PET/CT and PET/MR of Cardiac Tumors

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Disclosures

• No financial relationships to disclose
• No off-label uses will be discussed
Learning Objectives

• Review techniques for cardiac PET
• Review PET features of normal myocardium, benign and malignant cardiac tumors, and tumor mimics
• Discuss special PET techniques for cardiac tumors
Indications for Cardiac PET

- Myocardial Perfusion $^{82}$Rb, $^{13}$N
- Coronary atherosclerotic disease $^{18}$F
- Inflammatory cardiovascular disease $^{18}$F
- Cardiac tumors $^{18}$F, $^{68}$Ga
18FDG PET for Cardiac Tumors

• Diagnosis
• Staging/restaging disease
• Monitoring response to therapy
How to Perform PET for Cardiac Tumors

• Similar to traditional $^{18}$FDG PET
• Attenuation correction may be performed with either CT or MRI
• Post-processing may be performed to highlight cardiac data
FDG Metabolism of the Heart

• In the nonfasting state:
  • 50-70% of myocardial energy is derived from oxidation of fatty acids
  • Remainder is generated from carbohydrates

• In the fasting state:
  • Plasma insulin falls, which leads to decreased glucose metabolism in tissues, including the heart
  • Tumor imaging of the heart is therefore optimized when there is decreased myocardial glucose uptake
PET Patient Preparation Diet

- Routine $^{18}$FDG PET
  - Day of exam:
  - NPO 4 hours before scan
  - 24 hours prior:
  - Avoid high carb foods such as pasta, rice, bread, potatoes
  - May eat meats, eggs, cheese, vegetables, salad
PET Patient Preparation Diet

• Cardiac $^{18}$FDG PET
  • Day of exam:
    • NPO 4 hours before scan
  • 24 hours prior:
    • Avoid all carbs, including milk, cheese, vegetables, peanut butter, beans, fruit, pasta, rice, bread, potatoes
    • May eat meats, eggs, hot dogs
Suboptimal increased cardiac glucose metabolism

Optimized cardiac glucose metabolism
Normal Myocardial $^{18}$FDG Activity

• Variable, depends on level of myocardial glucose uptake

• Relatively homogeneous throughout normal LV myocardium, but may be more intense at the base

• FDG activity in the atria is associated with A-fib

• FDG activity may diffusely increase if there is chamber enlargement

• Normal pericardium should have no FDG activity
PET Features of Cardiac Tumors

• FDG PET activity of the mass depends on the mass

• Both primary and secondary malignant cardiac tumors tend to be hypermetabolic

• Benign masses typically demonstrate much less metabolic activity, though may still be considered hypermetabolic ($\text{SUV}_{\text{max}} > 2.5$)
Cardiac Tumors

Standardized Uptake Value (SUV)

Benign
Primary
Malignant
Secondary

$P < 0.01$

$P = ns$

$P < 0.01$

$SUV_{\text{max}} 3.5$

PET/CT
PET/CT

Physiologic Activity
Normal $^{18}$FDG cardiac activity
Physiologic activity in A-fib
Cardiac amyloid
PET/CT

Malignant Tumors
Metastatic melanoma
Metastatic Cholangiocarcinoma
Metastatic angiosarcoma
Lymphoma
Primary pericardial mesothelioma
Neuroendocrine Tumor PET Imaging

- Somatostatin receptors are overexpressed in neuroendocrine tumors
- $^{68}$Ga Dotatate is a somatostatin analog, binds to somatostatin receptors
- $^{68}$Ga Dotatate PET is more sensitive for NET than Octreoscan

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Metastatic Carcinoid

$^{18}$FDG PET
PET/CT

Benign Tumors
LA myxoma
LA thrombus
PET/CT

Tumor Mimics
Brown fat in lipomatous hypertrophy of interatrial septum
Cardiac sarcoidosis
Erdheim-Chester disease
PET/MR
Integrated $^{18}$F-FDG PET/MR Imaging in the Assessment of Cardiac Masses: A Pilot Study

Felix Nensa¹, Ercan Tezgah², Thorsten D. Poeppel³, Christoph J. Jensen⁴, Juliane Schelhorn¹, Jens Köhler⁵, Philipp Heusch⁶, Oliver Bruder⁴, Thomas Schlosser¹, and Kai Nassenstein¹
## Diagnostic Performance of PET and MR Features

<table>
<thead>
<tr>
<th>Feature</th>
<th>Sensitivity (%)</th>
<th>Specificity (%)</th>
<th>Positive predictive value (%)</th>
<th>Negative predictive value (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\text{SUV}_{\text{max}}$</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Cutoff $\geq 5.2$, optimal</td>
<td>100</td>
<td>92</td>
<td>88</td>
<td>100</td>
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<tr>
<td>Cutoff $\geq 3.5$ (10)</td>
<td>100</td>
<td>85</td>
<td>78</td>
<td>100</td>
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<tr>
<td>Tumor volume (cutoff $\geq 23.1 \text{ mL}$, optimal)</td>
<td>100</td>
<td>85</td>
<td>73</td>
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<td>Pericardial effusion</td>
<td>71</td>
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<td>Cine SSFP morphology</td>
<td>86</td>
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<tr>
<td>T1w hyperintensity</td>
<td>29</td>
<td>54</td>
<td>25</td>
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<tr>
<td>T2w hyperintensity</td>
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<td>100</td>
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<tr>
<td>Contrast enhancement</td>
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<td>46</td>
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<td>100</td>
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<tr>
<td>MR imaging overall</td>
<td>100</td>
<td>92</td>
<td>88</td>
<td>100</td>
</tr>
<tr>
<td>MR imaging overall &amp; $\text{SUV}_{\text{max}}$ (cutoff $\geq 5.2$, optimal)</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>
R lung cancer with LA invasion
L lung cancer with LA invasion
Sclerosed epithelioid fibrosarcoma
Lung cancer invading LA with thrombus

Courtesy of Felix Nensa, Essen, Germany
Summary

• In conjunction with other imaging findings, PET is helpful in distinguishing between benign and malignant cardiac tumors

• Patient preparation (pre-scan diet) is critical for optimum $^{18}$FDG PET imaging of the heart

• Newer PET radiopharmaceuticals can improve the evaluation of cardiac malignancies
Thank You!!
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