Multi-modality imaging in ischemic heart disease, arrhythmia and cardiac-mechanics
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**Summary and Conclusions
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The formation and growth of atherosclerotic plaques is a complex process which takes years before clinical symptoms occur. Chapter 2 demonstrates this dynamic process of coronary plaque evolution during long-term follow-up in a low-to-intermediate risk population. Men had more plaques in the coronary arteries on computed tomography (CT) than women, however the plaque burden normalized for the vessel volume on a per lesion analysis did not differ between men and women at baseline or during follow-up. Compositional plaque analysis demonstrated that women had lower fibro-fatty plaque volume at baseline and follow-up when compared to men. Furthermore, non-calcified and fibrous plaque volume regressed faster in women compared to men in the age category of less than 55 years of age. Conversely, no sex differences were noted in the patients aged 55 years or more. In Chapter 3, the relation between an anatomical marker of coronary artery disease (CAD), the coronary artery calcium (CAC) score, was compared with a functional marker of CAD, CT myocardial perfusion. The presence of inducible myocardial ischemia increased with increasing CAC score. Moreover, calcium score was the only determinant on multivariable analysis that significantly predicted the presence of inducible myocardial ischemia.

In Chapter 4, global left ventricular (LV) myocardial work efficiency was determined non-invasively using pressure-strain loops constructed from sphygmomanometric blood pressure measurements and 2D speckle tracking strain echocardiography. Global LV myocardial work efficiency was lower in individuals with structural heart disease: post ST-segment elevation myocardial infarction (STEMI) and heart failure with reduced LV ejection fraction. In individuals with cardiovascular risk factors but without structural heart disease, global LV myocardial work efficiency was similar to healthy subjects. In Chapter 5, segmental myocardial work efficiency and several other myocardial work indices were determined in patients following STEMI and compared to segmental hyperenhancement on late gadolinium contrast enhanced cardiac magnetic resonance (LGE CMR). Myocardial work index, constructive work and myocardial work efficiency were higher in non-infarcted segments, followed by segments with non-transmural infarction and transmural infarction respectively. Meanwhile, wasted work demonstrated an inverse relation.

Chapter 6 investigated the role of LV global longitudinal strain (GLS) and heart/ mediastinum (H/M) ratio on myocardial innervation/denervation imaging (using 123I-MIBG scintigraphy) in predicting ventricular arrhythmias (defined as appropriate therapy (shocks, anti-tachycardia pacing) on implantable cardioverter defibrillator (ICD)) in patients with heart failure. Both LV GLS and the H/M-ratio, were significantly more impaired in individuals with appropriate ICD therapy compared to those without, while LV ejection fraction was similar in both groups. Multivariate Cox regression analysis identified LV GLS and H/M ratio on 123I-MIBG scintigraphy as independent predictors of appropriate ICD therapy. Finally, in Chapter 7, attenuation of posterior left atrial adipose tissue on CT (as marker of inflammation) was shown to be a promising predictor of atrial fibrillation recurrence following catheter ablation.

Conclusions

Multimodality imaging is an important tool to guide the management of patients with cardiovascular disease. Technological advancements in CT have allowed for increased image quality with reduced radiation exposure. This permits CT to be utilized in larger populations with lower risk, and provides increasingly more information, alone or combined with other imaging modalities. Advanced echocardiographic techniques including 2-dimensional speckle tracking imaging (permitting measurement of LV GLS, and more recently non-invasive myocardial work) may provide important information in the characterization and risk-stratification of patients.

Further prospective studies in larger patient populations are needed to confirm the current results, before widespread clinical implementation of these sophisticated imaging techniques can be recommended.