Integration of myocardial perfusion and coronary calcium: increasing the evidence for routine clinical use

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Integrated imaging of cardiac/coronary morphology by computed tomography (CT), alongside with myocardial perfusion and function by single-photon emission computed tomography (SPECT) is increasingly penetrating the clinical arena, mostly because of two major benefits. First, CT-based transmission measurements can be used effectively for attenuation correction of SPECT images. This increases specificity and overall diagnostic accuracy of SPECT. And secondly, even non-contrast-enhanced CT can be used to obtain markers of atherosclerotic plaque burden, such as the coronary calcium score (CCS), which provide incremental information for risk assessment, on top of myocardial perfusion.

In this issue of the European Heart Journal Cardiovascular Imaging, Ghadri et al. combine these benefits in their imaging protocol and report how the integrated information of a perfusion defect and calcification in the supplying coronary artery refines risk stratification. There are several important new aspects to their work. First, the CT scan that is used for calcium scoring is also the scan that was used for attenuation correction of SPECT data. In previous practice, attenuation correction and calcium scoring were often performed based on two different CT scans. Although both scans generally are low-dose techniques, the use of just one scan for both purposes still marks a useful step towards minimizing radiation exposure, given the recent discussion about radiation exposure from cardiovascular imaging. Secondly, the authors focus on integration of regional results of perfusion and atherosclerosis. While prior studies documented an added prognostic value for global CCS, the authors recorded calcifications in individual coronary arteries and matched those with perfusion defects in the corresponding vascular territory. They show that patients who had a match of perfusion defect and calcification in the respective artery had the worst outcome over an average follow-up period of around 3 years. Patients with an unmatched abnormality (which were mostly subjects with coronary calcium but without perfusion defect) had better outcome, while those without any abnormality did best. Multivariate analysis showed that the presence of a matched abnormality was an independent predictor of outcome, which was superior to either perfusion or CAC alone.

These results of Ghadri et al. give further support to the notion that hybrid imaging devices should be used for implementation of coronary calcifications into the analysis of myocardial perfusion studies. Their results should be seen as hypothesis generation for subsequent prospective trials. While retrospective registries suggest a prognostic value of a diagnostic strategy, they provide no proof that adaptation of treatment (based on the diagnostic test result) truly improves outcome. Prospective trials are needed for this purpose. Some of the limitations of the present work by Ghadri et al. support this need. Roughly 5% of patients were, e.g. excluded from the retrospective analysis because they underwent an early revascularization. The early intervention was most likely triggered by the results of the SPECT-CT. As a consequence, cases with the presumably highest risk were not available in the registry. This may, e.g. explain the absence of a predictive value of perfusion defects alone, which is in contrast to many prior outcomes analyses. Also, due to a relatively small sample size, late revascularizations were included as a soft endpoint (which made up for 40% of all events). The decision to revascularize may still have been driven by the diagnostic test results at this later stage. Hence, although the authors present a confirmatory (but less well powered sub-analysis), where revascularization is completely excluded as endpoint, the conclusiveness of this study is somewhat diminished by the lack of control over the therapeutic decision.

Another issue that needs to be highlighted is that the authors used a dedicated calcium score CT scan for attenuation correction and for prognostic evaluation in this study. This is based on a previously validated approach, and it is a strength of their setup. Of note, the low-dose CT that is usually acquired for attenuation correction of nuclear data sets in hybrid imaging is a low amperage, non-gated study, often without breath hold. While those studies may give a visual impression of gross coronary calcifications, they cannot be used for reproducible quantification, and smaller calcified plaques...
may be missed due to motion, lower contrast, and resolution. When acquired with prospective electrocardiographic gating, a dedicated CAC scan provides accurate measures of coronary calcium at approximately equal radiation doses. The only requirement is a sufficiently fast multislice CT component of the hybrid system. Such components are increasingly utilized in the latest generation of hybrid systems, but even if they are not available, the approach by Ghadri et al. provides another option. As employed by the authors, the CT may be acquired on a separate system and it may then, by using fusion software, be integrated with the SPECT data set after completion of both scans. This adds another level of flexibility for realization of combined regional assessment of coronary calcium and myocardial perfusion.

In summary, with the recent developments in hardware and software, hybrid imaging of coronary calcium and myocardial perfusion by SPECT-CT is well on its way to becoming a standard approach in the workup of coronary artery disease. The study by Ghadri et al. provides additional evidence on the prognostic value of this approach. It will serve as a foundation for further trials which will link hybrid imaging prospectively with therapeutic decision-making. This will provide further evidence on the way towards the ultimate goal of non-invasive test-guided intervention-thal therapy for improved outcome in ischaemic heart disease.

References