Diuretic Renal Scintigraphy

Primary Indications: Evaluation of patients with known or suspected urinary tract obstruction.

Rationale: Some patients with pelvicalyceal or ureteral dilatation may not have physiologically significant obstruction. Diuretic renal scintigraphy is based on the concept that activity in an unobstructed system will clear rapidly as a result of the high urine flow rate that occurs following administration of a diuretic. Conversely, a high flow rate will not be achieved in the presence of significant obstruction, and there will be absent or slow clearance of pelvicalyceal and/or ureteral activity.

Interfering Conditions: Renal insufficiency may result in an indeterminate test result due to a poor response to the diuretic. If possible, imaging of neonates should be delayed until at least 1 month of age because of renal immaturity.

Precautions Radiation dose will be minimized by encouraging fluid intake and frequent voiding after the procedure. Check with patient and/or review patient’s chart to determine if patient’s fluid intake is being restricted. If so, consult with physician. Furosemide is a potent diuretic, which if given in excessive amounts, can lead to a profound diuresis with water and electrolyte depletion. Outpatients should be encouraged to drink fluids liberally after completion of the study and before leaving the medical center. Furosemide is contraindicated in patients with anuria and in patients with a history of hypersensitivity to furosemide. For other precautions, see package insert.

Radiopharmaceutical: Tc-99m Mertiatide (Tc-99m MAG3) is the preferred radiopharmaceutical. Tc-99m Pentetate (Tc-99m DTPA) may be substituted, in patients with normal or only mildly impaired renal function, (after discussion with the physician) for on-call procedures or on days when only one renal imaging procedure is anticipated (e.g., Saturday).

Adult Dosage: Tc-99m MAG3: 7.5 mCi
Tc-99m DTPA: 15 mCi

Pediatric Dosage: Tc-99m MAG3: 100 µCi/kg with a minimum dosage of 1.0 mCi.
Tc-99m DTPA: 210 µCi/kg with a minimum dosage of 2.0 mCi

Radiation Dosimetry: Tc-99m MAG3
Adult. Critical organ (bladder wall): 3.05 rem. Effective dose: 0.20 rem.
Infant (1-year). Critical organ (bladder wall): 1.18 rem. Effective dose: 0.08 rem.

Tc-99m DTPA
Adult. Critical organ (bladder wall): 3.61 rem. Effective dose: 0.35 rem.
(Dosimetry is altered in the setting of impaired renal function. For example, in renal failure, gastrointestinal tract doses are increased, although effective dose is slightly decreased. With acute unilateral obstruction, the dose to the obstructed kidney is substantially increased.)

**Route of Administration:** Intravenous.

**Pharmacologic Drug:** Furosemide (Lasix)

**Furosemide Dosage:** Adult: 40 mg; dose may be modified (e.g., in the setting of renal insufficiency) at the nuclear medicine physician’s discretion.
Pediatric: 1.0 mg/kg up to a maximum of 40 mg; a reduced dosage of 0.5 mg/kg may be used per direction of nuclear medicine physician or per direction of attending urologist, nephrologist, or pediatrician.

**Furosemide Route:** Intravenous, by slow injection over 1-2 minutes.

**Patient Preparation:** A patient with known or strongly suspected vesicoureteral reflux, bladder outlet obstruction or neurogenic bladder, or who is not able to void upon request (e.g., an infant) generally should be catheterized prior to injection of the radiopharmaceutical. A patient who has not been catheterized should void immediately prior to the diuretic portion of the study.
The patient should be well hydrated for the examination. Unless otherwise specified by the physician, the patient is to be hydrated prior to starting the study with approximately 16 ounces (500 mL) of water orally (for a 70-kg adult). If this is not possible, the patient should be hydrated using intravenous fluids. Adults should be hydrated with 500 mL of normal saline infused intravenously over 30 minutes starting 15 minutes prior to radiopharmaceutical administration. For children weighing more than 35 kg, 500 mL 5% dextrose/0.5 normal saline solution should be infused intravenously over 30 minutes starting 15 minutes prior to radiopharmaceutical administration. Smaller children should receive appropriate hydration based on body weight, using 5% dextrose/0.5 normal saline solution at a dosage of 0.5 mL/kg/min (maximum 500 mL) infused over 30 minutes starting 15 minutes prior to radiopharmaceutical administration. The patient should void immediately prior to the study.

**Equipment Setup:** Gamma Camera: LFOV camera for studies in adults with zoom; SFOV or zoomed LFOV camera for studies in small children.
Collimator: LEAP for studies in adults. For studies on the portable camera, a diverging collimator should be used for adults and a LEAP or converging collimator for small children or infants.
Following completion of the standard renal acquisition (see Renal Scintigraphy protocol), the gamma camera head should be placed vertically behind the patient, except as noted below (see Patient Positioning).
Energy Window: 140 keV with 20% window
Patient Positioning: Supine for the first 20 minutes of the study, prior to administration of furosemide. Erect (seated) for the post-void image and for the diuretic portion of the study. If the patient is unable to sit erect, consult with a physician to determine if supine or prone imaging is to be performed. For infants, the patient should be positioned supine with the camera beneath the table for the entire study. For diuretic imaging of a renal transplant, the patient should be positioned supine with the camera above the patient for anterior imaging throughout the study.

Procedure: The first 20 minutes of the study and the post-void image prior to furosemide administration are acquired according to the standard Renal Scintigraphy protocol, with the following exceptions. The intravenous line used for radiopharmaceutical injection should be left in place and kept open during the standard renal imaging procedure. A physician should be asked to evaluate the study at 10-15 minutes after radiopharmaceutical injection to determine whether furosemide administration will be needed. If so, the furosemide dose should be drawn into a syringe at that time and the patency of the intravenous line should be confirmed. After the post-void image, the physician will confirm that furosemide is to be administered. Data acquisition (20-second digital frames) should be initiated and, after 2-4 minutes of baseline data have been obtained, the physician will then inject the diuretic intravenously over 1-2 minutes, followed by approximately 20 mL of normal saline solution to flush the intravenous line. Near the mid-point of the injection, a radioactive source should be placed briefly beside the patient (in the camera field of view) to mark the time of furosemide administration. Continuous data acquisition is performed for 20 minutes following diuretic administration. A final post-void image is then obtained. The intravenous line should be removed.

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<tr>
<th>View</th>
<th>Image Display Parameters for Digital Images</th>
<th>Digital Data</th>
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<tbody>
<tr>
<td><strong>Standard renal acquisition</strong></td>
<td>See Renal Scintigraphy protocol</td>
<td>See Renal Scintigraphy protocol</td>
</tr>
<tr>
<td><strong>Pre-furosemide dynamic images</strong></td>
<td>Filmed in conjunction with post-furosemide images</td>
<td>Typically 6-12 x 20-sec images, 128 x 128 matrix word-mode</td>
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<tr>
<td><strong>Post-furosemide dynamic images</strong></td>
<td>Film using Display, Renal Display Lasix Function or &quot;U&quot; display (Uniform scaling) if not using preset formatting</td>
<td>Continue the dynamic collection with 60 x 20-sec images, 128 x 128 matrix word-mode, with additional images at the discretion of the physician</td>
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<tr>
<td><strong>Final post-void image</strong></td>
<td>1 x 2-min image</td>
<td>1 x 2-min image, 256 x 256 matrix word-mode</td>
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Items Required For Complete Study:

1. **Routine Renal Scintigraphy:** As described in the Procedure Manual.

2. **Diuretic Renal Scintigraphy:** Pre- and post-furosemide dynamic images and final post-void image. If filmed from a computer display, use Display, Renal Display, Lasix Function or a “U” display (Uniform scaling) for the post-furosemide images if not using preset formatting.

3. Following **transfer of the digital images**, processing will be performed by a physician.