

Aberrant vascular anatomy associated with artifactual focal avidity in the liver on PSMA PET

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Abstract: ⁶⁸Ga-PSMA PET/CT is a valuable tool for staging and re-staging of prostate cancer (PCa). PSMA expression is not specific to PCa, as it is expressed in normal tissues as well as in neoplastic and non-neoplastic processes. Awareness of the broad possibility of lesions with PSMA avidity is necessary to recognize normal variants and avoid potential pitfalls in image interpretation. Here, we present a series of cases showing physiologic focal PSMA avidity in hepatic segment IVb. We correlate this uptake with aberrant hepatic vasculature. The awareness of this variant is important for accurate image interpretation in order to prevent additional invasive procedures, undue treatment escalation and denial of curative treatment to patients.

Keywords: Aberrant hepatic vasculature, PSMA PET/CT, Liver segment IV, Artifact, Pitfall

Conflict of Interest: None

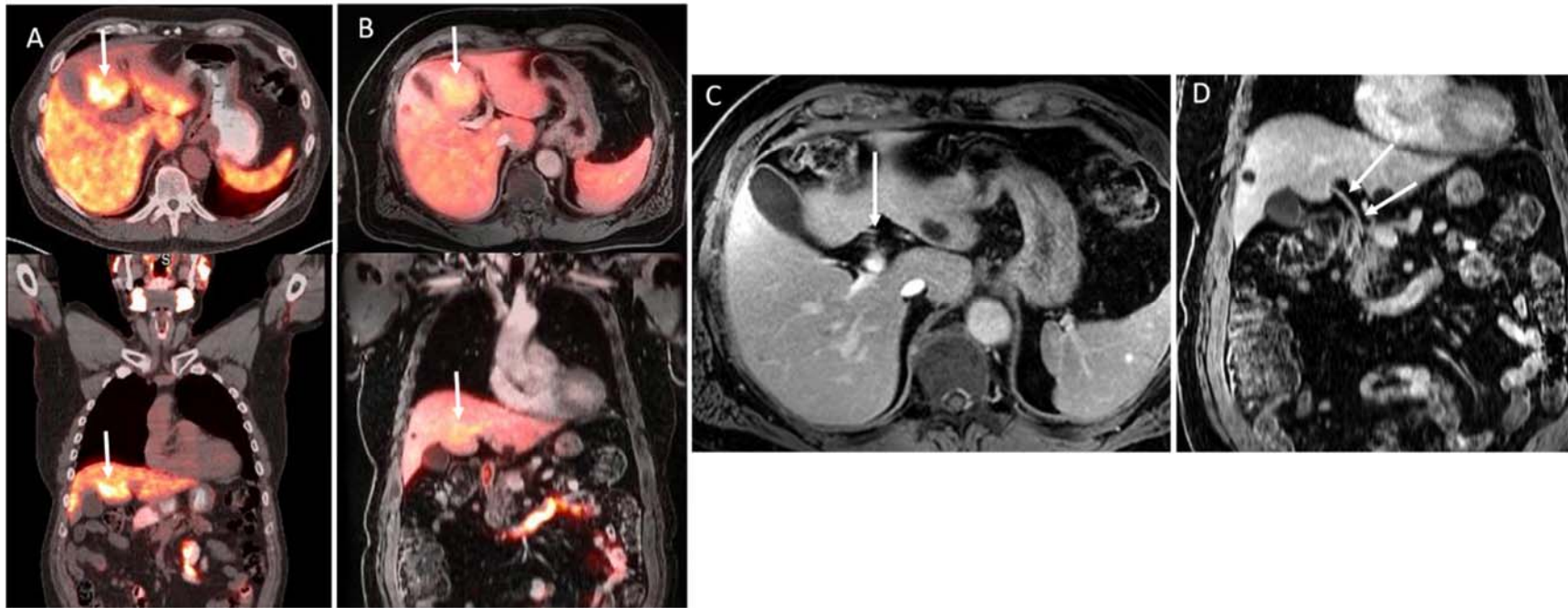


Figure 1. Case 1: A 75-year-old man with prostate cancer (PCa) post radical prostatectomy (Gleason 5+5). ^{68}Ga -PSMA PET/CT (fused trans-axial and coronal PET/CT images - A) done in November 2022 for localizing recurrence at a PSA of 0.57 ng/mL showed focal intense radiotracer avidity in liver segment IVb (arrows) and a solitary site of disease recurrence in L3 vertebra (not shown). A prior ^{18}F -DCFPyL (Pylarify) PET/MR (fused trans-axial and coronal PET/MR images - B) done after post-surgical radiotherapy in March 2022 at a PSA of 0.01 ng/mL also show increased radiotracer accumulation in the same region. Interestingly, review of the MR images showed an aberrant vessel entering hepatic segment IV (arrow; trans-axial MR - C) on axial post-contrast T1FS sequence without any hepatic parenchyma anomaly in the region. The coronal post-contrast T1FS sequence (D) demonstrates the aberrant vessel arising from the duodenum/pancreatic head and terminating within hepatic segment IV (arrows-D). Avidity on PSMA-targeted PET imaging has been widely reported in multiple non-prostate neoplastic, and non-neoplastic conditions, including cancer therapy-related injuries.¹⁻³ PSMA avidity due to aberrant vascular anatomy has not been widely reported. This case highlights many important lessons, including the consistency of this artifactual uptake with different PSMA-targeting radiopharmaceuticals, and across different imaging techniques.

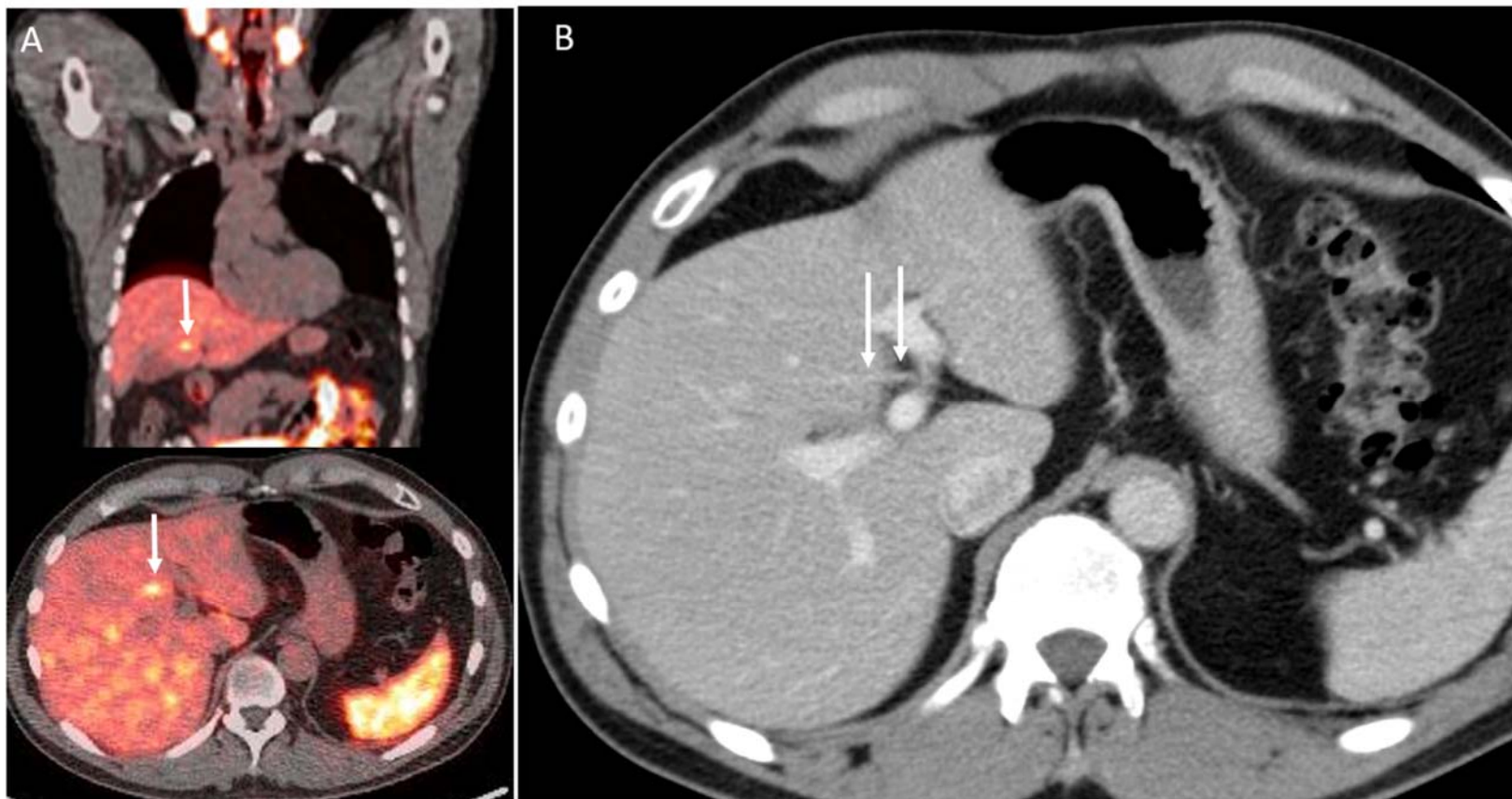


Figure 2. Case 2: A 58-year-old man status post radical prostatectomy for PCa (Gleason 4+3) had ^{68}Ga -PSMA PET/CT for evaluation of biochemical recurrence at a PSA of 0.34 ng/mL. PET/CT did not reveal any site of recurrence but showed mildly increased focal radiotracer avidity at hepatic segment IVb (fused coronal and trans-axial PET/CT image - A). Contrast-enhanced CT (ceCT) done two weeks prior (trans-axial image - B) showed no abnormality in the hepatic parenchyma, but an aberrant vessel entering hepatic segment IV (arrows), similar to case 1. This case supports a pattern of hepatic vascular variant associated with artifactual segment IVb avidity on PSMA PET.

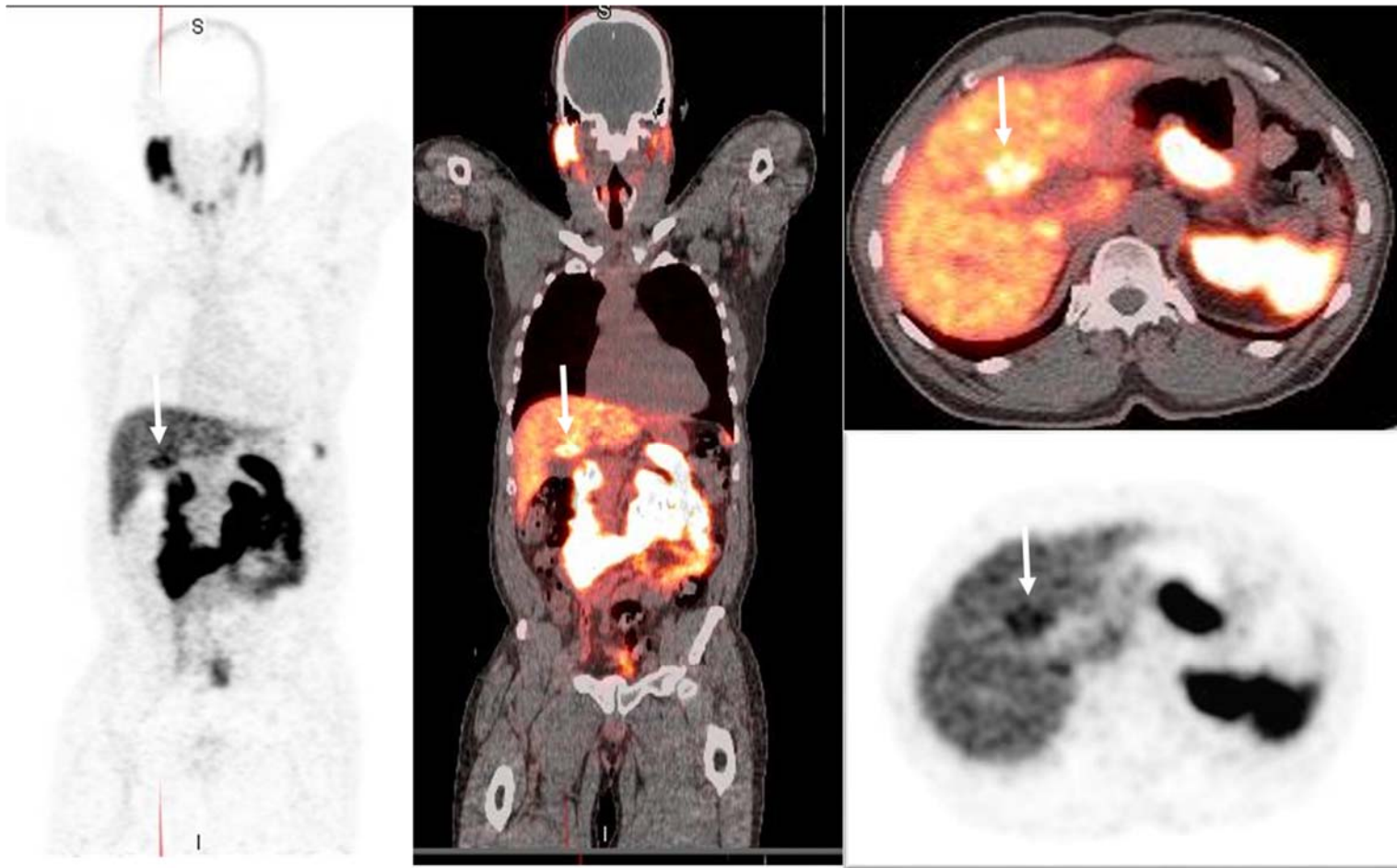


Figure 3. Case 3: A 71-year-old man with a history of PCa (Gleason 3+4) and radical prostatectomy. ^{68}Ga -PSMA PET/CT was obtained and localized PCa recurrence in a left obturator node (not shown) at a PSA of 3.98 ng/mL. An intense area of radiotracer avidity is seen in hepatic segment IVb, similar to the two cases above. No abnormality was seen in hepatic segment IVb on subsequent ceCT. Abdomino-pelvic MRI (not shown) four weeks prior to this PET/CT also did not demonstrate any hepatic lesion. No aberrant vessel could be identified though the study was not optimized for this indication.

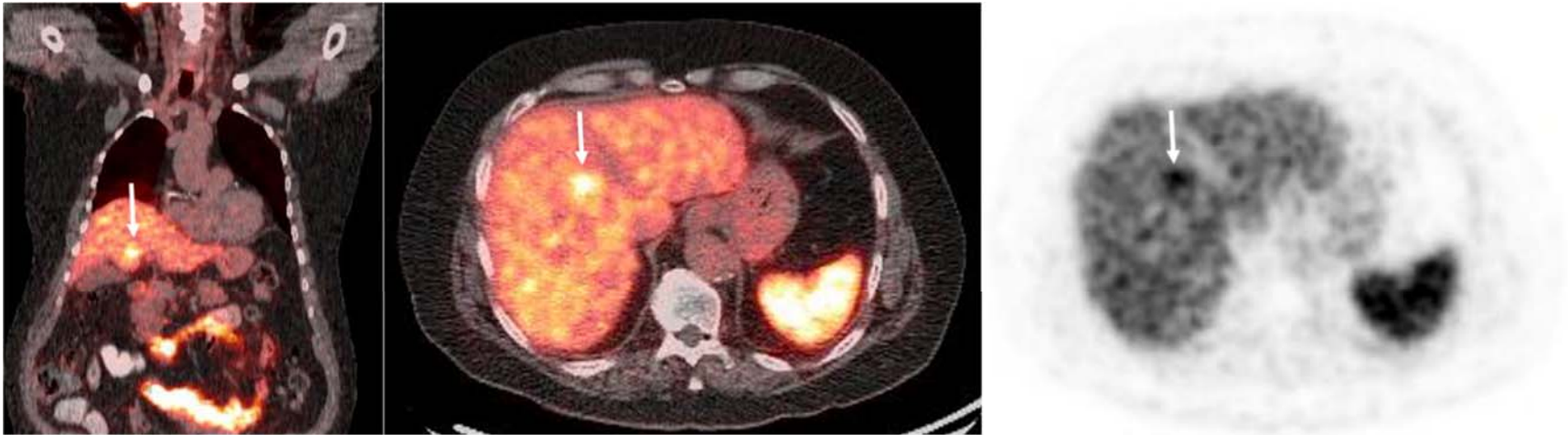


Figure 4. Case 4: Focal hepatic segment IVb radiotracer avidity seen on the ^{68}Ga -PSMA PET/CT imaging of a 74-year-old man with biochemical recurrence of PCa (Gleason 4+5) following radical prostatectomy. PSA was 0.57 ng/mL. A left inferior pubic ramus lesion suspicious for recurrence was seen on PET/CT (not shown). No abnormality in the liver parenchyma was seen on the ceCT (not shown) done two weeks prior to the PET/CT. An aberrant hepatic vasculature was also not identified. A case of focal intense ^{68}Ga -PSMA uptake in hepatic segment II has been previously reported in the literature.⁴ This focal avidity was presumably due to an intra-hepatic vascular malformation and is different from the cases herein presented, which are located in hepatic segment IVb, with at least two associated with an aberrant extra-hepatic vasculature. Muñoz and Fraum recently reported a case of focal avidity on PSMA PET in hepatic segment IVb.⁵ Similar to our cases, they also demonstrated an anomalous vessel piercing the hepatic capsule and entering hepatic segment IV. The hepatic vascular anatomy is unique for its two inflow systems, the portal venous and the hepatic arterial inflow. In some individuals, a third inflow system occurs as a normal variant. The origin of anomalous vascular supply to hepatic segment IV is highly variable.⁶ The third inflow system may cause focal contrast enhancement or radiotracer uptake on imaging, which can be misinterpreted as a neoplastic entity.⁷ ^{18}F -FDG uptake in the liver secondary to vascular obstruction is well known.⁸⁻¹⁰ No vascular obstruction was identified in any of the presented cases. These cases of artifactual focal hepatic avidity on PSMA PET are useful to raise awareness of their likelihood, and their potential to cause image misinterpretation leading to unwanted prostate cancer treatment escalation or denying patients therapy with curative intent. In this era of the application of PSMA PET imaging in hepatocellular carcinoma imaging,^{11,12} awareness of this potential pitfall is vital for the accurate quantification of hepatic tumor burden.

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References

1. Hofman MS, Hicks RJ, Maurer T, et al. Prostate-specific Membrane Antigen PET: Clinical Utility in Prostate Cancer, Normal Patterns, Pearls, and Pitfalls. *Radiographics*. 2018;38:200-217.
2. Lawal IO, Adediran OA, Muzahir S, et al. A Tale of 3 Tracers: Contrasting Uptake Patterns of 18F-Fluciclovine, 68Ga-PSMA, and 18F-FDG in the Uterus and Adnexa. *Clin Nucl Med*. 2023;48:e26-e27.
3. Adediran OA, Lawal IO, Muzahir S, et al. A Discordant Pattern of Uptake on ⁶⁸Ga-PSMA PET/CT Versus 18F-Fluciclovine PET/CT in Radiation-Induced Hepatitis: Implications for Early Postradiotherapy Imaging-Based Response Assessment. *Clin Nucl Med*. Epub ahead of print.
4. Hoberück S, Driesnack S, Seppelt D, et al. Hepatic Vascular Malformation Mimics PSMA-Positive Prostate Cancer Metastasis. *Clin Nucl Med*. 2020;45:e283-e284.
5. Muñoz GC, Fraum TJ. Aberrant right gastric vein mimicking hepatic spread of prostate cancer on PSMA PET/CT. *Radiol Case Rep*. 2023;18:1140-1143.
6. Jin GY, Yu HC, Lim HS, et al. Anatomical variations of the origin of the segment 4 hepatic artery and their clinical implications. *Liver Transpl*. 2008;14:1180-1184.
7. Elsayes KM, Shaaban AM, Rothan SM, et al. A Comprehensive Approach to Hepatic Vascular Disease. *Radiographics*. 2017;37:813-836.
8. Huot Daneault A, Le Blanc R, Voyer N, et al. Focal Liver 18F-FDG Uptake in a Patient Who Underwent Thrombolysis for Brachiocephalic and Subclavian Thrombosis: A Potential Pitfall. *Clin Nucl Med*. 2021;46:e173-e175.
9. Chan TK, Kung BT, Au Yong TK, et al. Re: Focal Liver 18F-FDG Uptake in a Patient Who Underwent Thrombolysis for Brachiocephalic and Subclavian Thrombosis: A Potential Pitfall. *Clin Nucl Med*. 2022;47:e381-e382.
10. Jundt MC, Broski SM, Binkovitz LA. 18F-FDG PET/CT Equivalent of the Hepatic Hot Spot Sign With CT Correlation. *Clin Nucl Med*. 2018;43:e147-e148.
11. Lu Q, Long Y, Fan K, Shen Z, Gai Y, Liu Q, Jiang D, Cai W, Wan C, Lan X. PET imaging of hepatocellular carcinoma by targeting tumor-associated endothelium using [⁶⁸Ga]Ga-PSMA-617. *Eur J Nucl Med Mol Imaging*. 2022;49:4000-4013.
12. Hirmas N, Leyh C, Sraieb M, et al. ⁶⁸Ga-PSMA-11 PET/CT Improves Tumor Detection and Impacts Management in Patients with Hepatocellular Carcinoma. *J Nucl Med*. 2021;62:1235-1241.