Whole-vessel coronary 18F-sodium fluoride coronary microcalcification activity is associated with Low density plaque

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Topic(s):
Positron Emission Tomography (PET)

Citation:
European Heart Journal (2019) 40 (Supplement), 3648

Background: 18F-sodium fluoride (18F-NaF) showed promise in imaging vulnerable coronary plaques. To date reporting of the highest per patient target to background ratio (TBR), total number of lesions with visual uptake and whole-heart tracer activity have been proposed. Unfortunately, each of these approaches has limitations which become especially prominent in patients with multiple foci of uptake, where reproducible global per-vessel measures are required. In oncology, the total metabolic active tumor volume has been found to be a significant prognostic factor for disease progression, recurrence and death. We evaluated if such methodology could be applied to coronary PET imaging.

Purpose: To quantify whole-vessel coronary 18F-NaF PET activity by utilizing automatically derived coronary vessel regions of interest (ROI) from CT angiography and assess the relationship between coronary microcalcification activity (CMA) and per vessel quantitative plaque characteristics on coronary CT angiography (CTA).

Methods: Twenty patients (68±6 years old, 70% males) with multivessel coronary artery disease underwent a 30 min single bed position PET 1h after a 250mB injection of 18F-NaF and CTA on a hybrid PET/CT scanner. We assessed coronary 18F-NaF uptake using novel whole-vessel tubular and tortuous 3D ROIs which were automatically extracted from CTA datasets. Within such ROIs we measured mean standard uptake value (SUV), maximum TBR (TBRmax) and the activity of voxels (CMA) above 1.25 the background SUV (left atrium activity). We used a previously established 1.25 TBRmax threshold to distinguish vessels positive and negative for 18F-NaF uptake. Coronary CTA datasets were analyzed by semi-automated software to quantify volumes and percentage lesion content of non-calcified plaque (NCP), low-density non-calcified plaque (LD-NCP, attenuation <30 Hounsfield units) and calcified plaque (CP).

Results: 13 (65%) patients and 24 (40%) out of 60 main epicardial vessels presented with 18F-NaF uptake exceeding the 1.25 TBRmax threshold. While coronaries positive for uptake had higher CMA 0.92 [0.17, 2.03] vs 0.0, p<0.001 and TBRmax 1.42 [1.35, 1.74] vs 1.09 [1.0, 1.19], there was no difference in whole-vessel SUVmean 0.90 [0.77, 1.17] vs 0.87 [0.78, 0.96], p=0.33 compared to 18F-NaF negative arteries. Of the quantitative plaque characteristics vessels positive for uptake had higher NCP 278.4 [145.6, 576.9] vs 184.6 [63.8, 367.0]mm³, p=0.030; and LD-NCP 8.4 [0.3, 11.0] vs 2.7 [12.1, 43.5]mm³, p=0.01. CMA showed a stronger correlation with LD-NCP (r=0.70, p<0.001) than TBRmax (r=0.52, p<0.001). On regression analysis LD-NCP acted as an independent predictor of CMA after adjustments for CP and vessel SUVmean (p<0.001).

Conclusions: Whole-vessel 18F-NaF coronary microcalcification activity assessment with CT angiography automatically derived 3-dimensional ROIs is feasible and the measured coronary microcalcification burden correlates well with low density plaque.
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Figure 1