CCTA-derived functional and morphological features and their comparative performance in predicting impaired coronary vasodilatation by PET-myocardial perfusion imaging.

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On behalf: EVINCI-SMARTOOL

Topic(s):
Coronary CT Angiography

Background/Objectives: The relationship between biomechanical characteristics of a coronary lesion with myocardial blood flow has not been studied. We investigated the relationship between local endothelial shear stress (ESS) and computed tomography coronary angiography (CTCA)-derived anatomical and plaque characteristics data with impaired vasodilating capability assessed by positron emission tomography myocardial perfusion imaging (PET-MPI).

Methods: A total of 92 coronary vessels of 53 patients who have undergone both CTCA and PET-MPI with 15O-water or 13N-ammonia were analysed. PET was considered abnormal when > 1 contiguous segments showed both stress Myocardial Blood Flow (MBF) ≤2.3mL/g/min and Myocardial Flow Reserve (MFR) ≤2.5 for 15O-water or <1.79 mL/g/min and ≤2.0 for 13N-ammonia respectively. CTCA images were used to assess stenosis severity, lesion specific total plaque volume (PV), non-calcified PV and calcified PV as well as plaque phenotype. ESS was calculated for the full length of a lesion (total), as well as in the proximal, minimum lumen area and distal lesion segments.

Results: ESS was weakly correalted with total PV (rho=0.273, p=0.008), non-calcified PV (rho=0.247, p=0.017) and the volume of necrotic core (rho=0.242, p=0.02). ESS increased progressively with stenosis severity (p≤0.001). ESS was also higher in functionally significant vs. non-significant lesions (10.4 [8.04-54.4] Pa vs. 3.9 [2.32-7.29] Pa, p ≤0.001). Addition of ESS to stenosis severity improved prediction (Δ[AUC]:0.113, 95% CI: 0.055 to 0.171, p=0.0001) of functionally significant lesions.

Conclusion: There is a weak positive association between lesion-specific ESS and plaque volume. ESS increases progressively with stenosis severity and is higher in functionally significant lesions by PET-MPI. The addition of ESS to CTCA-anatomical information improves prediction of an abnormal PET-MPI result.