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RESEARCH

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The F-18 FDG PET/CT evaluation of the metastatic adrenal lesions of the non-lung cancer tumors compared with pathology results

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Abstract

Background: The aim of this study was to evaluate the role of F-18 FDG PET/CT imaging in the diagnosis of primary and metastatic adrenal tumors that originate from non-lung cancer primary tumors.

Results: F-18 FDG PET/CT images of patients (8 male and 6 female; mean: 55.36 ± 16.2 years old) who attended with the diagnosis of primary or adrenal metastatic lesions other than lung cancer metastasis were evaluated in a retrospective manner. The diameter of the adrenal lesions was mean: 23.93 ± 36.6 mm with SUVmax levels of mean: 9.98 ± 7.8. The primary site of 2/3 of the patients with unknown primary was the adrenal gland, and in one of the patients primary tumor remained unknown during follow-up.

Conclusions: According to the results of this study, F-18 FDG PET/CT has high diagnostic performance in the diagnosis of the adrenal gland primary and metastatic lesions, which originate from non-lung cancer tumors. Further studies in the larger series are warranted.

Keywords: Adrenal, Metastasis, Primary, FDG

Introduction

The most common tumor that metastasizes to the adrenal gland is lung carcinoma; however, gastrointestinal tumors may also metastasize to the adrenal gland. Metastatic and primary tumors of the adrenal gland have significant fluorodeoxyglucose (FDG) uptake, and thus, these tumors might be visualized by F-18 FDG positron emission tomography (PET)/computerized tomography (CT). There are several reports about the diagnostic performance of F-18 FDG PET/CT in the discrimination of malignant and benign adrenal lesions [1]. Additionally, the diagnostic utility of F-18 FDG PET/CT in metastatic adrenal lesions has been addressed by multiple studies previously in the literature [2]. There are also case reports about the impact of F-18 FDG PET/CT in the patients' management in the patients with metastatic adrenal lesions [3–5]. Metabolic characterization of primary adrenal tumors might be performed by F-18 FDG PET/CT as well [6, 7]. However, there are no previous studies regarding this specific group of metastatic tumors that originate from primary sites other than lung carcinoma in the literature. The diagnostic performance of F-18 FDG PET/CT in the evaluation of primary and metastatic adrenal gland lesions was the aim of this study.

Methods

Patients

Fourteen patients (8 male and 6 female; mean: 55.36 ± 16.2-year-old Caucasian patients) who had metastatic or primary tumors of the adrenal gland and

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had non-lung cancer with primary tumor or without primary tumor were included in the study. The diagnosis of known malignancy was recorded in 11 patients and unknown primary tumor in three patients. The lactation, pediatric age and gestatation were the exclusion criteria for the study, and inclusion criteria were referral of the patients with diagnosis of a known malignancy other than lung cancer and documented metastatic lesion on adrenal gland (SUVmax levels two times more than the physiological liver uptake and or mass–mass-like lesion on surrenal gland suggesting metastasis). The patients with known primary tumors were referred to the Nuclear Medicine Department for staging ($n=2$) and treatment response evaluation ($n=9$). The study was approved by the ethics committee, and the informed consents of the patients were obtained for the imaging examination.

Imaging

The F-18 FDG PET/CT examination was performed after fasting for at least 6 h. The F-18 FDG was injected (approximately mean 370 MBq-10 mCi/at the dose adjusted according to the body weight) to the patients intravenously 60 min before the imaging. F-18 FDG PET imaging was performed by the PET/CT camera (GE, Discovery PET/CT 610, US) with a low-dose CT scan (130 kV, 50 mAs, a pitch of 1.5, a thickness of 5 mm, in 70 cm field of view) for attenuation correction in craniocaudal direction for 1 min per bed position.

Analysis

The F-18 FDG PET/CT images of the patients with metastatic or primary adrenal lesions were evaluated retrospectively by an experienced Nuclear Medicine physician and the dimensions and uptake values (SUVmax) of the lesion, characteristics of the patients as well as primary site and other metastatic sites were recorded. The F-18 FDG PET/CT imaging results were compared with the pathology, follow up or Magnetic resonance imaging (MRI) results as the gold standard.

Results

Fourteen patients (8 M/6 F; mean: 55.36 ± 16.2 years old) with the diagnosis of adrenal lesions were included in the study. The patients included in this study did not have the diagnosis of lung cancer. Among the patients who were referred for primary tumor investigation; the primary site of 2/3 patients was the adrenal gland and 1 patient remained unknown. The primary tumors of the patients were the gastrointestinal tract (stomach $n=1$ and colon $n=6$) and other tumors (Table 1).

The adrenal gland lesions of the patients were at right side ($n=6$) and left side ($n=6$) and bilateral ($n=2$) according to the frequency. The dimension of the adrenal gland lesions was mean: 23.93 ± 36.6 mm, and the SUVmax level of the adrenal lesions was mean: 9.98 ± 7.8.

The F-18 FDG PET/CT results revealed other metastatic lesions with distribution of the other metastatic lesions were mediastinum ($n=7$), lung ($n=5$), liver ($n=7$), abdominal lymph node ($n=4$), bone ($n=3$), mesenteric lesions ($n=5$) and cervical lymph nodes ($n=4$).

Table 1 The summary of the findings of patients included in the study

Patients no	Dimension (mm)	Uptake (SUVmax)	Primary tumor	Mortality	Ca	AST	ALT	CRP	ALP	Metastasis
1	13	4.1	Stomach		9	29.7	24.5	44.4		LN
2	23	13	Colon	Ex	8.4	30	13	319.1	92	LN, Li, B
3	10	6.4	CUP	Ex	7.6	89	1761	78.6	772	Li, Lung
4	11	5.8	Colon							
5	10	6	Colon	Ex	6.7	19.3	10.9	71	210.4	Lung
6	10	7	CUP	Ex	8	588	342	12.4	334	LN, Lung Li
7	10	8.3	Colon		10.1	20	76	0.9		LN
8	150	36	CUP	Ex	8.4	6	1261	277	251	Pleura, Periton
9	18	11.2	Colon			10	6	31.2		LN, Li
10	20	6.1	Adrenal		9.5	22	19	4.7	99	Periton
11	16	5	Langerhans		9.4	40.9	37.9	0.8		LN
12	22	7.9	Ovary	Ex	9	100	8	380	322	Li, Lung, LN
13	10	9.3	CUP	Ex	7.5	1321	635	122	646	LN, Li, Bone
14	12	13.9	Rectum	Ex	6.6	9330	2362	25	1839	Periton, Li, Bone, Lung

CUP: Carcinoma of unknown primary, SUVmax: standardized uptake value, Ca: calcium, CRP: C-reactive protein, ALP: alcalenephosphatase, LN: lymph node, Li: liver

The pathology/follow-up MRI results demonstrated metastatic ($n = 13$) and primary ($n = 2$) tumors of the adrenal gland as listed in table. One of the patients with primary sarcomatoid carcinoma (Fig. 1a–e) of the adrenal gland died during the disease course. In the follow-up a total of 8/14 patients died.

Discussion

In a previous series including patients with the diagnosis of the hepatocellular carcinoma, it was concluded that F-18 FDG PET/CT has limitations in the differential diagnosis of benign and malignant metastatic lesions [8] probably because primary and metastatic lesions of the hepatocellular carcinoma demonstrate variable FDG uptake. In this specific group of patients with HCC, it has been suggested to image with dual tracer modality C-11 choline and F-18 FDG in a previous study [9]. This study was the only study which evaluated the metastatic lesions of adrenal gland in this specific group of patients. According to the results of this study, F-18 FDG PET/CT clearly demonstrates the metastatic and primary adrenal lesions in the patients other than lung carcinoma. However, there are several other example cases of lack of FDG accumulation in adrenal lesions with specific other pathology types [10].

According to a previous study, F-18 FDG PET/CT has higher diagnostic accuracy compared to the contrast-enhanced CT in the determination of primary adrenal tumors and SUVmax has prognostic value [6]. The patients in this study group with higher SUVmax values died during the follow-up, but we did not analyze the prognostic value of this parameter due to small sample size. This issue might be evaluated in another study in a larger patient population. The F-18 FDG PET/CT provides additional information in the patients with recurrent or metastatic primary adrenal masses according to the literature [11]. In this series, the metastatic lesions of primary adrenal tumors were clearly indicated and treatment response evaluation of a case was performed efficiently by F-18 FDG PET/CT as well. In a previous study about primary adrenal carcinoma, F-18 FDG PET/CT have influenced the patients' management by correct determination of the primary tumor and provided staging at a single study [12, 13]. In the patients presented in this study, the PET/CT imaging changed the patients' management by correctly identifying the primary tumor in two of three patients with unknown primary tumor (60%) and correctly staged the patients (Fig. 2).

According to the study by Launay et al., the SUVmax value and the adrenal-to-liver SUVmax ratio might help to determine the malignancy in the patients with indeterminate adrenal lesions [14]. They have demonstrated primary (32/67), metastatic lesions ($n = 19$) and adenoma ($n = 16$) in their series which were verified by the pathology results [14]. Another study indicated a SUVmax cutoff level for discrimination of benign and malignant adrenal lesions [15]. The diagnostic performance of the F-18 FDG PET/CT in the characterization of primary and metastatic adrenal lesions as well as extra-adrenal lesions (unknown primary and staging) was sufficient in this present study.

Metastatic lesions of the adrenal gland are also candidates for surgical management, and there are case reports with good outcome after adrenalectomy as a single site

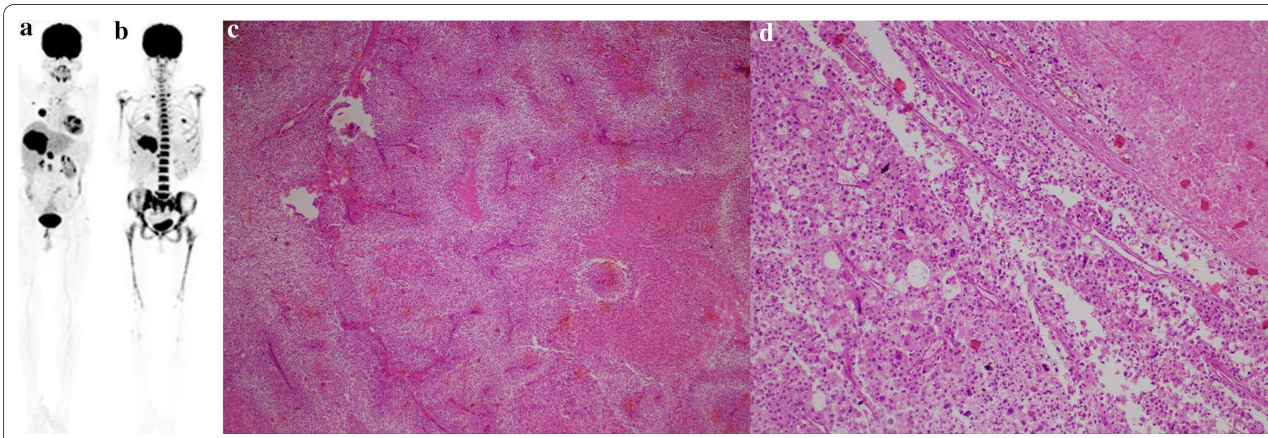

Fig. 1 **a** The multiple intensity projection image of the patient diagnosed as primary adrenal tumor showing right adrenal enlarged mass, abdominal metastatic lymph nodes and lung metastases. **b** The follow-up F-18 FDG PET/CT MIP image of the same patient two sickles after the chemotherapy showing shrinkage of the primary tumor, and no lymph node metastasis but also new developing lung metastasis and bone marrow uptake were also observed. **c** Cohesive tumor cell clusters with focal necrosis, HE, 40 ×. **d** Tumor cells with nuclear atypia and necrosis, HE, 200 ×.Table 1: The characteristics and results findings of the patients included in the study

Fig. 2 Sixty-nine-year-old female patient with the diagnosis of metastatic colon carcinoma; the coronal fusion FDG PET/CT slices corresponding to multiple metastatic adrenal lesions with significant FDG accumulation with the greatest dimension of 23 mm (SUVmax = 6.9 right/SUVmax = 8.3 left-liver background SUVmax = 3.9)

of metastasis determined by F-18 FDG PET/CT [16, 17]. The metastatic lesions of adrenal gland have been determined to be higher in autopsy series compared to the clinical studies [18]. The ratio of adrenal metastasis of the primary esophagus tumor has been observed to be 10% in a previous case series [19]. The results of this study also indicated a significant influence of the F-18 FDG PET/CT in the management of the patients with primary or metastatic adrenal lesions. Overall and disease-free survival of the patients with adrenalectomy due to metastatic lesion was good according to the previous reports [5, 20–22]. However, there were a significant number of the patients who died during follow-up in this series, but we did not analyze the mortality of the patients due to small sample size. This issue might be evaluated by future studies in larger series.

A review including 29 studies has pointed that the F-18 FDG PET/CT has high diagnostic accuracy in the determination of adrenal masses [23]. A previous study has indicated that adrenal metastasis could not be differentiated by means of contrast enhanced CT due to significantly low sensitivity [24]. Another review concluded that the diagnostic utility of the F-18 FDG PET/CT is significantly better with additional semi quantitative analysis compared to CT and MR in the determination of the adrenal masses [25]. Another recent study indicated the diagnostic significance of the F-18 FDG PET/CT in the discrimination of malignant versus benign adrenal tumors [26]. There are also case reports of the rarer pathologies metastatic to the adrenal gland [27, 28].

The limitation of this study was the lack of follow-up results of all the included patients due to the retrospective structure of the study and limited number of patients.

Conclusion

This study verified the sufficient diagnostic power of the F-18 FDG PET/CT in the determination of the primary and metastatic tumors of the adrenal gland. All the lesions included in this study showed significant FDG uptake. This is the first report about determination of metastatic lesions other than lung metastasis and primary lesions of the adrenal gland by FDG PET/CT as far as we know in the literature.

Future perspective

Probably, the F-18 FDG PET/CT might be the modality of choice in the determination of the primary or the metastatic adrenal tumors. As an accurate staging modality, the F-18 FDG PET/CT would be a part of evaluating metastatic adrenal tumors in both patients with lung cancer and non-lung cancer. Further studies are required in larger populations in order to determine the prognostic value and impact of the patient management of the FDG PET/CT.

Abbreviation

F-18 FDG PET/CT: F-18 Fluorodeoxyglucose Positron Emission Tomography/Computed Tomography.

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