Effect of Attenuation Corrected Myocardial Perfusion SPECT on Left Ventricular Ejection Fraction Estimates

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Objective

Using myocardial perfusion gated SPECT and the 3D-MSPECT quantitative software program.

- Evaluate the estimated EF dependence on the reconstruction arc length (180 or 360 degree).

- Evaluate the estimated EF dependence on the reconstruction algorithm (FBP versus the Michigan algorithm for attenuation correction).
Patient Population

79 patients imaged with a simultaneous gated transmission-emission tomographic system (M-STEP).
- Mean age: 55 ± 14 yo
- 58 males and 21 females

51 of the 79 patients received a bi-plane contrast ventriculogram study (CVG) performed within 90 days.
- Mean age: 56 ± 14 yo
- 39 males and 12 females
Imaging System

UM Modified STEP System (M-STEP)

Picker 3000 XP Triple Detector System

Detector 1 - Transmission and emission
  - 65cm focal distance fanbeam collimator

Detectors 2&3 - Emission only
  - Parallel hole collimators

Transmission Source
  - 5.5 GBq Am-241 (60 keV photopeak)
Acquisition Protocol

• Dual isotope imaging protocol. Gated stress Tc-99m-Sestamibi images were analysed in this study.

• Patients were imaged using a simultaneous gated transmission-emission tomographic system (M-STEP).

• Gated projection data acquired in 16 frames / R-R cycle, 20% window with forward-backward gating.

• 64x64 matrix with a pixel size of 6.3 mm.

• A 360 degree rotation with 60 projections at 16 sec/step.
U of M Processing Protocol

• **Uncorrected (NC) Emission Data** - Images were reconstructed over 360 and 180 degree using filtered back projection with a ramp filter.

• **Attenuation Corrected (AC) Emission Data** - Images were also reconstructed over arcs of 360 and 180 degrees (RAO-LPO) using an iterative penalized weighted least squares algorithm (PWLS-CD) developed at the University of Michigan.

• AC and NC transverse images were 3D post filtered with a Butterworth filter of order 4.0 and a cutoff of .20.

• Short Axis slices generated and entered into the 3D-MSPECT quantitative software application for automated estimation of left ventricular ejection fraction (EF).

• For comparison, the same AC and NC data sets were processed using the QGS quantitative software application.
Results: Gated SPECT vs. CVG

Correlation between 3D-MSPECT and CVG estimated EFs, n=51. The NC data from the 180 degree recon arc was input to 3D-MSPECT.

\[ y = 0.81x + 8.48 \quad r = 0.85 \]
3D-MSPECT: FBP Recon Arc Dependence

Left: Correlation between 3D-MSPECT estimated EFs from NC images reconstructed with 360 and 180 degree reconstruction arcs.

Right: Bland-Altman plot comparing the residual EF (NC360-NC180) with the EF from the NC180 data set.
3D-MSPECT: AC Recon Arc Dependence

Left: Correlation between 3D-MSPECT estimated EFs from AC images reconstructed with 360 and 180 degree reconstruction arcs.

Right: Bland-Altman plot comparing the residual EF (AC360-AC180) with the EF from the NC180 data set.
3D-MSPECT: Recon Algorithm Dependence

Left: Correlation between 3D-MSPECT estimated EFs from AC and NC reconstructed images. Reconstruction arc is 180 degrees.

Right: Bland-Altman plot comparing the residual EF (NC180-AC180) with the EF from the NC180 data set.
Left: Correlation between QGS estimated EFs from NC images reconstructed with 360 and 180 degree reconstruction arcs.

Right: Bland-Altman plot comparing the residual EF (NC360-NC180) with the EF from the NC180 data set.
QGS: AC Recon Arc Dependence

Left: Correlation between QGS estimated EFs from AC images reconstructed with 360 and 180 degree reconstruction arcs.

Right: Bland-Altman plot comparing the residual EF (AC360-AC180) with the EF from the NC180 data set.
QGS: Recon Algorithm Dependence

Left: Correlation between QGS estimated EFs from AC and NC reconstructed images. Reconstruction arc is 180 degrees.

Right: Bland-Altman plot comparing the residual EF (NC180-AC180) with the EF from the NC180 data set.
3D-MSPECT Results: Summary

• For the patients with CVG estimated EFs (n=51), the NC 180 degree data correlated best to the CVG data (r=.84).

• Correlations between all of the data sets were high. (> .90)

• From a t-test analysis, the EF estimates were not significantly different due to the reconstruction arc used (p=0.2). The mean EF difference due to the recon arc was < 1% for both AC and NC data sets.

• From a t-test analysis, the NC to AC EF estimates were significantly different (p<.05). The mean EF difference was –2.9% for AC compared to NC.
QGS Results: Summary

• QGS correlations and results were comparable to the 3D-MSPECT results.

• For the QGS program, the automated surface generator failed more frequently for 360 degree and AC data compared to the NC 180. For these data sets, the manual mode was used. This is due to the increased presence of splachnic activity.

  - NC180: 2 failures
  - NC360: 4 failures
  - AC180: 9 failures
  - AC 360: 11 failures

3D-MSPECT did not fail on any cases provided the LV center was properly positioned on the Setup screen.
Conclusions

• 3D-MSPECT EF values from either 180 or 360 degree recon arcs can be compared with minimal error.

• 3D-MSPECT EF values from NC or UofM AC image sets can also be compared with minimal error.

• Similar comparisons between commercial AC algorithms and NC data sets will have to be investigated to identify differences in estimated EFs.