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Review Article

Review of myocardial perfusion imaging in the state of unstable angina

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Abstract

Unstable angina may present as transient episodes of myocardial ischemia in different clinical presentations. The use of myocardial perfusion imaging (MPI) in the emergency department (ED) for the accurate diagnosis of unstable angina, in patients with a non-diagnostic ECG seems to be a safe, accurate and potentially cost-effective management technique. The use of MPI allows the measurement of myocardial area at risk, infarct size, collateral flow to the infarcted zone and subsequently, myocardial salvage during reperfusion therapy. Therefore, the determination of myocardium at risk for earlier intervention and the reduction in the extent of the affected area following intervention comprises a promising measurement technique for the assessment of acute therapy. This technique has provided significant advances in the field of imaging through efficient triaging of patients having chest pain indicative of unstable angina.

Myocardial perfusion imaging

MPI is a stress imaging modality used commonly in the treatment of coronary artery disease (CAD). Through detection of flow-limiting disease, assessment and quantification of patient risk, MPI is helpful in the evaluation of the presence and severity of CAD. A large number of MPI studies are done with gated single-photon emission computed tomography (SPECT), and more than 50% are done with vasodilator stress. Gated positron emission tomography (PET), which is nowadays increasingly being used for MPI, provides crucial information such as the severity and the extent of myocardial perfusion abnormalities, mechanical dyssynchrony, myocardial ischemia and left ventricular (LV) function and size. Based on past literature, MPI at rest is a valuable guide to patient management [1].

Unstable angina

Unstable angina may manifest as transient episodes of myocardial ischemia in various clinical presentations [2]. The pathophysiology of these episodes may include mechanisms such as intracoronary atheromatous plaque rupture, enhanced vasomotor tone, formation of thrombi and platelet aggregation [3,4]. The pathophysiology of the unstable angina and its clinical presentation determine the risk of the given patient [5].

Use of SPECT in myocardial imaging

The use of scintigraphy in the measurement of myocardial risk area with thallium-201 and technetium-99m sestamibi has been verified in several experimental and clinical studies [6-8]. A study by Bilodeau *et al.* [9] in 1991 demonstrated a high accuracy of Tc-99m SPECT imaging in the diagnosis of coronary artery disease (CAD) and delineation of involved coronary arteries in subjects with spontaneous chest pain.

Even in situations of low coronary blood flow, thallium 201 (TI-201) and technetium-99m (Tc-99m) sestamibi have a rapid myocardial uptake relative to blood flow [10]. Due to a considerable amount of radiopharmaceutical redistribution, necessitating immediate imaging after injection, the use of thallium-201 is restricted. As the redistribution amount of technetium-99m has been found to be minimal, it is better suited to evaluation of myocardial area at risk and delineation of zones of hypo perfusion [11]. Within minutes of the injection, it has been seen that the ratio of uptake between the normal and ischemic myocardial areas is determined and remains fixed for hours. Moreover, it is also readily available as a kit preparation [10].

Due to the high-count density of Tc-99m, acquisition of ECG synchronized gated tomograms adds value to angiography results by permitting correlations to be made between coronary anatomy and extent of at-risk myocardium [12].

Gated SPECT has also shown a good correlation with echocardiography for the assessment of both global and regional LV function [13]. A study by Berman *et al.* [14] has shown that separate acquisition dual-isotope myocardial perfusion SPECT is an excellent technique for the combined evaluation of stress myocardial perfusion and myocardial viability.

Unstable angina and SPECT

Myocardial perfusion imaging is known to be an important tool in the assessment of angiographic coronary artery disease [7]. In recent years, Tc-99m imaging at rest has been found to have value in the evaluation of perfusion abnormalities during symptomatic stages and asymptomatic or pain free states in unstable angina patients [9]. Optimal management of patients with angina in the emergency department is a major health economic and clinical issue. Majority of these patients may be hospitalized due to deficiencies in the diagnostic accuracy of clinical, historic and electrocardiographic data, despite non-ischemic etiologies for their chest pain. Although age, gender and known coronary disease have some discriminating value, diagnostic

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uncertainty arises due to overlap in clinical presentation in patients with and without cardiac ischemia [15-17]. The additional cost of evaluation of this patient group is four billion dollars annually [18]. It has also been shown that 4-8% of MI patients are inappropriately discharged from emergency departments, leading to deleterious consequences [19,20].

The use of myocardial perfusion imaging with Tc-99m sestamibi in ED patients with angina and a no diagnostic ECG seems to be a safe, accurate and potentially cost-effective management technique. If low-risk patients with chest pain with a normal scan become candidates for outpatient cardiac evaluation, SPECT can reduce the cost of managing ED patients [21].

The agent Tc-99m has provided significant advances in the field of imaging by allowing patient triaging of symptomatic patients (chest pain suggestive of unstable angina). The use of Tc-99m sestamibi perfusion scan allows the measurement of myocardial area at risk, infarct size, collateral flow to the infarcted zone and subsequently, myocardial salvage during reperfusion therapy. [22]

Patients having a normal SPECT perfusion scan also have excellent prognosis. A very low risk of adverse events both in the hospital and at 90 days of follow up has been shown in ED patients with typical angina with a non-diagnostic or normal electrocardiogram (ECG) with a normal initial SPECT perfusion scan (at the time of chest pain) [23]. Injection of Tc-99m can be given at a selected time while they are symptomatic due to minimal redistribution and scintigraphic acquisition may be performed 6-8 hours later after clinical stabilization, thereby preventing any delay in treatment initiation [12,24]. Sestamibi has been shown to have a higher sensitivity and specificity for the detection of acute ischemia as compared to clinical findings and ECG changes [9,25,26]. Varetto *et al.* [26] showed the SPECT imaging in the ED had a sensitivity of 100% for detection of ACS in symptomatic patients with non-diagnostic ECGs, with a specificity of 92% for CAD detection. Identification is important because there has been a dramatic increase in the numbers of patients with unstable angina over the years, approaching numbers of admitted MI patients [19,27]. A study by Gregoire *et al.* [10] showed that a negative perfusion scan in a symptomatic patient could rule out significant coronary stenosis with a high level of confidence, while a positive scan could predict its presence with high accuracy. Additionally, a reduction in the size of a perfusion defect between images obtained in the pain and pain- free states could aid in the diagnosis of myocardial ischemia.

Early detection and aggressive treatment of unstable angina can help in the reduction of high, short term cardiovascular morbidity and mortality. As elevated cardiac markers are not detectable in patients experiencing ischemia without myocardial necrosis, positive early perfusion imaging permits rapid treatment initiation that helps prevent progression to MI. Additionally, early stress testing can be performed on patients with negative perfusion imaging, thereby reducing hospital resource costs [24].

Although patients may be pain free at the time of injection, it is clear that positive early perfusion imaging accurately identifies patients with ongoing ischemia or infarction. [9,25,26] SPECT imaging has higher sensitivity for the diagnosis of small infarcts as compared to planar imaging [28,29]. The demonstrated benefit in the measurement of final infarct size and myocardial salvage showcases the fact that the use of myocardial perfusion imaging with SPECT provides a superior, new, powerful tool to ensure treatment efficacy in unstable angina. [30]

In conclusion, it is clear from all the previous studies that SPECT is a promising technique for the detection of unstable angina in the ED. However, only further research and randomized trials are required to throw further light on its efficacy as compared to the existing diagnostic modalities. Although past literature supports this idea, only greater exploration in the field of myocardial scintigraphy can determine whether this can be incorporated as a standard diagnostic modality in the diagnosis of unstable angina in the emergency setting.

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