The Scintillating Present and Future of Nuclear Cardiology

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The growth potential for Nuclear Cardiology techniques using radioactive isotopes is enormous; this is based upon some very promising results in the clinical trial and past 4 decades of routine applications of this technology in management of Coronary Artery Disease (CAD).

In this era of medial imaging, Nuclear medicine continues to occupy a prominent and significant place firstly because of the development of newer radio pharmaceuticals which are not only organ specific nut reflect the underlying pathophysiology more meaningfully. This is turn has given deeper insight into disease mechanism, which was not possible in vivo by any of the known imaging modalities. Secondly the newly developed era of "Fusion " technology has further revolutionalised imaging interpretation where the superior anatomical details of CT , MRI are co-registered with the physiological component measured by the Nuclear medicine technique. Third major contributor has been the exponential growth of software for quantification of the data available with us. Last but not the least been the growing awareness and interest among the physicians & cardiologists of the potential which Nuclear medicine technique have offered in management of patients with coronary artery disease.

Myocardial perfusion imaging: Myocardial perfusion imaging is the single most important contribution of Nuclear Cardiology and its wide spread use is likely to remain as mainstay in the investigative arena for CAD. Myocardial perfusion imaging allows us to view the bloodflow of the heart during the stress and at rest. Combining myocardial perfusion imaging with stress testing (either treadmill or pharmacological) raises the sensitivity for detection of coronary artery disease to > 90% with a specificity of 85-90%.

Currently thallium/stress /redistribution or rest/redistribution protocols and /or dual isotope (rest thallium/stress technetium-99m sestamibi) procedure is in routine use. All studies are performed with state of the art dual or triple headed SPECT (single photon emission computed tomography) camera. Following protocols are in wide spread use.

- Thallium Stress / Redistribution
- Thallium Rest /Redistribution
- Dual Isotope imaging
- Gated Myocardial Perfusion imaging

Pharmacological stress test: Increasing uses of pharmacological stress in diagnosis of CAD by the cardiologists have also undergone important changes and newer pharmacological agents have appeared. Patients with exclusions to treadmill testing or for those who cannot perform 85% of predicted maximal exercise or normal treadmill times, pharmacology stress testing using either Adenosine /Dobutamine studies using PET tracers shall form the area of future applications.

Adenosine is a potent coronary vasodilator and is our preferred agent for pharmacological stress testing since it has very reproducible homo-dynamic and pharmacological profile. However a subset of patients cant undertake this form of stress has hence one has to be careful in administering for adenosine include:

- High degree A-V block (i.e. 2^{nd} or 3^{rd} degree) in patients without pacemaker.
- Active bronchospasm or history of active asthma.
- Patients on theophylline or aminophylline or methylxanthines (such as Cafergot)
- Patients on oral dipyridamole (Persantine or Aggrenox) (One can substitute IV dipyridamole rather than adenosine in these patients)
- Patients with recent caffeine ingestion (within 12-24 hours). The caffeine in coffee, teas and in some sodas like colas, block adenosine receptors and decreases the vasodilator properties of adenosine . Please advice your patients to withhold caffeine including coffee, tea, soda or chocolates for atleast 12-24 hours (even if they are having treadmill test, just in case they will be switched to pharmacological test).

Dobutamine is used if patients has a contraindication to adenosine . Similarly the specific exclusion creteria's for dobutamine includes:

- Patients with tachyarrhythmias (VT or VF)
- Patients with atrial fibrillation with rapid ventricular response.

- Patients on beta blockers

Positron Emisson Tomography: Positron emission tomography (PET) is advance imaging approach which allows quantitative assessment of myocardial perfusion and metabolism. PET is used not only to diagnose coronary artery disease in patients with equivocal studies from conventional diagnostic technique but also to evaluate myocardial viability (ability of the heart to recover after revascularisation) in patients with heart failure. Studies from various laboratories have demonstrated that upto 50% of patients who were thought to need heart transplantation for severe heart failure could in fact undergo coronary artery bypass grafting safely and have increased heart function. In addition software using mathematical approaches has been developed and validated in various laboratories. PET is extensively used for research applications evaluating myocardial perfusion and metabolism in number of clinical protocols.

PET can be optimally and best used for:

- Patients with equivocal results of conventional myocardial stress imaging.
- Patients with high risk for revascularisation procedures but in whom revascularisation would be beneficial (i.e patients ischemic coronary artery disease with EFFECTS < 30%.
- Differentiating ischemic from non-ischemic cardiomyopathy.
- Determining whether a patients with ischemic cardiomyopathy being evaluated for transplantation can actually undergo go bypass surgery.

Bio Profile in Cardiology: The biological characterization more aptly called bio-profiling of targets (Strauss 2001) is based on identification of molecules which are unique and are expressed more precisely in any given tissue. For the success of such a strategy of bio-profiling it becomes imperative to study the histo-molecular characteristics of the disease state and identify the molecules that are expressed on the cell surface (Narula 2003)

Thus the potential areas of research and clinical applications shall include:

- Targeting strategies for identification of artherosclerotic plaques.
- Studying the stability /unstability of a plaque.

- Charcterisation of myocardial cell death (Zaret 2000).
- Precise identification of the salvageable myo-cellular insult.
- Prediction of outcome of heart failure.
- Assessment of angiogenesis.
- Non invasive recognition of apoptosis (Blanckenberg 1999, Narula 2001)
- Expression of metalloproteinase activity in artherosclerotic plaque (Narula 2001)
- Use of Beta emitters for prevention of re-stenosis of coronary artery opened by PTCA
- Finally used of radionuclide reporter probes during gene delivery are some of the scintillating areas where Nuclear Cardiology shall be looking forward in future (Narula 2003)

The growth of knowledge and expertise about cardiovascular disease in the past half century began with introducing the catheter as a valuable tool for exploration, diagnosis and eventually for treatment of coronary heart problems, scientist who are authorities in the various sub specialities that make up the field of cardiology have not only revolutionized the concepts of CAD but have significantly modified the management also. These tests cover noninvasive, invasive, diagnositic and therapeutic methods of responding to heart problems and also pursue new discoveries concerning the function and biology of the heart and the patho-physiology of cardiovascular disease.