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Decision-Making Impact of [18F]FDG PET/CT in the Management of a Bone Metastasis from Thyroid Carcinoma: Complete Biochemical Remission after Local Treatment

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Swiss Journal of Radiology and Nuclear Medicine - www.sjoranm.com - Rosenweg 3 in CH-6340 Baar, Switzerland

Abstract

Introduction: Bone metastases represent the second most common site of distant spread in differentiated thyroid cancer and are associated with a significantly poorer prognosis than lymph node or pulmonary metastases. In this context, poorly differentiated thyroid carcinomas generally show heterogeneous uptake on iodine-131 scintigraphy and on [18F]FDG PET/CT. The optimal therapeutic strategy for oligometastatic disease remains poorly defined, lying between systemic treatments (iodine-131 therapy) and localized approaches such as surgery or stereotactic radiotherapy.

Clinical Case: We report the case of a 54-year-old woman followed for papillary thyroid carcinoma. Post-therapeutic scintigraphy performed after administration of 100 mCi of radioactive iodine revealed a bone uptake focus in the mid-third of the left femur, suggestive of metastasis. The post-radioiodine therapy assessment showed a marked increase in serum thyroglobulin levels, reaching 1960 ng/mL. [18F]FDG PET/CT demonstrated a single, intensely hypermetabolic bone lesion extending from the mid- to the distal third of the left femoral diaphysis. Postoperative evolution was remarkable, with a spectacular drop in thyroglobulin levels following complete surgical excision performed with curative intent.

Conclusion: [18F]FDG PET/CT is an essential tool in the diagnostic and therapeutic evaluation of poorly differentiated follicular-origin thyroid carcinomas. Its contribution is pivotal in guiding clinical decision-making. Moreover, surgical management of isolated bone metastases can offer a genuine opportunity for durable disease control.

Keywords: Bone Neoplasms, Positron-Emission Tomography and Computed Tomography, Thyroglobulin, Thyroid Neoplasms

*Corresponding author: Batani - received: 12.12.2025 - peer reviewed, accepted and published: 31.01.2026

Introduction

Thyroid cancer is the most common malignant endocrine tumor worldwide. Histologically, differentiated thyroid carcinoma of follicular origin (DTC), which develops from the epithelial cells of the thyroid gland, is the most frequent subtype (1). In the 5th edition of the World Health Organization (WHO) classification of thyroid tumors, these neoplasms are categorized according to their pathological features, molecular profile, and biological behavior (2). Follicular carcinomas, papillary carcinomas, and clear cell ovarian carcinomas are traditionally grouped under

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well-differentiated thyroid carcinomas and are distinguished from other, less differentiated types. In this same edition, a new category of non-anaplastic high-grade follicular-derived carcinomas was introduced. It includes poorly differentiated thyroid carcinoma and high-grade differentiated thyroid carcinomas, characterized by tumor necrosis and/or increased mitotic activity, with an intermediate prognosis between well-differentiated and undifferentiated carcinomas (2).

Distant metastases are a rare but unfavorable prognostic event in DTC, with a prevalence of approximately 5% (3). Bone metastases represent the second most common site of distant spread in differentiated thyroid cancer (4) and are associated with a significantly poorer prognosis than lymph node or pulmonary metastases (5).

Iodine-131 scintigraphy ([^{131}I]I WBS) plays an essential role in the management of patients with DTC. It is used for postoperative assessment of residual thyroid tissue, detection of distant metastases, determination of eligibility for radioactive iodine therapy, and evaluation of treatment response (6). During the dedifferentiation process, thyroid cancer cells progressively lose their ability to uptake iodine and to organize functionally, which significantly limits the use of this radioisotope—not only for diagnosis but also for therapy—thus complicating patient management (7).

The introduction of positron emission tomography combined with computed tomography (PET/CT) has profoundly transformed the management of cancer patients. Among the various radiotracers, fluorodeoxyglucose ([^{18}F]FDG) is the most widely used, and its clinical value has been confirmed by numerous studies, particularly in patients with follicular-derived thyroid carcinoma, including poorly differentiated and undifferentiated subtypes (8, 9). Well-differentiated follicular-origin thyroid carcinomas, without high-grade features, typically show strong uptake of radioactive iodine and low uptake of [^{18}F]FDG. Conversely, dedifferentiated thyroid carcinomas are characterized by intense [^{18}F]FDG uptake and lack of radioactive iodine uptake. Poorly differentiated thyroid carcinomas may exhibit heterogeneous uptake of both radiotracers (7).

The optimal therapeutic strategy for oligometastatic disease lies between systemic treatments (radioiodine therapy) and localized approaches (surgery or stereotactic radiotherapy). We report the case of a poorly differentiated thyroid carcinoma that presented a remarkable biochemical response after local treatment of an isolated femoral metastasis.

Clinical Observation

This is a 54-year-old female patient followed for papillary thyroid carcinoma diagnosed fourteen years earlier. The initial treatment consisted of a left lobectomy–isthmectomy performed for diagnostic and therapeutic purposes, which concluded with a diagnosis of papillary microcarcinoma. Postoperative evolution under suppressive therapy was favorable, with no evidence of local or metastatic recurrence for several years.

During follow-up, biological tests revealed an elevation in thyroglobulin levels. At the same time, cervical ultrasound showed nodular changes classified as EU-TIRADS IV in the right thyroid lobe, with features suggestive of a suspicious contralateral thyroid carcinoma. The patient subsequently underwent a complementary right lobectomy–isthmectomy, resulting in a total thyroidectomy. Histopathological examination of the right surgical specimen revealed a 1.3-cm papillary thyroid carcinoma of the follicular variant, associated with a 4-mm papillary microcarcinoma, with no vascular emboli, no capsular invasion, nor lymph node involvement.

Given the histological subtype, the multifocal nature of the tumor, and the intermediate risk of recurrence, adjuvant radioactive iodine (^{131}I) therapy was indicated in accordance with international recommendations. The patient thus received a course of radioiodine therapy under TSH stimulation. Post-therapeutic scintigraphy showed residual thyroid uptake associated with a focus of osseous uptake in the mid-shaft of the left femur, consistent with a metastatic lesion (Figure 1).

The post-therapy assessment revealed a marked elevation of serum thyroglobulin, reaching 1960 ng/mL, with suppressed TSH and absence of anti-thyroglobulin antibodies. In this context, an [^{18}F]FDG PET/CT was performed in accordance with the American Thyroid Association (ATA) recommendations.

The examination demonstrated a single, intensely hypermetabolic osseous lesion extending from the mid-shaft to the distal third

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of the left femoral diaphysis (Figure 2). The lesion was intramedullary, associated with medullary expansion and cortical thinning, without overt bone lysis or pathological fracture. No additional pathological uptake was identified (Figure 2).

The isolated bone lesion prompted presentation of the case at a multidisciplinary orthopedic oncology and nuclear medicine tumor board. Given the solitary and accessible nature of the lesion, a complete curative-intent surgical excision was recommended. The procedure was performed without complication and allowed an en bloc resection of the femoral lesion while preserving bone stability.

Histopathological analysis of the surgical specimen confirmed the metastatic nature of the tumor, corresponding to a poorly differentiated thyroid carcinoma derived from a papillary carcinoma.

Postoperative evolution was marked by a dramatic drop in serum thyroglobulin from 1960 ng/mL to 2.2 ng/mL, indicating a complete biochemical response. No evidence of local or metastatic recurrence was observed on the six-month follow-up imaging.

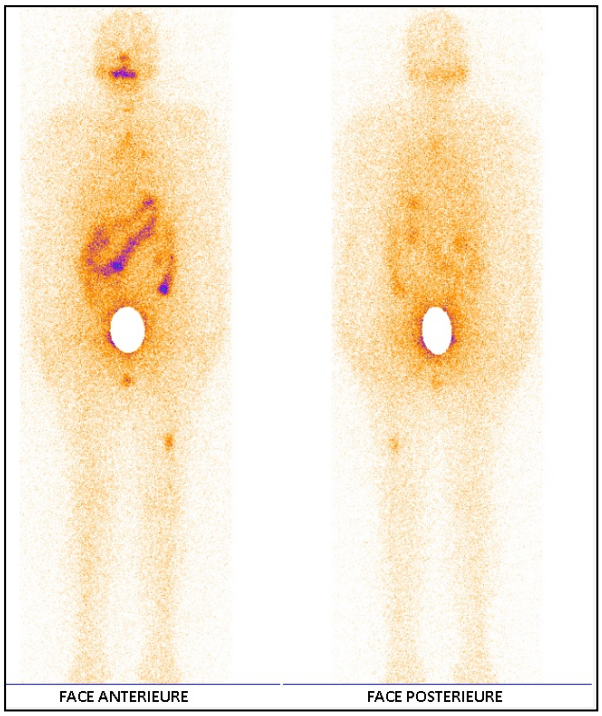

Figure 1: *Whole-body scan on day 4 post-radioiodine therapy.*

Discussion

Differentiated follicular thyroid carcinoma (DTC) is one of the most curable cancers (10). DFTCs are characterized by a slowly progressive evolution and show a 10-year survival rate of 90% (4). However, the occurrence of distant metastases reduces this rate to 40% (11). Age, sex, and the involvement of multiple organs are independent factors associated with mortality in patients with DTC.

Patients with DTC and bone metastases have a poor prognosis, with 10-year survival rates ranging from 0 to 34% (12). Bone metastases from DTC are resistant to radioactive iodine therapy (10, 13), the reference treatment for metastases particularly in vital organs—arising from differentiated thyroid cancer (DTC).

Surgical resection is generally recommended for isolated, solitary, and accessible metastases (14), and it is associated with a significant improvement in survival (15). However, in patients with multifocal disease, the role of surgical resection is less clearly defined. Local treatment of bone metastases is recognized as a significant factor in improving survival rates (16). Similarly, guidelines specify that complete resection of isolated bone metastases may prolong overall survival. In the patient presented in this case, surgical excision led to an almost complete decrease in thyroglobulin levels, reflecting an excellent therapeutic response.

This marked decrease represents a major biological indicator of treatment effectiveness, suggesting a significant reduction in residual tumor tissue and confirming the relevance of the surgical strategy adopted.

Conclusion

[^{18}F]FDG PET/CT is a valuable tool in the diagnosis and treatment of differentiated follicular thyroid carcinoma. Its impact on clinical management is tangible. Surgical management of isolated bone metastases, although rare, can offer curative potential or durable disease control. This case illustrates in an exemplary manner the relevance of [^{18}F]FDG PET/CT in the management of poorly differentiated thyroid carcinomas refractory to radioactive iodine.

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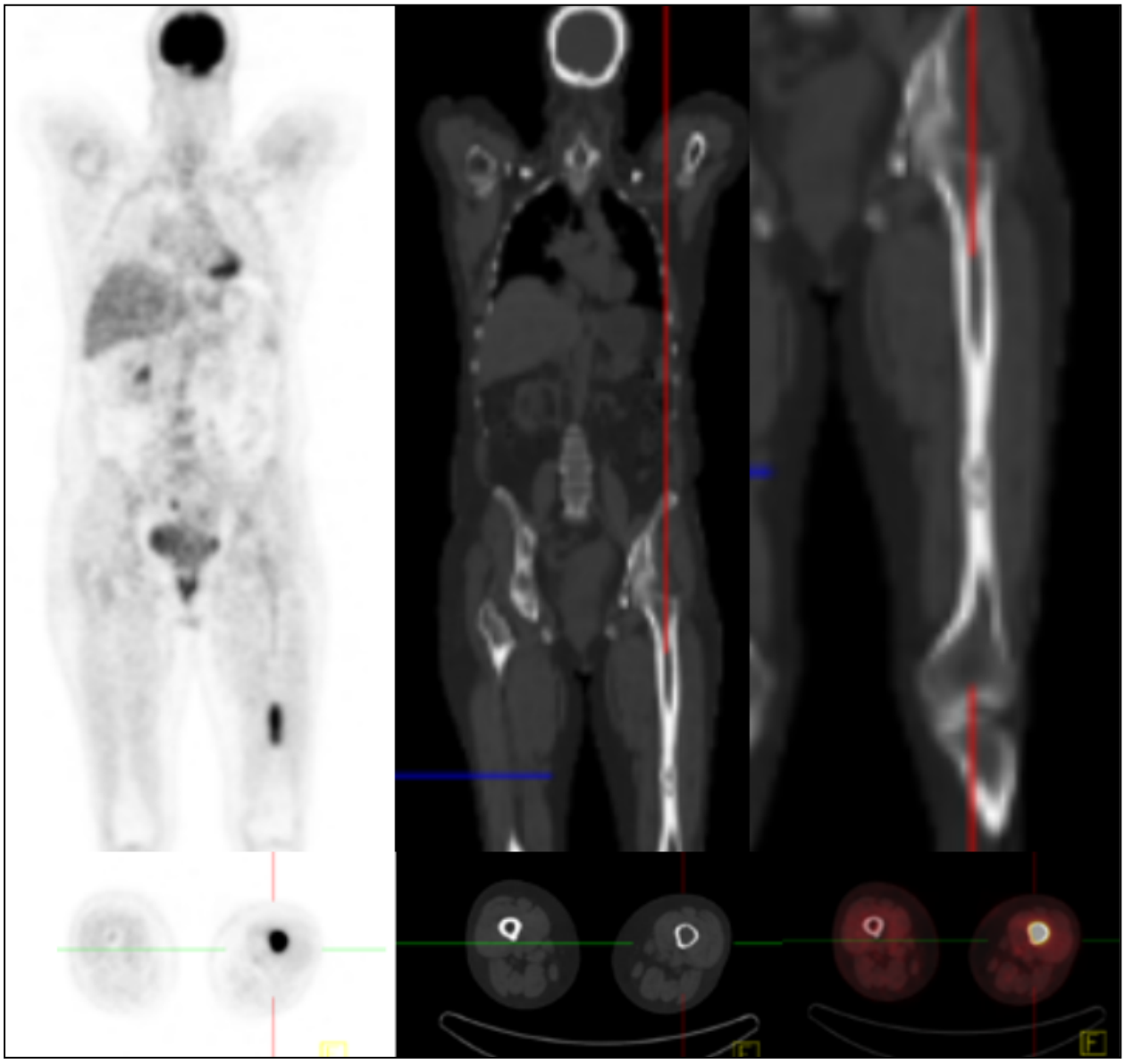

Figure 2: *PET/CT image showing a hypermetabolic lesion in the mid-third of the left femoral diaphysis*

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Authors' contributions:

1. Halima Batani: Conceptualization, investigation, data curation, writing – original draft.
2. Hafsa Bensimimou: Methodology, supervision, writing – review & editing.
3. Abdel Amide Gbadamassi: Formal analysis, visualization.
4. Zakaria Ouassafrar: Formal analysis, visualization.
5. Amal Guensi: Supervision, project administration, validation

Declarations

Consent for publication: The author clarifies that written informed consent was obtained and the anonymity of the patient was ensured. This study submitted to Swiss J. Rad. Nucl. Med. has been conducted in accordance with the Declaration of Helsinki and according to requirements of all applicable local and international standards. All authors contributed to the conception and design of the manuscript, participated in drafting and revising the content critically for important intellectual input, and approved the final version for publication. Each author agrees to be accountable for all aspects of the work, ensuring its accuracy and integrity.
Competing interests: None.
Funding: No funding was required for this study.

Conflict of interest:

The authors declare that there were no conflicts of interest within the meaning of the recommendations of the International Committee of Medical Journal Editors when the article was written.

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