Maximizing the Utility of Integrated PET/MRI in Clinical Applications

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Device: GE’s SIGNA PET/MR

- Concurrent System
- 3 Tesla MRI (750w system)
- PET
  - Silicon based PMT
  - TOF
From PET/CT to PET/MR: Considerations

1. Protocol/Workflow
2. Reporting
3. Technologists
1. Clear indications for both PET & MRI
   - Not by tumor type, but study type
Clinical PET/MR: Protocols/Workflow - Reporting - Technologists

PET/MR

Neurology
  • Brain

Oncology
  • Brain, Liver, Pelvis
  • Cardiac
# Clinical PET/MR: Protocols/Workflow-Reporting-Technologists

<table>
<thead>
<tr>
<th>Order</th>
<th>Study</th>
<th>Protocol</th>
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</thead>
<tbody>
<tr>
<td>PET/MR Brain</td>
<td>Brain MRI with FDG</td>
<td>Seizure Protocol</td>
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<tr>
<td></td>
<td>Brain MRI and Amyvid PET</td>
<td>Tumor Protocol</td>
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<tr>
<td>PET/MR WB with Brain</td>
<td>Brain MRI with WB PET</td>
<td>Dementia Protocol</td>
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<tr>
<td>PET/MR WB with Liver</td>
<td>FDG PET and liver MRI</td>
<td>Screening MR brain</td>
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<tr>
<td>PET/MR WB with pelvis</td>
<td>FDG PET and pelvis MRI</td>
<td>WB + Eovist Liver</td>
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<td></td>
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<td>WB + Gadavist Liver</td>
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<tr>
<td></td>
<td></td>
<td>WB + Rectal protocol</td>
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<td>WB + Uterine protocol</td>
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Clinical PET/MR: FUTURE PROTOCOLS

HEAD AND NECK
Challenge: MR protocol
Time: 2 to 3 months

CARDIAC
Challenges:
1. Technical development
2. Indication (ischemia, sarcoid, etc)
Time: To be determined
What is going to be largest volume?

PET/MR Abdomen and pelvis
- Large volume already
- Surgical planning

PET/MR Head and Neck

PET/MR BRAIN
- Epilepsy
- Dementia
- Amyloid

Current low clinical PET Volume
1. Overlapping PET & MRI study types

2. Total Examination Time

**Challenge:** MR protocols
PET/MR:
Clinical Examination Times

Currently: 90 minutes

Goal: 60 minutes

- Set up: 5 to 10 min
- Dedicate MR: 20 minutes
- WB PET: 20 minutes
1. Overlapping PET & MRI study types

2. Total Examination Time

3. Protocols
1st Clinical PET/MR: Metastatic Prostate Cancer
Clinical PET/MR: Rectal Cancer

1. FDG PET
2. Rectal MR

FINDING:
- T2 disease
- No LN or Mets
1. Dual Readout
   a. Nuclear Medicine
   b. Specific Section for MR

2. Two separate reports
   a. PET specific
   b. Dedicated MR
Clinical PET/MR:
Protocols/Workflow-Reporting-Technologists

Need at least one NM technologist

2 Technologists
- 1 NM
- 1 MRI

1 Technologist
- Trained in both NM&MR
- Not common training
- Solution:
  - NM tech with onsite MR training
PET/MR Challenges

Acceptance of PET/MR

- Imagers
- Referring Physicians
<table>
<thead>
<tr>
<th>MODALITY</th>
<th>ATTENUATION CORRECTION</th>
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<tbody>
<tr>
<td>PET Only</td>
<td>Emission</td>
</tr>
<tr>
<td>PET/CT</td>
<td>CT Attenuation Map</td>
</tr>
<tr>
<td>PET/MR</td>
<td>Atlas Segmentation Sequences</td>
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</table>
Q: How reliable is PET Quantification?

Accurate PET quantification essential
  • Staging, treatment response, restaging

Several papers have found SUV mean/max comparable between PET/MR and PET/CT
  • Except lung, bone and mediastinal blood

For MRAC, bone currently ignored
  • ↓ standard uptake value (SUV)
MR Bone:
Cortical Bone/AC Maps

- Conventional MR sequences too short
- Ignored in most MRAC
- Solution:
  - Bone Mu maps (atlas), Zero Echo Time (ZTE)

Delso G et al. JNM. 2015; 56: 417-422
MR Lung: Pulmonary Nodules

- CT method of choice for pulmonary nodules
- Studies have shown that MR and CT detect pulmonary nodules at a similar rate
  - 3D Dixon-based, dual-echo GRE
- Similar findings at UCSF with Ultra-short Echo Time (UTE)

Stolzmann P. Invest Radiol 2013 May (4): 241-6
MR Lung: Pulmonary Nodules

CT

Two Nodules
(1) 10 mm
(2) 4 mm

MR: LAVA

MR: UTE
- Both nodules seen

MR: LAVA
- 10 mm seen
- 4 mm not seen

??

Courtesy of Nicholas Burris & Tom Hope
PET/MR Challenges:
Imagers-Referrers

Hesitant to change current clinical practice

- **PET/CT** → **CT chest for pulmonary nodules**
- **PET/MR** → **Seen as experimental**
- Perception of full body MR
- Scant clinical data comparing current standard-of-care imaging
• Uncertainty of how to integrate PET/MR into the current clinical practice
  • Epilepsy:
    • Ictal studies
      • In hospital
    • SPECT with EEGs on
What have we learned?

Take away:

1. Clinical PET/MR is gaining momentum

2. Need to be patient
   • PET/MR is still young and developing
   • Similar to PET/CT, PET/MR needs to find its fit compared to SOC imaging
Take away:

3. Imagers and referrers have to work together
   a. Expectations and education
      a. Referrers
      b. None PET readers

4. MR and PET imagers need to work closely
   a. MR pulmonary nodule evaluation
   b. Compare PET/MR to SOC imaging
PET/MR: Future

Determine PET/MR role in clinical environments:
  - Multisite trials
  - Cost effectiveness

Refine MR bone/lung sequences

Refinement of MRAC and workflow

Reimbursement