Gated blood pool ventriculography: Is there still a role in myocardial viability?

Oliver C. Alix, MD
Adult Clinical and Nuclear Cardiology
St. Luke’s Medical Centre - Global City
A 62-year-old male patient experienced a gradual decline in exercise capacity over the last 2 years, and presented with heart failure symptoms according to New York Heart Association Class III without angina. The patient had a history of an antero-septal and an inferior infarction, 11 and 12 years before the current presentation.

Seven years before presentation this patient had undergone coronary artery bypass grafting with a LIMA-graft to the left anterior descending artery and a venous jump-graft to an intermediate branch, the obtuse marginal branch and the right posterior descending artery. The ECG showed left bundle branch block.
How should this patient be further evaluated?
Introduction

- Chronic heart failure (CHF)
  - increased dramatically over the past decades
  - high morbidity and mortality
- Coronary artery disease (CAD) – 70% of cases
Introduction

• ischemia-induced LV dysfunction exhibited improvement in LV function following revascularization

• LV dysfunction in CAD patients is not necessarily an irreversible process

• not all patients improved in regional and/or global contractile function

Introduction

• improvement in contractile function reported 24% and 82% of all dysfunctional segments

• myocardial segments with improved contractility following revascularization contain myocytes that are still viable

Introduction

• “viability”
  • Dysfunctional myocardium
  • potential to regain contractile function

• revascularization of non-viable or scar tissue will not result in improvement of function

• Improvement in contractile function is associated with an increased annual survival rate.

Rahimtoola SH.. Am Heart J 1989;117:211–21
Identification of hibernating myocardium

- SPECT Thallium-201
  - perfusion tracer
  - intact sarcolemmal membranes and adequate membrane ATP stores

- reinjection of a second, smaller dose
  - identify viable territories in as many as 50–70% of regions that were previously classified as scar
Identification of hibernating myocardium

Viable Inferior Wall Demonstrated on 24-hour Thallium Single Photon Emissions Computed Tomography Imaging
Identification of hibernating myocardium

- SPECT technetium-99m labeled tracers
  - dependent on myocardial perfusion
  - cell membrane integrity
  - and mitochondrial function
  - dysfunctional segments with a tracer uptake of more than 50–60% are considered hibernating

Identification of hibernating myocardium

- (FDG) positron emission tomography (PET)
  - considered as the gold standard for viability assessment
  - FDG - viable cardiac myocytes
    - remains within the myocyte

Identification of hibernating myocardium

- amount of F-18DG PET metabolism mismatch in a hypoperfused segment is proportional to the percent improvement in cardiac contractility

Tc-99mFDG PET perfusion–FDG mismatch!!!
Identification of hibernating myocardium

- Dobutamine stress echocardiography
  - contractile reserve of dysfunctional myocardium in response to inotropic agents.
  - biphasic response.
    - dobutamine (5-10ug/kg/min) contractile reserve is recruited - improving contractility
    - dobutamine (>10ug/kg/min) causes subendocardial ischemia - reduction in contractility

Identification of hibernating myocardium

- diastolic wall thickness <5mm on echocardiography is the best simple single predictor of non-recovery of LV dysfunction

Identification of hibernating myocardium

- Dobutamine stress magnetic resonance imaging
- End-diastolic wall thickness (>5.5mm)
- Dobutamine-induced systolic wall thickening (more than 1mm)
- Time-consuming and not suitable for patients with severe claustrophobia or for patients with pacemakers

Identification of hibernating myocardium

- Delayed Contrast-enhanced magnetic resonance imaging
  - Gadolinium-DTPA
  - scarred myocardium will show hyper enhancement
Identification of hibernating myocardium

- hibernation - areas without hyperenhancement + reduced contractility on cine MRI

- subendocardial myocardial wall delayed enhancement of >50% thickness are unlikely to recover after intervention
Delayed Contrast-enhanced Short-axis Cardiac Magnetic Resonance Demonstrates a Right Coronary Artery Infarction
Identification of hibernating myocardium

- Delayed CE-CMR in detecting viability
  - equal to FDG-PET
  - superior to low-dose dobutamine echocardiography and thallium-SPECT

Sensitivity and specificity of several viability techniques to predict improvement in regional left ventricular function after revascularization

<table>
<thead>
<tr>
<th>Method</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dobutamine echo or CMR</td>
<td>Shows viability and function (30 minutes)</td>
<td>Dobutamine risk; less helpful with DCM</td>
</tr>
<tr>
<td>24-hour thallium delay</td>
<td>Also evaluates ischemia</td>
<td>Low sensitivity; 24-hour delay</td>
</tr>
<tr>
<td>FDG PET</td>
<td>Metabolic viability (2 hours)</td>
<td>Less available; need glucose clamp</td>
</tr>
<tr>
<td>Delayed CE-MRI</td>
<td>Available, rapid (20 minutes), easy to visualize</td>
<td>Displays non-viability; contrast agent</td>
</tr>
<tr>
<td>Delayed CE-CT</td>
<td>Available, rapid (20 minutes), easy to visualize</td>
<td>Displays non-viability; contrast agent, radiation</td>
</tr>
</tbody>
</table>
Reliable Findings Regarding Myocardial Viability

<table>
<thead>
<tr>
<th>Viability: what do we know?</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Normally contracting</td>
<td>Viable</td>
</tr>
<tr>
<td>Dobutamine response</td>
<td>Viable</td>
</tr>
<tr>
<td>Uptake of FDG, MIBI, 201Tl, 82Rb</td>
<td>Viable</td>
</tr>
<tr>
<td>LV &lt;5mm thick</td>
<td>Non-viable</td>
</tr>
<tr>
<td>Delayed enhancement</td>
<td>Non-viable</td>
</tr>
</tbody>
</table>
Gated blood pool SPECT (GBPS)

- LVEF is clinically the most important quantitative parameter obtained
- right ventricular function
  - pulmonary disease
  - congenital heart disease
  - heart failure
  - valvular disease
- left and right ventricular volumes
Gated blood pool SPECT (GBPS)

- regional ventricular wall motion
- irregularities and abnormalities of the heart structures

Intra- and interobserver variability of left ventricular ejection fraction (LVEF) calculation by equilibrium radionuclide angiocardiography

Wackers FJTh, Berger HJ, Johnstone DE, et al. *Am J Cardiol* 1979;43:1159
• Left Ventricular Diastolic Function

• Quantitative parameters of left ventricular filling
  • peak filling rate (PFR)
    • units of end diastolic volumes/per second
      • > 2 - 2.5 end-diastolic volumes/second
  • time to peak filling rate (TPFR)
    • Milliseconds
      • > 180 milliseconds
Parameters of diastolic function on equilibrium radionuclide angiocardiography.
Is there still a role for GBPS in the assessment of myocardial viability?

Not routinely.
Gated blood pool SPECT (GBPS)

• highly accurate and reproducible technique for assessing left ventricular function

• well suited for clinical situations in which serial monitoring of ventricular function is needed
  • chemotherapy
  • before and after heart transplantation
  • severe severe CHF