Introduction: So You Bought a PET/MR Scanner: Now What?

Shreyas S. Vasanawala, MD, PhD

1. Which of the following exams are unlikely to have degraded image quality on a PET-MR system compared to a dedicated MRI scanner?
   A. Cardiac MRI
   B. Liver MRI
   C. Brain MRI
   D. Knee MRI
   E. Abdomen MRA

   Correct Answer: D

Rationale
Gradients and some receiver coils for PET-MR systems have decreased performance compared to modern dedicated MRI systems. Thus, exams involving fast gradient recalled imaging and diffusion weighted imaging will suffer.

Reference

2. Which expertise is necessary for a successful PET-MR program?
   A. MRI
   B. Nuclear medicine
   C. Billing/finance
   D. All of the above

   Correct Answer: D

Rationale
Many aspects to creating a robust clinical program.

Reference
3. **PET-MR can be challenging when quantifying hepatic tumor uptake as compared to PET-CT because:**
   A. MR yields worse contrast that CT in soft tissues
   B. PET in PET-MR is less sensitive than PET in PET-CT
   C. MR-based attenuation correction is more challenging than CTA
   D. MR is less sensitive to motion than CT
   E. MR allows to reduce radiation dose to the patient but at a cost of increased noise

   **Correct Answer: C**

   **Reference**

4. **Attenuation compensation in PET-MR can be a limiting factor for quantitative imaging because:**
   A. MR yields worse contrast that CT in soft tissues
   B. PET in PET-MR is less sensitive than PET in PET-CT
   C. MR-based attenuation correction is more challenging than CTA
   D. MR is less sensitive to motion than CT
   E. MR allows to reduce radiation dose to the patient but at a cost of increased noise

   **Correct Answer: D**

   **Reference**

**PET/MR in Pediatric Oncology**

*Maria Rosana Ponisio, MD*

5. **Select the BEST statement regarding the advantages of PET/MR:**
   A. Lower cumulative dose of ionizing radiation with removal of the CT component
   B. Allows for combined metabolic, functional and anatomical imaging
   C. Increases the safety profile for vulnerable patients reducing radiation and anesthesia requirements.
   D. All of the above.

   **Correct Answer: D**

   **References**
6. **Select the CORRECT answer regarding simultaneous PET/MR:**
   A. MR based PET attenuation correction is not needed for PET/MR
   B. There is no correlation between standardized uptake values (SUVs) on PET/CT and PET/MR
   C. PET/MR has lower cost and shorter scan times than PET/CT
   D. PET/MR provides superior evaluation of the lung parenchyma over PET/CT
   E. None of above.

   **Correct Answer: E**

**References**

**Making PET-MRI More Accessible for Children**
*Michael S. Gee, MD, PhD*

7. **Child life specialists can help reduce the need for sedation in pediatric MRI. Which one of the following is not a typical role for child life specialists?**
   A. Help the patient and parents become familiar with the MRI environment.
   B. Use play therapy to increase cooperation and decrease anxiety.
   C. Maintain effective communication with the patient and parents before, during, and after the MRI.
   D. Determine the optimal sedative agent based on the patient’s level of anxiety and the expected duration of the scan, and participate in its administration.
   E. Collaborate with the radiologist to estimate the ability of the patient to cooperate and tailor the examination to realistic expectations.

   **Correct Answer: D**

**Rationale**
The correct answer is D. Determination of optimal sedative agent and sedative administration are typically performed by physicians and/or nurses.

**References**
8. What of the following statements is correct regarding the use of intravenous gadolinium-based intravenous contrast for PET-MR imaging of children with cancer?
   A. It always adds diagnostic value beyond noncontrast imaging.
   B. It never adds diagnostic value beyond noncontrast imaging.
   C. For some tumor types, it does not add diagnostic value beyond noncontrast imaging.
   D. All of the above.

   **Correct Answer: C**

**Rationale**
For pediatric tumors in the abdomen and pelvis, FDG and noncontrast MR images show high concordance with post-contrast MR images and gadolinium enhancement may not provide additional information.

**Reference**

**PET/MR and the Role of Contrast Agents**
*Heike E. Daldrup-Link, MD, PhD*

9. Which technique can be used for whole body PET/MR scans?
   A. Unenhanced T2-FSE + 18F-FDG PET
   B. Gd-enhanced T1-GE + 18F-FDG PET
   C. Feruoxytol T2-FSE + 18F-FDG PET
   D. Feruoxytol T1-GEE + 18F-FDG PET
   E. All of the above

   **Correct Answer: D** *(They will require variable acquisition times.)*

**Reference**

10. How can false positive signal of normal spleen, marrow and lymph nodes on T2w and DW-MRI be suppressed?
   A. Inject gadolinium chelate
   B. Oral water before scan
   C. Inject iron oxide nanoparticles
   D. Apply fat saturation
   E. All of the above

   **Correct Answer: C**

**Reference**
11. Which radiopharmaceutical is not FDA approved?
   A. 18F-FDG  
   B. 68 Ga-DOTATATE  
   C. 18F-NaF  
   D. 18F-DOPA

   **Correct Answer: D**

   References

12. 18F-DOPA has potential benefit in the evaluation all of the following EXCEPT
   A. Neuroendocrine tumors  
   B. Congenital Hyperinsulinism  
   C. Crohn’s disease  
   D. Neuroblastoma

   **Correct Answer: C**

   References
   1. SNMMI. Fluorodopa F-18. SNMMI PET Center of Excellence and the Center for Molecular Imaging Innovation & Translation. May 2013. Http://interactive.snm.org/docs/PET_PROS/FDOPA.pdf

Cancer Predisposition Syndromes and Cancer Screening: PET-MR vs. WBMRI
Sudha A. Anupindi, MD

13. Which of the following cancer predisposition syndromes is currently evaluated by WBMRI based on recent publications?
   A. Beckwith-Wiedemann Syndrome  
   B. VACTERL syndrome  
   C. Hemihypertrophy  
   D. Li-Fraumeni syndrome

   **Correct Answer: D**

   Rationale
   Rationale for correct answer D: Li-Fraumeni syndrome is one of the cancer predisposition syndromes where patients are at very high risk for developing or dying from a tumor in their lifetime. This is result of a germline mutation in the P53 tumor suppressor gene. WBMRI has been used to screen these patients and their families as described in the references above.
Option A and C- are not correct answers as children with Beckwith-Wiedemann Syndrome and
and Hemihypertrophy, although at risk for developing solid tumors, are generally screened with
ultrasound (US) rather than WBMRI. In fact if US shows an abnormality suspicious for a tumor,
 further evaluation with contrast enhanced MRI will often be performed as the next step.

Option B- is not a cancer predisposition syndrome and therefore not a correct answer.

References
1. Anupindi SA, Bedoya MA, Lindell RB, Rambhatla SJ, Zelley K, Nichols KE, Chauvin NA,
Diagnostic Performance of Whole-Body MRI as a Tool for Cancer Screening in Children
germline TP53 mutation carriers with Li-Fraumeni syndrome: a prospective
3. Eustler EP and Khanna G, Whole-body magnetic resonance imaging in children:
technique and clinical applications; Pediatr Radiol (2016) 46:858–872

14. Regarding technique of WBMRI and PET-MR (one of the following is a correct statement):
A. Anatomical Coverage is limited from vertex to knees only
B. Moving table cannot be used with both techniques
C. Field inhomogeneity and incomplete fat suppression are known pitfalls
D. Diffusion weighted images do not add any extra time and do not provide
complementary information.

Correct Answer: C

Rationale
Rationale for Correct Answer C: The main advantage of PET-MR is that it provides both
anatomical and functional information and when applying it to neoplasms, evaluation of tumor
response can be assessed.

Option A and B is incorrect because the anatomical coverage for both studies can be acquired
from vertex to ankles as described in both of the references by Eustler EP and Hirsch WF.
Overall coverage for PET-MR is variable and the complete lower legs and feet can be included
separately as a different station.

Option C is correct and is a known challenge/pitfall of Whole body MR imaging as well as PET-
MR. The ends of the extremities are often areas of inhomogeneous fat suppression and field
inhomogeneity. This is also more pronounced at the areas of overlap. However, with
optimization these challenges may be overcome.

Option D is also not correct as DWI provides complimentary information.

References
1. Eustler EP and Khanna G, Whole-body magnetic resonance imaging in children:
technique and clinical applications; Pediatr Radiol (2016) 46:858–872.
2. Hirsch WF et al. PET/MR in children. Initial clinical experience in paediatric oncology
using an integrated PET/MR scanner; Pediatr Radiol (2013) 43:860–875
15. Radiotracers that have potential utility for Cardiac PET/MR imaging include all of the except:
   A. 18F-FDG
   B. 13N-NH3 (ammonia)
   C. 124I-MIBG
   D. 82Rb
   
   **Correct Answer: C**

   **Rationale**
   A. **True:** 18F-FDG is usually for studies involving myocardial metabolism where distinguishing irreversibly ischemic myocardium from stunned myocardium is needed. Also used in the evaluation of endocarditis around prosthetic valves.
   B. **True:** 13N-NH3 (ammonia) is a valuable agent for measuring either absolute or relative myocardial blood flow. Ammonia may cross myocardial cell membranes by passive diffusion or as ammonium ion by the active sodium-potassium transport mechanism and is either incorporated into the amino acid pool as N-13 glutamine or back-diffuses into the blood. Limitations: cyclotron production and 10 min half-life.
   C. **False:** 124I-MIBG can be used for tumor imaging (NBL and neuroendocrine tumors). It is a PET agent, but has no role in cardiac imaging. Other limitations include poor dosimetry
   D. **True:** 82Rb. Well established and highly accurate technique for detecting hemodynamically significant CAD. Requires an onsite generator; short half-life of 75 sec allows rest/stress studies.

**References**
References for this question are the same for the next question.

16. Which of the radiotracers listed below has the greatest potential utility for orthopedic PET/MR applications:
   A. 99mTc-MDP
   B. 18F-Fluoride
   C. 18F-FLT
   D. 68Ga-DOTATATE

   **Correct Answer: B**

   **Rationale**
   A. **False:** 99mTc-MDP is commonly used for orthopedic bone scintigraphy applications but is a gamma-emitting radiopharmaceutical, not a PET agent.
   B. **True:** 18F-Fluoride is retained to a high degree in bone. The 18F ion exchanges for an OH(-) ion in the surface hydroxyapatite matrix of bone, and then becomes incorporated into the crystalline matrix of bone, where it is retained. Favorable dosimetry and high resolution images are equivalent/superior to 99mTc-MDP.
   C. **False:** 18F-FLT has no current role for in orthopedic PET imaging. 18F-FDG can be used for detecting infectious and inflammatory processes, but is less useful for routine orthopedic applications
   D. **False:** 68Ga-DOTATATE has specific potential application for identification and characterization of neuroendocrine tumors and tumor-induced osteomalacia, but has no role for routine orthopedic applications.
References