Accuracy and Variability of 3D-MSPECT for Estimating the Left Ventricular Ejection Fraction as a Function of Gating Frames and Reconstruction Filters

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Introduction

• Increased clinical utilization of Gated SPECT Perfusion.
• Initial protocol utilized 16 frames / R-R interval.
• Results in increased processing time and disk space requirements.
• Concerned with effect of filter selection and number of frames on left ventricular ejection fraction determinations using 3D-MSPECT processing.
Study Objective

• Characterize the accuracy and reproducibility of the cardiac quantification program 3D-MSPECT.

• Estimating the left ventricular ejection fraction as a function of number of gating frames (8 vs 16).

• Estimating the left ventricular ejection fraction as a function of the reconstruction filter cutoff.
Patient Population

- 51 patients receiving a Bi-Plane Contrast Ventriculogram (CVG) study performed within 90 days of the tomographic study.
- 39 males and 12 females.
- The mean EF from CVG was (58 ± 14)%
- Each were processed for estimation of left ventricular ejection fraction.
Myocardial Perfusion Gated SPECT

• Dual Isotope protocol.

• Rest images acquired 15 minutes post-injection of 111-148 MBq Tl-201.

• Stress testing performed with either the Bruce or pharmacological protocols.

• Tc-99m Sestamibi (1.1 GBq/70 kg) injected at maximal stress.

• Gated stress images acquired 30-60 minutes post stress.
Acquisition Protocol

- Patients were imaged using a simultaneous gated transmission-emission tomographic system (M-STEP).
- Tomographic 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.
Reconstruction Processing Protocol

• Temporal filter (1-2-1) applied to raw gated projection data.

• Transverse images reconstructed from RAO-LPO data using filtered backprojection with a ramp filter.

• Frame Dependence Study
  – Transverse images are 3D Butterworth post filtered with a cutoff = 0.20 and an order of 4.
  – Adjoining frames of transverse images summed to produce 8 frame study.

• Filter Dependence
  – 16 frame transverse 3D post filtered with Butterworth filter, cutoffs = 0.25, 0.20, 0.15 and an order of 4.
• Short axis slices were generated for all data sets (8, 16 and filter comparison data sets).

• Short axis slices were entered into 3D-MSPECT software which automatically computed the left ventricular ejection fraction and ED and ES volumes over the cardiac cycle.

• Ejection fractions, EDv and ESv were also estimated with the QGS software program.
Gated SPECT vs. CVG

3D-MSPECT

QGS

y = 0.81x + 8.48  \( r = 0.85 \)

y = 0.648x + 12.799  \( r = 0.683 \)
8 vs. 16 Frame Comparison

\[ y = 0.92x + 3.79 \quad r = 0.97 \]
Filter Comparison (0.25 vs. 0.20)

\[ y = 0.94x + 2.09 \quad r=0.98 \]
Filter Comparison (0.20 vs. 0.15)

\(y = 0.73x + 11.56\) \(r=0.82\)
## Results: Filter Comparison with Large Heart

<table>
<thead>
<tr>
<th>Date</th>
<th>Time</th>
<th>UngVol</th>
<th>ED Vol</th>
<th>ES Vol</th>
<th>EF</th>
</tr>
</thead>
<tbody>
<tr>
<td>9/2/1999</td>
<td>13:57:33</td>
<td>102 ml</td>
<td>159 ml</td>
<td>74 ml</td>
<td>54 %</td>
</tr>
</tbody>
</table>

Interval: 8 of 16

COFFEY LOUIS 30056656

52 yo MALE

### Images

- **Anterior**
- **Septal**
- **Apex**
### Results: Filter Comparison with Small Heart

<table>
<thead>
<tr>
<th>Date/Time</th>
<th>Uncollimated Volume (ml)</th>
<th>ED Volume (ml)</th>
<th>ESV Volume (ml)</th>
<th>EF (%)</th>
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<tbody>
<tr>
<td>10/7/1999 13:04:30</td>
<td>40 ml</td>
<td>79 ml</td>
<td>11 ml</td>
<td>87%</td>
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<td>Interval: 8 of 16</td>
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#### Mid-LLA

#### Slice: Frame:

<table>
<thead>
<tr>
<th>Date/Time</th>
<th>Uncollimated Volume (ml)</th>
<th>ED Volume (ml)</th>
<th>ESV Volume (ml)</th>
<th>EF (%)</th>
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</thead>
<tbody>
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<td>39 ml</td>
<td>74 ml</td>
<td>7 ml</td>
<td>90%</td>
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<tr>
<td>Interval: 8 of 16</td>
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</tr>
</thead>
<tbody>
<tr>
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<td>27 ml</td>
<td>49 ml</td>
<td>22 ml</td>
<td>56%</td>
</tr>
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</tr>
</tbody>
</table>

#### Mid-LLA

#### Slice: Frame:
Conclusion

- Accuracy of the ejection fraction estimates was excellent for both 8 frame and 16 frame data sets.
- Difference between 16 and 8 frame data was < 3%.
- Variability of 3D-MSPECT EF values due to filter selection is quite low between 0.15 and 0.25, where 0.20 is the lower limit for small hearts.
- Based on this data, 3D-MSPECT provides flexibility in processing parameters with minimal effects to the estimated EF.