PET/CT PSMA Practical Imaging Guidelines

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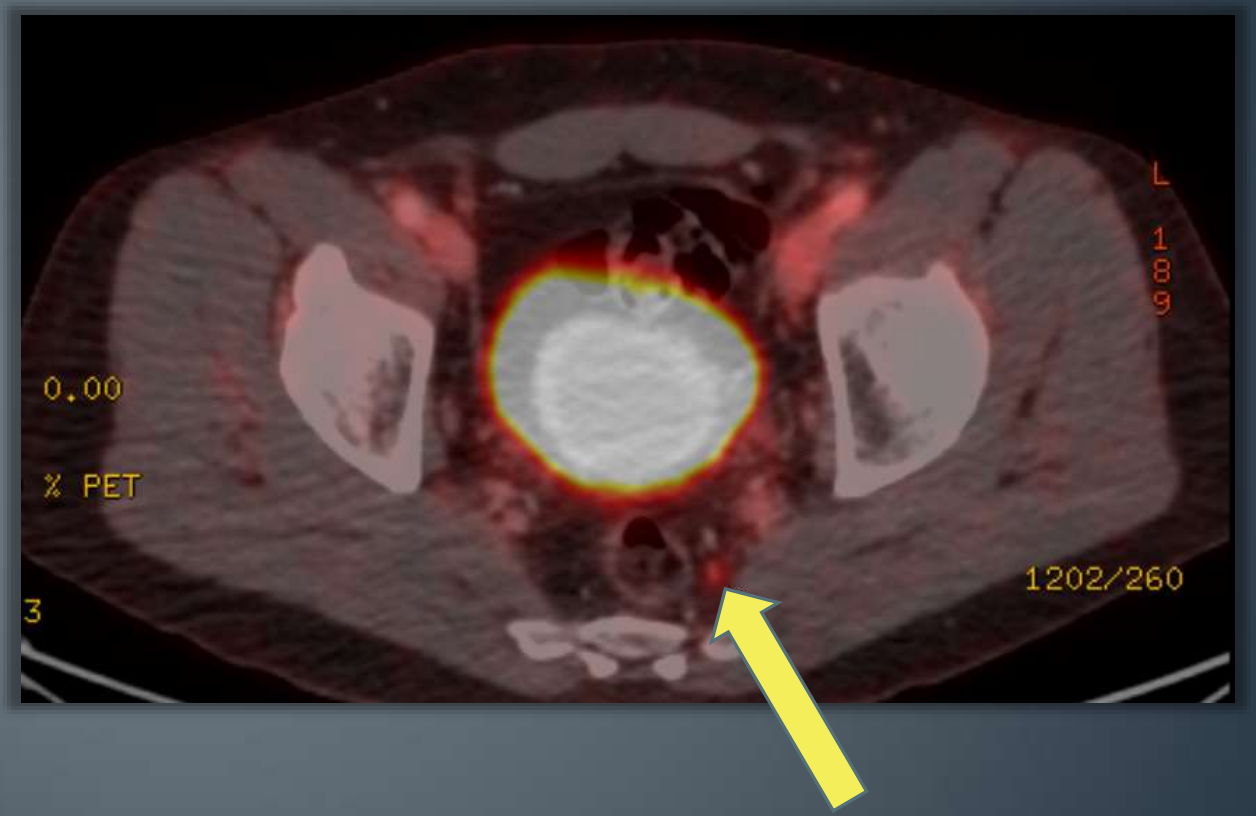
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% PET
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Objectives

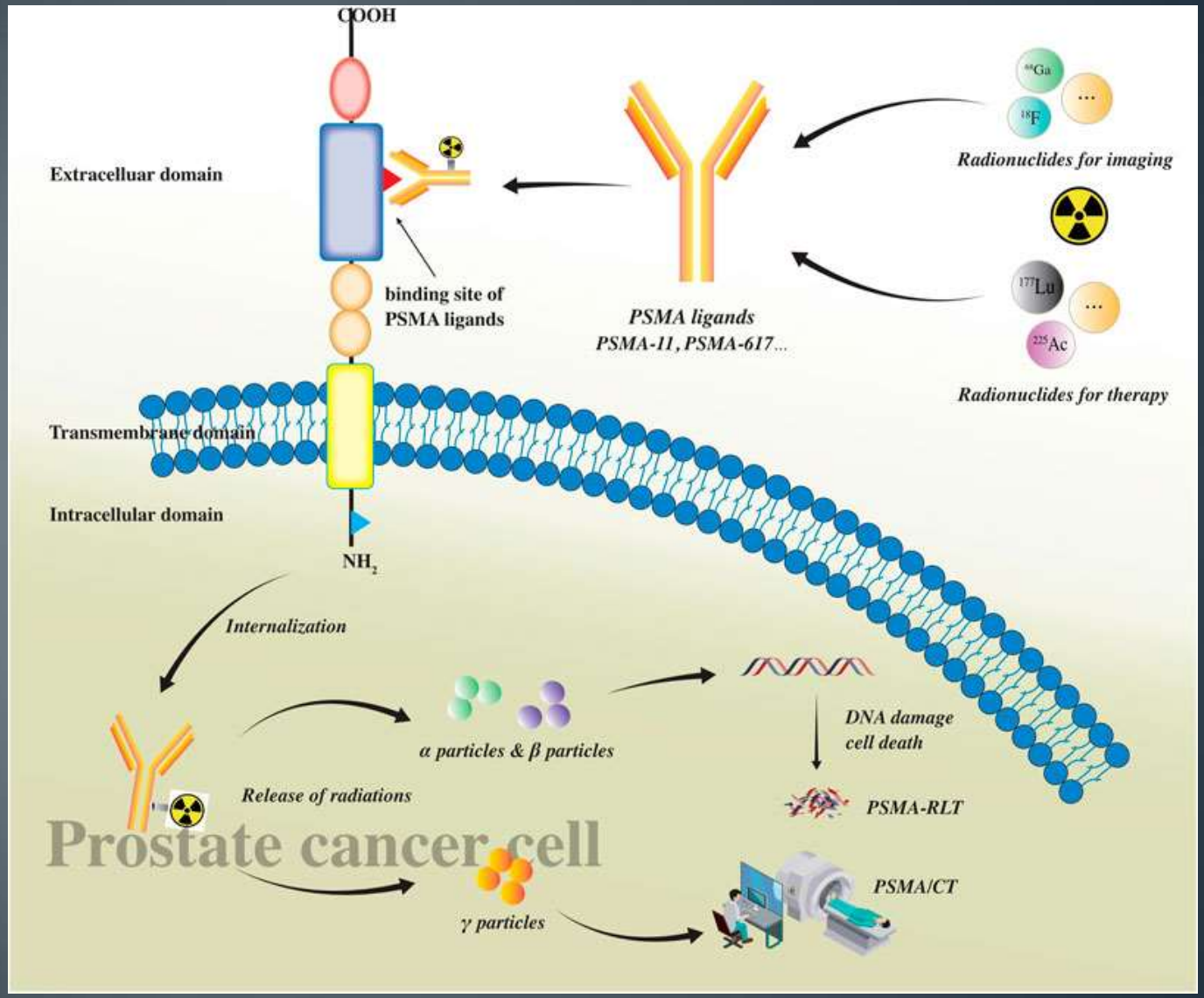
- Briefly explain PSMA ligands and the method of uptake
- Describe the biodistribution of PSMA ligands
- Determine proper reason for exam
- Explain proper patient preparation and discharge instructions for PSMA PET/CT imaging
- Implement proper dosing, injection, and scan parameters into practice
- List some advantages of using PSMA-based radiopharmaceuticals over other PET/CT imaging agents for prostate cancer

^{68}Ga-PSMA-11 & ^{18}F-DCFPyL

- ^{68}Ga-PSMA Gozetotide
  - Illucix
  - Locametz
- ^{18}F-PSMA Piflufolastat
  - Pylarify
- Approved by the FDA
  - Pylarify – 5/21
  - Illucix – 12/21
  - Locametz & Pluvicto – 3/22
- No evidence to date that one is superior to the other

How are PSMA ligands used in imaging?

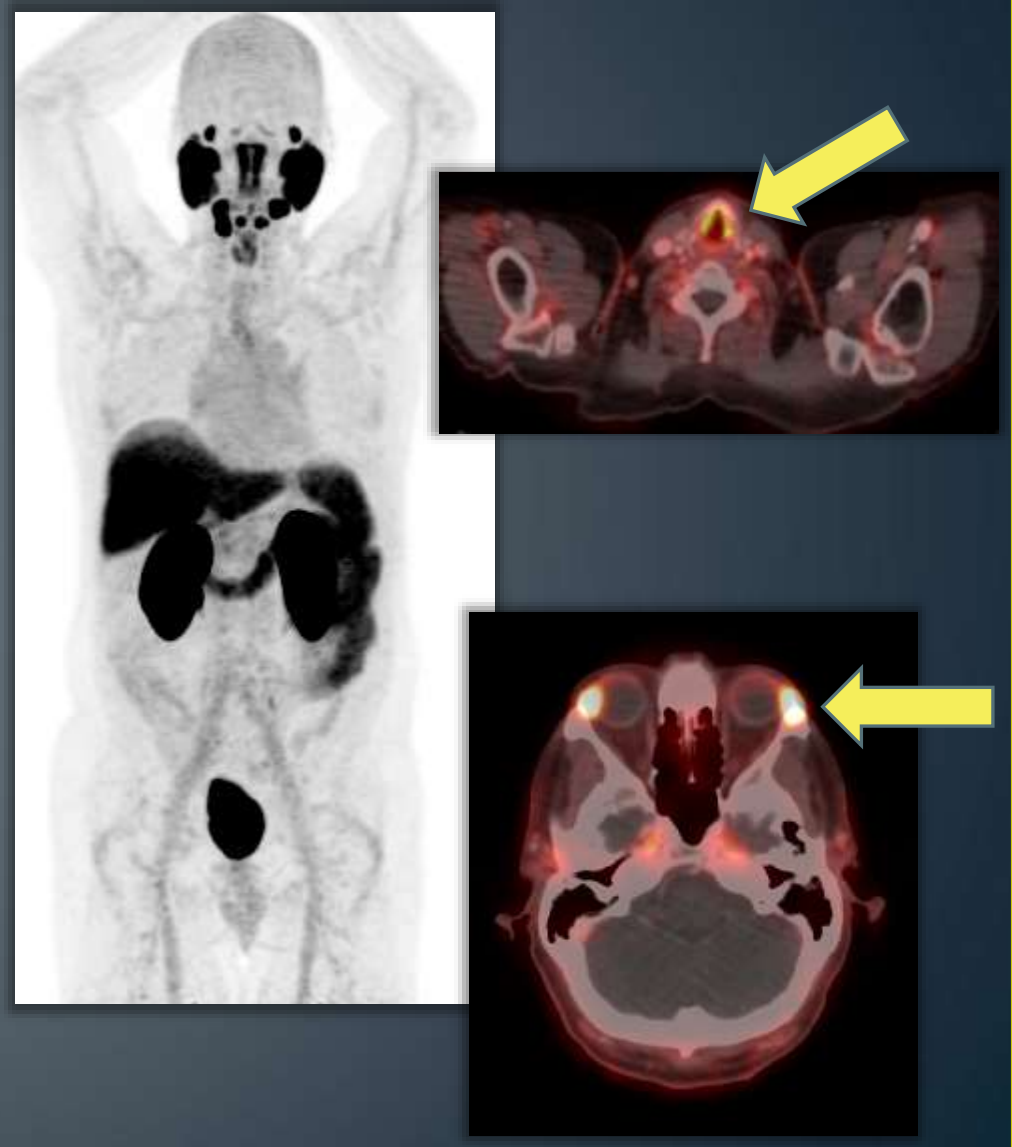
- 90-95% of prostate cancer cells express more PSMA cell surface proteins than in other PSMA-expressing tissues such as kidneys, proximal small intestines and salivary glands
- PSMA is a transmembrane glycoprotein consisting of intracellular, transmembrane and extracellular components
- There is a ligand binding site in the extracellular region where the PSMA ligands bind for either imaging or treatment



https://www.frontiersin.org/files/Articles/958180/fcell-10-958180-HTML/image_m/fcell-10-958180-g001.jpg

Biodistribution

- **Normal areas of PSMA ligand uptake**
  - Lacrimal glands
  - Salivary glands
  - Vocal cords
  - Liver
  - Gallbladder
  - Spleen
  - Small intestine
  - Colon
  - Kidneys and Bladder

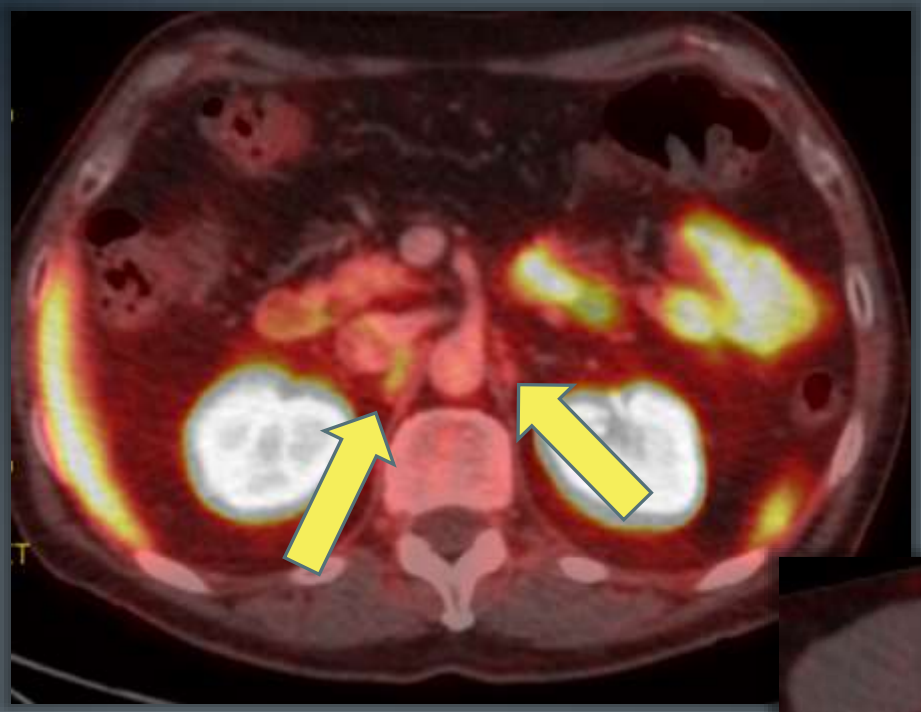


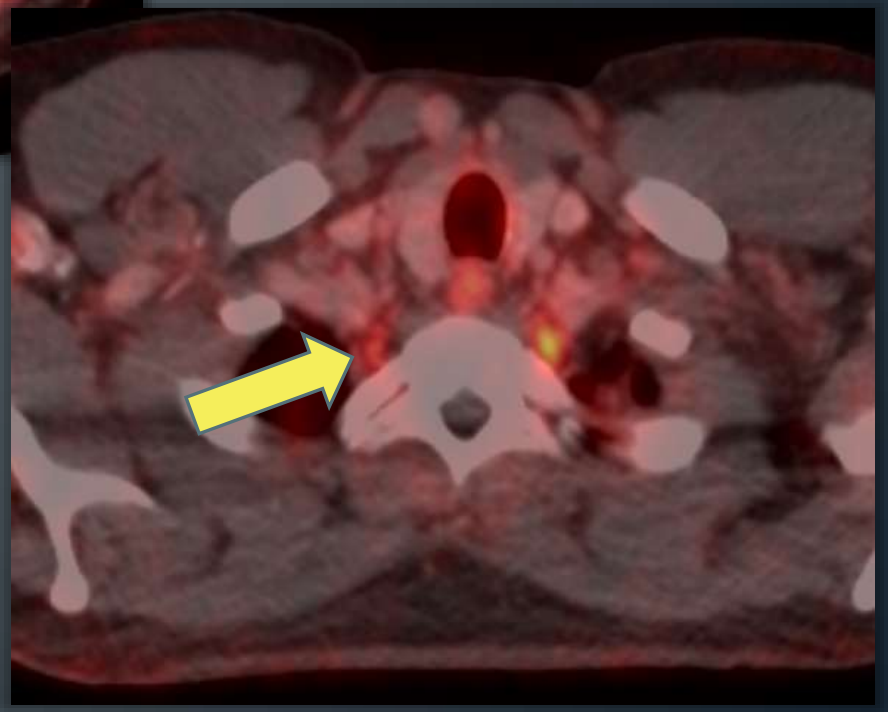
Biodistribution

- Possible areas variable normal uptake
  - Inflammation & infection
  - Benign bone lesions
    - Osteopyhtes
    - Fibrous dysplasia
  - Autonomic nervous system ganglia
    - Stellate ganglia (cervicothoracic region)
    - Celiac ganglia (retroperitoneal region)
    - Sacral ganglia (presacral region)

*Shetty D, Patel D, Le K, Bui C, Mansberg R. Pitfalls in Gallium-68 PSMA PET/CT Interpretation – A Pictoral Review. *Tomography.* 2018;4:182-193

Celiac Ganglia





Stellate Ganglia

Biodistribution

- While currently approved specifically for prostate cancer imaging, PSMA uptake is NOT prostate specific

- Abnormal processes
  - Osseous fractures
  - Paget's disease
  - Non-small cell lung cancer
  - Renal cell cancer
  - Neuroendocrine tumor

Androgen Deprivation Therapy

- The goal of this treatment is to suppress levels of the male hormones called androgens as they can stimulate prostate cancer cells to grow

- Often this will cause a shrinking or slowing of the prostate cancer, but alone it does not cure the cancer

- Considerations
  - "Androgen deprivation therapy (ADT) and other therapies targeting the androgen pathway, such as androgen receptor antagonists, may result in changes in uptake of _____ in prostate cancer. The effect of these therapies on performance of _____ PET has not been established."

Biodistribution

- Androgen Deprivation Therapy considerations
  - PSMA expression is upregulated heterogeneously following the start of ADT therapy
  - Hormone naïve men
    - Significant reduction in uptake in 86% of men 9 days after ADT
    - PET might underestimate the volume of metastatic disease
  - Castration-resistant men
    - Flares of increased PSMA uptake were variably observed but do not necessarily represent disease progression
    - Bone lesions seem more susceptible
    - Long-term ADT reduces the visibility of castration-sensitive PC
  - Perform PET/CT prior to onset of new ADT when possible

Emmett L, Yin C, Crumbaker M, Hruby G, Kneebone A, Epstein R, Nguyen Q, Hickey A, Ihsheish N, O'Neill G, Horvath L, Chalasani V, Stricker P, Joshua A. Rapid Modulation of PSMA Expression by Androgen Deprivation: Serial 68Ga-PSMA 11 PET in Men with Hormone-Sensitive and Castrate-Resistant Prostate Cancer Commencing Androgen Blockade. *JNM.* 2019; 60, 950-954

Reason for Exam

- Initial staging of prostate cancer for suspected mets
- Restaging recurrent or persistent prostate cancer following curative intent therapy, based on an elevated serum prostate-specific antigen (PSA) level
- Localization of prostate cancer which is non-metastatic by conventional imaging
- Staging prior to PSMA-directed radioligand therapy
  - Helps assess the likelihood of response to RLT such as ^{177}Lu-PSMA

*Beheshtii M, Bomanji J, Ceci F, Eiber M, Fanti S, Goffin K, Fendler W, Giesel F, Haberkorn U, Herrmann K, Kopka K, Krause B, Mottaghy F, Oprea-Lager D, Wan S, Wester HJ, Calais J, Cho S, Hope T, Jacene H, Koo P, Liindenberg L, Marcus C, Osborne J, Piert M, Rowe S, shoder H. PSMA PET/CT: Joint EANM and SNMMI procedure guideline for prostate cancer imagaing: version 2.0. 2022

Potential Issues

- Insurance approval
- Multiple radiopharmaceuticals for same indication
  - Educate and guide clinicians if needed

Preparing a patient for PSMA PET/CT scan without iodinated contrast

- Fasting is not required, including all medications
- Well hydrated
- Diuretic such as Furosemide just prior to or after PSMA injection (not required)
  - Issues: incontinence, obstruction or contraindication

Preparing a patient for PSMA PET/CT scan with iodinated contrast

- Three hours fasting is required, except clear liquids
- All medications can be taken
- Well hydrated
- Kidney function needs to be verified per facility protocol
  - Refer to the American College of Radiology (ACR) Manual on Contrast Media for guidance
- Diuretic such as Furosemide just prior to or after PSMA injection (not required)
  - Issues: incontinence, obstruction or contraindication

Iodinated Contrast Premedication

- Prednisone (50mg) ***or*** Hydrocortisone (50mg) at 13 hours, 7 hours and 1 hour prior to imaging

- Diphenhydramine (25 or 50mg oral or IV) 1 hour prior to imaging

Conflicting Exams

- Nuclear Medicine Exams
- Procedure using Barium Sulfate (ex. Barium Swallow, UGI)
- CT (if giving contrast, scans should be 24-hours apart)

Protocols

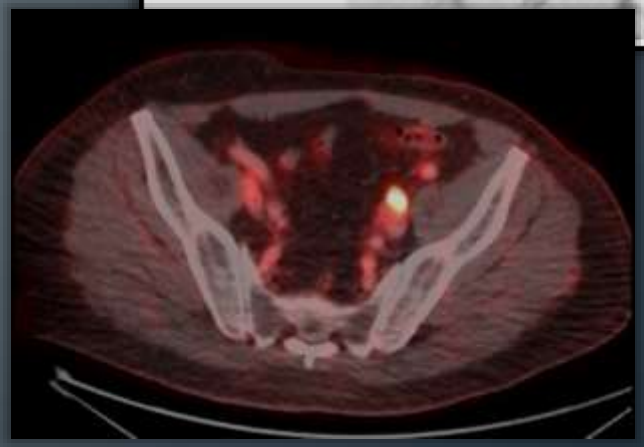
- Injection
  - Inject as an intravenous bolus, using an intracatheter when possible (except Locametz)
  - Flush well, using a three-way stopcock
  - No activity restrictions while localizing

Protocols

- ^{18}F-DCFPyL
  - 8 - 10 mCi
  - 60-90-minute localization
- ^{68}Ga Gozetotide PSMA 11 (Locametz / Illuccix)
  - 3-7 mCi
  - 50-100-minute localization

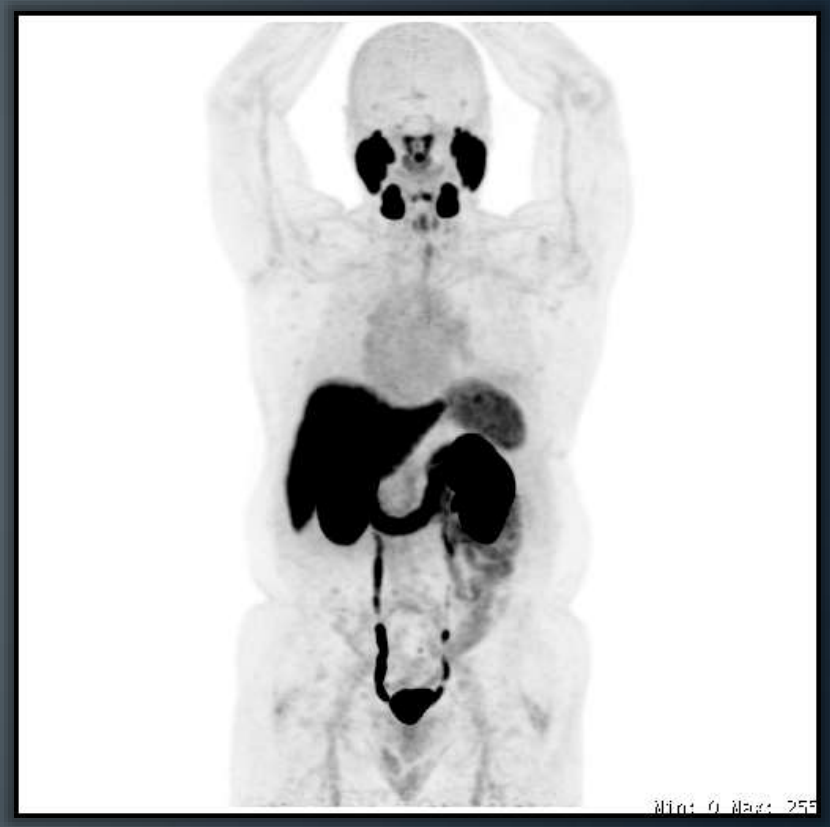
Protocols

- Imaging
  - Patient voids just prior to imaging
    - Incontinence issues
  - Supine with arms above head
  - Mid-thigh through vertex of skull is recommended
  - PET is imaged caudo-cranial



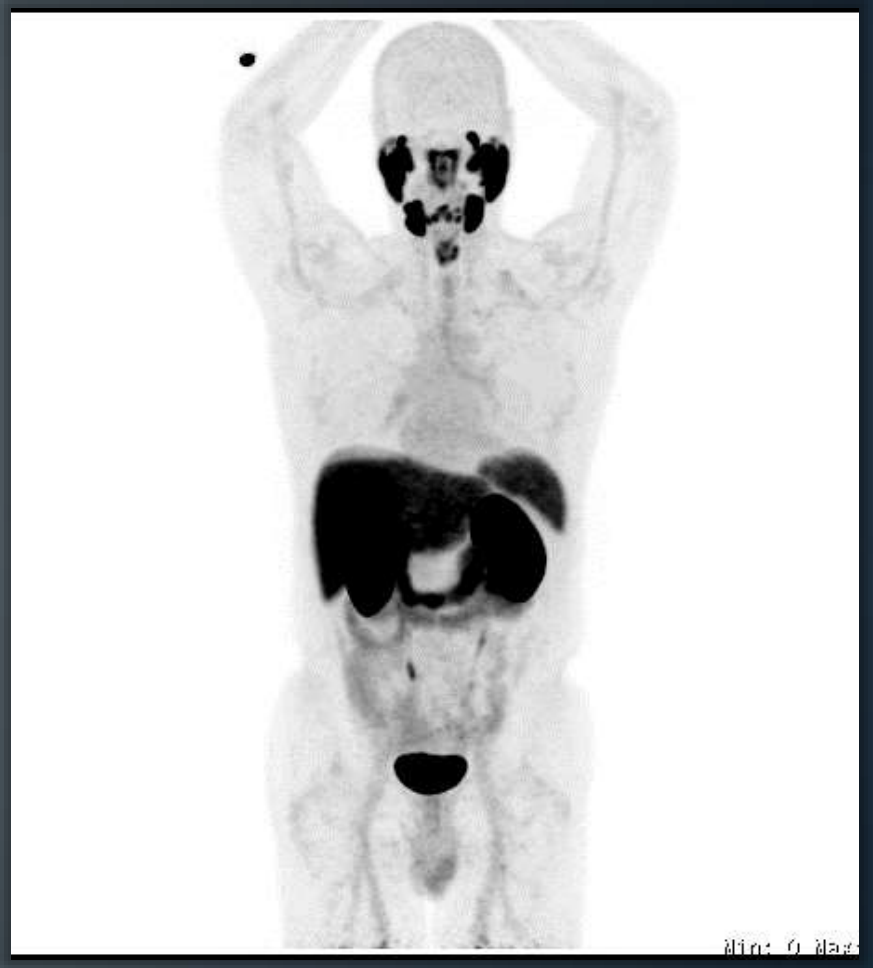
Protocols

- Imaging
  - 1-5 minutes/bed or the equivalent on continuous bed motion
  - Metallic artifact reduction (MAR) algorithms are useful if patient has hip replacements or other metal in regions of interest
  - If contrasted, image during portal venous phase



Discharge Instructions

- **After a PET/CT scan without contrast**
  - No dietary or medication restrictions
  - Drink plenty of fluids
  - Void often

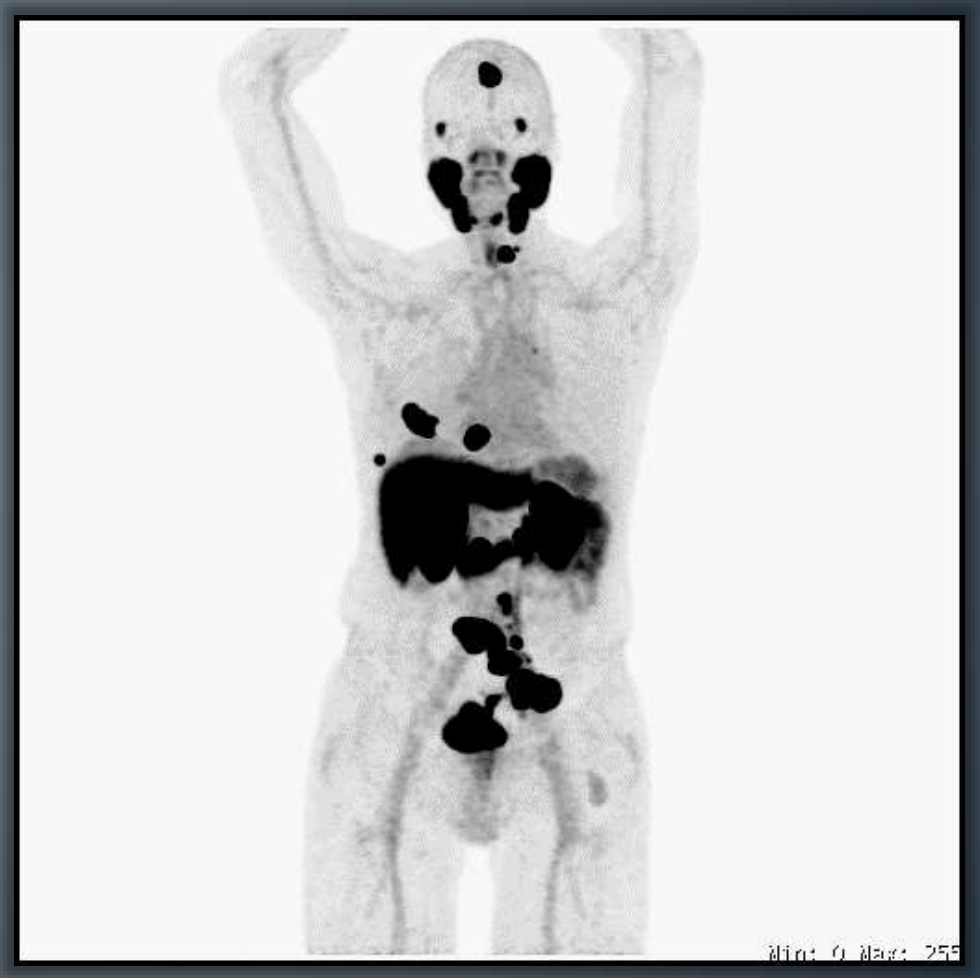


Discharge Instructions

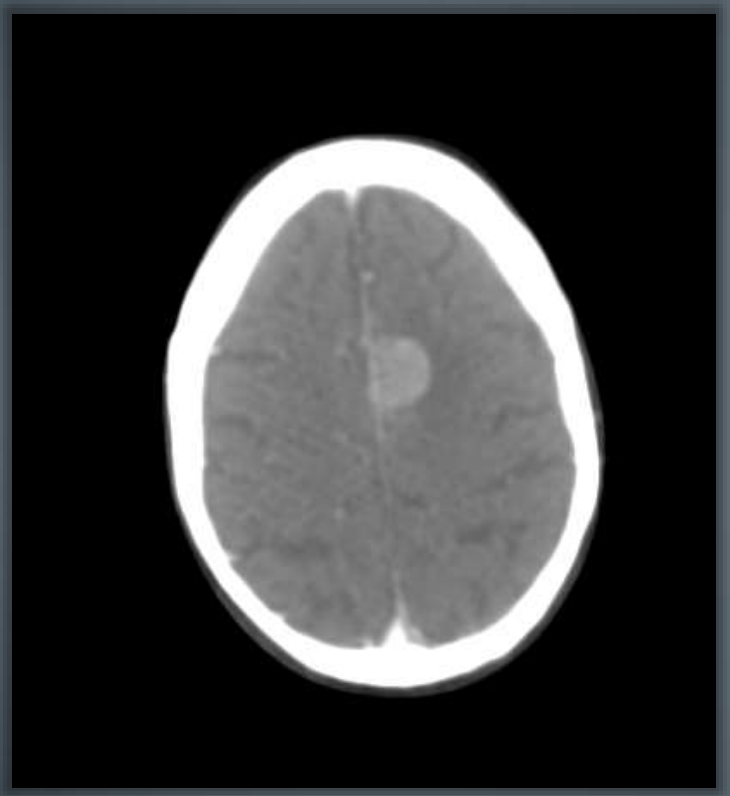
- **After a PET/CT scan with contrast**
  - Same as PET/CT without contrast
  - Instructed to increase water consumption unless otherwise indicated
  - Watch for symptoms of a delayed reaction

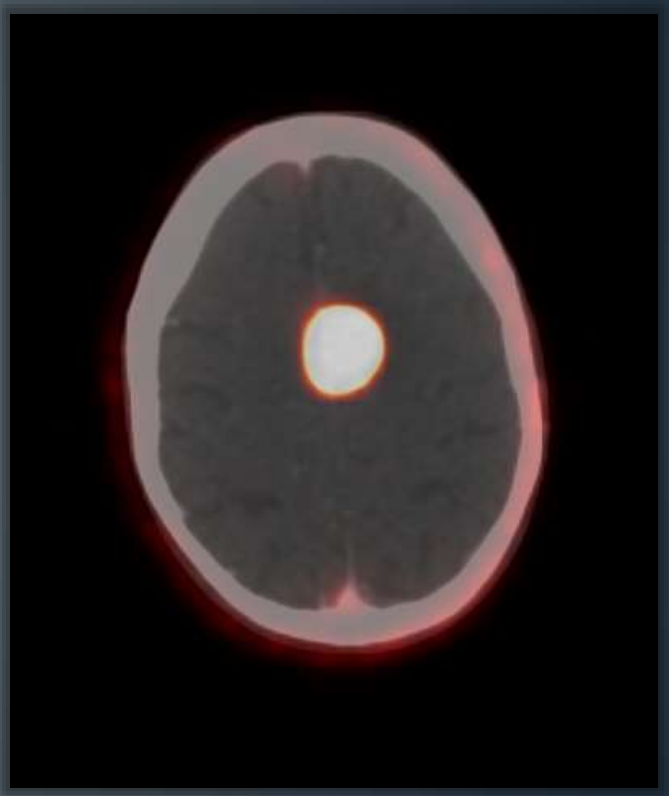
RRX	Half-life	Expiration Time	Indications	Prep	Localization Time
F18 Piflufolastat	109.7 min	Use w/in 10 hrs of end of synthesis	• Initial Staging • Restaging	• No prep unless receiving iodinated contrast	60-90 minutes
Ga68 Gozetotide	68 min	Use w/in 4 hrs of end of synthesis	• Initial Staging • Restaging	• No prep unless receiving iodinated contrast	50-100 minutes
F18 Fluciclovine	109.7 min	Use w/in 10 hrs of end of synthesis	• Restaging after therapy and has increased PSA	• No significant exercise 24 hours prior • 4-hour fast except water	Begin scan 3-5 minutes after injection
C11 Choline	20.4 min	Use w/in 60 min of end of synthesis	• Restaging after therapy, has a non-informative CT/Bone scan/MRI, and has increased PSA	• 6-hour fast except water	Begin scan 0-15 minutes after injection
F18 FDG	109.7 min	Use w/in 12 hrs of end of synthesis	• Restaging	• 4-6-hour fast except water • Diabetic considerations	40-100 minutes

^{68}Ga-PSMA-11



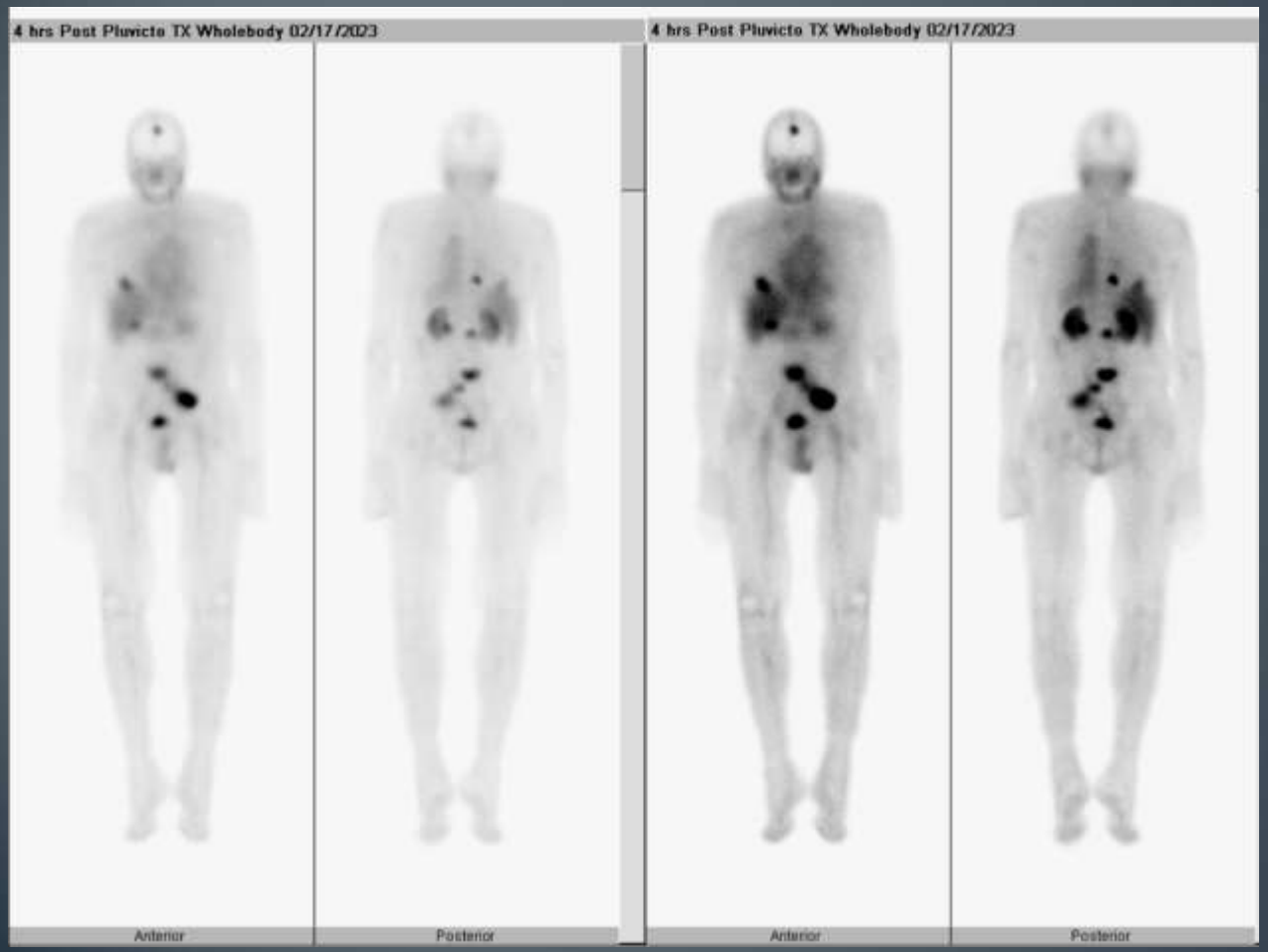
^{68}Ga-PSMA-11

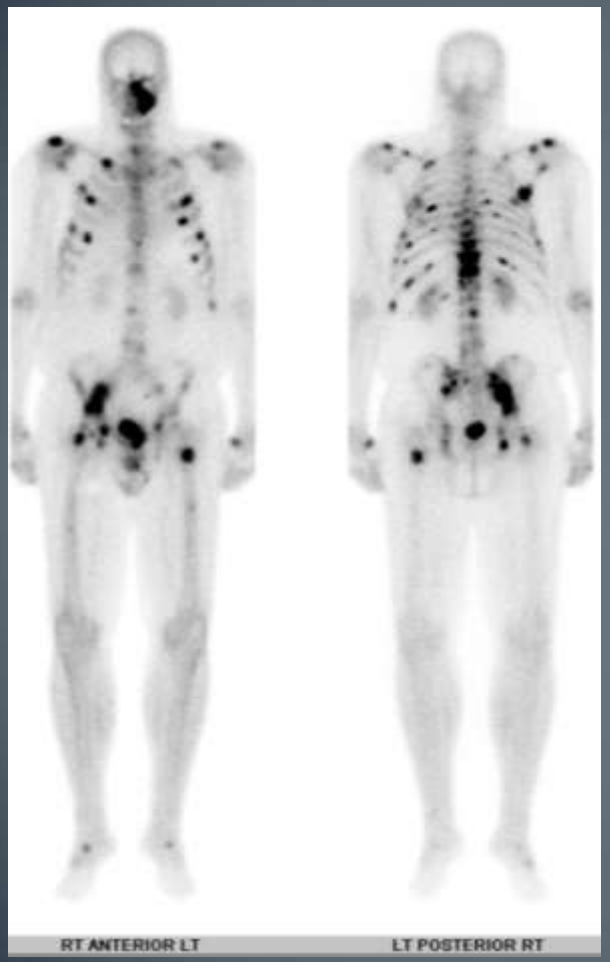




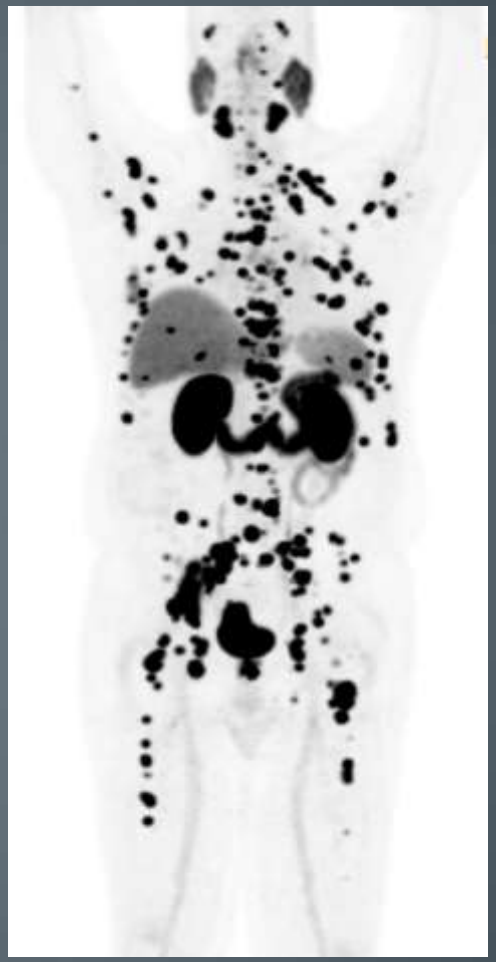
- New edematous lesion not seen on Ga68 PSMA-11 scan 6 months prior
- MRI: Dural metastasis to left-sided falx with evidence of brain invasion
- Treated with gamma-knife and showed response on MRI

Pluvicto Scan vs. ^{68}Ga-PSMA-11

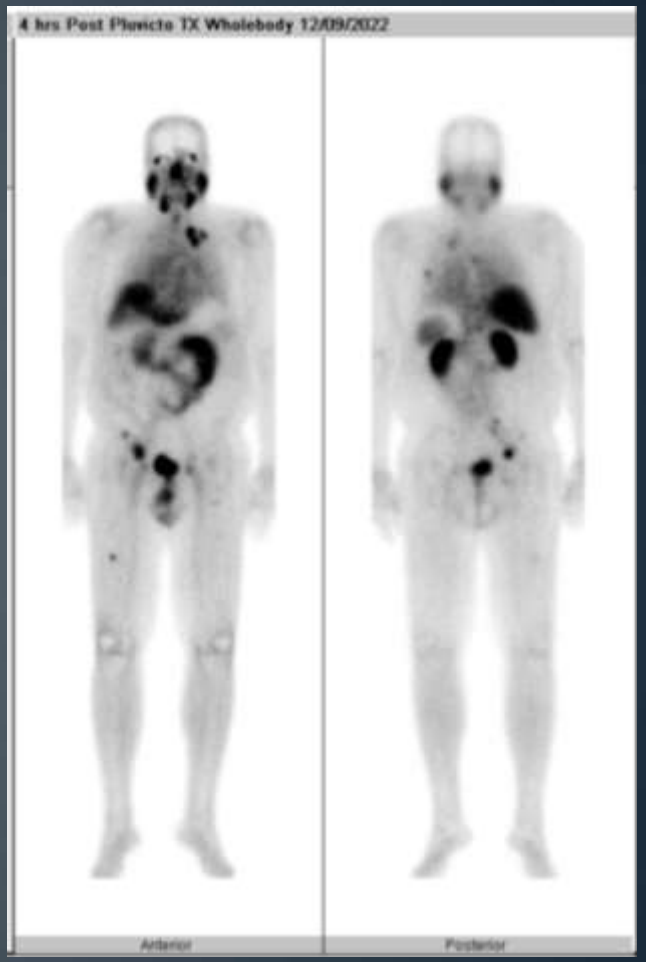




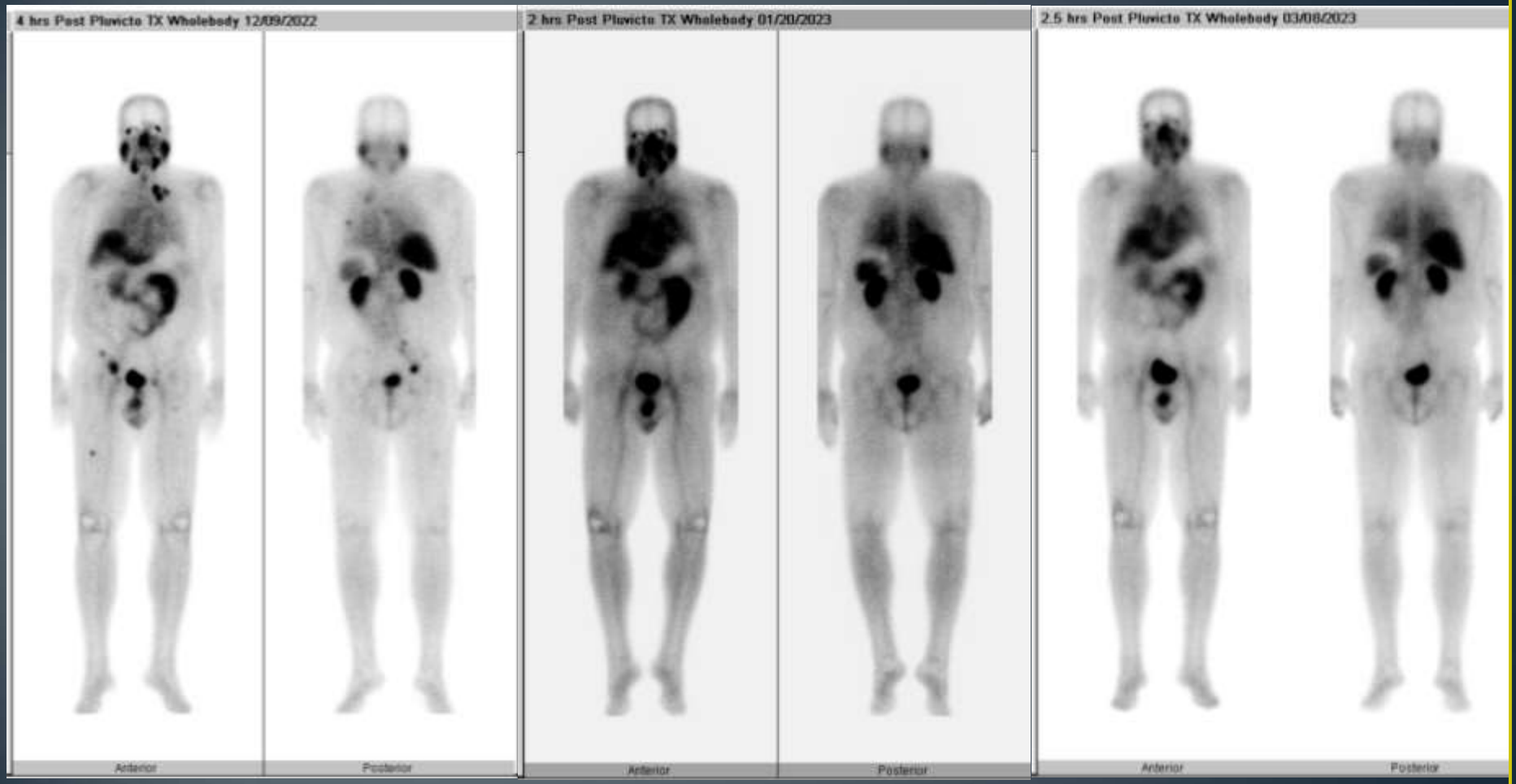
Bone Scan: 9/15/22



Ga68 PSMA: 10/4/22



Pluvicto: 12/9/22


4 hrs Post Pluvicto TX Wholebody 12/09/2022
Anterior
Posterior
2 hrs Post Pluvicto TX Wholebody 01/20/2023
Anterior
Posterior
2.5 hrs Post Pluvicto TX Wholebody 03/08/2023
Anterior
Posterior

PSMA: 7/28/22

Bone Scan: 8/3/22

PSMA: 2/23/22

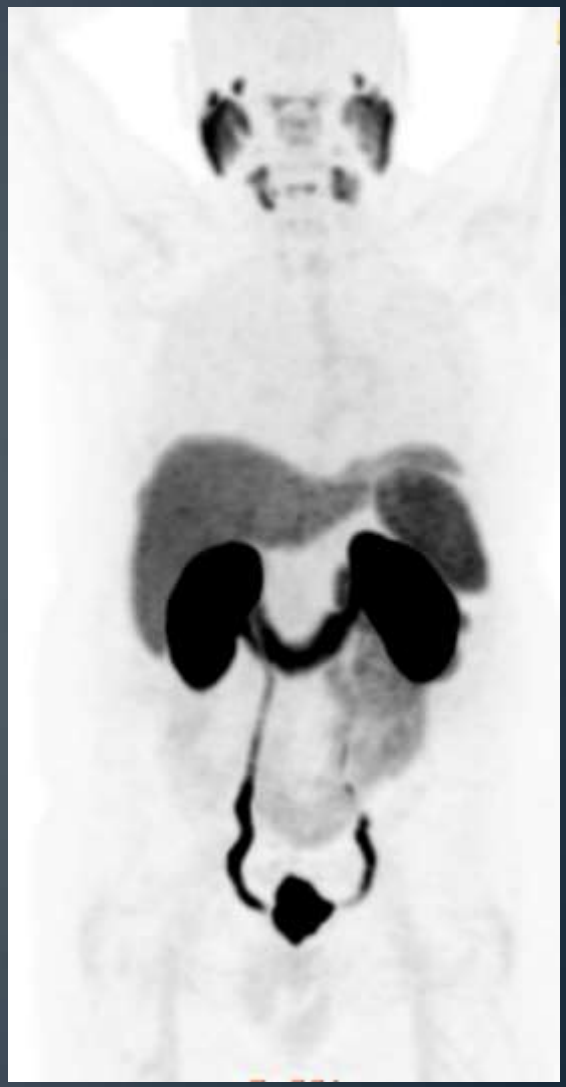
FDG: 2/25/22

PSMA: 10/13/21

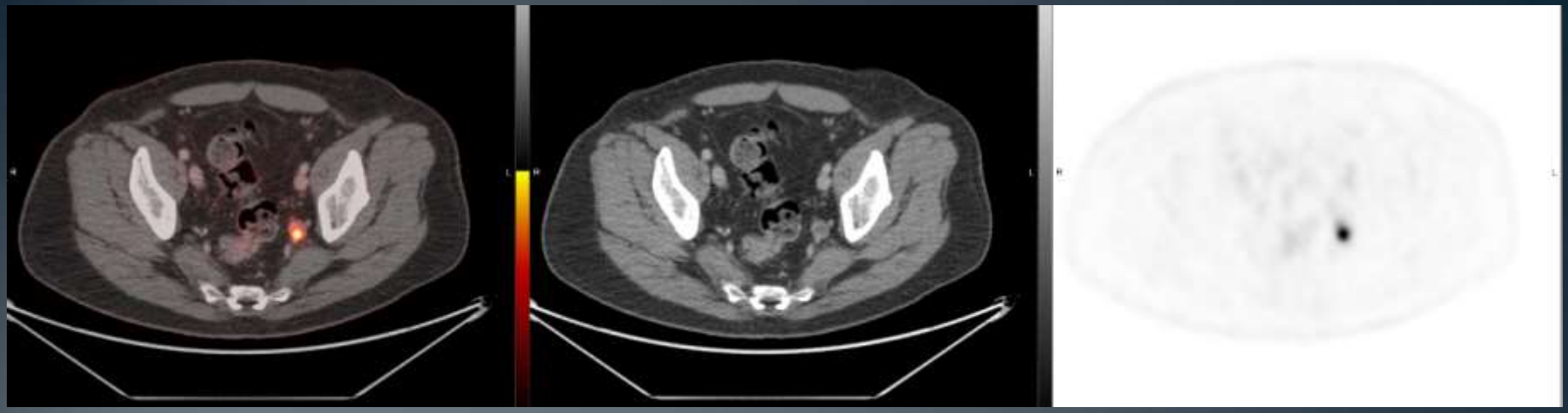
Axumin: 2/04/22

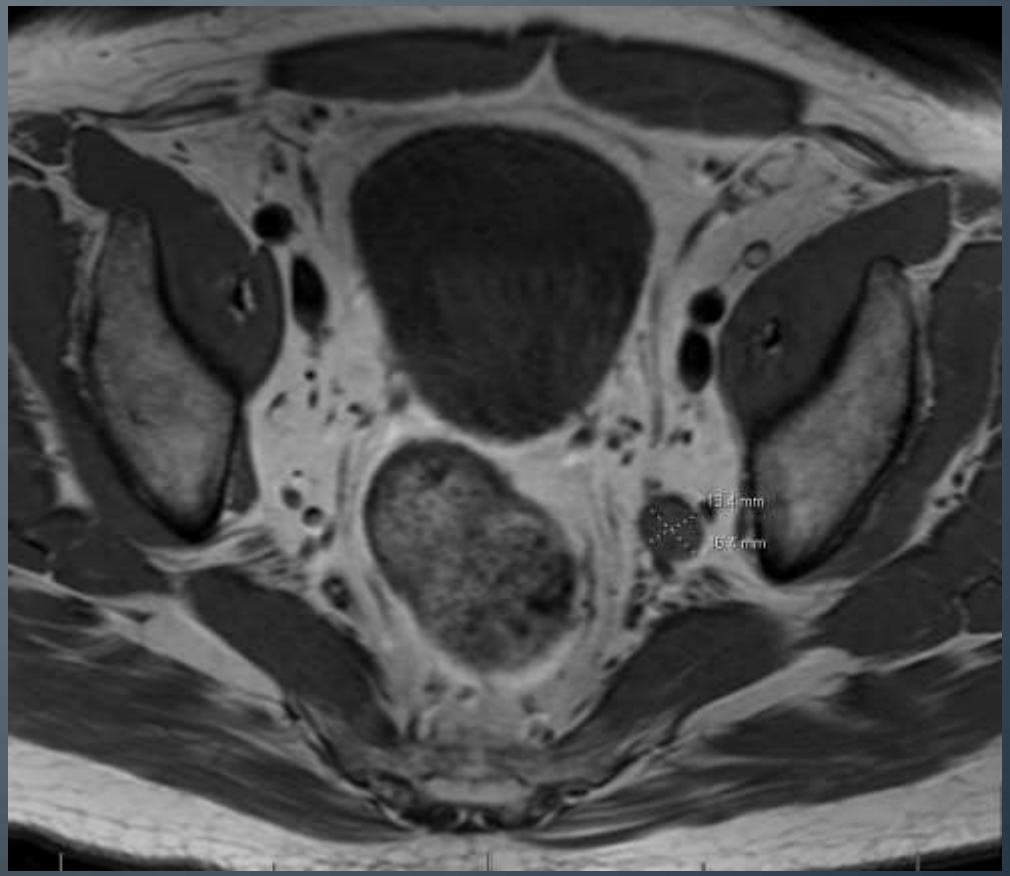
Axumin: 10/11/21

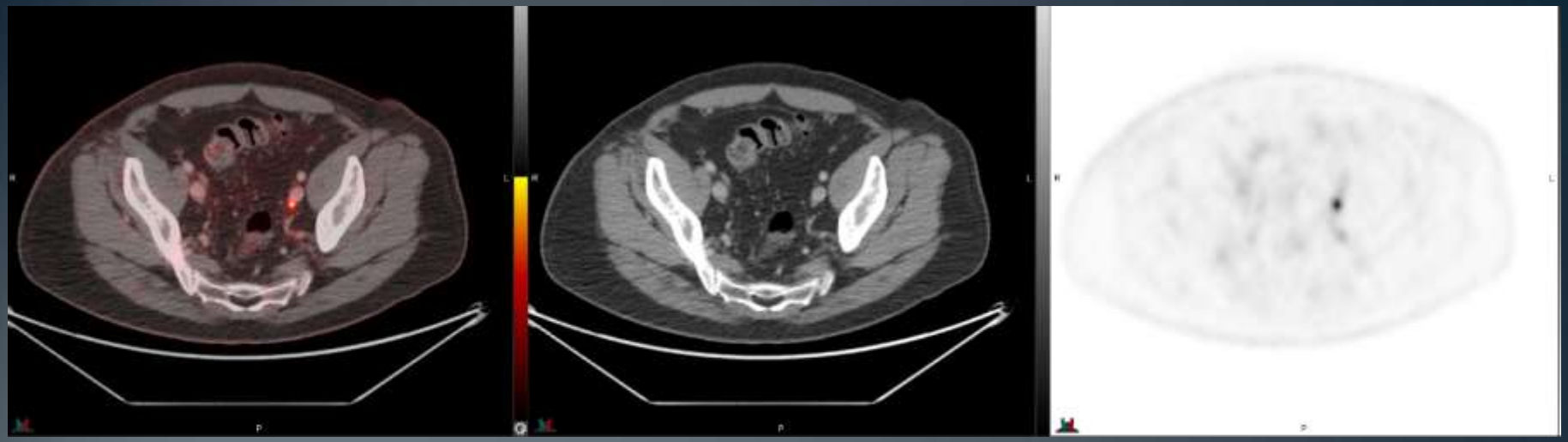
PSMA: 10/14/21

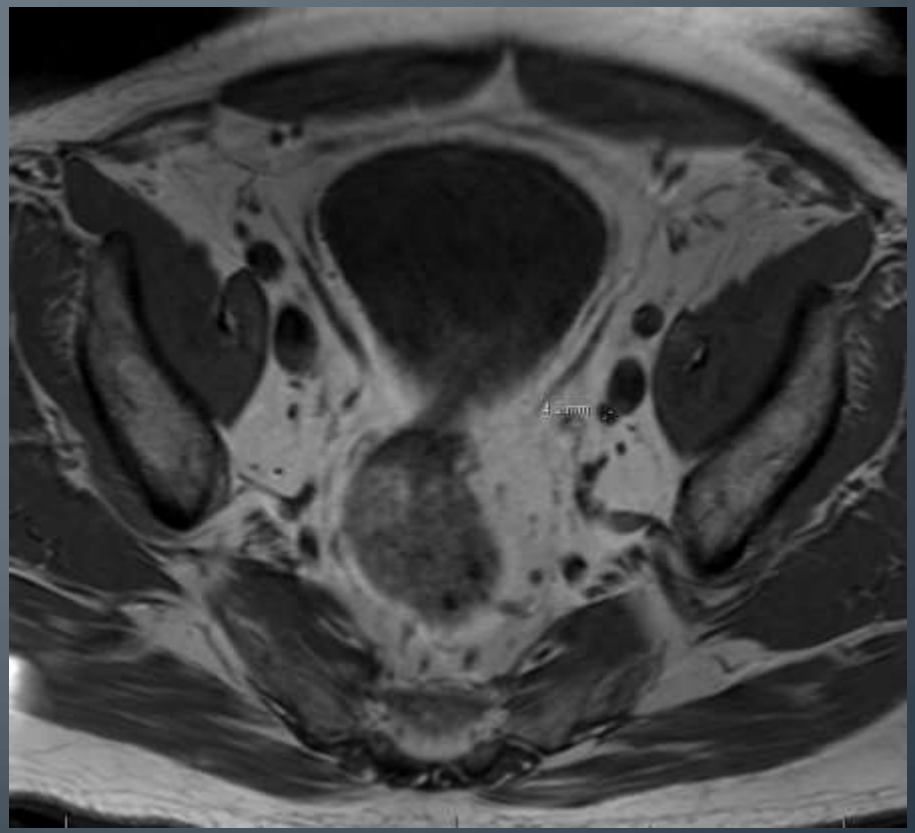


PSMA: 1/10/22







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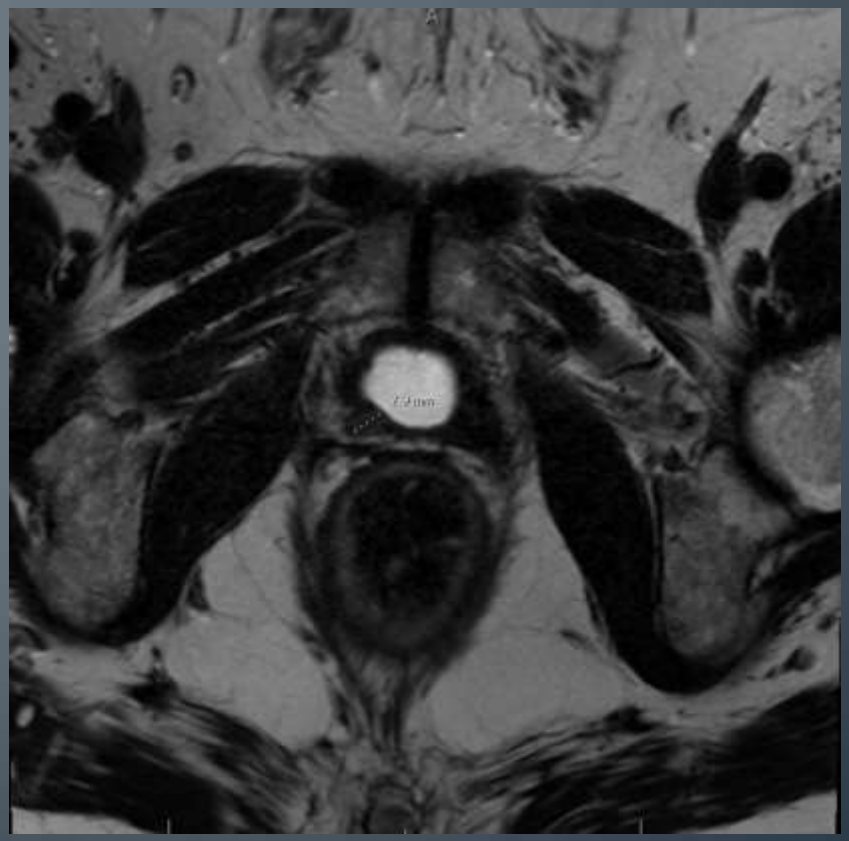

T12 Lesion