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Research Article

Incidence of Incidental Findings on Pediatric Oncologic PET/CT

Abstract

The purpose of this study is to determine the incidence and significance of incidental findings on pediatric oncologic PET/CT. A retrospective analysis of all PET/CT scans obtained at Helen DeVos Children's Hospital between 2004-2008 in pediatric oncology patients was performed. Specific data points for study including DOB, primary diagnosis, secondary diagnosis, treatment status (chemotherapy and radiation) and PET/CT findings were obtained. Studies were reviewed and findings confirmed with board certified Nuclear Medicine and Pediatric Radiologists. Total of 104 patients with various tumors/malignancies underwent 323 integrated PET/CT for staging or monitoring. Of these 104 patients, 71 (68%) had at least one incidental finding present on the PET/CT and 116 of 323 (36%) studies had at least 1 incidental CT finding. In conclusion, our retrospective study shows that careful evaluation of especially the CT component of integrated PET/CT scans provides clinically important information which may necessitate additional workup or treatment.

Significance

Determine the incidence and significance of incidental findings on pediatric oncologic PET/CT.

Introduction

PET with the glucose analog 18F-FDG is increasingly recognized as a powerful tool in evaluating patients with various malignant tumors [1-3]. Recently, combined PET and CT systems (PET/CT) have emerged as promising imaging modalities and are being more routinely used in clinical situations [4-6]. PET/CT offers routine precise fusion of metabolic PET images with high-quality CT images.

Routine PET combines information from emission scans obtained with F-FDG and from transmission scans obtained with germanium-68 or cesium-137 for attenuation correction. CT has been adapted as the transmission scan, and the adaptation has enabled acquisition of fused PET/CT images. The CT component of PET/CT is also whole-body CT, and abnormalities that can affect treatment decisions or warrant additional treatment may be present. Therefore, it is important that CT images be interpreted in addition to PET images.

The purpose of our study was to report the prevalence of abnormalities that do not show increased F-FDG uptake on the CT component of integrated PET/CT in pediatric oncology patients.

Materials and Methods

A retrospective analysis of consecutive PET/CT scans in pediatric oncology patients obtained at Helen DeVos Children's Hospital between 2004-2008 was performed. A total of 104 pediatric patients with various tumors/malignancies underwent 323 integrated PET/CT scans for staging or monitoring during the study period.

The most important variables for this study are the malignancy type, treatment status, and other diagnoses.

Axial CT images from all of the PET/CT studies were reviewed on stand-alone Picture Archiving and Communications Systems (PACS) workstations and correlated with findings from the accompanying PET and fused PET/CT images. The studies were reviewed and the findings confirmed by a board certified Nuclear Medicine and Pediatric Radiologist. For each patient with an abnormality present on CT scans that did not show increased F-FDG uptake, details were recorded concerning the nature of the abnormality, the anatomic location, and any information from previous and subsequent imaging studies and from the medical notes.

All recorded findings were classified as being of major, moderate, or minor significance, corresponding to definitions previously used in similar studies [7-9].

Major significance

CT appearance was highly suspicious for an abnormality relevant to the immediate treatment of the patient (e.g., additional cancers, metastatic lesions, other abnormalities that necessitated prompt clinical assessment).

Moderate significance

Imaging appearances suggested clinically important disease but required further correlation with other clinical or imaging findings.

Minor significance

Imaging appearances did not suggest clinically important disease and did not require additional workup.

Results

A total of 104 (46 female, 58 male) pediatric patients with various tumors/malignancies underwent 323 integrated PET/CT scans for staging or monitoring during the study period.

Lymphoma (52)
Rhabdomyosarcoma (7)

Osteosarcoma (7)
Ewing Sarcoma (6)

- Testicular cancer (3)
- Wilms tumor (2)
- Glioma/Low grade glioma (1)
- Noonan’s syndrome (1)
- Right chest mass/PNET (1)
- Epilepsy or intractable seizures with Leukemia (7)
- Pheochromocytoma (2)
- Undifferentiated metastatic renal cell carcinoma (1)
- Low grade adenocarcinoma of the parotid gland (1)
- Melanoma (4)
- Myofibroma (3)
- Undifferentiated sarcoma (4)
- Castleman’s syndrome (1)
- Thyroid carcinoma (1)

71 (68.2%) had at least one finding present on the CT component of the studies that did not exhibit correlative F-FDG activity.

116 of 323 (35.9%) studies had incidental findings on CT, constituting a total of 128 abnormalities **Tables 1-3, (Figures 1-8)**.

Location

- Thorax (45)
- Abdomen or pelvis (44)
- Head and neck (29)
- Bony skeleton (10)

Significance of findings

- Major – 17/128 (13.3%)
- Moderate – 73/128 (57%)
- Minor – 38/128 (29.6%)

Discussion

The CT component of PET/CT, even if performed for purely anatomic localization, must be comprehensively interpreted to accurately identify all potentially important findings [9]. Evidence in our study shows that careful evaluation of the CT component of integrated PET/CT scans provides clinically important information.

Table 1: Incidental thoracic PET/CT findings that did not accumulate F-FDG.

Findings	Total	Major	Moderate	Minor
Pulmonary nodules	15	15		
Parenchymal consolidation	15		15	
Pleural effusion & atelectasis	4		4	
Pericardial effusion	2		2	
Thrombus	8		8	
Paramediastinal fibrosis	1			1

Table 2: Incidental head, neck and bony skeletal PET/CT findings that did not accumulate F-FDG.

Findings	Total	Major	Moderate	Minor
Paranasal sinus disease	25		25	
Thyroid hypodensities	2			2
Minimal downward displacement of cerebellar tonsils	1			1
Post treatment changes in thalamus and midbrain	1			1
Spondylolysis	5			5
Pectus carinatum deformity	1			1
	1			1
Schmorl’s nodes	1			1
Focal hypodensity in left obturator	1			1
Large lytic lesion in inferior pubic ramus	1			1

Table 3: Incidental abdominal and pelvic PET/CT findings that did not accumulate F-FDG.

Findings	Total	Major	Moderate	Minor
Renal hypodensities(cysts vs. infarction)	12			12
Focal fatty infiltration of liver	3		3	
Renal calculi	1			1
Hydronephrosis	2		2	
Cholethiasis	2			2
Intussusceptions	2	2		
Nodular bowel thickening (enteritis)	3		3	
Splenic cysts	1			1
Splenomegaly	7		7	
Ascites	1		1	
Dermal thickening (breasts & buttock & posterior thigh)	2		2	
Mural thickening of bladder	1		1	
Calcification of adrenal gland	1			1
Ovarian cysts	6			6

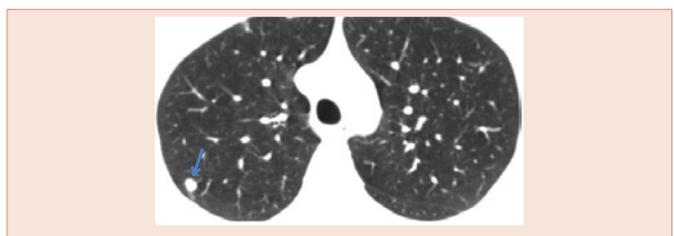


Figure 1a: 18 year old male with metastatic testicular germ cell cancer and incidental multiple pulmonary nodules (arrow) at routine PET/CT imaging.

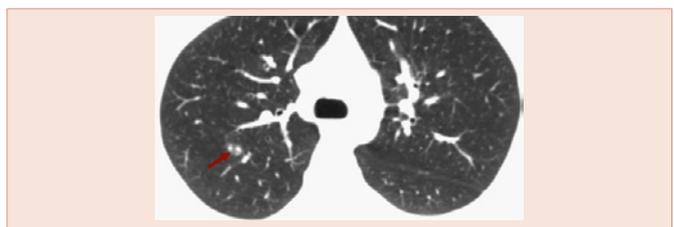


Figure 1b: 18 year old male with metastatic testicular germ cell cancer and incidental multiple pulmonary nodules (arrow) at routine PET/CT imaging.

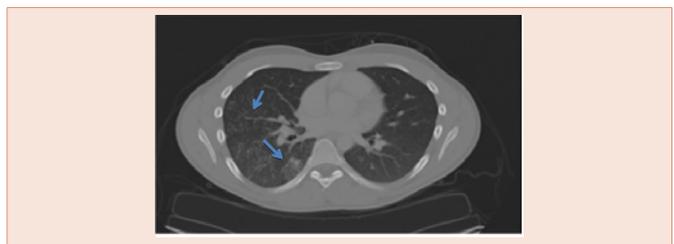


Figure 2: 17 year old male with large cell lymphoma and incidental right middle lobe pneumonia (arrow) detected at routine PET/CT imaging.

Our classification of abnormalities as being of major, moderate, or minor clinical importance, although somewhat subjective to the pediatric population, was used in an attempt to quantify the significance of abnormalities present on the PET/CT studies.

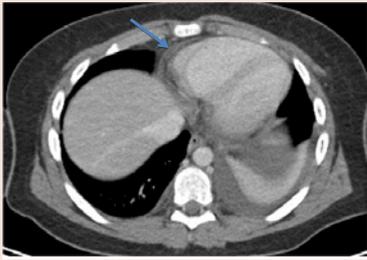


Figure 3: A 15 year old male with Burkitt's Lymphoma and incidental pericardial fluid collection (arrow) detected on routine PET/CT imaging.



Figure 4a: A 16 year old female with anaplastic large cell lymphoma and incidental marked mural thickening (arrow) of proximal ascending colon on routine PET/CT imaging.

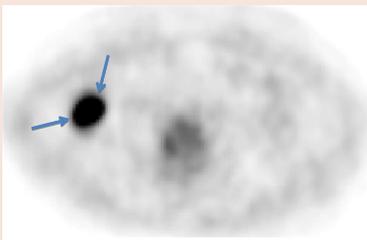


Figure 4b: A 16 year old female with anaplastic large cell lymphoma and incidental marked mural thickening of proximal ascending colon (arrow) on routine PET/CT imaging.



Figure 5: A 16 year old male with stage 4 Hodgkins lymphoma and incidental transient small bowel Intussusception (arrow) on routine PET/CT imaging.

Some findings, such as transient intussusceptions, are unique to the pediatric population. Most cases of intussusceptions occurring between birth and five years of age are idiopathic. When intussusceptions develop in older children, it is usually due to what is known as a pathologic lead point. Meckel's diverticulum and

lymphoma are two classic examples of lead points. All three of the patients in our study with transient intussusceptions were older children with lymphoma.

In any patient with an underlying malignancy, there should be a heightened awareness to identify metastatic disease. Lymphoma, sarcoma, and testicular carcinoma, among others, have a high tendency to metastasize to the lungs. In our study, we had 15 patients with incidental pulmonary nodules on the CT thorax component of PET/CT. These nodules were identified and followed up closely on consequent PET/CT studies.



Figure 6: A seven year old male with nasopharyngeal rhabdomyosarcoma and incidental severe sinusitis (arrow) on routine PET/CT imaging.



Figure 7: An 18 year old male with Hodgkins lymphoma and incidental transient intussusceptions (arrow) in the left upper quadrant bowel on routine PET/CT imaging.

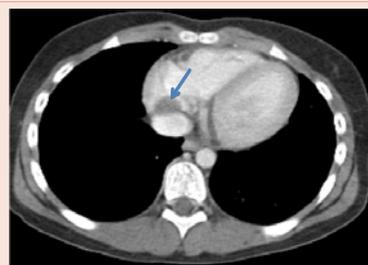


Figure 8: An 11 year old female with osteosarcoma with incidental right atrial thrombus (arrow) detected on routine PET/CT imaging.



Most of our patients are in a hypercoagulable state due to their malignancy. A hypercoagulable prothrombotic state of malignancy occurs due to the ability of tumor cells to activate the coagulation system and it has been estimated that hypercoagulation accounts for a significant percentage of mortality and morbidity in cancer patients [10]. In our study, we identified 8 patients with a thrombus. Twelve patients were identified with renal hypodensities that could represent either simple cysts or small infarcts.

Oncology patients are also in an immunosuppressed state and their chances of acquiring an atypical infection is high. We identified a total of 15 patients with pneumonia and a total of 25 patients with paranasal sinus disease. Four patients had pleural effusions.

The CT component of PET/CT is also very useful for identifying radiation/chemotherapy induced changes. It is important to become aware of these changes so that these are not confused with tumor or reoccurrence of tumor. We had three patients with enteritis of colon, 3 patients with focal fatty liver, two patients with dermal changes (breast and buttocks), one patient with bladder wall thickening, and one patient with radiation induced changes in the brain, two patients with hydronephrosis, and one patient with pericardial effusion.

Finally, it is good to identify findings that are of minor clinical relevance because if symptoms due to these abnormalities develop, it is likely that the diagnosis will be reached more quickly if the presence of the abnormalities is known [11]. We identified 5 patients with spondylosis, 1 patient with a large lytic lesion in the inferior pubic ramus (likely an enchondroma), two patients with cholelithiasis, one patient with a non-obstructive renal calculi.

Conclusion

Our retrospective study indicates that incidental findings are common and most had moderate or major significance. This

establishes that PET/CT imaging is a very valuable tool for diagnosing additional pathology that may necessitate additional workup or treatment.

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