikely.

Interfering Conditions: Eating or prolonged fasting, chronic cholecystitis and severe liver disease can prevent filling of the gallbladder. Patients should fast for a minimum of 2 hours (preferably 4 hours) in order to avoid doing the study when the gallbladder is contracted in response to eating. Measurement of gallbladder ejection fraction in patients who have recently been given narcotic analgesics is not recommended since the gallbladder ejection fraction may be artifactually lowered because of spasm of the sphincter of Oddi.

Precautions See the precautions listed for sincalide below. Ensure Plus should be used in lactose intolerant patients instead of whole milk, if sincalide is unavailable.

Radiopharmaceutical: Tc-99m mebrofenin

Adult Dosage: Bilirubin ≤ 5 mg/dL  
3.0 mCi  
Bilirubin > 5 mg/dL  
6.0 mCi

Pediatric Dosage: Bilirubin ≤ 5 mg/dL  
40 μCi/kg  
minimum (300 μCi) maximum 3.0 mCi  
Bilirubin > 5 mg/dL  
80 μCi/kg  
minimum (600 μCi) maximum 6.0 mCi

Radiation Dosimetry: Adult (3 mCi). Critical organ (gallbladder wall): 1.2 rem. 
Effective dose equivalent: 0.27 rem
Infant (1 year). Critical organ (gallbladder wall): 1.4 rem.
Effective dose equivalent: 0.22 rem
**Route of Administration:** Intravenous

**Pharmacologic Drug:** Sincalide infusion is preferred. When sincalide is unavailable, oral administration of whole milk or Ensure Plus may be used.

**Sincalide (Kinevac®)**

- **Adult dose:** 0.02 μg/kg (maximum dose - 2.4 μg)
- **Pediatric dose:** Consult with the nuclear medicine physician
- **Route of administration:** Intravenous

The preferred method of injection is to use a syringe pump to infuse the sincalide at a constant rate over a period of 30 minutes. If the pump is unavailable the sincalide can be injected by hand at a constant rate over a period of 3 minutes or longer.

**Precautions:**

1. Inject slowly over 3 minutes or longer. More rapid injection can cause nausea and vomiting as well as abdominal pain. In addition, rapid injection can cause nonphysiologic contractions of the cystic duct or gallbladder neck that may functionally obstruct the gallbladder thereby preventing normal emptying.

2. Sincalide increases the secretion of pancreatic enzymes and is therefore contraindicated in patients with acute pancreatitis.

3. Sincalide should not be administered to pregnant women, especially those who are in their third trimester, because of the possibility of inducing premature labor.

4. Sincalide is contraindicated in patients with a known sincalide allergy.

The following methods may be used if sincalide is unavailable.

**Whole milk**

- **Adult dose:** 240 mL (8 oz)
- **Pediatric dose:** 3.5 mL/kg (maximum 240 mL)
- **Route of administration:** Orally

**Precautions:**

1. Patients with lactose intolerance should be identified at the time of scheduling. Patients with lactose intolerance should be given Ensure Plus instead of whole milk.

**Ensure Plus**

- **Adult dose:** 240 mL (8 oz)
- **Pediatric dose:** 3.5 mL/kg (maximum 240 mL)
- **Route of administration:** Orally
Precautions: None

Patient Scheduling: The physician requesting the study should be referred to the nuclear medicine physician. The nuclear medicine physician should determine (1) the indication for the study; (2) the patient's most recent bilirubin level; (3) time of the patient most recent meal; (4) results of other pertinent imaging tests (especially gallbladder ultrasonography); (5) pertinent medical and surgical history; (6) current medications and (7) whether there are any contraindications to administering sincalide, whole milk, or Ensure Plus.

Patient Preparation: Patients must be fasting for at least 2 hours (preferably 4 hours).

Equipment Setup: Gamma Camera: LFOV camera for adult studies; SFOV or zoomed LFOV camera for studies in small children
Collimator: LEAP for studies in adults; converging collimator for studies in small children.
For gallbladder ejection fractions, use a converging collimator or electronic zoom.
Energy Window: 140 keV with 20% window

Patient Positioning: Supine for flow and initial sequential images.

Procedure: Typically this study consists of a flow study, sequential images for up to 120 minutes and selected static images. The field of view should initially include the liver and upper abdomen. The radiopharmaceutical is injected as a bolus and the radionuclide angiogram is acquired. As soon as there is sufficient activity in the gallbladder, sincalide should be given to assess gallbladder emptying. It is not necessary to have activity in the small bowel prior to sincalide administration or milk administration.
When a 30-minute pump infusion of sincalide is used, the intravenous tubing from the pump to the patient should be filled with the sincalide solution prior to beginning the acquisition of images. The acquisition of 30 one-minute sequential images should be started on the computer simultaneously with the start of the pump infusion.
When a hand injection of sincalide is used, the acquisition of 30 one-minute sequential images should be started on the computer before the sincalide is injected. Sincalide can be given after 2 or 3 frames have been acquired. The midpoint of the injection of sincalide should be marked on the computer. Imaging should continue for at least 20 minutes after the injection of the sincalide.
When milk or Ensure Plus is used, an acquisition of 60 one-minute sequential images should be started on the computer. After 2 or 3 frames have been acquired, the patient should quickly get out from under the camera so he/she can drink the milk in the sitting position. The patient should drink the milk in less than one minute and should be quickly repositioned under the camera. Image acquisition should continue for at least 55 minutes after the ingestion of milk or Ensure Plus.
Quantification of the gallbladder ejection fraction will be performed by the physician. The lower limit of normal for gallbladder ejection fraction at 30 minutes after intravenous administration of Sincalide is 35%. The lower
limits of normal for gallbladder ejection fraction at 60 minutes after oral administration of 240 mL whole milk or 240 mL Ensure Plus are 44% and 33%, respectively.

<table>
<thead>
<tr>
<th>View</th>
<th>Digital Acquisition</th>
<th>Screenshots</th>
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<tr>
<td><strong>Sequential Images</strong>&lt;br&gt;Anterior liver and upper abdomen (if dual-head camera is used, collect sequential images from the posterior view also).</td>
<td>60 x 1-minute 128 x 128 matrix, word mode, followed by a 30 x 1-minute 128 x 128 matrix, word mode&lt;br&gt;Mobile camera will acquire 30 x 2-sec dynamic and 30 x 1-min images or 60 x 1-minutes images without a flow study.</td>
<td>6 General Purpose display ➔ Display ➔ Hida Display ➔ Hida Function</td>
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<tr>
<td><strong>Right Lateral</strong></td>
<td><strong>128X128 Matrix (1.45 zoom)</strong>&lt;br&gt;5 minute static</td>
<td>STATIC Image</td>
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<tr>
<td><strong>For Gallbladder Ejection Fraction</strong>&lt;br&gt;For Sincalide: 30 x 1 minute, 128 x 128 matrix, For Milk or Ensure Plus: 60 x 1 minute, 128 x 128 matrix, word mode, with electronic magnification or a converging collimator</td>
<td>Dynamic display</td>
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**Items Required For Complete Study:**
1. Radionuclide angiogram
2. Sequential images
3. Transfer of all digital images to workstation
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