Sensitive Detection of a Small Parathyroid Adenoma Using Fluorocholine PET/CT: A Case Report

Thanseer N. T. K. Padinhare-Keloth¹ · Sanjay K. Bhadada² · Ashwani Sood¹ ·
Rajender Kumar¹ · Arunanshu Behera³ · Bishan D. Radotra⁴ · Bhagwant R. Mittal¹

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Abstract Primary hyperparathyroidism is caused by parathyroid adenoma in the majority of cases and diagnosis is usually made biochemically. Pre-surgical localization of parathyroid adenoma is essential to limit the extent of surgery and avoid missing them at ectopic sites. Anatomical and functional imaging are used for the localization, but may fail to identify the small and ectopic parathyroid adenoma. We present a case of small sized ectopic parathyroid adenoma at unusual location detected by F-18 fluorocholine (FCH) PET/CT, where other imaging modalities failed. The post-operative histopathology confirmed the diagnosis of ectopic parathyroid adenoma.

Keywords F-18 fluorocholine · Minimally invasive parathyroidectomy · Parathyroid adenoma · PET/CT · Tc-99m sestamibi · Ultrasonography

Introduction

Recently, minimally invasive parathyroidectomy (MIP) has become a choice for abnormal parathyroid tissue excision and pre-operative imaging is an essential part in the work-up for patients suffering from primary hyperparathyroidism (PHPT). Ultrasonography, CT scan and MRI are commonly

employed morphological imaging methods for pre-surgical localization, however post-surgical changes in neck, ectopic parathyroid adenoma and co-existence of multiple thyroid nodules have resulted in a wide range of sensitivity and specificity. 4DCT have recently shown encouraging results [1, 2]. Tc-99m sestamibi (MIBI)/Tc-99m pertechnetate dual tracer subtraction and dual phase, planar or SPECT/CT scintigraphy are the most commonly employed functional imaging with high diagnostic accuracy, but still fall short in localizing the small sized parathyroid adenoma, with thyroid abnormalities or with ectopic location [3, 4]. Recently, positron emitting radiopharmaceuticals have shown an emerging utility in detection of parathyroid tissue in patients suffering from PHPT. F-18 fluorocholine (FCH) PET/CT has shown better diagnostic accuracy in comparison to available modality in a few of the studies and case reports published so far; though its role is still evolving [5–8]. We present a case of small sized ectopic parathyroid tissue localization with FCH PET/CT resulting in clinical improvement, where other imaging modalities failed to identify the same.

Case Report

A 72-year-old diabetic and hypertensive female presented with altered sensorium and easy fatigability for the last 20 days. She had recurrent history of right feet fracture in the last 4 years. Her biochemical profile revealed serum PTH-278 (normal 10–65 pg/ml), calcium-11.8 (normal 8.8–10.5 mg/dl) and phosphate-2.0 (normal 3.0–4.5 mg/dl). She was referred to our institute for further management after her failure to get relief from previous treatment outside. Her neck ultrasonography followed by Tc-99m MIBI dual phase planar and early SPECT/CT imaging of the neck and mediastinum were inconclusive (Fig. 1a–f). In

✉ Ashwani Sood
sood99@yahoo.com

¹ Department of Nuclear Medicine, PGIMER, Sector-12, Chandigarh 160012, India

² Department of Endocrinology, PGIMER, Chandigarh 160012, India

³ Department of Surgery, PGIMER, Chandigarh 160012, India

⁴ Department of Histopathology, PGIMER, Chandigarh 160012, India

view of strong suspicion of parathyroid adenoma, FCH PET/CT imaging was done after intravenous injection of 185 MBq at 10 min and 1 h just to observe any difference in the tracer uptake at two given different times. It revealed a tracer avid sub-centimetric soft tissue lesion in the pre-vertebral location on the right side of neck at the level of C4 vertebra with SUV max of 1.2 and 5.5 at 10 min and 1 h respectively (Fig. 1g–i). The patient underwent surgical excision of tracer avid soft tissue lesion (size $\sim 0.5 \times 0.5$ cm) from the same site and confirmed to be parathyroid adenoma on histopathology. The photomicrograph showed a well circumscribed lesion composed entirely of oxyphil cells. At one end a normal parathyroid gland is identified (H&E stain $\times 100$) (Fig. 2). Post-surgery serum PTH and calcium became normal (12.4 pg/ml and 9.1 mg/ml respectively). The patient is asymptomatic at present on follow-up for the last 4 months.

Discussion

The parathyroid adenoma is the most common incriminating cause for PHPT and its localization before surgery is paramount. The surgery in the form of MIP has the advantage of shorter operative time, smaller incision length, lesser complication rate and lower cost. The present available imaging modalities have so far shown good results though negative or equivocal findings are still seen in patients, in spite of strong clinical suspicion.

The hybrid imaging (PET/CT) using C-11 choline and FCH have shown encouraging results in the recent past. Mapelli et al. demonstrated incidental detection of parathyroid adenoma on C-11 choline PET/CT done in a metastatic prostate carcinoma patient (post hormonal therapy), later confirmed by PTH level, USG neck, Tc-99 m sestamibi parathyroid imaging and histopathology of

Fig. 1 Tc-99 m sestamibi dual phase planar imaging of neck and mediastinum at early 10 min (a), at 1 h delayed (b) and at 2 h delayed (c) revealed no abnormal tracer distribution anywhere in neck and mediastinum region. SPECT/CT imaging (early); maximal intensity projection (MIP) image (d) of neck and mediastinum show only physiological tracer uptake of MIBI. The transaxial CT image (e) showed ill-defined soft tissue in right paravertebral region. The fused

transaxial SPECT/CT image (f) showed no focal tracer avidity in the corresponding region. F-18 fluorocholine PET/CT imaging; MIP image (g) showed a small tracer avid focus in the right side of lower neck (arrow). The transaxial CT image (h) showed a small soft tissue lesion in right pre-vertebral area at the level of C4 vertebra (arrow). The fused transaxial PET/CT image (i) acquired at 1 h showed tracer avidity in the corresponding soft tissue lesion (arrows)

Fig. 2 Photomicrograph of a section of the parathyroid adenoma showing a well-circumscribed lesion composed entirely of oxyphil cells. At one end, a normal parathyroid gland is identified (H&E stain $\times 100$)

excised tissue [5]. Similarly, FCH PET/CT revealed incidental and ectopic parathyroid hyperplasia in a prostate cancer patient with end stage renal disease on dialysis for 15 years [6]. The incidental detection of parathyroid adenoma with these PET tracers prompted other investigators to undertake the pilot studies.

Luka et al. in their pilot study evaluated the utility of FCH PET/CT in preoperative localization of hyperfunctioning parathyroid tissue in 24 patients of biochemically proven PHPT. FCH PET/CT, Tc-99 m MIBI SPECT/CT dual phase and Tc-99 m pertechnetate subtraction imaging were compared against the histology of 39 surgically removed lesions (21 adenomas and 18 hyperplastic parathyroid glands) as the gold standard along with postoperative serum Ca^{2+} and iPTH values. The sensitivity and specificity of FCH were 92 % and 100 % respectively in contrast to combined sensitivity and specificity of 64 % and 100 % for conventional scintigraphic imaging. They found FCH was superior in patients with multiple lesions or hyperplasia [7]. Similarly Michaud et al. in a pilot study for 17 patients of primary or secondary hyperparathyroidism compared FCH PET/CT, USG and I-123/Tc-99 m MIBI dual phase dual isotope scintigraphy in preoperative localization. Their result showed that FCH was significantly superior to USG and a trend for a better sensitivity than scintigraphy on a per-patient and per-lesion bases with histopathology as reference standard. FCH uptake was found to be more intense in adenomas than in hyperplastic glands [8]. Orevi et al. evaluated C-11 choline PET/CT and Tc-99 m MIBI imaging in 27 surgical proven cases of parathyroid adenoma. In 23 cases, both the imaging showed matched surgical findings in their pilot study. However in one case, parathyroid adenoma was correctly localized by choline and not with MIBI, while in the other two cases, findings of neither imaging methods matched with surgical findings [9]. Similarly, FCH PET/CT could detect

abnormal foci in 13 out of 15 negative or equivocal MIBI study having the mean SUV of 5.0 (range 3.0–9.2) in the lesions, though only three of them underwent and confirmed with surgery [10]. The results of four pilot studies using two different tracers have shown that FCH PET/CT has as a high sensitivity as MIBI SPECT/CT. However, higher resolution, better images and shorter acquisition time are the advantages with FCH PET/CT. There was no ectopic parathyroid tissue in the above mentioned series except one ectopic cervical lesion which was missed by all employed imaging modalities. The present case showed the clear benefit of using FCH PET/CT in detection of small sized ectopic parathyroid adenoma where other imaging modalities failed. Similarly, Cazaentre et al. in the case report detected incidental ectopic parathyroid hyperplasia with the help of FCH PET/CT [6].

In the index case, the ultrasonography and MIBI imaging were negative while FCH PET/CT picked the lesion resulting in its surgical removal and improvement in patient's condition. The ultrasonography and MIBI imaging might have missed parathyroid tissue due to its ectopic location and small size. It is evident that FCH is a promising imaging modality for localization of parathyroid tissue because of better image quality and quick acquisition, however further studies are needed to identify its superiority over morphological imaging/conventional parathyroid scintigraphy and to establish its right place in hyperfunctioning parathyroid tissue imaging.

Compliance with Ethical Standards

Conflict of Interest Thanseer NTK Padinhare-Keloth, Sanjay Kumar Bhadada, Arnanshu Behra, Ashwani Sood, Rajender Kumar, Bishan Dass Radotra and Bhagwant Rai Mittal declare that they have no conflict of interest. There is no source of funding.

Ethical Approval All procedures performed in studies involving human participants were in accordance with the Helsinki declaration and its later amendments or comparable ethical standards.

Informed Consent The institutional review board of our institute approved this retrospective study, and the requirement to obtain informed consent was waived.

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