Pictorial Essay

Patterns of brown fat uptake of 18F-fluorodeoxyglucose in positron emission tomography/computed tomography scan

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ABSTRACT

Fluorodeoxyglucose (FDG) positron emission tomography (PET) has become the common imaging modality in oncological practice. FDG uptake is seen in brown adipose tissue in a significant number of patients. Recognizing the uptake patterns is important for optimal FDG PET interpretation. The introduction of PET/computed tomography (PET/CT) revolutionized PET imaging, bringing much-needed anatomical information. Careful review and correlation of FDG PET images with anatomical imaging should be performed to characterize accurately any lesion having high FDG uptake.

Keywords: Brown adipose tissue, brown fat, fluorodeoxyglucose positron emission tomography

INTRODUCTION

Brown adipose tissue (BAT) functions as a thermogenic organ by producing heat to maintain body temperature in many mammals, especially in the young.[1,2] It is involved in nonshivering thermogenesis and in diet-induced thermogenesis. This tissue has elevated cellular density, rich vascularization, innervations, and multilocular intracellular lipid droplets. BAT overexpress uncoupling protein (UCP1) more than white fat. Fluorodeoxyglucose (FDG) uptake in this hypermetabolic BAT can be confused with nodal uptake, leading to false positive results.[3] It not only can leads to false-positive findings but also can decrease the sensitivity of the tumor uptake by decreasing the pool of FDG availability.[4] BAT requires glucose not as a direct source of heat production but as a source of adenosine triphosphate. The adenosine triphosphate resulting from glycolysis is required for continued fatty acid oxidation in the mitochondrial UCPs in BAT, which is a main mechanism for heat production.[5] It is richly innervated by sympathetic nervous system predominantly expressing β_3-adrenergic receptor and glucose accumulation of brown fat is increased by sympathetic stimulation.[6] Brown fat uptake is noted in neck, shoulder, paravertebral region, mediastinum, perirenal, and perigastric regions [Figures 1-6].[7,8] Positron emission tomography/computed tomography (PET/CT) allows to verify BAT uptake (standardized uptake value max = 1.9–20) foci have no corresponding anatomic soft-tissue mass detectable by computed tomography (CT) scanning. Rather, the FDG–avid focus fused to tissues of fat density. The corresponding hounsfield are within the reported fat-density range (−150 to −50).[9] It seems improbable that malignant pathologic foci of this intensity and size shown by positron emission tomography (PET) imaging could have no corresponding CT findings. The PET findings could help in recognizing this artifact. The intensity and standardized uptake value are not reliable tools for differentiating among these categories. Several pharmacologic methods have been tried to reduce FDG uptake by hypermetabolic BAT, e.g., use of propranolol, fentanyl, etc. Among the nonpharmacologic approaches use of high-fat, very low-carbohydrate, protein-permitted diet, and warming are the useful approach for significant reduction of the frequency of BAT hypermetabolism. None has been reliable, and most have involved pharmacologic intervention, which is especially undesirable in the pediatric population. Warming has been used, as has administration of benzodiazepines, propranolol, and even fentanyl.[10-13] Nicotine

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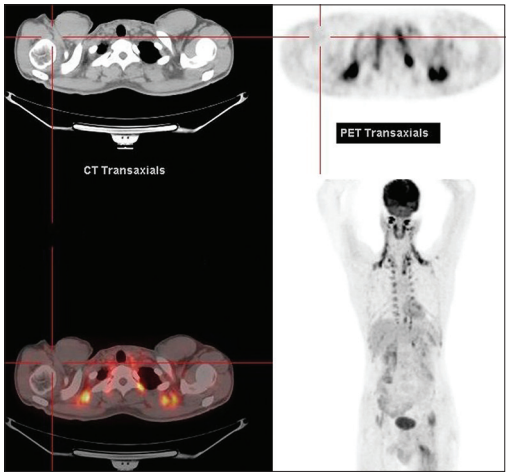

Figure 1: Positron emission tomography/computed tomography images, of a 25-year-old male who presented with chondrosarcoma of left inferior pubic ramus, showing supraclavicular, and paravertebral brown fat fluorodeoxyglucose uptake

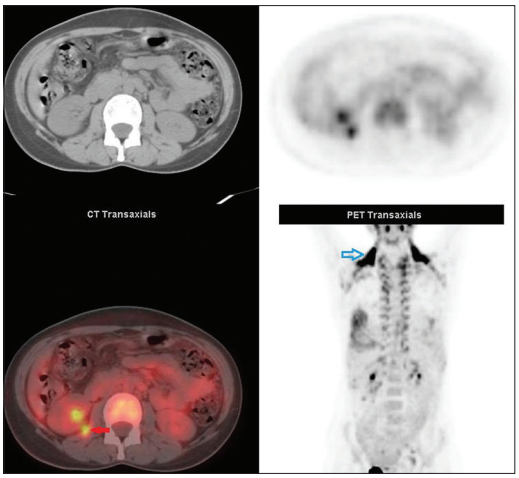

Figure 2: A 23-year-old female presented with right subretinal granuloma was subjected to positron emission tomography/computed tomography that shows supraclavicular, paravertebral, and perirenal brown fat fluorodeoxyglucose uptake

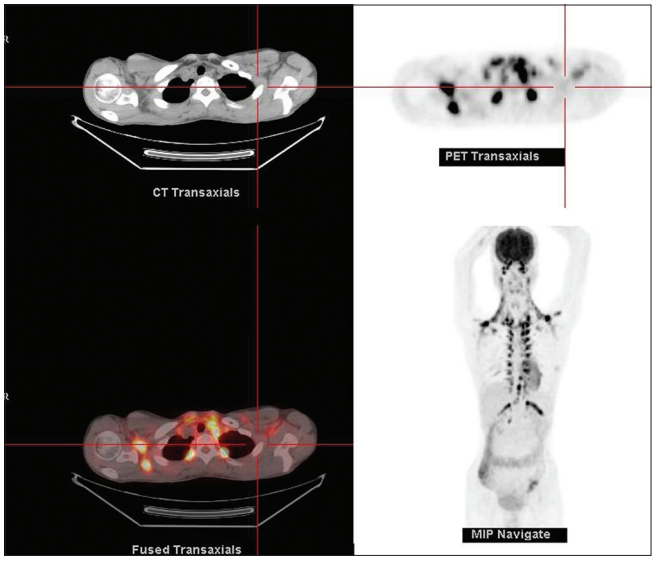

Figure 3: Positron emission tomography/computed tomography imaging in a 20-year-old male case of nonHodgkin lymphoma post six cycles of salvage chemotherapy showing supraclavicular, paravertebral, perisplenic, and perirenal brown fat fluorodeoxyglucose uptake

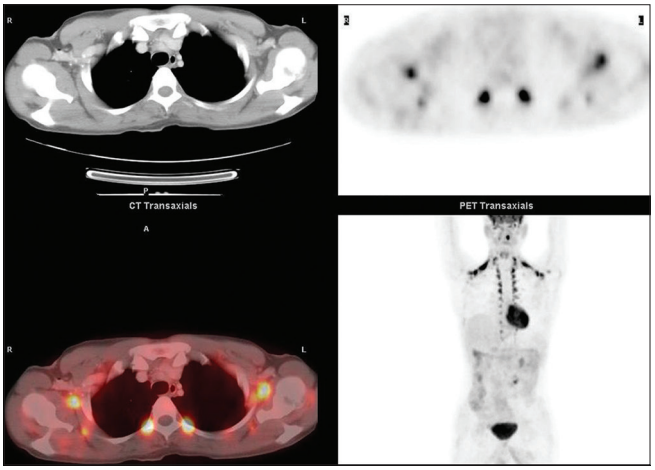

Figure 4: Positron emission tomography/computed tomography imaging in a 34-year-old male patient of left-sided seminoma testis post six cycles of chemotherapy and radiotherapy showing supraclavicular, axillary, and paravertebral brown fat fluorodeoxyglucose uptake

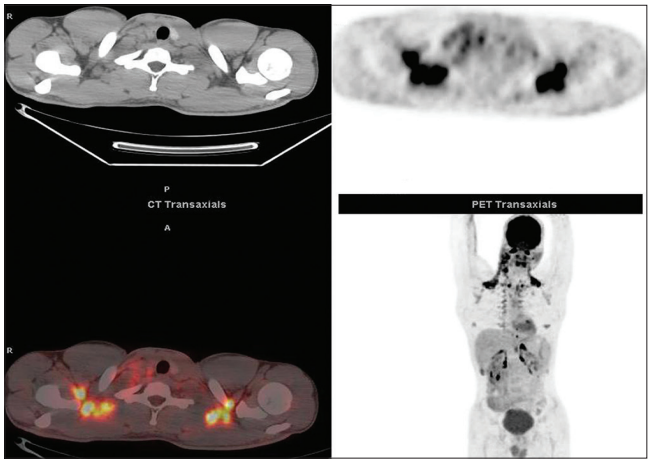

Figure 5: Positron emission tomography/computed tomography imaging in a 22-year-old male patient with Hodgkin's disease showing asymmetrical, perisplenic, and perirenal brown fat fluorodeoxyglucose uptake

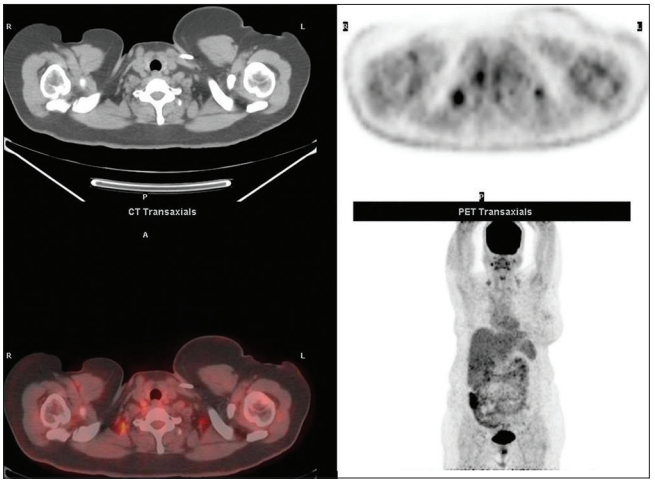

Figure 6: Positron emission tomography/computed tomography images of a 48-year-old female who presented with right carcinoma breast post total mastectomy and axillary clearance, chemotherapy, and radiotherapy. Small area of brown fat fluorodeoxyglucose uptake is seen in the neck

has been found to increase uptake of hypermetabolic BAT.[14] We present some patterns of brown fat uptake.

CONCLUSION

Unexpected and varied FDG uptake is seen in whole body FDG PET/CT studies. During interpretation of FDG PET/CT scan it should be kept in mind and PET images are correlated with CT images and Hounsfield Units, which will minimize the false positive findings.

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