Preoperative Cardiac Evaluation for Non-Cardiac Surgery; Role of Myocardial Perfusion Studies: A Review Article

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Nuclear cardiology is a growing area within the field of nuclear medicine where radiotracer methods are used to provide non invasive, highly accurate and unique information on myocardial perfusion, ventricular function, cardiac functional reserve and myocyte recovery potential. In the preoperative assessment of patients undergoing non cardiac vascular or major general surgery, myocardial perfusion imaging with pharmacological stress has been shown to be a valuable tool for risk management and prognostication, minimizing perioperative ischemic events and defining long term prognosis[1,2]. Studies have shown that the presence and extent of reversible perfusion defects are the best predictors of perioperative cardiac events whereas a normal myocardial perfusion study predicts an essentially benign perioperative course[3-5]. This is a review of the subject with a suggested protocol for preoperative evaluation of patients undergoing non-cardiac vascular / major surgery.

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History

In the late 1970's, preoperative cardiac assessment for non cardiac surgery evolved around what was called "Goldman Index"[5]. Nine independent variables were identified and assigned a score. The variables were: S3 or elevated Jugular Venous Pressure (JVP), Myocardial Infarction (MI) <6 months prior to planned surgery, >5 Ventricular Extrasystoles (VE) per minute, not sinus rhythm, age >70, major surgery, emergency surgery, severe aortic stenosis and poor medical condition. Patients were classified into low, intermediate and high cardiac risk groups according to their scores. Nuclear medicine studies came to play a role in 1984, when Pasternack et al[7] identified increased perioperative risk in patients with a preoperative low resting Left Ventricular Ejection Fraction (LVEF). In his study, perioperative MI was not seen in patients with LVEF >55%. It was seen in 4 out of 20 (20%) patients with LVEF between 36-55% and in 4 out of 5 (80%) patients with an ejection fraction between 27 and 35%.

Myocardial Perfusion Studies

In 1985, a group from Massachusetts General Hospital[8] performed Persantine thallium studies on 54 "intermediate risk" patients prior to vascular surgery. The patients had to have chest pain, previous MI or an abnormal ECG. High risk patients were also excluded. Twenty two out of 54 patients had reversible defects, of these 6 patients had their surgery postponed. Of the 16 patients who underwent surgery, 8 (50%) had cardiac events. The remaining 32 patients with fixed or no defects were event free. In this study, the presence of a reversible thallium defect had a sensitivity of 100%, specificity of 80%, a positive predictive value of 50% and a negative predictive value of 100% for the occurrence of adverse cardiac events. Although occasional studies have disagreed with this data[9], the general consensus[10] remained that this was an excellent screening test. The negative predictive value has remained very high in all studies indicating that if there is no ischemia present on imaging, adverse events are unlikely to occur. The low positive predictive value mandates that patients undergo some type of clinical assessment first.

Clinical and Scintigraphic Data

To address the problem of relatively low specificity and to prevent the complication of unnecessary cardiac catheterization, Eagle et al[3] studied 200 patients for clinical Persantine thallium study variables. They confirmed five clinical predictors (Q waves, VE's, Diabetes, age >70 and Angina) and two stress criteria (ECG changes, Reversibility). The presence of ≥3 clinical variables had a 50% incidence (10 out of 20 patients) of cardiac events (death, MI, angina). patients who had 1-2 clinical variables were then assessed by thallium criteria. With a reversible defect there was 30% (16 out of 54 patients) cardiac event rate, while no reversibility had only a 3% (2 out of 62 patients) cardiac event rate. Patients with no clinical variables also had a 3% (2 out of 64 patients) event rate, irrespective of thallium results. Therefore by using both criteria specificity increases from 66% to 81%. The study clearly indicates that the optimal use of myocardial perfusion studies is in patients with an intermediate number of risk factors. In such a population the test will operate at its highest efficiency.

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Risk Stratification

Lette et al[11] used a semi-quantitative assessment of planar imaging and derived a value called "summed reversibility index", which depended on the number of segments and amount of reversibility involved. High scores were predictive of cardiac events. In June 1992, the same group[4] proposed a "3-step, 3-segment model". In their study of 355 patients, they ignored the "minor segments" (apex and septum), leaving the anterior and posterolateral segments for assessment. They also noted transient LV dilatation. The study group was divided into: Step 1 - Normal 3 segments and no LV dilatation (225 patients). Step 2 - Redistribution in all segments or LV dilatation or 1 severe reversible defect (29 patients). Step 3 - Patients with some reversibility in some segments (101 patients). Three of step 1 patients had a cardiac event (1.3%). In step 2 patients, the event rate was 15 out of 29 (52%). Step 3 patients represented a group where the use of both clinical parameters (age >70 and diabetes) and the number of reversible segments (1 or 2) was needed for risk stratification. Patients <70 years of age and with no h/o diabetes, a defect in one segment had a 5% cardiac event rate (2 out of 40). Patients in the same category but with a 2 segments defect had 8% event rate (1 out of 18). Patients with h/o diabetes and 1 segment defect had a 15% cardiac event rate (2 out of 13), with a 2 segments a 17% event rate (1out of 6). Patients of age 70 or more, regardless of their diabetes status, had an event rate of 11% with a defect in one segment and 35% with a two segment defect.

Brown et al[14] found that the best predictor of perioperative cardiac death or non fatal MI was the quantitative extent of jeopardized viable myocardium reflected in the number of myocaridal segments with transient thallium defects on planar images. Only diabetes mellitus had any added predictive value among clinical predictors (Figure 1). The study also stresses two important points: (1) that this relationship should be viewed as a continuum, not categorically, and (2) decisions should be individualised as much as possible.

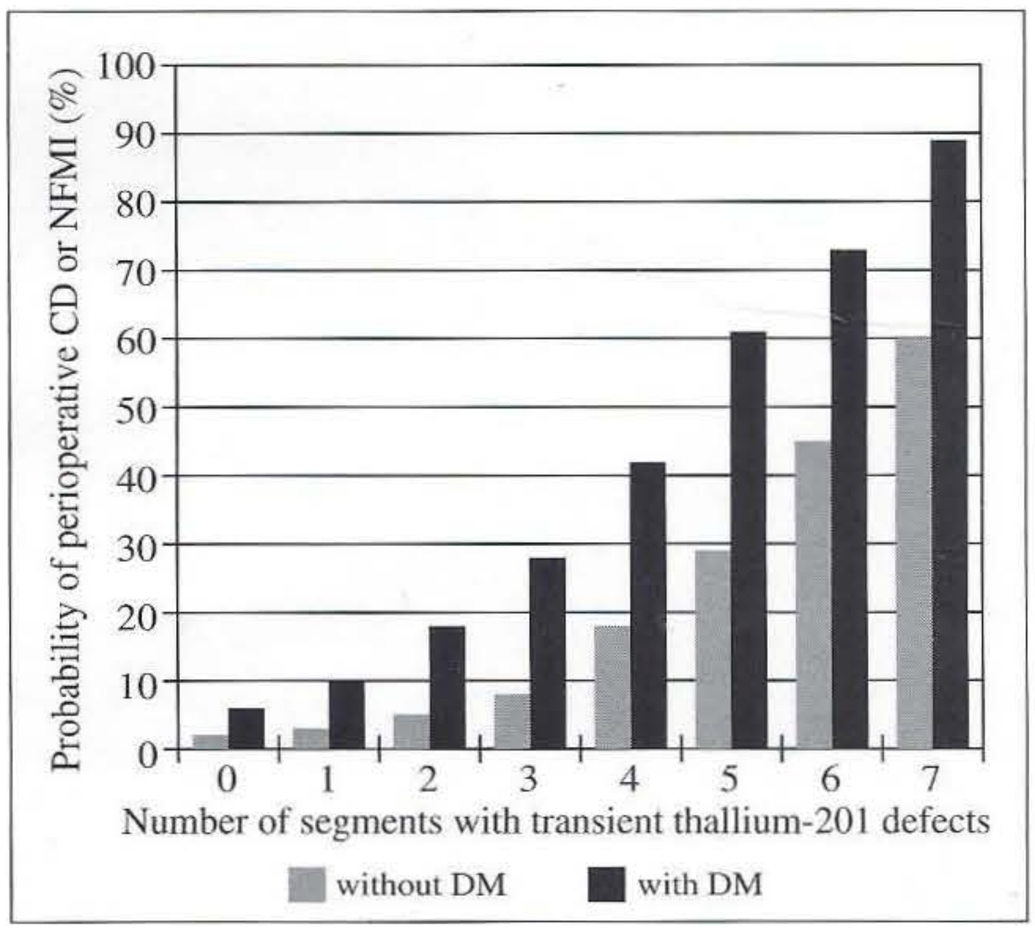


Figure 1. Risk of perioperative cardiac events among patients undergoing myocaridal perfusion imaging before non cardiac surgery.
CD=cardiac death, NFMI=non fatal myocardial infarction. Data from Brown et al[14]

Late cardiac events, long term follow-up

Lette et al[4] found that Dipyridimole induced transient left ventricular cavity dilatation (as a marker for diffuse ischemia) was the best predictor of long term events. Other significant predictors included the extent of reversible defects and the clinical variables of age and history of Congestive Heart Failure (CHF). The long term cardiac event rate was 3.5% in patients with normal or fixed perfusion defects and 22% in patients with reversible defects. Hendel et al[13] found that a fixed perfusion defect was the strongest predictor of a late cardiac event. A history of CHF was the only other significant variable that added prognostic value. More data is needed to address the clinical implication of long term stratification in the management of patients considered for vascular or other major non cardiac surgery.

Where to now ?

Currently, each patient should get an individualised decision, as no gold standard is available. Even with all the advancements in nuclear medicine myocardial perfusion studies with gated Single Photon Emission Computerised Tomography (SPECT) acquisitions, reinjection methods and different pharmacological and perfusion agents, the decision will still be difficult (Fig 2). One approach will be to evaluate all surgical patients by use of clinical indices.

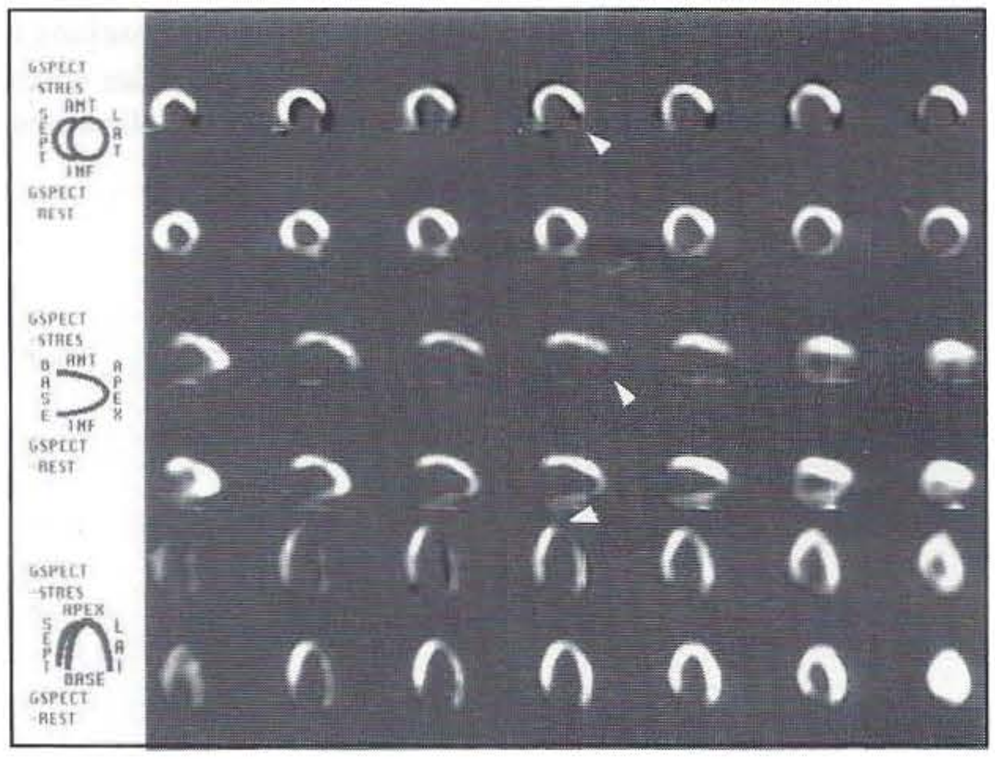
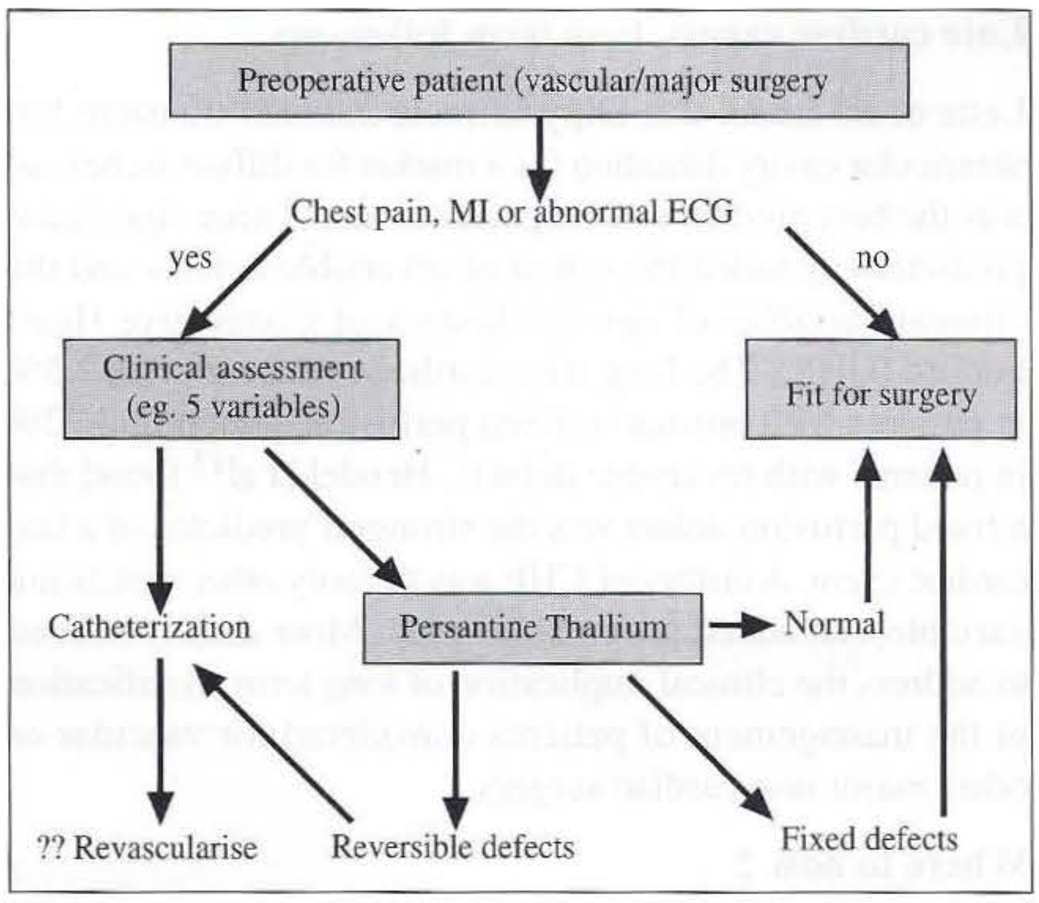


Figure 2: Tc-99m Tetrofosmin SPECT Myocardial Perfusion Study with pharmacological stress (Persantine). There is a partially reversible perfusion defect in the Interior, Inferolateral and Posteriolateral Walls (arrows) consistent with ischemia.

Low risk patients need no further evaluation before surgery. High risk patients need optimal management of their high risk problem including aggressive anti-ischemic therapy and may need to have their elective procedures cancelled. Intermediate-risk patients are probably the group that benefits most from further non-invasive stress testing, of which Dipyridamole thallium scintigraphyis the most thoroughly studied and validated option[3-10]. The following summary algorithm for preoperative risk stratification is suggested; followed by a clinical example of the use of myocardial perfusion imaging for assessment of patients prior to major surgery.



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