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Role of 18F-FDG PET/CT in bone and soft tissue sarcoma

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Introduction: Precise diagnosis and staging was required for effective management pationts. Imaging techniques, such as ultrasound, computed tomography (CT), and magnetic resonance imaging (MRI), are commonly used for the detection of the location, size, as well as morphological and structural changes of adjacent tissues. Nonetheless, these modalities provide little information about tumor biology.
Objective: This study presents the experiences of a private clinical center regarding the role of F-fluorodeoxyglucose positron emission tomography/computed tomography (18F-FDG PET/CT) in the diagnosis, staging, restaging, and monitoring of treatment response in the management of patients with sarcoma.
Methods: The records of patients with bone and soft tissue sarcoma referred to a private specialized hospital for 18F-FDG PET/CT from 2016 to 2019 were evaluated in this study. Information, such as radiotherapy, chemotherapy, and pathology of patients, was recorded.
Results: Regarding gender, 66.7% of cases were male (mean age of 26.37 years) and 33.3% of subjects were females (mean age of 28.76 years). Among SUV_{max} reported in observed lesions, either metastasis or recurrence, and primary tumor, the highest value was observed in the lymph node on the right side of the neck due to metastasis of the giant cell tumor of the bone (SUV_{max} = 18.23) and the lowest in the right lung pulmonary node due to the retroperitoneal sarcoma metastasis (SUV_{max}=0.88). Furthermore, the mean SUV_{max} of the hepatic right lobe was not significantly different between diabetic and non-diabetic patients (P=0.761).
Conclusion: As evidenced by the obtained results, 18F-FDG PET/CT appears to be a noninvasive measurement method for the prediction of events and outcomes; nonetheless, it is currently considered an optional test, which calls for further studies to corroborate its case-effectiveness.
Keywords: PET, 18F-FDG, Soft tissue, Sarcoma

Introduction

Soft-tissue sarcomas (STS) are rare primary tumors that begin in connective tissue. They are heterogeneous neoplasms with great variation in histologic type, degree of malignancy, and invasion [1-3]. In addition to the type of histopathology, acceptable prognostic factors include patient age, tumor size, depth of invasion, as well as malignancy grade and stage [2]. Nonetheless, there are some special radiological crtiteria before surgery for the evaluation of malignancies of different STS. The F-fluorodeoxyglucose (18F-FDG) positron emission tomography/computed tomography (PET/CT) is a unique diagnostic tool for the in vivo evaluation of tumor glucose metabolism.

Sarcomas are usually highly 18F-FDG-avid tumors [4]; therefore, PET appears to be an ideal modality for assessing the disease stage. This modality is of great help in correct treatment planning and detection of local recurrence [5] and distant metastases [6]. Moreover, 18F-FDG PET/CT can be used for guided biopsy in STS [7], as well as the assessment of treatment response [8] and staging [9]. There is a dearth of studies on glucose metabolism by 18F-FDG PET/CT in patients with bone and soft-tissue sarcoma as a prognostic factor. These studies pointed to a significant difference between the 18F-FDG PET/CT value in high-grade benign and malignant sarcomas, as well as between high-grade and low-grade sarcomas [19-20].

Nonetheless, previous studies on bone and soft-tissue sarcomas have yielded contradictory results in terms of grade and histotype; therefore, the use of 18F-FDG PET/CT in different histotypes is still controversial. [13 and 21] and required further studies. Therefore, the present study aimed to present the experiences of our clinical center regarding the role of 18F-FDG PET/CT in the diagnosis, staging, restaging, and monitoring of response to treatment in the management of patients with sarcoma.

Materials and Methods

The present study was conducted on 39 patients with bone and soft tissue sarcomas who had been referred to 18F-FDG PET/CT imaging at our clinical center in one of the private subspecialty hospitals from 2016-2019. Informed consent forms were obtained from patients, and their information was retrospectively extracted from their medical records. The principle of confidentiality was observed in accordance with hospital regulations. The pathological results of the patients were reviewed, and their information was recorded.

Each patient received 3.7 MBq/kg of 18F-FDG intravenously, and PET/CT was performed 60± 10 min after injection. The 18F-FDG was produced by a

standard method in our radiopharmacy, and PET/CT images were taken using a Siemens device. The PET emission scans were acquired for 2 min bed position from the vertex of the scalp to thighs, and CT was also used for nonuniform attenuation correction. The CT parameters were 120 KV, 80 mA, 80 S, and 3.7 mm thickness. To optimize FDG uptake in normal and neoplastic tissues, patients were required to fast for at least 6 h and come to imaging with an empty bladder. It is noteworthy that 7% of patients were diabetic.

Standardized uptake value (SUV) was calculated for all lesions, and 79% of patients underwent surgery with a negative surgical margin. Patients had received external radiotherapy and chemotherapy according to the STS guidelines, and decisions were made in the multidisciplinary group. In general, chemotherapy in 60.5% of patients was neoadjuvant or adjuvant in accordance with current protocols. Moreover, 23.6% of subjects received radiotherapy before or after surgery. It should be noted that the brand of all the devices was Siemens. In the present study, the data collected after coding was analyzed in SPSS software. The patient characteristics are presented as frequency (percent) for discrete variables or mean±SD for continuous variables.

Results

The mean age of patients at the time of imaging was 23.21 years (age range of 2-74 years). In terms of gender, 66.7% of cases were male (mean age of 26.37 years and age range of 2-67 years), and 33.3% of subjects were female (mean age of 28.76 years and age range of 4-74 years). The clinical and demographic data are reported in Table 1. None of the patients had comorbidities, such as heart attack or stroke. Moreover, 7% of patients were diabetic, and approximately 13% had glucose intolerance. They had referred for staging (18%), restaging (13%), response to treatment evaluation (20%), metastasis evaluation (18%), recurrence evaluation (13%), and residual disease evaluation (18%).

The mean SUV of the right hepatic lobe was reported to be 21.02± 0.54 (range of 0.84–3.16). Among SUV_{max} reported in the observed lesions, either metastatic or recurrent and primary tumors, the highest value was related to the lymph node on the right side of the neck due to the metastasis of giant cell tumor of the bone (SUV_{max} =18.23), and the lowest belonged to the right lung pulmonary node caused by the metastasis of the retroperitoneal sarcoma (SUV_{max} =0.88).

Among the patients who were evaluated for treatment response, only 5 cases had responded to treatment, with the results of their imaging suggesting a fall in SUV_{max}, compared to previous scans. It indicates that SUV_{max} could be an appropriate criterion for prognostic evaluation. On the other hand, among those who did not respond to treatment, there was a case of brain sarcomas that had invaded the mastoid, along with pulmonary and scalp metastasis. Another patient had endometrial sarcoma with lung and bone metastasis, and one subject had osteosarcoma, with the residual surgery failing to respond to the treatment. Mean SUV_{max} hepatic right lobe was not significantly different between diabetic and non-diabetic patients (P=0.761).

Discussion

As evidenced by the results of the present study, 18F-FDG PET/CT can have various applications ranging from staging to evaluation of treatment response and recurrence or metastasis of diverse bone and soft tissue sarcomas. In previous studies, 18F-FDG PET was introduced as an effective diagnostic tool for evaluating local or metastatic recurrence of STS [22]. In addition, SUV_{max} in 18F-FDG PET has been demonstrated to be associated with prognosis in several types of epithelial tumors, including lung cancer, esophageal cancer, anal cancer, as well as head and neck tumors [23]. This connection has also been reported in small and heterogeneous cases in bone and STS [24]. As noted in the present study, the value of SUV_{max} observed in lesions may be an indicator of response to treatment before and after treatment.

Different STS histotypes and bone sarcomas vary widely in clinical behavior and histologic features. Research pointed out that STS represent heterogeneous tumors with diverse histopathologic features that may affect glucose metabolism, as well as 18F-FDG uptake [25]. In the present study, SUV_{max} in the hepatic right lobe was not significantly different between diabetic and non-diabetic patients and did not interfere with the diagnosis. Nonetheless, since there were a few diabetics in the current research, further studies are required to shed light on this point.

The 18F-FDG PET/CT was able to provide a detailed report to evaluate treatment response in the cases studied at our clinical center. The pathologic response to early systemic treatment is determined by the extent of tumor necrosis in the resected specimen. Some authors measure standard uptake before (SUV1) and after (SUV2) chemotherapy, with the disease-free survival improving if SUV2 is <25 [26]. The results of the current study revealed that PET/CT may be of great help in predicting response to chemotherapy in stages II and III for the firm and deep masses greater than 3 cm [26]. A study of 42 patients with resectable biopsy-proven high-grade soft tissue suggested that FDG PET can predict the pathologic response to neoadjuvant therapy [27].

PET scan was performed to determine cancer cell function before and after neoadjvant treatment. In 19% of respondents, the scan exhibited a significant decrease in FDG uptake. The decreased FDG uptake percentage, which is suggested as an optimal cut-off value for responders and non-responders, varies from 25%-60% in different articles. This disparity in values in different studies can be attributed to the fact that patients received a varying number of chemotherapy cycles. Sarcoma subtypes were also variable in these studies. Some studies used tumor-to-background ratio and some used SUV_{max} and SUVs to calculate cut-offs. In the present study, SUV_{max} was employed [28].

Given the small sample size in this research, as in other studies, and the considerable debate over the specific role of 18F-FDG PET scans before surgery in patients with resectable STS and bone sarcoma for predicting survival and prognosis and even the role of this imaging modality in many other issues, long-term follow-up studies are recommended for these patients.

Conclusion

Based on the research findings, 18F-FDG PET/CT appears to be a noninvasive measurement method for the prediction of events and outcomes; nonetheless, it is currently considered an optional test. This calls for further studies to confirm cast-effectiveness. The prognostic value of 18F-FDG PET/CT should also be taken into account in the detection of non-suspected metastases and monitoring of treatment response.

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Conflicts of Interest

The authors declare that they have no conflict of interest.

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