Quantification of Left Ventricular Function by Gated Perfusion Tomography: Testing of a New Fully Automatic Algorithm

A Chugh, EP Ficaro, M Moscucci, JN Kritzman, JR Corbett

University of Michigan Health System, Ann Arbor, MI

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Disclosure

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

- LV ejection fraction (EF) is an important predictor of outcomes in patients with heart disease.

- LVEF is commonly measured using gated SPECT perfusion imaging.
Background

• With gated SPECT, certain common image characteristics have been problematic
  – Intense peri-cardiac activity distributions, e.g., hepatic and bowel
  – Extensive, severe perfusion defects
The objective of this study was to test a new algorithm (4D-MSPECT) for measuring EF against contrast ventriculography (CVG) and another gated SPECT quantification program (QGS).
Patients

- Consecutive patients referred for gated Sestamibi perfusion SPECT.
- Contrast ventriculogram performed within 90 days of gated SPECT study
- N = 105 (75 males)
- Average age: 59 ± 13 years
Patients

• 57 patients with history of myocardial infarction

• Patients with atrial fibrillation were not excluded (n = 3).

• Contrast ventriculograms with significant ectopy were excluded.
Methods (CVG)

• Blinded to previous estimation of EF (SPECT, ECHO, CVG).
• End-diastolic and end-systolic contours were manually constructed using single-plane RAO contrast ventriculography.
• EF values were obtained via Simpson’s rule algorithm using the GE Advantx DLX review station.

• Three sets of contours were constructed for each patient and then the EF values were averaged.

• For patients with atrial fibrillation, EFs were calculated using several RR intervals and then averaged.
Methods (4D-MSPECT)

- All data were acquired with a Picker (Marconi) 3000XP SPECT system.

- Acquisition parameters
  - 360° orbit, 60 steps/detector, 16 secs/step
  - 16 gating intervals
  - 64 x 64 matrix, 6.3 mm pixel size

- All gated data were reconstructed from 180° projection image orbits from RAO to LPO using filtered backprojection.
Methods (4D-MSPECT)

- Transverse images were filtered using a Butterworth filter (order 5.0, cut-off 0.25).
- Reconstructed images were resliced into LV short-axis images of the entire ventricular volume.
- All data were evaluated for EF, end-systolic and end-diastolic volumes with both 4D-MSPECT and QGS.
62 year old male s/p CABG with progressive angina
72 year old male with NQMI complicated by CHF
Results

• With 4D-MSPECT, smooth visually acceptable LV surface estimates were obtained without user intervention.

• 4D-MSPECT vs. CVG:
  
  \[ y = 0.87x + 5.03 \ (r = 0.90, \ p < 0.001) \]

• QGS vs. CVG:
  
  \[ y = 0.74x + 7.98 \ (r = 0.85, \ p < 0.001) \]
4D-MSPECT vs. CVG

\[ y = 0.87x + 5.03 \quad r = 0.90 \]
QGS vs. CVG

$y = 0.74x + 7.98 \quad r = 0.85$
4D-MSPECT vs. QGS

\[ y = 1.06x + 1.35 \quad r=0.96 \]
Conclusions

• The new automatic algorithm was robust in providing accurate measurements of LV function in patients with diverse image characteristics.

• 4D-MSPECT performed well in the setting of small hyperdynamic hearts and in hearts with multiple severe perfusion defects and impaired LV function.
Limitations

• CVG EFs were obtained with single-plane ventriculography (cf. biplane).

• Gated SPECT quantification may be associated with increased variance in EF calculation in patients with small hearts.