# VALIDATION OF A DEFORMABLE ATLAS-BASED LEFT VENTRICULAR SEGMENTATION METHOD FOR PET AND SPECT: COMPARISON TO CARDIAC COMPUTED TOMOGRAPHY ANGIOGRAPHY (CCTA) VOLUMES

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## Purpose & Objectives

Gated myocardial perfusion SPECT and PET are commonly used to calculate left ventricular ejection fraction (LVEF) and assess left ventricular end diastolic (EDV) and end systolic volumes (ESV). A number of software methods have been developed to automatically calculate these parameters. In a previous work we compared the LV parameters (EF, EDV, ESV) for three software packages: MIMcardiac®, QGS, and 4D-MSPECT for gated myocardial perfusion SPECT. This work demonstrated the methods correlated well but were still significantly different. The various software packages utilize different methods for LV segmentation therefore understanding the accuracy of each method is essential. Our goal in the current work is to evaluate the left ventricular volumes calculated by MIMcardiac (MIM Software Inc) for gated myocardial perfusion PET and SPECT using CCTA as the reference standard.

## Methods & Materials

### *Image Data:*

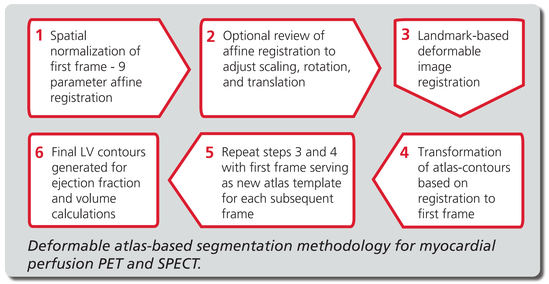
CCTA images were collected for 15 patients with a corresponding gated (8 frame) stress Tc99m-Sestamibi SPECT study and 10 patients with a corresponding gated (8 frame) Rb82-PET. The median time difference between CCTA and PET was 2 days and between CCTA and SPECT was 29 days. There was a single corresponding CCTA image for each of the 15 SPECT patients and for 3 of the 10 PET patients. The remaining 7 patients with PET scans had CCTA's from two different parts of the cardiac cycle. Three of the 7 patients with 2 CCTA's also had both a stress and rest gated Rb82-PET.

### *Data Processing:*

The left ventricular endocardial cavities were semi-automatically contoured on the CCTA's (MIM®, MIM Software Inc.) The CCTA images were fused to the corresponding gated PET or SPECT study and the most closely matched frame was identified without the operator's knowledge of PET/SPECT contours or volume. The gated SPECT and PET scans were then processed using MIMcardiac to generate time volume curves. The volume from the frame that was previously determined to most closely match the CCTA was recorded. All segmentations for PET and SPECT were completely automatic with no manual adjustments.

### *Statistical Analysis:*

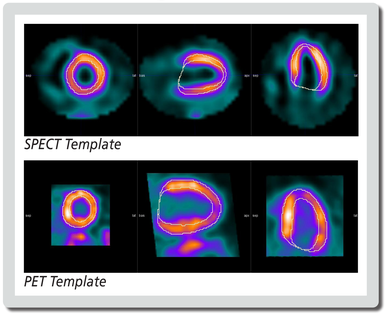
Volumes for the PET and SPECT frame corresponding to the CCTA frame were recorded and mean volume, difference, percent difference, and correlation coefficients were calculated. Systematic differences between SPECT and CCTA and PET and CCTA derived volumes were assessed using a Bland Altman Plot. Significance was calculated using Student's t-test.




*Deformable atlas-based segmentation methodology for myocardial perfusion PET and SPECT.*

**Figure 1**

***Templates Used for Registration with Atlas Contours***



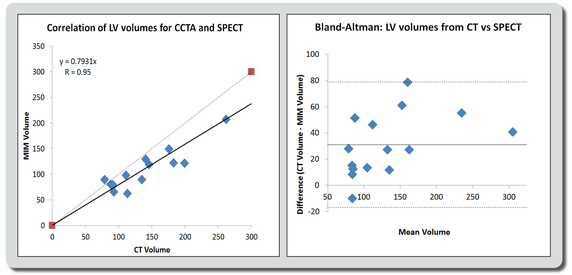

### *MIMcardiac Deformable Registration:*

MIMcardiac uses deformable image registration and atlas-based segmentation to generate the left ventricular myocardial contours. Atlas templates were previously defined for both PET and SPECT that had myocardium and valve plane defined using aligned CCTA image volumes. The atlas template (see Figure 1) is deformed to match the size, shape, and orientation of the patient images. Using this same deformation, contours are transformed from the template back to the original patient image.

## Results

### *SPECT:*

The LV volumes from CT and MIMcardiac correlated significantly ($r = 0.95$, $p < 0.0000001$) (Correlation Graph). The average CT LV volume was 149± 71 mL, while the average SPECT LV volume generated using MIMcardiac was 118 ± 60 mL. The average difference and percent difference in volume between the two methods was 31±24 mL and 23% ± 18) respectively.




### *PET:*

The LV volumes from CT and MIMcardiac correlated significantly ($r = 0.92$, $p < 0.00000001$). The average CT LV volume was 81± 38 mL, while the average PET LV volume generated using MIMcardiac was 81± 35 mL. The average difference and percent difference between the two methods was 0± 15 mL and -3%± 22) respectively.

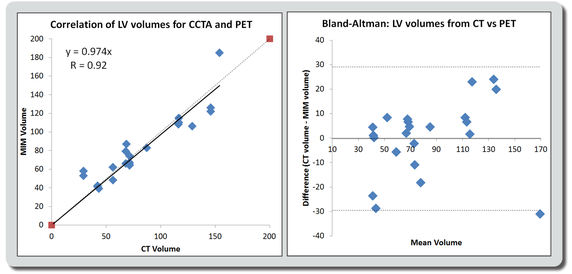
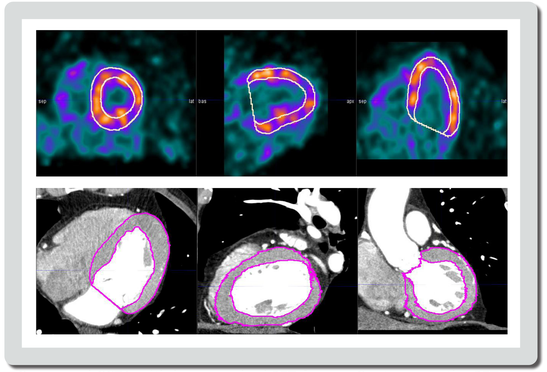



**Figure 2**

***CCTA with Contours and Segmented PET***



*Contoured CCTA with best matched PET frame. Contours on the PET were generated automatically from registration to the PET template and atlas-based segmentation.*

## Conclusion

The left ventricular volumes generated automatically by MIMcardiac for both PET and SPECT correlated significantly with LV volumes derived from CCTA. All PET and SPECT processing was completely automatic suggesting a high degree of consistency would be possible with this method.

## Reference

Pirozzi SD, Nelson AS, Nelson AD, et al. Comparison of QGS, 4D-MSPECT, and MIMcardiac for the evaluation of left ventricular functional parameters for gated myocardial perfusion SPECT. J Nucl Med 2012; 53 (Suppl 1):2297