DIAGNOSTIC VALUE OF NITRATE ENHANCED Tc-99m SESTAMIBI GATED MYOCARDIAL SPECT IN MYOCARDIAL VIABILITY:
PROSPECTIVE ANALYSIS
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Introduction

Hibernation:

• Term coined by Rahimtoola¹.

• Chronically ischemic myocardium with decreased blood flow & down regulation of contractility; reversible with blood flow restoration².

• Meta-analysis 3088 patients (24 studies), annual mortality with ‘viability’ was 16% with medical tx & 3.3% with revascularization (p<0.0001)³.


Introduction

• The role of MIBI is well established in detection of severely ischemic but viable myocardium¹.

• Used alone Tc-99m MIBI may underestimate the viable myocardium²,³.

• Nitrates have been used to augment uptake of Tc tracers. It dilates epicardial vessels and flow through collateral vessels increase⁴.

Diagnostic techniques

- Myocardial Metabolism: **PET (FDG)**- Gold standard.
- Cell membrane integrity: **Rb & TI-201**.
- Cellular metabolism: **$^{99mTc}$-MIBI & $^{99mTc}$-tetrophosmine** (Nitrates/trimetazidine enhanced).
- Contractility: **LDD Echo & LDD MRI**.
- Microvascular damage: **Delayed enhancement MRI**.


SPECT imaging with Tc-99m MIBI

- Diffuses across cell membrane & sequestered in mitochondria.
- Retention dependent on cell membrane integrity & mitochondrial function (depends on active metabolism).\(^1\)
- For hibernating myocardium Sensitivity (rest) : **80%**, Specificity: **60-70%**.\(^2\)
- **With nitrate** Sensitivity : **77-95%**, Specificity: **69-88%** in small groups of patients.\(^3\)

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Aims and Objectives of the study

• To assess myocardial viability with nitrate enhanced Tc-99m sestamibi Gated Single Photon Emission Computed Tomography (GSPECT) in patients with coronary artery disease.

Materials and Methods

• A prospective study of 48 patients with known CAD & history of myocardial infarction was done from Jan 2009 to Jan 2010.

• Inclusion criteria
  1. Consecutive patients referred to Nuclear Cardiology section of Lady Reading Hospital Peshawar, Pakistan.
  2. History of MI.

• Exclusion criteria
  1. Hypotension.
Materials and Methods

- **99mTc-MIBI Gated SPECT:**

  1. **Patient preparation:**
     - Through explanation of procedure
     - H & P examination using a comprehensive proforma
     - Informed consent.

  2. **Pre-procedure pertinent information:**
     - Fasting for at least 4 hours.

  3. **Dose:**
     - 925-1,110 MBq (25-30mCi) 99mTc-MIBI, Intravenously.
     - Medi-MIBI 500µgm kit from Hungary was used.

Materials and methods

4. **Instrumentation:**
   - Large FOV Siemens gamma camera - eCAM signature series single head system with LEHR collimator.

   - Symmetric 15% energy window centered over the 140kev photopeak.

5. **Patient position:**
   - Supine.
Materials and methods

6. Imaging protocol (Two-day):
- **Baseline study**: RP @ rest and image acquisition @ 30-60min
- **Nitrate study**: Sublingual nitrates (1-2 tablets) & RP after 15 minutes. Image acquisition @ 30-60 minutes.

![Diagram of imaging protocol]

Materials and methods

7. Image processing:
- Data processing Syngo 2007A software.
- Short axis, vertical long axis and horizontal long axial slices obtained.
- Quantification & gated image acquisition- Corridor4DM v5.1 software applied.
Materials and methods

- Image interpretation of Tc-99m GSPECT:
  - Two independent observers interpreted the studies.
  - Conventional slice display of SPECT images was done.
  - Perfusion defect severity & extent evaluated with Semi-quantification method using 20 segment model.
  - Gated imaging quantified with Corridor4DM v5.1 software.

- Statistical analysis:
  - Paired t test.

Results

- Total of 48 patients (age range 24-82 years) were included. 39 males, 9 females.

- **960** segments evaluated
  - LAD: 480,
  - RCA: 192,
  - LCx: 288.
Results

Comparison of SPECT baseline and Nitrate enhanced study

<table>
<thead>
<tr>
<th>Territory</th>
<th>Segments</th>
<th>Baseline study (viable segments)</th>
<th>Nitrate study (viable segments)</th>
<th>%age improvement of viability with nitrates</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>LAD</td>
<td>480</td>
<td>244</td>
<td>276</td>
<td>13.11%</td>
<td>&lt;0.01</td>
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<tr>
<td>RCA</td>
<td>192</td>
<td>148</td>
<td>153</td>
<td>3.38%</td>
<td>0.096</td>
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<tr>
<td>LCx</td>
<td>288</td>
<td>206</td>
<td>241</td>
<td>16.99%</td>
<td>&lt;0.01</td>
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<tr>
<td>Total</td>
<td>960</td>
<td>598</td>
<td>670</td>
<td>12.04%</td>
<td>&lt;0.01</td>
</tr>
</tbody>
</table>

Results

- Gated study information for both rest and nitrate enhanced study was also assessed for same 48 patients.

- For gated study total segments evaluated were 960 (LAD: 480, RCA: 192 & LCx: 288).
## Results

### Comparison of Gated baseline & Nitrate enhanced study

<table>
<thead>
<tr>
<th>Territory</th>
<th>Gated segments</th>
<th>Gated Baseline study (viable segments)</th>
<th>Gated Nitrate study (viable segments)</th>
<th>%age improvement of viability with nitrates</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>LAD</td>
<td>480</td>
<td>224</td>
<td>240</td>
<td>7.14%</td>
<td>0.16</td>
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<tr>
<td>RCA</td>
<td>192</td>
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<td>120</td>
<td>-</td>
<td>0.4</td>
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<tr>
<td>LCx</td>
<td>288</td>
<td>244</td>
<td>245</td>
<td>0.41%</td>
<td>0.86</td>
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<td>Total</td>
<td>960</td>
<td>593</td>
<td>605</td>
<td>2.02</td>
<td>0.39</td>
</tr>
</tbody>
</table>

### Comparison of (SPECT + Gated) baseline & (SPECT + Gated) Nitrate enhanced study

<table>
<thead>
<tr>
<th>Territory</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>LAD</td>
<td>0.001</td>
</tr>
<tr>
<td>RCA</td>
<td>1</td>
</tr>
<tr>
<td>LCx</td>
<td>0.001</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>0.001</strong></td>
</tr>
</tbody>
</table>
Results

• Gated image acquisition in addition to SPECT:
  - P value was not significant when gated rest and gated nitrate study was compared.
  - But combination of both (SPECT + Gated) baseline & (SPECT + Gated) nitrate enhanced showed significant p value (0.001).
Literature Review

- Niyaz K, et al. 35 patients (31 M, 4F) hx of MI.
- Baseline and NTG Tc-99m MIBI (2 day protocol).
- 15 had Rest/redistribution TI-201 (3 day protocol).
- Images divided into seven segments for qualitative & semiquantitative analysis.
- > 55% tracer activity compared to max - viable.


Literature Review

- Baseline 168/245 (68.57%) viable, ↑ to 197 (80.40%) in Nitrate MIBI (p=0.001 vs baseline).
- Concordance of viable segments detection between NTG MIBI & redistribution TI-201 found in 100/105 segments (95.24%) for 15 pts.
- Nitrate MIBI SPECT results in improved detection of viable segments & achieves results similar to TI rest/Redistribution.

Literature Review

• **Galli et al** – 54% patients showed significant decrease in mean perfusion defect after sublingual NTG\(^1\).

• **Maurea et al** – 27% perfusion defects showed improvement after NTG\(^2\).

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Limitations

1. Lack of Positron emission tomography or thalium-201 for comparison.

2. Need of follow-up studies to see the effect of revascularization.

3. Better attenuation correction.
Conclusion

• Nitrate augmented Tc-99m sestamibi myocardial SPECT significantly improves detection of viable (Hibernating) myocardium.

• Gated images may further improve the accuracy of detection of hibernating myocardium in borderline cases.
Thank You