CASE REPORT

Localisation of ectopic mediastinal parathyroid adenoma by ¹⁸F-fluorocholine PET/CT

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SUMMARY

We report the case of two patients with newly diagnosed primary hyperparathyroidism: a 40-year-old woman during pregnancy and a 60-year-old man with initial hypercalcaemic crisis. In the first case, a bilateral neck exploration with parathyroidectomy during the second trimester of pregnancy was unsuccessful and the patient remained hypercalcaemic. Postpartum imaging assessment with technetium (^{99m}Tc)-sestamibi scintigraphy could not supply conclusive diagnostic results. The use of ¹⁸F-fluorocholine (FCH) positron emission tomography (PET)/CT provided the accurate localisation of an ectopic parathyroid adenoma in the anterior mediastinum which was successfully resected by a thoracoscopic approach. In the second case, ^{99m}Tc-sestamibi scintigraphy was inconclusive as well and FCH-PET/CT localised an ectopic parathyroid adenoma in the mediastinum and thus bilateral neck exploration could be spared. Both patients had surgical cure of their disease.

BACKGROUND

Primary hyperparathyroidism (pHPT) is characterised by the autonomous secretion of parathyroid hormone (PTH) by one or more parathyroid glands. The most frequent cause of pHPT, occurring in 80%–90% of patients, is a benign solitary parathyroid adenoma.¹ Ectopic localisation is found in up to 22%, the prevalence is even higher in patients with redo surgeries.^{2,3} Surgery is the only definitive cure for pHPT and is indicated in all symptomatic patients, as well as in a defined subgroup of so-called ‘asymptomatic’ patients.⁴ The goals of parathyroid surgery are to remove all hyperfunctioning tissue and to preserve normal parathyroid glands. In the past, the standard surgical approach included bilateral cervical exploration. Nowadays, focused approaches have currently gained more acceptance as they are safe and effective alternatives. However, the essential prerequisite for focused parathyroidectomy is proper localisation of all autonomic tissue, including detection of ectopic and supernumerous parathyroid lesions. The most commonly used imaging modalities for this purpose are ultrasound of the neck and parathyroid scintigraphy with technetium (^{99m}Tc)-sestamibi (most often combined with single-photon emission CT (SPECT)/CT).⁵ However, sensitivity of ultrasound and scintigraphy is limited in several situations. Recent patient level studies have shown good accuracy and equal or even superior detection using ¹⁸F-fluorocholine PET/CT (FCH-PET/CT) compared with commonly

used imaging using ^{99m}Tc-sestamibi scintigraphy or ultrasound.^{6–9} In this publication, we report two cases of patients with pHPT due to an ectopic parathyroid adenoma in the mediastinum and negative/equivocal conventional imaging procedures (neck ultrasound and ^{99m}Tc-sestamibi scintigraphy/SPECT/CT). Both had successful localisation of the mediastinal adenoma by FCH-PET/CT and subsequently surgical cure of the pHPT.

CASE PRESENTATION

Case presentation 1

A 40-year-old female patient presented in the eighth week of gestation with nausea and extensive hyperemesis gravidarum. In the clinical examination, she was hypotensive, had a reduced skin turgor and dry mucous membranes. Laboratory analysis revealed elevated serum calcium level and PTH level (albumin-corrected serum calcium level 3.04 mmol/L [reference range 2.15–2.50 mmol/L], PTH level 120 pg/mL [reference range 15–65 pg/mL]) and a low serum phosphate level of 0.81 mmol/L (reference range 0.87–1.45 mmol/L). Genetic testing was negative for a Multiple Endocrine Neoplasia Type 1 (MEN-1).

Due to persistent, symptomatic hypercalcaemia and associated maternal and fetal risks, the patient underwent bilateral neck exploration during the second trimester. Preoperative localisation diagnostic with ultrasound was inconclusive; scintigraphy could not be performed because of pregnancy.

Biopsies of all four resected parathyroid glands showed no evidence of adenomas or malignancy. After an uncomplicated caesarean section and after cessation of breast feeding, hypercalcaemia persisted. Imaging studies were complemented by ^{99m}Tc-sestamibi scintigraphy/SPECT/CT which suspected the presence of an ectopic parathyroid adenoma in the right middle mediastinum nearby residual thymic tissue. Further investigation with FCH-PET/CT confirmed the presence of a 6 mm parathyroid adenoma (figure 1). The patient underwent thoracoscopic thymic resection (figure 2) and the presence of an intrathymic parathyroid adenoma was verified by histological examination.

Case presentation 2

A 60-year-old patient presented with bilateral muscle weakness, paraesthesia, anorexia and a weight loss of 24 kg in the past year. Laboratory analysis confirmed pHPT by clearly elevated serum calcium level and PTH level

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Figure 1 ^{18}F -fluorocholine PET/CT in patient 1. Diagnostic-enhanced contrast CT (left) and PET (right) showing the adenoma located in the right middle mediastinum (arrow). PET, positron emission tomography.

(albumin-corrected serum calcium level 3.60 mmol/L [reference range 2.20–2.55 mmol/L], PTH level 349 pg/mL [reference range 15–65 pg/mL]) and a low serum phosphate level of 0.44 mmol/L (reference range 0.87–1.45 mmol/L). Localisation diagnostic with ultrasound and $^{99\text{m}}\text{Tc}$ -sestamibi scintigraphy/SPECT/CT was inconclusive. Further imaging with an FCH-PET/CT localised a central necrotic, ectopic parathyroid gland within the right superior mediastinum (figure 3). The patient underwent thoracoscopic exploration of the mediastinum with complete resection of the hyperfunctioning parathyroid tissue which was classified as an adenoma in the histopathological work-up.

OUTCOME AND FOLLOW-UP

Immediate and long-term postoperative calcium levels remained within the normal range. The first follow-up of both patients was 6 months postoperative. Further regular controls are also planned.

DISCUSSION

Preoperative evaluation of patients with pHPT who are candidates for surgery includes cervical ultrasound and $^{99\text{m}}\text{Tc}$ -sestamibi scintigraphy/SPECT/CT to optimise tumour localisation,

avoid unnecessary bilateral neck exploration and minimise surgical complications. However, sensitivity of both localisation procedures is reduced in patients with multiglandular disease, multinodular goitre or with ectopic localisation of the adenoma.^{10 11}

In 2013, Quak *et al*¹² first described the incidental diagnosis of a parathyroid adenoma by FCH-PET/CT in a patient with prostate cancer. In the following years, small case series showed that FCH-PET/CT is a very sensitive diagnostic tool with—compared with scintigraphy/SPECT—equal or even better diagnostic accuracy.^{13–15} In selected cases, FCH-PET/CT can be useful for definitive diagnosis in patients with equivocal or negative sonographic and scintigraphic findings.

Compared with scintigraphy and SPECT, PET offers better spatial resolution, a better lesion to background ratio and can be easily combined with a diagnostic CT to provide the surgeon with important anatomical information. With optimised PET/CT protocols, radiation doses of FCH-PET/CT are comparable to sestamibi scintigraphy/SPECT/CT (approximately 8 mSv).^{16 17} At our clinic, costs of FCH-PET/CT are about double the costs of $^{99\text{m}}\text{Tc}$ -sestamibi SPECT/CT (CHF2874 compared with CHF1464, respectively; €3391 compared with €1727, respectively). However, image acquisition time of FCH-PET/CT is much shorter and less complicated (one examination phase of 20 min after an hour of uptake waiting time). For acquisition of $^{99\text{m}}\text{Tc}$ -sestamibi SPECT/CT, a dual phase is needed: a first examination of 10 min duration after 15 min uptake waiting time and a second examination phase of 30 min duration after 2 hours uptake waiting time.

In our patients, imaging with FCH-PET/CT led to a correct localisation of an ectopic mediastinal parathyroid adenoma in both cases with subsequent surgical cure of the disease. In the second case, the use of FCH-PET/CT spared the patient an unnecessary bilateral neck exploration. In our opinion, FCH-PET/CT offers a promising new imaging modality in patients with negative/equivocal ultrasound and/or scintigraphy/SPECT findings and is especially helpful in patients with mediastinal parathyroid adenoma. Compared with $^{99\text{m}}\text{Tc}$ -sestamibi scintigraphy/SPECT/CT in particular, it shows superior imaging results with comparable radiation exposure. However, larger head-to-head studies, comparing different imaging methods are needed for the approval of FCH-PET/CT as a first-line parathyroid imaging in the future.

Figure 2 Intraoperative, thoracoscopic situation in patient 1: right pleural cavity, lateral view. 1: parathyroid adenoma enclosed by hyperplastic thymus (subpleurally located); 2: superior vena cava and phrenic nerve; 3: pericardium (right ventricle); 4: superior pulmonary lobe (collapsed); 5: right internal mammary artery/vein.

Figure 3 ^{18}F -fluorocholine PET/CT in patient 2. Diagnostic-enhanced contrast CT (left) and PET (right) showing the adenoma located in the right superior mediastinum (arrow). Due to central necrosis within the adenoma, there is only low choline uptake (maximum standardised uptake value 3.5). PET, positron emission tomography.

Learning points

- In primary hyperparathyroidism, proper localisation of all autonomic tissue is essential for focused parathyroidectomy, including detection of ectopic and supernumerous parathyroid lesions.
- First-line diagnostic imaging includes ultrasound of the neck and parathyroid scintigraphy with technetium ($^{99\text{m}}\text{Tc}$)-sestamibi (most often combined with single-photon emission CT (SPECT)/CT).
- ^{18}F -fluorocholine (FCH)-PET/CT shows equal or even superior detection of ectopic parathyroid adenomas in the mediastinum and negative/equivocal conventional imaging procedures. Replacement of $^{99\text{m}}\text{Tc}$ -sestamibi scintigraphy/SPECT/CT by FCH-PET/CT as a first-line parathyroid imaging modality could be possible in the near future.

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Competing interests None declared.

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