Imaging microvascular dysfunction

The coronary microvasculature (vessels <300 μm in diameter) cannot be directly imaged in vivo, assessment of myocardial blood flow (MBF) and flow reserve (CFR) using non-invasive imaging detects abnormalities in coronary arteries without hemodynamically significant lesions, this approach allows to identify patients with coronary microvascular dysfunction (CMD) and to prevent subsequent major cardiac events\(^1,2\). The patients who can be eligible for these third level investigations are those without a known history of coronary artery disease (CAD) and symptoms suspect for myocardial ischemia; those with an increased suspicion for multi-vessel CAD; presence of risk factors, Left ventricular hypertrophy (LVH), Heart Failure preserved Ejection Fraction; heart transplant patients with “angiographically normal” epicardial arteries to detect initial allograft vasculopathy\(^3\). In cooperation with the Noninvasive Cardiovascular Imaging Program, Brigham and Women’s Hospital, Boston (MA) we quantified MBF and CFR in 4029 consecutive symptomatic patients referred for rest/stress myocardial perfusion with positron emission tomography. CFR was a stronger predictor of cardiovascular risk beyond traditional cardiovascular risk factors, left ventricular ejection fraction, myocardial scar and ischemia and revascularization after scan. Preserved CFR even in the presence of impaired maximal myocardial blood flow can identify low-risk patients with <1% annual cardiovascular mortality risk\(^4\).

Patients with both primary and secondary LVH have evidence of coronary microvascular dysfunction (CMD). Patients with LVH secondary to arterial hypertension have a reduced CFR which is inversely related to systolic arterial pressure but not to left ventricular mass index\(^5\). These patients can develop both heart failure with preserved ejection fraction (HFrEF) and heart failure with reduced ejection fraction (HFrEF). These patients can develop HFrEF via a 'direct pathway' with an interval myocardial infarction and also in its absence. The measurement of the extension of myocardial scar and replacement fibrosis with increase of the extracellular space is feasible by measuring the longitudinal relaxation (T1) time with cardiac magnetic resonance. We are currently collecting data on the transition from hypertension with coronary microvascular dysfunction to HFpEF in collaboration with the CMR Unit at Niguarda Hospital Milan. Multiparametric myocardial perfusion and T1 mapping are promising and powerful tools for the diagnosis and risk stratification of individuals with suspected cardiac allograft vasculopathy (CAV). A severe and diffuse reduction in MBF during peak hyperaemia can reflect the integrated effects of large and small vessel abnormalities, consistent with severe diffuse CAD that in turn can induce patchy microscopic ischaemic injuries, interstitial, perivascular, replacement fibrosis and chronic inflammation. We have demonstrated that the extent of late gadolinium enhancement (LGE) could independently predict adverse outcomes in cardiac transplant recipients in addition to CAV detection and represent a marker of cardiac allograft condition\(^6\). At Niguarda Hospital we are currently recruiting transplanted patients to assess the longitudinal prognostic value of T1 mapping and extracellular volume measurements in addition to CAV and LGE extension. Finally, I am involved in an international study (across 7 countries (USA, UK, Germany, Spain, Italy, Australia, and Japan) aimed at prospectively assessing the clinical characteristics and long-term prognosis of CMD subjects in the current era in an multicenter, observational, and prospective registry study. The primary endpoint is the composite of major cardiovascular events (MACE), including cardiovascular death, non-fatal myocardial infarction, non-fatal stroke, hospitalization due to heart failure or unstable angina\(^7\).

References:


5. Rimoldi O, Rosen SD and Camici PG. The blunting of coronary flow reserve in hypertension with left ventricular hypertrophy is transmural and correlates with systolic blood pressure. *J Hypertens.* 2014; 32: 2465-71; discussion 2471.


**Keywords:** Blood Flow, Coronary circulation physiopathology, Magnetic resonance, Positron emission tomography

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