Normal LV Ejection Fraction Limits Using 4D-MSPECT: Comparisons of Gated Perfusion and Gated Blood Pool SPECT Data with Planar Blood Pool

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Conflict of Interest

The University of Michigan receives royalties from the sale of the cardiac quantification software, 4D-MSPECT.

Objective

- The objective of this study was to estimate the difference in left ventricular ejection fractions (LVEF) measured in normals studied with gated perfusion and blood pool (GBP) SPECT quantified using 4D-MSPECT.

- A comparison with conventional planar blood pool processing was also conducted in the same patient population.

Patient Population

- The study consisted of 63 patients (42M, 59±15yo) who had undergone gated myocardial perfusion SPECT, gated blood pool SPECT (GBPS), and gated planar (LAO projection) blood pool imaging.

- Each of these patients had
  - Low (≤ 5%) pre-test likelihood for cardiac disease
  - No perfusion or wall motion abnormalities

Methods – Planar Blood Pool Processing

- 16 frame planar image at LAO projection.
- The LVEFs were measured using standard methods from background subtracted end-diastolic (ED) and end-systolic (ES) regions of interest (Marconi Odyssey software).
- Planar data was processed blinded to the results of the other data sets.

Methods – Myocardial Perfusion SPECT

- 16 frame, uncorrected FBP reconstructions from RAO to LPO with 5mm voxels.

- LVEF, EDv and ESv values were determined <u>automatically</u> with 4D-MSPECT v2.1.

Methods – GBPS Surface Algorithm

- 16 frame, uncorrected FBP reconstructions from RAO to LPO with 5mm voxels.
- The algorithm incorporates standard image processing tools
  - Gradient operators
  - Segmentation and morphologic operators
  - Weighted spline interpolators

Methods – GBPS Surface Algorithm

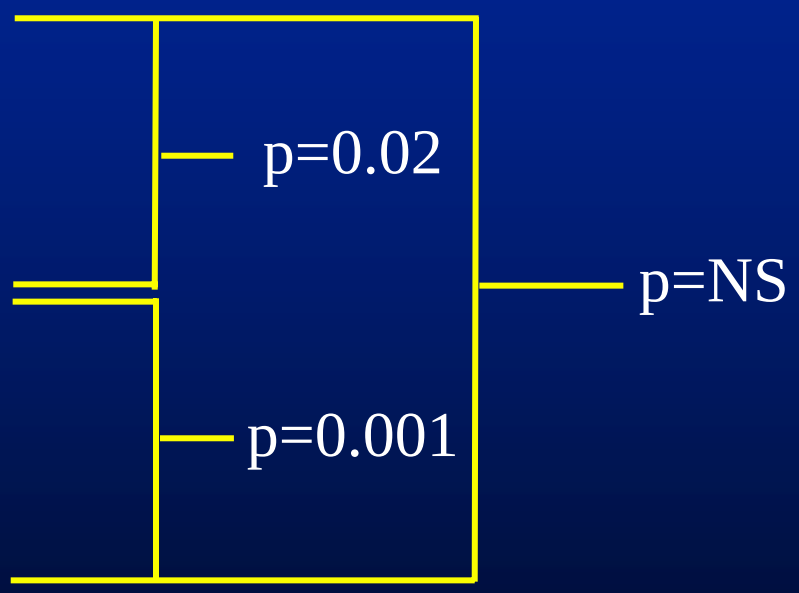
- Cylindrical/Spherical Sampling System
- Line profile analysis from mid-HLA is used to delineate RV from LV.
- Thresholding the mid-HLA gradient image for first frame is used to delineate the LV from the left atrium (LA).
- Surfaces are iteratively determined from 2D gradient LA images.
- Weighted spline interpolators (LA, SA and temporal) are employed for smooth contours throughout the cardiac cycle.
- The final LV basal positions at ED and ES are determined from information extracted from the segmented gradient images, stroke images, and phase analysis. Using the ED and ES limits, a periodic spline is used to define the location for all frames in the cardiac cycle.

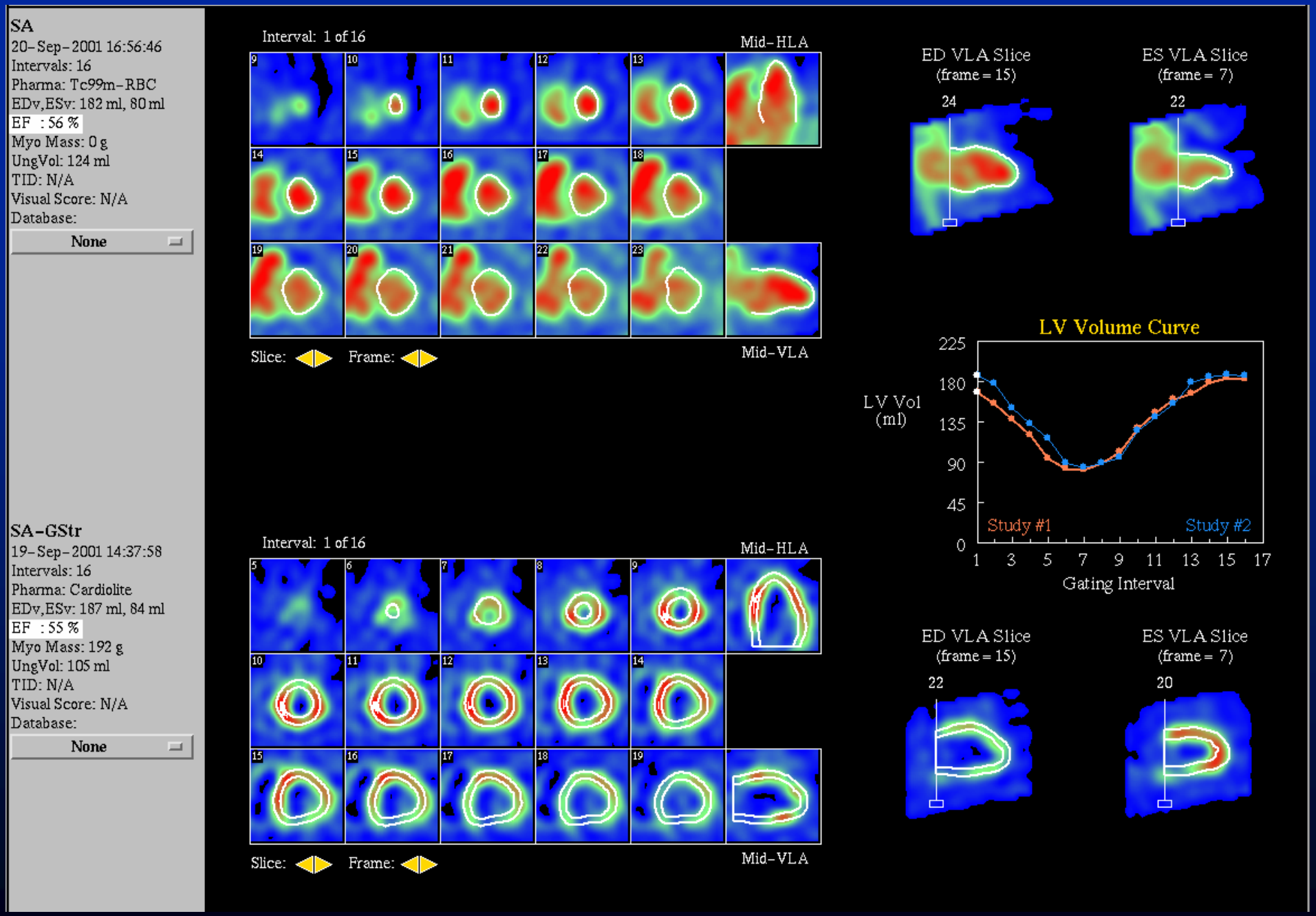
Results – Means and Linear Correlations

- Mean LVEF
  - Perf SPECT: (70 ± 7)%
  - GBP SPECT: (72 ± 7)%
  - GBP Planar: (68 ± 8)%
- Linear Correlations
  - GBP SPECT vs GBP Planar: $y = 1.05x - 0.24$, $r=0.95$
  - GBP SPECT vs Perf SPECT: $y = 0.97x + 3.6$, $r=0.98$

Results – Mean LV Ejection Fractions

- Perf SPECT: (70 ± 8)%
- GBP SPECT: (68 ± 7)%
- GBP Planar: (71 ± 8)%

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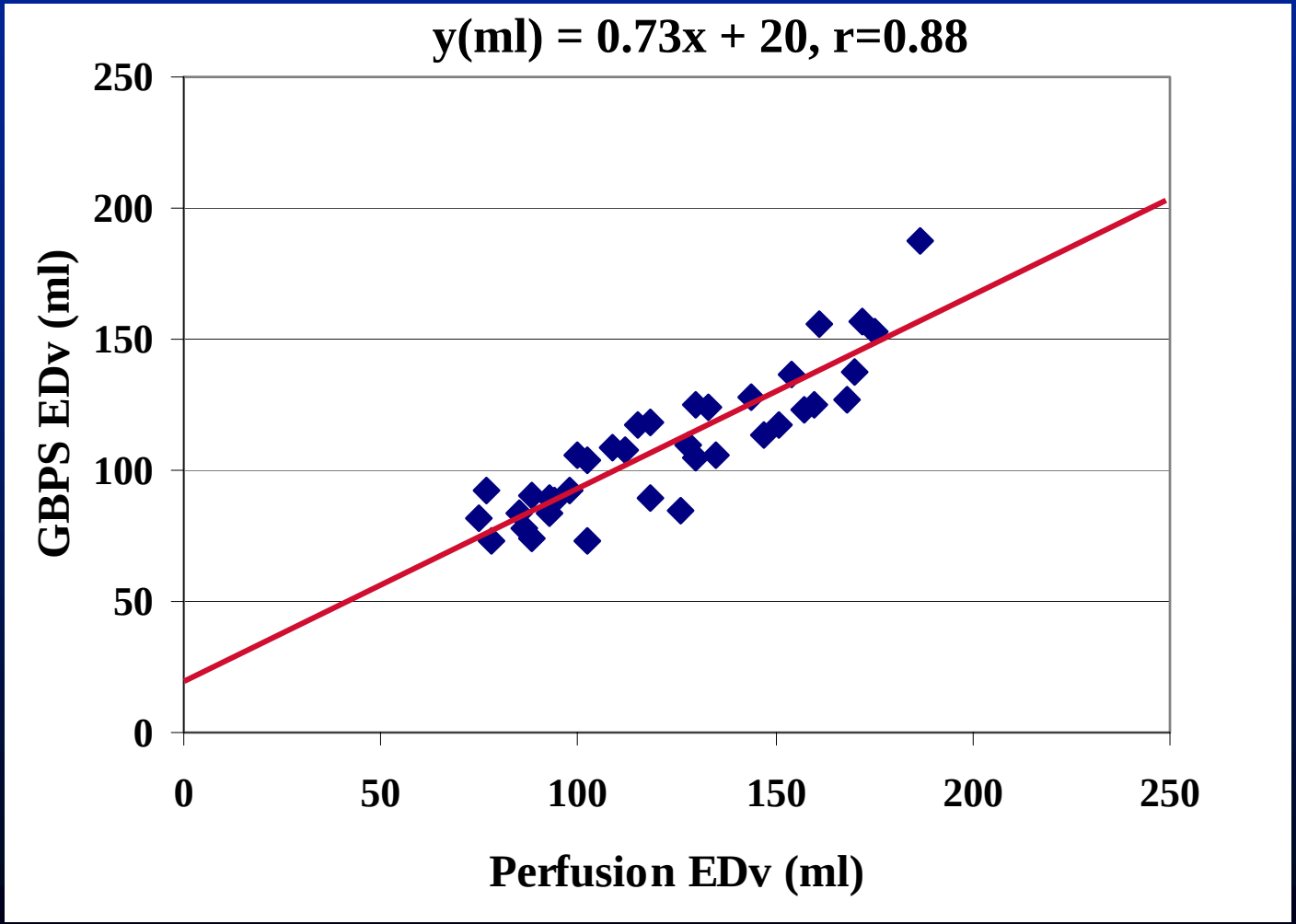
Pharma: Tc99m-RBC
EDv,ESv: 182 ml, 80 ml
EF : 56 %
Myo Mass: 0 g
UngVol: 124 ml
TID: N/A
Visual Score: N/A
Database:
None
Interval: 1 of 16
Mid-HLA
Slice:
Frame:
Mid-VLA
ED VLA Slice
(frame = 15)
24
ES VLA Slice
(frame = 7)
22
LV Volume Curve
LV Vol
(ml)
225
180
135
90
45
0
Study #1
Study #2
1 3 5 7 9 11 13 15 17
Gating Interval
SA-GStr
19-Sep-2001 14:37:58
Intervals: 16
Pharma: Cardiolite
EDv,ESv: 187 ml, 84 ml
EF : 55 %
Myo Mass: 192 g
UngVol: 105 ml
TID: N/A
Visual Score: N/A
Database:
None
Interval: 1 of 16
Mid-HLA
Slice:
Frame:
Mid-VLA
ED VLA Slice
(frame = 15)
22
ES VLA Slice
(frame = 7)
20

EDv Correlation: GBPS vs. Perfusion SPECT



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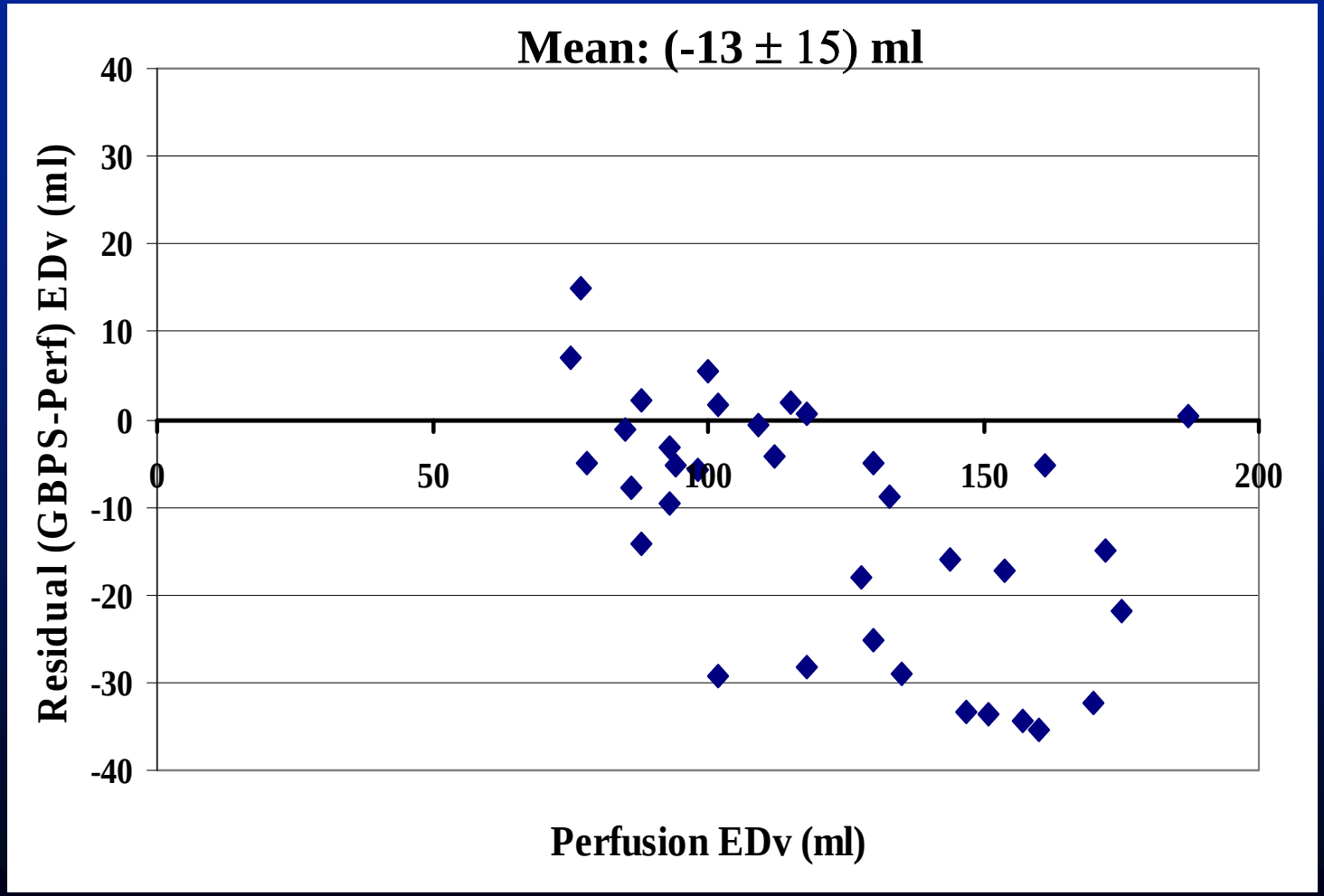
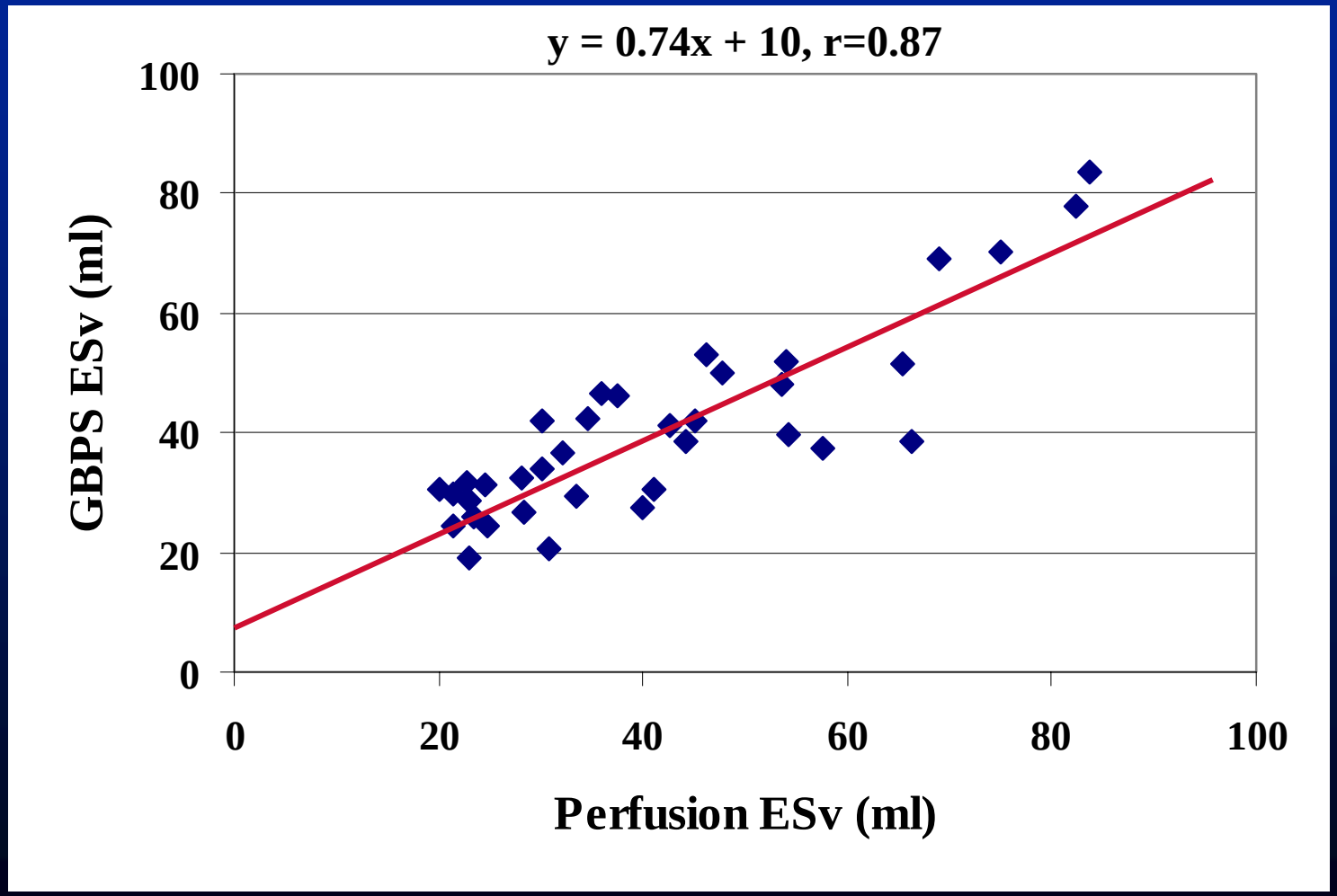
EDv Bland-Altman: GBPS vs. Perfusion SPECT



ESv Correlation: GBPS vs. Perfusion SPECT



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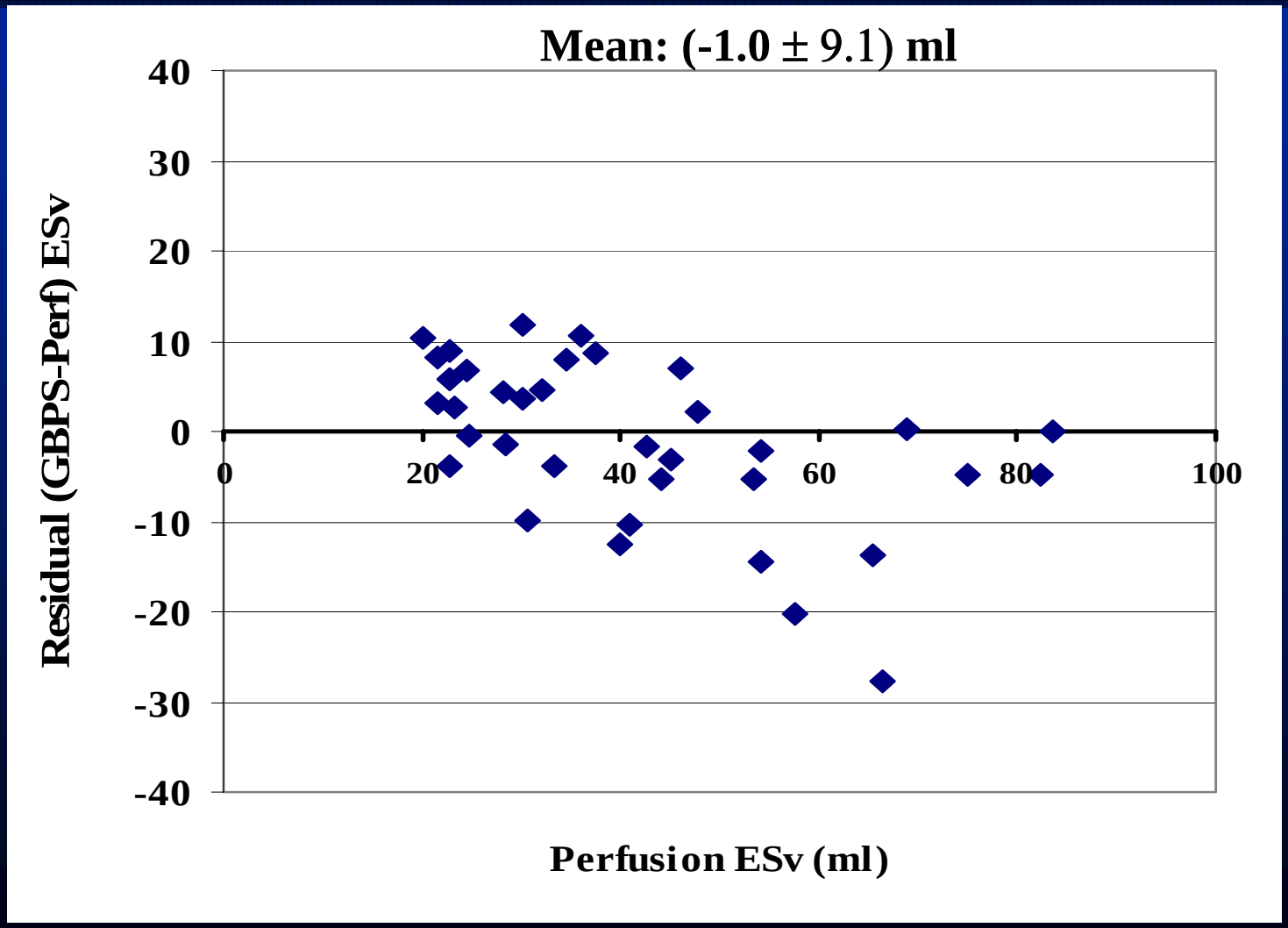
ESv Bland-Altman: GBPS vs. Perfusion SPECT



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Summary

- Results from this population demonstrated good accuracy for LVEF for GBPS compared to myocardial perfusion SPECT and planar blood pool imaging.

- While the LVEF differences were small (2-4%) they should be known when serial comparisons are required.

- For EDv and ESv, there was good correlation between GBPS and perfusion SPECT. However, the GBPS volume estimates tended to be lower than those estimate from perfusion SPECT data.