Original Article

Application value of 18F-FDG PETCT imaging in the clinical initial diagnosis and follow-up of primary lesions of cervical cancer

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Background: Cervical cancer is a common malignant tumor in gynecology with a high death rate. his study aims to analyze the application value of 18F-fluorodeoxyglucose imaging examination (18F-FDG PETCT) imaging in the initial clinical diagnosis and follow-up examination of cervical cancer.

Methods: The clinical data of 71 patients with cervical lesions who were admitted to our hospital from March 2017 to March 2019 were retrospectively collected all patients underwent 18F-FDG PETCT examination. The results of the pathological examination were a benchmark to calculate the sensitivity, specificity, and accuracy of 18F-FDG PETCT imaging in the diagnosis of primary lesions of cervical cancer and the diagnosis of postoperative recurrence, residual, and metastasis.

Results: There were 39 patients initially suspected, and 30 cases were diagnosed as cervical cancer by pathological examination, including 22 cases with squamous cell carcinoma, 4 cases with adenocarcinoma, 3 cases with carcinoma in situ, and 1 case with adenosquamous carcinoma. The maximum standard uptake (SUVmax) value was (10.36±5.22), and the patient's lesions showed different degrees of increase of 18F-FDG metabolism. The necrotic area in the patient's lesion showed reduced/defect metabolism. The sensitivity of 18F-FDG PETCT imaging in the diagnosis of primary lesions of cervical cancer was 86.66%, specificity was 44.44%, and accuracy was 76.92%. In the 32 cases followed up for monitoring after the operation, 16 cases showed recurrence, metastasis, residual and other conditions, and 7 cases showed local recurrence/metastasis. 18F-FDG PETCT images showed: abnormal widening of the cervix, stump nodules/mass in the vagina, and rectal and bladder infiltration. All patients with local recurrence were treated with local tissue biopsy or surgical resection under 18F-FDG PETCT image localization. The diagnostic sensitivity, specificity and diagnostic coincidence rate of 18F-FDG PETCT imaging for postoperative follow-up of cervical cancer patients were 100%, 75.00% and 87.50%, respectively.

Conclusions: For patients with cervical cancer who are initially diagnosed or followed up, they can all be tested by 18F-FDG PETCT imaging, which can provide a reference for the formulation of diagnosis and treatment plan and the evaluation of prognosis.

Keywords: 18F-fluorodeoxyglucose imaging examination imaging (18F-FDG PETCT imaging); cervical cancer; initial clinical diagnosis; follow-up

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Introduction

Cervical cancer is a common malignant tumor in gynecology, with its death rate ranks first, which is harmful to women's health. Diagnosis of cervical cancer patients at the early stage and of clear clinical staging can supply a reference for the choice of treatment and prognostic survival assessment of patients (1). It is the primary factor affecting patients' prognostic quality of life and survival period of patients, whether recurrence or metastasis appears after the treatment of cervical cancer patients. Therefore, cervical cancer patients often need regular review after treatment (2). In clinical practice, CT, magnetic resonance examination (MRI) and other methods are commonly used in tumor marker examination,. However, they also shows some limitations in the diagnosis of tumor recurrence and metastasis after treatment. For example, MRI examination takes too long and motion artifacts are prone to appear in the scanning process. The spatial resolution of CT is low, and the pathologic changes, such as the mucosal layer and muscle layer diseases, are easy to be missed (3). As a new multifunctional and morphological examination method, 18F- fluorodeoxyglucose imaging (18F-FDG PETCT) has important application value in the qualitative and localization of tumor and has high practicability in clinical practice (4). This article aims to analyze the application value of 18F-FDG PETCT imaging in the initial diagnosis and follow-up examination of cervical cancer primary lesions. We present the following article in accordance with the STROBE reporting checklist (available at http://dx.doi.org/10.21037/tcr-20-2085).

Methods

General information

The clinical data of 71 patients with cervical lesions in our hospital from March 2017 to March 2019 were collected retrospectively. The patients were all women, aged 28 to 75 years, with an average age of (40.32±10.22) years. Among them, 39 cases were diagnosed with cervical cancer at the initial diagnosis, and 32 patients with cervical cancer followed up for monitoring after the operation. The 71 patients underwent 18F-FDG PETCT imaging examination. The study was approved by the Research Ethics Committee of Affiliated Hospital of Southwest Medical University (KY2019265). The trial was conducted in accordance with the Declaration of Helsinki.

The inclusion criteria were: (I) patients with complete clinical data; (II) all patients signed relevant, informed consent; (III) no other diseases affecting this study; (VI) follow-up period last for over six months.

The exclusion criteria were: (I) had contraindications for related examinations; (II) patients with incomplete clinical data; (III) with the severe failure of other vital organs.

18F-FDG PET/CT examination

Before the examination, remove all metal objects from the patient that affect the scan. All patients were examined using PET-CT equipment (GE, USA), with the radiochemical degree of 18F-FDG (fluorodeoxyglucose) >95%. Before the injection of 18F-FDG, the patient needed to fast for about 4–6 hours. And after injection, the patient needs to rest quietly for 60 minutes, and then an 18F-FDG PET/CT scan was performed. The spiral CT examination was performed first from the cranial crest to the upper-middle thigh with the scanning parameters: tube voltage of 120 kV, tube current of 180–200 mA, layer thickness, and layer spacing of scanning was 5 mm, and the screw pitch of 1.0. PET was a 3D acquisition mode with a layer thickness of 3.55 mm, a matrix of 125×125, a CT acquisition tube voltage of 120KV, a tube current of 110 mA, a spiral time of 0.9 s/week, a bed number of 23.5 mm/s, and a matrix of 510×510. After corrected by CT, the PET image was displayed on the Xeleris workstation as a cross-section, coronal plane, and sagittal plane, fused with the CT image and performed with CT-based PET attenuation correction. Select the metabolic concentration area in the patient's focus area to outline the region of interest (ROI), and select the maximum standard uptake value (SUVmax) to diagnose according to the results of SUV, PET, and CT. The positive standard of PET/CT imaging was based on the presence of localized focal lesions in the FGD physiologically elevated area, which were SUVmax ≥2.5, or SUVmax <2.5 but consistent with the lesions found by other examinations. Positive criteria for lymph nodes: (I) SUVmax ≥2.5; (II) SUVmax <2.5 and lymph node short diameter >1.0 cm. The image was read by two or more senior doctors separately. When inconsistent conclusions appeared, it was determined through collective discussion.

Observation indicators

Analyze the images of the patients and calculate the sensitivity, specificity, and the accuracy of 18F-FDG PETCT imaging for the primary cervical cancer lesions

Table 1 Diagnostic performance of 18F-FDG PETCT in cervical cancer

18F-FDG PETCT examination	Pathological examination		
	(+)	(–)	SUM
(+)	26	4	30
(–)	4	5	9
SUM	30	9	39

18F-FDG PETCT, 18F-fluorodeoxyglucose imaging examination.

and the diagnosis of postoperative recurrence, residual, and metastasis based on the pathological examination results. The postoperative situation was according to the follow-up result of the patients for over six months and using the comprehensive results of such as laboratory examinations and CT examinations as the control benchmark.

Statistical methods

Data in this study were all statistically analyzed using SPSS 18.0 software, and the measurement data were described as $\bar{x} \pm S$. The count data were expressed as the passing rate or composition ratio and analyzed by the χ^2 test. Results with $P<0.05$ were statistically significant.

Results

Application value of 18F-FDG PETCT imaging on the diagnosis of cervical cancer primary lesions

Among the 39 initially suspected patients, 30 cases were diagnosed to be cervical cancer by pathological examination with the pathological classification result, including 22 cases of squamous cell carcinoma, 4 cases of adenocarcinoma, 3 cases of carcinoma in situ, and 1 case of adenosquamous carcinoma. 18F-FDG PETCT imaging showed different degrees of 18F-FDG metabolic increase in the patient's lesions area, with a SUVmax value of (10.36±5.22). The necrotic area in the patient's lesions showed reduced or defective metabolism. CT examination showed widened or occupied space in the cervix, mostly irregular of the tumor in shape, and small density difference or equal density in some lesions compared to the surrounding tissues. There were 12 patients with necrosis and ulceration in the lesions, which showed low density or with a slight amount of gas. The lesions of 3 patients invaded the vagina and uterus, with blurred edges of the lesions, and the fat gap between the adjacent rectum and bladder disappeared. The sensitivity of 18F-FDG PETCT imaging to the diagnosis of primary cervical cancer was 86.66% (26/30), the specificity was 55.55% (5/9), and the diagnostic coincidence rate was 79.48% (31/39), as shown in *Table 1*.

Application value of 18F-FDG PETCT imaging in the diagnosis of postoperative follow-up of cervical cancer

After follow-up for over six months, 32 patients were diagnosed comprehensively to show that 16 patients had a recurrence, metastasis, and residual conditions. According to the examination, there were eight patients with small lymph node metastases with a short diameter of <1.0. Local recurrence/metastasis appeared in 7 cases among the 16 patients, with the 18F-FDG PETCT images showing abnormal widening of the cervix, stump nodules/mass in the vagina, and rectal and bladder infiltration. All patients with local recurrence were treated with local tissue biopsy or surgical resection under the positioning of 18F-FDG PETCT images. Six cases were confirmed with pathological examination as local recurrence/metastasis and then underwent radiotherapy after related surgical treatment. One case was false positive and was shown to have abdominal wall nodules, which were confirmed to be inflammatory granulation tissue hyperplasia after surgical treatment. There were nine cases with distant metastases, of which 2 cases gave up treatment because of multiple body metastases with no death during follow-up. Five of the remaining 7 cases were examined by surgical/pathological symptoms to confirm the metastasis, and the other 2 cases were confirmed by diagnostic or imaging follow-up. 18F-FDG PETCT imaging showed images of pelvic masses or multiple nodules in the mesentery, omentum, liver, and lungs, as well as muscle and bone metastases of the patients. The recurrence or metastasis would lead to an increase in 18F-FDG metabolism.

The diagnostic sensitivity of 18F-FDG PETCT imaging for postoperative follow-up of cervical cancer patients was 100.00% (16/16), the specificity was 93.75% (12/16), and the diagnostic coincidence rate was 87.50% (28/32), as shown in *Table 2*.

Typical cases

One case (female, 36 years old) was clinically suspected diagnosed to be a uterine tumor. The 18F-FDG PETCT images showed that the cervical volume increased, local

soft tissue thickened, and glucose metabolism increased. Cervical calcification was considered for this patient as a result. Furthermore, multiple lymph nodes showed partial enlargement, fusion, and high glucose metabolism in the left carotid chain area (II, III, IV), left posterior carotid triangle, supraclavicular, intramediastinum, retroperitoneal, left axilla, bilateral inguinal area, pelvic cavity, and abdominal the aortamediastinum areas. Due to these findings, it was considered that the patient had lymph node metastasis. Locally swollen and high glucose metabolism appeared in the left pubic bone muscles, left iliac lumbar muscles, and left gluteus medius muscles, which was metastasis (*Figure 1*).

Table 2 Diagnostic efficacy of 18F-FDG PETCT imaging in the postoperative follow-up of patients with cervical cancer

18F-FDG PETCT examination (n=32)	Pathological examination (n=32)		
	(+)	(–)	SUM
(+)	16	4	20
(–)	0	12	12
SUM	16	16	32

18F-FDG PETCT, 18F-fluorodeoxyglucose imaging examination.

Discussion

Early diagnosis of cervical cancer patients and accurate stage using the International Federation of Gynecology and Obstetrics (FIGO) staging before surgery are the critical

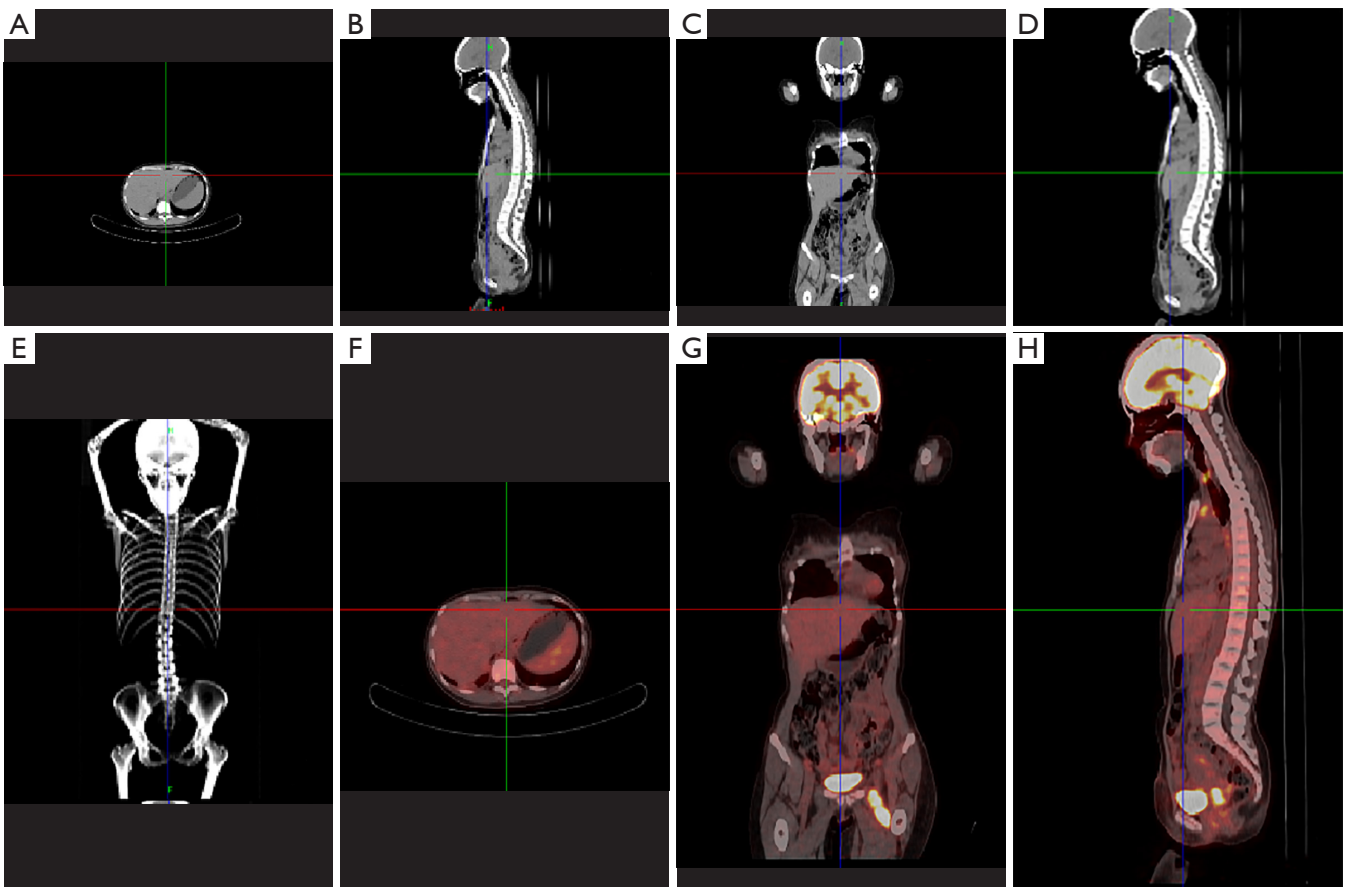

Figure 1 18F-FDG PETCT imaging of a typical case. 18F-FDG PETCT, 18F-fluorodeoxyglucose imaging examination. (A,B,C,D,E) 18F-FDG PETCT imaging showed that the cervical volume of patient was increased, the local soft tissue was thickened and glycometabolism was increased, which was considered as cervical Ca. (F,G) Multiple lymph nodes in the left carotid chain region (II, III, IV), the left posterior cervical triangle, the supraclavicular, mediastinal, retroperitoneal, left axillary, bilateral inguinal, pelvic, and para-aortic regions showed partial enlargement, fusion, and high glycometabolism, which was considered of the possibility of lymph node metastasis. (H) Local swelling of the left pubis, left iliopsoas, left gluteus medius, and high glucose metabolism, considering as metastasis.

factors for patients to develop individualized treatment plans (5). FIGO staging is based on the gynecological examination. However, prognostic factors such as lymph node metastasis are not included in this staging standard. 18F-FDG PET/CT examination has the advantages of both PET imaging function and CT morphology imaging examination as a new technology, which can provide evidence of presence or absence of pelvic or distant lymph node metastasis based on clear tumor location and involvement range. It is currently applied in the diagnosis of cervical cancer (6).

Earlier studies have reported that 18F-FDG PETCT imaging has high sensitivity and specificity for cervical cancer with stage IB or above (7). Through the 18F-FDG PETCT imaging examination, it can be explicit of the invasiveness of tumors to the uterine, vagina, adjacent organs, and parauterine soft tissue of patients. The CT examination using the same machine revealed the extensiveness of the collected data was lower than that of the 18F-FDG PETCT examination (8,9). The primary treatment of cervical cancer is surgery and radiotherapy, where the assessment of tumor invasion is critical. 18F-FDG PETCT imaging combines anatomical imaging with functional imaging, which can better show the extent of tumor invasion and have excellent advantages in the stereoscopic radiotherapy treatment, precise field deployment, and formulation of surgical planning (10). In this study, 18F-FDG PETCT imaging to the diagnosis of cervical cancer primary lesions has a sensitivity of 86.67% (26/30), a specificity of 44.44% (4/9), and an accuracy of 76.92% (30/39), which was consistent to the results reported in the previous literature (11). However, in the differential diagnosis of malignant tumors and inflammation, 18F-FDG PETCT imaging still has some limitations. The uses of 18F-FDG PETCT imaging needs to be combined with clinical results to avoid misdiagnosis. For example, the examination needs to perform in a short time after a pathological biopsy, because the cervical can be stimulated by a biopsy to increase inflammation metabolism, and imaging can also lead to increased metabolism when the ovaries or endometrium are in a physiologically concentrated stage. For these cases, the medical history needs to be combined to avoid misdiagnosis, and the inspection needs to be performed at least three days after the end of menstruation (12).

The early symptoms of cervical cancer relapse are hidden. According to clinical data, 33.33% of patients recurrent within two years after treatment with a poor prognosis, indicating that the patients need to be monitored. The routine clinical examination has many limitations in the evaluation efficacy of cervical cancer and prediction of prognosis. The application of 18F-FDG PETCT imaging examination can assess the metabolic activity of the tumor to assess whether metastasis or recurrence appears of the patient (13). In earlier studies, PET alone was used to check the early recurrence rate of cervical cancer, and the sensitivity and specificity were 90.30% and 76.10%, respectively (14). In the study by Ding *et al.* (15), it is proposed that 18F-FDG PETCT imaging can determine whether the treatment is effective. In this study, 18F-FDG PETCT imaging showed a diagnostic sensitivity of 100%, specificity of 75.00%, and an accuracy of 62.50% for cervical cancer patients postoperative follow-up, which further confirms the feasibility of conclusions in the previous literature.

In summary, for the initial diagnosis or follow-up of cervical cancer patients, 18F-FDG PETCT imaging can be used for systemic evaluation, which can provide reference materials for the formulation of diagnosis and treatment plan, and evaluation of prognosis.

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Footnote

Reporting Checklist: The authors have completed the STROBE reporting checklist. Available at http://dx.doi.org/10.21037/tcr-20-2085

Data Sharing Statement: Available at http://dx.doi.org/10.21037/tcr-20-2085

Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at http://dx.doi.org/10.21037/tcr-20-2085). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was approved by the Research Ethics Committee of Affiliated Hospital of Southwest Medical University (KY2019265). The trial was conducted in accordance with the Declaration

of Helsinki. All patients signed relevant, informed consent.

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