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RADIO-GUIDED PARATHYROIDECTOMY USING Tc-99m MIBI FOR ECTOPIC PARATHYROID ADENOMA : A CASE REPORT

Anamarija Jankulovska[1], Zeynep Yentur[2], Ylenia Borg[3], Ege Ozmenekse[2], Natasha Stojkovska[4], Nevena Manevska[1], Sinisha Stojanovski[1]
[1]Institute of Pathophysiology and Nuclear Medicine, Faculty of Medicine, "Ss. Cyril and Methodius" University in Skopje, North Macedonia,
[2]Faculty of Medicine, Yeditepe University, Istanbul, Turkey,
[3]Faculty of Medicine and Surgery, University of Malta, Msida, Malta,
[4]Institute of Histology and Embryology, Faculty of Medicine, "Ss. Cyril and Methodius", University in Skopje, North Macedonia

Abstract

Ectopic parathyroid adenomas pose diagnostic and therapeutic challenges. Preoperative Tc-99m sestamibi SPECT/CT scan and radio-guided surgical technique enhance intraoperative accuracy enabling precise detection of an ectopic parathyroid gland.

Case presentation: We present a case of a 54-year-old female patient with PHPT due to an ectopic parathyroid adenoma located in the suprasternal region. Neck ultrasonography showed a normal-sized thyroid with a cystic nodule in the right lobe and a hypoechoic mass in the suprasternal region, raising suspicion of an enlarged parathyroid gland. Dual-phase SPECT parathyroid scintigraphy with Tc-99m sestamibi revealed homogeneous uptake in both thyroid lobes and intense accumulation below the right thyroid lobe, suggesting hyperfunctional ectopic parathyroid tissue. The patient successfully underwent a minimally invasive radio-guided parathyroidectomy using a handheld gamma probe.

Conclusion The management of ectopic parathyroid adenomas requires a multidisciplinary approach, utilizing advanced imaging and minimally invasive techniques such as parathyroid scintigraphy with SPECT/CT and intraoperative gamma probes for the safe and precise removal of these hyperfunctional glands.

Keywords: Ectopic parathyroid adenoma, 99mTc-sestamibi scintigraphy,SPECT/CT, radio–guided surgery.

Introduction

Primary hyperparathyroidism (PHPT) is the leading cause of hypercalcemia in the outpatient population. Its incidence is estimated to be between 0.4 and 82 per 100,000 patients. In 85–96% of cases, the underlying cause for the overproduction of parathyroid hormone (PTH) is typically a single parathyroid adenoma. Less common causes include double adenoma, parathyroid hyperplasia, and parathyroid carcinoma [1].

The biochemical diagnosis of PHPT is confirmed by detecting elevated total or ionized serum calcium levels, alongside increased intact PTH levels with normal renal function tests [2]. Parathyroidectomy is recommended for all patients with symptomatic hyperparathyroidism and for those with asymptomatic hyperparathyroidism who fulfill established consensus criteria [3].

Focused parathyroidectomy is the preferred treatment for PHPT, with scintigraphy as a key method for preoperative localization of the hyperfunctioning parathyroid tissue [4]. In 10-22% of PHPT cases, an ectopic parathyroid gland is present. Technetium-99m sestamibi (Tc-99m sestamibi) parathyroid scintigraphy has demonstrated a sensitivity of approximately 89% for detecting ectopic glands [5].

When the scan is supplemented with a hybrid SPECT/CT modality and combined with ultrasonography, the sensitivity improves significantly, reaching 95%. This multimodal imaging approach is a standard in the preoperative localization, aiding in the success of minimally invasive parathyroidectomy [6].

Radio-guided surgery enhances the removal of parathyroid glands, especially ectopic ones, by using intraoperative gamma probes. It has been shown to improve precision, reducing false positives and operative failures [7].

Radio-guided parathyroidectomy combined with preoperative SPECT/CT increases the success rate and is more cost-effective than traditional invasive approaches [8].

The objective of this case report is to highlight the benefits of scintigraphy and radio-guided surgical techniques in improving surgical accuracy and enabling precise detection of an ectopic parathyroid gland.

Case report

A 56-year-old woman with laboratory findings suggesting PHPT was sent to the Nuclear Medicine Department to undergo preoperative parathyroid scintigraphy. The patient consistently showed high levels of PTH (431 pg/ml, normal range: 11–62 pg/ml), total calcium (3.37 mmol/L, normal range: 2.1–2.6 mmol/L), and ionized calcium (1.6 mmol/L, normal range: 1.12-1.32 mmol/L). The serum phosphate level was below normal at 0.78 mmol/L (normal range: 0.8-1.4 mmol/L), while the serum level of vitamin D was within the normal range at 37.1 ng/mL (normal range: 20.00 - 44.00 ng/mL).

Ultrasound examination of the neck revealed a normal-sized thyroid with an isoechoic, inhomogeneous appearance with a homogeneous nodule with cystic degeneration measuring 25 mm in the lower third of the right thyroid lobe. After a thorough examination of the neck, a hypoechoic mass measuring 17 mm in greatest diameter was observed in the suprasternal region below and medial to the right thyroid lobe, raising suspicion of an enlarged parathyroid gland.

The patient had a dual-phase SPECT parathyroid scintigraphy (10 minutes and 2 hours) after receiving a 20 mCi intravenous injection of Tc-99m sestamibi. The early SPECT image showed a relatively homogeneous uptake in both thyroid lobes, with intense radiopharmaceutical uptake in the area below and medially from the right thyroid lobe. The late SPECT images showed the tracer being washed out from the thyroid tissue, but remaining in the area below the lower pole of the right thyroid lobe, although with less intensity. This area corresponded to the sonographic finding and suggested the presence of hyperfunctional ectopic parathyroid tissue with faster washout.

The patient was planned for minimally invasive radio-guided parathyroidectomy. On the day of the surgical intervention, SPECT/CT was done 10 minutes after the IV injection of 10 mCi Tc-99m sestamibi. This hybrid imaging method obtained a detailed anatomical presentation of the ectopic hyperfunctional parathyroid tissue, which was presented with high accumulation in a hypodense lesion located centrally at the suprasternal notch (Figure 1). One hour after the SPECT/CT method, surgical intervention was successfully performed using a handheld gamma probe for detection and measurement of radioactivity. After the right thyroid lobectomy, the probe accurately located the radioactive parathyroid tumor in the lower neck region. The resected tumor measured 2.5 x 1.8 x 1.3 cm and the confirmed histology was a benign adenomatoid thyroid tumor and parathyroid adenoma. Postoperatively, the patient's PTH level dropped to 69.9 pg/mL, and serum ionized calcium level to 1.18 mmol/L. She was discharged on the fourth postoperative day without complications. At the six-month follow-up, both serum calcium and PTH levels remained within normal range.

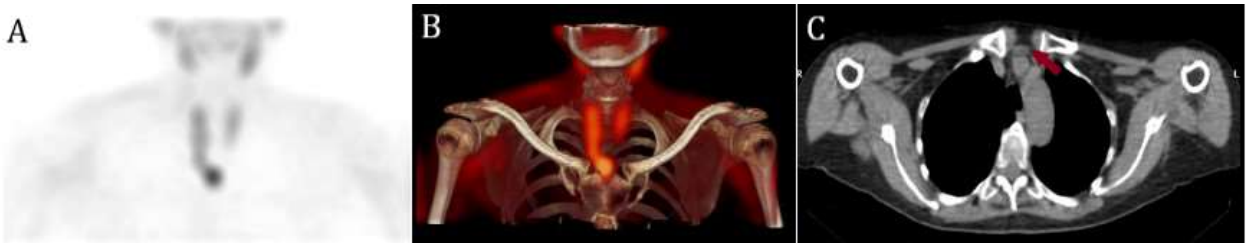

Figure 1. Tc-99m sestamibi SPECT/CT in a 56-year-old patient with ectopic parathyroid adenoma

SPECT (A) and SPECT/CT fused image (B) showed relatively homogeneous uptake in both thyroid lobes with intense focal accumulation below and medial to the right thyroid lobe, corresponding to a hypodense lesion located centrally in the suprasternal area on the axial CT image (C). The final pathological report was parathyroid adenoma.

SPECT/CT: single photon emission computed tomography/computed tomography.

Discussion

This case report highlights the successful use of radio-guided parathyroidectomy, enhanced by SPECT-CT imaging, to precisely localize and excise an ectopic hyperfunctioning parathyroid gland in a 56-year-old woman with PHPT.

Historically, the first parathyroidectomy, performed by Felix Mandl in 1925, marked a pivotal advancement in the treatment of PHPT [9]. For decades, bilateral neck exploration was the standard surgical approach, achieving a cure rate exceeding 95% by allowing visualization of all four parathyroid glands. However, more than 80% of PHPT cases are attributed to a single hyperfunctioning gland, which has driven a shift toward focused parathyroidectomy [10].

Ectopic parathyroid adenomas can be challenging to detect due to their variable size and atypical location. The superior parathyroid glands originate from the fourth pharyngeal pouch and migrate to the upper thyroid. In contrast, the inferior glands arise from the third pouch and descend with the thymus to the lower thyroid poles or the thyrohyoid ligament. Due to its longer migration path, the inferior pair is more vulnerable to variations in ectopic locations. Ectopic parathyroid adenomas can develop anywhere along the embryologic migration pathway of the parathyroid glands, extending from the base of the tongue to the mediastinum. This migration accounts for their presence in various locations [11,12].

Ectopic parathyroid glands are most commonly located near the thymus or within the thymus itself, comprising up to 38% of all diagnosed ectopic adenomas. Less frequently, they may be identified in the visceral mediastinum, paraesophageal region, or near the tracheal bifurcation. The incidence of ectopic parathyroid adenomas in specific locations varies, including retroesophageal space (8%–31%), paraesophageal region (16%), thyro-thymic ligament (12%), intrathyroidal (7%–18%), and anterior mediastinum (14%). Rare ectopic sites, such as the carotid sheath or submandibular region, account for less than 5% of all ectopic parathyroid adenomas [13 14].

Advances in preoperative imaging modalities, including coupling parathyroid scintigraphy with SPECT-CT have revolutionized surgical techniques. Other imaging methods include ultrasound, CT, MRI, PET/CT and PET/MR. These innovations facilitate accurate localization of hyperfunctioning ectopic parathyroid tissue, significantly enhancing surgical precision while reducing operative risks and recovery times [15].

Our case study demonstrated more accurate results with SPECT/CT imaging compared to ultrasonography for localizing the ectopic hyperfunctioning parathyroid gland. These findings align with previous studies indicating that the overall sensitivity of ultrasound imaging is lower than that of SPECT. Neck ultrasound is often the first imaging choice for parathyroid evaluation but has limited sensitivity in detecting ectopic glands, particularly in complex anatomical regions. In contrast, SPECT/CT offers superior precision in identifying ectopic parathyroid tissue, making it a valuable complementary imaging modality

[16]. Several studies have reported the sensitivity of ultrasound to range between 55-87%, with even lower sensitivity for ectopic parathyroid tissues [17,18]. In addition, a recently published retrospective study showed that Tc-99m sestamibi scintigraphy outperformed ultrasound in sensitivity (89.5% vs. 77%) and accuracy (86% vs. 75%), although both had comparable positive predictive values (95% vs. 95.7%). The authors recommended combining ultrasound and Tc-99m sestamibi to improve preoperative localization of parathyroid adenomas and optimize surgical outcomes [19].

A meta-analysis of 24 studies involving 1276 patients found that SPECT/CT had a pooled sensitivity of 0.86, outperforming SPECT (0.74) and planar imaging (0.70) in localizing parathyroid adenomas, including ectopic sites. SPECT/CT fusion imaging enhances preoperative planning for minimally invasive surgery and is particularly beneficial for identifying ectopic glands and addressing coexisting thyroid nodular disease [20]. Notably, SPECT/CT also improves sensitivity for detecting early washout parathyroid glands. This technique ensures minimally invasive surgery, even in cases of adenomas with faint uptake that may not be detected with the gamma probe before or after an incision [21].

Surgical intervention using an intraoperative gamma probe is recommended for patients with positive parathyroid scintigraphy, as well as those with resistant or recurrent hyperparathyroidism and ectopic parathyroid adenomas. The gamma probe enhances surgical efficiency by accurately identifying areas of interest, thereby reducing surgical time. Additionally, it provides the advantage of confirming successful excision through ex vivo counts of the removed tissue [15].

As demonstrated in our case, the gamma probe effectively differentiated the ectopic parathyroid adenoma from surrounding tissues, enabling complete surgical excision and ensuring optimal outcomes.

In conclusion, the management of ectopic parathyroid adenomas is complex and requires a multidisciplinary approach involving endocrinologists, nuclear medicine specialists, and surgeons. We recommend targeted, minimally invasive techniques guided by advanced imaging modalities, such as parathyroid scintigraphy with SPECT/CT and supported by intraoperative gamma probes, for the precise and safe removal of ectopic neck and mediastinal parathyroid adenomas.

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