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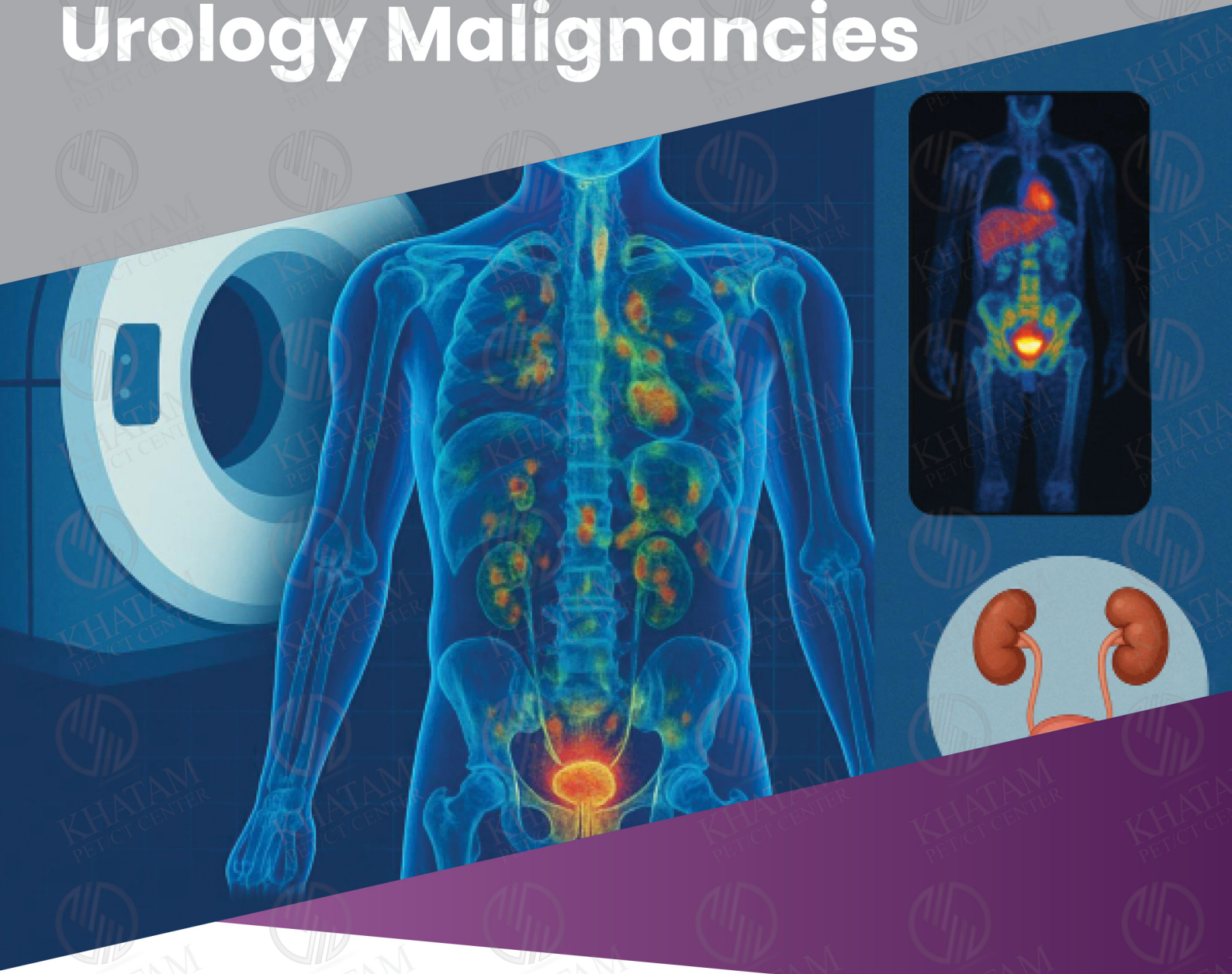
PET/CT Applications In Urology Malignancies



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Introduction

Molecular imaging with Positron Emission Tomography (PET) is increasingly recognized as a valuable imaging modality in urology, particularly in the management of urologic malignancies. Its ability to combine functional and anatomical imaging has made it indispensable in diagnosis, staging, treatment planning, and monitoring of various urological cancers. With the advent of hybrid positron emission tomography with computed tomography (PET/CT) and magnetic resonance imaging (PET/MRI), morphologic and functional imaging has been combined with the promise of providing better information in guiding therapy.

Also, various PET radiotracers with promising results are being investigated in urological malignancies that should be introduced in a separate publication.

This review aims at summarizing the latest EAU (European Association of Urology)/NCCN (National Comprehensive Cancer Network) guidelines recommendations on PET application in urological cancers.

Prostate Adenocarcinoma:

Prostate cancer is one of the most frequent forms of neoplasm affecting men. Its incidence is related to the age of the patients with an estimated 1,400,000 cases and about 375,000 deaths annually. To obtain prognostic and survival information and to choose the best therapeutic option, patients affected by prostate cancer are stratified into low-, intermediate-, and high-risk groups based on different clinicopathological characteristics such as the Gleason score derived from biopsy results, serum PSA levels, and clinical stage. Also, imaging plays an important role in the diagnostic assessment of prostate cancer as well as in the definition of the risk category of each patient. In this setting, many different imaging modalities can be used to evaluate these subjects, starting from multiparametric magnetic resonance imaging (mpMRI) which has been recognized as a precise imaging method for prostate cancer detection and for T stage assignment.

In recent years and among various PET radiotracers, prostate-specific membrane antigen (PSMA) positron emission tomography (PET) imaging performed with PET/MRI or PET/CT has emerged as an accurate and useful modality for both staging and restaging settings of prostate cancer patients, as well as for the assessment of therapeutic response and therefore of prognosis prediction. In particular, it has been underlined that PSMA PET/CT scan is a promising tool in the management of low- to intermediate-risk prostate cancer, improving risk stratification and identifying patients at risk of pathological upstaging. Based on prior trials, in men with newly diagnosed high-risk prostate cancer; PSMA PET/CT has superior diagnostic accuracy for detection of pelvic nodal or distant metastases to conventional imaging with CT scan and bone scintigraphy.

Appropriateness of use criteria for ^{68}Ga-PSMA PET/CT scan in prostate cancer:

The most important indications are summarized in Table 1. Also in the following sections the current recommendations for use of PSMA PET scan in prostate cancer according EAU and NCCN guidelines are explained.

Table 1: Indications for PSMA-ligand PET/CT (2023 SNMMI*/EANM** guidelines)

- Initial staging of prostate cancer
- Localization of recurrent (BCR) or persistent (BCP) prostate cancer
- Localization of prostate cancer which is non-metastatic by conventional imaging (non metastatic castration-resistant prostate cancer; nmCRPC)
- Staging before PSMA-directed radioligand therapy
- Guidance of prostate biopsy
- Imaging metastatic prostate cancer
- Monitoring of systemic treatment for metastatic prostate cancer

*The Society of Nuclear Medicine and Molecular Imaging (SNMMI)

**The European Association of Nuclear Medicine (EANM)

^{68}Ga-PSMA PET/CT scan applications in prostate cancer in EAU guideline (Version.2025 - March 2025):

Prostate-specific membrane antigen (PSMA) PET/CT uses several different radiopharmaceuticals; most published studies used [68 Ga]Ga-labelling for PSMA PET imaging, but some used [18 F]F -labelling (e.g. ^{18}F-DCFPyL,^{18}F-PSMA-1007,^{18}F-PSMA-JK-7).

PSMA is also an attractive target because of its specificity for prostate tissue, even if the expression in other non-prostatic malignancies or benign conditions may cause incidental false-positive findings. PSMA PET/CT has a good sensitivity and specificity for lymph node (LN) involvement, possibly impacting clinical decision-making. PSMA PET/CT is more sensitive in N-staging as compared to MRI, abdominal contrast-enhanced CT or choline PET/CT.

However, small LN metastases, under the spatial resolution of PET, may still be missed though mainly used for staging purposes, PSMA PET/CT (or PET/MRI) prostate expression may be used to indicate and target biopsies in future.

Table. 2 Evidence and guidelines for staging of prostate cancer

Recommendations	Strength rating
Any risk group staging	
Use pre-biopsy magnetic resonance imaging (MRI) for local staging information.	Weak
Low-risk localised disease	
Do not use additional imaging for staging purposes.	Strong
Intermediate-risk disease	
"For patients with International Society of Urological Pathology (ISUP) grade group 3 disease perform prostate-specific antigen-positron emission tomography/computed tomography (PSMA-PET /CT) if available to increase accuracy or at least cross-sectional abdominopelvic imaging and a bone-scan."	Weak
High-risk localised disease/locally advanced disease	
Perform metastatic screening using PSMA-PET/CT if available or at least cross-sectional abdominopelvic imaging and a bone-scan.	Strong

Table 3. Recommendations for the management of persistent PSA after radical prostatectomy

Recommendations	Strength rating
"Offer a prostate-specific membrane antigen (PSMA) positron emission tomography/ computed tomography (PET/CT) scan to men with a persistent prostate-specific antigen (PSA) and rising if the results will influence subsequent treatment decisions."	Weak
Treat men with persistent PSA and no evidence of distant metastatic disease with salvage radiotherapy and additional hormonal therapy.	Weak

Table. 4 Summary of evidence and guidelines for imaging in patients with biochemical recurrence

Recommendations	Strength rating
Prostate-specific antigen (PSA) recurrence after radical prostatectomy	
"Perform prostate-specific membrane antigen (PSMA) positron emission tomography/ computed tomography (PET/CT) if the PSA level is >0.2 ng/mL and if the results will influence subsequent treatment decisions (EAU BCR risk groups)."	Weak
"In case PSMA PET/CT is not available, and the PSA level is >=1 ng/mL, perform fluciclovine PET/CT or choline PET/CT imaging if the results will influence subsequent treatment decisions.	Weak
PSA recurrence aher radiotherapy	
Perform prostate magnetic resonance imaging to localise abnormal areas and guide biopsies in patients fit for local salvage therapy.	Weak
Perform PSMA PET/CT (if available) or fluciclovine PET/CT or choline PET/CT in patients fit for curative salvage treatment.	Strong

^{68}Ga-PSMA PET/CT scan applications in prostate cancer in NCCN guideline (Version 1.2025 - December 04, 2024):

PSMA PET/CT scan can be considered as an alternative to standard imaging of bone and soft tissue for initial staging, the detection of biochemically recurrent disease and as workup for progression.

Because of the increased sensitivity and specificity of PSMA-PET tracers for detecting micrometastatic disease compared to CT, MRI, and bone scan at both initial staging and BCR, PSMA-PET/CT or PSMA-PET/MRI can serve as a more effective frontline imaging tool for these patients.

PSMA imaging should be done before initiation of androgen deprivation therapy (ADT) because they may affect detection sensitivity.

^{18}F-FDG PET/CT should not be used routinely for staging prostate cancer since data are limited in patients with prostate cancer.

The increasing use of PSMA PET has identified the potential for considerable biological diversity among disease foci within a given individual with prostate cancer, especially metastatic castration-resistant prostate cancer (mCRPC) patients and that this heterogeneity can be detected with a combination of PSMA PET and FDG PET scans.

Initial data suggest that metastases with PSMA-negative/FDG-positive mismatches may exist in patients with mCRPC undergoing ^{177}Lu-PSMA radioligand therapy and that patients with these mismatches may have worse outcomes. Currently, no robust clinical trial data exist to support the incorporation of FDG PET into routine clinical use alongside PSMA PET.

To overcome the limitations of PSMA-PET in PSMA-negative metastatic disease, the NCCN panel currently recommends the use of contrast-enhanced CT scan or MRI in these patients, as the non-contrast CT component of PSMA PET/CT is insufficient to detect visceral metastatic disease.

Conclusion:

PSMA PET/CT scan is considered a valuable tool for patient care in the clinical management of prostate cancer and has shown promising results in initial staging of prostate cancer, localization of recurrent or persistent disease, and staging before PSMA-directed radioligand therapy. It also has potential applications in guiding prostate biopsy, guiding metastatic-directed therapy and monitoring treatment response.

While the impact on patient outcomes and management is still being assessed, PSMA PET has been included in clinical guidelines and consensus documents, highlighting its superior accuracy and additional value in prostate cancer staging.

Further research and evaluation are in progress to establish role of PSMA imaging in treatment monitoring and patient outcomes.

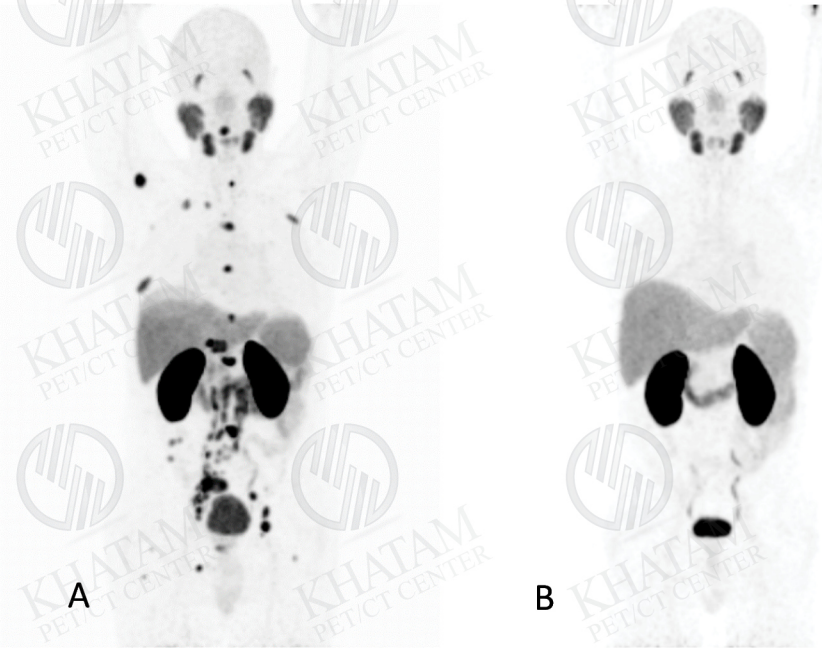

Image 1. Response to treatment of prostate cancer
A) MIP image of ^{68}Ga-PSMA PET/CT for primary staging of a patient with prostate adenocarcinoma reveals a PSMA positive soft tissue lesion involving bilateral prostate lobes along with multiple PSMA positive metastatic skeletal lesions as well as abdominopelvic lymph nodes.
B) MIP image of ^{68}Ga-PSMA PET/CT for restaging status post 12 months ADT showed complete molecular response to therapy due to interval resolution of all previously seen primary and metastatic lesions.

Renal cell carcinoma

Renal cell carcinoma (RCC) accounts for around 2% of all cancer cases, with the greatest prevalence observed in Western countries. The global incidence of RCC in 2022 was expected to be 434840 new cases. Incidence and mortality are the highest in Europe and Asia whereas age standardised incidence rate per 100,000 person/years (age-standardized rate [ASR] World) is the highest in Northern America and mortality in Eastern Europe. Renal cell carcinoma is the predominant solid tumor found in the kidney, making for around 90% of all kidney malignancies. It consists of many RCC subtypes that have distinct histological and genetic features. There is predominance in men over women ASR 13.7 and 6.4 respectively with a higher incidence in the older population.

Common risk factors that have been identified include lifestyle choices such as smoking, having a high body mass index (BMI) above 35, hypertension, and metabolic syndrome. Approximately 50.2% of patients diagnosed with RCC have a history of smoking, either as current smokers or as individuals who have quit smoking. There is a higher likelihood of developing RCC if one has a close family member who has been diagnosed with kidney cancer. There is now no clear understanding of why moderate alcohol use has a protective impact, but it is observed. Similarly, any degree of physical exercise also appears to have a protective effect, although the reasons behind this are not fully understood.
The morphological prognostic markers encompass tumor size, venous invasion and extension, collecting system invasion, perinephric- and sinus fat invasion, adrenal involvement, as well as lymph node and distant metastasis. Tumor grade, RCC subtype, lymphovascular invasion, tumor necrosis, and invasion to the collecting system are considered histological prognostic markers.
Emerging technologies have a growing body of evidence with regard to prostate-specific membrane antigen (PSMA) positron emission tomography (PET)-CT, ^{99}TC sestamibi SPECT/CT and ^{89}Zr-DFOGirentuximab PET-CT for differentiation of RCC subtypes, differentiation between benign tumours and RCC, and differentiation between high grade from low grade tumours. Additionally some of these modalities are being evaluated for staging purposes.

The role of Positron Emission Tomography (PET) in RCC: The precise value of PET in RCC has yet to be determined. At present, PET or PET/CT is not a suggested imaging method for diagnosing kidney cancer or monitoring for signs of recurrence after nephrectomy.
^{18}F-FDG PET/CT scan reveals that the metabolic activity in RCC is usually comparable to or slightly higher than that in the normal renal tissue. However, it is significantly lower than the metabolic activity in urine. This makes it difficult to detect RCC with ^{18}F-FDG PET/CT, unless the tumor is protruding (exophytic), which is also true for oncocytoma. Distinguishing between oncocytoma and renal cell carcinoma has shown to be a difficult task for all imaging techniques. A new PET radiopharmaceutical, ^{89}Zr-DFO-girentuximab, is currently being developed. It has been found to be taken up by renal clear cell carcinoma but not by oncocytoma. The use of ^{89}Zr-DFO-girentuximab in the standard imaging method enhances the identification of lesions from 56% to 91%. It should be emphasized that renal cell carcinomas have been observed to exhibit uptake on PSMA PET. Nevertheless, this topic has not been thoroughly investigated thus far. The radiotracer ^{18}F-fluciclovine exhibits enhanced absorption in renal papillary cell carcinomas, but not in renal clear cell carcinoma.

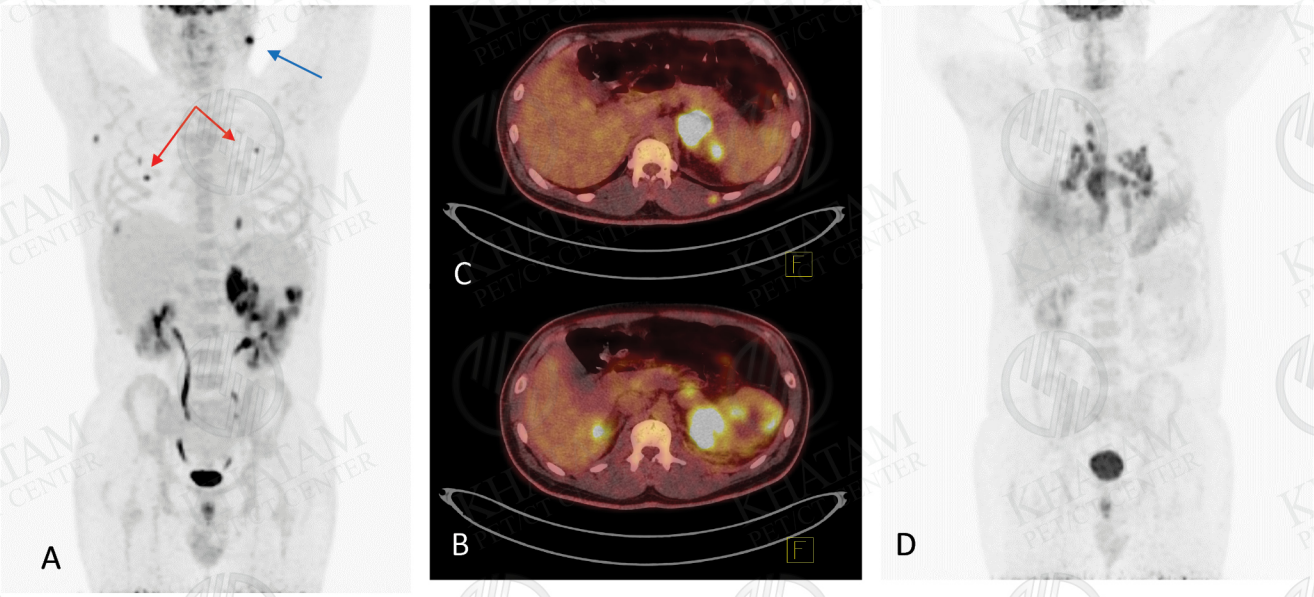

Image 2. Known case of RCC referred for staging [A; MIP], ^{18}F-FDG PET/CT images reveals a heterogeneously FDG avid large mass involving the left kidney (B; Axial), an FDG avid left adrenal lesion (C), multiple FDG avid metastatic pulmonary nodules (red arrow) and an FDG avid left intraparotid lymph node that is suspicious for metastasis (blue arrow).
D; MIP image of ^{18}F-FDG PET/CT of the same patient after left nephrectomy and immunotherapy showed complete metabolic response to therapy due to interval resolution of all prior primary lesion and metastases. Also there is development of several FDG avid mediastinal lymph nodes in favor of immunotherapy-induced inflammatory process.

Bladder cancer

Bladder cancer is the 7th most commonly diagnosed cancer in males, while it drops to 10th position when both genders are considered. Risk factors for developing bladder cancer include male sex, white race, smoking, personal or family history of bladder cancer, pelvic radiation, environmental/occupational exposures, exposure to certain medications, chronic infection or irritation of the urinary tract and certain medical conditions including obesity and diabetes.

Patient with bladder cancer usually present with painless hematuria. The final diagnosis is made by a histological analysis of tissue resected during transurethral resection of the bladder tumor (TURBT). When it shows non-muscle invasive bladder cancer (NMIBC), the disease can be managed with local treatments and tends to recur but is generally not life-threatening. A systemic imaging work-up for metastatic disease is not needed in that case, except for a few patients with high-risk NMIBC. When muscle-invasive bladder cancer (MIBC) is present (about 30% of patients), i.e., ≥pT2 in the WHO classification, a regional and distal cross-sectional imaging work-up must be performed to search for lymph node and distant metastases as well as concomitant upper urinary tract urothelial carcinoma. According to current guidelines (ESMO, EAU, AUA), it must include a contrast-enhanced CT scan or MRI of the abdomen-pelvis combined with a chest CT scan.

- According to the 2025 version of EAU Guidelines on Muscle-invasive and Metastatic Bladder Cancer; ^{18}F-FDG PET/CT scan is increasingly being used in clinical practice but its exact role still needs to be further evaluated. However, in most studies evaluating ^{18}F-FDG PET/CT for lymph node assessment reported higher sensitivity than CT scan, with comparable specificity. ^{18}F-FDG PET/CT scan can provide additional information to guide local treatment in case of presence of pelvic nodes metastases. In addition, evidence for the role of FDG-PET/CT for staging distant metastases of MIBC is still limited. In a recent series of 711 patients, FDG-PET/CT has been shown to provide important staging information through the detection of distant metastases, which may impact the clinical management of MIBC patients.

Table. 5: The role of imaging in treatment planning (EAU guideline, March 2025):

Goal	Imaging modality
Differentiate TI from T2 tumours	MRI using the Vesical Imaging Reporting and Data System (VI-RADS) score
Evaluate locally-advanced stage or spread to LNs	CT scan and MRI for abdominal- and pelvic LNs or PET/CT scan
Assess UUT or other distant organs	CT urography for evaluating the UUT and PET/CT to detect distant organ metastasis

- Based on latest NCCN guideline for bladder cancer (version 1.2025), ^{18}F-FDG PET/CT scan can be used in these indications in muscle invasive bladder cancer:
  - In primary staging; ^{18}F-FDG PET/CT may be beneficial in selected patients with T2 (muscle-invasive disease) and in patients with ≥cT3 disease.
  - For follow-up with or without cystectomy: ^{18}F-FDG PET/CT may be performed if not previously done or if metastasis is suspected in selected patients.
  - Follow-up of cT4b and metastatic disease: ^{18}F-FDG PET/CT may be performed if not previously done or in patients with high-risk MIBC in whom metastatic disease is suspected. This could also be used to guide biopsy in certain patients.

Conclusion:

Imaging provides important information in the staging and restaging of patients with bladder cancer. CT scan is the most frequently used imaging modality for bladder cancer. MRI offers additive value for the evaluation of muscular invasion and the local staging, which is critically important to optimize patient's management.

The main interest of ^{18}F-FDG PET/CT lies in its ability to detect distant metastases. At the lymph node level, its performance is better than that of contrast-enhanced CT scan. Prospective studies are underway and may provide information on this subject in the near future, as well as on ^{18}F-FDG PET/CT usefulness in restaging and therapeutic evaluation of bladder cancer patients.

Upper urinary tract carcinoma (UUTC), although rare, typically have a poor prognosis due to early invasion into the surrounding muscular structures. Importantly, urothelial carcinoma has a high rate of recurrence despite periodic surveillance using standard MR imaging and CT imaging, which impacts the management of the disease. There has been an increasing role in the use of ^{18}F-FDG PET/CT scan in the diagnosis of primary and recurrent urothelial carcinoma, which can play a role in restaging to assess the extent of disease/disease burden and management decisions. ^{18}F-FDG PET/CT imaging has been shown to have improved detection of recurrent disease post-treatment compared to standard CT imaging alone.

Based on EAU guidelines (version 2025) for Upper Urinary Tract Urothelial Carcinoma; ^{18}F-FDG PET/CT for the detection of nodal metastasis in 117 surgically-treated UTUC patients reported promising sensitivity and specificity of 82% and 84%, respectively. Suspicious Lymph nodes on FDGPET/CT were associated with worse recurrence-free survival (RFS). FDG-PET can also be used to assess (nodal and distant) metastases in patients unfit for iodinated contrast media due to renal impairment or allergy.

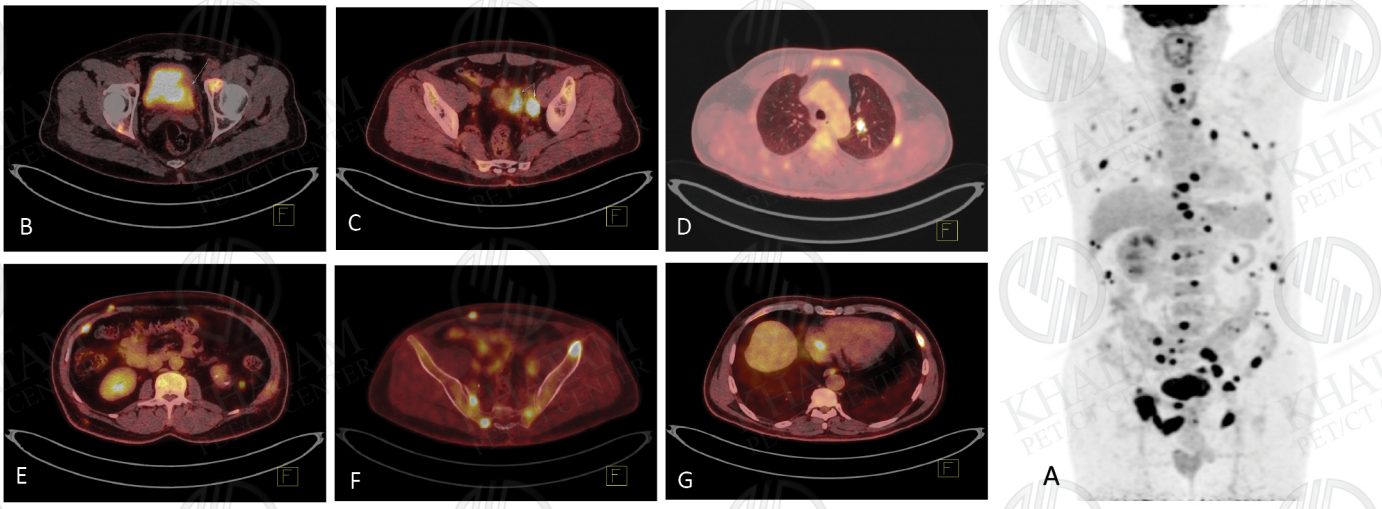

Image 3. Known case of high grade papillary urothelial carcinoma, status post TURB, referred for staging [A; MIP].
FDG-avid left lateral urinary bladder wall thickening resembles the primary malignancy[B], FDG-avid metastatic left external iliac lymph nodes [C], few metastatic pulmonary nodules [D], sub-cutaneous and muscular lesions [E], skeletal metastases [F], and a pericardial lesion [G].

Testicular cancer

Testicular cancer (TC) accounts for 1% of all adult neoplasms and 5% of urological tumors. The prevalence of TC has escalated in recent decades, primarily in developed nations, and it continues to ascend. Upon diagnosis, bilateral involvement is observed in 1-2% of cases, while germ cell tumors (GCT) account for 90-95% of all instances. Non-seminomatous germ cell tumor (NSGCT) and mixed GCT patients often experience the highest occurrence rate in their third decade of life, while seminoma testis (ST) individuals tend to have the highest incidence in their fourth decade.

GCTs can be classified into two primary types based on their development and epigenetic characteristics. The majority of malignant GCTs that occur after puberty develop from germ cell neoplasia "in situ" (GCNIS). From a histological and clinical perspective, these can be split into two categories: seminomas and non-seminomas. The non-seminomas include the somatic and extra-embryonic components of embryonal carcinoma, yolk sac, choriocarcinoma, and post-pubertal teratoma. Non-GCNIS derived malignancies comprise pre-pubertal type teratoma and yolk sac tumor, which manifest in early childhood, and spermatocytic tumors, typically found in older males. While there may be similarities in the tissue structure between pre-pubertal type teratoma/yolk sac and the teratoma and yolk sac tumor elements in the GCNIS-derived NSGCT, they have distinct and unique origins.

The risk factors for GCNIS-derived GCTs include several elements of the testicular dysgenesis syndrome, such as cryptorchidism, hypospadias, reduced spermatogenesis, and reproductive problems or disorders of sex development. Other risk factors include a familial history of testicular cancer among immediate family members and the existence of a testicular tumor on the opposite side or GCNIS, however the risk was reduced if testicular cancer patients had previously undergone platinum-based chemotherapy. Genome-wide association studies have identified specific genetic regions that are associated with an elevated relative risk of developing TC.

The role of PET in the management of TC, specifically Seminoma, is significant. Imaging and tumor markers should be used to monitor a residual mass of seminoma initially. According to the NCCN guideline, using FDG-PET scans from the base of the skull to the middle of the thigh can be used to evaluate how well chemotherapy is working and to check for any remaining masses in patients with seminoma. Considering the high negative predictive value (NPV) of FDG-PET, it is advisable to utilize this method in patients with residual masses larger than 3 cm in diameter to obtain additional insights on the survivability of the disease. The procedure should be delayed until a minimum of two months after chemotherapy has been completed, as the inflammation and desmoplastic reaction caused by chemotherapy could potentially lead to a misleading positive outcome. Negative predictive value (NPV) for the current disease is greater than 90%, which can provide reassurance. On the other hand, the positive predictive value (PPV) varies from 23% to 69%. Therefore, it is recommended to exercise caution when starting active therapy based only on positive results from ^{18}F-FDG PET/CT. According to the NCCN guideline, patients who have a residual mass measuring more than 3 cm after chemotherapy and have a negative FDG PET scan should have an MRI with and without contrast or an abdomen/pelvis CT scan with contrast every 6 months for the first year, and then once a year for the next 5 years.

If a mass that was previously positive after chemotherapy still shows positive results on reclassification with FDG PET, but there is no growth in volume, it is recommended to repeat the FDG PET scan 6 weeks later. A new study has demonstrated a low positive predictive value (PPV) for detecting viable tumors in residual lesions, particularly those larger than 3 cm, following treatment in metastatic seminoma. The PPV ranges from 11%

to 38%, depending on the specific subgroup being analyzed. Hence, it is advisable to exercise caution when using ^{18}F-FDG PET/CT as the sole criterion for making clinical decisions regarding a persistent mass. The NCCN guideline advises that if a patient has an inconclusive PET/CT result, it is recommended to repeat the FDG PET/CT or CT scan after a period of 6-8 weeks.

Nonseminoma refers to a type of tumor that does not originate from the cells that produce sperm. After the initial treatment with first-line BEP, it has been observed that approximately 7% of remaining masses still have active malignancy, 33% consist of post-pubertal teratoma, and 40% are composed solely of necrotic-fibrotic tissue. The remaining portion consists of less common occurrences, such as the malignant transformation of teratoma. ^{18}F-FDG PET/CT is not useful for evaluating how well treatment is working or for detecting any remaining masses after chemotherapy in patients with nonseminoma.

Currently, the utilization of ^{18}F-FDG PET/CT scan for surveillance is not suggested. Retrospective evaluations have shown that staging and follow-up in patients with CS 1 have a good level of accuracy for surveillance purposes or for detecting the stage in more advanced disease. Nevertheless, in order to reduce radiation exposure and take into account the compelling evidence supporting the use of MRI, the current NCCN guideline does not endorse the utilization of ^{18}F-FDG PET/CT for surveillance purposes.

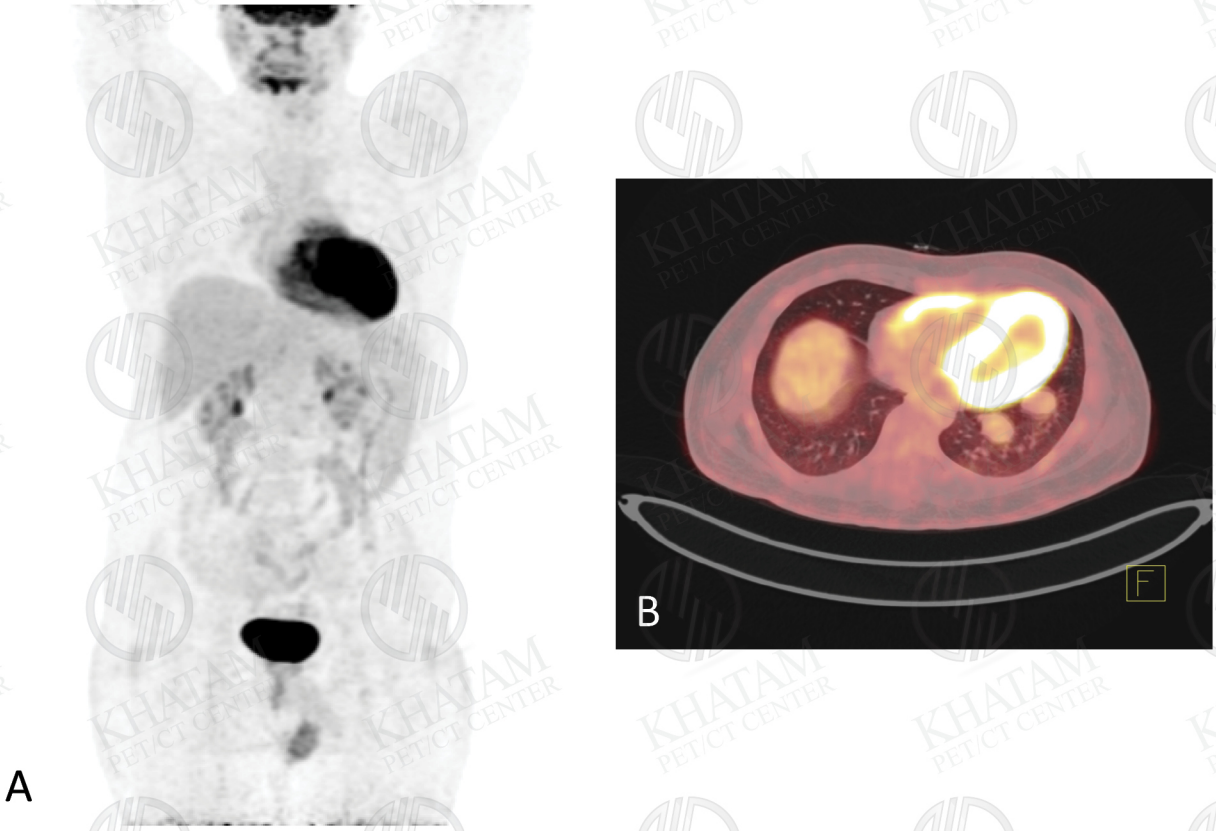

Image 4: A case of testis mixed germ cell tumor, status post right orchiectomy (one and half year ago) followed by chemotherapy, referred for restaging after therapy (A; MIP).
B: Multiple bilateral FDG avid metastatic pulmonary nodules.

Penile cancer

Penile cancer is a rare disease. The majority of these cancers are squamous cell carcinoma, but other histological types and subtypes such as basaloid and warty squamous cell, and melanoma can occur. The worldwide incidence has significant geographic variations, which is mainly explained by circumcision, sexual practices and socioeconomic circumstances.

Imaging and other staging techniques have improved the risk stratification of penile cancer. Ultrasound-guided fine needle aspiration biopsy, sentinel node biopsy and various forms of lymph node dissections are invasive techniques that have improved lymph node staging. Also, imaging modalities such as CT scan, MRI and PET/CT have evolved.

The latest version of EAU Guidelines on penile cancer (2025) stated ^{18}F-FDG PET/CT application in staging of penile cancer patients, because imaging with ^{18}F-FDG PET/CT in clinically node-positive (cN+) patients showed higher sensitivity/specificity than CT scan alone in the pre-operative staging of the pelvic lymph nodes and distant metastasis. Therefore in cN+ patients, this guideline recommended staging the pelvis and exclude distant metastases with ^{18}F-FDG PET/CT scan or CT scan of the chest and abdomen before initiating treatment.

Also, the NCCN guideline (versions 2.2025) has raised the use of ^{18}F-FDG PET/CT in two scenarios of penile cancer as listed below:

- Staging: Considering FDG PET/CT in patients with suspected inguinal lymph node-positive disease.
- Treatment Response Assessment: Considering FDG PET/CT to assess treatment response and disease progression in patients with suspected inguinal lymph node-positive disease.

In penile cancers both the primary tumors and lymph node metastases show high FDG uptake. Nearly all penile cancers are FDG-avid, but some very small tumors may not be detected on PET; however, urinary excretion of the FDG can interfere with an accurate diagnosis in some cases.
In conclusion, ^{18}F-FDG PET/CT scan has high sensitivity and good specificity for pelvic staging and a high positive predictive value (PPV) for distant staging in penile cancer patients at risk of pelvic metastases.

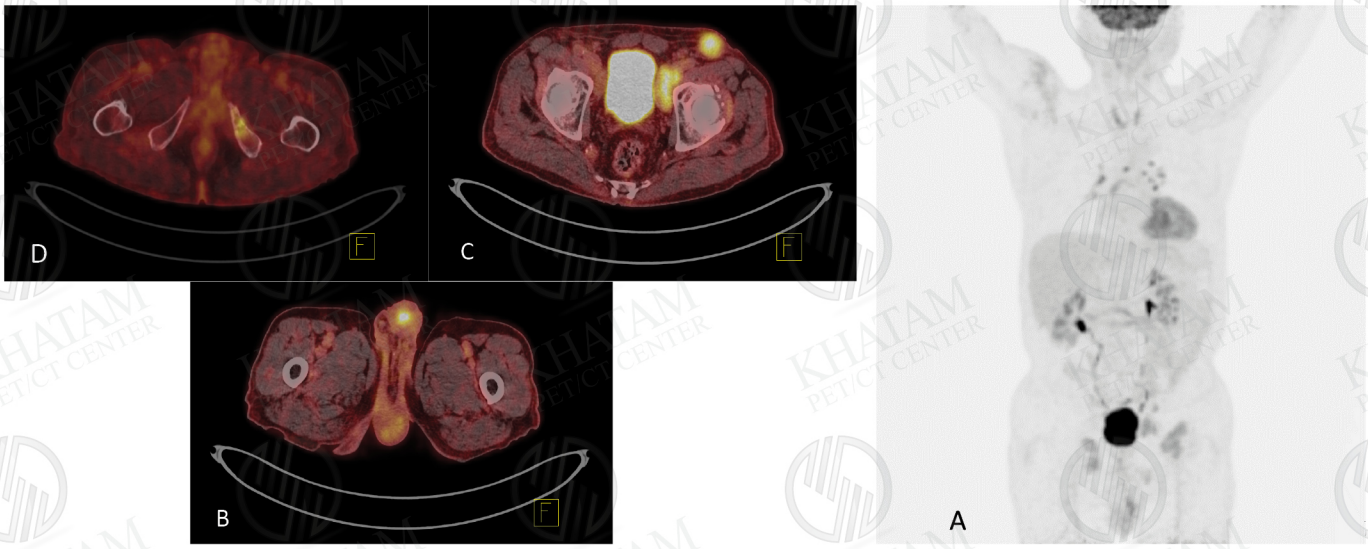

Image 5: A case of penile squamous cell carcinoma, status post chemotherapy, referred for restaging (A; MIP).
Focal FDG uptake is seen in the penis compatible with residual malignancy(B). Multiple FDG avid bilateral external iliac and inguinal lymphadenopathies (C). FDG avid mixed lytic sclerotic lesion is present in the left inferior pubic ramus (D).

Conclusion:

PET/CT imaging has an established role in the diagnosis of some urological malignancies and in specific clinical indications. The use of PET/CT with ^{18}F-FDG, the most commonly used radiotracer, is constantly increasing. Although ^{18}F-FDG in urological oncology is sometimes challenging due to urinary excretion of FDG; however, ^{18}F-FDG PET/CT was recently shown to be useful in selected indications. On the other hand, along the established roles of FDG PET/CT, the advances of novel radiotracers for PET/CT imaging in urological malignancies such as PSMA PET/CT, allows evaluation in the settings of staging, recurrence, response to therapy and prognosis. Also, PET/CT imaging helps in planning and assessing response to therapy. Molecular images identify early changes that conventional anatomical studies cannot and for this reason, the images performed on PET/CT are becoming increasingly indispensable in various clinical situations and with precise indications according to the type of urological malignancy.

Reference:

1. Dondi F, Antonelli A, Suardi N, Treglia G, Bertagna F. The Role of PSMA PET Imaging in the Classification of the Risk of Prostate Cancer Patients: A Systematic Review on the Insights to Guide an Active Surveillance Approach. Cancers. 2024; 16(6):1122. https://doi.org/10.3390/cancers16061122
2. Fendler, W.P., Eiber, M., Beheshti, M. et al. PSMA PET/CT: joint EANM procedure guideline/SNMMI procedure standard for prostate cancer imaging 2.0. Eur J Nucl Med Mol Imaging 50, 1466–1486 (2023). https://doi.org/10.1007/s00259-022-06089-w
3. EAU - EANM - ESTRO - ESUR - ISUP - SIOG Guidelines on Prostate Cancer (2025).
4. NCCN Guidelines – Prostate Cancer - Version 1.2025
5. Houshmand S, Lawhn-Heath C, Behr S. PSMA PET imaging in the diagnosis and management of prostate cancer. Abdom Radiol (NY). 2023 Dec;48(12):3610-3623. doi: 10.1007/s00261-023-04002-z. Epub 2023 Jul 26. PMID: 37493837; PMCID: PMC10682054.
6. NCCN guidelines – RCC - Version 1.2025
7. EAU Guidelines on Renal Cell Carcinoma (2025).
8. NCC guidelines – Testicular Cancer - Version 2.2025
9. EAU Guidelines on Testicular Cancer (2025).
10. EAU Guidelines on Muscle-invasive and Metastatic Bladder Cancer (2025).
11. Hang-Yin, J.; Girard, A.; Marchal, E.; Lebret, T.; Homo Seban, M.; Uhl, M.; Bertaux, M. PET Imaging in Bladder Cancer: An Update and Future Direction. Pharmaceuticals 2023, 16, 606. https://doi.org/10.3390/ph16040606
12. NCCN Clinical Practice Guidelines - Bladder Cancer - Version 1.2025
13. EAU Guidelines on Upper Urinary Tract Urothelial Carcinoma (2025).
14. EAU-ASCO Collaborative Guidelines on Penile Cancer (2025).
15. NCCN Clinical Practice Guidelines - Penile Cancer - Version 2.2025
16. Ottenhof SR, Vegt E. The role of PET/CT imaging in penile cancer. Transl Androl Urol. 2017 Oct;6(5):833-838. doi: 10.21037/tau.2017.04.36. PMID: 29184780; PMCID: PMC5673802.
17. Bray, F., et al. Global cancer statistics 2022: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. CA Cancer J Clin, 2024. 74: 229
18. World Health Organization. Cancer Today. 2024

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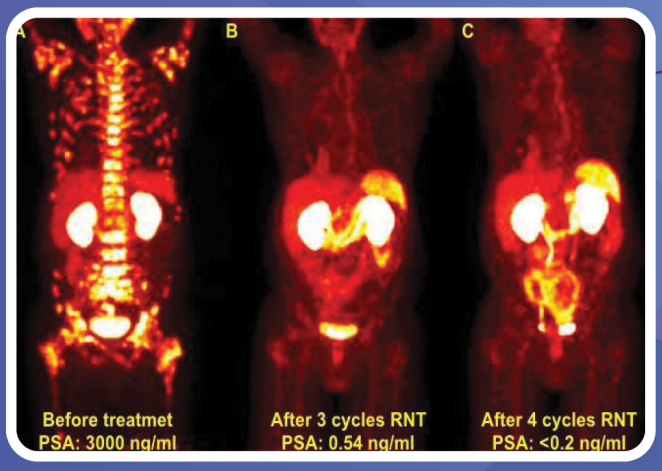
Targeted Tumor Therapy By New Radiopharmaceuticals

Lutetium -177



Lu-PSMA :

^{177}Lu-PSMA considered in patients who have:

- mCRPC progressive after exhaustion of approved therapies;
- Do not have any other approved therapy option planned by a multidisciplinary team.
- Confirmed PSMA expression of tumor and metastases, ideally by baseline PSMA-directed imaging (PET or SPECT)

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مجهزترین دستگاه PET/CT کشور با ۱۲۸ CT اسلایس

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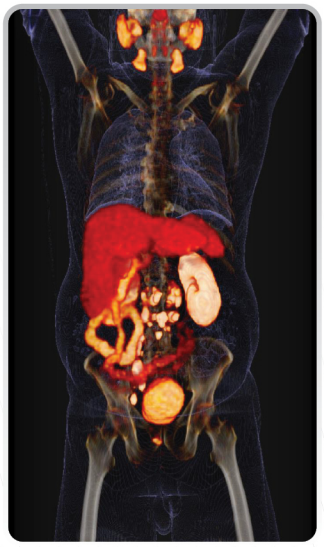
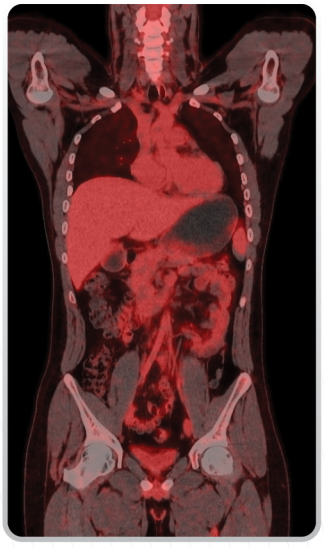
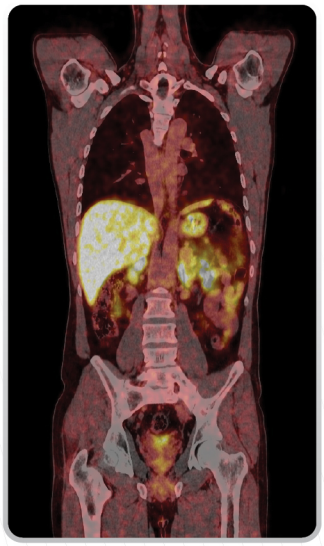
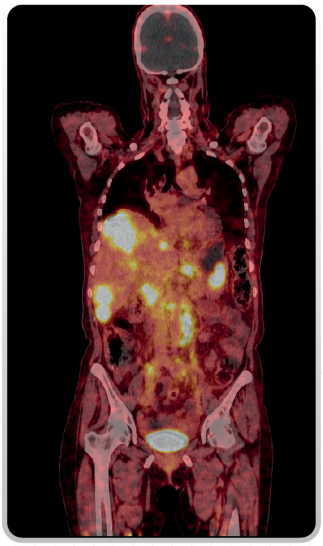

^{68}Ga-PSMA PET/CT


^{18}F-FDG PET/CT


^{68}Ga-DOTATATE PET/CT


^{68}Ga-FAPI PET/CT

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خط ویژه:
۰۲۱-۹۲۰۰۲۲۰۲

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