Renovascular HTN Renogram

Updated 9/8/2024

- **Indications**
  - To assess for renovascular HTN in the setting of abrupt onset or severe HTN, HTN resistant to 3-drug therapy, onset of HTN before age 30 or after age 55, abdominal/flank bruits, unexplained azotemia or recurrent pulmonary edema in an elderly HTN patient, worsening renal function during therapy with an ACE inhibitor or grade 3 or 4 hypertensive retinopathy.
- **Radiopharmaceutical:**
  - 1 mCi Tc-99m MAG3 administered IV for the first routine renogram portion
  - 5-10 mCi Tc-99m MAG3 administered IV for the second ACE inhibitor renogram portion
- **ACE Inhibitor:**
  - Option 1 - 25 mg Captopril administered by mouth 1 hr prior to radionuclide administration
  - Option 2 - 40 μgm/kg Enalaprilat (max 2.5 mg) administered IV over 3-5 mins 15 mins prior to radionuclide administration
  - Leave the IV line in the patient until after the exam in case of symptomatic hypotension requiring IV fluids.
  - Blood pressure must measure at least 120/80 mmHg prior to administering the ACE inhibitor.
  - Blood pressure must be measured every 15 mins for 1 hr after ACE inhibitor administration.
  - ACE inhibitor use is contraindicated in pregnant women. A negative urine pregnancy test is required in potentially-pregnant patients prior to administration.
- **Patient Preparation:**
  - Patients receiving an oral ACE inhibitor for the exam should be instructed to not eat a solid meal for at least 4 hrs before receiving the ACE inhibitor.
  - Have the patient drink 16-20 oz of water 30-60 mins prior to exam to ensure adequate hydration.
  - Have the patient empty his/her bladder immediately prior to imaging. Instruct the patient to void frequently for a day following the exam.
- **Conflicting Examinations/Medications:**
  - Patients taking an ACE inhibitor or angiotensin II receptor blockers should hold the medication for 3-7 days prior to the exam (if possible).
  - Patients taking diuretics should hold the medication for 3-5 days prior to the exam (if possible) to reduce volume depletion and decrease the risk of hypotension after receiving ACE inhibitor.
  - No Nuclear Medicine exams within the previous 24 hrs.
  - No barium GI exams within the previous 48 hrs.
- **Pregnancy/Lactation:**
  - ACE inhibitor use is contraindicated in pregnant women. A negative urine pregnancy test is required in potentially pregnant patients prior to administration. See Pregnant, Potentially Pregnant and Lactating Patients policy for specifics.
  - Breast feeding mothers should discard breast milk for 4-24 hrs following Tc-99m MAG3 administration.
- **Imaging Technique:**
  - Collimator - LEAP preferred over LEHR
  - Photopeak - 140 keV 20% window for Tc-99m
  - Image Preset Counts
    - Flow Images - 2 secs/image for 1 mins (30 images)
    - Dynamic Images - 60 secs/image for 34 mins (34 images)
    - Static Images - 60 secs/image
  - Matrix Size - 128 x 128 (flow and dynamic), 256 x 256 (static)
  - Zoom - none
  - Patient Positioning - supine

- **Baseline Renogram Images/Views:**

  Perform a routine MAG3 exam (without ACE inhibitor or Lasix).

  - Administer 1 mCi Tc-99m MAG3 IV
  - Flow Images
    - Begin imaging immediately before radionuclide administration.
    - Obtain posterior images of the abdomen and pelvis for 60 secs.
  - Dynamic Images
    - Begin imaging immediately after flow imaging
    - Obtain posterior images of the abdomen and pelvis for **29** mins.
  - Static Images
    - Obtain posterior pre and post void images of the abdomen and pelvis after dynamic images.
  - Obtain anterior images rather than posterior images if imaging a renal transplants.

- **ACE Inhibitor Renogram Images/Views:**

  Perform a MAG3 exam following ACE inhibitor administration (without Lasix).

  - When a 1 mCi dose of Tc-99m MAG3 is used for the baseline renogram, the ACE inhibitor portion can begin immediately after the baseline renogram is finished.
  - Administer 5-10 mCi Tc-99m MAG3 IV
  - Flow Images
    - Begin imaging immediately before radionuclide administration.
    - Obtain posterior images of the abdomen and pelvis for 60 secs.
  - Dynamic Images
    - Begin imaging immediately after flow imaging
    - Obtain posterior images of the abdomen and pelvis for **29** mins.
  - Static Images
    - Obtain posterior pre and post void images of the abdomen and pelvis after dynamic images.
  - Obtain anterior images rather than posterior images if imaging a renal transplants.

- **Image Post Processing:**
  - Use the appropriate software to generate flow and time-activity curves and calculate the T_{max}, $T_{1/2}$, 20 min/max ratio and split renal function percents.
  - Calculation of split renal function is most accurate when ROIs are drawn around each kidney (to include both the renal parenchyma and the collecting system / renal pelvis).
  - Assessment of response to diuretic is most accurate when ROIs are drawn around each renal collecting system / pelvis (excluding the renal parenchyma).
  - The most accurate method of measuring background activity is to draw C-shaped ROIs around the upper, lateral and lower aspects of each kidney rather than an ROI.
  - See practice guideline for additional image processing guidelines.

- **Notes:**
  - Renovascular disease includes renal artery stenosis, renovascular HTN and azotemic renovascular disease (ischemic nephropathy).
  - Renovascular HTN is defined as an elevated blood pressure caused by renal hypoperfusion, usually resulting from renal artery stenosis and activation of the renin–angiotensin system.
  - Azotemic renovascular disease (ischemic nephropathy) refers to renal functional impairment associated with renal atrophy, intrarenal vascular lesions and interstitial nephritis and fibrosis in the presence of severe renal artery stenosis.
  - Renovascular HTN is estimated to affect less than 1%–3% of the unselected hypertensive population and up to 15%–30% of patients referred to a subspecialty center because of refractory HTN.

- Criteria associated with renovascular HTN include worsening of the renogram curve, reduction in relative uptake (>10% decrease from baseline), delay in the excretion of the radionuclide into the renal pelvis (≥2 min from baseline), prolongation of the renal and parenchymal transit time, an increase in the 20 min/max ratio (≥0.15 from baseline) and prolongation of the T_{max} (>2–3 min or 40% from baseline).
- Unilateral parenchymal retention after ACE inhibition is the most important criterion for diagnosis renovascular HTN.
- It is important to distinguish parenchymal (significant) from pelvic (insignificant) retention. Cortical ROIs are often used to evaluate parenchymal retention, but cortical renogram curves may be noisy when a low dose ofTc-99m MAG3 is administered for a baseline exam and renal function is poor. In this setting the whole-kidney renogram will provide a better index of parenchymal function if there is no tracer retention in the renal pelvis or calyces.
- Bilateral symmetrical changes after ACE inhibition usually do not represent renovascular HTN and may be associated with hypotension, salt depletion, the use of calcium channel blockers and/or a low urine flow rate.
- Interpretation Categories
  - Low Probability (<10%) - normal findings on ACE inhibitor renogram (pattern 0), abnormal baseline renogram (pattern 1 or 2) that improves after ACE inhibition.
  - Intermediate Probability - abnormal baseline renogram that is unchanged following ACE inhibition
  - High Probability (>90%) - a renogram that changes markedly more abnormal after ACE inhibition
- Sources of error include ingestion of food within 4 hrs of administering ACE inhibitor, radionuclide infiltration, retention of radionuclide in the renal pelvis, dehydration, hypotension and a full bladder impairing drainage. Pelvic retention is likely to be related to the patient's state of hydration but will result in an abnormal whole-kidney renogram curve, which may be incorrectly interpreted as representing renovascular HTN. Dehydration and hypotension may lead to bilateral parenchymal retention and bilateral renogram curve abnormalities.

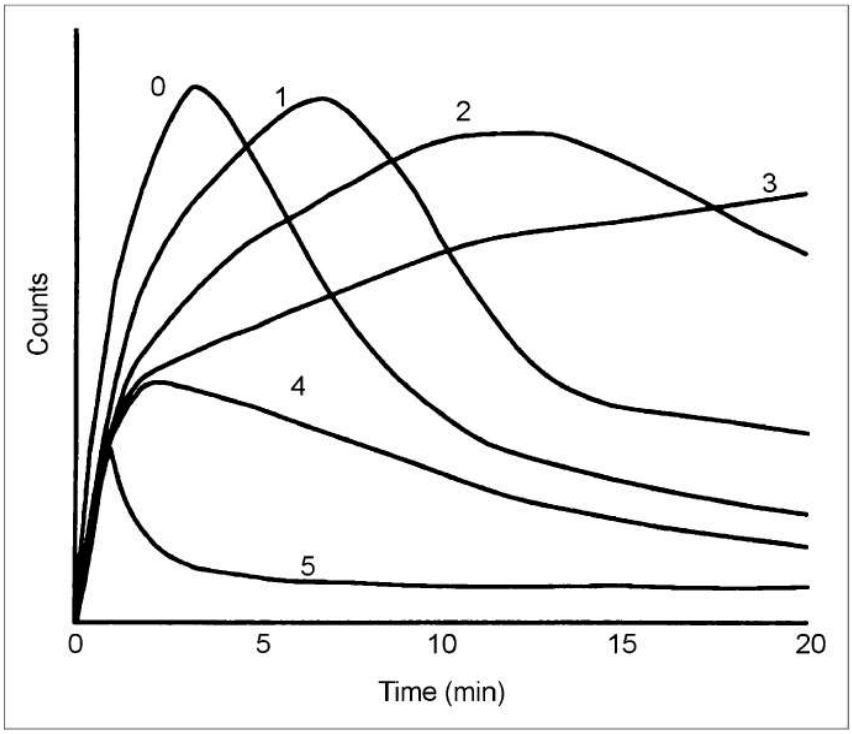

FIGURE 5. Common renogram patterns used for visual interpretation of ACE inhibition renography: type 0, normal; type 1, time to peak (Tmax) of >5 min and 20-min/maximum count ratio of >0.3 for background-subtracted ^{131}I-orthoiodohippurate and ^{99m}Tc-MAG3 curves; type 2, more exaggerated delays in time to peak and in parenchymal washout; type 3, progressive parenchymal accumulation (no washout detected); type 4, renal failure pattern but with measurable renal uptake; type 5, renal failure pattern representing blood background activity only.