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Imaging features of chest wall mass in the hybrid imaging modalities: SPECT/CT and PET/CT

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Abstract

Background: The chest wall tumors are rare lesions thus there are limited literature data about the radiologic appearance of these tumors and no previous study exists about the diagnostic performance of the functional imaging modalities. Aim of this study is to analyze the diagnostic accuracy of the hybrid imaging modalities: Single photon emission computed tomography/computed tomography (SPECT/CT) and Positron emission tomography/computed tomography (PET/CT) in comparison to the histopathology results of the chest wall tumors.
Materials and Methods: Imaging results of the patients (n=20, 7F/13M, mean: 53±21,9 years of age) with the diagnosis of chest wall mass were recorded. Retrospective evaluation of the images were performed by an experienced Nuclear Medicine physician and compared with the histopathology results as gold standard.
Results: The lesions of the patients that were involved in this study were mean: 63±33.8 mm and the standardized uptake value (SUVmax) were mean: 13.7±10.8. The imaging/metabolic characteristics of the lesions were considered malign in all the patients included. All the patients diagnosed to have malign neoplasms except two.
Conclusion: The hybrid imaging has excellent diagnostic facility in diagnosis of the chest wall neoplasm. Prospective studies about this issue are warranted.

***Keywords*:** *hybrid, bone, radionuclide, chest wall, PET.*

Background

The chest wall neoplasms might be originated from benign conditions and malign lesions [1, 2]. The diagnostic tests evolved in recent years and hybrid imaging modalities take place in the diagnosis of these tumors as well. The PET/CT is the test of choice in malign tumors due to the possibility to achieve both information regarding the malignity of the primary lesion as well as staging in the single session. Bone scintigraphy was also a preferable method in diagnosis of chest wall tumors with hampered diagnostic facility due to the false positive

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results. Possibility of observing the lesion characteristics and exclusion of fractures (recent or previous) by additional CT (as a SPECT/CT single modality) provided additional diagnostic power as a hybrid modality. The hybrid imaging protocols has been accepted as effective characterization modalities in the determination of most of the lesions in the body. The combination of morphological data with metabolic information provides the best information about the malign-benign discrimination of the lesions in the chest wall. Additional to the metabolic characterization the staging of the tumor and rarely finding out metastatic involvement of the chest might be possible by means of hybrid imaging modalities (PET/CT and SPECT/CT) [3, 4]. There are limited data in the determination, metabolic characterization and staging of the chest wall tumors by means of hybrid imaging in the literature which is limited to case reports. The aim of this study was to investigate the accuracy of the hybrid imaging methods in the chest wall neoplasms.

Methods

The study was approved by local ethics committee and the informed consents of the patients were obtained prior to the imaging study. Twenty patients (n=20, 7F/13M, mean: 53±21,9 years old) who were attended to the Nuclear Medicine Department for FDG PET/CT between January 2016-January 2019 were subjects of this study. The patients either have a known primary malignancy referred for restaging or for the characterization of an unidentified thoracic mass. The exclusion criteria were the pregnancy and lactation or contraindication for the PET/CT or bone scintigraphy. The inclusion criteria were thoracic lesion without histopathology result and having no contraindicated condition for the thoracic operation.

The patients were prepared for the examination with at least 6 hours fasting and decreasing physical effort at least 24 hours before the study. The radiopharmaceutical F-18 Fluorodeoxyglucose (FDG) injection was performed (mean 370 MBq (10 mCi), according to the body weight) to each patient via venous line 60 minutes before the imaging. The imaging was performed by PET/CT scanner (Discovery PET/CT 610, General Electric, (Boston MA), US) with additional low dose CT scan (130 kV, 50 mAs, a pitch of 1.5, a slice thickness of 5 mm, in 70 cm field of view) for attenuation correction without intravenous contrast administration with oral contrast administration from the skull base to the upper thigh with the acquisition time of 3 min per bed position.

Bone scintigraphy was performed by intravenous administration of 20 mCi (as adult dose, adjusted according to the body weight) Technetium-99m hydroxy methylene phosphonate (Tc-99mm HMDP) after 2-3 hours waiting interval as three phase and whole body imaging protocol. Additional SPECT imaging (performed by a SPECT gamma camera; Symbia, Siemens, Germany) from the thoracic region was performed with CT imaging in the PET/CT gantry as a low dose protocol in order to limit the total dose of the patient (ALARA protocol) at the same single study within 2 weeks after or before the FDG PET/CT. Fusion of the SPECT/CT images was performed by mac-OS reading console.

The images were analyzed by an experienced Nuclear Medicine physician and compared side by side as hybrid PET/CT and SPECT/CT images. Quantitative values belongs to PET/CT images (SUVmax) were recorded. Lytic-expansive lesion in the chest wall with or without significant FDG accumulation (for every SUVmax levels) considered malignant.

The mean±2SD levels of the numeric variables were calculated by One sample T Test.

Results

The thoracic wall lesions (main lesion) of the patients that were involved in this study were mean: 63±33.8 mm in size (maximum diameter) and the standardized uptake value (SUVmax) of these lesions were mean: 13.7±10.8. The imaging/metabolic characteristics of the lesions were considered malign in all the patients included. All the patients diagnosed to have malign neoplasms by histopathology results except two. Thus diagnostic sensitivity and accuracy of the combination of the two modalities were 100% and 91% respectively.

The characteristics of the patients, lesions and histopathology results are summarized in the table 1. Four patients had known primary tumor (lung carcinoma, malignant menengioma, breast carcinoma (n=2)) and the lesions of these patients were metastatic involvement of the chest wall. Fourteen patients had metastatic lesions elsewhere in the body. Radionuclide bone imaging (SPECT/CT) was performed to six patients and metabolic imaging F-18 FDG PET/CT was performed to all patients. According to the malignancy criteria all the patients were considered malignant (two patients with lower SUVmax levels than 2.5 but lesion characteristics were lythic-destructive) except two patients who was diagnosed as benign condroid neoplasia and inflammatory fibrosclerozing lesion (Figure 1, 2); pathology results of all the patients were malignant.

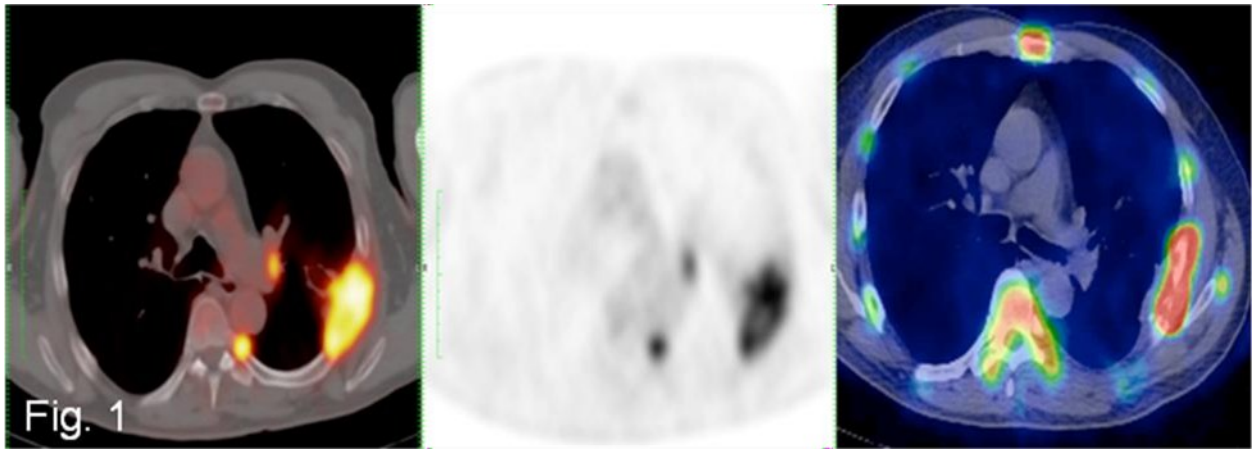

Figure 1. Transaxial fusion (A), and PET (B) images of F-18 FDG PET/CT image of the left thoracic tumor with destructive lytic characterization and significant FDG uptake (SUVmax=15.1) and fusion SPECT/CT image (C) of the same lesion with high osteoblastic activity in the adjacent costaes.

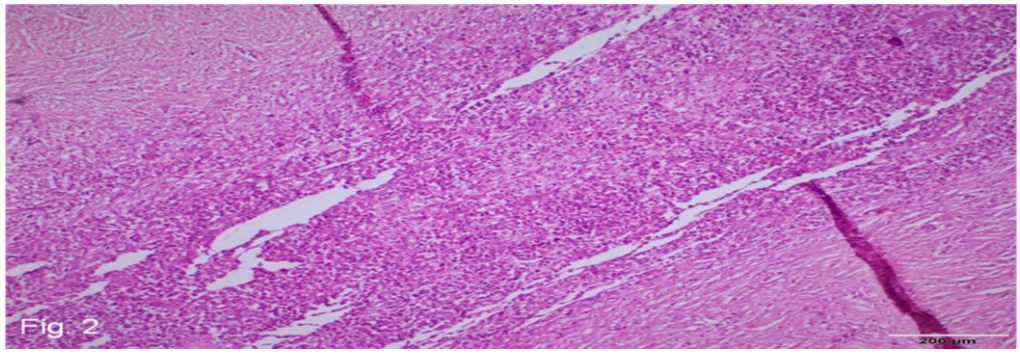

Figure 2. Pathology images with hematoxylene eosine dye in x40 magnification showing fibrosclerosing inflammatory lesion.

Table 1. Lesion characteristics of the patients included in the study.

No	Age	Lesion site	Size/SUVmax	Bone Scintigraphy and SPECT/CT	Pathology
1	81	Left supraclavicular	45 mm/9,3		Basal cell carcinoma
2	74	Right 2nd rib	35 mm/10,4		Plazmocytoma
3	73	Left posterolateral thorax	70 mm/16		Malignant mesothelioma
4	52	Left 7.-8th rib	110 mm/15,1	Increased activity in the left 7. and 8. ribs	Inflammatory fibrosclerosing lesion
5	61	1-2nd rib	50 mm/7,1		Lung adenocarcinoma
6	62	Left 4-7th rib mid aksillar region	62 mm/14,7	Increased activity in the left 5-8. ribs	Squamous cell carcinoma
7	53	Left 4th rib	47 mm/1,3		Benign condroid neoplasia
8	15	Right 10th and 8th rib	41 mm/2,5	Increased vascularity and uptake at right lateral ribs	Low grade mezenchimal tumor
9	32	Right 2-3rd rib	60 mm/3,3		Condrosarcoma
10	27	Left 2nd rib	96 mm/10,1		Low grade osteosarcoma
11	60	Left hemithorax	150mm/15		Squamous cell lung carcinoma
12	79	Right hemithorax	102mm/17,2		Small cell lung carcinoma
13	47	Left apeks	68mm/23,8	Activity accumulation in left 3. and right 6. And 7. Ribs	Sarcomatoid carcinoma
14	51	Right superior sulcus	75mm/14,1		Metastatic malign menengioma
15	48	Sternum	23mm/14,7		Metastasis of breast carcinoma
16	49	Left 2-4th rib	45mm/5,1	Significant uptake in right 4. rib, T4 and L5 vertebra	Osteochondroma
17	69	Left subscapular	167mm/38,7	Increased activity accumulation in right 8 and 10 . ribs	Malignant mesenchimal tumor
18	53	Left 4th rib	47mm/1.3		Benign chondroid neoplasia
19	69	Right 6th rib	36mm/2		Metastatic lymph node
20	68	Right 8-10th rib	20mm/2		Plasmocytoma
21	78	Left pectoral	50mm/38,2		B cell nonhodgkin lymphoma

SUVmax: Standardized uptake value.
SPECT/CT: Single photon emission tomography/Computed tomography

Discussion

The diagnostic effectiveness of the hybrid modality is documented in many types of malignant tumors of different parts of the body. There is limited number of malignant tumors which has lower affinity for the FDG

thus the sensitivity of FDG PET/CT might be low. In that case PET/CT should not be the method of choice in the staging. The chest wall lesions are specific tumors that might be investigated by both SPECT/CT and PET/CT. Thus in case of low sensitivity tumors SPECT/CT might be preferable modality. In this series we have observed that in case of thoracic wall tumor with significant FDG uptake local invasion to the ribs might be problematic due to shine through effect. In these situations positive uptake in corresponding costae could be observed by means of bone scintigraphy and clearly depicted by SPECT/CT. Another observation in this series was false positive tumors due to inflammatory tumors with significant FDG accumulation or confusing CT lesion without significant FDG uptake.

In a previous review about the chest wall neoplasms it has been reported that the half of the chest wall neoplasms is malignant; either metastasis or primary tumors [3-6]. Although this review has suggested the performance of F-18 FDG PET/CT in not first diagnosis but staging treatment response evaluation and for recurrence detection this study showed that also primary tumor detection and metabolic characterization might be possible especially if it is combined with SPECT/CT. The review limits the performance of PET/CT in the setting of discrimination of soft tissue sarcoma and benign neoplasms.

Conventional contrast enhanced CT has high diagnostic specificity but low sensitivity whereas Ultrasound (US) has high sensitivity in determination of these lesions [7, 8]. There is no comparison of these modalities with hybrid imaging previously in the literature however this subject needs to be evaluated. Hybrid imaging bone scintigraphy as well as PET/CT has diagnostic advantage of being a whole body imaging protocol. Thus another primary bone tumor or soft tissue tumor might be shown by these modalities. Additionally staging of the tumor which would be malignant might be provided in a single stage modality. The diagnostic efficiency of PET/CT is higher in osteolytic bone tumors and osteoblastic tumors in bone scintigraphy. Thus complementary imaging with these modalities provides excellent diagnostic accuracy for the bone tumors. Additionally PET/CT has excellent diagnostic facility for determination of soft tissue tumors and synchronous tumors elsewhere in the body. Additionally the CT or Magnetic Resonance imaging (MRI) does not have sufficient diagnostic accuracy for discrimination of the benign from malignant chest wall tumors [9, 10]. However the soft tissue sarcomas has high FDG uptake with increasing aggressiveness and grade thus PET/CT has high discriminative capacity and prognostic value in soft tissue tumors of the thoracic wall [2]. Rarely the metastatic lesions might be presented with chest wall mass as reported in this series which can be demonstrated by PET/CT sufficiently which was reported in the literature as well [11]. PET/CT has been reported to be effective in the discrimination of benign versus malignant schwannomas of the chest wall and recurrent tumors previously in the literature [1, 12]. Other reasons for the chest wall tumors are the benign lesions which was the case in two of the patients in this case. There are previous reports of fibroelastoma dorsi, hamartoma and solitary fibrous tumors demonstrated by PET/CT in the literature [13-15].

In this study there is a selection bias towards malignant chest wall neoplasms because of the selection of chest wall neoplasms in this study had malignant characteristics in previous imaging modalities (Plain radiograph/contrast enhanced CT) in an attempt to characterize as well as staging of the tumors. This issue might be considered a drawback of this study.

Conclusion

Metabolic characterization of the thoracic wall malignancies provides sufficient information regarding the benign/malignant lesions of the primary lesions as well as staging. Additional SPECT/CT determines the local invasion of the thoracic wall lesions in better accuracy due to the advantage of positive imaging. These combinations of the hybrid imaging protocols provide excellent diagnostic performance with few exceptions.

Abbreviations:

PET/CT: Positron Emission Tomography/Computed Tomography

CT: Computed Tomography

SPECT/CT: Single Photon Emission Tomography/Computed Tomography

MR: Magnetic Resonance Imaging

FDG: Fluorodeoxyglucose

SUV: Standardized uptake value

Declerations

Ethics approval was obtained, consent to participate obtained, consent for publication obtained, availability of data and material provided, competing interests;nothing to disclose, funding; none provided, authors' contributions; sufficently participated, acknowledgements; none.

Peer-review: Externally peer-reviewed.

Authorship Contributions

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