reconstruction was used for all data sets and all images were reconstructed with a slice thickness of 0.5 mm and an increment of 0.3 mm. Invasive FFR was measured using a pressure wire. CT-derived FFR was calculated using an on-site prototype. Coronary stenoses with invasively measured FFR ≤0.80 were classified as hemodynamically significant. Agreement between CT-derived FFR using both reconstruction parameters was compared to invasive FFR.
Results: 70 vessels in 50 patients (mean age 62±10 years) were analyzed. 18 lesions were classified as hemodynamically significant according to invasive FFR measurement. Compared to the medium smooth reconstruction kernel, using a sharp reconstruction kernel a significantly higher correlation with invasive FFR could be observed (r=0.72, p<0.0001 vs. r=0.5, p=0.0001, for sharp vs. smooth reconstruction kernel, respectively). ROC curve analysis showed an AUC of 0.9 (p<0.0001) for cFFR using sharp reconstruction kernel to correctly identify/exclude hemodynamically significant stenosis compared to invasive FFR, whereas a smaller AUC of 0.79 (p<0.0001) was observed for medium smooth reconstruction kernel. A cFFR value of 0.82 using sharp reconstruction kernel data sets showed a sensitivity of 93% and a specificity of 82% to detect lesions causing ischemia compared to the invasive gold standard. Bland-Altman analysis showed a closer agreement between invasive FFR and cFFR using sharp reconstruction kernel compared to a medium smooth reconstruction kernel (mean difference 0.004, 95% limits of agreement 0.14 to -0.14 vs. mean difference of 0.01, 95% limits of agreement 0.18 to -0.15 for sharp vs. medium smooth reconstruction kernel, respectively).
Conclusion: Compared to invasively measured FFR, cFFR using sharp image reconstruction parameters shows higher diagnostic accuracy for detecting lesions causing ischemia, potentially altering decision making in a clinical setting.

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Comparison between stress cardiac computed tomography perfusion versus fractional flow reserve CT derived in the evaluation of suspected coronary artery disease: PERFECTION prospective study

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Background: Coronary computed tomography angiography (cCTA) has been recently introduced as an alternative imaging modality to rule out CAD with low radiation exposure and the potential for improving prognostic assessment. However, there are still some concerns regarding to the use of cCTA in the specific subset of intermediate-to-high-risk patients as gatekeeper to ICA due to the limited positive predictive value of cCTA. In this regard, new cCTA techniques such as fractional flow reserve CT derived (FFRCT) and stress computed tomography perfusion (stress-CTP) recently emerged as potential strategies to combine anatomical and functional evaluation in one-shot scan.
Purpose: The PERFECTION study is a longitudinal, prospective and consecutive cohort study to compare the feasibility and accuracy of FFRCT versus stress-CTP for the diagnosis of functionally significant CAD.
Methods: One-hundred-forty-seven consecutive symptomatic patients (Mean age: 65.8±9.2; Male: 105) for chest pain who were referred for non-emergent, clinically indicated ICA plus invasive FFR were enrolled. The primary endpoint was to compare the diagnostic accuracy of cCTA versus cCTA+FFRCT versus cCTA+stress-CTP for the detection of significant CAD in a vessel and patients-based analysis defined by ICA with an invasive FFR ≤0.80 or coronary artery stenoses ≥80% or totally occluded vessels.
Results: Rest cCTA was successfully performed in all patients, FFRCT was performed in 143 out of 147 patients and stress-CTP was performed in 144 out of 147 patients. cCTA demonstrated a vessel and patient-based sensitivity (SE), specificity (SP), negative predictive value (NPV), positive predictive value (PPV) and diagnostic accuracy (ACC) of 99%, 76%, 100%, 61%, 82% and 95%, 54%, 94%, 63%, 74%, respectively. The diagnostic performance of integrated protocol of rest cCTA+FFRCT showed a vessel and patient-based SE, SP, NPV, PPV and ACC of 88%, 94%, 95%, 84%, 92% and 90%, 85%, 92%, 83%, 87%, respectively. Finally, the diagnostic performance of integrated protocol of rest cCTA+stress-CTP showed a vessel and patient-based SE, SP, NPV, PPV and ACC of 92%, 95%, 97%, 87%, 94% and 98%, 87%, 99%, 86%, 92%, respectively. Both FFRCT and stress-CTP significantly improved SP, PPV and overall ACC in both per-vessel and per-patient based model when added to cCTA, while no differences were found between cCTA+FFRCT versus cCTA+stress CTP.
Conclusions: Both FFRCT and stress-CTP are valid tool in addition to cCTA to evaluate the functional relevance of CAD. Based on these results, in patients with suspected CAD, cCTA alone or with integrated FFRCT might be sufficient to exclude relevant stenosis with the advantage to require a single acquisition with a low radiation exposure and low amount of contrast agent. Nevertheless, it might be reasonable to combine stress-CTP data in some patients with positive integrated cCTA+FFRCT exam thanks to the better specificity.

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Clinical usefulness of CT-FFR and myocardial perfusion imaging in comparison with invasive FFR

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Background: Coronary computed tomography angiography (CTA) are widely used for diagnosis of coronary artery disease (CAD). However, additional functional test, such as myocardial perfusion imaging (MPI) using SPECT, to detect ischemia would be needed in some cases. Newly developed CT-FFR using fluid structure interactions can be calculated on on-site workstation.
Purpose: To assess the clinical usefulness of CT-FFR, the diagnostic accuracy of CT-FFR and MPI were evaluated in comparison with invasive FFR as a gold standard.
Methods: In patients with suspected CAD, patients who underwent CTA/CT-FFR or MPI were enrolled. Of these, patients who underwent invasive FFR were included in this study. CTA image was scanned by 320-slice CT at 70–99% of R-R interval in one heart beat. Exclusion criteria were as follows: age <20 years old, after coronary artery bypass grafting (CABG), heart rate >65bpm at CT scan, and atrial fibrillation. Four CT images were reconstructed from the available phases (at 70%, 80%, 90%, and 99% of R-R interval). Semi-automatic calculation of CT-FFR was performed on a on-site workstation (sure-Cardio CT-FFR, Research Version, W.I.P., Canon Medical Systems, Japan). CT-FFR≤0.8, luminal stenosis of ≥50% on CTA, and summed difference score ≥1 on MPI were defined as abnormal findings. Diagnostic accuracy of CT-FFR, CTA, and MPI for detection of ischemia was evaluated in comparison with invasive FFR as a gold standard.
Results: CT findings were compared with invasive FFR in 103 branches of 95 patients (age 70±9 year, male 77%). Average Agatston score was 621±828. Interclass coefficient revealed that there was significant correlation between CT-FFR and invasive FFR (R=0.514, 95% CI= 0.30–0.67, p<0.0001). There was no lesion of CT-FFR≤0.8 in vessels with stenosis grading <50%. In lesions with ≥50% stenosis, CT-FFR distributed both ≤0.8 and >0.8. Invasive FFR ≤0.8 was detected in 34 (33%) branches. MPI and invasive FFR were available in 128 lesions of 103 patients, and 44 (34%) lesions were invasive FFR ≤0.8. Diagnostic accuracy of CT-FFR to detect invasive FFR ≤0.8 improved compared with luminal stenosis on CTA: accuracy 80 vs. 47%, sensitivity 82 vs. 100%, specificity 78 vs. 20%, positive predictive value (PPV) 65 vs. 38%, and negative predictive value (NPV) 90 vs. 100%. Diagnostic accuracy of MPI were accuracy 70%, sensitivity 23%, specificity 94%, PPV 67%, and NPV 70%, respectively. Area under the curve showed higher diagnostic accuracy of CT-FFR compared with CTA and MPI (AUC: 0.80 vs. 0.60 vs. 0.58).
Conclusions: CT-FFR was feasible for diagnosis of CAD. CT-FFR might be superior to MPI as a gatekeeper of invasive coronary angiography (ICA) and FFR. On-site assessment of CT-FFR would be useful for daily clinical practice; 1) high degree stenosis of >90% on CTA would need ICA without CT-FFR, 2) intermediate stenosis would be candidate for CT-FFR, 3) mild stenosis and intermediate stenosis with CT-FFR >0.8 would defer ICA.

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Evaluation of blood flow patterns for personalized stroke risk assessment in atrial fibrillation

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Purpose: Development of a personalized pipeline based on a computational fluid-dynamics (CFD) model of the left atrium (LA) for a comprehensive evaluation of the hemodynamic implications of atrial fibrillation (AF).
Method: Dynamic CT acquisition from two patients with persistent AF. Data were processed in order to extract the patient-specific 3D LA anatomical model by applying a specifically developed image segmentation algorithm. The patient-specific LA motion field was extracted by applying a non-rigid registration approach to the CT data and then applied to the corresponding 3D LA anatomical model. The CFD model consisted in the numerical implementation of the arbitrary Lagrangian Eulerian formulation of the Navier-Stokes equations. To set the CFD model boundary conditions, a representative mitral valve (MV) flowrate (the same for the sinus rhythm (SR) and AF condition apart from the absence of the A wave) was considered; given that the LA volume variation throughout the cardiac cycle was known, the flowrate at each PV was assigned by enforcing the mass balance equation and weighting the flow by each PV sectional area. CFD simulations were performed in both SR and AF conditions that differed in the motion model employed: SR employed the patient-specific LA motion model extracted from the CT sequence; AF was simulated by applying a random displacement function in order to reproduce the unsynchronized and strongly reduced LA contractile activity.
Summary of results: Velocity computed in three time instants of the cardiac cycle (ventricular systole, MV opening and atrial contraction in the first, second, third row respectively) by the CFD model in SR and AF is depicted in the figure. The