Impact of Different Reconstruction Methods on Apical Appearance in Myocardial Perfusion SPECT

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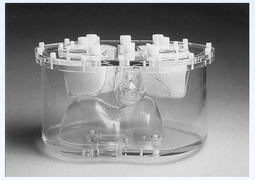
Introduction

Decreased apical counts are more frequently observed in myocardial perfusion images when images are reconstructed with attenuation and scatter correction (AC). We evaluated the impact of different reconstruction methods on apical thickness and spatial distribution of apical counts.

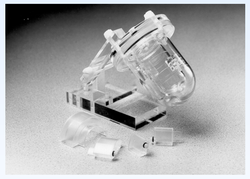
Methods and Materials

Phantom

- Data Spectrum Anthropomorphic Torso phantom (Figure 1)
- Cardiac insert with uniform 10-mm thick myocardial wall chamber (Figure 2)
- The phantom was filled with Tc-99m
  - Myocardial wall chamber: ~0.4 mCi
  - Liver: ~1.5 mCi
  - Background ~2.5 mCi in myocardial wall chamber, liver, and background



1. Anthropomorphic phantom with cardiac insert in place



2. Cardiac and defect inserts

Data Acquisition

- Phantom scanned on Philips BrightView XCT SPECT/CT camera
  - CT: 1-mm isotropic voxels
  - SPECT: 6.4-mm pixel size, 20 seconds/frame, 64 frames

Reconstruction Methods

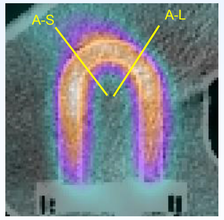
- FBP: Filtered backprojection reconstruction without attenuation correction (AC), scatter correction (SC), resolution recovery (RR), or noise reduction (NR), but with a low-pass filter applied to projection data for noise control.
- OSEM: Iterative ordered-subsets expectation-maximization (OSEM) reconstruction without AC, SC, RR, or NR. A post reconstruction low-pass filter is applied for noise control.
- OSEM-RR: Iterative OSEM reconstruction with RR and NR but without AC or SC
- OSEM-AC: Iterative OSEM reconstruction with AC and SC but without RR or NR. A post reconstruction low-pass filter is applied for noise control.
- OSEM-RR-AC: Iterative OSEM reconstruction with AC, SC, RR, and NR.

Data Analysis

- Visual comparison
- Myocardial wall thickness at apical-septal (A-S) and apical-lateral (A-L) walls are compared

  Wall thickness = FWHM of line profiles through the walls

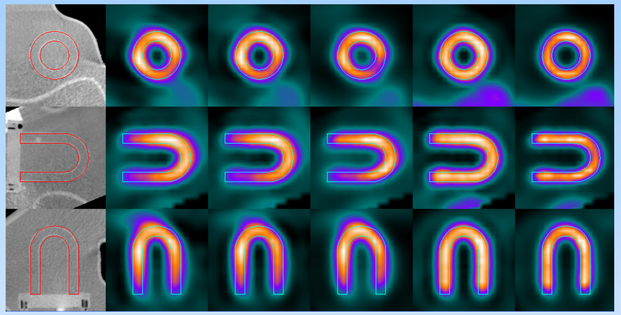
  Two profiles in each reconstructed images are drawn (Figure 3)
- A-S to A-L wall thickness ratio is used to indicate the severity of image distortion in the apical region in each reconstruction method



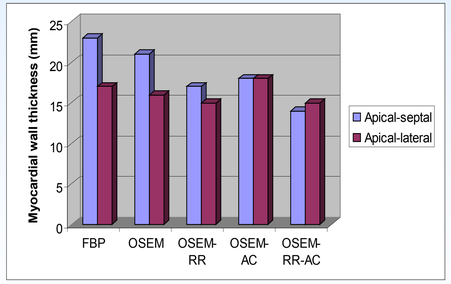
3. Myocardial wall thickness was measured at apical-septal (A-S) and apical-lateral (A-L) locations. The edges of the wall were determined by a threshold at 50% of the maximum myocardial value.

Results and Discussions

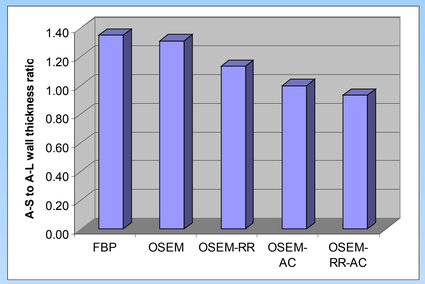
Reconstructed Images



4. CT and reconstructed SPECT images of the phantom. The images are oriented in short-axis (top row), vertical long-axis (middle row), and horizontal long-axis (bottom row) views. Image reconstruction methods used are labeled at the bottom of each column. The boundaries of the myocardial wall is overlaid on each image. Thicker apex is seen in reconstructed SPECT images without attenuation correction (AC). Applying AC improves both wall thickness and count uniformity significantly. Inclusion of resolution recovery (RR) only (without AC) does not remove wall thickness non-uniformity. When applying RR with AC, the image resolution is enhanced with slight wall thickness non-uniformity increase.



5. Myocardial wall thickness in apical-septal and apical-lateral directions with respect to reconstruction methods. The true wall thickness is 10 mm. FBP produces the largest asymmetry between A-S and A-L walls, while OSEM-AC has the smallest asymmetry. The wall thickness from OSEM-RR-AC is closest to the truth.



6. Ratio between measured myocardial wall thickness in apical-septal and apical-lateral directions with respect to reconstruction methods. The ideal ratio is 1.0.

Conclusion

Apical thickening and distortions appear in cardiac phantom images reconstructed without AC. Attenuation correction reduces these artifacts. These data suggest that patient data reconstructed with AC would provide a truer representation of counts from the apical region than those reconstructed without AC.

Disclosures

All authors are employed by Philips Healthcare.

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