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PET-CT evaluation of solitary pulmonary nodules: with or without a radiologist?

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Abstract

BACKGROUND: CT scan provides information about the anatomy and morphology, may confirm whether the change is single or has multifocal character and may suggest the probability of malignancy. Due to increased metabolism, at PET examination malignant tissues usually show a greater uptake of 18F-FDG than benign changes and healthy tissue. In several cases, PET-CT is described only by a specialist in nuclear medicine without consulting a radiologist. The aim of this study is to evaluate the accuracy of PET with assessment performed by a single nuclear medicine specialist and multidisciplinary assessment by both nuclear medicine and radiology specialists.

MATERIALS AND METHODS: PET-CT was performed in 58 consecutive patients referred from John Paul II Hospital in Cracow because of radiologically diagnosed solitary pulmonary nodule (SPN) with diameter > 1 cm. An histopatological specimen was obtained in 37 patients. In 17 cases PET-CT images were evaluated by a single nuclear medicine specialist (group A), while for the remaining 20 cases, the image evaluation was performed shoulder-to-shoulder by a nuclear medicine specialist and a radiologist (group B).

ANALYSIS OF DATA: Overall PET sensitivity, specificity, positive and negative predictive value and accuracy were calculated on the basis of anatomopathologic results. These data were also calculated separately for groups A and B.

RESULTS: The histopatologic examination demonstrated the non neoplastic character of 7/37 lesions. The sensitivity, specificity, accuracy, positive and negative predictive values for group A were 85.7%, 100%, 100%, 33.3% and 88% while for group B were 92.8%, 83.3%, 92.8%, 83.3% and 90% respectively.

CONCLUSION: PET-CT is an accurate diagnostic method to assess the nature of solitary pulmonary nodules. The consultation with radiologist does not substantially affect the PET-CT diagnostic accuracy, but can lead to a higher negative predictive value.

Key words: PET-CT, 18-F fluorodeoxyglucose, solitary pulmonary nodule, interpretation, multidisciplinary, radiology

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Background

Hybrid PET-CT imaging has gained a wide acceptance for diagnosing and staging malignancies [1]. The possibility to couple the spatial resolution of CT to the molecular imaging of PET is the most attractive feature of the combined PET-CT devices. These scanners are now supplied by all the major manufacturers and are available at an increasing number of medical centers.

Since the execution of any PET scan requires an injection of radioactive material into the patient's body, PET-CT examination obviously falls under the branch of nuclear medicine.

The topographic data is first of all used for attenuation correction purposes, allowing to shorten the scan time from 40 to 15 minutes, compared to PET stand-alone homographs. However, attenuation correction may not represent all of the benefits of integrating CT with PET. The interpretation of PET-CT images can

Table 1. Group A results. From left: patient number, lesion diameter at histopathological report, SUVmax parameter measured in PET-CT examination, PET conclusion (cancer: lesion suspected to be of malignant nature; no cancer: lesion non-oncologically suspected) and results of histopathological examination

Group A				
Patient nr	Lesion diameter	SUV	PET conclusion	Histopathological results
1	28	9	Cancer	NSCLC squamous cell carcinoma
2	31	2.6	Cancer	NSCLC Adenocarcinoma
3	32	9.6	Cancer	NSCLC squamous cell carcinoma
4	17	1.2	No cancer	NSCLC squamous cell carcinoma
5	45	5.7	Cancer	NSCLC squamous cell carcinoma
6	18	8.1	Cancer	NSCLC squamous cell carcinoma
7	23	0.3	No cancer	Hamartoma
8	30	16.9	Cancer	NSCLC squamous cell carcinoma
9	55	10.5	Cancer	NSCLC squamous cell carcinoma
10	40	11.1	Cancer	NSCLC squamous cell carcinoma
11	36	13.8	Cancer	NSCLC squamous cell carcinoma
12	40	3.8	Cancer	NSCLC squamous cell carcinoma
13	15	1.1	No cancer	NSCLC Mucinous adenocarcinoma
14	29	5.1	Cancer	NSCLC Adenocarcinoma
15	23	6.6	Cancer	NSCLC Adenocarcinoma
16	45	20	Cancer	NSCLC squamous cell carcinoma
17	30	7.7	Cancer	Neuroendocrine tumor

be further improved by incorporating the morphological appearances on CT into the image analysis.

In the ideal situation, the interpretation of the images should be performed by a multidisciplinary team, with a radiologist and nuclear medicine specialists working shoulder-to-shoulder [2, 3].

On the other hand, constant presence of a radiologist in a PET-CT laboratory is limited by several logistic and economic reasons. In clinical setting, the images interpretation is quite frequently performed by a single nuclear medicine specialist only.

The number of physicians with a double specialization, in both radiology and nuclear medicine, is still very limited, and in most laboratories the nuclear medicine specialist usually uses the morphological data to localize the foci of uptake seen on the molecular imaging.

This solution has some limitations. Most nuclear medicine specialists actually working in PET laboratories have not received a specific training for the interpretation of topographic images, so there is potential risk of an insufficient definition of the exact localization of metabolic changes [4]. Moreover, a clinically relevant lesion seen on a CT scan but not showing significant radiotracer uptake is a relatively common finding and it represents a situation with no univocal conduct to follow.

We analyzed two series of patients who underwent PET-CT examination for the same indication (evaluation of solitary pulmonary nodule) and whose results were interpreted respectively by a nuclear medicine specialist alone and by a team with a nuclear medicine specialist and a radiologist.

Materials and methods

PET-CT was performed on 58 consecutive patients referred from the Department of Thoracic Surgery from John Paul II Hospital in Cracow because of a radiologically diagnosed solitary pulmonary nodule (SPN) with > 1 cm in diameter.

A histopathological specimen was obtained from 37 patients, by thoracothomy (36 patients) or transthoracic needle biopsy (1 patient). 7 patients had metastatic lesions at PET and did not undergo further invasive procedures. A histopathological specimen was not obtained from the remaining 21 patients for other reasons.

PET-CT tests were performed by using hybrid tomographs: Philips Gemini GXL (20 patients) or Siemens mCT (17 patients).

In 17 cases PET-CT images were evaluated by a single board-certified nuclear medicine specialist (group A), while for the successive 20 patients the image was analyzed by a team with a nuclear medicine specialist and a radiologist (group B).

In all cases the PET-CT description was performed in accordance with the guidelines of the European Association of Nuclear Medicine [5] with a final conclusion reporting the probability of malignant nature for each described lesion.

Results

The histopathological examination demonstrated non-neoplastic character of 7/37 lesions (1 fibrotic nodule, 1 sarcoidosis, 2 hamartomas and 3 inflammatory nodules), while the other lesions had neoplastic nature. The SUVmax value for the neoplastic lesions was 9.4 ± 4.8 while for the benign nodules it was 1.3 ± 0.7.

Lesion diameter, metabolic and morphological features, clinical conclusion of the PET report and the results of histopathological examination are reported in Table 1 and 2 for groups A and B respectively. The overall values of sensitivity, specificity, accuracy, positive and negative predictive values for the groups are shown in Table 3.

Table 2. Group B results. From left: patient number, lesion diameter at histopathological report, SUVmax parametermeasured in PET-CT examination, PET conclusion (cancer: lesion suspected to be of malignant nature; no cancer: lesion non-oncologically suspected) and results of histopathological examination

Group B				
Patient nr	Lesion diameter	SUV	PET conclusion	Histopathological results
1	38	2.5	Cancer	NSCLC squamous cell carcinoma
2	37	6.5	Cancer	TBC
3	15	3.2	Cancer	NSCLC large cell
4	30	12	Cancer	NSCLC squamous cell carcinoma
5	20	1.1	No cancer	Inflammation
6	27	1.9	No cancer	Solitary fibrous nodule
7	32	12.9	Cancer	NSCLC squamous cell carcinoma
8	12	12.5	Cancer	NSCLC Adenocarcinoma
9	10	0.8	No cancer	Hamartoma
10	32	10.6	Cancer	NSCLC squamous cell carcinoma
11	27	6.7	Cancer	NSCLC squamous cell carcinoma
12	15	8.6	Cancer	Small cel lung cancer
13	70	13.7	Cancer	NSCLC squamous cell carcinoma
14	15	1.6	Cancer	Neroendocrine tumor
15	20	0.5	No cancer	Inflammation
16	40	9.7	Cancer	NSCLC squamous cell carcinoma
17	10	2.1	No cancer	NSCLC squamous cell carcinoma
18	60	18.1	Cancer	NSCLC Adenocarcinoma
19	50	14.5	Cancer	NSCLC squamous cell carcinoma
20	10	2.2	No cancer	Sarcoidosis

Table 3. PET-CT Sensitivity, specificity, accuracy, positive and negative predictive values for both A and B groups

	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Accuracy (%)
Overall	90	85.70	96.6	66.60	89.10
Group A	85.70	100	100	33.30	88
Group B	92.80	83.3	92.80	83.30	90

Discussion

Our data is consistent with the data reported in the literature. The value of the diagnostic accuracy was approximately 90% for all the groups, without statistically significant differences. The lowest sensitivity and negative predictive values were found in group A (study described only by the specialist in nuclear medicine), while it was also the group where the highest specificity was observed. This fact is probably due to the reluctance of the nuclear medicine specialist to refer a nodule with faint FDG uptake as positive, even in the presence of radiological findings of malignancy, as for patient 4 and patient 13 in group A (Figure 1).

On the other hand, the accuracy was similar in both A and B groups.

Although the diagnostic performance of PET is improved by the use of CT to localize FDG-avid lesions anatomically, further benefits can be obtained by incorporating the morphological appearances on CT into the overall interpretation. A study by Nomori et al. [6] illustrates this concept particularly well by demonstrating that the diagnostic performance of PET in characterizing focal lung lesions is markedly affected by the CT appearances of the lesion. Other reports evidenced the need to analyze the PET-CT scan in an integrated and multidisciplinary way in order to maximize its diagnostic potential [7–9]. In our data this is quite evident for patient 20 in group B (Figure 2), where the radiological pattern of the mediastinal adenopathy allowed to make the suggestion of sarcoidosis, even in the presence of evident FDG uptake in the metabolic picture [10].

Finally, it is worth signalizing that several radiological changes caused by inflammation, emphysema, atelectasia or tuberculosis do not necessarily affect the metabolic image, but may be important for the referring doctor. An accurate radiological report gives a large amount of important information to the referring doctor, which will not necessarily be reported by the nuclear medicine specialist.

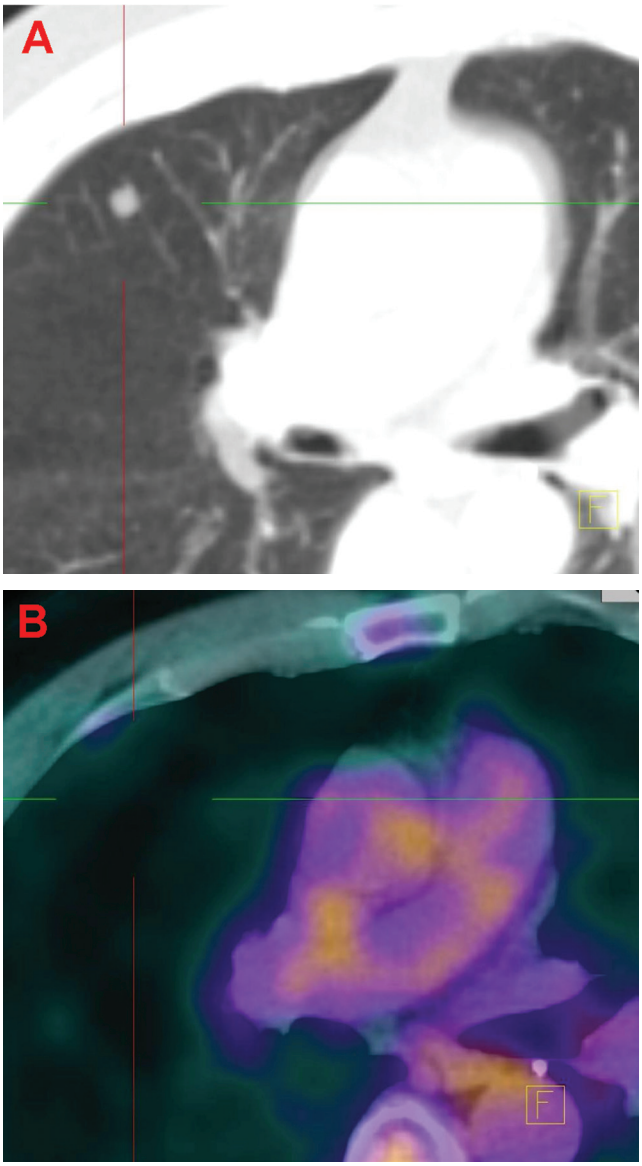

Figure 1. Group A patient number 13. In CT scan (**A**) is visible a solitary nodule in upper right lobe, while fused images (**B**) showed no significant FDG uptake. Nuclear medicine specialist reported PET-CT as negative for malignancy, histopathology revealed a mucinous adenocarcinoma with diameter 15 mm.

Figure 2. Group B patient number 20. CT scan (**A**) showed a little nodule in right upper lobe with a concomitant large bilateral mediastinal adenopathy. Fusion image (**B**) revealed FDG uptake in both nodule and enlarged lymph nodes. PET-CT scan was described as highly suggestive for sarcoidosis by a multidisciplinary team with radiologist and nuclear medicine specialist. Histopathologic results confirmed this diagnosis

Conclusion

PET-CT is an accurate diagnostic method to assess the nature of solitary pulmonary nodules. The consultation with a radiologist does not substantially affect the PET-CT diagnostic accuracy. Nonetheless, given the importance of some radiological findings, it seems warranted that the PET-CT examination will be carefully examined by a radiologist or, in suborder, by a physician with appropriate radiological skills.

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