15 Application of PET in Cancer of the Endocrine Organs

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The role of functional imaging for endocrine abnormalities has increased over the last few decades. Endocrine tumors can be overlooked on conventional anatomic imaging because of small tumor size as well as limited or equivocal clinical data. It can also be difficult for conventional imaging to differentiate disease recurrence from postsurgical changes. Furthermore, anatomic imaging does not provide information on tumor activity. Endocrine malignancies are uncommon, comprising 1–2 % of all tumors affecting adults, and 4–5 % of tumors affecting children. Some endocrine tumors are functional and secrete active substances that trigger physiological symptoms that prompt patient presentation. A smaller fraction of patients with endocrine neoplasms present with symptoms associated with mass effects that are more typically seen in patients with large nonfunctional tumors, which are commonly detected incidentally (so-called incidentaloma). The increasing use of whole-body multidetector CT@ (MDCT) scans has led to an appreciable rise in the identification of such tumors.

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The Role of PET-CT in Thyroid Disorders

Thyroid nodules are extremely common among the adult population, ranging from 4 to 7 % within the whole population and a female-to-male ratio of 4:1. The occurrence of malignancy in these nodules is fairly rare. However, correctly categorizing identified nodules is critical for management decisions. Current strategies for characterizing these nodules include thyroid scintigraphy as well as thyroid ultrasound. Iodine-123 scintigraphy or even Tc- 99m thyroid scan allows analysis of nodules and classification of "hot" versus "cold" nodules. These terms describe uptake of radiotracer by the nodule and the surrounding thyroid gland. Hot nodules, which display high uptake of I-123 or Tc-99m, are rarely malignant, while cold nodules, which display low uptake or absence of tracer, represent malignancy in 10–15 % of cases. Cold nodules in younger patients can harbor malignant tissue up to 35–40 %. This test does provide useful data but may require biopsy to delineate a more accurate diagnosis.

Thyroid carcinomas are classified as either differentiated (i.e., papillary or follicular) or undifferentiated (i.e., anaplastic), depending on the histologic and cytopathologic findings. Typically, patients with papillary or follicular carcinomas receive iodine-131 (I-131) total body scans in their evaluation. Figure 15.1 shows a

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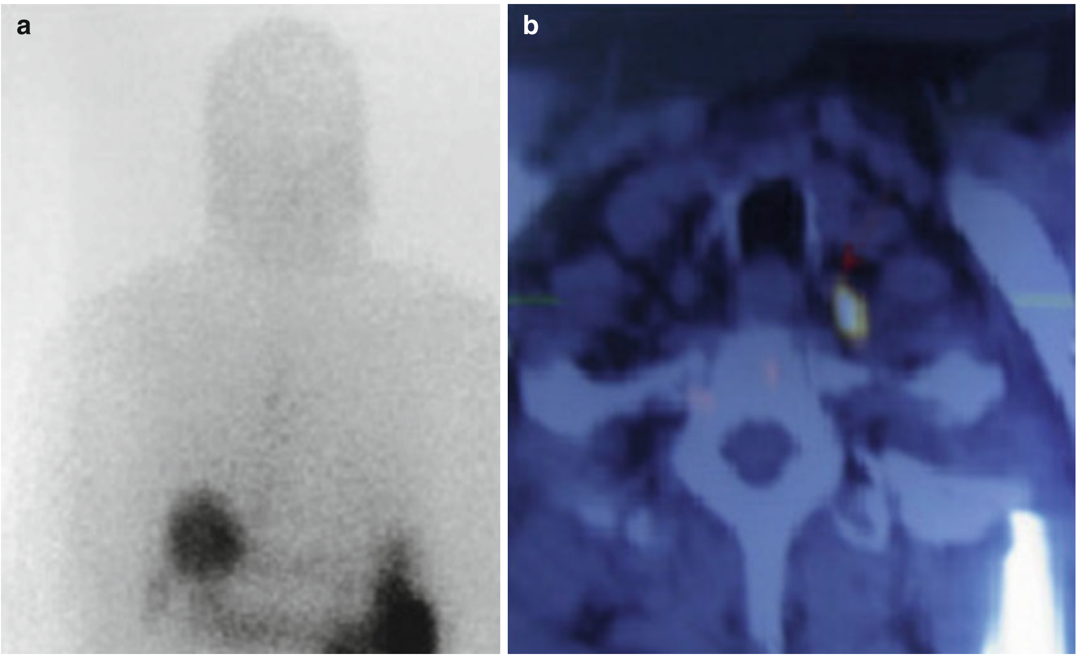

Fig. 15.1 Radio iodine scan (**a**) showing no remnant tissue in the thyroid bed. However, FDG-CT image shows an 8-mm lesion in the left thyroidectomy bed (**b**)

patient who underwent total thyroidectomy for papillary thyroid cancer and was being evaluated for increasing thyroglobulin levels after surgery. This patient had a negative I-131 scan along with an 18F-FDG PET-CT scan that showed increased metabolic activity within the thyroid bed approximately 6 months after surgery.

There have been numerous reports of patients with negative I-131 scans and positive 18F-FDG PET scans and vice versa. This phenomenon was attributable to dedifferentiation of the cancer. Figure 15.2 shows a patient who underwent an 18F-FDG PET-CT evaluation after a total thyroidectomy for biopsy-proven papillary thyroid cancer. This particular patient was treated with I-131 on two separate occasions and on follow-up 2 years later was noticed to have increasing thyroglobulin levels. He had an I-131 scan that was negative and was referred for 18F-FDG PET-CT evaluation for metastatic disease. The FDG studies showed presence of malignant tissue at different sites.

These and other studies noted that more differentiated cancers are better imaged by I-131, while dedifferentiated thyroid cancers are better imaged by 18F-FDG PET. Therefore, the role of 18F-FDG PET-CT is presently applied to those patients who have a negative I-131 scan, a negative chest CT (looking for metastasis), and rising serum thyroglobulin levels following initial thyroidectomy. These patients are thought to have recurrent or metastatic disease that is undetectable by conventional imaging but biochemically apparent because of increasing thyroglobulin measurements. A recent study reported 18F-FDG PET-CT sensitivity of 68.4 %, which is slightly lower than previous reported data, for detecting recurrent or metastatic thyroid cancer. However, several studies revealed higher sensitivities for 18FFDG PET-CT with higher thyroglobulin levels, with a sensitivity approaching 72 % when thyroglobulin levels exceed 10 ng/mL. Other studies have reported 18F-FDG PET (using visual fusion with CT) and dedicated 18F-FDG PET-CT sensitivities for recurrent or metastatic thyroid cancer to be 95–100 %.

The advantage of 18F-FDG PET and PET-CT in thyroid cancer imaging can be further verified by reviewing data on patient management affected by 18F-FDG PET-CT results. In many

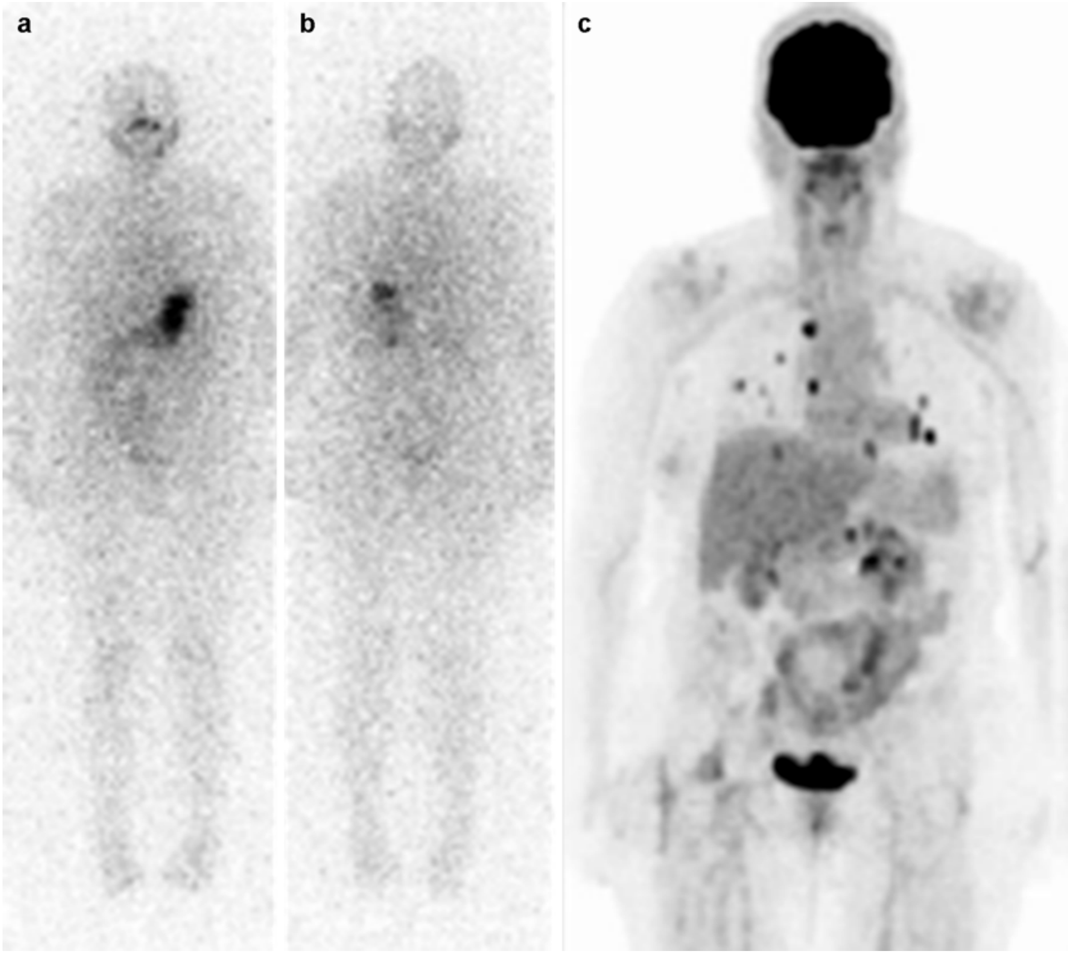

Fig. 15.2 Anterior (**a**) and posterior (**b**) radio iodine whole body scan of a thyroid cancer patient after NTT and two times high-dose RI therapy. There is no abnormal uptake suggestive of any metastatic lesions. However, TG was high. FDG PET (**c**) image shows multiple metastases

cases, finding distant metastases using 18F-FDG PET (with CT comparison) led to alteration of the initial plan and management in some surgical cases. These distant metastases were identified on a 18F-FDG PET staging scan. Using FDG PET-CT modification of the treatment has been necessary in more than 40 % of cases.

The Role of 18F-FDG PET-CT in Adrenal Tumors

Up to 79 % of adrenocortical cancers produce some hormone or active agent that may lead to clinical symptoms. Adrenal pheochromocytomas account for approximately 80 % of catecholamine-secreting neoplasms and generally measure 4–5 cm at presentation. Since functioning adrenocortical tumors can be elucidated using hormonal assays, it is the nonfunctioning tumors that require additional testing and imaging to determine management for optimal patient care.

Imaging of patients with suspected pheochromocytoma usually begins with CT or magnetic resonance imaging (MRI) to assess the tumor. However, the variable appearance of pheochromocytomas on these modalities sometimes makes it quite difficult to establish an accurate diagnosis. These tumors can range from solid to cystic, fatty to necrotic, and homogenous to heterogeneous. Functional imaging provides localization of the

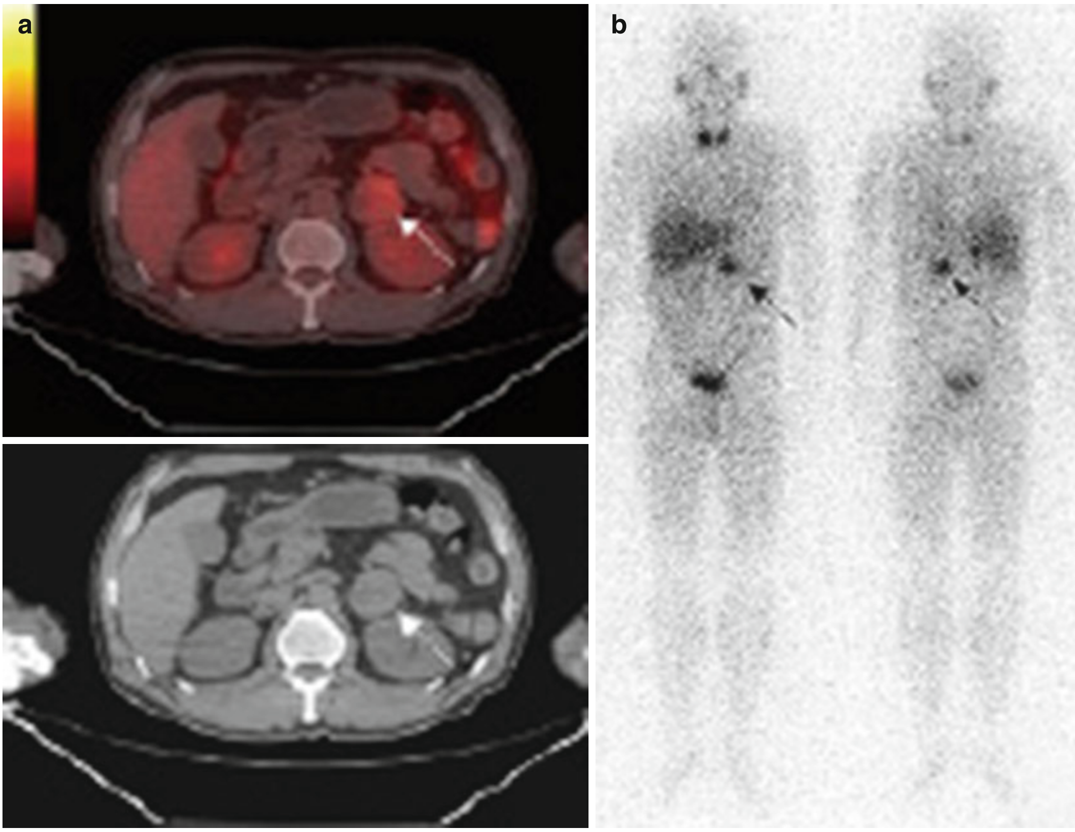

Fig. 15.3 Pheochromocytoma of the left adrenal seen in FDG-PET-CT (**a**) and I-131 MIBG whole body scan showing the tumor (see *arrow*) in (**b**) of the same patient.

tumor to any part of the body, especially extra-adrenal sites or previously postsurgical areas that can have distorted anatomy. Functional imaging with either I-123 metaiodobenzylguanidine (MIBG) scintigraphy or 18F-FDG PET-CT can prove useful for localization. However, due to the anatomic correlation that CT fusion offers, PET scanning is superior to that of MIBG alone (Fig. 15.3).

Several studies have shown variable uptake of MIBG and 18F-FDG in pheochromocytomas. Some pheochromocytomas fail to accumulate MIBG but are able to accumulate increased 18F-FDG on PET-CT. Some pheochromocytomas also accumulate MIBG without increased metabolic activity seen on 18F-FDG PET-CT. Studies have shown that most malignant pheochromocytomas are better visualized with 18F-FDG, while more benign pheochromocytomas are better detected with MIBG.

A recent study showed also superiority of 18F-FDG PET-CT in detecting metastatic foci in patients with paragangliomas pheochromocytomas (Fig. 15.4).

With the increased utilization of whole-body PET-CT scans for diagnosis and clinical staging in oncology, the incidence of unsuspected adrenal gland abnormalities is increasing. It has been reported that up to 1 % of patients being evaluated with abdominal CT and as many as 2–5 % of patients being scanned with contrast-enhanced CT have been found to have adrenal incidentalomas. The majority of these incidentalomas are benign and do not produce any biologically active metabolites.

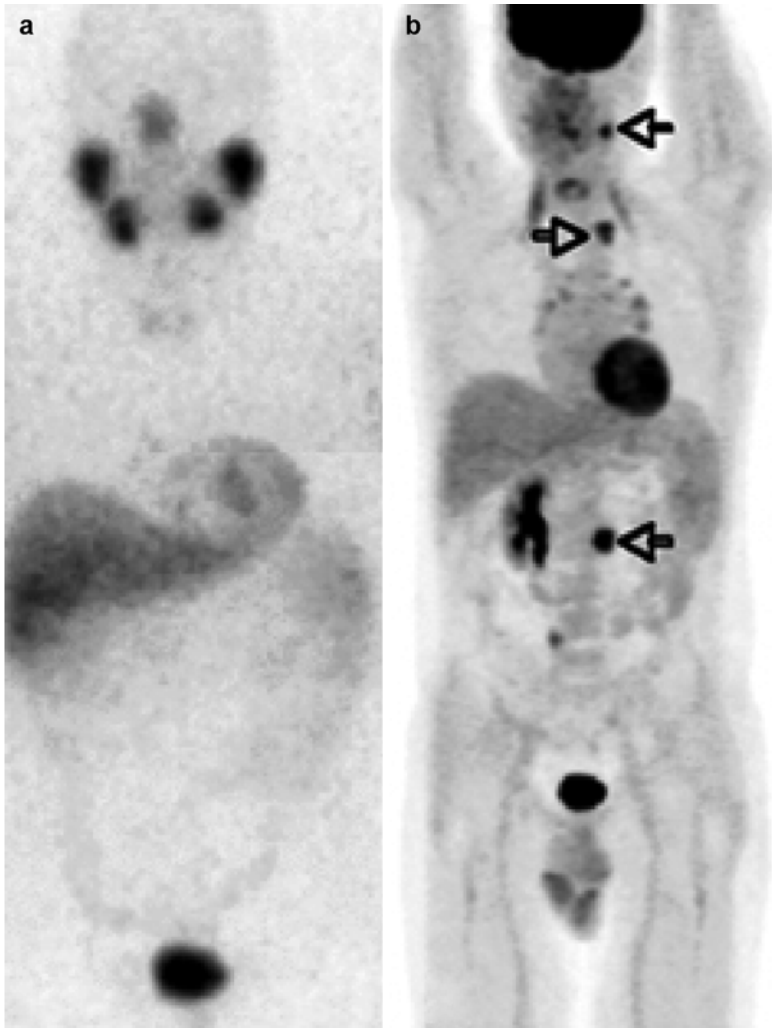

Fig. 15.4 Demonstrates a case of metastatic pheochromocytomas clearly seen in 18F-FDG PET image (**a**) with negative 123-I-MIBG scan (**b**). In this case, PET scan is shown to be more accurate

For Further Reading

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