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Original Article

^{18}F-Choline PET/CT scan in staging and biochemical recurrence in prostate cancer patients: Changes in classification and radiotherapy planning☆

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ABSTRACT

Objective: To evaluate the role of the ^{18}F-Choline PET/CT in prostate cancer management when detecting distant disease in planning radiotherapy and staging and to evaluate the therapy changes guided by PET/CT results.
Material and methods: A retrospective evaluation was performed on ^{18}F-Choline PET/CT scans of patients with prostate cancer. Staging and planning radiotherapy scans were selected in patients with at least 9 months follow up. There was a total of 56 studies, 33 (58.93%) for staging, and 23 (41.07%) for planning radiotherapy. All scans were obtained using a hybrid PET/CT scanner. The PET/CT acquisition protocol consisted of a dual-phase procedure after the administration of an intravenous injection of 296–370 MBq of ^{18}F-Choline.
Results: There were 43 out of 56 (76.8%) scans considered as positive, and 13 (23.2%) were negative. The TNM staging was changed in 13 (23.2%) scans. The PET/CT findings ruled out distant disease in 4 out of 13 scans, and unknown distant disease was detected in 9 (69.3%) scans.
Conclusions: ^{18}F-Choline PET/CT is a useful technique for detecting unknown distant disease in prostate cancer when staging and planning radiotherapy. The inclusion of ^{18}F-choline PET/CT should be considered in prostate cancer management protocols.

La PET/TC con ^{18}F-Colina en la estadificación y recidiva bioquímica de pacientes con cáncer de próstata: cambios en la clasificación y planificación de radioterapia

Palabras clave:
PET/TC
Colina
Cáncer de próstata
Estadificación
Recurrencia bioquímica
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RESUMEN

Objetivo: Valorar la utilidad de la ^{18}F-Colina PET/TC en la detección de enfermedad a distancia en la estadificación inicial de pacientes con cáncer de próstata de alto riesgo y en pacientes con recidiva bioquímica, con intención de planificación con radioterapia, así como valorar los cambios en el manejo terapéutico influenciados por los resultados de la misma.
Material y métodos: Se evaluaron de manera retrospectiva los estudios ^{18}F-Colina PET/TC de pacientes con diagnóstico de adenocarcinoma de próstata, con indicación de estadificación inicial en pacientes de alto riesgo (o con sospecha de afectación a distancia) y/o planificación de radioterapia y en pacientes con recidiva bioquímica con intención de rescate con radioterapia con un seguimiento adecuado durante al menos 9 meses. Se seleccionaron un total de 56 estudios, 33 (58,93%) de estadificación y 23 (41,07%) de planificación de radioterapia.
Para el estudio PET/TC se empleó un equipo multimodal PET/TC, la dosis empleada fue de 296-370 MBq de ^{18}F-Colina, con un protocolo de adquisición en 2 fases.

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Resultados: Del total de los 56 estudios, 43 (76,8%) fueron considerados positivos (para enfermedad local, a distancia o ambas) y 13 (23,2%) negativos.
En 13 estudios (23,2%) los hallazgos de la ^{18}F-Colina PET/TC modificaron la clasificación NM. En 4 de los 13 estudios (30,7%) bajó la clasificación (descartando afectación a distancia sospechada por otras técnicas) y en 9 (69,3%) detectó enfermedad a distancia no conocida.
Conclusiones: La ^{18}F-Colina PET/TC es una técnica útil en la estadificación, recurrencia bioquímica y planificación de radioterapia en el cáncer de próstata para localizar enfermedad a distancia no detectada con pruebas de imagen convencionales, por lo que deberían ampliarse sus indicaciones en las guías de manejo del mismo.

Introduction

The main tools used for the initial evaluation of prostate cancer (PC) are digital examination, serum PSA determination and bone scintigraphy (BS) complemented by computerized tomography (CT) or magnetic resonance (MR) according to the characteristics of the patient. Correct disease staging and re-staging are essential for the optimal choice of treatment for each patient. MR is considered to be the technique of choice for correct delimitation of local extension of PC.[1]

With regard to the evaluation of lymph node involvement, although in clinical practice different predictive normograms of the pathological stage are used, the method of choice is surgical lymph node dissection[2] with extensive compared to conventional dissection being preferred.[3,4] Sentinel lymph node biopsy may also be considered in PC. This technique has been validated in both open and laparoscopic surgery and may help to localize lymph nodes outside the widened sentinel lymph node dissection regions.[5] Nonetheless, evaluation of lymph node involvement should always be carried out when the results influence therapeutic decision making.

In regard to metastatic involvement, at present BS continues to be the method most frequently used to evaluate bone metastases (being more effective than clinical evaluation, bone radiography and serum alkaline phosphatase determination). Nonetheless, several techniques such as whole body MR,[6] positron emission tomography (PET)/CT with choline[7,8] and ^{18}F-fluoride PET/CT[9–11] have shown to more effective in detecting bone disease.

The aim of the present study was to evaluate the use of ^{18}F-choline PET/CT in the staging, detection of recurrence and radiotherapy (RT) planning in patients with PC attended in our center. We also evaluated the changes in TNM classification determined by PET/CT findings as well as their influence on the therapeutic management of these patients.

Material and methods

Study population

We retrospectively evaluated the ^{18}F-choline PET/CT studies carried out in patients diagnosed with prostate adenocarcinoma in the Department of Nuclear Medicine of our hospital from March 2011 to September 2014. The follow up ^{18}F-choline PET/CT studies performed after September 2014 in patients included before this date (new studies of biochemical recurrence or for treatment planning) were also included.

The inclusion criteria were studies describing the initial staging of high risk patients (or with suspicion of distant involvement by other imaging techniques) and RT planning in patients with biochemical recurrence. In both cases there should have been adequate follow up during at least 9 months (except in one case in which the patient died at 6 months after the study due to the advanced stage of the disease), with control of serum PSA values, the diagnostic tests performed, treatments and clinical evolution. Patients with incomplete follow up were excluded from the study.

The inclusion criteria were met in 56 studies in 55 patients (one patient underwent a second study). A database was elaborated for collection of data related to the patient characteristics and the clinical history. Of the 56 studies, 23 (41.07%) were for RT planning and 33 (58.93%) were for staging (Table 1).

At present, ^{18}F-choline PET/CT is not authorized for routine use in Spain and its use in special situations is regulated by the Real Decree 1015/2009 of June 19. Once a request has been approved by the Spanish Agency of Medication and Healthcare Products and informed consent is obtained from the patient, the radiotracer is obtained and the ^{18}F-choline PET/CT can be performed. Data confidentiality was maintained according to the Organic Law of Data Protection (LOPD).

Study technique. Radiotracer, imaging and processing protocol

The ^{18}F-choline was provided to the Department of Nuclear Medicine by an external company. Fasting prior to the study was not necessary. Neither oral nor intravenous contrast was administered before the PET/CT study.

A multimodal Siemens Biograph 6 (Biograph; Siemens, Erlangen, Germany) was used for the PET/CT study. With the patient supine the intravenous line was placed followed by the injection of a dose of 296–370 MBq of ^{18}F-choline. Then the patient was placed with the arms crossed above the head for correct image acquisition. The protocol of PET acquisition was a 2-phase process. First, a sequential study was performed immediately after the injection of the radiotracer, making 5 sequential images of the pelvis (1 BED) of 2 min each during the first 10 min. Second, a whole body study from the head to the pelvis (6-7 BED of 4 min, in a caudocranial direction) was made 50 min after the injection. Each CT acquisition (one in each phase) was preceded by a scout (80 kV, 10 mA, anteroposterior) to determine the limits of PET/CT acquisition. The CT parameters were: 120 kVp; 95 mAs, with a tube rotation of 0.5 seconds, pitch of 6, and slice thickeness of 5 mm. All the PET studies were acquired in 3D mode with a field of view (FOV) diameter of 70 cm.

The images were processed in a Leonardo workstation (Syngo™ software system; Siemens Medical Imaging, Forchheim, Bavaria, Germany) using Trued software. Correction of segmentary attenuation was made in the postinjection transmission image followed by interative reconstruction.

Image interpretation

The studies were interpreted by 2 expert nuclear medicine physicians. Axial, coronal and sagittal slices of the 2 modalities (PET and CT) and fusion of the two were used for interpretation of the images (Figs. 1 and 2). Images corrected by attenuation and maximum intensity projection (MIP) reconstructions of the PET were also used.