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Review article – *Special issue: Acute Coronary Syndromes*

Radionuclide imaging in acute coronary syndromes

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ABSTRACT

Introduction: Acute coronary syndrome encompasses acute forms of ischemic heart disease – unstable angina and myocardial infarction with or without ST elevation. Chest pain patients have a wide spectrum of cardiac risk including those with typical symptoms and abnormal electrocardiography who require immediate catheter angiography with a view to intervention; at the other end of the spectrum are those of low risk with atypical symptoms and a normal ECG who can be discharged without investigation. Between these two groups is a large number of patients with diagnostic uncertainty.

Methods: Radionuclide imaging can be useful in different phases of the course of atherosclerosis with subsequent myocardial ischemia. Primarily, radionuclide imaging can be used for the identification of subclinical coronary artery atherosclerosis to enhance primary prevention of CAD, acute myocardial infarction, and sudden cardiac death. Secondly it can be used at the emergency department to help to decide whether to admit or discharge a patient presenting with chest pain. And finally it helps to stratify and follow patients who survive ACS for choosing optimal treatment strategy.

Results: Radionuclide imaging is potentially able to detect endothelial dysfunction and early, preclinical atherosclerotic plaques vulnerable to rupture. Rest ^{99m}Tc-sestamibi SPECT has been shown to improve medical decision making by decreasing unnecessary hospitalizations. The strength of resting MPI lies with its high negative predictive value, approaching 100%. A possible future approach for risk stratification of patients with suspected ACS involves imaging myocardial fatty acid metabolism. The study of myocardial perfusion and metabolism in the sub-acute phase of STEMI has allowed us to considerably improve our knowledge of its pathophysiology, but its clinical usefulness is limited by the complex interplay between epicardial artery obstruction, coronary microvascular obstruction, and inflammatory cell activation.

Conclusion: The optimal imaging strategy in acute coronary syndromes is determined not only by the diagnostic performance of a modality but also by local practice, expertise with imaging techniques, medical facilities, and individual patient characteristics.

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Contents

Introduction

The entity acute coronary syndrome (ACS) encompasses acute forms of ischemic heart disease (IHD) – unstable angina and myocardial infarction (MI) with or without ST elevation [1]. Patients with ACS frequently present with acute chest pain complaints. Chest pain may be cardiac related or may be due to non-cardiac causes such as musculoskeletal or gastrointestinal pain; thus, acute chest pain is a common diagnostic dilemma in the emergency department and its impact on the health care system is substantial. It is important to identify those patients with ischemic heart disease presenting with chest pain [2]. Chest pain patients have a wide spectrum of cardiac risk including those with typical symptoms and abnormal electrocardiography (ECG) who require immediate catheter angiography with a view to intervention; at the other end of the spectrum are those of low risk with atypical symptoms and a normal ECG who can be discharged without investigation. Unfortunately, between these two groups is a large number of patients with diagnostic uncertainty [3]. The results of a large multicenter study showed that although most patients (>60%) with suspected ACS were hospitalized for further evaluation, only 17–20% were ultimately diagnosed with ACS. Despite this conservative approach, a small proportion of patients (0.4–10%) with ACS are misdiagnosed and discharged without appropriate intervention with double the risk-adjusted mortality of admitted patients [1,3–6]. Patients with ACS who are mistakenly discharged from the emergency department generally have a worse prognosis than appropriately managed patients, partly not only because of their risk for sudden cardiac death, but also because of the delay in implementing treatments that are known to be beneficial for ACS [1].

Coronary artery disease (CAD) is the development of cholesterol-rich plaques within the walls of coronary arteries (atherosclerosis). At any stage in the development of atherosclerosis, and often when the coronary artery lumen is narrowed only slightly or not at all, an unstable plaque may develop a tear of its inner lining cell layer, exposing the underlying cholesterol-rich atheroma to the vessel lumen. This atheroma is extremely thrombogenic and initiates platelet aggregation and thrombus formation. Clinical consequence of such a situation is ACS. Depending on the degree of occlusion of the vessel lumen, time duration of the thrombus (spontaneous thrombolysis), collateralization from other vessels and conditioning of the myocardium to ischemia cell death with subsequent necrosis can or cannot occur [3]. Patients with ACS can die, can develop congestive heart failure or can survive without clinical impairment depending on the extent of myocardial necrosis.

Another important consideration is the presence of coincidental CAD. The prevalence of asymptomatic non-obstructive CAD is high, especially in the elderly population. This disease may not be the cause of the patient's pain and it is important not to ascribe the pain to being cardiac just because of the presence of CAD. Confirmatory evidence must be sought so as to not ''convert'' an individual with non-cardiac chest pain and coincidental CAD into a cardiac patient [3].

Radionuclide imaging can be useful in different phases of the course of atherosclerosis with subsequent myocardial ischemia. I would like to divide its use into three groups. Primarily, radionuclide imaging can be used for identification of subclinical coronary artery atherosclerosis to enhance primary prevention of CAD, acute myocardial infarction, and sudden cardiac death [6]. It is potentially able to detect endothelial dysfunction and early, preclinical atherosclerotic plaques vulnerable to rupture. Secondly it can be used at the emergency department to help to decide whether to admit or discharge a patient presenting with chest pain. And finally it helps to stratify and follow patients who survive ACS for choosing optimal treatment strategy [7].

Radionuclide imaging in primary prevention

The term vulnerable plaque has been introduced indicating the high risk of plaque rupture or erosion, which subsequently leads to ACS. The vulnerable plaque is, however, difficult to detect, and no biomarkers have been identified so far to allow for early detection of the disease [8]. Sites of atherothrombosis leading to ACS are associated with plaque rupture (60%), plaque erosion (30%), calcified nodules (2–7%) or very rarely with isolated intra-plaque hemorrhage. Plaque rupture has been initially considered predominantly mechanical, as it occurs at sites of turbulent blood flow. Very soon several distinct biological features of rupturing plaques became apparent. They are characterized by the presence of a thin fibrous cap, overlying a necrotic core which is heavily infiltrated by macrophages (density up to 26%) and T lymphocytes. While a morphological assessment of atherosclerotic plaques provides limited information in predicting ACS, a functional assessment of inflammatory cells within the plaque might better serve this scope. In particular, molecular imaging of inflammatory cells within the plaque might help to