Preface

# Advances in cardiac CT

Advances made by cardiac CT in the last decade have been unparalleled in the field of medical imaging. Breathtaking technological advances in scanner hardware such as wide-array/volume scanners, dual source, high-pitch helical mode, fast gantry rotation time, smaller detectors and improved electronics have made it easy to routinely and consistently obtain high quality images of the heart (1). There has been development of multi-energy/spectral/dual energy CT using various technologies that provides improved tissue and material characterization compared to what is possible with a conventional CT, which can be used in a variety of clinical applications including myocardial perfusion, lesion characterization, improving vascular contrast, decreasing artifacts and minimizing radiation (2). Advances in radiation dose reduction techniques such as automatic tube current modulation, ECG based tube current modulation, automatic tube current and voltage selection and several generations of iterative reconstruction algorithms have ensured that high quality cardiac images can be obtained with minimal radiation (3).

The accuracy of cardiac CT in depicting coronary artery anatomy compared to invasive coronary angiography (ICA) has now been established beyond any doubt (4), and CT outperforms all other noninvasive imaging tests. The high accuracy and negative predictive value make CT well suited to exclude obstructive coronary artery disease in the low to intermediate risk population (5). This has been applied effectively in the emergency room setting to triage patients presenting with chest pain and discharge negative patients faster, providing cost savings to the healthcare system (6). Application of CTA in the high-risk group is limited, primarily because of its lower specificity and difficulty to estimate the hemodynamic significance of intermediate stenotic lesions (7). Now there are options available to obtain functional information from CT. Myocardial perfusion CT performed using a variety of techniques has higher specificity (68–98%) and PPV (55–94%) in the diagnosis of myocardial ischemia than conventional CT, although there is additional radiation and contrast dose (8). CT-FFR is an advanced post-processing technique, performed either offsite or onsite, where using mathematical assumptions and modeling, computational fluid dynamic model is generated and FFR is obtained non-invasively from a routine coronary CTA. This technique has been shown to convert 68% of CT 'false positives' to true negatives, and obviating the need for ICA in 61% of individuals compared to a simple CTA based algorithm (9).

Large multicenter trials have also established the role of CT in predicting major cardiovascular events which helps in prognostication and early initiation of preventive therapy at subclinical stage. Calcium score has been convincingly shown to be useful in a wide spectrum of age and risk factors, as an adjunct to traditional risk stratification models, due to its ability to reclassify, particularly in those who in the intermediate group and are considered/recommended statins (10). A zero calcium score has been shown to give a warranty period of at least 15 years in a recent study (11). Presence of high risk plaque features such as positive remodeling and low attenuation plaques and plaque progression are important risk factors for the development of acute coronary syndrome (ACS), both at short and mid-term (12,13). Even plaques without high risk factors increase the cardiovascular risk over a 5-year period based on CONFIRM registry data (14). Due to these predictive abilities, the use of CT has been shown to improve outcomes and reduce adverse events by early initiation of therapy, particularly in the recent SCOT-HEART and PROMISE trials (15,16). A recent study showed that even at 80-month follow up, the adverse event rate was lower in a treatment pathway that included cardiac CT (17).

These advances in cardiac CT and additional issues are explored in more detail in this special focused issue by several leaders in the field of cardiac CT. Dr. Achenbach's article gives a bird's eye view of the future directions of cardiac CT (18). Branch *et al.* discuss the technique, applications and challenges of CT myocardial perfusion in detail (19). Kueh *et al.* describe the principles, technique and applications of noninvasive fractional flow reserve with cardiac CT (20). Rajiah and Maroules provide a perspective on CT ischemia testing, comparing and contrasting CT perfusion, CT-fractional flow reserve and transluminal attenuation gradient (21). Kolossvary *et al.* provide a comprehensive review on CT based plaque imaging and risk assessment (22). Otton *et al.* eloquently review the technique of 3d printing from cardiovascular CT and provide a practical guide on applying it in clinical practice (23). Halliburton *et al.* review the advances in cardiac CT reconstruction strategies (24). Scholz *et al.* provide practical tips on the advances in contrast injection and acquisition protocols in cardiac CT (25). Kalisz *et al.* illustrate the applications of cardiac CT in the evaluation of cardiomyopathies (26).

We hope that you enjoy reading this special issue and benefit from these cutting-edge topics on the state-of-the-art cardiac CT as much as we did.

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