Artifacts and Pitfalls in MPI

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MPI Overview

- ~ 40% of all Nuclear Medicine Procedures
- ~ 9 million procedures every year in US
- >95% are SPECT, <5% are PET
- One day rest - pharmacologic stress protocol
- Abnormal results have declined from 41% to 9%
- Most extensively validated for risk strat. of CAD
  - Sensitivity: 85 – 90%
  - Specificity: 70 – 75% (artifacts causing false +ves)

Acquisition and Processing

- Dual head gamma camera with High Res Collimators
- 20% window set around 140 keV
- Circular orbit (vs elliptical/body contouring)
- 180 degree SPECT: LPO to RAO
- Step and shoot (20-30 sec); Frame mode (vs List)
- Resting SPECT and post stress Gated SPECT (16 fr)
- Filtering (lower cut off = more filtering / smoothing)
- Processing (FBP vs OSEM)
MPI SPECT – Normal Study

- No significant non cardiac activity
- No patient motion or soft tissue attenuation
- Uniform uptake at rest and stress
- No fixed or reversible myocardial perfusion defects
- Normal myocardial wall motion and thickening
- Normal LVEF (>50%), EDV (<110), ESV (<50)
- Normal polar plots and scores (SRS, SSS, SDS)

MPI SPECT Artifacts

- Soft Tissue Attenuation
- Patient Motion
- Non Cardiac Activity
- Non Coronary Disease
- Image Normalization

- Prep. / Injection / Stress test
- Processing Related
- Flood Field Non Uniformity
- COR Misalignment
- Camera Head Misalignment

Soft Tissue Attenuation

- Causes: diaphragm, breasts, obese body habitus
- Imaging Characteristics: decreased counts, fixed defects, worse at rest, normal wall motion, ischemia
- Recognition: review raw data, inferior wall in males, anterior/lateral/apical in women, worse with Thallium
- Solution: reimaging, prone imaging, breast / arm positioning, attenuation correction (CT)

No reversible defects. Normal Function. Inferior wall attenuation
No reversible defects. Normal Function. Patient motion and Arm attenuation

Patient Motion
- Causes: vertical (or horizontal) motion (≥ 2 pixels)
- Imaging Characteristics: opposed defects and streaks from edges, anterior / inferior (hurricane sign) vs septal / lateral, cardiac creep – exercise and thallium
- Recognition: review raw data in cine mode
- Solution: reimaging, preparation and positioning, motion correction software

Non Cardiac Activity
- Causes: liver, stomach, bowel or tumor uptake
- Imaging Characteristics: scattering → increased counts, ramp filter artifact → decreased counts
- Recognition: review raw data in cine mode
- Solution: drink water / milk, walk / low level exercise, and reimage, optimize injection to imaging time

No reversible defects. Normal function. Artifactual extra-cardiac uptake in stomach
No reversible defects. Normal function. Artifactual extra-cardiac uptake in colon

No reversible defects. Normal function. Uptake in the right axillary adenopathy from NHL

Thymoma

Ascites
Non Coronary Disease

- Causes: LBBB, hypertrophic cardiomyopathy, short septum, apical thinning, balanced ischemia, dextrocardia
- Imaging Characteristics / Recognition: perfusion defect at increased heart rate (pharmacologic stress test), septum > lateral wall, septal defect, apical defect, false – ve / stunning, right sided heart / processing
- Solution: review patient history, EKG, Echo, prior studies

No reversible defects. Normal Function. LVH

No Ischemia. Normal Function. Right Ventricular Hypertrophy

Dextrocardia
Prep. / Injection / Stress test

- Causes / Examples: inadequate preparation (coffee / NPO, attenuators / uncomfortable) / suboptimal IV access, suboptimal stress test
- Recognition: low count images, artifacts from infiltration / contamination, false negative studies
- Solution: attention to detail, teamwork, effective communication, ALARA

Normalization Artifacts

- Causes: images normalized to the hottest pixel (cardiac or non cardiac)
- Imaging Characteristics: focal hot spot (papillary muscle), decreased counts in myocardium
- Solution: reprocess / reimaging, increase intensity

Processing Related Artifacts

- Causes: user (technologist) / software (QPS/ECT)
- Steps in Processing: define center, limiting ROI, basal and apical limits, create axis
- Recognition: review processed images: VLA points to the right, HLA points up, equal number of slices, comparable between rest and stress
- Solution: reprocess

Non Uniformity Artifacts

- Causes: flood field non uniformity
- Imaging Characteristics: ring artifact, fixed or reversible defect
- Recognition: review uniformity flood
- Solution: reimage after camera repair, Q/C

Flood Non Uniformities

- Normal
- PMT malfunction/uncoupling
- Poor mixing
- Cracked crystal
- Poor gain alignment (tuning) of PMTs
- Collimator defect
COR Misalignment

- Causes: center of rotation misalignment
- Imaging Characteristics: oblong cavity, decreased activity, streaks, blurred images
- Solution: COR correction, Q/C

Camera Head Misalignment

- Imaging Characteristics: decreased counts, defects similar to patient motion, blurred images
- Recognition: review raw data
- Solution: Camera Q/C

Camera Quality Control

<table>
<thead>
<tr>
<th>TEST</th>
<th>FREQUENCY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy peaking</td>
<td>Daily/once to 2 weeks, documentation not required</td>
</tr>
<tr>
<td>Sensitivity or noise uniformity</td>
<td>Daily/once to weekly</td>
</tr>
<tr>
<td>Resolution and Beauty</td>
<td>Weekly</td>
</tr>
<tr>
<td>Center of rotation (SPECT)</td>
<td>Monthly</td>
</tr>
<tr>
<td>Overall system performance testing</td>
<td>Annually</td>
</tr>
<tr>
<td>Calibration</td>
<td>Annually</td>
</tr>
<tr>
<td>Uniformity calibration</td>
<td>Per manufacturer’s recommendations</td>
</tr>
<tr>
<td>Equipment maintenance</td>
<td>Every 6 months</td>
</tr>
</tbody>
</table>

References


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