The Metabolic Mirage: High FDG Avidity (SUV_{max} 14) in Severe Radiation-Induced Hypothyroidism with Normal Ultrasound

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Abstract

Introduction: Incidental thyroid uptake on 18F-FDG PET/CT poses a diagnostic dilemma. While focal uptake carries a high malignancy risk, diffuse uptake is generally benign. We report a rare case of intense diffuse uptake (SUV_{max} 14.0) mimicking malignancy in a post-radiation patient.

Case Presentation: A 51-year-old female treated for carcinoma of the buccal mucosa (surgery and radiotherapy completed Feb 2025) presented with profound hypothyroidism ($TSH > 100 \mu IU/mL$) in Feb 2026. Review of records revealed she was treated with Propylthiouracil (PTU) for post-radiation thyrotoxicosis ($T4$ 24 mcg/dL, $T3$ 256 ng/dL), which was likely destructive in nature. A surveillance PET/CT revealed intense diffuse FDG avidity (SUV_{max} 14.0), raising suspicion for metastasis or lymphoma. However, high-resolution ultrasound (USG) was benign, and TSH Receptor Antibodies (TRAb) were negative.

Discussion: The dissociation between high metabolic activity and normal structural integrity is explained by "First Principles": massive TSH stimulation upregulates GLUT-1 glucose transporters on follicular cells, driving FDG uptake. This functional "overdrive" can mimic cancer.

Conclusion: In the presence of severe hypothyroidism, even high-grade diffuse FDG uptake is often physiological. Correlation with ultrasound is critical to avoid unnecessary biopsy.

Keywords: FDG PET/CT, Hypothyroidism, GLUT-1, Radiation Thyroiditis, Incidentaloma.

Introduction

The detection of thyroid incidentalomas on 18F-FDG PET/CT is increasingly common. The clinical approach typically dichotomizes findings into **focal uptake** (malignancy risk ~35%) and **diffuse uptake** (malignancy risk ~4%).[2]

However, diagnostic confusion arises when diffuse uptake presents with excessively high Standardized Uptake Values ($SUV_{max} > 10$), a range typically associated with aggressive malignancies like Primary Thyroid Lymphoma or Anaplastic Carcinoma.[2] We present a case where physiological analysis—focusing on the effects of TSH on GLUT-1 transporters—prevented invasive workup in a post-cancer patient with an SUV_{max} of 14.0.

Case Report

A 51-year-old female presented to the Endocrine clinic in February 2026 with fatigue and weight gain. She had a known history of **Carcinoma of the Left Buccal Mucosa**, managed with composite resection (Nov 2024) followed by 30 cycles of radiotherapy (completed Feb 08, 2025).

Drug History: Following radiotherapy, she was prescribed **Propylthiouracil (PTU) 100 mg BD** for 6 months by an outside physician for thyrotoxicosis. * **Initial Reports (Post-RT):** $TSH < 0.001 \ \mu IU/mL$, Total $T4$ 24 mcg/dL, Total $T3$ 256 ng/dL. * **Current Analysis:** Retrospective calculation of the **T3/T4 ratio** (ng/mcg) yielded a value of **10.6**, which typically indicates destructive thyroiditis rather than Graves' disease (> 20). PTU was stopped in May 2025.

Biochemical Evaluation (Feb 2026): * **TSH:** $> 100\ \mu IU/mL$ (Ref: 0.27–4.2) * **Free T4:** $0.97\ ng/dL$ (Ref: 0.93–1.7) * **Free T3:** $0.2\ pg/mL$ (Ref: 2.0–4.4) * **TSH Receptor Antibody (TRAb): Negative** (Ruling out Graves' disease).

Imaging Findings (PET/CT - 30.01.2026): An 18F-FDG PET/CT was performed for oncological surveillance. * **Head & Neck:** Post-surgical changes with diffuse mucosal FDG avidity (SUV_{max} 6.6) in the flap region. * **Thyroid: Intense, diffuse FDG avidity** was noted in both thyroid lobes with an SUV_{max} **of 14.0** (right lobe). * **Structural:** The CT component showed a morphologically normal thyroid gland.

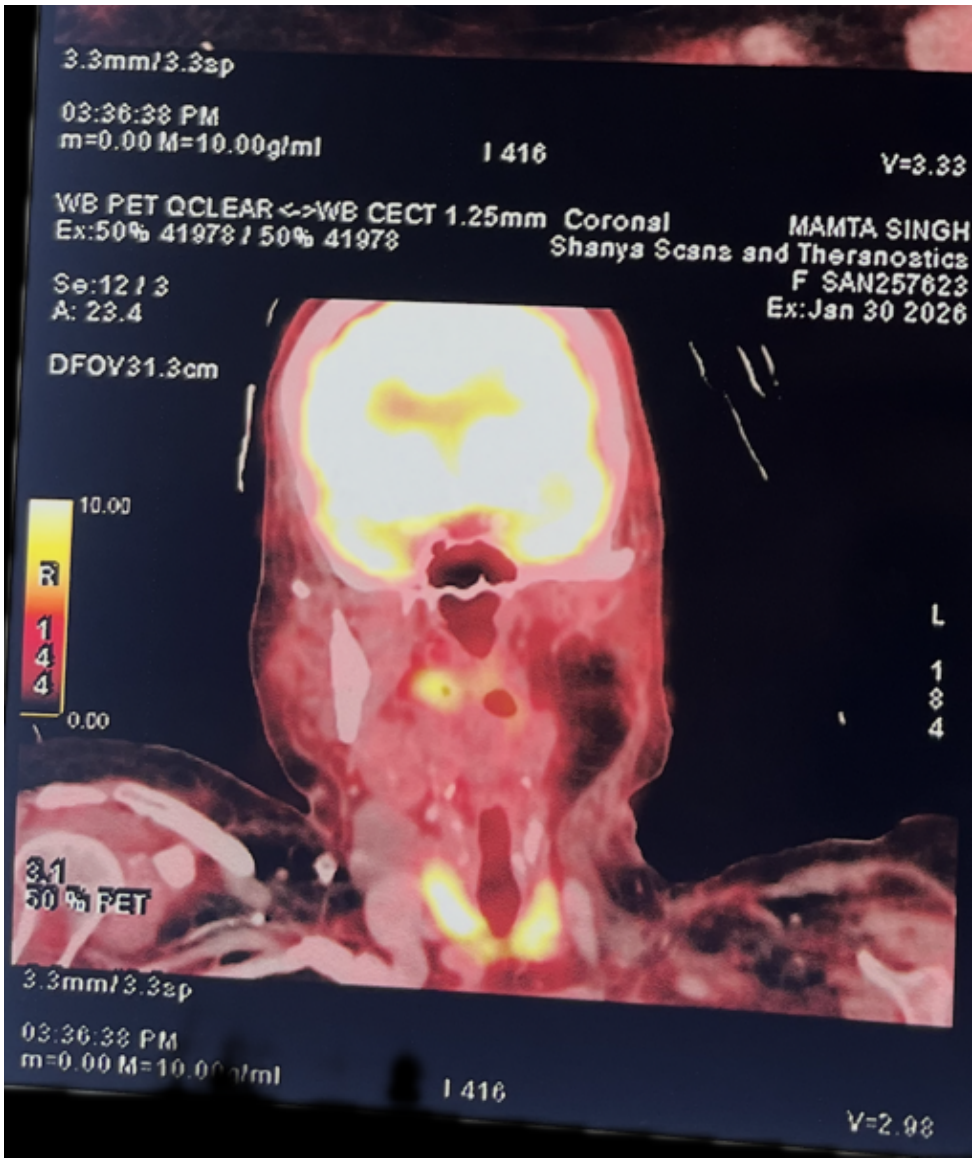

Figure 1: **Figure 1A:** Coronal Fused PET/CT showing intense diffuse FDG uptake in the thyroid gland (SUV_{max} 14.0), mimicking malignancy.

Ultrasound Neck: Despite the history of radiation, the gland showed **preserved volume and absence of focal nodularity** on high-resolution imaging, ruling out a discrete mass or lymphoma.

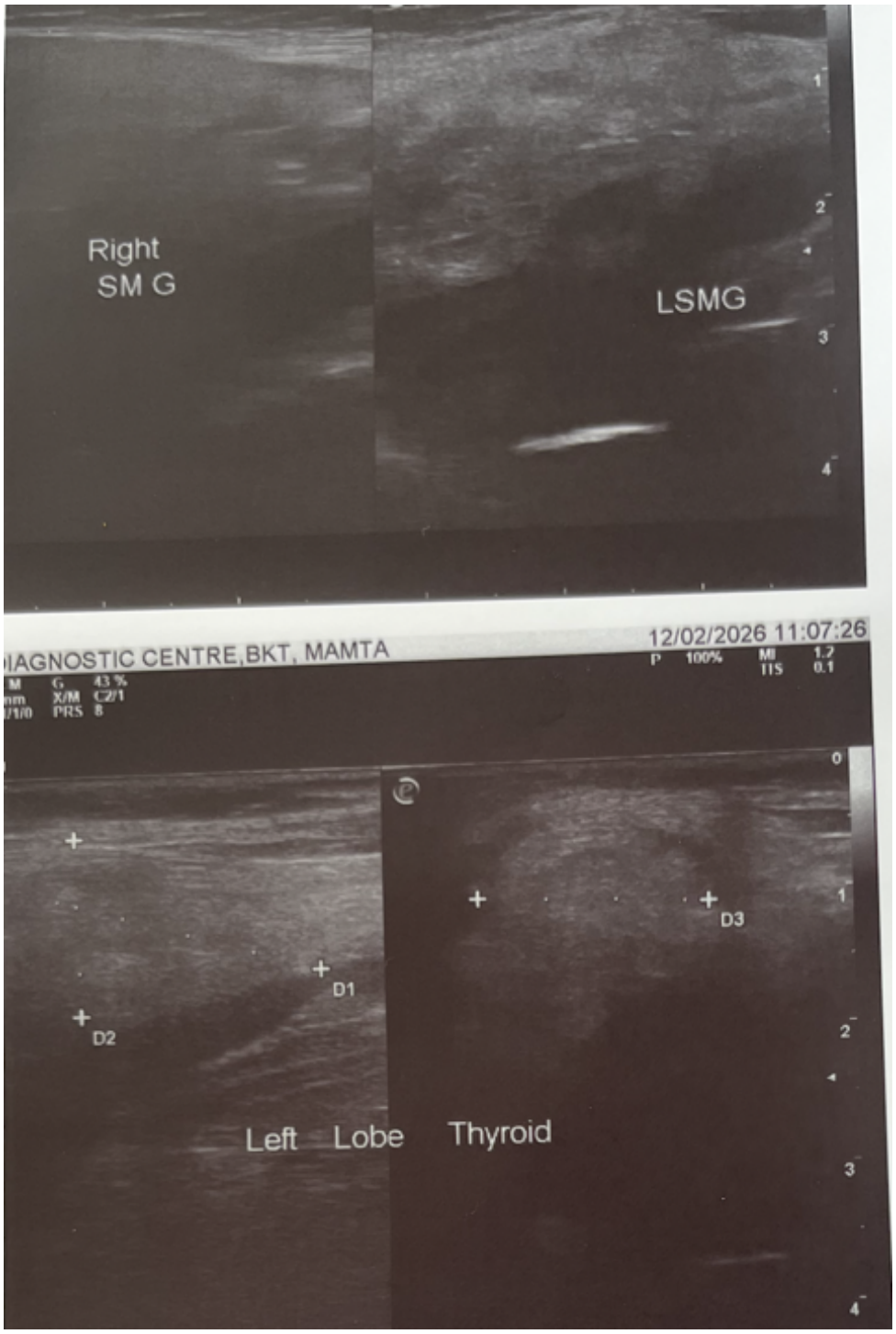

Figure 2: **Figure 1B:** High-Resolution Ultrasound of the Left Lobe showing normal echotexture and absence of nodules, ruling out structural malignancy.

Discussion

This case illustrates a "Physiological False Positive" driven by a perfect storm of **Radiation Damage**, **PTU Suppression**, and **TSH Overdrive**.

The Diagnostic Trap

An SUV_{max} of 14.0 is alarmingly high. Karantanis et al. note that diffuse uptake is typically associated with autoimmune thyroiditis, but usually with lower intensity.[3] Haber et al. demonstrated that GLUT-1

expression (the driver of FDG uptake) is a marker of malignancy in 46% of thyroid cancers.[4] The absence of structural abnormalities on USG and the **Negative TRAb** were the pivot points against malignancy and Graves' disease.

Retrospective Root Cause Analysis

The initial presentation was mismanaged with PTU. The initial **T3/T4 ratio of 10.6** (256/24) strongly supports **destructive radiation thyroiditis** (leakage of preformed T4) rather than Graves' disease (which favors T3 hypersecretion, ratio >20). The use of PTU likely accelerated the hypothyroid phase by blocking new hormone synthesis while the gland was already leaking.

First Principles: The GLUT-1 Mechanism

Why was the thyroid "glowing" without a tumor? 1. **TSH Stimulation:** TSH receptors on thyroid follicular cells utilize the cAMP pathway to upregulate **GLUT-1 glucose transporters**.[1] 2. **The "Starving Cell" Hypothesis:** The gland, damaged by radiation and previously blocked by PTU, was functionally failing. The pituitary responded with massive TSH secretion (> 100). This forced the remaining viable thyrocytes to hyper-express GLUT-1 and avidly trap FDG to fuel hormone synthesis.[6]

Management

Recognizing this as a functional rather than pathological uptake, we initiated **Levothyroxine replacement (1.6 mcg/kg)**. Biopsy was deferred. While chronic thyroiditis typically causes persistent low-grade uptake independent of TSH,[3] a **significant reduction** in the high-grade FDG avidity (SUV_{max} 14) is expected after TSH normalization, confirming the functional "overdrive" component.

Conclusion

High-grade diffuse FDG uptake ($SUV_{max} > 10$) in the thyroid does not always indicate malignancy. In the setting of severe hypothyroidism ($TSH > 100$), it is often a marker of **TSH-mediated GLUT-1 upregulation** and a predictor of future thyroid dysfunction.[5] Clinicians must correlate PET findings with Ultrasound; if the USG is benign, treat the hypothyroidism and observe, rather than biopsy.

References

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