Original article

Positron emission tomography/computed tomography exam request form under review. Is it effective?


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A R T I C L E   I N F O

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A B S T R A C T

Aim: Our objective was to analyze all the rejected PET/CT-request forms (rf), its primary question to be answered and the impact of not performing the PET/CT studies for the management of the patients.

Material and methods: We retrospectively reviewed all the cancelled PET/CT-rf received in our department from January 2007 to June 2011. The reasons for cancelling were patient clinical status, request from referring physician, patient request and criteria of nuclear medicine physician. PET/CT-rf were classified according to the primary question to be answered. The clinical evolution of patients was followed up for 6 months after PET/CT was requested.

Results: Thirty-nine studies were cancelled due to the patient clinical situation (mainly advanced state of neoplastic disease), 46 due to request from referring physician, 18 by patient request and 74 PET/CT-rf were rejected due to nuclear medicine physician criteria. Thirty-four patients with a rejected PET/CT had known neoplastic history. The more prevalent primary questions to be answered were: evaluation of pulmonary (20) and bone lesions (13). Regarding pulmonary nodules, only 4 patients had previous neoplastic disease and their size was less than 5 mm. The rejection of PET/CT studies did not cause any impact in the natural evolution of the disease of the patients.

Conclusion: This procedure avoided unnecessary PET/CT scans reducing expenses and radiation without any detriment to the patients.

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Revisión de volantes peticionarios de tomografía por emisión de positrones-tomografía computarizada. ¿Es efectiva?

R E S U M E N

Objetivo: Nuestro objetivo fue analizar todos los volantes peticionarios rechazados de PET-TAC, el motivo primario de solicitud y el impacto de no realizar esta exploración en el manejo de los pacientes.

Material y métodos: Revisamos retrospectivamente todos los volantes peticionarios de PET-TAC recibidos y cancelados en nuestro servicio desde enero de 2007 a junio de 2011. Los motivos de cancelación fueron situación del paciente, por solicitud del facultativo peticionario, debido a requerimiento del paciente y según criterio del médico nuclear. Los volantes de PET-TAC fueron clasificados según el motivo primario de solicitud. La evolución clínica de los pacientes fue valorada mediante un seguimiento clínico de hasta 6 meses tras la solicitud de la PET-TAC.

Resultados: Treinta y nueve estudios fueron cancelados debido a situación clínica del paciente (principalmente estado avanzado de la enfermedad), 46 debido a requerimiento del facultativo peticionario, 18 por petición del paciente y 74 volantes fueron rechazados según el criterio del médico nuclear. Treinta y cuatro pacientes con solicitud de PET-TAC rechazada tenían antecedente neoplásico. Los motivos primarios de solicitud a ser contestados más prevalentes fueron: evaluación de nódulos pulmonares (20) y lesiones óseas (13). En relación a los nódulos pulmonares, solo 4 pacientes tuvieron antecedente neoplásico previo y su tamaño fue inferior a 5 mm. El rechazo de estudios PET-TAC no causó impacto alguno en la evolución natural de la enfermedad de los pacientes.

Conclusión: Este procedimiento evitó PET-TAC innecesarios reduciendo costes y radiación sin ningún detrimento en los pacientes.

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Introduction

The knowledge of the patient's clinical information is fundamental in the interpretation of positron emission tomography (PET) exams. The clinical information can be obtained by a medical report or a request leaflet. The coexistence of inflammatory or infectious disease and chemotherapy or radiotherapy treatment affects radiopharmaceutical biodistribution especially for non-specific tumoral agents as [18F]fluoro-2-deoxyglucose (FDG).

Furthermore, knowing the patient's clinical history in advance may have other connotations. For example, an advanced state of the disease or the impairment of the clinical situation due to other concurrent diseases (neoplastic or not) can be reasons for cancelling the PET exam.

Nowadays FDG PET or PET/computed tomography (CT) indications are clear in some neoplastic pathologies but inconsistent in others. On the other hand, the non-specific FDG uptake in some clinical situations, besides FDG avid tumors, must make us especially cautious, not only in the interpretation but also in the selection of the studies. This is especially important in cases with a low pre-test probability of malignancy.

A quality procedure consists of reviewing the PET/CT-request form (rf) before the PET study appointment date. By doing this we can check the clinical indication, patient state and the coexistence of other clinical conditions that can affect the normal distribution of the radiotracer. The PET/CT-rf must contain information related to patient state, current clinical history, previous diagnostic studies and what is especially important, the primary question to be answered (Table 1).

Reviewing of all rf to apply for a scintigraphy or a PET/CT is a normal procedure in our department. The PET/CT-rf is rejected when there is a lack of clinical evidence for performing a PET/CT exam, based on the established clinical indications or recommendations of our Health Department or reported evidence.

Our objective was to analyze all the rejected PET/CT-rf, their primary question to be answered, the impact in the management of the patient and the chronological evolution of the rejecting criteria.

Material and methods

We retrospectively review all the rejected PET/CT-rf received in our department from January 2007 to June 2011. In this period, approximately 10,500 scans were performed. The reasons for cancelling the studies were classified attending to the clinical situation of the patient, request of the referring physician, patient request and nuclear medicine physician criteria. We focus on the PET/CT-rf rejected by the nuclear medicine physician, because PET/CT was indicated in the other circumstances. Nevertheless the former has not indication or was doubtful.

The group of PET/CT scans rejected by nuclear medicine criteria was divided into categories according to the patient background (neoplastic or not) and the primary question to be answered: imaging diagnosis of a specific lesion (benign or malignant), location of the lesion (liver, bone, brain, and lung) and size of lesion being studied (mm). In neoplastic cases we evaluated the status of the disease: surveillance without signs of recurrence, treatment response, recurrence or staging. Furthermore the coexistence of an infectious process was evaluated.

All the rejected PET/CT-rf were evaluated in consensus between 2 nuclear medicine physicians and the referring physician.

In most of the cases the referring physician informed to the patient about the reason for not performing the PET/CT exam. In the rest of cases, the nuclear medicine physician informed directly to the patient. In cases where it was not possible to contact with the referring physician, or under request of the referring physician, a written report rejecting the PET/CT was performed.

The clinical record was reviewed in all the cases to establish the clinical situation of the patient (oncological or no), status of the disease and whether the PET/CT scan was performed or not in the following 6 months after receiving the first PET/CT-rf.

We assessed the criteria for rejecting PET/CT-rf and the evolution of these criteria for the four years.

Results

The number of PET/CT scans cancelled for the period from January 2007 to June 2011 was 177. Of these, 74 PET/CT-rf were rejected by the nuclear medicine physician. Therefore the percentage of cancelled and rejected PET/CT-rf, with respect to the total number of performed PET/CT scans in that period, was of 1.7% and 0.7% respectively in that period.

Thirty-nine rf were cancelled due to the patients clinical situation (advanced status of neoplastic disease), 46 were cancelled by request of the referring physician (current treatment of the patient or carrying out other diagnostic test), 18 by patient request and 74 PET/CT-rf were rejected due to nuclear medicine physician criteria.

With respect to the categories of rejected PET/CT-rf, 34 patients had neoplastic history. The study of a specific lesion was the most prevalent primary question to be answered.

Table 2 shows the distribution of cases being the evaluation of pulmonary (20) and bone lesions (13) the most frequent.

In the case of pulmonary lesions, only 4 patients had previous neoplastic disease (gastric, lymphoma, renal and rectum carcinoma) and the size of the nodules was inferior to 5 mm. The remaining cases consisted of pulmonary nodules <10 mm. Only 2 cases consisted of masses vs. infiltrates where infectious or inflammatory origin was demonstrated. In none case malignancy was confirmed.

Ten out of 13 patients with bone lesions had neoplastic history: prostate (4), breast (4), and melanoma (2). These cases were blastic lesions or patients had a previous negative PET/CT scan or a previous negative biopsy. The other three cases consisted of cortical fibrous defect, sclerotic costal lesion in a patient with previous fracture and long evolution lytic lesions in a patient with constitutional symptoms and no other evidence of neoplastic disease. Bone metastatic disease was demonstrated in only one patient.
with breast cancer due to a blastic lesion without FDG avidity in a previous PET/CT scan and therefore only detectable in magnetic resonance imaging (MRI).

About lymph nodes, in 4 cases there was previous neoplastic background: two thyroid cancers without biochemical recurrence, one breast cancer with nodes in axillary region without changes with respect to previous studies and one patient with a previous endometrial cancer with an isolated supraclavicular lymph node of 1 cm without other evidence of neoplastic disease. In none of these cases malignancy was demonstrated in the follow-up. In the group without previous malignant background (3 cases), malignant disease was confirmed by biopsy in one case with mediastinal lymph node involvement.

Four cases corresponded to liver nodules in patients without neoplastic background. All were benign in the follow-up.

The distribution of the lesions and the results is shown in Table 2.

### Table 2

<table>
<thead>
<tr>
<th>Lesion/location</th>
<th>n</th>
<th>Size* (mm)</th>
<th>Neoplastic background</th>
<th>Final diagnosis: malignancy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pulmonary lesions</td>
<td>16</td>
<td>25 (**)</td>
<td>Not</td>
<td>Not</td>
</tr>
<tr>
<td>Bone lesions</td>
<td>4</td>
<td>5</td>
<td>Yes</td>
<td>Not</td>
</tr>
<tr>
<td>Lymph nodes</td>
<td>10</td>
<td>n.a.</td>
<td>Malignant (1)</td>
<td>Not</td>
</tr>
<tr>
<td>Liver nodules</td>
<td>4</td>
<td>15 (***)</td>
<td>Yes</td>
<td>Not</td>
</tr>
<tr>
<td>Encephalic lesion</td>
<td>4</td>
<td>5</td>
<td>Not</td>
<td>Not</td>
</tr>
<tr>
<td>Renal</td>
<td>1</td>
<td>75</td>
<td>Not</td>
<td>Not</td>
</tr>
<tr>
<td>Retropertitoneal cyst</td>
<td>1</td>
<td>n.a.</td>
<td>Not</td>
<td>Not</td>
</tr>
<tr>
<td>Prostate lesion</td>
<td>1</td>
<td>n.a.</td>
<td>Not</td>
<td>Not</td>
</tr>
<tr>
<td>Total</td>
<td>48</td>
<td>19</td>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>

| n: number, *biggest diameter in axial image; (**) in a case with pulmonary infection, the rest of lesion’s diameter were ≥10 mm; n.a.: not available; (***) in a mediastinal location; (+) probable brain metastasis due to an incomplete CT due to lack of patient collaboration.|

Discussion

Reviewing the clinical information of the patients is an aspect inherent to the imaging diagnostic process for maximum benefit of PET/CT report. Diagnostic information is crucial for the patient clinical management and clinical information provided by the referring physician is very important.

This clinical information can be provided by a request form or a medical report. Requesting a PET/CT exam with a medical report is an effective option to get all the necessary clinical information. However, obtaining the information requires close reading of the medical report by the nuclear medicine physician to integrate the relevant information when reporting the PET/CT exam. Because of this, the clinical information summarized in a PET/CT-rf is the preferred option. Furthermore PET/CT-rf should provide information about the requested procedure: standard PET/CT from the head to the upper thighs, raised or down arms acquisition, brain scan in cases of suspected brain metastasis or in oncological diseases with a higher incidence (small lung cell carcinoma or pulmonary adenocarcinoma), intravenous contrast protocols and other relevant clinical information (Table 1).

The review of all clinical information is particularly important to check the correct indication of explorations with high cost or moderate doses of radiation to the patient like in the PET/CT scan. This review should be performed in cases with a previous oncological diagnosis and in cases where with a suspicious lesion in a patient without oncological background.

The importance of reviewing the PET/CT-rf in oncological cases is to assess the best time to perform the study, especially in patients who have undergone invasive diagnostic procedures as colonography, biopsy or treatments that cause FDG uptake interferences like chemotherapy or radiotherapy.

The state of the disease is also an important issue because patient’s condition. For example, advanced disease status or claustrophobia, could cause the cancellation of the PET/CT exam and a waste of the radiotracer.

Due to the importance of PET in the management of oncological patients, it is not debatable to reject a PET/CT in these cases, except for patients in complete remission without suspicion of recurrence or underwent to active treatment (chemotherapy plus radiotherapy) like five patients in our sample.

With respect to the other PET/CT indications, especially the screening of lesions, we must be cautious and check all the provided information to guaranty that there are no limitations for the PET/CT scan, such as small lesions or lesions with low on non-FDG avidity.

### Table 1

<table>
<thead>
<tr>
<th>Lesion/location</th>
<th>n</th>
<th>Size* (mm)</th>
<th>Neoplastic background</th>
<th>Final diagnosis: malignancy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pulmonary lesions</td>
<td>3</td>
<td>25 (**)</td>
<td>Not</td>
<td>Not</td>
</tr>
<tr>
<td>Bone lesions</td>
<td>5</td>
<td>5</td>
<td>Yes</td>
<td>Not</td>
</tr>
<tr>
<td>Lymph nodes</td>
<td>1</td>
<td>15 (***)</td>
<td>Yes</td>
<td>Not</td>
</tr>
<tr>
<td>Liver nodules</td>
<td>1</td>
<td>15 (**)</td>
<td>Not</td>
<td>Not</td>
</tr>
<tr>
<td>Encephalic lesion</td>
<td>1</td>
<td>5</td>
<td>Not</td>
<td>Not</td>
</tr>
<tr>
<td>Renal</td>
<td>1</td>
<td>75</td>
<td>Not</td>
<td>Not</td>
</tr>
<tr>
<td>Retropertitoneal cyst</td>
<td>1</td>
<td>n.a.</td>
<td>Not</td>
<td>Not</td>
</tr>
<tr>
<td>Prostate lesion</td>
<td>1</td>
<td>n.a.</td>
<td>Not</td>
<td>Not</td>
</tr>
<tr>
<td>Total</td>
<td>8</td>
<td>19</td>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>

n: number, FUO (fever of unknown origin), (+) previous thyroid cancer with low levels of stimulated thyroglobulin (less than 2 ng/ml); (**) without confirmation of malignant disease; (*) malignant disease background, (I) breast lesion corresponding to T1 neuroendocrine lesion.
Pulmonary nodules

Assessment of pulmonary nodules in oncological and non-oncological context is an important reason for requesting a PET/CT exam and an established indication.

FDG PET/CT is currently the main and cost-effective method to investigate indeterminate lung nodules. However, pre-test probability of malignancy and nodule size are important factors to take into account in order to improve the diagnostic capability of PET/CT. In a recent study, PET/CT showed a high sensitivity and a moderate specificity (95% and 72% respectively) in the detection of malignancy in nodules between 0.5 and 0.99 mm but in patients being examined for potential lung cancer. In our sample, most of patients (16/20) with pulmonary lesions had not oncological background and had nodules smaller or equal to 1 cm except in two patients who had bigger lesions. No patient was diagnosed of malignancy in the follow-up. Patients with nodules bigger than 7 mm (5 cases) had a low pre-test probability of malignancy because the nodules had not demonstrated changes in a previous radiologic follow up with CT.

Lymphadenopathies

The study of lymphadenopathies detected by morphologic diagnostic techniques, previous to the histological confirmation of malignancy, is not an indication for a PET/CT exam due to the multiple causes of lymph node enlargement, especially not oncological. However in cases with difficult biopsy access PET/CT can be very useful to direct a biopsy in the most accessible hypermetabolic location.

Liver lesions

In the study of a liver lesion, patient background is especially important to establish the indication or not for a FDG PET/CT. For example a PET is not useful in the diagnosis of a liver lesion in a patient without a neoplastic background or in the assessment of lesions smaller than 1 cm, like the 4 patients in our sample. But on the contrary, this technique is especially useful in oncological cases to rule out a metastatic disease especially in patients with colorectal cancer.

Bone lesions

In the same way, PET/CT can help in the diagnosis of bone lesions in oncological patients, but in a non-oncological context it loses its value, especially for blastic lesions. The lack of sensitivity of FDG-PET in the detection of sclerotic osseous lesions in patients with prostate and breast cancer was published previously. FDG uptake is probably decreased in sclerotic lesions owing to their acellular nature with a correspondingly low glycolytic rate. These findings emphasize that sclerotic lesions in the spine require particular attention and close follow-up, even if negative results are found with FDG-PET, or even biopsy.

Brainstem lesions

There is little experience in brainstem tumors and although, at the spinal level, molecular imaging may help to detect progression or recurrence of metastatic disease after surgical treatment, it is well documented that there are substantial molecular and cellular differences between brain and spine.

Intense tracer uptake in brainstem gliomas, compared with gray matter, suggests decreased survival but there has not been reported the utility of FDG-PET in less aggressive tumors as we reported in our sample.

In thyroid cancer, it has been demonstrated the low accuracy of PET/CT to detect recurrent disease in patients with low level of thyroglobulin as the patients of our review.

PET/CT technique is currently expanding, with new facilities and indications appearing every year. With regard non-oncological indications PET/CT according to a recent survey on multiple technique imaging in Europe, clinical PET or PET/CT was used also for neurology, infection/inflammation and cardiology purposes by 39, 30% and 25% of responding members of the European Society of Radiology and by 60%, 54% and 40% of responding members of the European Association of Nuclear Medicine, respectively. In our department we have expanded the indications to FUO due to the reported evidence.

One of our most important limitations was the retrospective nature of our revision. PET/CT-rf were analyzed by different nuclear medicine physician. This could affect the results attending the criteria for rejecting the PET/CT exams due to a lack of established indications for that. Although we keep all the PET/CT-rf just in case the referring physician or patient claims additional information, some request forms could escape of the control.

In our opinion, the rejecting criteria are dynamic and depend on the medical experience, reported investigation and learning curve of referring and nuclear medicine physicians.

A direct communication with the referring physician is very important in order to establish the correct indication of doubtful cases. Therefore, the assessment of the correct indication, avoiding unnecessary radiation is a responsibility of both, referring and nuclear medicine physicians.

An important issue is addressed in this work and, despite the importance of reviewing all the clinical information previous to a PET/CT exam, there has not been any previously reported literature that had assessed the impact of “filtering” the PET/CT-rf.

Conclusion

Correct diagnostic information in the PET/CT-rf is essential in the establishment of the accurate indication of this procedure.

The fact of reviewing the PET/CT-rf and rejecting the cases of doubtful indication or justification for a PET/CT has implications in the costs without detriment in the patient outcome in our sample of patients.

Conflict of interest

None.

References


