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Role of Positrone Emission Tomography in Assessment of Renal Masses

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Abstract: Background: Positron emission tomography (PET) and combined PET/computed tomography (CT) are increasing lyused for oncologic imaging. Fluorodeoxy glucose (FDG) PET demonstrates abnormal metabolic features associated with malignancy that often precedes morphologic findings demonstrated with anatomicimaging. **Aim of the work:** The aim of this work is to evaluate the role of PET- CT in assessment of renal masses. **Patient and Methods:** The study will be carried out on 50 patients referred to the Radiodiagnosis department at Sharq El Madina Hospital presenting with different types of malignancies during the time period starting at April 2017 till august 2019. **Results:** 25 (50%) of cases have high FDG uptake distributed as, and 24 cases all are malignant lesions (48%), 19 cases (76%) have RCC with mean SUV max 10.7, 3 cases have lymphoma (12%) with mean SUV max 36.5, 1 case has renal metastasis (4%) with SUV max 6 and 1 case has urothelial tumour (4%) with SUV max 14, and 1 case was pathologically proved oncocytoma with SUV max 19. **Conclusion:** FDGPET is better for evaluating a local recurrence of RCC due to high metabolic activity of a tumor and not influenced by several factors, such as migration of the adjacent normal organs into the empty renal fossa, postoperative scarring and artifacts from surgical clips that make interpretation of CT of the renal bed difficult.
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Keywords: Positrone Emission Tomography, Renal masses, PET/CT imaging

1. Introduction

Positron emission tomography (PET) and combined PET/computed tomography (CT) are increasing lyused for oncologic imaging. Fluorodeoxyglucose (FDG) PET demonstrates abnormal metabolic features associated with malignancy that often precedes morphologic findings demonstrated with anatomic imaging. **(Tatsumm et al; 2006).** Focal incidental renal lesions are commonly encountered on FDG PET/CT imaging. The vast majority of these lesions are benign. **(Kochhar et al; 2010).** Renal cysts are the most commonly encountered renal lesions, on imaging with FDG PET/CT, simple renal cysts are photopenic. Simple renal cysts do not need PET/CT for characterization and do not require follow up. The challenge is with complex cysts and FDG PET/CT has a role for the non-invasive characterization of indeterminate cysts PET/CT can also help in precise anatomic localization and percutaneous drainage of an infected cyst in autosomal dominant polycystic kidney disease because these are difficult to localize with conventional imaging. **(Kaim et al; 2001).** Angiomyolipoma is the most common benign solid renal neoplasm and has a higher incidence of association with lymphangioleio myomatosis and tuberous sclerosis. Angiomyolipomas are often diagnosed on CT by the presence of macroscopic fat in the absence of calcification. FDG uptake is variable but often low. (**Arnold et al; 2009).** There are several benign tumors that arise from the renal parenchyma, such as oncocytomas, papillary renal cell adenomas, and metanephric adenomas. Most of these lesions are rare; however, renal oncocytomas are thought to represent up to 5% of renal cortical tumors. The vast majority are well differentiated and benign FDG PET/CT cannot discriminate between RCC and oncocytoma, and at issue diagnosis is necessary. (**Zhang et al; 2007).** Renal metastasesr are and often clinical lysilent. They are small, multicentric and bilateral, and can be easily missed on conventional CT imaging. Among the primary tumors that are the most common sources of renal metastases lymphoma, lung cancer and colon cancer show particularly intense FDG activities. Metastases to the kidney from these types of primary malignancies can be detected clearly on FDG PET as hotspots of increased uptake. **(Kaneta et al; 2006).**

The aim of this work is to evaluate the role of PET- CT in assessment of renal masses.

2. Materials and methods

Ethical committee approval: The aim and

nature of the study were explained for each patient before inclusion. An informed consent was obtained Then examinations were performed.

The study will be carried out on 50 patients referred to the Radiodiagnosis department at Sharq El Madina Hospital presenting with different types of malignancies during the time period starting at April 2017 till august 2019.

Exclusive criteria included

- Patient proven to be normal by PET\CT.
- Pregnant females.

Patients were subjected to the following:

1. Full history taking.
2. Laboratory Testing.
3. PET/CT examination:

Exams were done and data were obtained using Siemens Bio-graph true point PET/CT scanner. These dedicated systems integratea PET scanner with amulti-slicehelical CT scanners permit the acquisition of co-registered CT and PET images in one session.

Imaging protocol Patient Preparation

All patients were asked to fast for six hours prior to scan. All metallic items were removed from the patients and they were given gown to wear. Patients were asked to empty their bladders before the procedure. An I.V. cannula was inserted in the patient's arm for administration of 18F-FDG. The patients were instructed to avoid any kind of strenuous activity prior to the examination and following injection of the radioisotope to avoid physiologic muscle uptake of FDG and the patient was asked to void prior to scanning**.**

Serum glucose was routinely measured prior to 18F-FDG injection, and fasting levels were 70–170 mg/dl. The strategies for decreasing brown fat were; providing a controlled-temperature (warm) environment for patients before 18F-FDG injection and high-fat, low- carbohydrate, protein-permitted diet before the examination.

Dosage administration of FDG

About one liter of negative oral contrast agent (5% mannitol) approximately one hour before the exam. A dose of 0.1 mCi/kg of 18F-FDG IV injection 45–90 minutes before examination was administered**.**

Scanning Technique

I. CT Technique
II. PET Technique
III. PET/CT Fusion PET/CT Interpretation

Statistical analysis of the data

Data were fed to the computer and analyzed using IBM SPSS software package version 20.0**.** Qualitative data were described using number and percent. Quantitative data were described using range (minimum and maximum), mean, standard deviation and median.

3. Results

Table 1: show that Most of bengin lesions are accidentally discovered 24 cases (renal cysts, angiomyolipoma, oncocytoma), or coming for follow up after partial nephrectomy 2 cases (renal scars), while malignant lesions coming for follow up 21 cases (42%), or a known case of lymphoma 3 cases (6%) or a malignant neoplasm with unknown primary 2 cases (4%). **Table 2**: Show that 13 cases (26%) have local invasion, all 13 cases have facial invasion, 4 cases (30.8%) have local lymph node invasion, 3 cases (23%) have psoas muscle invasion 1 case has renal vein invasion (7.7%), and 1 case invade hepatorenal pouch 7.7%. **Table 3:** show that 13 cases out of 50 (26%) have metastasis to different organs, the most common metastasis were to lung 6 cases outof13(46%), 5 cases (38.5%) have bone metastasis and 4 cases (30.8%) have liver metastasis, 4 cases (30.8%) have adrenal metastasis, 3 cases (23.1%) have metastasis to distant node. 3 cases (23.1%) have peritoneal metastasis. And 3cases (23.1%) have IVC invasion. **Table 4:** show that 25 (50%) of cases have high FDG uptake distributed as, and 24 cases all are malignant lesions (48%), 19 cases (76%) have RCC with mean SUVmax10.7,3 cases have lymphoma (12%) with mean SUV max 36.5, 1 case has renal metastasis (4%) with SUV max 6 and 1 case has urothelial tumour (4%) with SUV max 14, and 1 case was pathologically proved oncocytoma with SUV max 19.

Table (1): Distribution of the studied cases according to site (n = 50)

Complaint	No.	%
Follow up	21	42.0
Accidentally	24	48.0
Known lymphoma	3	6.0
Unknown primary	2	4.0

Table (2): Distribution of the studied cases according to site of local invasion (n = 50)

Site Local and Local LN invasion	No.	%
No	37	74.0
Yes	**13**	**26.0**
Fascial invasion	**13**	**100**
Local lymph node	4	30.8
Hepatorenal pouch	1	7.7
Psoas muscla	3	23
Renal vein	1	7.7

Table (3): Distribution of the studied cases according to presence of metastasis & its site (n = 50)

Metastasis & its site	**No.**	**%**
No	37	74.0
Yes	**13**	**74.0**
Pulmonary	6	46.2
Bone	5	38.5
Adrenal	4	30.8
Liver	4	30.8
Peritoneal	3	23.1
Distant node	3	23.1
IVC invasion	3	23.1

Table (4): Distribution of the studied high uptake cases (n =25)

Pathology	No	%
RCC (Mean suv max 10.7)	19	76.0
Lymphoma (Mean suv max 36.5)	3	12.0
Metastasis (SUV max 6)	1	4.0
Urotheialtumour (Suv max14)	1	4.0
Oncocytoma (SUV max19)	1	4.0

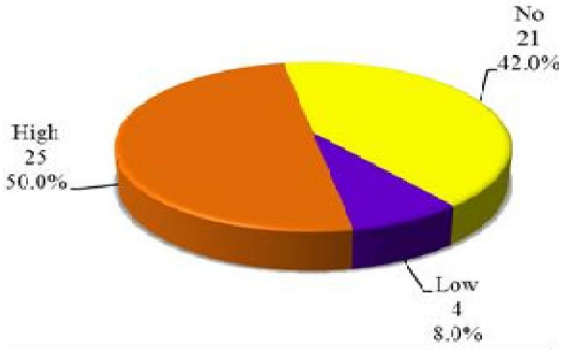

Figure (1): Distribution of the studied cases according to uptake (n = 50)

4. Discussion

In our study 50 cases were studied, 26 cases (52%) were benign lesions they discovered accidentally as a part of other cancer follow up, most common benign lesions are simple renal cysts 19 cases (38%), renal scar after nephrectomy or as part of pyelonephritis 2 cases (4%), both have no FDG uptake 42%, In a study by Goldberg et al., PET correctly classified in determinate cysts as benign in 7 of the 8 patients confirmed by surgery or needle aspiration, and a negative PET scan in conjunction with a negative cyst aspiration offers confirmatory evidence of benignity. PET/CT can also help in precise anatomic localisation and percutaneous drainage of an infected cyst in auto somal dominant polycystic kidney disease because these are difficult to localize with conventional imaging. **(Goldberg et al., 1997)**. In our study 2 cases of angiomyolipoma, were found 4%, with low FDG pet uptake. With low suv max, mean suv max 2. In a study by Chun et al the study reviews FDGPET and PET/CT images of 21 patients diagnosed with renal AML. The diagnosis is based on the classical appearance of an AML on CT scan with active surveillance for 6 months. CT scans illustrated renal masses typical of AMLs, and the corresponding FDG PET scans showed minimal FDG activities in the area of the tumors. None of the 21AMLs showed a maximum standardized uptake value (SUVmax) greater than 1.98. **(Chun et al., 2013)**. Both oncocytoma and RCC are treated surgically. In fact, recent articles have reported cases of local recurrence and even metastases following gresection of oncocytoma. **(Choyke et al., 2003)** These observations suggest that oncocytoma could represent the benign form of malignant chromophobe cell tumours such as RCC. **(Kochhar et al., 2010)**. In our study 3 cases of oncocytoma were studied (6%), 2 of them have low FDG uptake with SUV max less than 3 and one case (2%) has a high FDG uptake and pathologically proved to be oncocytoma. As with AML, the published reports on the FDG appearances of oncocytoma are also limited, in a case study by Michael et al., a renal oncocytoma has intense FDG uptake. In other however, on cocytoma may not have any appreciable uptake of FDG, limiting the usefulness of FDG PET/CT in characterisation. The diagnostic conundrum that usually arises is the differentiation between oncocytoma and RCC, and metabolic imaging may not be helpful in differentiating these lesions. **(Michael et al., 2006)**. In

our study we studied 19 cases (38%) of Renal cell carcinoma all coming for follow up after proper diagnosis, and they were pathologically proved, or coming to follow up after surgery, all has high uptake, 5 cases 10% have local recurrence after prtial nephrectomy, or recuurent to epsilateral node or renal fossa, and 1 case has residual lesion after surgery (2%), and has a post operative residual. Park et al reported local recurrence at the renal fossa, ipsilateral adrenal gland or ipsilateral regional lymph nodes in 12 patients, among them five (8% of the total) had an isolated local recurrence, and the other seven also had distant metastases. Also **Nakatani et al., (2011)** reported two cases with local recurrence (8.7%) & two cases with abdominal lymph nodes (8.7%). Park et al, (Park 2009) discussed that several factors, such as migration of the adjacent normal organs into the empty renal fossa, postoperative scarring and artifacts from surgical clips, make interpretation of CT of the renal bed difficult. The metabolic activity of a tumor is not influenced by these factors. Therefore, FDG PET was found to be better for evaluating a local recurrence. Combined test (CT and PET) may be necessary in management decisions were to be taken and this would take advantage of the high sensitivity of CT and high specificity of PET inpatients with metastatic RCC. PET can also serve as a "problem-solving" modality in cases with equivocal CT or bone scan findings and may prove useful in monitoring treatment response as more effective treatments become available. In our study, 13 cases (26%) have local invasion, all 13 cases have facial invasion,4cases (30.8%) have locally mphnodeinvasion, 3 cases (23%) have psoas muscle invasion 1 case has renal vein invasion (7.7%), and1caseinvadehepatorenal pouch 7.7%, 13 cases of metastatic renal neoplasm were found (26%) there were different sites of distant metastasis that distributed as follow lung is the commonest (6 patients = 46.2%), second is the bone (5 patients=38.5%), third is adrenal (4 patients=30.8%), and the liver (4 patient=30.8%) then distant node (3 patients=23.1%) and peritoneal deposits 3 patients =23.1%), invasion to IVC (3 patients =23.1%) The results of previous study done by Bianchi et al, (109) who reported that The most commonsites were lung (45.2%), bone (29.5%), lymph nodes (21.8%), liver (20.3%), adrenal (8.9%). Bretagna et al, (Bianchi 2012) stated that lung metastases is the most common site which present in 12 (29.3%) patients, lymph nodes metastases in 8 (19.5%) patient, lymph nodes plus lungs in 3 (7.3%) patients, bone metastases in 3 (7.3%) patients, adrenal gland metastases in 1 (2.4%) patient. **Kumar et al., (2010)** found that 28 lesions were in the lungs, 21 in the bones, 12 in retroperitoneal lymph nodes and 27 were at other sites (liver, mediastinal and supraclavicular nodes, abdominal wall, Inferiorvenacava, adrenal glands and psoas muscle). Because the kidneys do not contain lymphoid tissue, primary renal lymphoma is a rare disease representing only 0.1–0.7% of extranodal lymphoma. Renal involvement is, however, commonly encountered in patients with disseminated non‐Hodgkin's lymphoma and is detected in 3–8% of all patients undergoing routine CT imaging there are a number of typical radiological patterns of renal lymphoma, namely: multiple renal masses, solitary masses, renal invasion from contiguous retroperitoneal disease, perirenal disease and diffuse renal infiltration. The commonest appearance on contrast‐enhanced CT is of multiple bilateral low attenuation renal masses. **(Kochhar et al., 2010).**

5. Conclusion and Recommendations

- Most common benign lesion is simple cyst and discovered accidentally on FDG pet study.
- Oncocytoma and angiomyolypoma have Variable FDG uptake. so FDG PET has a limited role in its charectarization.
- Many different renal lesions can be detected clearly as hotspots of elevated uptake on FDG PET/CT. However, excreted FDG in the urinary tract mimics disease and can interfere with image interpretation.
- PET/CT imaging plays a vital part in the restaging and detection of metastatic disease of RCC mainly for LN metastases which can often be falsely negative using the CT size criteria with inability to identify malignant involvement in normal-size lymph nodes or differentiates between malignant and inflammatory enlargement of lymphnodes.
- PET/CT combines the advantages of the excellent functional information provided by PET and the super spatial and contrast resolution given by CT.
- FDG PET is better for evaluating a local recurrence of RCC due to high metabolic activity of a tumor and not influenced by several factors, such as migration of the adjacent normal organs into the empty renal fossa, postoperative scarring and artifacts from surgical clips that make interpretation of CT of the renal bed difficult.
- Renal involvement by lymphoma, leukemia, or metastatic disease is often intenselyavidon FDG PET/CT. However, metabolically active pathology can be missed without close at tention to both the PET and CT portions of the examination, primarily because of physiologic tracer excretion by the kidneys. Therefore, close attention to the kidneys is needed to identify renal lesions and to guide further management.

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