Planar ERNA Provides an Accurate Estimate of Volume and EF: A Dynamic Phantom Validation

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**Background:** Left ventricular ejection fraction (LVEF) is a measurement that is frequently performed to make important clinical decisions (i.e., whether to proceed with chemotherapy or whether a patient would benefit from implantation of an AICD) and is also used as a prognostic marker in patients with known or suspected coronary artery disease. There are several modalities that can be used for evaluation of left ventricular ejection fraction including: echocardiography, ERNA, gated SPECT myocardial perfusion, Gated Blood Pool SPECT (GBPS), and cardiac MRI. Clinical studies comparing the various imaging modalities are often limited by the absence of an independent gold standard. To date, there have not been studies utilizing a phantom model that allows for the direct measurement of ejection fractions and the validation of ERNA and GBPS.

**Specific Aims:**
1. To develop a Calibrated Dynamic Cardiac Phantom to be used in validating cardiac blood pool imaging volume calculations
2. To assess the accuracy of a commercial program for the calculation of end-diastolic volume (EDV), end-systolic volume (ESV), and ejection fraction (EF) from planar equilibrium radionuclide angiography (ERNA)

**Hypothesis:** A Calibrated Dynamic Cardiac Phantom will be developed that can be used in validating blood pool imaging techniques and software. A commercially available program will be shown to be accurate in assessing volumes and ejection fractions using planar ERNA acquisitions.

**Methods:** A Calibrated Dynamic Cardiac Phantom was developed consisting of two balloons emulating the Left Ventricular (LV) and Right Ventricular (RV) bloodpools within a water-tight container. The LV balloon was attached to a pulsatile pump with gating trigger that allowed sinusoidal LV inflation with known concentration of Tc99m (10µCi /mL), while the RV was kept static. As the LV was inflated, the LV volume displaced surrounding fluid into the graduated cylinder reflecting the true dynamic changes in LV volume. Gated planar images (5 min/acquisition) were acquired using 12 different sets of volumes and EF’s on a GE Infinia Hawkeye 4. The image sets were each processed three times by three observers using the EF Analysis and Peak Filling Rate (GEEF) software (GE Healthcare). Volumes were estimated using the technique of Massardo, et al.

**Results:** The 12 acquisitions yielded EDV and ESV ranging from 24.5 to 81.5 mLs producing a range of EFs from 4% to 42%. The estimated volumes (EV) and EF’s (EEF) were compared with the measured volumes (MV) and EF’s (MEF) and linear regressions and standard errors (SE) were calculated. The planar approach provided an excellent estimate of volume (EV = 1.05MV + 4.1, R² = 0.97, SE = 3.26) and EF (EEF = 1.03MEF + 0.47, R² = 0.98, SE = 1.61).

**Conclusions:** We developed a Calibrated Dynamic Cardiac Phantom for validation of planar and SPECT bloodpool imaging. Using this phantom we demonstrated that planar ERNA analyzed with the GEEF utility provided an accurate estimation of a wide range of volumes and EFs, although under conditions of minimal attenuation, scatter, and primarily a spherical LV shape.