Fully Automatic Left Ventricle Segmentation in Dynamic ^{82}Rb PET/CT Using Deep Learning

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Purpose

To develop and evaluate a fully automatic deep learning–based method for left-ventricular (LV) segmentation in dynamic ^{82}Rb PET/CT, building on a robust manual multi-modal LV delineation protocol to further enable advanced endo-to-epicardial myocardial perfusion analysis.

Materials and Methods

This retrospective study included 40 non-gated dynamic PET/CT volumes from 20 patients who underwent ^{82}Rb PET/CT examinations for revascularization, each with rest and stress scans. The cohort included cases with apical thinning and hypoperfused septal and lateral walls. LV contours were manually delineated across multiple time frames, excluding the blood pool, using CT images to ensure that contours remained within the myocardium. This dataset was used to train and evaluate a 3D nnU-Net architecture with 5-fold cross-validation. Performance was assessed using Dice coefficient, precision, and recall. A simple semi-automatic baseline based on thresholding (35% of the maximum LV intensity) was also implemented for comparison.

Results

Baseline nnU-Net achieved a mean Dice of 0.8778 and mean precision and recall of 0.8809 and 0.8904 across folds. The best semi-automatic thresholding configuration reached a mean Dice of 0.7509, with mean precision and recall of 0.7018 and 0.8255, clearly underperforming the nnU-Net. Thresholding especially failed to contour the LV in patients with marked hypoperfusion and apical thinning, where nnU-Net segmentations remained substantially closer to the manual reference, although these cases remained the most challenging.

Conclusion

Deep convolutional neural networks enable fully automatic LV segmentation in dynamic ^{82}Rb PET and substantially reduce manual effort. The evaluated nnU-Net model achieves high overall accuracy and clearly outperforms simple threshold-based methods, including in hypoperfused and thinned regions, supporting reliable quantification of myocardial perfusion.