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Investigation of Potential Splenic Metastasis on Prostate-Specific Membrane Antigen (PSMA) Imaging in High-Risk Prostate Cancer: A Role for MRI?

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Carson H. Neal [1], Matthew D. Miller [2], Chance L. Matthiesen [3]

1. Radiation Oncology, Kansas City University, Joplin, USA 2. Hematology/Oncology, Freeman Health System, Joplin, USA 3. Radiation Oncology, Freeman Health System, Joplin, USA

Corresponding author: Carson H. Neal, carson.neal21@gmail.com

Abstract

Computed tomography (CT), magnetic resonance imaging (MRI), and bone scintigraphy are utilized to diagnose and stage prostate cancer. There is a growing interest in the utilization of prostate-specific membrane antigen-positive emission tomography (PSMA PET) scans for the diagnosis and monitoring of prostate cancer. Here, we present a case of biopsy-proven prostate cancer with solitary focal splenic uptake on PSMA PET initially concerning for splenic metastasis. Further imaging with MRI indicated a benign splenic etiology in this case. The patient underwent radiation therapy (RT) and initiated two years of androgen deprivation therapy (ADT) for high-risk localized prostate adenocarcinoma. The patient's prostate-specific antigen (PSA) level decreased from a peak of 93.6 to 0.165 following treatment. Repeat PSMA PET scan three months post-radiation demonstrated no change in the splenic lesion despite decreased PSA. This case suggests that benign splenic lesions can demonstrate PSMA uptake on imaging and should be considered in cases of PSMA focal uptake in the spleen. This is significant because the presence of true metastases on PSMA PET scan significantly changes treatment recommendations for the patient. Further evaluation of benign findings that demonstrate PSMA avidity and appropriate follow-up testing for confirmation is necessary to avoid harmful overtreatment of patients.

Categories: Radiology, Radiation Oncology, Oncology
Keywords: mri, prostate cancer, psa, psma pet, radiation therapy, splenic metastasis

Introduction

Prostate cancer is the most common cancer in men in the United States, with the exception of skin cancer [1]. There were an estimated 299,010 new cases in 2024, comprising 14.9% of new cancer cases. Despite its high prevalence, prostate cancer was only responsible for an estimated 5.8% of cancer deaths, correlating to a five-year relative survival rate of 97.5% [2].

Approximately 95% of prostate cancers are adenocarcinoma [3]. Prostate adenocarcinoma is often localized and asymptomatic at the time of diagnosis, but symptoms include nonspecific lower urinary tract symptoms, hematuria, hematospermia, or bone pain from metastasis [4]. At the time of diagnosis, prostate cancer is localized in 78% of patients, 12% have regional lymph node involvement, and only 6% have distant metastases [4]. The most common site of metastasis is bone, followed by distant lymph nodes, liver, and thorax [5].

Prostate-specific membrane antigen (PSMA) PET scan is a more recent form of prostate cancer imaging. PSMA is a cell surface receptor that internalizes bound antibodies or particles, including imaging agents that can be visualized on a PET scan. PSMA is expressed in 95% of prostate cancers and provides good tumor localization [6]. PSMA PET has demonstrated a higher sensitivity and specificity than abdominal CT and MRI for nodal staging [7]. It has also been shown to be 27% more accurate than conventional imaging (bone scintigraphy) for bone metastases, with a higher sensitivity and specificity [7]. There are currently two main tracers utilized in PSMA PET scans, ^{68}Ga and ^{18}F, that produce similar results overall [8].

PSMA uptake is known to be observed normally in many benign and physiologic tissues, such as, but not limited to, salivary glands, urinary tract, bladder, kidneys, and bowel, which presents one of the limitations of this form of imaging [9]. ^{18}F-PSMA-1007 has demonstrated uptake in various ganglia, occurring in up to 67% of patients, which could be mistaken for involved lymph nodes [10]. Non-specific bone uptake is also common, which can be mistaken for bone metastasis [10]. PSMA uptake is present in many other non-prostatic malignancies, including renal cell carcinoma, bladder transitional cell carcinoma, colonic carcinoma, glioblastoma multiforme, metastatic breast cancer, and myeloma [10,11]. ^{18}F-PSMA PET has a significantly higher rate of PSMA uptake in benign lesions, almost five times more than ^{68}Ga-PSMA PET [10]. Uptake has been demonstrated in thyroid adenoma, rib fractures, Paget's disease, meningioma,

peripheral nerve sheath tumors, schwannomas, sarcoidosis, liver and bone hemangiomata, and benign soft-tissue lesions [10,11]. The given number of known PSMA-avid false-positive tissues suggests that with continued widespread usage for the evaluation of prostate cancer, other prior and unknown etiologies will register similar PSMA uptake patterns, which also are false-positives in regard to prostate cancer [11].

Here, we present a case of high-risk prostate cancer with a PSMA-avid splenic lesion on PSMA PET imaging. The splenic lesion required classification to stage the prostate cancer and guide appropriate treatment recommendations.

Case Presentation

A 67-year-old male patient presented for investigation of a significantly elevated prostate-specific antigen (PSA) level from prior measurements many years prior. He was noted to have elevated PSA levels, approximately 10 years prior, ranging from 25 to 29 ng/mL. This prompted initial workup and biopsy of the prostate, which returned negative for carcinoma. He continued to follow-up after the biopsy with PSA levels, which remained consistent with previous values, but then was lost to follow-up for approximately 10 years. At re-presentation with his primary care physician without symptomatic concerns, PSA was drawn and noted to be very elevated at 74.9 ng/mL. Confirmatory repeat PSA was performed again three weeks later when it showed a dramatic increase to 93.6 ng/mL. This was despite the patient having no symptoms and a continued normal digital rectal examination, prompting repeat referral to urology for evaluation. MRI prostate was performed, which showed an approximate 38 mL gland size with a Prostate Imaging Reporting and Data System (PI-RADS) category 5 lesion present in the left transition zone, as well as anterior capsular bulging concerning for extra-prostatic extension. Twelve core needle biopsies were performed via trans-rectal ultrasound of the gland, sampling bilaterally the base, mid, and apex of each gland side medially and laterally. This produced the diagnosis of prostate adenocarcinoma. More specifically, regarding biopsy pathology, at the left apex, (2/2) cores were positive for adenocarcinoma, Gleason 7(3+4). The left mid-gland showed (1/2) cores positive for adenocarcinoma, Gleason 7(4+3). The left apex showed (1/2) cores positive for adenocarcinoma, Gleason 7(4+3). All other sampled cores were benign.

The patient underwent ^{18}F-PSMA-PET scan to evaluate for metastasis. The PET scan demonstrated localized uptake in the prostate with an additional 1.4 cm focus in the spleen (Figures *1*, *2*). No other metastases were noted on the PET scan.



FIGURE 1: MIP PSMA PET scan showing splenic radiotracer uptake.

Maximum Intensity Projection (MIP) PSMA PET scan demonstrated expected physiologic accumulation of radiotracer in the salivary glands, lacrimal glands, liver, spleen, and kidneys. Focal uptake in the lateral aspect of the spleen is denoted by the circle.

PSMA PET: Prostate-specific membrane antigen-positive emission tomography.

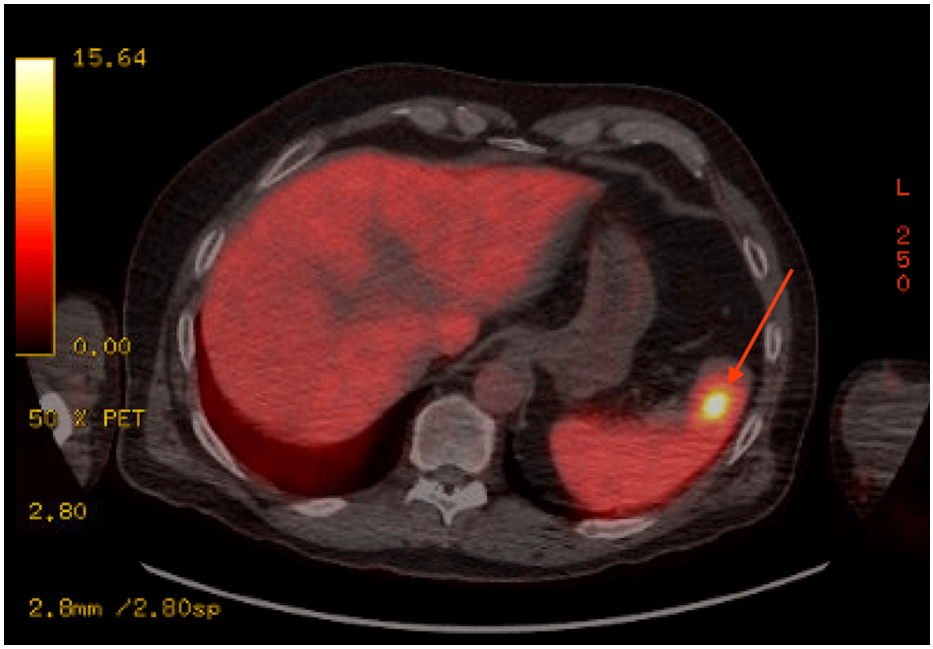


FIGURE 2: Axial PSMA PET demonstrating radiotracer avid splenic lesion.

Axial-blended PSMA PET imaging showing an intensely avid 14 mm focal lesion in the lateral aspect of the spleen, denoted by the arrow. Lower-intensity physiologic uptake is noted in the liver and remainder of the spleen.

PSMA PET: Prostate-specific membrane antigen-positive emission tomography.

Given the PET findings, there was concern for an atypical solitary splenic metastasis. Additional imaging and sampling options were discussed in order to guide appropriate treatment. CT-guided biopsy of the splenic lesion was discussed to rule out metastasis, but interventional radiology stated splenectomy would be the only safe option for tissue sampling. Literature review indicated MRI as an appropriate modality to evaluate for benign etiologies [10], so MRI of the abdomen with and without contrast was performed. The results of the MRI of the abdomen demonstrated a subtle focal mild enhancement of the left lateral aspect of the spleen, measuring 12 mm, corresponding to PSMA PET/CT finding. A benign etiology such as hemangioma was favored by the radiologist's interpretation (Figure 3).



FIGURE 3: MRI imaging demonstrating benign lesion of the spleen.

MRI without contrast performed to assess metastatic potential of the splenic lesion. The report described a 12-mm enhancing nodule of the lateral spleen, denoted by the circle, favoring a benign etiology.

The imaging results were deemed sufficient for radiologic diagnosis of benign etiology in the spleen versus metastasis. The patient was diagnosed with localized prostatic adenocarcinoma with high-risk classification. He began curative treatment with radiation therapy (RT) and two years of androgen deprivation therapy (ADT). The patient was treated with intensity-modulated radiation therapy (IMRT) planning techniques. Treatment was delivered utilizing a Varian TrueBeam linear accelerator (Varian Medical Systems, Palo Alto, CA). Treatment delivery was delivered via RapidArc treatment delivery with Varian Eclipse treatment planning software (Varian Medical Systems, a Siemens Healthineers company, Palo Alto, CA). Contouring was performed in Eclipse after patient simulation utilizing a vac-loc and 2.5-mm CT scan slices. The prostate gland and seminal vesicles were contoured at a clinical target volume (CTV) 1, and the pelvic lymph nodes were contoured as CTV2. Expansions of CTV to planned target volume (PTV) were 7 mm expansions for pelvic lymph node PTV and 8 mm expansion for prostate/seminal vesicles for PTV1. Dose and fractionation were 1.8 Gy×28 fractions to the pelvic lymph nodes for PTV2, and 2.25 Gy per fraction×28 fractions to the prostate and seminal vesicles for PTV1. Treatment was planned utilizing a simultaneous integrated boost technique. Spacegel placement was performed prior to simulation to enhance rectal separation. The final dose-volume histogram analysis showed at least 95% of the patient's PTV receiving at least 95% of the planned prescription dose for both target volumes. All normal tissue constraints were within appropriate tolerance levels as per the quantitative analyses of normal tissue effects in the clinic (QUANTEC) data.

After IMRT completion, repeat PSA levels at one, three and six months post RT completion were 0.165 ng/mL, 0.162 ng/mL, and 0.137 ng/mL, respectively. Repeat PSMA PET scan performed three months after completion of RT and eight months after initial imaging demonstrated no change in the splenic lesion (Figures *4*, *5*). Repeat imaging results supported the diagnosis of localized prostatic adenocarcinoma with an incidental finding of a benign splenic lesion. The patient continued ADT and PSA monitoring as per above.



FIGURE 4: Repeat MIP PSMA PET demonstrating stable splenic radiotracer uptake.

PSMA PET performed three months after completion of RT and initiation of ADT. The splenic lesion, denoted by the red circle, is unchanged from imaging eight months ago prior to treatment (Figures 1, 2).

RT: Radiation therapy; ADT: androgen deprivation therapy; PSMA PET: prostate-specific membrane antigen-positive emission tomography.

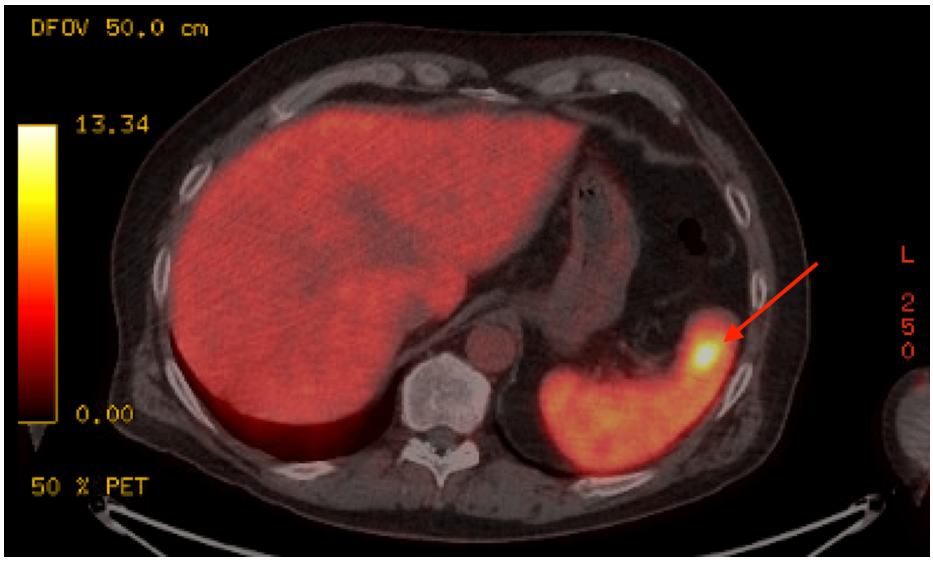


FIGURE 5: Repeat Axial PSMA PET demonstrating stable radiotracer avid splenic lesion.

PSMA PET performed three months after completion of RT and initiation of ADT. The splenic lesion, denoted by the red arrow, is unchanged from imaging eight months ago prior to treatment (Figures 1, 2).

RT: Radiation therapy; ADT: androgen deprivation therapy; PSMA PET: prostate-specific membrane antigen-positive emission tomography.

Discussion

This case describes a patient with high-risk prostate cancer with PSA levels suggestive of metastatic potential demonstrating abnormal focal splenic uptake on PSMA PET. It is critical to distinguish benign findings from metastasis in this case to guide appropriate treatment. Localized disease (M0) allows curative treatment, but evidence of diffuse metastatic disease mandates non-curative options [12]. Oligometastatic patients may also benefit from curative intent therapy with the treatment addressing oligometastatic lesion(s). However, this remains under active investigation at this time. Patients demonstrating abnormal patterns of uptake on PSMA PET require clinical correlation and potential additional imaging or biopsy to determine appropriate staging and treatment recommendations.

Literature review returned one case of solitary splenic metastasis of prostatic adenocarcinoma [13]. Compérat et al. describe a patient who underwent radical prostatectomy and hormone therapy and then experienced a progressive increase in PSA accompanied by pain five years after the operation [13]. CT scan demonstrated an isolated splenic nodule 2 cm in diameter without evidence of other metastases. The patient was initiated on chemotherapy. A CT scan six months later demonstrated the growth of the splenic mass and an increase in the PSA level. Splenectomy was performed, leading to a significant decrease in the PSA level. Pathology examination of the spleen revealed the localization of moderately differentiated adenocarcinoma that was positive for PSA markers [13].

Athiraman et al. describe a PSMA PET scan that demonstrated prostate cancer with an area of intense activity in the spleen concerning for possible metastasis [14]. The team utilized MRI to evaluate the splenic lesion and determined that it was likely a splenic hemangioma. MRI also demonstrated lumbar spine hemangiomas in the patient, which were not noted on the PSMA PET scan [14]. Splenic hemangiomas consist of an overgrowth of blood vessels in the spleen and appear macroscopically as a blood-filled cyst [15]. They are the most common type of benign tumor of the spleen, although autopsy studies suggest an incidence of 0.02%-0.16% [15] and an imaging study of living patients suggested an incidence of 0.1% [16]. They are typically asymptomatic and do not require treatment unless there is concern for rupture, at which point splenectomy is recommended [15,16].

PSMA PET demonstrates 85% sensitivity and 98% specificity for metastatic prostate cancer [17]. PSMA is an effective marker for prostate cancer metastasis and is reliable compared to conventional imaging, but PSMA uptake has been demonstrated in other benign conditions [11]. Notably, PSMA is expressed in areas of neovascularization but not normal endothelium [11]. Extensive neovascularization in benign tumors of vascular origin, such as hemangiomas, can demonstrate intense tracer uptake and mimic secondary lesions [11]. This raises questions about other roles of PSMA and presents important considerations when interpreting PSMA PET images.

Investigation of the splenic lesion was necessary for clinical decision-making in this case. Splenic metastatic lesions would typically demonstrate inhomogeneous contrast enhancement with a ring-like peripheral pattern [18]. The lesion was determined by MRI to be benign (Figure *3*), classifying the patient's prostate cancer as localized (M0). Therefore, the patient was offered curative treatment options. Suspicion of metastasis would necessitate discussion of splenectomy and the significant risks involved: intraoperative risks, including bleeding and splenic rupture, and postoperative risks, including increased risk of severe infection and abdominal thromboembolism [19]. Long-term health concerns for splenectomy include changes in hematologic parameters and greater susceptibility to infection, specifically from encapsulated organisms, requiring lifelong monitoring and preventive measures, including vaccination and prophylactic antibiotics [19]. To avoid harmful overtreatment, it is imperative that necessary imaging be performed to appropriately classify abnormal findings on PSMA PET scans. As mentioned previously, PSMA has demonstrated uptake in benign etiologies, so clinicians must have a high degree of suspicion, especially for findings that do not follow typical patterns of metastasis.

The patient was observed following treatment for any increases in PSA level or findings suggestive of a malignant etiology of the splenic lesion. Following the completion of planned RT regimen and initiation of ADT, the patient's PSA level demonstrated a marked decrease to 0.165 ng/mL. A significant limitation of this study is that the patient received both RT and ADT as per the National Comprehensive Cancer Network (NCCN) protocol [12]. The addition of ADT would lead to decreased PSA levels regardless of the etiology of the splenic lesion. Another significant limitation is the difficulty in acquiring splenic tissue for testing, limiting the evaluation to PSA level and imaging.

The patient returned for follow-up with repeat PSMA PET three months after completion of RT. Repeat PSMA PET demonstrated no change in the splenic lesion. Three months was selected as an appropriate timeframe for radiographic response, if present, to assist in the determination of the confirmation of clinical decisions and treatment recommendations. It was initially denied by insurance as this is not recommended per guidelines, but given the unique circumstance of this case and implications for radiographic changes and potential upstage, it was approved after peer physician review. Persistence of the splenic lesion on imaging with concurrent low PSA level supports the diagnosis of a benign etiology and treatment for localized prostate cancer. These findings suggest and support the consideration of MRI as an appropriate modality for further evaluation of potentially false-positive splenic lesions from PSMA PET imaging as opposed to

splenectomy or spleen biopsy. Further investigation is required to evaluate the efficacy of MRI in this setting before any clinical recommendations can be made. The short follow-up interval limits the validity of the findings, so the patient will require long-term follow-up of PSA levels. PSMA PET in this case will only be repeated for increasing PSA level but may be clinically indicated in other cases.

Conclusions

Prostate cancer is a common malignancy in men that is likely to metastasize to bone and certain other organs. PSMA PET appears to be an effective imaging modality for identifying prostate cancer and metastases, but it does carry a certain risk for false positive results with uptake by benign lesions. This report highlights a likely case of uptake in a splenic hemangioma and adds to the current knowledge regarding potential false-positive results with PSMA PET scans. It also supports the use of MRI as a reliable imaging modality for evaluating abnormal avid lesions in the spleen. Clinicians should continue to be aware of situations in which false-positive results may be produced to provide appropriate treatment for all patients and avoid harm.

Additional Information

Author Contributions

All authors have reviewed the final version to be published and agreed to be accountable for all aspects of the work.

Concept and design: Carson H. Neal, Chance L. Matthiesen, Matthew D. Miller

Acquisition, analysis, or interpretation of data: Carson H. Neal, Chance L. Matthiesen

Drafting of the manuscript: Carson H. Neal, Chance L. Matthiesen

Critical review of the manuscript for important intellectual content: Carson H. Neal, Chance L. Matthiesen, Matthew D. Miller

Supervision: Chance L. Matthiesen

Disclosures

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References

1. Key Statistics for Prostate Cancer. American Cancer Society . (2026). Accessed: September 4, 2025: https://www.cancer.org/cancer/types/prostate-cancer/about/key-statistics.html.
2. Cancer Stat Facts: Prostate Cancer. National Cancer Institute . (2026). Accessed: September 4, 2025: https://seer.cancer.gov/statfacts/html/prost.html.
3. Alizadeh M, Alizadeh S: Survey of clinical and pathological characteristics and outcomes of patients with prostate cancer. Glob J Health Sci. 2014, 6:49-57. 10.5539/gjhs.v6n7p49
4. Taplin, ME, Smith JA: Clinical presentation and diagnosis of prostate cancer. UpToDate. Robert Lee W, Richie JP, Sartor AO (ed): Wolters Kluwer, 2025.
5. Gandaglia G, Abdollah F, Schiffmann J, et al.: Distribution of metastatic sites in patients with prostate cancer: a population-based analysis. Prostate. 2014, 74:210-6. 10.1002/pros.22742
6. Nguyen DP, Xiong PL, Liu H, et al.: Induction of PSMA and internalization of an anti-PSMA mAb in the vascular compartment. Mol Cancer Res. 2016, 14:1045-53. 10.1158/1541-7786.MCR-16-0193
7. Uemura M, Watabe T, Hoshi S, Tanji R, Yaginuma K, Kojima Y: The current status of prostate cancer treatment and PSMA theranostics. Ther Adv Med Oncol. 2023, 15:17588359231182293. 10.1177/17588359231182293
8. Giesel FL, Hadaschik B, Cardinale J, et al.: F-18 labelled PSMA-1007: biodistribution, radiation dosimetry and histopathological validation of tumor lesions in prostate cancer patients. Eur J Nucl Med Mol Imaging. 2017, 44:678-88. 10.1007/s00259-016-3573-4
9. Kumar SA, Meena A, Sood A, Kumar R, Mittal BR: Tubarial salivary glands on PSMA ligands based PET imaging and post (177)Lu PSMA therapy scan: reiterating its importance. Asia Ocean J Nucl Med Biol. 2024, 12:43-5. 10.22038/AOJNMB.2023.72138.1505
10. Foley RW, Redman SL, Graham RN, Loughborough WW, Little D: Fluorine-18 labelled prostate-specific membrane antigen (PSMA)-1007 positron-emission tomography-computed tomography: normal patterns, pearls, and pitfalls. Clin Radiol. 2020, 75:903-13. 10.1016/j.crad.2020.06.031

11. de Galiza Barbosa F, Queiroz MA, Nunes RF, et al.: Nonprostatic diseases on PSMA PET imaging: a spectrum of benign and malignant findings. Cancer Imaging. 2020, 20:23. 10.1186/s40644-020-00300-7
12. NCCN Clinical Practice Guidelines in Oncology - Prostate Cancer. National Comprehensive Cancer Network . (2025). Accessed: October 25, 2025: https://www.nccn.org/professionals/physician_gls/pdf/prostate.pdf.
13. Compérat E, Azzouzi AR, Chartier-Kastler E, Ménégaux F, Capron F, Richard F, Charlotte F: Late recurrence of a prostatic adenocarcinoma as a solitary splenic metastasis. Urol Int. 2007, 78:86-8. 10.1159/000096942
14. Athiraman H, Miller K, Guido J, Borghero Y: Unusual prostate-specific membrane antigen (PSMA) splenic uptake in a patient with prostate cancer. Cureus. 2024, 16:e70751. 10.7759/cureus.70751
15. Fotiadis C, Georgopoulos I, Stoidis C, Patapis P: Primary tumors of the spleen . Int J Biomed Sci. 2009, 5:85-91.
16. Gundogan E, Sansal M, Gunes O, Akinci EC, Erkenekli TE, Sumer F: The incidence of splenic hemangioma and its rupture risk. Ann Med Res. 2018, 25:368-70.
17. Hofman MS, Lawrentschuk N, Francis RJ, et al.: Prostate-specific membrane antigen PET-CT in patients with high-risk prostate cancer before curative-intent surgery or radiotherapy (proPSMA): a prospective, randomised, multicentre study. Lancet. 2020, 395:1208-16. 10.1016/S0140-6736(20)30314-7
18. Palas J, Matos AP, Ramalho M: The spleen revisited: an overview on magnetic resonance imaging . Radiol Res Pract. 2013, 2013:219297. 10.1155/2013/219297
19. Yi SL, Buicko Lopez JL: Splenectomy. StatPearls. StatPearls Publishing, Treasure Island, FL; 2025.