Case Report

# $^{11}$C-Methionine positron emission tomography-computed tomography in localization of methoxyisobutyl isonitrile negative ectopic parathyroid adenoma

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ABSTRACT

Primary hyperparathyroidism is caused by parathyroid adenomas in 85% of the cases. Since parathyroid adenomas are known for their ectopic location, presurgical localization of the suspected site of adenoma is desirable. However, current imaging modalities are not always successful in localizing ectopic parathyroid adenomas. The aim of this case report is to show that $^{11}$C-methionine positron emission tomography could accurately localize ectopic parathyroid adenomas in patients in whom conventional imaging had failed or is inconclusive.

**Keywords:** $^{11}$C-methionine, parathyroid gland, positron emission tomography, primary hyperparathyroidism

## INTRODUCTION

Presurgical localization of adenoma in symptomatic primary hyperparathyroidism is desirable. However, all widely available techniques may have difficulty in localizing the site of adenomas since they are known for their ectopic nature. Ectopic parathyroid adenomas have been reported earlier, and mediastinum is one of the most common locations for ectopic parathyroid adenomas.[1] Various imaging modalities have been used to localize ectopic parathyroid adenomas responsible for primary hyperparathyroidism. Ultrasonography (USG), computed tomography (CT), magnetic resonance imaging (MRI), and $^{99m}$Tc-methoxyisobutyl isonitrile (MIBI) scintigraphy are the commonly used imaging modalities for this purpose.[2]

In cases where commonly used imaging techniques are inconclusive $^{11}$C-methionine positron emission tomography-CT ($^{11}$C-Met PET-CT) can be used as complementary imaging technique for detection and localization of these adenomas.[3]

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## METHOD

Dual phase MIBI scintigraphy was first performed with injecting around 370 MBq of $^{99m}$Tc MIBI intravenously and high-count planar images were obtained of the neck and thorax at approximately at approximately 20 min and at 2 h using a gamma camera fitted with low energy high resolution parallel-hole collimator. In view of inconclusive MIBI scintigraphy $^{11}$C-Met PET-CT which was done, by injecting around 740 MBq of $^{11}$C-methionine intravenously and approximately 20 min later $^{11}$C-Met PET-CT scan of neck and thorax region was acquired in a whole-body full ring PET-CT scanner (General Electric, Fairfield Connecticut,United States) (GE Discovery STE16). A low dose CT was obtained on the same area for attenuation correction and co-registration. Images were reconstructed using a three-dimensional VUE algorithm and slices were reformatted into transaxial, coronal, and sagittal views.



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## CASE REPORT

A 30-year-old female presented with the complaints of pain in bilateral lower limb and with difficulty in walking for more than 1-month. She had no previous history of trauma. She had a past history of nephrolithiasis. Her routine investigation revealed serum calcium levels of 12.4 mg/dl (normal 8.8–10.5 mg/dl), serum phosphate 1.8 mg/dl (normal 3.0–4.5 mg/dl), serum alkaline phosphatase > 750 IU/L (normal 30–120 IU/l) and serum parathyroid hormone (PTH) was 1258 pg/ml (normal 10–65 pg/ml). Other investigations revealed normal complete blood count and renal parameters. Since primary hyperparathyroidism is mostly caused due to adenomas, USG of neck and MIBI scintigraphy was performed both of these modalities did not show evidence of parathyroid adenoma. Hence, the patient was referred for an $^{11}$C-Met PET-CT scan for detection and localization of parathyroid adenoma. The $^{11}$C-Met PET-CT scan showed focal area of abnormal tracer uptake in the anterior mediastinum (anterior to aortic arch) with $^{11}$C-methionine avid multiple lytic expansible lesion involving ribs, bilateral clavicle, bilateral scapulae, and bilateral humerus.

## DISCUSSION

Primary hyperparathyroidism is a common endocrine condition caused by the overproduction of PTH by either a single adenomatous gland (85%) or, less commonly, by multiple adenomatous or hyperplastic glands (15%).[4,5] Diagnosis of primary hyperparathyroidism in a clinically suspected case is suggested by hypercalcemia, hypophosphatemia, raised levels of bone-specific alkaline phosphatase and raised intact PTH levels. Excess PTH leads to the involvement of skeletal system and the kidneys in the majority of cases. Skeletal involvement is mainly as a result of increased bone resorption leading to characteristic manifestations such as osteitis fibrosa cystica, subperiosteal resorption of distal phalanges, bone cysts, and "brown tumors." Renal involvement is seen in many cases of primary hyperparathyroidism and is mainly due to hypercalciuria leading to nephrocalcinosis and nephrolithiasis. In our case-patient did not have hypercalciuria but had a past history of nephrolithiasis. The anterior neck mass may occasionally be palpable in a case of parathyroid adenoma, however, in our case no neck mass was palpable.

Surgical resection of the abnormal parathyroid adenoma is the standard treatment, and the goal of initial parathyroidectomy is a durable biochemical cure. Since ectopic parathyroid adenomas can be high cervical, intrathymic, intrathyroidal, retro-oesophageal, in the carotid sheath, interthyrotracheal, and in the mediastinum [Figure 1],[1,6] preoperative localization is necessary. Various imaging modalities like CT, MRI, and $^{99m}$Tc MIBI scintigraphy have been used to localize these glands preoperatively.[2,7] Presently, $^{99m}$Tc MIBI scintigraphy is the most commonly used investigation for this purpose.[8] However, In this case, MIBI scintigraphy did not show any radiotracer retention [Figure 2], but $^{11}$C-Met PET scan showed ectopic parathyroid adenoma anterior to the arch of the aorta [Figure 3].

$^{11}$C-methionine uptake mechanism is not yet fully understood; it is presumed to be involved in the synthesis of pre-pro-PTH, a PTH precursor which results in intense and specific uptake in

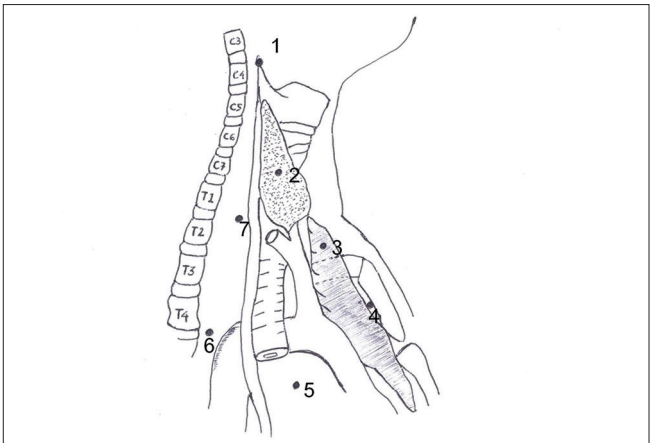


**Figure 1:** Ectopic parathyroid gland locations

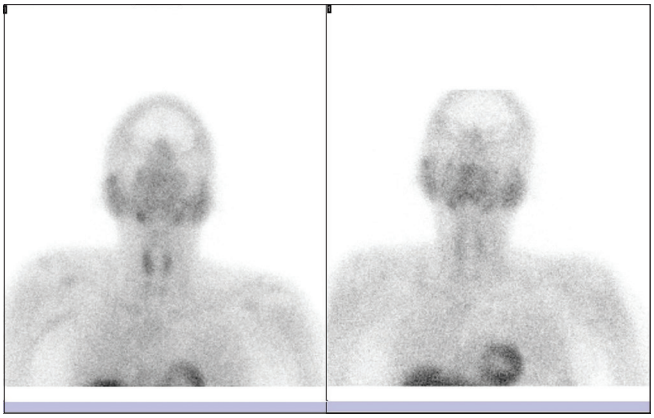

**Figure 2:** $^{99m}$Tc-methoxybutyl isonitrate scintigraphy showing no tracer retention on delayed images

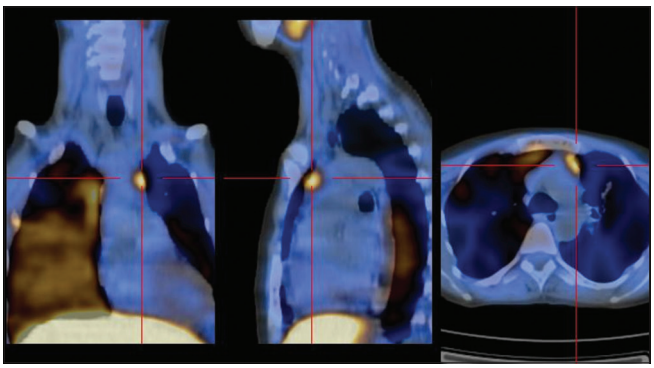

**Figure 3:** $^{11}$C-methionine positron emission tomography-computed tomography showing location of ectopic parathyroid gland near the arch of aorta

hyper functioning parathyroid glands.[9,10] Conversely, uptake of MIBI depends on the size, cellularity of the glands and PTH level, adenomas weighing more than one gram have greater than 95% sensitivity.[11] However, some parathyroid adenomas may show rapid washout or do not have any MIBI uptake in such cases $^{11}$C-Met PET-CT scanning was found to have a sensitivity of 83%, a specificity of 100% and an accuracy of 88% in successfully locating parathyroid adenomas.[3,12,13]

## CONCLUSION

$^{11}$C-Met PET-CT is a reliable and highly accurate technique for localizing ectopic parathyroid adenomas in patients especially where conventional imaging techniques have failed or are inconclusive.

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### Conflicts of interest
There are no conflicts of interest.

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