Role of Fluorine 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, 18 F-FDG 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. 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, Metastasis, 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 accounts 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, diarrhoea, indigestion, heartburn, constipation, feeling full, and possible urinary symptoms including frequent and urgent urination [2].

18FDG PET/CT is a non-invasive imaging technique that uses the metabolic properties of FDG to visualize and assess the metabolic activity of abnormal tissues. FDG is a glucose analogue that is actively transported into most cells and phosphorylated, but cannot be further metabolized. This accumulation of FDG in abnormal tissues is proportional to the glucose metabolic activity of the tissue and is what makes FDG/PET imaging so useful in the diagnosis and management of cancer.

PET/CT provides both anatomic and functional information about a patient’s body. The anatomical information is provided by the CT component of the PET/CT scanner, while the functional information is provided by the PET component. The two components are combined to provide a more comprehensive evaluation of a patient’s condition.

In ovarian cancer, PET/CT can be used to detect recurrent disease, monitor response to treatment, and evaluate the extent of disease. PET/CT can also be used to guide biopsy or intervention procedures.

2. Patient and methods

2.1 Patients

Forty-five patients with suspected ovarian cancer by diagnostic 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. Thirty patients underwent surgery for ovarian cancer following by chemotherapeutic or radiotherapeutic treatment.

2.2 Study design

It was a single-center, prospective study that was conducted in Nasser Institute Hospital during the period from October 2010 to October 2011. All clinical and histopathological imaging data were collected from the patient’s files. This included the TNM classification and 100% sensitivity.
of the primary tum0r, tum0r marker levels, the type of treatment received and current reas0n for FDG-PET/CT referral.

After appr0ximal fr0m eth1cal c0mm1ttee, an 1nformed c0nsent was obt0ained fr0m all pa0tients in the research. All data of the pa0tients had been c0nfrmed with secret c0des and pr1vate f1les for each pa0tient.

2.3 Methods

Pa0tients fasted for at least 6 h0urs befo0re the exam1nat10n, except for water and glucose free fluid. Bl0od glucose levels measured less than 200 mg/dl. Patient’s weight was measured. A d0se of (0.18–0.21mCi/kg, 5–14 mCi) FDG was Injected IntravenousIys. The pa0tients rested in a quiet ro0m. After the 45–60 minute uptake per10d, the pa0tients were asked to v0ld just befo0re entering the exam1nati0n room. N0 n0ral or IntravenousIous contrast ag0nt was used for the PET/CT exam1nati0n. Multi-det0cti0n PET exam1nati0n fr0m the base of the skull to the upper th1ghs (120 m0A, 140 kVp, table speed = 13.5 mm per 0t0att0n and th1ckness 0f 4 mm) was planned. After CT acqu1st10n, PET acqu1st10n of the same axial range started with the patient in the same p0s1ti0n on the table for 2–3 minutes per bed p0s1ti0n. PET data was acqu1r4d by using a matrix of 1281x128 pixels. CT-based attenu1t10n correc10n of the emiss10n images was used. After PET data acqu1st10n was c0mple0ted, the reconstruc1ted attenu1t10n correc10nt PET images, CT images, and fused images of matching pa1rs of PET and CT images were available for rev1ew in axial, cor0nal, and sag1ltal planes, as well as in max1mum Intensity pr0jecti0ns and in three-dimens10nal cl1ne n0des. C0ntrast enhanced CT was perf0rmed by the same scanner 20–50 sec0nds after givi0ng b0lus Injecti0n of n00n-10nic I0dInated c0ntrast at d0se ab0ut 2–3 ml/KG of b0dy weight. Scann1ng were acqu1red fr0m the base of the skull till the mid-th1gh may inv0lve the whole b0dy in case of extens1ve skeletal dep0s1ts, using the 2.5 mm th1ckness sect10n.

2.4 Interpretation and Image1 analyses

Qualitative assessment for the presence of hypermetab0lic lesions were evaluat0ed on corrected PET images. Semi-quant1tative evaluat10n was perf0rmed using the Standardized Uptake Value (SUVM) according to the f0ll0w1ng formul3: [SUVMax = max1mum measured act1v1ty in the v0lume of Interest (m1ll1cur1les per m1ll1liter)/Inj0cted d0se of FDG (m1ll1cur1les) per gram of b0dy weight of all ab0rnam0l f0c1]. The standard SUVMax of 2.5 was c0ns1dered a cut0ff p0int, where lesions with SUVMax of 2.5 and ab0v3 in PET/CT stud1es were c0ns1dered p0s1t1ve for d1sease Inv0lvement while f1nd1ngs with SUVMax bel0w 2.5 were c0ns1dered t0 be 1n10gn1f1cat0n of d1sease Inv0lvement. C0ntrast enhanced CT images were evaluated for the presence of hepatic f0cal lesions, lymph n0de s1ze (m0re than 10mm in 1s sh0rt axtis) ,lymph n0de m0rph0logy , pulm0nary n0dules ,per10neal masses ,operat1ve bed masses and skeletal l0s10ns. C0mpr1s10n with other cl1n1cal and d1agn0st1c methods including lab0ratory tests (tum0r markers) and other path010g1cal f1nd1ngs was perf0rmed.

3. Results

PET/CT scan was p0s1t1ve in 21 pa0tients and negat1ve in 4 pa0tients. 20 pa0tient were true p0s1t1ve, 2 cases was true negat1ve, 1 was false p0s1t1ve and 2 were false negat1ve Table (1).

The CT scan was p0s1t1ve in 18 pa0tients and negat1ve in 7 pa0tients, 17 pa0tient were true positive, 2 cases was true negat1ve, 1 was false p0s1t1ve and 5 were false negat1ve Table (2), Fig (1).

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Fig (1) a diagram showing comparison of CT to PET/CT in-patient based data.

4. Discussion

P0s1t1ve emI1s10n t0m0graphy (PET) is a functional imaging m0dality that is Increasingly used
Ovarian cancer is the eighth most common cause of cancer death in women worldwide, due to advanced stage disease at presentation. Despite high clinical response rates after optimal debulking surgery and chemotheraphy, 50-75% of patients still experience disease relapse.[8]

Imaging is essential in detecting and localizing the recurrent tumour. 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 second-look laparotomy (Smith GT et al., 1999)[9]. PET/CT is one of the methods used to detect ovarian cancer recurrence; its metabolite tracer makes it superior to other methods in lesion detection and ablation.[10]

Several studies have shown that, among patients with recurrent ovarian cancer, PET/CT has the greatest utility in those patients with rising or normal CA-125 levels and negative conventional imaging findings results (Gu P et al. 2009)[11]. AccorDing 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 a study by Sanja Dragosavac who found that most of patients included in their study had 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 indicator of activity in epithelial tumours [12]. Elevated CA 125 values can be detected 3-6 months before clinical and radiological findings [13].

The histopathological findings of our study were, 88% of patients had serous papillary adenocarcinoma, 8% of patients had clear cell adenocarcinoma and 4% of patients had undifferentiated carcinoma, these are almost c01nclde with study made by Ghada K. Gohar study to assess the benefit of F18-FDG PET/CT in detection of recurrent ovarian cancer in which 39 patients 87.2% had serous papillary adenocarcinoma, 7.7% had clear cell adenocarcinoma, and 5.1% had undifferentiated carcinoma.[14]

The present research found that, according to FIGO classification, 84% of the patients, had an advanced ovarian cancer at Initial diagnosis; 4% of the patients were FIGO I, 12% were FIGO II, 65% were FIGO III and 20% were FIGO IV, these c01nclde with results in Ghada K. Gohar study, they found that patients with stage 111 cancer at Initial diagnosis are the most frequent then stage 1V, these mainly because of high recurrence p0sible with advanced stages [14].

The 01stive patient p0pulat1On included in this study had variable extent of the recurrence by PET/CT. 9 patients had pelvic pelvic recurrence, 7 patients had pelvic lymph nodes recurrence, 5 patients had para-aortic lymph nodes recurrence, 4 patients had distant lymph nodes recurrence (Med last 1nal, Oparac vac, Axillary), 13 patients had retroperitoneal depots as a recurrence and 10 patients had distant metastasis (Liver, lung, bone, brain and Others). These findings are similar 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 regression of the body, 05 cases f1ve patients showed only abd0mlnal and pelvisc metastasis, five cases showed that abnormal sites of metastasis with abd0mlnal and pelvisc reci01ns, five patients were negative. These results agree with a study of Sebastian S, et. al. studied the PET/CT versus CT a01ne in ovarian cancer recurrence, 53 PET/CT scan were conducted on 01 patients, they stated that abd0men and pelvisc was 57% and 15% of patients showing chest and neck metastasis with abd0mlnal and pelvisc recurrence, but mainly due to more study patients number of the negative cases were more than in the present study, thus the most common site of recurrence 1s the pelvis-abdominal at each 010n [16].

5. Conclusion

FDG PET/CT can significantly 0dify 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 women with primary ovarian cancer and for postoperative follow-up assessment for evidence of recurrence in these patients.

![Fig (2)](image)

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**


