

# Comparison of Diastolic Function Parameter Estimates from Planar and SPECT Blood Pool Imaging



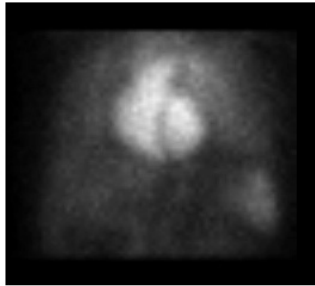
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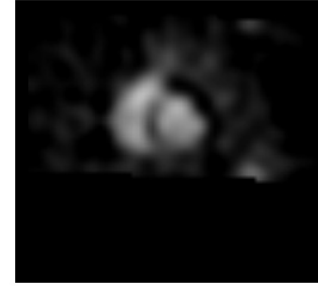
## Background

Planar radioventricular measurements of cardiac function are readily available. Current technology allows the collection of gated blood pool SPECT data. Advances in quantitative software allow the assessment of cardiac functional parameters from the gated blood pool SPECT and perfusion SPECT images.

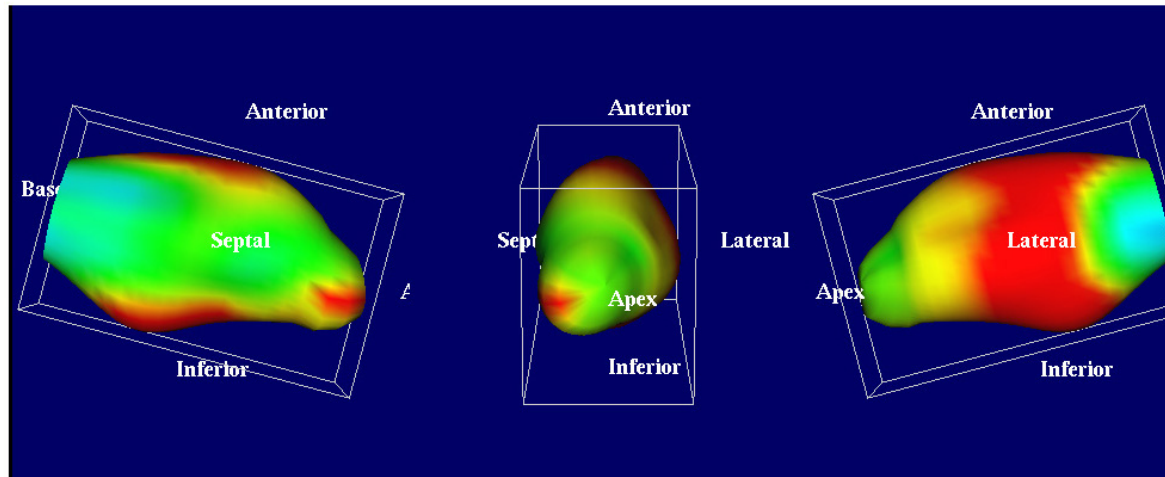
Planar LAO



SPECT Short Axis



3 Dimensional Volume Rendering



## Objective

Assessments of cardiac function in patients with systolic and diastolic dysfunction include the peak rates of ventricular emptying and filling and the timing of these events. Particularly, the rate of ventricular filling may be useful in the patient with heart failure and normal or near normal systolic function. Although gated SPECT is widely used for the assessments of ejection fraction and regional wall function, little has been done with the assessments of emptying and filling parameters using SPECT. In this study we compared the estimated diastolic parameters for peak ejection rate, peak filling rate, time to peak ejection rate and time to peak filling rate from planar and gated blood pool SPECT (GBPS) data.

## Methods – Patient Population

- Test Population
  - Forty-one consecutive patients
  - Gender: 13 female/28 male
  - Mean age:  $56 \pm 13$  years old
  - Planar EF range 19.2 – 79.2%
  - Mean EF  $55\% \pm 14.5$

## Methods – Acquisition / Reconstruction Protocol

- All data acquired with a Marconi 3000XP Prism imaging system
- Planar LAO images were acquired 1 - 5 minutes post 1.3 GBq Tc-99m labeled RBC's injection at rest.
- Planar Acquisition Parameters
  - 64 x 64 matrix, 6.6 mm<sup>2</sup> pixels
  - 16 frames / cardiac cycle
  - forward/backward gating
  - 20% beat acceptance window
  - 600 sec. Acquisition time

- Post Acquisition Processing Parameters
  - 3 point temporal filtering
- GBPS images were acquired immediately following the planar LAO acquisition
  - 60 projection/detector, 360° acquisition arc
  - 10 sec/projection
  - 64 x 64 matrix, 6.6 mm<sup>3</sup> voxels
  - 16 frames / cardiac cycle
  - forward/backward gating
  - 20% beat acceptance window
  - 64 x 64 matrix, 6.6 mm<sup>3</sup> voxels
  - 120 projections

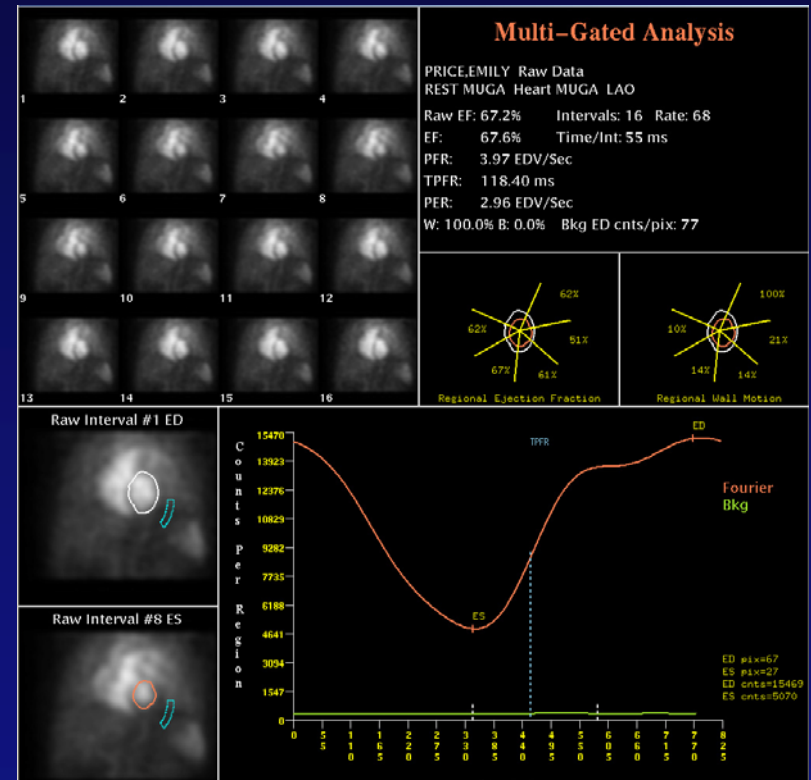
- Reconstruction parameters
  - 3 point temporal smoothing
  - transverse image reconstruction using filtered back-projection
  - images filtered using a Butterworth filter Order 5.0, cut-off frequency 0.25 cycles/cm

## Methods – Processing Protocol

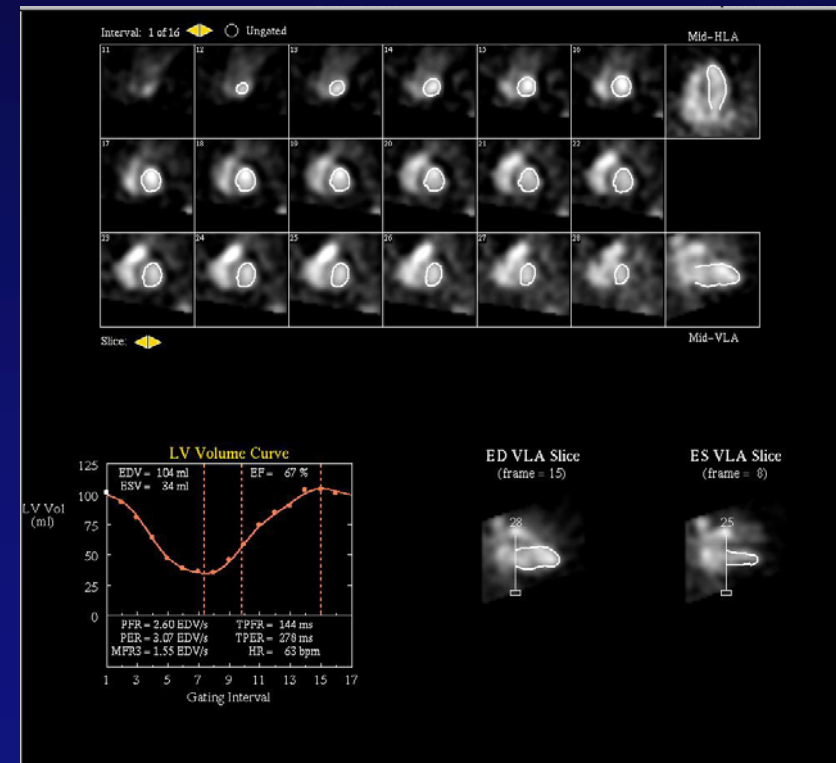
- Reconstructed GBPS images were re-sliced into LV short-axis images of the entire ventricular volume
- LV 3D surfaces were automatically rendered using the quantitative software program, 4D-MSPECT and short and long-axis slice displays were automatically generated.

# Methods – Analyses

- Planar studies were analyzed by two observers blinded to the GBPS data employing the commercial Odyssey multigated software
  - Regions of interest were manually optimized prior to creation of diastolic function curves



- SPECT studies were analyzed by two observers blinded to the planar MUGA results using the commercially available 4D-MSPECT software
  - Basal plane selection at ED and ES were optimized by the users prior to the creation of diastolic function curves
  - 4DM SPECT applies a 4th order harmonic to the diastolic function curves for calculation of functional parameters



- The diastolic parameters peak filling rate (PFR), time to PFR (TPFR), peak emptying rate (PER) and the time to PER (TPER) were estimated from the planar and GBPS analyses.
  - PER: Maximal rate of change in volume during the period from ED to ES. TPER is the time of PER from the time of ED.
  - PFR: Maximal rate of change in volume during the first 1/3 of the period from ES to ED. TPFR is the time of the PFR from the time of ES.
- The planar and GBPS results were correlated for both observers and between the observers for the GBPS estimates.

## Results

### Planar vs. GBPS Correlation

PER:  $y = 0.87x + 0.78, r = 0.80$

PFR:  $y = 1.02x + 0.58, r = 0.82$

Correlation coefficients for TPER and TPFR were marginal  
(0.4, 0.3)

## Results – GBSP Variability

### GBPS Interobserver Variability

PER:  $y=1.02x-0.01, r=0.94$

PFR:  $y=1.01x-0.10, r=0.89$

Correlation coefficients for TPER and TPFR were good to fair  
(0.8, 0.5)

## Discussion

- Since the LV volume curve is dependent on basal motion, it is believed that even small adjustments to basal plane location at end-diastole and end-systole can have a significant effect on the time to peak values and the variability in PER and PFR.
- For the GBPS studies, the basal location during the cardiac cycle is defined on slice boundaries. These integer basal locations can have a significant effect on the LV volume curve, with the most significant impact on TPER and TPF. An interpolated, non-integer placement for the basal limits may be necessary to optimize results and improve the correlation for estimated diastolic parameters.
- To reduce interobserver variation in PER and PFR, basal plane selection techniques should be consistent.

## Conclusion

- The diastolic parameters peak emptying and peak filling rates, correlated well between planar and SPECT blood pool imaging and expand the clinical utility of GBPS for the assessment of patients with diastolic heart failure.
- GBPS also provides the additional diagnostic information of ventricular volumes, indexed volumes and cardiac output.