Scientific Research Publishing

International Journal of Otolaryngology and Head & Neck Surgery, 2026, 15(3), 195-200
https://www.scirp.org/journal/ijohns
ISSN Online: 2168-5460
ISSN Print: 2168-5452

Seeing the Unseen: Near-Infrared Autofluorescence (PTeye) in the Excision of an Intrathyroidal Parathyroid Adenoma

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How to cite this paper: Almaged, S., Reddy, V., Alaaraj, H. and Roy, D.S. (2026) Seeing the Unseen: Near-Infrared Autofluorescence (PTeye) in the Excision of an Intrathyroidal Parathyroid Adenoma. *International Journal of Otolaryngology and Head & Neck Surgery*, **15**, 195-200.
https://doi.org/10.4236/ijohns.2026.153017

Received: March 13, 2026
Accepted: April 27, 2026
Published: April 30, 2026

Abstract

Intrathyroidal parathyroid adenomas are rare ectopic lesions that can be difficult to localize, as they often mimic benign thyroid nodules and may produce discordant anatomical and functional imaging findings. We report a 57-year-old woman with recurrent nephrolithiasis and persistent hypercalcemia due to primary hyperparathyroidism. Neck ultrasound demonstrated multiple thyroid nodules, while Tc-99m sestamibi SPECT/CT localized a focus of activity at the inferior aspect of the right thyroid lobe. Subsequent ^18F-fluorocholine PET/CT confirmed a right inferior intrathyroidal parathyroid adenoma. Intra-operatively, near-infrared autofluorescence using the PTeye system confirmed intrathyroidal parathyroid tissue, enabling targeted enucleation without thyroid tissue sacrifice. Intra-operative parathyroid hormone declined by more than 80% following excision, with postoperative normalization of serum calcium. Histopathology confirmed a parathyroid adenoma. This case highlights the value of combining advanced functional imaging with near-infrared autofluorescence to achieve accurate localization and thyroid-sparing surgery in intrathyroidal parathyroid adenomas.

Keywords

Primary Hyperparathyroidism, Intrathyroidal Parathyroid Adenoma, 18F-Fluorocholine PET/CT, Near-Infrared Autofluorescence, Thyroid-Sparing Surgery

1. Introduction

Primary hyperparathyroidism is a common endocrine disorder most frequently caused by a solitary parathyroid adenoma. Accurate preoperative localization is essential for minimally invasive surgical approaches. However, ectopic parathyroid glands, particularly intrathyroidal parathyroid adenomas, pose a diagnostic challenge due to their rarity and their tendency to mimic thyroid nodules on imaging [1] [2].

Advances in functional imaging, including ^18F-fluorocholine PET/CT, and intraoperative technologies such as near-infrared autofluorescence, have improved localization and surgical precision [3]-[5]. We report a case of an intrathyroidal parathyroid adenoma successfully localized using multimodal imaging and excised using a thyroid-sparing approach guided by intraoperative autofluorescence.

2. Case Report

A 57-year-old woman with long-standing rheumatoid arthritis was referred for evaluation of primary hyperparathyroidism in the context of recurrent nephrolithiasis. She had previously undergone three surgical interventions for renal stone disease. Biochemical evaluation confirmed primary hyperparathyroidism with end-organ involvement. Preoperative laboratory evaluation demonstrated elevated serum calcium of 2.73 mmol/L (albumin-corrected calcium 2.75 mmol/L) and parathyroid hormone of 12.10 pmol/L. Serum phosphorus was low at 0.64 mmol/L, with normal renal function (creatinine 66 μmol/L, eGFR 93 mL/min/1.73m^2). Vitamin D level was not available at the time of evaluation. Preoperative, intraoperative, and postoperative biochemical parameters are summarized in Table 1.

Table 1. Biochemical parameters before, during, and after parathyroidectomy.

Parameter	Preoperative	Intra-operative (20 min post-excision)	Postoperative
Parathyroid hormone (PTH), pmol/L	12.10	1.2	2.5
Serum calcium, mmol/L	2.73	—	2.53
Serum Phosphorus, mmol/L	0.64	—	1.00

Neck ultrasound demonstrated a heterogeneous thyroid gland of normal size with multiple nodules (Figure 1). A mixed-composition, isoechoic nodule measuring 11 × 10 × 6 mm was identified within the lower anterior aspect of the right thyroid lobe and classified as TI-RADS **2** (Figure 2). Two additional left-sided thyroid nodules were identified and considered incidental.

Ultrasound-guided fine-needle aspiration of the right lower thyroid nodule confirmed parathyroid tissue based on cytological findings, with immunohistochemical staining positive for GATA3 and negative for TTF-1.

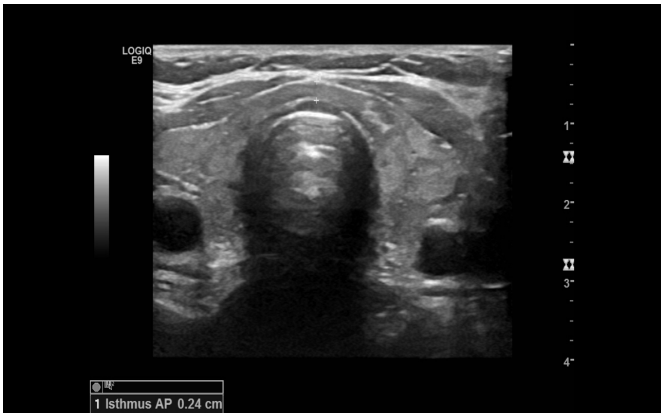


Figure 1. Transverse neck ultrasound demonstrating a heterogeneous thyroid gland of normal size, with both thyroid lobes visualized.

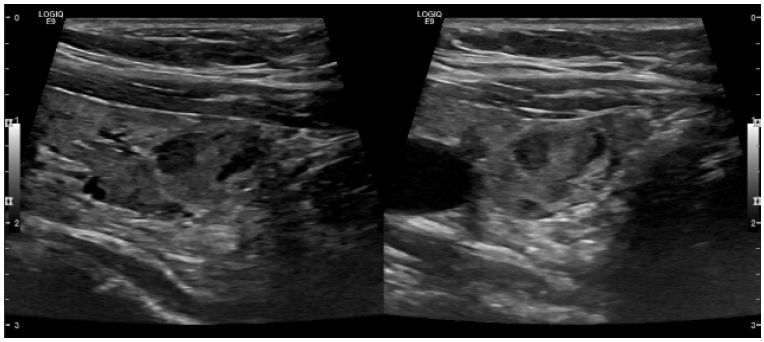


Figure 2. Ultrasound image of a mixed-composition, isoechoic nodule within the lower anterior aspect of the right thyroid lobe (TI-RADS 2), later confirmed to represent an intrathyroidal parathyroid adenoma

Tc-99m sestamibi parathyroid scintigraphy with SPECT/CT demonstrated a small focus of retained tracer activity at the inferior aspect of the right thyroid lobe, resulting in discordant anatomical and functional localization findings (**Figure 3**) [6]. Given the discordance between ultrasound and sestamibi SPECT/CT findings and the suspicion of ectopic parathyroid disease, ^18F-fluorocholine PET/CT was performed to improve localization, which enabled precise surgical targeting of the intrathyroidal lesion.

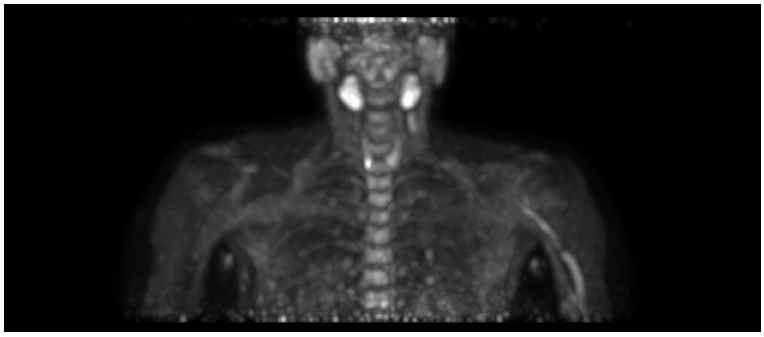
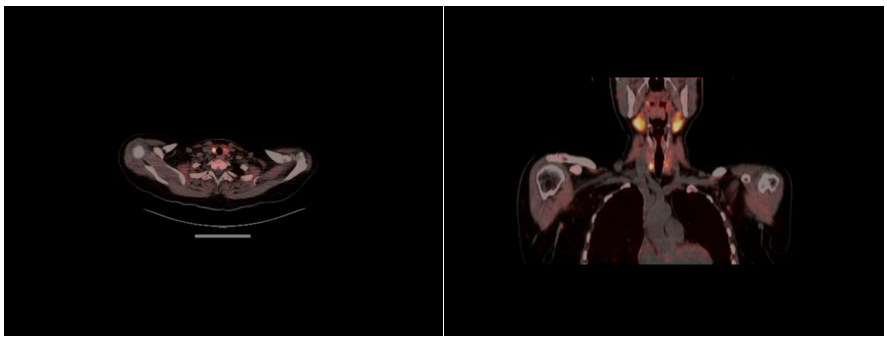


Figure 3. Tc-99m sestamibi parathyroid scintigraphy with SPECT/CT demonstrating a focal area of retained tracer uptake at the inferior aspect of the right thyroid lobe.

Subsequent ^18F-fluorocholine PET/CT demonstrated focal tracer uptake corresponding to an approximately 6 × 4 mm intrathyroidal nodule at the lower pole of the right thyroid lobe on early-phase imaging (**Figure 4(a)**), with increased uptake on delayed imaging (**Figure 4(b)**), confirming a right inferior parathyroid adenoma [3]. No abnormal tracer uptake was identified in the left-sided thyroid nodules.



(a) (b)

Figure 4. (a) ^18F-fluorocholine PET/CT early-phase imaging demonstrating focal tracer uptake within a right inferior intrathyroidal nodule, corresponding to the site of the parathyroid adenoma; (b) Delayed-phase ^18F-fluorocholine PET/CT demonstrating increased tracer uptake within the right inferior intrathyroidal nodule, confirming the presence of a parathyroid adenoma.

The patient underwent right neck exploration and parathyroidectomy. Intraoperative ultrasound confirmed the previously identified right lower intrathyroidal lesion. Near-infrared autofluorescence using the PT Eye system demonstrated a strong autofluorescent signal within the inferior pole of the right thyroid lobe, consistent with intrathyroidal parathyroid tissue. This facilitated targeted enucleation of the adenoma without the need for thyroid tissue sacrifice. The recurrent laryngeal nerve was identified and preserved, and frozen section analysis confirmed abnormal parathyroid tissue.

Intra-operative parathyroid hormone measurements demonstrated a decline exceeding 80% at 20 minutes post-excision, consistent with biochemical cure [4] [7]. Postoperative biochemical parameters are summarized in **Table 1**. Histopathological examination confirmed a parathyroid adenoma weighing 0.18 g, surrounded by a compressed rim of normal parathyroid tissue.

The patient was reviewed at 1 week and 6 weeks post-operatively. At 6-week follow-up, she remained clinically well with no active complaints, and serum calcium and parathyroid hormone levels were within normal limits, with no recurrence of nephrolithiasis or related symptoms.

3. Discussion

Primary hyperparathyroidism is most commonly caused by a solitary parathyroid adenoma, while ectopic parathyroid glands account for a minority of cases [8].

Intrathyroidal parathyroid adenomas represent a rare ectopic subtype, reported in approximately 1.3% - 6.7% of cases, with true intraparenchymal lesions being particularly uncommon [1] [2]. Their intrathyroidal location often results in imaging features that overlap with benign thyroid nodules, contributing to diagnostic uncertainty.

Accurate preoperative localization is essential for surgical planning. Conventional ultrasound and Tc-99m sestamibi scintigraphy may be inconclusive or discordant in intrathyroidal lesions, particularly in the presence of multinodular thyroid disease [6]. In the present case, ultrasound demonstrated multiple thyroid nodules with benign sonographic characteristics, while functional imaging localized disease to a right inferior intrathyroidal lesion.

18F-fluorocholine PET/CT has emerged as a highly sensitive modality for detecting small or ectopic parathyroid adenomas in patients with negative or equivocal conventional imaging [3]. In this patient, fluorocholine PET/CT was decisive in localizing the right intrathyroidal parathyroid adenoma and guiding further diagnostic and surgical management.

Historically, suspected intrathyroidal parathyroid adenomas have often been managed with thyroid lobectomy to ensure complete excision; however, this approach carries a risk of unnecessary thyroid tissue loss and postoperative hypothyroidism [1] [2]. Increasing evidence supports thyroid-preserving strategies, such as targeted enucleation, when accurate localization and intra-operative confirmation can be achieved [9].

Near-infrared autofluorescence exploits the intrinsic fluorescent properties of parathyroid tissue, allowing real-time, label-free intra-operative identification [4] [5]. In the present case, use of the PTeye system enabled confident identification of intrathyroidal parathyroid tissue and facilitated precise enucleation while preserving surrounding thyroid parenchyma. The marked intra-operative parathyroid hormone decline further confirmed complete adenoma excision and aligns with established biochemical cure criteria [4].

4. Conclusion

Intrathyroidal parathyroid adenomas are rare and diagnostically challenging lesions that may mimic benign thyroid nodules. This case demonstrates that the integration of advanced functional imaging with near-infrared autofluorescence enables accurate localization and thyroid-sparing surgery, achieving definitive biochemical cure while avoiding unnecessary thyroid resection.

Declarations

Patient Consent: Written informed consent was obtained from the patient for publication of this case report and accompanying images.

Ethics Approval: Ethical approval was obtained from the Institutional Review Board of American Hospital Dubai.

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