[18F]FDG- PET/CT Imaging Spectrum of the Most Prevalent Adrenal Lesions

Abstract

Detection of adrenal lesions either incidentally, or in symptomatic cases and/or during staging/restaging of oncological cases, it is very crucial to know the adrenal lesion is benign or malignant. Fluorodeoxyglucose positron emission tomography–computed tomography (FDG PET/CT) helps in this comprehensive evaluating process. Here, we present the most frequently facing adrenal lesions in routine oncological PET/CT scans. The aim of this presentation is to know the FDG uptake spectrum of various adrenal lesions on PET/CT scan so that increase the diagnostic accuracy and spectrum of differential diagnosis.

Keywords: *Adrenal lesions, fluorodeoxyglucose, positron emission tomography–computed tomography*

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Introduction

^{18}F-fluorodeoxyglucose positron emission tomography–computed tomography (FDG PET/CT) is the useful imaging tool for various adrenal lesions. It may be difficult to differentiate various adrenal lesions without careful correlation with the patients' histories, laboratory tests, and other imaging findings. Accurate characterization of adrenal lesions is crucial, as demonstration of adrenal metastases indicates Stage IV disease and alters the patient's management.[1]

The purpose of our study was to evaluate the characteristic spectrum and FDG uptake pattern of adrenal lesions on ^{18}F-FDG PET/CT. We retrospectively assessed routinely performed oncological ^{18}F-FDG PET/CT scan data of patients having histologically proven primary or adrenal lesions/diagnosed on other anatomical imaging modalities.

We present a pictorial case series highlighting the characteristic FDG uptake patterns in a spectrum of various adrenal lesions including normal, bulky, adenoma, myelolipoma, adrenocortical carcinoma, pheochromocytoma, lymphoma, and metastasis.

Normal

Normal adrenal glands are inverted Y or V shaped[2] and well visualized against the surrounding low attenuating retroperitoneal fat on CT. Normal measurements of the body and limbs of the adrenal glands are taken perpendicular to the long axis. The maximum width of the body of the adrenal gland is ~0.6 cm (standard deviation [SD]: 0.2) of the right and ~0.79 cm (SD 0.21) of the left. The thickness of the limb of the right adrenal gland is slightly less than the left (i.e., 0.14–0.49 cm, compared with 0.13–0.5 cm on the left) and in general practice should not measure over 0.5 cm.[3] On noncontrast CT, adrenal glands have similar attenuation as the liver and spleen, but on contrast-enhanced CT (CECT), it enhances approximately 50–60 HU. as On FDG PET/CT mostly normal adrenal do not take FDG or no significant FDG uptake is noted.[4] A case of normal adrenal gland on PET/CT scan is represented in Figure 1.

Bulky

Bilateral/unilateral bulky adrenal gland signifies enlargement of the adrenal gland on imagining with maintained the normal adreniform contour. Adrenal glands become nonneoplastically enlarged and hypertrophied during an acute stress event.[5] A wait and watch approach should be followed if there are no other clinical symptoms and signs of adrenal disorders. At autopsy, adrenal metastases are found in approximately 27% of patients with known primary.[6] Imaging will only detect metastases if there is a focal nodularity or

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distortion of the adrenal contour, but a normal appearing gland does not exclude microscopic tumor infiltration. However, with increasing role of anatomical (i.e., CT and magnetic resonance imaging [MRI]) and functional (i.e., PET/CT imaging) in diagnosis, staging, restaging, and follow-up of carcinoma patients, the adrenal metastasis are now frequently being detected.[7] On CECT findings are significantly overlaps with adenomas in terms of attenuation and absolute percentage washout/relative percentage washout. On PET/CT, bulky adrenal glands must be reported and follow-up should be done. Figure 2 represents the bulky left adrenal gland in the diagnosed case of lung carcinoma.

Adenoma

Adrenal adenoma is the benign neoplasm of the adrenal cortex and accounts for 54%–75% of adrenal incidentaloma.[8] Most adrenal adenomas are rich in intracytoplasmic fat. For the evaluation of adrenal adenoma, adrenal-dedicated CT/MRI is the preferred imaging modality. On CT, it usually presents as a small well-circumscribed nodule with unenhanced attenuation of <10 Hounsfield unit (being ~100% specific)[9] with CT contrast washout >50%. However, Contrast enhanced computed tomography (NCCT) alone is not diagnostic because ~15%–30% adenomas are lipid poor and show higher attenuation.[10] In such types of cases, CECT images are acquired in a specific adrenal protocol. Adrenal adenomas enhance quickly and rapidly washout compared to metastasis which shows intense enhancement and prolonged washout. On FDG PET/CT imaging, most of the adrenal adenomas are nonavid/no significant FDG avidity, i.e., FDG uptake is less than the liver.[11,12] A left adrenal adenoma is shown in a case of carcinoma gallbladder as shown in Figure 3.

Myelolipoma

Myelolipoma is rare benign neoplasm that predominantly occurs in adrenal gland and primarily composed of mature adipocytes and benign hematopoietic tissue.[13] It ranges from 6% to 16% of adrenal incidentalomas and emerging as the second most frequent following adrenal adenoma.[14] For adrenal myelolipomas, CT scan is the preferred imaging modality, which shows smoky/variegated areas of interspersed higher attenuation depending on the various amount of fat and myeloid tissue. Small (<4 cm) myelolipomas and low attenuating (<10 HU) on NCCT are considered benign. On CECT myelolipoma typically takes slight enhancement because of its poor vascularity. On follow-up serial CT unchanged imaging findings confirm their benign nature. On FDG PET/CT, it shows mild homogeneous FDG uptake in soft tissue component with no uptake in fat component. Such characteristic on PET/CT needs no further evaluation and considered as benign nature. In patients of oncological workup, special attention is needed in such cases where there is any deviation from the typical presentation like focal increased radiotracer uptake.[15,16] Figure 4 represents the histologically confirmed case of myelolipoma in a patient of carcinoma breast.

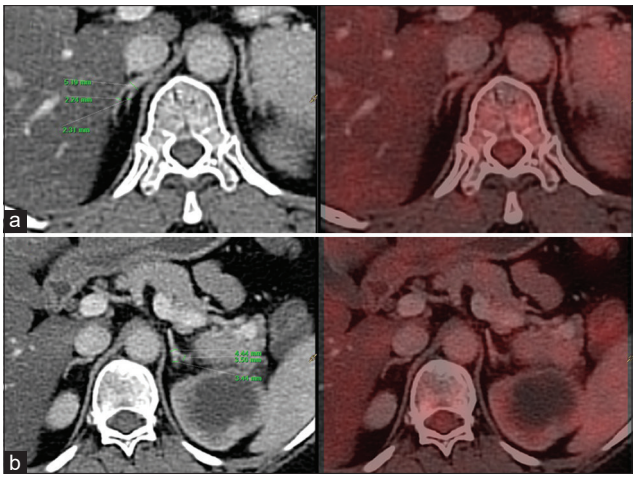

Figure 1: Normal. Computed tomography (CT) and corresponding positron emission tomography/CT images showing metabolically inactive normal appearing bilateral adrenal glands. CT images also demonstrating the measurements of both adrenal glands (a [right] and b [left]), i.e., maximum width of the body and both limbs

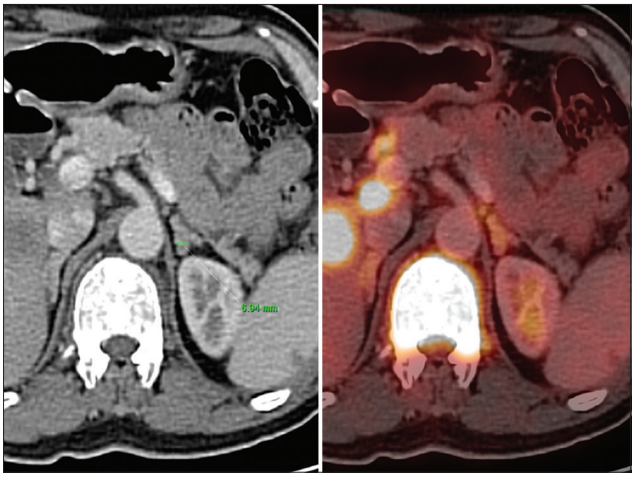

Figure 2: Bulky adrenal gland. Diagnosed case of a 50-year-old male having lung carcinoma computed tomography (CT) and corresponding positron emission tomography-CT images showing mildly metabolically active (SUV_{max} of 2.6) bulky left adrenal gland with retained adreniform contour

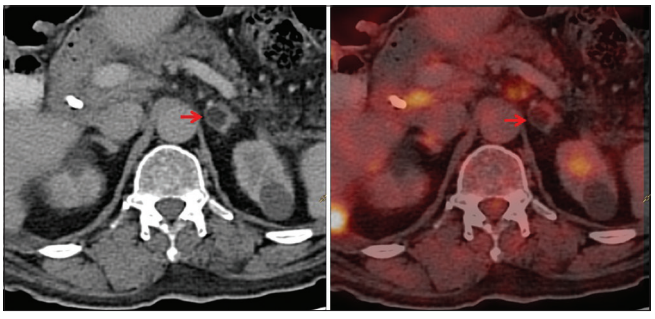

Figure 3: Adenoma. A 75-year-old male having carcinoma gallbladder with incidentally detected adrenal adenoma on fluorodeoxyglucose positron emission tomography–computed tomography (PET/CT). CT and corresponding PET/CT images showing a metabolically inactive homogenous well defined hypodense nodule in the left adrenal gland

Adrenocortical carcinoma

Adrenal cortical carcinoma (ACC) is a rare entity and most common primary of adrenal gland.[17] On imaging, there are several features which are suggestive of ACC like tumor >4 cm size, irregular margins, heterogeneous enhancement, central hemorrhage/necrosis, invasion of adjacent structure, venous extension, and calcifications. Anatomical cross-sectional imaging like CT and MRI is essential for staging and management of the disease. The typical appearance on NCCT is of a large, well-defined heterogeneous mass, and after contrast agent injection, it shows heterogeneous enhancement.[18] Metastatic disease is the independent prognostic factor for adrenocortical carcinoma.[19] The median survival of patients with Stage I–III is significantly higher than Stage IV disease.[20] PET/CT is the useful modality to discriminate malignant from benign lesions, staging the disease[21,22] and having higher diagnostic accuracy more than conventional imaging like ultrasound, CECT, and MRI.[12,23] We represent a case of histopathologically confirmed case of a right adrenocortical carcinoma on PET/CT imaging in Figure 5.

Pheochromocytoma

Pheochromocytoma is the neuroendocrine tumor of adrenal medulla. They have variable clinical, imaging, and pathological features, so difficult to diagnose. Diagnostic cross-sectional imaging CT and/MRI have high sensitivity for detection but lacks specificity.[24] Small pheochromacytomas are mostly well defined solid but larger can be cystic or hemorrhagic to variable degrees with intense contrast enhancement because of hypervascularity.[25] Spontaneous neoplastic hemorrhage in adrenal is most common in pheochromocytoma and it account for approximately 50% of cases.[26] Functional imaging like PET/CT has prime importance in their detection because of its sensitivity and specificity.[27] In their diagnostic algorithm for interpretation of accurate clinical, biochemical, anatomical and functional imagining helps for tailoring the individualized patient centered treatment plan. ^{18}F-FDG PET/CT is used for high-grade neuroendocrine tumor and in majority of case where there is discrepancy between diagnostic positive CT and negative SSTR PET/CT.[28] Here, we have a classical presentation of pheochromocytoma on FDG PET/CT having left adrenal mass with solid cystic component, central fluid attenuation (hemorrhage) and fluid-fluid level in Figure 6.

Lymphoma

Adrenal lymphoma is the rare condition which may be either primary or secondary to a systemic lymphoma. Primary accounts for <1% of all the non-Hodgkin's lymphoma and have poor prognosis.[29,30] In clinical scenario, adrenal insufficiency is expected. Usual manifestation of primary adrenal lymphomas is large (>3 cm), well defined, homo or slightly heterogeneous/complex hypoattenuating mass which shows slight enhancing on CT with retained adreniform shape. Adrenal lymphomas are FDG avid on PET/CT.[29,31,32] We present the two cases of non-Hodgkin's

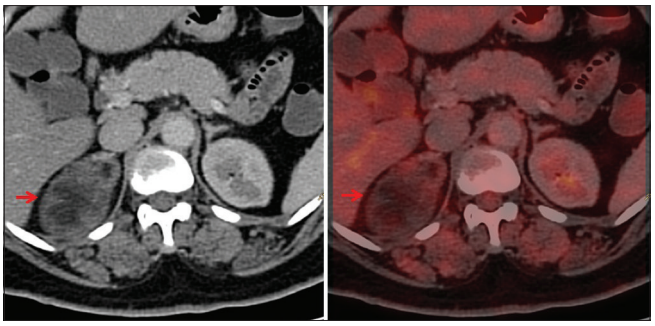

Figure 4: Myelolipoma. A 45-year-old female with carcinoma of the left breast having myelolipoma of the right adrenal gland (histopathologically proven) on positron emission tomography–computed tomography (PET/CT) scan. CT and corresponding PET/CT images showing a metabolically inactive well-defined mass of the right adrenal gland with admixture of low and higher attenuation content

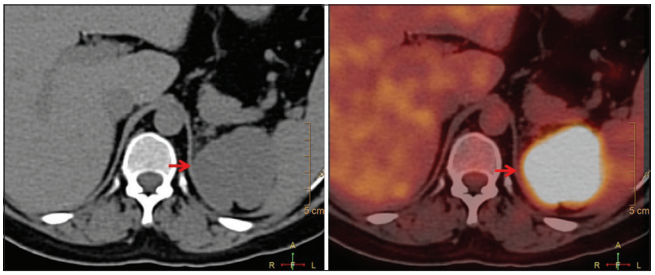

Figure 5: Adrenocortical carcinoma. A 30-year-old histopathologically confirmed case of adrenocortical carcinoma on positron emission tomography–computed tomography (PET/CT) scan. Noncontrast CT and corresponding PET/CT images showing a hypermetabolic large homogenous mass of the left adrenal gland (noncontrast CT was performed because of renal insufficiency)

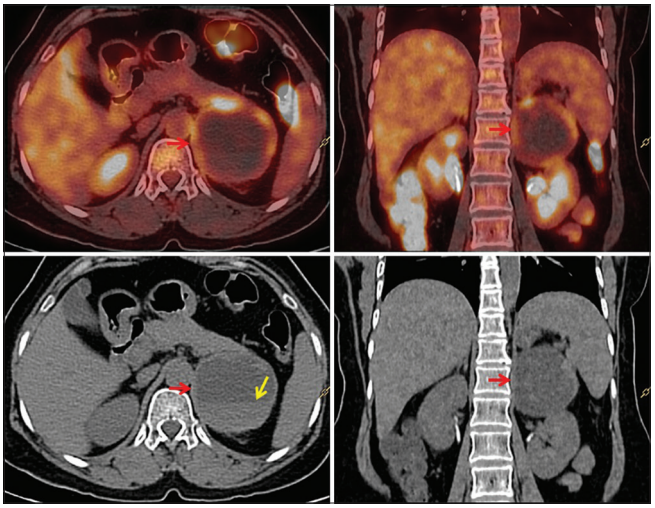

Figure 6: Pheochromocytoma. Histopathologically confirmed case of a 56-year-old male having pheochromocytoma on fluorodeoxyglucose positron emission tomography–computed tomography (PET/CT) scan. Noncontrast CT and corresponding PET/CT images showing peripheral hypermetabolism in a well-defined heterogeneous lesion (solid cystic type) with central area of fluid attenuation and fluid–fluid level (yellow arrow)

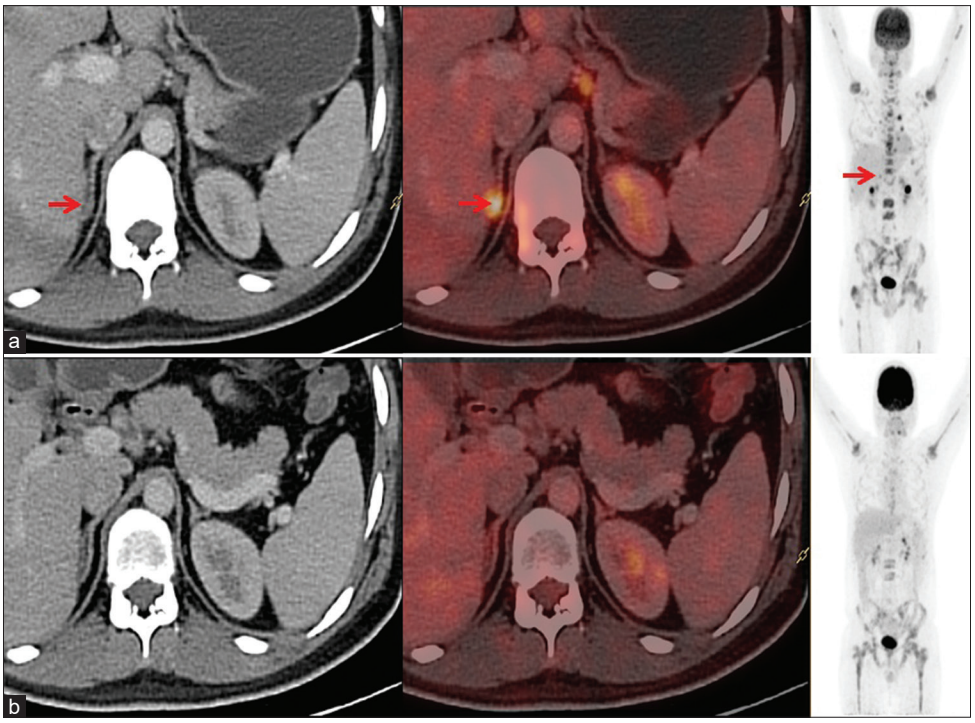

Figure 7: Non-Hodgkin's lymphoma. (a) A 30-year-old male histologically confirmed case of Non-Hodgkin's lymphoma (NHL) came for staging and restaging positron emission tomography–computed tomography (PET/CT) after 6 cycles of chemotherapy. CT, PET/CT, and maximum intensity projection showing a metabolically active nodule in the medial limb of the right adrenal gland. (b) Metabolic as well as anatomic resolution of the right adrenal nodule on restaging PET/CT

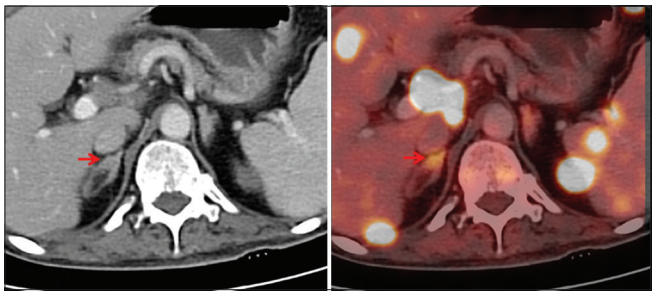

Figure 8: Non-Hodgkin's lymphoma. Computed tomography (CT) and corresponding positron emission tomography/CT of a 68-year-old male having diffuse large B cell lymphoma diagnosed from ascending colon (postexcisional specimen) showing a metabolically active nodule in the lateral limb of the right adrenal gland. Images also showing metabolically active abdominal lymph nodes and hepatic, splenic, and peritoneal deposits

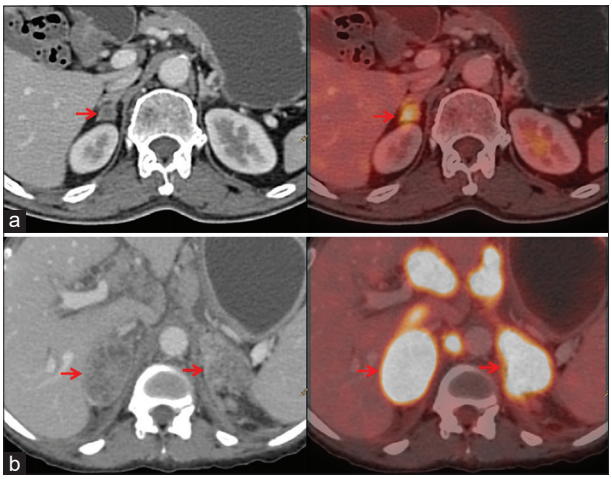

Figure 9: Metastases. (a) A 63-year-old male having squamous cell carcinoma of the lung having right adrenal metastasis on positron emission tomography–computed tomography (PET/CT) scan. CT and corresponding PET/CT images showing a metabolically active hypodense nodule in the right adrenal gland. (b) A 35-year-old female having gallbladder carcinoma on PET/CT scan. CT and corresponding PET/CT images showing metabolically active heterogeneously enhancing lesions of the bilateral adrenal gland. Images also showing metabolically active abdominal and retroperitoneal lymph nodes

lymphoma, one having metabolically active left adrenal nodule which completely resolved metabolically as well anatomically after 6 cycle of chemotherapy [Figure 7] and latter is diagnosed case having metabolically active lymphomatous right adrenal nodule [Figure 8].

Metastasis

Metastasis is the second most common adrenal lesion. Adrenals are the most frequent metastatic site for all cancers after the lung, liver, and bone.[33] The vast majority of adrenal metastases are found on autopsy but uncommon clinical presentation[7,34,35] and during cancer staging or on incidental scan.[36] On NCCT, adrenal metastasis usually has higher attenuation density (>10 HU) and having intense and prolonged enhancement on contract but shows slower washout in comparison to adenomas. Adrenal metastases have significant FDG uptake.[37] PET/CT and biopsy have high accuracy in the diagnosis of adrenal metastases.[21,38] We show the unilateral and bilateral adrenal metastases in diagnosed cases of lung and gallbladder carcinoma [Figure 9].

Conclusions

It may be difficult to differentiate various adrenal lesions without careful correlation with the patients' clinical histories, laboratory test, and other imaging findings. ^{18}F-FDG PET/CT is a powerful tool to evaluate the various adrenal lesions. Knowledge of characteristic spectrum and pattern of FDG uptake of adrenal lesions is helpful for increasing diagnostic accuracy in reading of FDG PET/CT scan and expanding the differential diagnosis.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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