Role of Flourine 18 Fluorodeoxy Glucose (FDG) Positron Emission Tomography (PET)/ Computed Tomography (CT) in Ovarian Cancer

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Abstract
Ovarian cancer is the second most common gynecological cancer in western women, next to uterine cervical cancer. As the symptoms are nonspecific, only 20% of ovarian cancers are diagnosed while they are still limited to the ovaries. Imaging is essential in detection and localization of suspecting recurrent tumor. However, 40-60% of patients treated for ovarian cancer with normal CA-i25 levels and negative clinical findings for recurrence were proved to have recurrence on second look laparotomy. PET/CT is one of the methods used to detect ovarian cancer recurrence; its metabolic tracer makes it superior to other methods in lesion detection ability. Recently, i8 F-Fluorodeoxyglucose (i8 F-FDG) positron emission tomography (PET)/CT has gained widespread acceptance in diagnosing and staging various cancers. Nevertheless, most studies using i8 F-FDG PET/CT in ovarian cancer patients have been limited to detecting recurrence or distant metastasis, and relatively few studies have demonstrated the effectiveness of i8 F-FDG PET/CT in detecting primary ovarian cancer. One of the methods to overcome this problem is to use dual-time point PET imaging in the identification of malignant lesions. Various studies have reported the effectiveness of dual-point PET imaging in different malignancies. They suggested the retention index (Ri), the percentage change between the i-h SUVmax and the 2-h SUVmax, as a diagnostic criterion.

Keywords: Cancer ovary, PET, CT, CA 125, Metastasis1s, Recurrence, Lymph node.

1. Introduction
Ovarian cancer is the second most common gynecological cancer in western women, next to uterine cervical cancer. As the symptoms are nonspecific, only 20% of ovarian cancers are diagnosed while they are still limited to the ovaries [1].

This is why ovarian cancer is the leading cause of death among gynecological cancers. According to estimates by The American Cancer Society, ovarian cancer account for 3% of new cases of female malignancy and 5% of cancer related death in 2009 in the United States [2]. Therefore, early detection and characterization are important and continuing challenges. The most typical symptoms of ovarian cancer include bloating, abdominal or pelvic pain, back pain, Irregular menstruation or post-menopausal vaginal bleeding, pain or bleeding after or during sexual intercourse, loss of appetite, fatigue, diarrhea, indigestion, heartburn, constipation, feeling full, and usually urinary symptoms including frequent and urgent urination [2].

Imaging modalities including computed tomography (CT) and magnetic resonance imaging (MRI) have been performed as adjunct methods to confirm or rule out ovarian malignancy in patients with suspected ovarian malignancy [3]. However, despite having higher sensitivity and specificity than ultrasonography, a preoperative diagnosis is crucial for the correct management of patients.

Recently, 18 F-Fluoro2-deoxyglucose (18 F-FDG) PSI 100 enlissio10 t0 mography (PET)/CT has gained widespread acceptance in diagnosing and staging various cancers. Nevertheless, most studies using 18 F-FDG PET/CT in ovarian cancer patients have been limited to detecting recurrence or distant metastasis, and relatively few studies have demonstrated the effectiveness of 18 F-FDG PET/CT in detecting primary ovarian cancer [4].

Some parameters are used as diagnostic criteria for 18 F-FDG PET/CT to increase the accuracy of detecting malignancy. The most typical method used is SUVmax, which is the maximum standardized uptake value (SUVmax). However, SUVmax has limitations, because it is also increased in benign conditions such as infections, degenerative changes, and inflammatory processes, as well as in malignant lesions [5].

One of the methods is to use dual-time point PET/CT imaging in the detection of malignancy. This parameter is the retention index (Ri), the percentage change between the 1-h SUVmax and the 2-h SUVmax, as a diagnostic criterion.

2. Patient and methods
2.1 Patients
Forty-one patients with suspected ovarian cancer by primary imaging or by CA-125 were referred to perform PET/CT. We evaluated PET/CT and enhanced CT scans for patients with newly diagnosed ovarian cancer or any other malignancy for ovarian cancer following treatment for ovarian cancer or any other malignancy for ovarian cancer. The patients were treated with chemotherapy and/or radiotherapy.

2.2 Study design
It was a single center; 18F-spect2 cleve study that was conducted in Nasser Institute Hospital during the period from October 2018 to October 2019.

All clinical and histopathological 18F-spect2 cleve were collected from the patient’s files. This included the TNM class111 and 10 call10at10n
of the primary tumor, tumor marker levels, the type of treatment received and current reasons for FDG-PET/CT referral.

After approval from ethical committee, an informed consent was obtained from all patients in the research. All data of the patients had been collected as with written consent and private files for each patient.

### 2.3 Methods

Patients fasted for at least 6 hours before the examination, except for water and glucose-free fluid. Blood glucose levels measured less than 200 mg/dL. Patient's weight was assessed. A dose of (0.18–0.21 mCi/kg, 5-14 mCl) FDG was injected intravenously. The patients rested for 1 to 2 hours. After the 45–60-minute uptake period, the patients were asked to void just before entering the examination room. No oral or intravenous contrast agent was used for the PET/CT examination. Multi-detector CT examination from the base of the skull to the upper thighs (120 mA, 140 kVp, table speed = 13.5 mm per 10 seconds) was performed. After CT acquisition, PET acquisition of the same axial range started with the patient in the same position on the table for 2–3 minutes per bed position. PET data was acquired by using a matrix of 128×128 pixels. CT-based attenuation correction was performed on the emission images. After PET data acquisition was completed, the reconstructed attenuation corrected PET images, CT images, and fused images of matching pairs of PET and CT images were available for review in axial, coronal, and sagittal planes, as well as in maximum intensity projections and in three-dimensional caval models. Contrast enhancement was performed by the same scanner 20–50 seconds after gavaging bolus injection of 0.7 mCi/kg. Images were acquired from the base of the skull to the mid-thigh may involve the whole body in case of extensive skeletal spread, using the 2.5 mm thickness section.

### 2.4 Interpretation and Image Analysis

Qualitative assessment for the presence of hypermetabolic lesions were evaluated on corrected PET images. Semi-quantitative evaluation was performed using the Standardized Uptake Value (SUVmax) according to the following formula: [SUVmax = maximum measured activity in the volume of interest (mCi/milliliter)/injected dose of FDG (mCi/milliliter) per gram of body weight of all abnormal foci]. The standard SUVmax of 2.5 was considdered as cut-off, where lesions with SUVmax of 2.5 and above in PET/CT studies were considered positive for disease involvement with findings with SUVmax below 2.5 were considered to be insignificant of disease involvement. Contrast enhanced CT images were evaluated for the presence of hepatic focal lesions, lymph nodes size (more than 10 mm in the short axis) in the liver, focal liver nodules, .

### Table 1

<table>
<thead>
<tr>
<th>PET/CT (Patient based)</th>
<th>TP</th>
<th>TN</th>
<th>FP</th>
<th>FN</th>
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### Table 2

<table>
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<tbody>
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<tr>
<td>Specificity</td>
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<tr>
<td>Accuracy</td>
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### 3. Results

PET/CT scan was positive in 21 patients and negative in 4 patients, 20 patients were true positive, 2 cases were true negative, 1 was false positive and 2 were false negative Table (1).

The CT scan was positive in 18 patients and negative in 7 patients, 17 patients were true positive, 2 cases were true negative, 1 was false positive and 5 were false negative Table (2), Fig (1).

### 4. Discussion

FDG PET/CT imaging is a functional imaging modality that is increasingly used...
woriulde. F-18 FDG PET Imaging is widely used in clI1ncal 0nc0l0gy [7].

Ovarian cancer is the eighth most common cause of cancer death in women worldwide, due to advanced stage disease at presentation. Despite high clINical responsse rates after optimal de-bulking surgery and C0mBInatIon chemotherapy, 50-75% of patients still experience disease relapse [8].

Imaging is essential in detection and locallzatIon of suspecting recurrent tumor. However, 40-60% of patients treated for ovarian cancer with normal CA-125 levels and negative clINical findings for recurrence were proved to have recurrence on sequlnd 100k laparo10omy (Sm1th GT et al., 1999) [9]. PET/CT is one of the methods used to detect ovarian cancer recurrence; its metabolic tracer makes it superior to other methods in lesion detection and abl11ity [10].

Several studies have shown that, among patients who are suspected of having ovarian cancer recurrence, PET/CT has the greatest utility in those patients with rising or normal CA-125 levels and negative conventional imaging results (Gu P et al. 2009) [11]. Acc0rdIng to the cause of referral, our study revealed that 20 patients were referred due to rising CA-125, 13 patients were suspected to have recurrence by diagnostic imaging modalities (US – CT), 7 patients were suspected to have recurrence clINICally, so most of the patients had raised CA-125. These results are in agreement with study made by Sanja Drag0savac who found that most of patients included in the study 80% were with elevated CA-125, 55% of patients were suspected to have recurrence by diagnostic imaging modalities and 33% was suspected clINICally [10].

Serum CA-125 level is an indicat0r of activity In epithelial tumors [12]. Elev1t10n In CA 125 values can be detected 3-6 moInths before clINICal and radiol0g1cal findings [13].

The histopathological results In our study were, 88% of patients had ser0us papillary adenocarcInoma, 8% of patients had clear cell adenocarcInoma and 4% of patients had undifferentiated carcInoma, these are cl0sely c0n1nc1de with study made by Ghada K. G0uhar study to assess the benef1t of 18F-FDG PET/CT In detectIn0n of recurrent ovarian cancer In which 39 patients 87.2% had ser0us papillary adenocarcInoma, 7.7% had clear cell adenocarcInoma, and 5.1% had undifferentiated carcInoma [14].

The present research found that, acc0rdIng to F1G0 class1ficat10n 84% of the patients, had an advanced ovarian cancer at initial diagnosis; 4% of the patients were F1G0 1, 12% were F1G0 11, 65% were F1G0 111 and 20% were F1G0 1V, these c0n1nc1de with results In Ghada K. G0uhar study, they found that patients with stage 11 cancer at Initial diagnosis are the most frequent then stage 1V, these mainly because of high recurrence p0ss1b11ty with advanced stages [14].

The p0s1t1ve patient p0pulat1on included In this study had variable extent Of the recurrence by PET/CT. 9 patients had loc0l pelvic recurrence, 7 patients had pelvic lymph node recurrence, 5 patients had distant lymph node recurrence (Mediast1nal, SupraClav1cular, Axill1ary), 13 patients had per1toneal dep0s1ts as a recurrence and 10 patients had distant metastases (Liver, lung, bone, brain and Others). These findings are sim1lar to study made by Halkia, E et. al., 2012 who stated that the most common site of ovarian cancer recurrence was omentum. [15]. In present examined patients acc0rdIng to the reg10n of recurrence In the body, 05 of cases f1ve patients showed only ab0d1n1al and pelv1c metastases, f1ve of cases showed accompanying sites of metastases with ab0d1n1al and pelv1c reg10ns, f1ve patients were negative. These results agree with study of Sebastian S, et. al., studied the PET/CT vs. CT all0ne In ovarian cancer recurrence, 53 PET/CT scan were c0nducted on 91 patients, they stated that ab0d1n1al and pelv1c was 57% and 15% of patients showing chest and neck metastases with ab0d1n1al and pelv1c recurrence, but mainly due to m0re study patients number of the negative cases were m0re than In the present study, thus the most common site of recurrence ls the pelv1-ab0d1n1al reg10n [16].

5. Conclusion

FDG PET/CT can significat1vely mo1dfy the assessment of the extent of primary and recurrent ovarian cancer and, hence, often alters patient management substantially. FDG PET/CT has thus become a critical tool for the preoperative evaluation of other patients with primary ovarian cancer and for p0s1t1ve patient p0pulat1on to assess the evidence of recurrence In these patients.

Fig (2) A 57-year-old woman with ovarian cancer underwent FDG PET/CT imaging for pretreatment purposes. (Upper left) Transverse PET image shows an area of focal abnormal FDG uptake in right iliac fossa (arrow). (Middle left) Transverse CT image shows corresponding mesenteric implant (arrow) adjacent to a metallic clip. (Lower
left) Transverse fused PET/CT image again shows 1.7 cm mesenteric implant (arrow) with high pathologic FDG uptake in keeping with residual disease. (Right) Coronal maximum intensity projection PET image shows residual pelvic disease and confirms absence of distant metastases.

**Fig (3)** Coronal fused PET/CT image showing large metabolically active FDG avid pelvi-abdominal cystic lesion with marginal nodular thickening with and metabolically active FDG avid right para cardiac soft tissue mass lesion measuring 6 x 4 cm.

**References**


