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Case report

Incidental prostate-specific membrane antigen-avid meningioma detected on ⁶⁸Ga-prostate-specific membrane antigen PET/CT ☆,☆☆

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ARTICLE INFO

Article history:

Received 3 August 2021

Revised 5 August 2021

Accepted 6 August 2021

Keywords:

⁶⁸Ga-PSMA

Meningioma

PET/CT

MRI

ABSTRACT

A 70-year-old gentleman with a history of Gleason score 7 (3 + 4) prostate adenocarcinoma was treated with radical prostatectomy with clear surgical margins. Postoperatively his prostate specific antigen was undetectable. However, his prostate specific antigen was slowly rising and he was referred for a ⁶⁸Galium-Prostate Specific Membrane Antigen (PSMA) PET/CT scan. Findings were suggestive of local prostatic cancer recurrence with no evidence of nodal or distant metastasis. An incidental PSMA avid focus was noted in the left frontal lobe, inseparable from the left frontal bone laterally. Subsequent MRI findings were consistent with meningioma. Meningioma is the most common primary brain tumor and may be a cause of false positive prostate cancer metastasis due to ⁶⁸Ga-PSMA uptake.

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Introduction

Prostate-specific membrane antigen is a transmembrane protein, which is highly expressed in prostate carcinoma cells. PSMA is also expressed in various other organs such as the kidney, proximal small intestine, lacrimal glands,

salivary glands, liver, and spleen. As PSMA is also expressed in the endothelial cells of tumor vascular endothelium, other benign and malignant lesions can also demonstrate ⁶⁸Ga-PSMA uptake. We present a case of meningioma showing ⁶⁸Ga-PSMA uptake, in a patient with recurrent prostate adenocarcinoma with no nodal or distant metastatic disease.

☆ Acknowledgments: None.

☆☆ Competing Interests: None.

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<https://doi.org/10.1016/j.radcr.2021.08.014>

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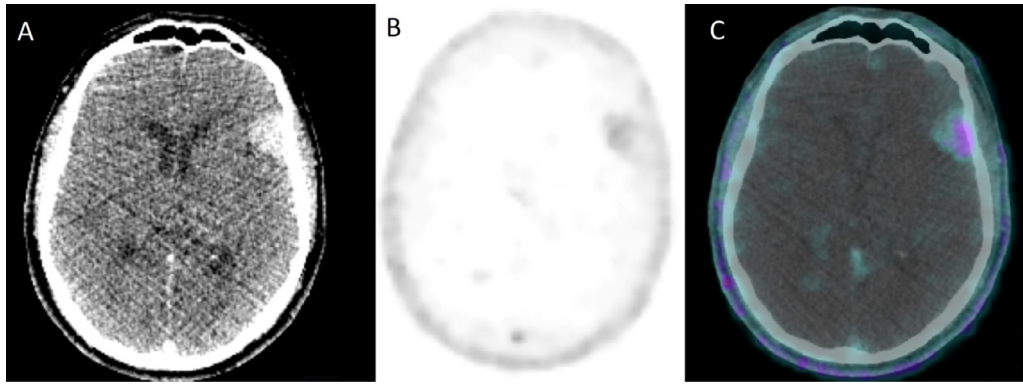


Fig. 1 – Axial low dose CT (A), ^{68}Ga -PSMA PET (B), fused PET/CT (C) demonstrates PSMA avid lesion that is hyper-dense compared to brain parenchyma in the left sylvian fissure.

Case report

A 70-year-old-gentleman with a background history of hypercholesterolemia, glucose intolerance, hypertension and osteoarthritis underwent robotic radical prostatectomy for a Gleason score $3 + 4 = 7$ prostate cancer. This was confined to the prostate gland with no extracapsular or seminal vesicle extension and the surgical margin was narrow but clear of tumor. Following prostatectomy, he had urinary incontinence which was subsequently treated with a sling procedure.

His postoperative prostate specific antigen (PSA) was $< 0.01 \mu\text{g/L}$ ($0.3 - 5.5 \mu\text{g/L}$) and monitored every 6-12 months which fluctuated at low levels ($0.01-0.02 \mu\text{g/L}$) for 3 years. His PSA level started to rise slowly and measured $0.05 \mu\text{g/L}$ at 36 months, $0.08 \mu\text{g/L}$ at 42 months, $0.12 \mu\text{g/L}$ at 51 months and $0.19 \mu\text{g/L}$ at 58 months with a doubling time of approximately 12 months. He was otherwise well and denied any symptoms of concern.

He was referred for ^{68}Ga -PSMA PET/CT scan for evaluation which showed a PSMA avid soft tissue nodule in the right prostatic bed with a SUVmax of 13.8 and was highly suspicious for local recurrence of prostate malignancy. There was no other PSMA avid metastasis identified. An incidental PSMA avid lesion was noted in the left frontal lobe laterally (SUVmax 2.0) (Fig. 1A-C). He underwent MRI scan of the brain to further investigate the PSMA avid lesion in the left frontal lobe which demonstrated a solid lesion centred on the left sylvian fissure anteriorly with signal intensity similar to grey matter in T1-weighted pre-contrast images (Fig. 2A). The lesion was hyper-intense relative to grey matter on T2/FLAIR images (Figure 2E-G) and there was relatively homogenous enhancement following administration of contrast (Figs. 2B and C). There was evidence of white matter buckling, cerebral spinal fluid cleft and a dural tail which is consistent with a diagnosis of meningioma. There was also an underlying calcification seen on the susceptibility weight images. There was no abnormal signal in the adjacent brain parenchyma or cranium. The patient subsequently received salvage radiotherapy to the prostate bed which substantially improved his PSA to $0.02 \mu\text{g/L}$.

Discussion

Meningiomas are extra-axial brain tumors and represent the most common primary brain primary central nervous system tumor, accounting for around 1/3 of all primary brain and central nervous system tumors. ^{1, 2} Meningioma can be diagnosed due to their characteristic appearance on MRI. The typical MRI signal intensity characteristics consist of isointensity to slight hypointensity relative to grey matter on T1-weighted sequence and isointensity to slight hyperintensity relative to grey matter on the T2 sequence. After intravenous contrast administration, meningiomas typically demonstrate homogeneous contrast enhancement [3,4].

PSMA is a transmembrane protein highly expressed in prostate carcinoma cells and is also expressed in the kidney, proximal small intestine, lacrimal glands, salivary glands, liver, and spleen [4]. Previous studies suggest that ^{68}Ga -PSMA PET/CT has favorable sensitivity and specificity in the detection of prostatic metastases even at low PSA levels [5,6]. However, PSMA expression and uptake has also been reported in several other conditions, including normal nonprostatic epithelial cells, inflammation, nonprostatic neoplastic cells and nonprostatic tumor-associated neovasculature [7,8]. PSMA expression in non-prostatic solid tumors maybe attributed to expression in vascular endothelium in tumor neovasculature, hence various malignant lesions such as renal cell carcinoma, lymphoma, thyroid cancer, rectal cancer, lung cancer as well as gastric and colorectal cancers have been reported to show high uptake of PSMA [9-14].

PSMA uptake within various inflammatory, infectious and neoplastic brain lesions have also been described in neurocysticercosis, cerebral tuberculosis, cerebral infarct, breast cancer metastasis, prostate cancer metastases, and glioblastoma [15-19]. PSMA uptake in these lesions is likely to be caused by PSMA expression related to tumor neoangiogenesis and breakdown of the blood-brain barrier [20]. In routine PSMA imaging, normal brain parenchyma does not demonstrate significant PSMA uptake which provides a suitable background and contributes to the sensitivity for the detection of these various brain pathologies. ^{17,20} Our case report adds to the

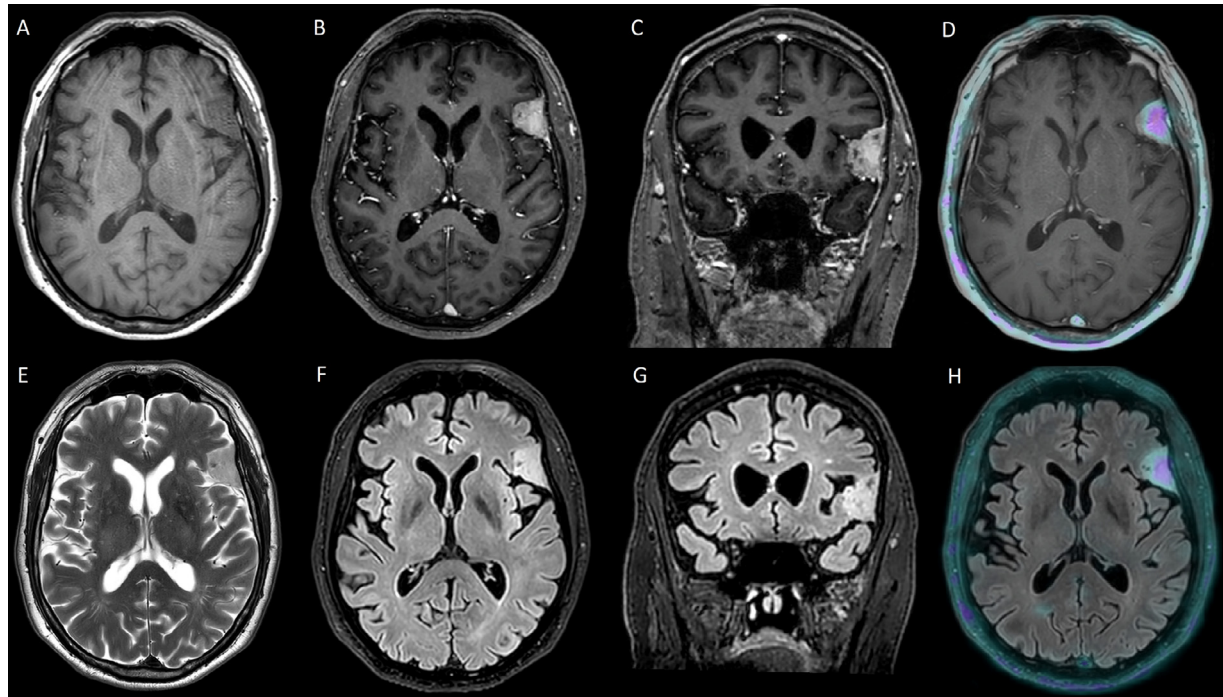


Fig. 2 – Axial MRI images shows a solid extra-axial lesion with signal intensity similar to grey matter in T1-weight precontrast images (A) and hyper-intense to grey matter on T2 (E) and FLAIR images (axial F, coronal G). On T1-weight post-contrast images, it demonstrates relatively homogenous enhancement (axial B, coronal C). Fused PSMA PET and T1-weighted post-contrast image (D) and FLAIR (H) shows PSMA uptake in the extra-axial lesion. There is evidence of white matter buckling, cerebral spinal fluid cleft and dural tail which is consistent with a diagnosis of meningioma.

existing literature of cases of meningioma showing ^{68}Ga -PSMA uptake [[21–24]].

Conclusion

Non-prostatic diseases exhibiting PSMA uptake on PET are becoming more recognized which illustrates that PSMA uptake is in fact not prostate-specific and can be taken up physiologically and pathologically in other conditions. Although brain metastases from prostate cancer are uncommon, PSMA uptake in the brain should be interpreted with caution and differentiation between metastatic prostate cancer and other inflammatory, benign or malignant brain neoplasms is essential. Correlation with further radiological modalities such as MRI or CT should be considered.

Patient consent

Patient Informed consent and permission obtained.

REFERENCES

- [1] Wiemels J, Wrensch M, Claus EB. Epidemiology and etiology of meningioma. *J Neurooncol* 2010;99:307–14.
- [2] Kunimatsu A, Kunimatsu N, Kamiya K, Katsura M, Mori H, Ohtomo K. Variants of meningiomas: a review of imaging findings and clinical features. *Jpn J Radiol* 2016;34:459–69.
- [3] Watts J, Box G, Galvin A, Brotchie P, Trost N, Sutherland T. Magnetic resonance imaging of meningiomas: a pictorial review. *Insights Imaging* 2014;5(1):113–22.
- [4] Afshar-Oromieh A, Malcher A, Eder M, Eisenhut M, Linhart H, Hadaschik B, et al. PET imaging with a [^{68}Ga]gallium-labelled PSMA ligand for the diagnosis of prostate cancer: biodistribution in humans and first evaluation of tumour lesions. *Eur J Nucl Med Mol Imaging* 2013;40:486–95.
- [5] Eiber M, Maurer T, Souvatzoglou M, Beer A, Ruffani A, Haller B, et al. Evaluation of hybrid (^{68}Ga)-PSMA ligand PET/CT in 248 patients with biochemical recurrence after radical prostatectomy. *J Nucl Med* 2015;56:668–74.
- [6] Perera M, Papa N, Christidis D, Wetherell D, Hofman M, Murphy D, et al. Sensitivity, specificity, and predictors of positive ^{68}Ga -prostate-specific membrane antigen positron emission tomography in advanced prostate cancer: a systematic review and meta-analysis. *Eur Urol* 2016;70(6):926–37.
- [7] de Galiza, Barbosa F, Queiroz MA, Nunes RF, Costa LB, Zaniboni EC, et al. Nonprostatic diseases on PSMA PET imaging: a spectrum of benign and malignant findings. *Cancer Imaging* 2020;20(1):23.
- [8] Shetty D, Patel D, Le K, Bui C, Mansberg R. Pitfalls in Gallium-68 PSMA PET/CT interpretation—a pictorial review. *Tomography* 2018;4(4):182–93.
- [9] Rowe SP, Gorin MA, Hammers HJ, Javadi MS, Hawasli H, Szabo Z, et al. Imaging of metastatic clear cell renal cell carcinoma with PSMA-targeted ^{18}F -DCFPyL PET/CT. *Ann Nucl Med* 2015;29:877–82.

- [10] Kanthan GL, Coyle L, Kneebone A, Schembri G, Hsaio E. Follicular lymphoma showing avid uptake on 68Ga PSMA-HBED-CC PET/CT. *Clin Nucl Med* 2016;41:500–1.
- [11] Taywade SK, Damle NA, Bal C. PSMA expression in papillary thyroid carcinoma: opening a new horizon in management of thyroid cancer? *Clin Nucl Med* 2016;41:e263–5.
- [12] Huang YT, Fong W, Thomas P. Rectal carcinoma on 68Ga-PSMA PET/CT. *Clin Nucl Med* 2016;41:e167–8.
- [13] Shetty D, Loh H, Bui C, Mansberg R, Stevanovic A. Elevated 68Ga prostate-specific membrane antigen activity in metastatic non-small cell lung cancer. *Clin Nucl Med* 2016;41:414–16.
- [14] Haffner MC, Kronberger IE, Ross JS, Sheehan CE, Zitt M, Mühlmann Gilbert, et al. Prostate-specific membrane antigen expression in the neovasculature of gastric and colorectal cancers. *Hum Pathol* 2009;40:1754–61.
- [15] Vadi SK, Kumar R, Singh H, Singh S, Mittal B. 68Ga-prostate-specific membrane antigen expression in Neurocysticercosis lesions in a patient with prostate carcinoma. *Clin Nucl Med* 2018;43:e122–4.
- [16] Wong VCK, Shen L, Nasser E, Adams DN, Mansberg R. 68Ga-prostate-specific membrane antigen uptake in cerebral tuberculosis. *Clin Nucl Med* 2020;45(3):238–40.
- [17] Noto B, Vrachimis A, Schäfers M, Stegger L, Rahbar K. Subacute stroke mimicking cerebral metastasis in 68Ga-PSMA-HBED-CC PET/CT. *Clin Nucl Med* 2016;41(10):e449–51.
- [18] Salas Fragomeni RA, Amir T, Sheikhabahaei S, Harvey SC, Javadi MS, Solnes LB, et al. Imaging of non-prostate cancers using PSMA-targeted radiotracers: rationale, current state of the field and a call to arms. *J Nucl Med* 2018;59:871–7.
- [19] Nomura N, Pastorino S, Jiang P, Lambert G, Crawford J, Gymnopoulos M, et al. Prostate specific membrane antigen (PSMA) expression in primary gliomas and breast cancer brain metastases. *Cancer Cell Int* 2014 Mar 20;14(1):26.
- [20] Mahzouni P, Shavakhi M. Prostate-specific membrane antigen expression in neovasculature of glioblastoma multiforme. *Adv Biomed Res* 2019;8:18.
- [21] Sasikumar A, Joy A, Pillai MRA, et al. Diagnostic value of 68Ga PSMA-11 PET/CT imaging of brain tumors—preliminary analysis. *Clin Nucl Med* 2017;42:e41–8.
- [22] Bilgin R, Ergül N, Çermik TF. Incidental meningioma mimicking metastasis of prostate adenocarcinoma in 68Ga-Labeled PSMA ligand PET/CT. *Clin Nucl Med* 2016;41:956–8.
- [23] Gupta N, Verma R, Belho ES. Prostate-specific membrane antigen-avid meningioma detected in 68Ga-prostate-specific membrane antigen PET/CT. *Clin Nucl Med* 2020;45:692–3.
- [24] Junqueira MZ, Rocha NH, Sapienza MT. 68Ga-prostate-specific membrane antigen PET/CT uptake in intraventricular meningioma in the choroid plexus. *Clin Nucl Med* 2021;46:58–9.