

Multimodality imaging of carotid artery plaques: 18F-FDG PET, CT, and MRI

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Purpose. The objective was to compare carotid plaque assessment with ¹⁸F-Fluoro-2-DeoxyGlucose Positron Emission Tomography (¹⁸F-FDG PET), Computed Tomography (CT), and Magnetic Resonance Imaging (MRI).

Methods and Materials. Fifty patients with symptomatic carotid atherosclerosis underwent ¹⁸F-FDG PET/CT and MRI. Correlations and agreement between imaging findings were assessed by Spearman and Pearson rank correlation tests, T-tests, and Bland-Altman plots.

Results. No strong correlations were found between plaque ¹⁸F-FDG standard uptake values (SUVs) and CT/MRI findings (Spearman ρ 's -0.088-0.385). Maximum SUV was significantly larger in plaques with IPH (1.56 vs. 1.47, $P=0.032$). SUVs did not significantly differ between plaques with an intact and thick, versus plaques with a thin and/or ruptured fibrous cap at MRI (1.21 vs. 1.23, $P=0.323$; and 1.45 vs. 1.54, $P=0.727$). Pearson ρ 's between CT and MRI measurements varied from 0.554-0.794 ($P<0.001$). For lipid-rich necrotic core (LRNC) volume, the CT-MRI correlation was stronger in mildly ($\leq 10\%$) than in severely ($>10\%$) calcified plaques (Pearson ρ 0.730 vs. 0.475). Mean difference in measurement $\pm 95\%$ limits of agreement between CT and MRI for minimum lumen area, volumes of vessel wall, LRNC, calcifications, and fibrous tissue were 0.4 ($P=0.744$) ± 18.1 mm², -41.9 ($P=0.450$) ± 761.7 mm³, 78.4 ($P<0.001$) ± 305.0 mm³, 180.5 ($P=0.001$) ± 625.7 mm³, and -296.0 ($P<0.001$) ± 415.8 mm³, respectively.

Conclusion. Overall, correlations between ¹⁸F-FDG PET and CT/MRI findings are weak. Correlations between CT and MRI measurements are moderate-to-strong, but there is considerable variation in absolute differences. Future prospective longitudinal studies should determine which imaging modality is most effective for risk stratifying patients for stroke.

Figure 1. Fused ¹⁸F-FDG PET/CT image of a transverse section of a plaque in the internal carotid artery. Region of interest (ROI) (yellow) encompassing the plaque was drawn on the CT image. On the co-registered ¹⁸F-FDG PET image, mean and maximum SUV of ¹⁸F-FDG was measured within this ROI.

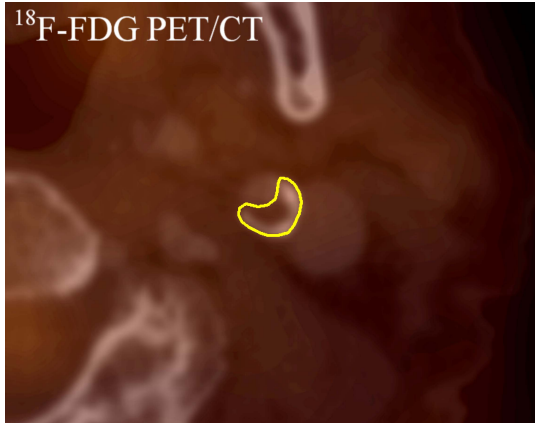


Figure 3. CT images of a transverse section of a carotid plaque. ROI encompassing the plaque and arterial lumen has been drawn on the CT image (A). To differentiate lumen area from the plaque area and from calcified tissue, a second ROI has been drawn (B). This second ROI should include the attenuated lumen area, but no calcifications. After the input of the cut-off values that differentiate the plaque components and the lumen, a pixel map based on HU values was obtained (green=arterial lumen; blue/white=calcifications; yellow=lipid; magenta/red=fibrous tissue) (C).

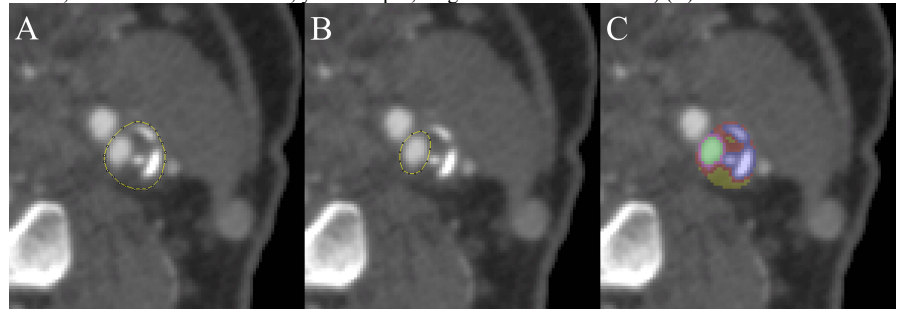


Figure 3. Co-registered T1w TFE, TOF, T2w TSE, pre- and post-contrast T1w TSE images of a transverse section of a carotid plaque. The right Bottom panel displays the ROIs: red=lumen; green=outer vessel wall; yellow=LRNC; orange=calcifications; remaining vessel wall area=fibrous tissue. Intraplaque hemorrhage was scored as being present (asterisk in TOF image) and the FC was designated as thin and/or ruptured (arrow in post-contrast T1w TSE image).

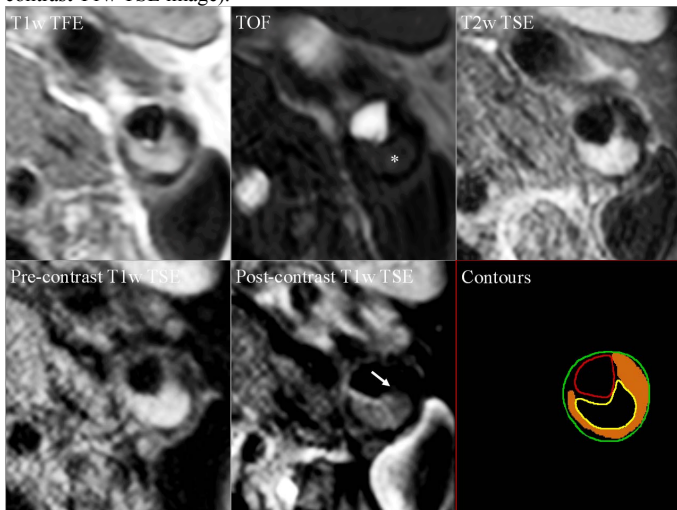


Table 3. Comparisons between CT and MRI.

CT- and MRI-assessed parameter	Mean value at CT \pm SD	Mean value at MRI \pm SD	P-value
Minimum lumen area (mm ²)	18.7 \pm 14.9	18.2 \pm 9.9	0.744
Vessel wall volume (mm ³)	836.3 \pm 604.7	878.2 \pm 405.8	0.450
LRNC volume (mm ³)	169.1 \pm 187.5	90.8 \pm 147.3	<0.001
Volume of calcifications (mm ³)	246.3 \pm 356.6	65.8 \pm 80.3	<0.001
Volume of fibrous tissue (mm ³)	421.0 \pm 292.1	716.9 \pm 281.0	<0.001

Acknowledgement

Supported by Dutch Heart Foundation grant 2006B61.

Table 1. Correlations between mean and maximum SUVs and CT/MRI-assessed Morphological and compositional plaque characteristics.

CT-assessed parameter	Mean SUV		Maximum SUV	
	Spearman ρ	P value	Spearman ρ	P value
Minimum lumen area	0.026	0.859	0.032	0.827
Vessel wall volume	0.114	0.429	0.319	0.024
LRNC volume	0.222	0.122	0.377	0.007
Volume of calcifications	-0.088	0.542	0.070	0.629
Volume of fibrous tissue	0.187	0.194	0.385	0.006
MRI-assessed parameter	Spearman ρ	P value	Spearman ρ	P value
Minimum lumen area	0.119	0.410	0.064	0.656
Vessel wall volume	0.188	0.192	0.353	0.012
LRNC volume	0.088	0.541	0.246	0.085
Volume of calcifications	-0.102	0.481	-0.030	0.838
Volume of fibrous tissue	0.253	0.076	0.378	0.007

Table 2. Correlations between CT and MRI.

CT- and MRI-assessed parameter	Pearson ρ	P-value
Minimum lumen area	0.794	<0.001
Vessel wall volume	0.773	<0.001
LRNC volume		
• All plaques	0.591	<0.001
• Only mildly ($\leq 10\%$) calcified plaques	0.730	0.003
• Only severely ($>10\%$) calcified plaques	0.475	0.003
Volume of calcifications	0.554	<0.001
Volume of fibrous tissue	0.727	<0.001

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