The role of myocardial perfusion imaging in patient assessment after acute myocardial infarction

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Myocardial perfusion imaging (MPI) is a useful non-invasive test for the evaluation of patients following acute myocardial infarction (AMI). Early (2–3 days post-admission) pharmacological stress or pre-discharge exercise MPI in patients with uncomplicated AMI is safe and provides important prognostic information of the risk of subsequent cardiac events. The most powerful predictors of prognosis (total defect size, extent of reversibility and resting left ventricular ejection fraction) can be assessed with a single non-invasive test employing gated single photon emission computed tomography (gated-SPECT) technology.

Introduction

Radionuclide techniques can be useful in the clinical evaluation of postinfarction patients with respect to determining infarct size, assessing the degree of myocardial viability after reperfusion and detecting inducible myocardial ischaemia within or remote from the infarct zone using either exercise or pharmacological stress[1–4].

High-risk variables

High-risk myocardial perfusion imaging (MPI) variables in patients undergoing stress scintigraphy with sub-maximal exercise or pharmacological stress before discharge after acute myocardial infarction (AMI) are summarized in Table 1.

Non-imaging variables provide complementary information for risk stratification in patients undergoing stress perfusion imaging. Finding ≥1.0 mm of ST-segment depression with exercise stress, particularly at a low workload, is indicative of high-risk status. Patients who manifest episodes of non-sustained ventricular tachycardia during exercise stress are also at higher risk for subsequent cardiac death, particularly when associated with concomitant ischaemia. Mere failure to achieve target heart rate is a high-risk finding. Patients who exhibit limiting angina that prevents them from completing the exercise protocol are at a higher risk for a subsequent ischaemic event than patients without inducible angina on stress testing. Ischaemic ST-segment depression associated with reversible defects on pharmacological stress imaging is predictive of an increased risk of a subsequent cardiac event after discharge.

Stress imaging after uncomplicated myocardial infarction and outcomes

In a pooled analysis[5] of studies relevant to exercise stress MPI after myocardial infarction, the mortality rate was 7.1% in patients with a stress-induced reversible

Table 1  High-risk myocardial perfusion imaging variables in patients undergoing stress scintigraphy with sub-maximal exercise or pharmacological stress imaging prior to discharge after acute myocardial infarction

<table>
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<th>Reversible defects within or remote from the infarct zone</th>
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<td>A multivessel disease scan pattern*</td>
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<td>A large non-reversible defect suggesting an extensive area of irreversible myocardial injury</td>
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<td>Increased lung 201Tl uptake when that tracer is employed for scintigraphy</td>
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<td>A gated 99mTc sestamibi or 99mTc tetrofosmin SPECT image showing an ejection fraction of &lt;40%</td>
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*An infarct defect in the distribution of the right coronary artery and remote ischaemia in the supply zone of the left anterior descending coronary artery.  
201Tl=thallium-201;  
99mTc=technetium-99m;  
SPECT=single photon emission computed tomography.
defect on stress imaging compared with 1-6% in those without a reversible defect. Similarly, patients with multiple defects in more than one coronary supply region had a 16-7% combined death or myocardial infarction rate compared with a 2% event rate in patients without a multivessel disease scan pattern. In the era before thrombolytic therapy, Gibson et al[6] using submaximal exercise thallium-201 (201Tl) scintigraphy before hospital discharge, found that approximately 50% of patients with an uncomplicated myocardial infarction who had a high-risk scan experienced a subsequent cardiac event (cardiac death, non-fatal infarction, or rehospitalization for class III–IV angina). In contrast, the cardiac event rate was only 6% in patients with a low-risk scan. In the VANQWISH trial[7], 36% of patients in the conservative group had reversible 201Tl defects on stress planar imaging without ST-segment changes, whereas only 8% had ST-segment changes without reversible 201Tl defects.

Quantitative 201Tl single photon emission computed tomography (SPECT) imaging performed with exercise stress in postinfarction patients who had received thrombolytic therapy provided significant incremental prognostic value, whereas coronary angiography did not further improve the model that comprised clinical data, the resting ejection fraction and 201Tl SPECT variables[8]. Identification of high- and low-risk subgroups (based on a cut-off defect size of the left ventricle of <20%, indicative of a very low subsequent event rate) was comparable with that achieved with coronary angiography.

Exercise or pharmacological technetium-99m (99mTc) sestamibi SPECT can be used as an alternative to 201Tl stress scintigraphy after myocardial infarction. Travin et al.[9] reported that the presence of either ischaemia seen on 99mTc sestamibi SPECT imaging or defects seen in multiple vascular regions identified 92% of patients who subsequently experienced an event after hospital discharge. Cox regression analysis of clinical, ECG stress test and imaging variables, showed that the number of ischaemic defects on 99mTc sestamibi scans was the only significant correlate of future events. Patients with more than three 99mTc sestamibi reversible defects had an event rate of 38% in that study.

Vasodilator stress 99mTc sestamibi imaging can be substituted for exercise scintigraphy in postinfarction patients undergoing pre-discharge risk stratification. Vasodilator stress can be performed as early as 3 days after admission in patients who have had an uncomplicated hospital course. A large multicentre trial[10] in which dipyridamole 99mTc sestamibi imaging was performed 2–4 days after admission for AMI showed that the extent and severity of defect reversibility had significant incremental prognostic value when added to clinical and stress test variables for predicting in-hospital cardiac events. Annual cardiac death or myocardial infarction rates as a function of the summed difference score (SDS) for a given summed stress score (SSS) are shown in Fig. 1. The SSS and SDS are derived using a 17-segment model in which segmental tracer uptake is graded by a five-point scoring system ranging from 0, indicative of normal, to 4, indicative of absence of tracer activity. The SDS represents segmental defect reversibility. For each of the subgroups demarcated by the extent and severity of the post-stress defect (SSS), the cardiac event risk increased as the extent of defect reversibility (SDS) increased. This effect was greatest in the intermediate SSS group. It should be emphasized that, in this multicentre study, the cardiac event rate at 2 years was <2% per year in patients with a low-risk dipyridamole SPECT 99mTc sestamibi scan.

Conclusion

There is considerable evidence to suggest that early pre-discharge exercise or pharmacological stress MPI in patients with uncomplicated AMI can adequately stratify patients as being at high or low risk of subsequent cardiac events. Very early imaging at 2–3 days post-admission with pharmacological vasodilator stress imaging is safe and provides significant prognostic information for subsequent outcome. The most powerful predictors of prognosis (total defect size, extent of reversibility and resting left ventricular ejection fraction) can be assessed with a single non-invasive test employing gated-SPECT technology.

References