

Focal Thyroid Uptake during ^{18}F -Choline PET/CT: A Case Report

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Abstract

Here we report the case of a 60-year-old patient previously affected by prostate cancer treated with prostatectomy. After surgery, the patient was scheduled for routine follow up examinations including biochemical and imaging evaluations. PSA testing evidenced a light, continuous increase in the course of the last four samplings. This finding calls for a biochemical recurrence. Thus the patient underwent a ^{18}F -Fluorocholine (FCH) PET/CT to detect the possible sites of the relapse. FCH PET/CT did not disclose any focal uptake suggesting a metastatic spread. However, one focal uptake was noticed in the lower pole of the right thyroid lobe, corresponding to a hypodense nodule. Therefore, the patient was studied with $^{99\text{m}}\text{Tc}$ thyroid scan and neck ultrasound. Both examinations had findings suspicious of a neoplasm. The fine needle aspiration biopsy (FNAB) that was carried out to rule out a malignancy, gave a TIR2 result. FCH PET/CT may give thyroidal uptakes in benign lesions.

Keywords

^{18}F -Choline, PET/CT, Prostate Cancer, Thyroid Incidentaloma

1. Introduction

^{18}F -Choline (^{18}F -FCH) is a radiopharmaceutical used for positron emission tomography (PET) imaging of tumors with low glucose metabolism. The main application of ^{18}F -FCH PET/CT is in the follow-up of patients af-

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ected by prostate cancer with biochemical recurrence. In spite of its relatively low sensitivity, ^{18}F -FCH PET/CT has shown a good specificity, with very few mimickers of metastatic disease reported in the literature. However, the ^{18}F -FCH intrinsic uptake mechanism makes it possible to image other neoplasms with a high membrane phospholipid metabolism. Here we describe the rare case of an ^{18}F -FCH uptake in the thyroid corresponding to one focal “cold” area on thyroid scintigraphy.

2. Case Report

A 60-year-old man underwent total prostatectomy and local regional lymph nodes dissection in 2011 for a prostate neoplasm. The final pathology was prostate adenocarcinoma, Gleason Score 3 + 4, pT2N0. No other treatments were scheduled after surgery. In 2014, a series of follow up examinations evidenced a light, continuous raise in PSA levels. The final trigger PSA value on December 2014 was 0.135 ng/ml, (Doubling Time 15.0 months, Slope Log 0.6, Velocity 0.1 ng/mL/yr) suspicious of a locoregional relapse. However, the trans rectal ultrasound did not disclose any suspicious finding in the prostate fossa. In spite of the relatively low PSA levels detected, ^{18}F -FCH PET/CT was scheduled in order to obtain the earliest diagnosis of the relapse and thus the maximum clinical value in a young patient. PET/CT was carried out 5 minutes and 60 minutes after the i.v. administration of nearly 185 MBq of ^{18}F -FCH. The early acquisition studied only the patient’s pelvis. Examinations were carried out using a Biograph mCT PET/CT scanner (Siemens). The patient underwent regional ^{18}F -FCH PET/CT imaging (1.5 min/bed position). A region of interest was drawn along the margin of the thyroid uptake for the measurement of maximum standardized uptake values (SUVmax).

The examination did not evidence any focal uptake of ^{18}F -FCH in the pelvis, the corresponding lymphatic basin and in the whole body imaged.

However one focal area of uptake was detected in the lower pole of the right thyroid lobe (**Figure 1**). The subsequent clinical evaluation confirmed the presence of one well defined, nearly 2 centimeters palpable node located in the right thyroid lobe. No other palpable lesions were detected in both laterocervical spaces.

This finding elicited a diagnostic dilemma. Indeed, the mechanism of ^{18}F -FCH uptake depends on the metabolism of the phospholipidic bilayer of the membrane of both normal and neoplastic cells. Moreover, despite the relatively high specificity of ^{18}F -FCH PET/CT examination for prostate cancer cells, its uptake is not only an exclusive characteristic of this neoplasm. Indeed, the literature reports of ^{18}F -FCH uptake by neoplasms other than prostate [1]-[7].

Two weeks later, the patient underwent a $^{99\text{m}}\text{Tc}$ thyroid scan. This examination showed one focal area of reduced uptake located in the lower right thyroid lobe, corresponding to the suspicious finding on PET/CT (**Figure 2**).

The neck ultrasound carried out to fulfill the diagnostic work out, confirmed the presence of a hypoechoic nodule in the right thyroid lobe and addressed the patient to a fine needle aspiration biopsy.

Ultrasound guided FNAB was carried out one week after the previous examination (**Figure 3**). The cytology was TIR2 result, a category including colloid goiter, autoimmune thyroiditis (Hashimoto’s) and granulomatous thyroiditis (de Quervain’s).

Thus the patient was scheduled for a close follow-up with ultrasound repetition after six months. No specific treatments for thyroid were scheduled.

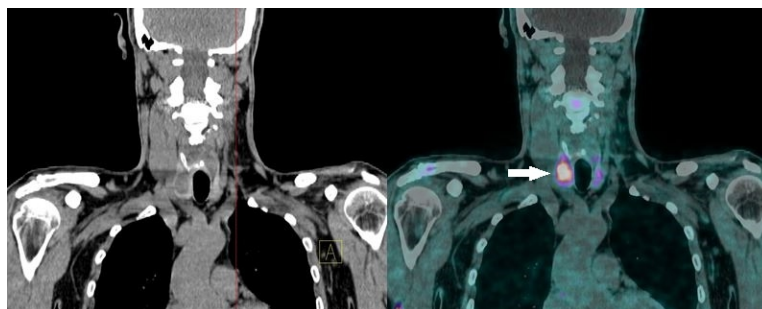


Figure 1. ^{18}F -FCH PET/CT of the patient. The left panel shows the co-registered CT. On the right side the fused images. The focal area of increased uptake is evidenced by the white arrow.

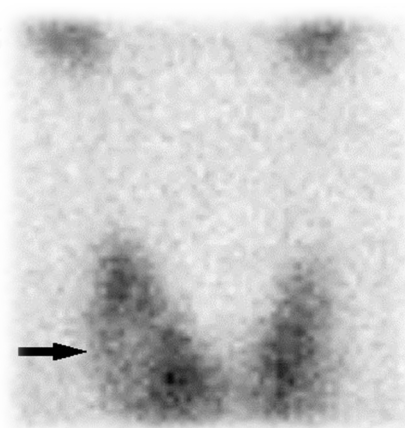


Figure 2. 99 mTc scintigraphy. It is evident one round-shaped area of reduced uptake of the radiopharmaceutical in the right thyroid lobe.

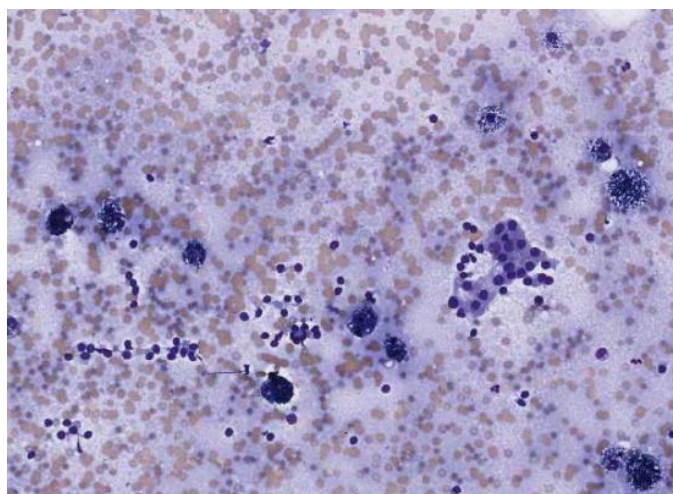


Figure 3. Citology of the nodule showing colloid and thyroid cells defined as TIR2.

3. Discussion

Choline is an essential component of cell membranes. Radiolabelled choline uptake in tumours is induced by the upregulation of choline kinase. This results in the incorporation and trapping of choline in the form of phosphatidylcholine in the tumour cell membrane. Choline may enter the cell with three different mechanisms: a low-affinity sodium-independent transport system, a high affinity sodium-dependent system and a choline-specific transporter protein. After the choline has been taken up by the cell it is phosphorylated to phosphocholine, a major substrate of membrane cells. The description of the whole cycle of choline uptake and membrane assimilation should clearly demonstrate that ^{18}F -FCH PET/CT may respectively image physiologic and pathologic but not neoplastic conditions.

^{18}F -FCH PET/CT is an accurate examination to study prostate cancer with biochemical relapse. This is particularly true considering some clinical characteristics of the disease spread. Indeed, the nodal basins usually interested by metastases are the pelvic (obturator, iliac) and abdominal (para-aortic) ones. Moreover, the PSA kinetic may address the careful evaluation of different districts. Keeping in mind these considerations, the nuclear medicine physician may neglect the sites of increased ^{18}F -FCH which are physiologic (spleen, liver, gut walls, mediastinal nodes). Basically, no other sites of nonspecific ^{18}F -FCH uptake are usually present and must be considered during the reporting.

^{18}F -FCH PET/CT may sometimes show areas of focal uptake in location not related to prostate cancer but to

other neoplasms. The most frequent of these findings concern the lungs, the bladder and the brain.

However, the incidental uptake of ^{18}F -FCH by the thyroid is very low in the literature. This data is remarkable if we consider the incidence of benign and malignant nodules in the thyroid and the mechanism of ^{18}F -FCH uptake. To the best of our knowledge, only five cases of thyroid nodules ^{18}F -FCH uptake have been reported in the literature to date, but only four were related to thyroid disease (two differentiated thyroid cancer, one Hurtle Cell adenoma and one to a benign thyroid nodule not otherwise specified) [8]-[10]. The uptakes of these neoplasms measured by SUV ranges from 8 (corresponding to a benign thyroid nodule) to 17.69 (papillary carcinoma).

One of the possible explanations of the lack of ^{18}F -FCH uptake reports in the thyroid bed, in spite of the incredibly high prevalence of nodule in the population, is that most of the thyroid nodules (both benign and malignant) do not show a significant uptake.

Our case report describes the rare case of a focal ^{18}F -FCH thyroidal uptake corresponding to a benign thyroid nodule. Due to the paucity and the divergence of the data concerning the clinical meaning of this finding, when thyroid incidentalomas are detected by ^{18}F -choline PET/CT, further investigations are required to exclude a thyroid malignancy.

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