CARDIAC GATED BLOOD POOL STUDY - REST
(Tc-99m-Red Blood Cells)

Overview

- The resting Cardiac Gated Blood Pool Study evaluates right and left regional ventricular wall motion and ejection fraction at rest. A radiotracer that is confined to the vascular space, such as Tc-99m-red blood cells, is used to acquire images of the heart at multiple intervals throughout the cardiac cycle with the assistance of the electrocardiograph (EKG) signal. These images are displayed dynamically to evaluate wall motion visually or are analyzed with regions of interest to quantitate ventricular ejection fraction.

Indications

- Evaluate ventricular regional wall motion (1,2).
- Quantitate ventricular ejection fractions (1-3).
- Monitor cardiotoxicity of doxorubicin (4,5).
- Differentiate pulmonary and cardiac causes of dyspnea.

Examination Time

- 1 hour.

Patient Preparation

- Place 3 EKG leads on the patient:
  1. Ensure good electrical contact; this can be done by preparing the skin with methyl alcohol and/or extra-fine sandpaper (6).
  2. The right arm lead is placed in the region of the right axilla, the left arm lead in the region of the left axilla, and the right leg lead in the right upper quadrant of the abdomen.

Equipment & Energy Windows

- Gamma camera: Large (40 cm) field of view camera with electronic magnification to a 25 cm field of view or small (25 cm) field of view camera.
- Collimator:
  - q Low energy, general purpose, parallel hole.

- q Low energy, high resolution, parallel hole.

- Energy window: 20% window centered at 140 keV (7).

- Computer with cardiac gated blood pool software.

- Cardiac gating device, either built into the camera or stand alone.

Radiopharmaceutical, Dose, & Technique of Administration

- Radiopharmaceutical: Tc-99m-labeled red blood cells.

- Dose: 25 mCi (925 MBq).

- Red blood cell labeling method (Either the in vivo/in vitro method or in vitro method gives high labeling efficiencies.):
  - q In vivo/in vitro method (8-11).
  - q In vitro method (12,13).
  - q In patients with difficult veins, the in vivo method may be used (14,15).

- Injection technique: Flush method:
  1. Move the patient's arm away from his/her side so the basilic vein is not compressed.
  2. Remove tourniquet.
  3. Rapidly inject labeled red blood cells.
  4. Flush with 10 mL of saline.

Patient Positioning & Imaging Field

- Patient position: Supine.

- Imaging field of view: Center on the heart in the lower left chest.

Acquisition Protocol (16)

- Any comment regarding first pass will not be covered this semester. A closer look will be given when we study nuclear cardiology in the Spring semester.

- For patients in normal sinus rhythm, set the cardiac cycle-length acceptance window at 15%. For patients with irregular rhythms, e.g. atrial fibrillation, set the cardiac cycle-length acceptance window at a percentage appropriately greater than 15%.

- Set the computer program to divide each cardiac cycle into 16 or more frames (17).

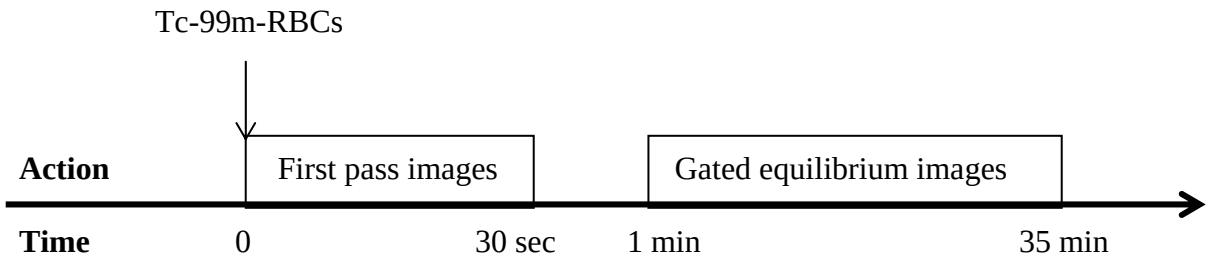
- Position the camera in the LAO projection in order to maximize separation of the right and left ventricles.

- Inject the radiopharmaceutical in bolus fashion for the “first pass” part of study.

- Acquire serial 1 second images for 30 seconds beginning with the release of the tourniquet; these may be analog, digital, or both:

- Acquire 10 minute gated (EKG synchronized) images in the ANT, LAO, and L LAT projections on the computer. The LAO acquisition is positioned to give maximum separation of the left and right ventricles as viewed in the persistence scope; the angle may be greater or less than 45°.
    1. Use a 10-20° caudal tilt in the LAO projections to increase the separation of atria and ventricles.
    2. Forward gated time-activity curves are sufficiently accurate (18).

Protocol Summary Diagram



Data Processing

- Calculate the left ventricular ejection fraction using the LAO projection, and the software and protocol provided with your computer (19-21):
    1. Be sure that the regions of interest for background and the left ventricle are properly positioned throughout the cardiac cycle.
- If the software is available on your computer, create cine displays that alternate between just end systole and end diastole to facilitate evaluation of regional wall motion. This display facilitates wall motion evaluation.

Optional Maneuvers

- SPECT acquisition: SPECT may be added to the EKG synchronized acquisition to give a series of cine tomograms of the heart (22). The tomographic approach is more time consuming, but improves the definition of cardiac chambers and regional wall motion. In addition, the three dimensional data of the gated SPECT

images may be displayed in two dimensions using the technique of volume rendering (23-25).

- Phase analysis: A phase analysis and phase histogram may be constructed from the LAO projection (26-28).

- Parameters other than ejection fraction: These can be calculated from the left ventricular time-activity curve, but at this time their accuracy and clinical value are questionable (29-31).

Principle Radiation Emission Data - Tc-99m (32)

- Physical half-life = 6.01 hours.

Radiation	Mean % per disintegration	Mean energy (keV)
Gamma-2	89.07	140.5

Dosimetry - Tc-99m-Labeled Red Blood Cells (33)

Organ	rads/25 mCi	mGy/925 MBq
Heart	2.0	20.0
Liver	1.8	18.0
Spleen	1.5	15.0
Lungs	1.4	14.0
Kidneys	1.4	14.0
Blood	1.4	14.0
Red marrow	0.8	8.0
Whole body	0.4	4.0

References

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Normal Findings

> Wackers FJTh, Berger HJ, Johnstone DE, et al: Multiple gated cardiac blood pool imaging for left ventricular ejection fraction: Validation of the technique and assessment of variability. Am J Cardiol 43:1159-1166, 1979.
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