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Incidental Finding of Parathyroid Adenoma in a Patient with Breast Carcinoma Detected by PET/CT 18F -FDG Examination and Confirmed by 99 mTc -Terofosmin SPECT/CT

Albena Botushanova[1], Aleksandar Botushanov[2]*, Nikolay Botushanov[3], Veselin Popov[1]

[1]Department of Clinical Oncology, Faculty of Medicine, Medical University of Plovdiv, Bulgaria; [2]Department of Propaedeutics of Internal Diseases, Faculty of Medicine, Medical University of Plovdiv, Bulgaria; [3]Department of Endocrinology and Metabolic Diseases, Faculty of Medicine, Medical University of Plovdiv, Bulgaria

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***Correspondence:** Aleksandar Botushanov, Department of Propaedeutics of Internal Diseases, Faculty of Medicine, Medical University of Plovdiv, Bulgaria. E-mail: abotushanov@gmail.com
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Abstract

BACKGROUND: Primary hyperparathyroidism (PHPT) is due to the overproduction of PTH by one or more abnormally altered parathyroid glands and leads to the development of hypercalcemia.

CASE PRESENTATION: We present a case of a 69-year-old female patient who was diagnosed with carcinoma of the right mammary gland in 2010. She underwent surgical treatment (right sided mammectomy) and follow-up hormone therapy with Letrozole until cancer remission in 2020. The patient was sent for a positron emission tomography-computed tomography (PET/CT) scan for restaging in May 2022. The patient underwent a whole-body PET/CT 18F-Fluorodesoxyglucosae (18F-FDG) examination on a "SIEMENS" hybrid PET/CT device, model "Biograph mCT64." During the processing of the hybrid PET/CT images, a rounded lesion suspicious for a parathyroid adenoma of the lower right parathyroid gland was visualized with a slightly increased metabolic activity of SUVmax-2.91. The neck ultrasound revealed a solid, hypoechoic, rounded formation with peripheral blood supply suspicious for a lower right parathyroid adenoma. Blood tests revealed primary hyperparathyroidism osteoporosis of the proximal femur. To diagnostic clarification of the area caudal to the right lobe of the thyroid gland, after 1 month, a single isotope two-phase scintigraphy with 99 mTc-tetrofosmin combined with an early single-photon emission CT (SPECT/CT) technique was performed on a SPECT/ CT gamma camera "Siemens," model "Symbia Intevo 6." In the early phase (20 min.) and on the early SPECT/CT images, a hyperfixing zone accumulating the radiomarker, suspicious for a parathyroid adenoma, was visualized under the right lobe of the thyroid gland. The patient underwent surgery, during which a parathyroid adenoma was histologically proven.

CONCLUSION: This case shows that PET/CT 18F-FDG examination can be useful in discovering parathyroid adenomas.

Introduction

Patients with hyperparathyroidism are diagnosed by changes in serum levels of calcium, phosphorus, and parathyroid hormone (PTH), due to the asymptomatic course of the disease. Primary hyperparathyroidism (PHPT) is due to the overproduction of PTH by one or more abnormally altered parathyroid glands and leads to the development of hypercalcemia. While, pre-operative scintigraphy of parathyroid glands with 99 mTc, Sestamibi or 99 mTc-Tetrofosmin plays a major role in detecting hyperfunctioning adenomas and is well validated in clinical practice, 18F-Fluorodesoxyglucosae (FDG) Positron emission tomography/computed tomography (PET/CT) is considered more sensitive, but less specific [1], [2]. The diagnostic value of 99 mTc-tetrofosmin for localization of abnormal parathyroid glands in patients with hyperparathyroidism was studied by Valleios V. and co-authors [3]. They found that 99 mTc-tetrofosmin was suitable for preoperative detection of abnormal parathyroid glands. Early images at 15 min were better than those at 120 min. 99 mTc-tetrofosmin cleared more slowly from normal thyroid tissue than 99 mTc–sestamibi, with both radiopharmaceuticals performing better than pertechnetate Tl-201 in the subtraction technique.

In their study, Gallowitsch HJ and co-authors [4] noted that 99 mTc-tetrofosmin appears to be a promising alternative marker with similar abilities to 99 mTc-sestamibi in the localization of parathyroid adenomas. Single-photon emission CT (SPECT) imaging shows clear advantages in terms of sensitivity over planar scintigraphy. This technique should be used in cases of poor or absent accumulation with the single-isotope dual-phase technique.

Dual isotope subtraction scintigraphy with 99 mTc-tetrofosmin/99 mTc–pertechnetate and SPECT are highly sensitive methods for the localization of parathyroid adenomas, and their combination may further improve diagnostic accuracy [5].

Case Presentation

We present a case of a 69-year-old female patient who was diagnosed with carcinoma of the right mammary gland in 2010. She underwent surgical treatment (right-sided mammectomy) and followed up hormone therapy with Letrozole until cancer remission in 2020. She was diagnosed with kidney stone disease. The patient was sent to a PET/CT scan for restaging in May 2022. The patient followed the preparation protocol of keeping a low carbohydrate diet and lack of physical activity 24 h before examination and fasting at least 6 h before it. After confirming normal blood glucose level, the radiopharmaceutical 18F-FDG was administered intravenously. The patient underwent a PET/CT whole-body examination 60 min after I administration of 263 MBq 18F-FDG on a "SIEMENS" hybrid PET/CT device, model "Biograph mCT64." During the processing of the hybrid PET/CT images a rounded lesion suspicious for a parathyroid adenoma of the lower right parathyroid gland was visualized caudal to the right thyroid lobe with slightly increased metabolic activity of SUVmax-2.91 (Figure 1). No areas of increased metabolic activity that can be associated with the underlying disease were visualized.

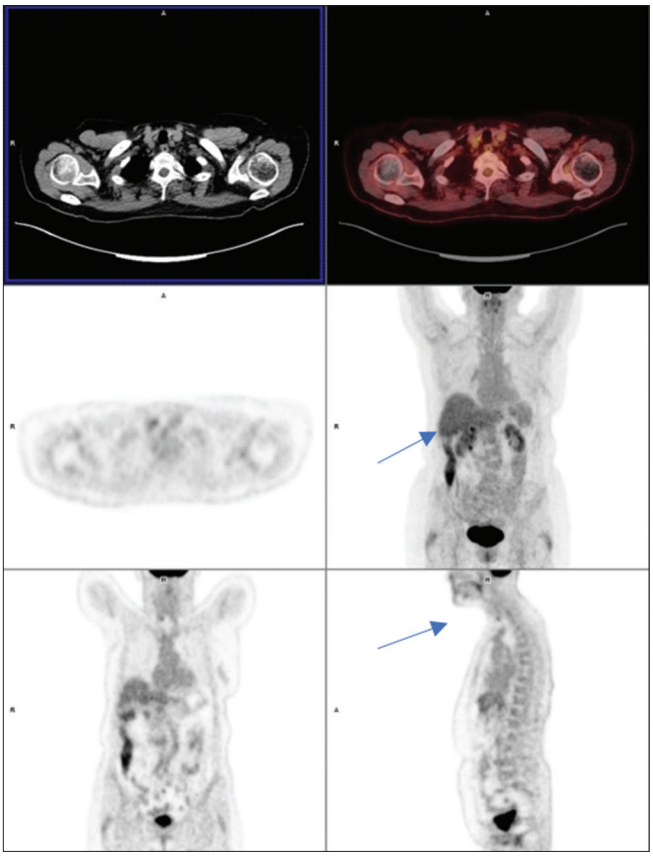

Figure 1: Positron emission tomography-computed tomography images-a lesion with slightly increased metabolic activity of 18F-Fluorodesoxyglucosae is visualized, caudally of the right thyroid lobe, suspicious for a parathyroid adenoma

After the PET/CT scan, the patient was referred to an endocrinologist. A neck ultrasound revealed a normal structure of the thyroid gland with a total volume of 7.5 mL. Caudally and dorsally of the right thyroid lobe, a solid, hypoechoic, rounded formation with peripheral blood supply and dimensions of 5.4/6.1/7.8 mm suspicious for lower right parathyroid adenoma was registered (Figure 2). No suspicious neck lymph nodes were detected. Laboratory data showed hyperparathyroidism: PTH – 162.2 pg/mL (normal range – 15.0–68.3 pg/mL); Calcium-total (Ca) – 2.76 mmol/L (normal range 2.12–2.62 mmol/L); Phosphorus – serum – 0.98 mmol/L (normal range – 0.77–1.34 mmol/L). Dual X-ray absorptiometry scan revealed osteoporosis of the proximal right femur bone with T-score – 2.8 and bone mineral density (BMD) = 0.663 g/cm^2, whilst lumbar vertebrae BMD = 1079 g/cm^2 was preserved with a T-score - 0.8.

For diagnostic clarification of the area caudal to the right lobe of the thyroid gland, after 1 month a single isotope two-phase scintigraphywith 99 mTc-tetrofosmin combined with an early SPECT/CT technique was performed on a SPECT/CT gamma camera "Siemens," model "Symbia Intevo 6."

In the early phase (20 min) and on the early SPECT/CT images, the thyroid gland was visualized with a non-uniform accumulation of the radiopharmaceutical (Figures 3 and 4]. Under the right lobe of the gland, a hyperfixing area suspicious of a parathyroid adenoma was visualized.

The patient underwent surgical intervention with removal of the parathyroid adenoma of the lower right parathyroid adenoma which was confirmed by histology.

Discussion

This clinical case gives the opportunity to compare two nuclear medicine techniques with different equipment and radiopharmaceuticals-PET/CT with 18F-FDG and single isotope two-phase scintigraphy with 99 mTc-Tetrofosmin, combined with early SPECT/CT in the same patient to visualize parathyroid adenoma.

In the last few years, reports on the application of PET/CT in the detection of adenomas of the parathyroid glands have become more frequent.

PET with 18F-FDG has been used to detect increased metabolic activity in adenomas with variable success. Some data show that 18F-FDG PET is more sensitive but less specific than 99 mTc–sestamibi SPECT [1]. Other authors have reported very low sensitivity [2].

PET imaging has improved sensitivity and spatial resolution over SPECT imaging. PET provides better accuracy and clearer images with faster acquisition compared to SPECT [6]. Several molecular

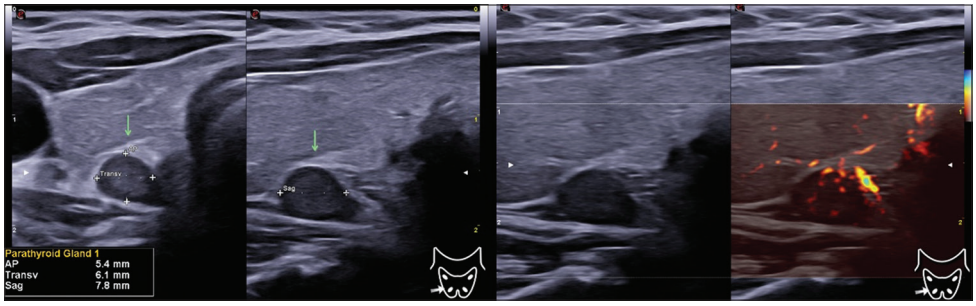

Figure 2: The neck ultrasound reveals an oval hypoechoic formation with peripheral vascularization located caudally and dorsally of the right thyroid lobe

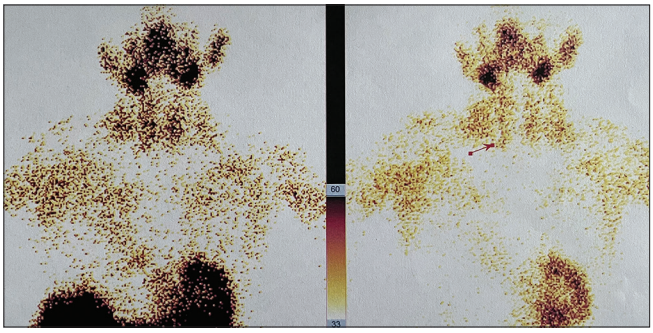

Figure 3: 20 min. - Early phase 120 min. - Late phase

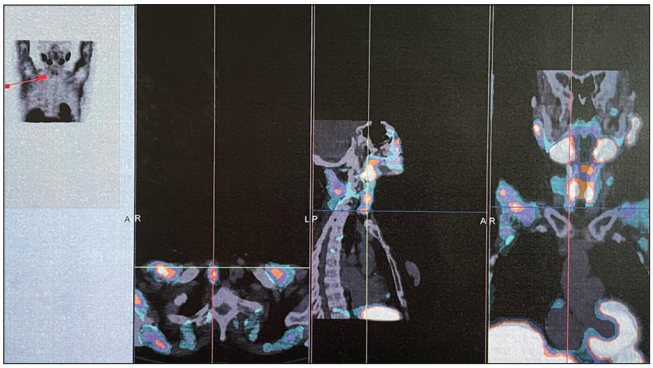

Figure 4: On the single-photon emission computed tomography/computed tomography images, a hyperfixing lesion was registered, caudal and dorsal to the right lobe of the thyroid gland

markers for PET imaging of the parathyroid gland are currently being evaluated. Earlier PET imaging studies in patients with PHPT suggested 11 C-methionine as a promising agent, but new studies have focused on choline because of its increased accuracy [7]. 11 C-choline and 18 F-fluorocholine (FCH) have been reported to be useful in imaging parathyroid hyperplasia and adenomas. Production of 11 C requires an on-site cyclotron and its half-life is only 20 min, while 18 F-FCH appears to be a more practical PET marker for potential commercial use. The major drawback of choline is that it tracks common neoplastic processes and is not a targeted biomarker for parathyroid disease. Choline uptake in neoplastic cells is thought to be due to increased phospholipid synthesis in cells with high proliferative activity [8]. It is thought that in benign parathyroid adenomas, increased lipid-dependent choline kinase activity due to PTH hypersecretion may account for the increased choline uptake [9]. In a recent systematic review of the literature, Treglia *et al*. reported a meta-analysis including 14 studies containing a total of 517 patients. They reported that choline PET imaging for detecting hyperfunctioning parathyroid glands in patients with hyperparathyroidism on a per-patient basis had a sensitivity of 95% (95% confidence interval [CI]: 92–97%), a positive predictive value (PPV) of 97% (95% CI: 95–98%) and detection rate 91% (95% CI: 87–94%). Lesion analysis gave similar results with 92% sensitivity and PPV [10].

Our case shows that PET/CT with 18F-FDG visualized a parathyroid adenoma as an incidental finding in a patient examined for a restaging of an oncological disease. The finding was also confirmed with another radiopharmaceutical 99 mTc – Tetrofosmin in a single-isotope two-phase scintigraphy, combined with early SPECT and SPECT/CT techniques.

Conclusion

The various hybrid devices used in nuclear medicine practice (SPECT/CT and PET/CT), various suitable radiopharmaceuticals – 18F-FDG and 99 mTc-Tetrofosmin, as well as the various research methods have their advantages and disadvantages and require an individualized approach to selection for each patient personally, according to the clinical case and indications. Our case showed that, although not used routinely, PET/CT with 18F-FDG could also have a role in the detection of parathyroid adenomas, especially in patients with oncological conditions where 18-FDG is used routinely.

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