4 Esophageal and Gastric Neoplasms

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Case 4.1

History

A 73-year-old male with history of metastatic gastric carcinoma and peritoneal disease, on chemotherapy. Patient is status post total gastrectomy and splenectomy.

Findings

Review of images demonstrates a large hypermetabolic mass in the left mid to upper abdomen at the site of multiple surgical clips with SUVmax of 10.0 (Fig. 4.1). A hypermetabolic mesenteric focus in the mid abdomen inferior to the left hepatic lobe demonstrates SUVmax of 5.3 is identified (Fig. 4.2). Focal activity along the medial aspect of colon in the right lower quadrant is compatible with serosal involvement with SUVmax of 4.1 (Fig. 4.3). Focal FDG activity at the presacral area likely represents a hypermetabolic iliac lymph node with SUVmax of 8.4 (Fig. 4.4). Correlation of the areas with increased PET activity with specific anatomic locations was difficult due to the complete lack of intraperitoneal fat causing poor definition of intra-abdominal structures.

Impression

1. Multiple hypermetabolic peritoneal and mesenteric metastatic disease
2. Pelvic nodal metastatic disease

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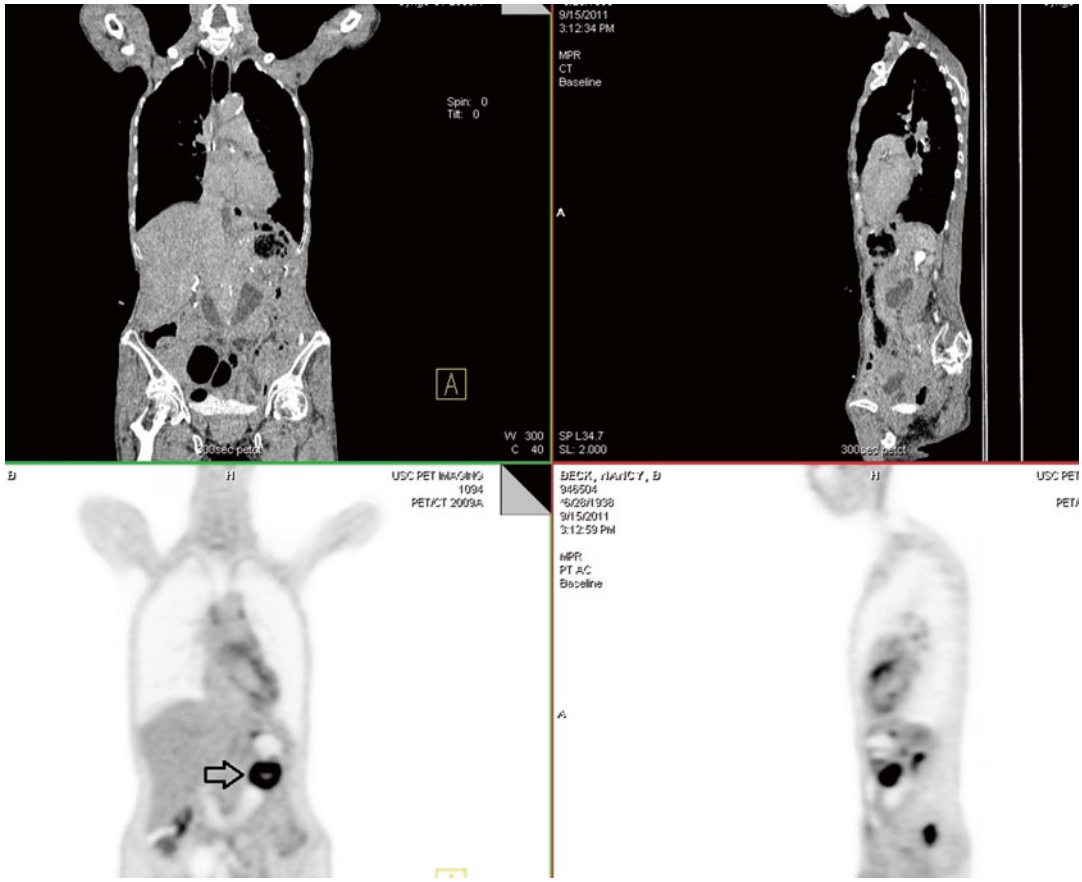

Fig. 4.1

Pearls and Pitfalls

1. FDG PET may be useful in evaluation of recurrent gastric cancer as well as detecting distant metastatic disease
2. Staging of gastric cancer with FDG PET scanning will alter the clinical management in patients with recurrence and complement standard staging methods such as laparoscopy, which are more effective at staging local nodal spread and peritoneal disease

Discussion

Gastric cancer is one of the most prevalent cancers worldwide and is a leading cause of cancer mortality. Complete resection of gastric cancer is the only method of achieving permanent control. However, surgeries can be morbid and futile in patients who have advanced disease, making appropriate staging and characterization of disease burden of paramount importance.

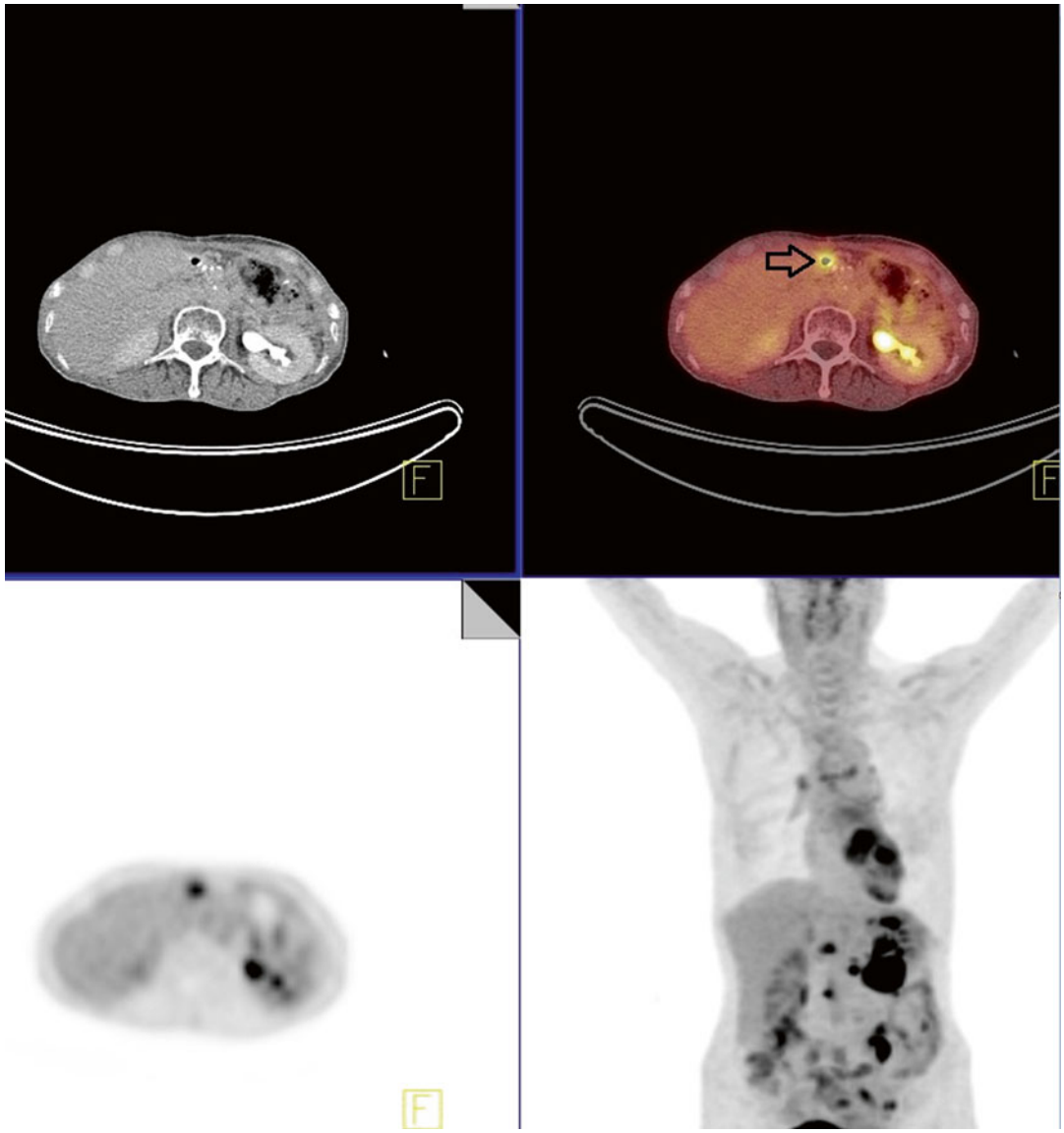

Fig. 4.2

The value of PET-CT has been of increasing interest among clinicians and increased its use in the detection, staging, and management of a variety of malignancies. During and after therapy, PET-CT may be useful in determining response to chemotherapy. It may be helpful for restaging and diagnosing recurrence at an earlier time or with greater certainty.

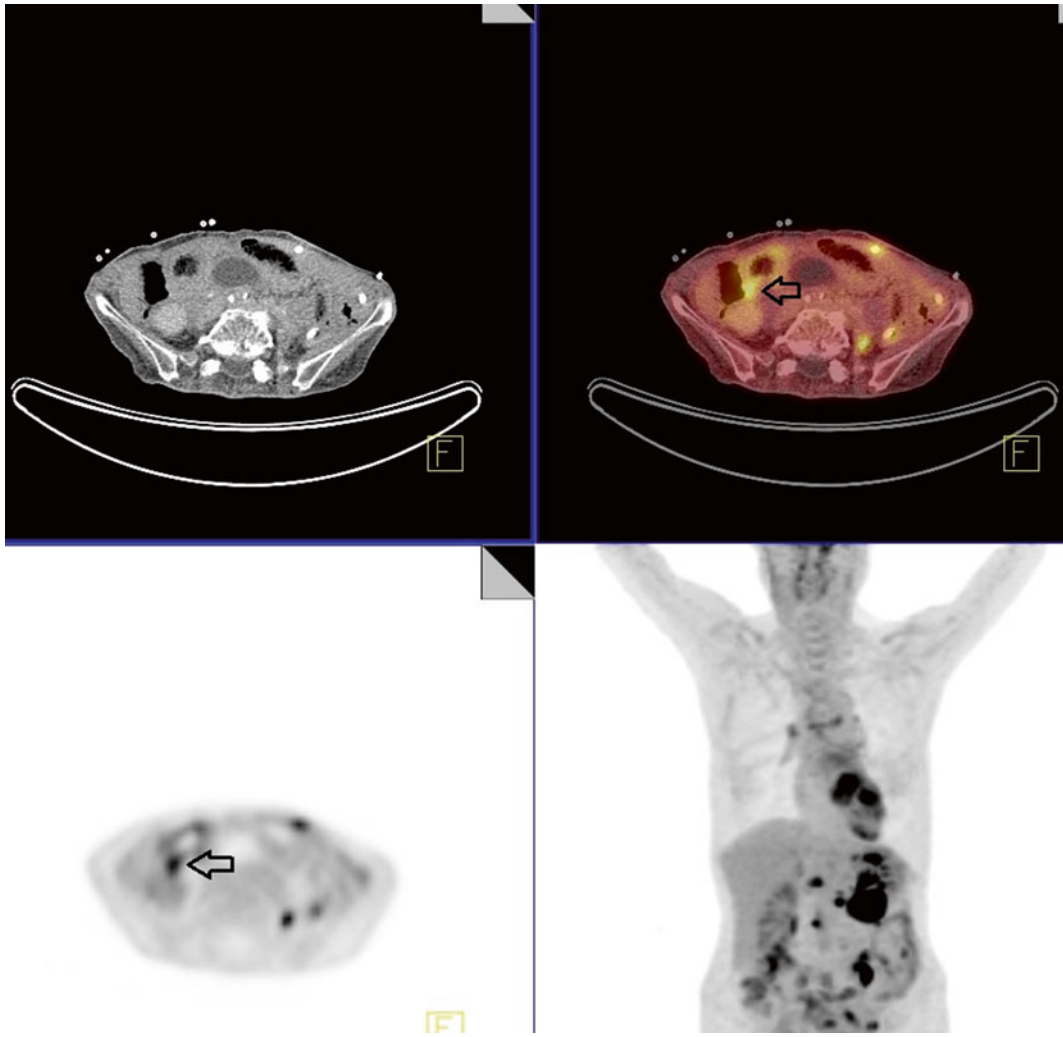

Fig. 4.3

Case 4.2

History

A 53-year-old male patient with submucosal squamous cell carcinoma of the esophagus, status post thoracic laparoscopic esophagectomy with gastric pull-up.

Findings

A hypermetabolic mass measuring 4 × 4.1 × 4.2 cm with SUVmax 19.9 in the proximal esophageal anastomosis is identified. There were no enlarged or hypermetabolic hilar, mediastinal, or axillary lymph nodes (Fig. 4.5).

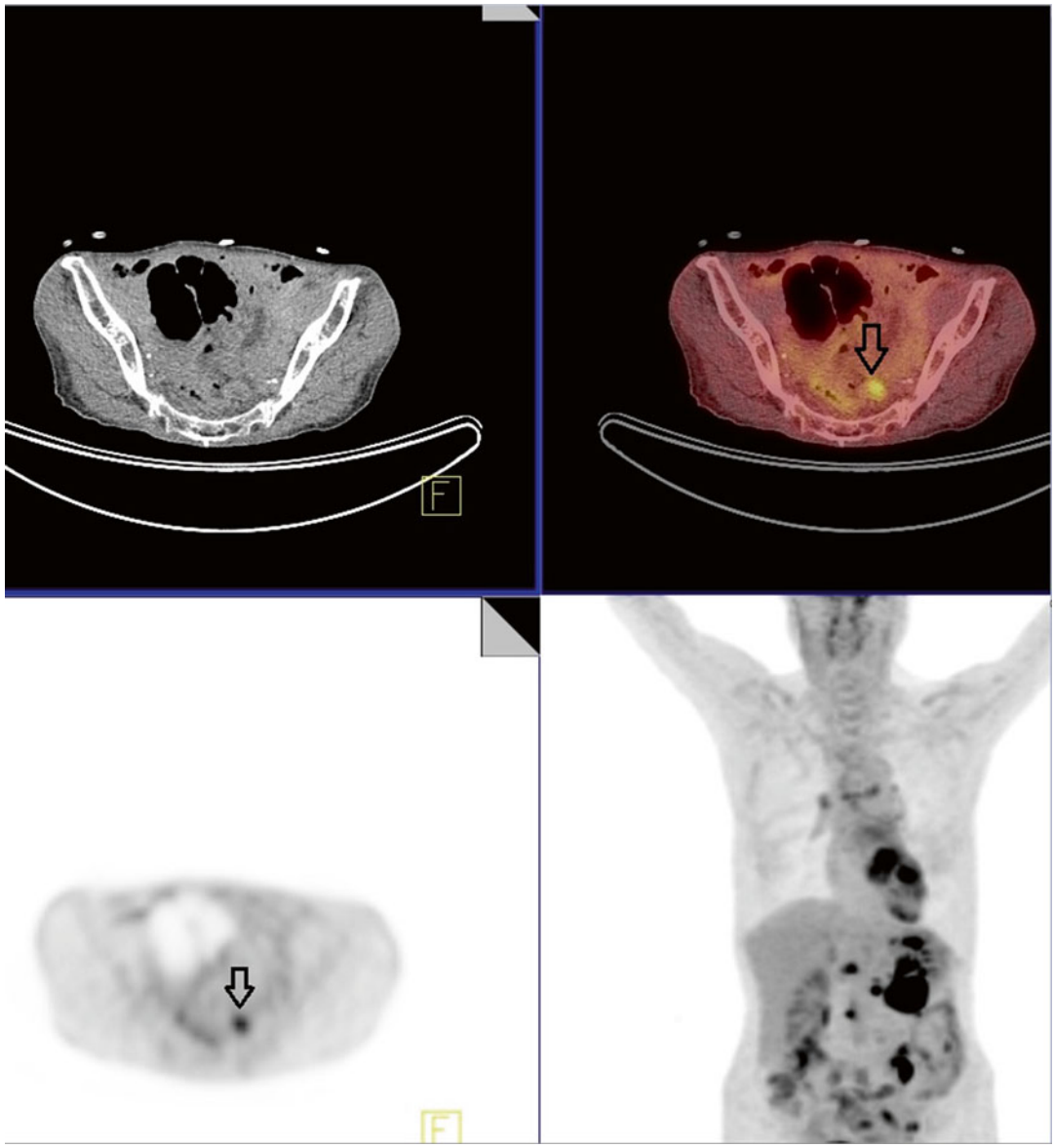

Fig. 4.4

Impression

1. Hypermetabolic mass at the proximal esophagogastric anastomotic site, consistent with locally recurrent disease
2. No nodal or distant metastatic disease

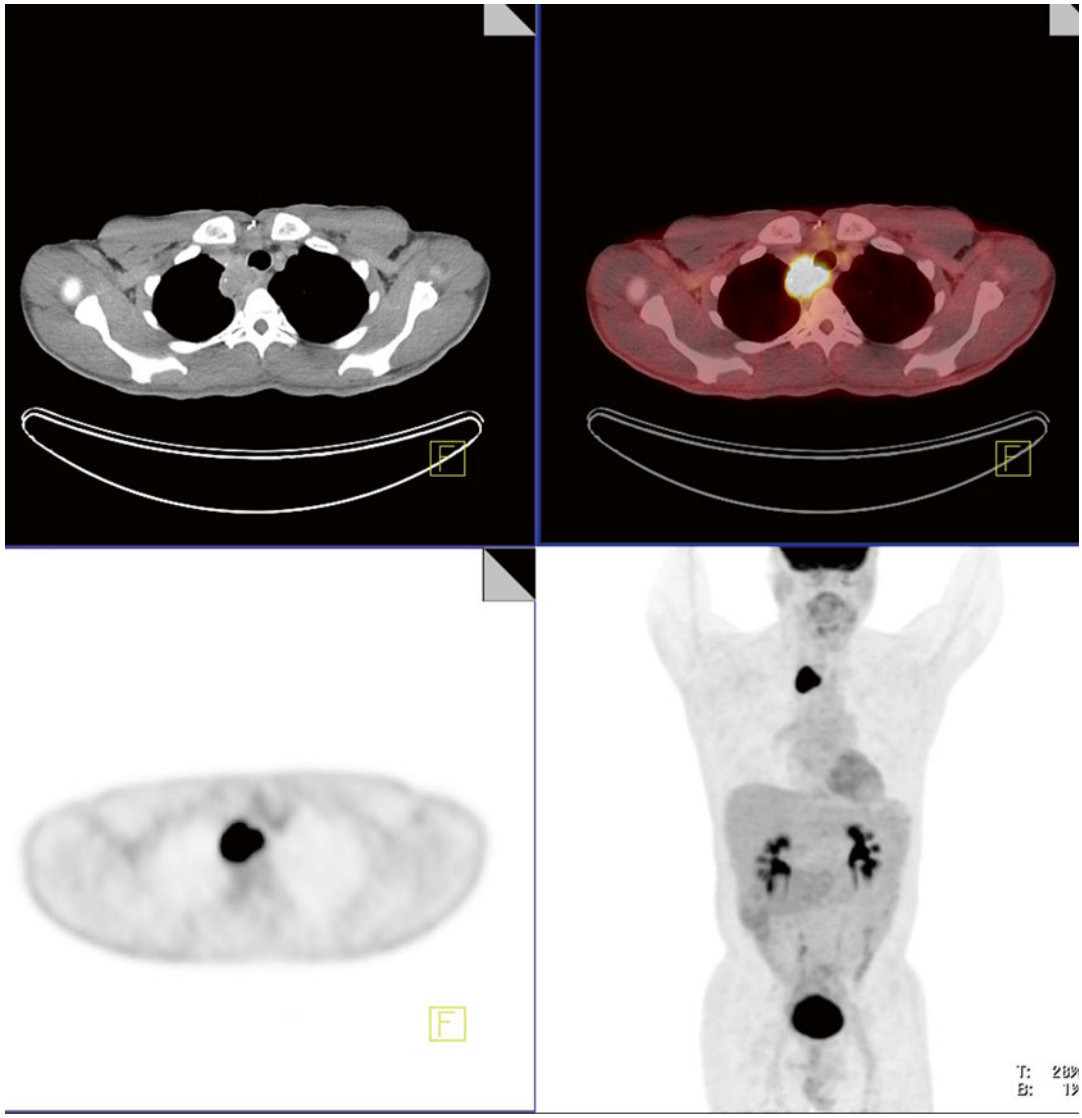

Fig. 4.5

Pearls and Pitfalls

1. Sensitivities for FDG PET imaging are between 91 and 100 %. False-positive uptake can occur due to inflammation, and there can be normal mild FDG activity from muscular contractions.
2. Accuracy of FDG PET in the staging of regional lymph node metastases ranges from 24 to 90 %. The major limitation of FDG PET with regard to the detection of nodal metastases adjacent to the primary tumor is its relatively poor spatial resolution (approximately 6 mm for a dedicated PET scanner) which reduces sensitivity. The level of metabolic activity and pattern of mediastinal and hilar lymph nodes as well as coexisting nodal calcification is helpful in determining inflammatory versus metastatic etiology.
3. Recurrence is most common near the esophagogastric anastomosis.

Discussion

Because esophageal cancer is associated with unfavorable prognosis, proper assessment of primary tumor and regional/distant metastasis is necessary for treatment selection and follow-up planning. The depth of invasion and presence of lymph node metastasis are independent prognostic variables in esophageal cancer. Open esophagectomy with comprehensive lymph node dissection is the most accurate method for pathologic staging as well as the most common treatment method for esophageal cancer. However, this operation is frequently associated with significant morbidity, and a mortality rate from experienced institutes is reported in the range of 6–7 %. There are several noninvasive staging methods for esophageal cancer. Endoscopic ultrasound (EUS) and ^{18}F-FDG PET have recently shown good results for clinical staging in esophageal cancer. The degree of ^{18}F-FDG uptake in the primary tumor presenting as the standardized uptake value (SUV) is associated with prognosis in esophageal cancer.

Case 4.3

History

Patient with invasive well-differentiated adenocarcinoma of the distal esophagus.

Findings

There is a hypermetabolic distal esophageal circumferential thickening with SUVmax of 17.4, consistent with biopsy-proven tumor (Fig. 4.6). There are subcentimeter subcarinal and right hilar nodes with SUVmax of 3.3 and 2.9, respectively. Constellation of latter findings is most suggestive of granulomatous disease by pattern. There was also an AP window node with SUVmax of 4.5, measuring 6 mm (white arrow), also more suggestive of inflammatory (likely granulomatous disease) than malignant etiology (Fig. 4.7). There are several subcentimeter mediastinal nodes with no PET activity but below PET resolution. No enlarged or hypermetabolic axillary lymph nodes are identified.

Impression

1. Hypermetabolic distal esophageal mass consistent with biopsy-proven malignancy
2. Hypermetabolic mediastinal lymph nodes as noted above

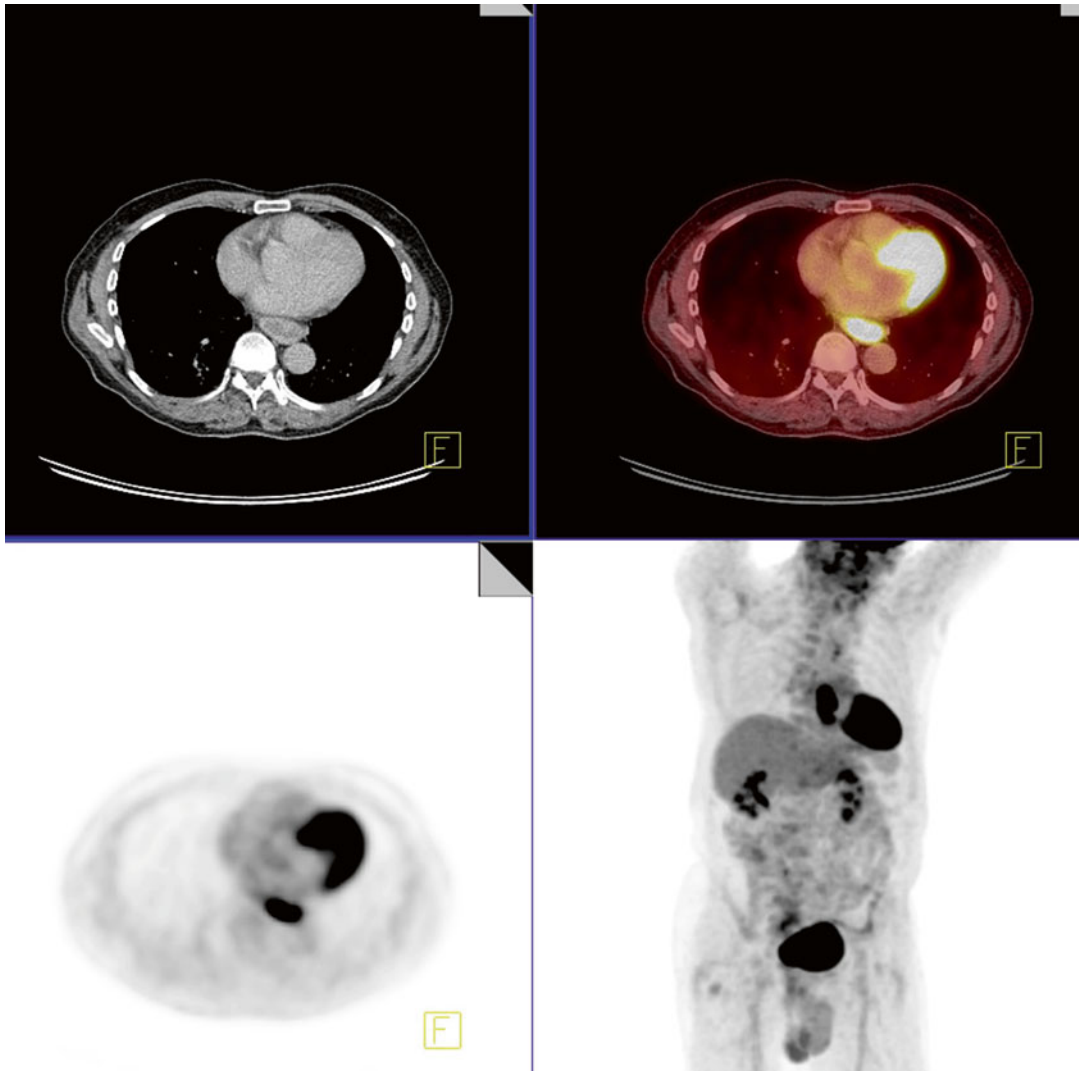

Fig. 4.6

Pearls and Pitfalls

1. PET is a useful tool for staging in esophageal cancer prior to surgical intervention and has higher accuracy in comparison with CT (88 % versus 65 %).
2. PET is not sensitive enough to assess local invasion.
3. Carcinoma in situ and small volume tumors are predisposing factors for false-negative PET.

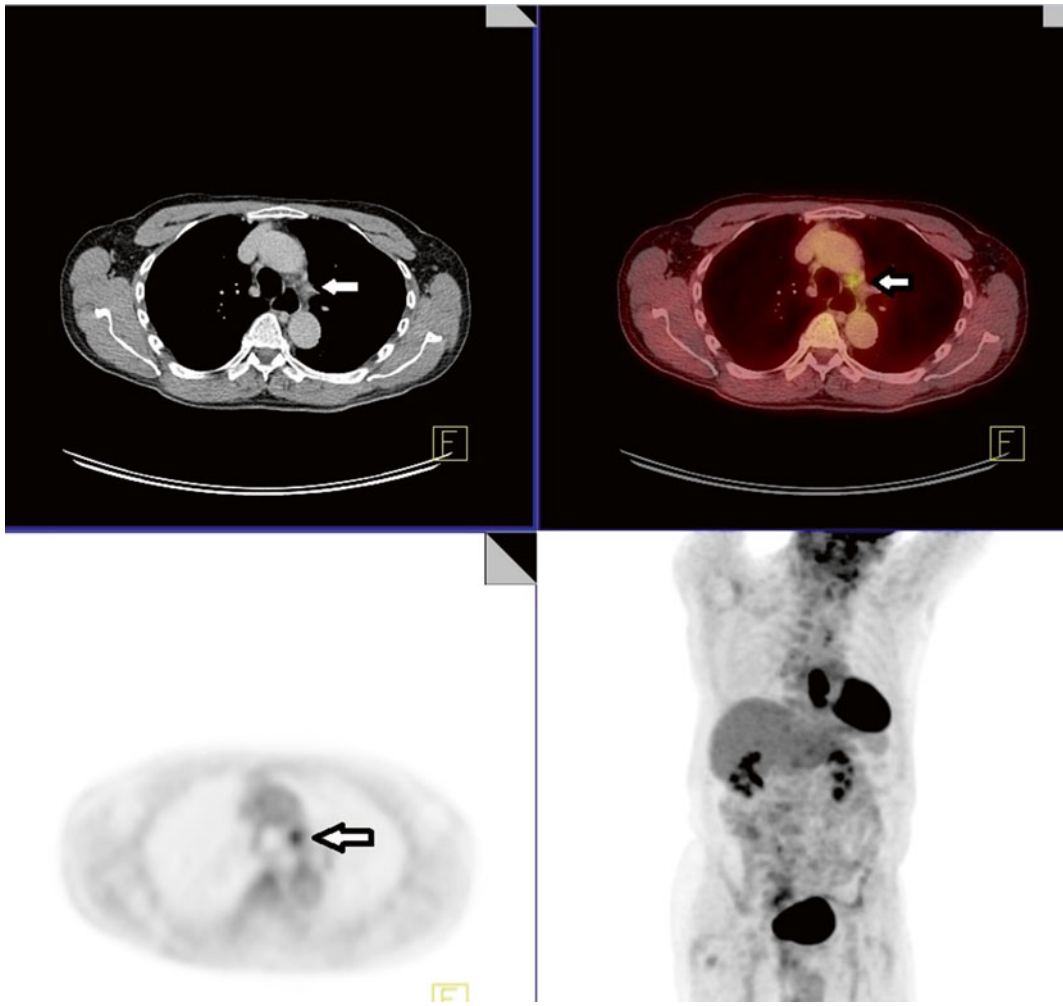

Fig. 4.7

Discussion

There are two histologic types of esophageal carcinoma that account for the majority of malignant cases: squamous cell carcinoma (>75 to 90 %) and adenocarcinoma. Esophageal cancer tends to be aggressive in its behavior. It invades locally, spreads to local lymph nodes, and then metastasizes throughout the body. Approximately 15 % of esophageal cancers occur in the upper third of the esophagus, 45 % in the middle third of the esophagus, and 40 % in the distal third of the esophagus.

Esophageal carcinoma carries a poor prognosis. Although it is a disease that can be treated, it can rarely be cured. By the time the patient becomes symptomatic, the disease is usually at an advanced stage.

The overall 5-year survival rate in patients who undergo surgery ranges from 5 to 20 %, while the 5-year survival rate in patients with lymph node metastases (nonsurgical patients) ranges from 0 to 7 %. Once the diagnosis of esophageal cancer has been made, staging is the next critical step in determining the most appropriate treatment plan for the patient.

Case 4.4

History

Patient with a history of moderate to poorly differentiated adenocarcinoma of the distal esophagus, status post trans-hiatal esophagectomy and gastric pull-up. Patient had biopsy-proven metastatic disease involving the mesentery and liver and was on chemotherapy at the time of imaging.

Findings

There is status post esophagectomy and gastric pull-up with prominent physiologic and/or inflammatory metabolic activity (white arrow) (Fig. 4.8). There are reticular nodular fibrotic changes, predominantly in the lower lungs, suggestive of posttreatment changes (red arrow).

Several metabolic active hypoattenuating hepatic lesions are identified. One of which demonstrates SUVmax of 4.5 in the lateral right lobe; another lesion is seen in the inferior posterior right hepatic lobe with SUVmax of 3.7 (Fig. 4.9).

Two hypermetabolic mesenteric nodules are identified that are most consistent with metastatic disease. One of these nodules is at the level of L3–L4 (ventral to third part of duodenum), measuring 2.1 cm with SUVmax of 4.5 (Fig. 4.10).

Impression

Enlarged and metabolically active metastatic disease involving mesentery and liver parenchyma.

Pearls and Pitfalls

1. ^{18}F-FDG PET is sensitive and accurate in the preoperative staging of distant metastases in patients with cancer of the esophagus and leads to upstaging.
2. Though performance of PET in assessing N1 disease is not better than that of current staging methods, there is a significant advantage in detection of M1 disease, avoiding unnecessary surgery.

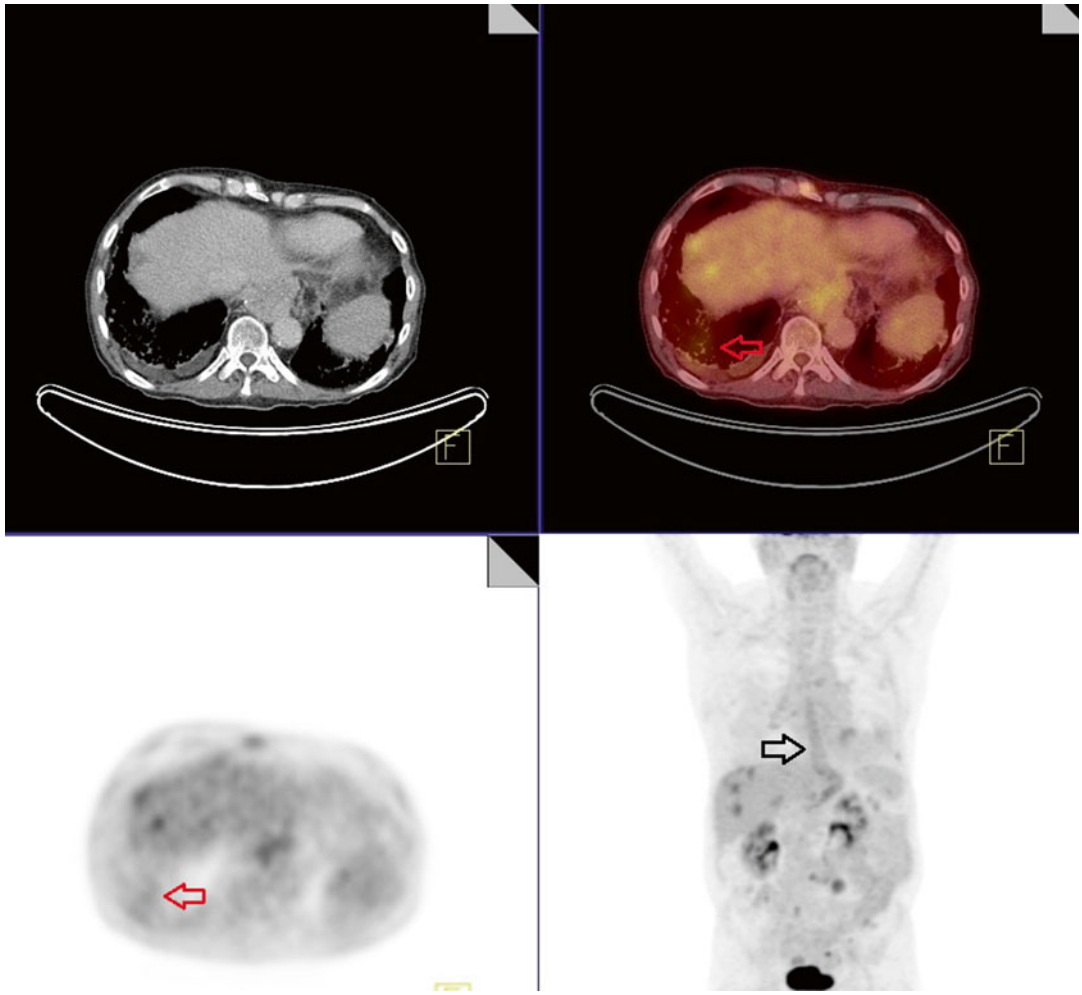

Fig. 4.8

Discussion

Performance of PET in assessing N1 disease is not better than that of current staging methods. There is a significant advantage in detection of M1 disease, avoiding unnecessary surgery. ^{18}F-FDG PET detects 95 % of the primary esophageal tumors. To identify unsuspected M1 disease, ^{18}F-FDG PET performed better than the combination of CT and EUS. The rate of M1 metastases only detected by ^{18}F-FDG PET in conventionally staged tumors is 10–20 %. ^{18}F-FDG PET upstaged the disease in about 20 % as M1 disease. The accuracy of 69 % for detecting M1 disease with CT and EUS increased to 86 % when combined with ^{18}F-FDG PET.

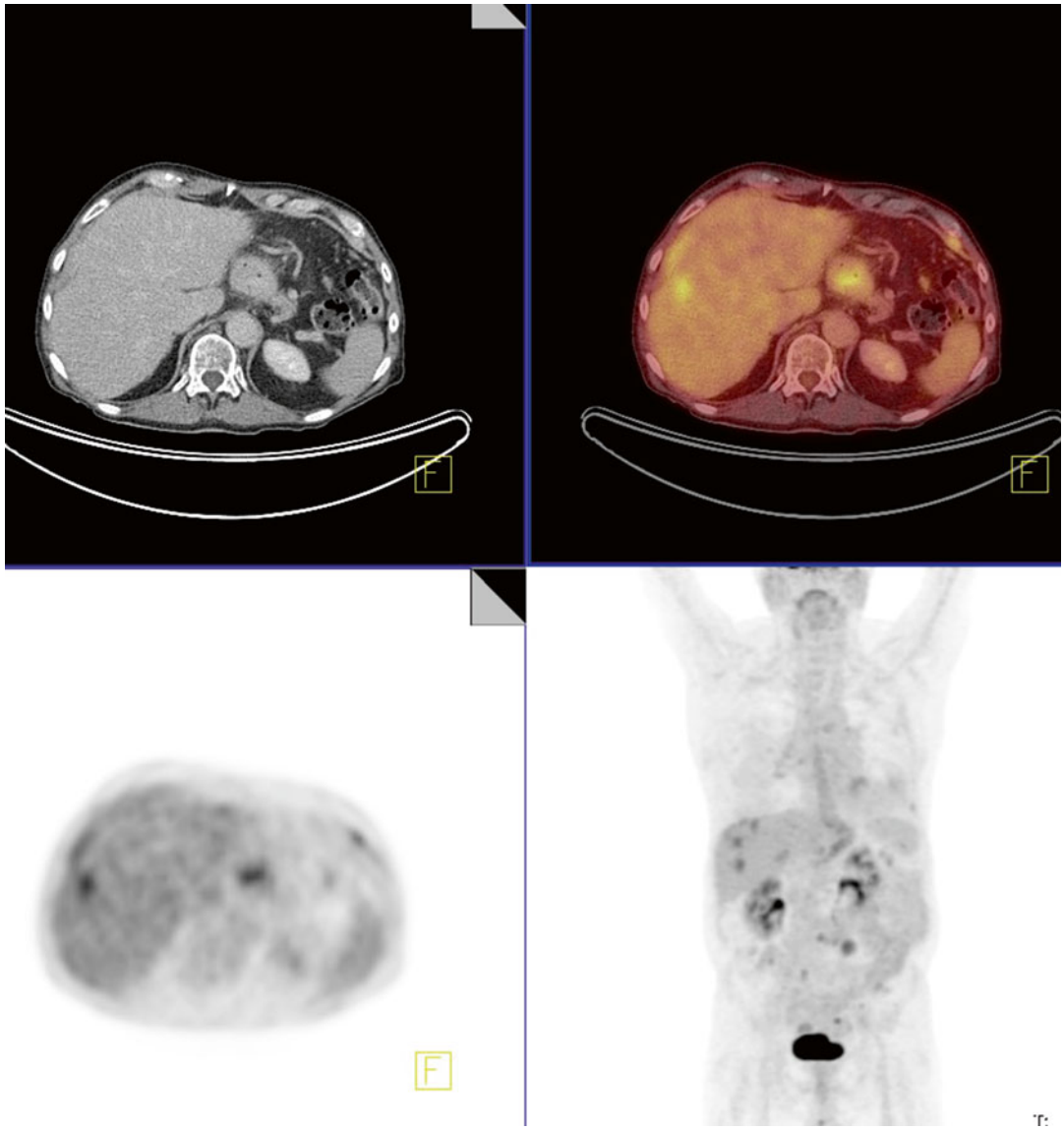

Fig. 4.9

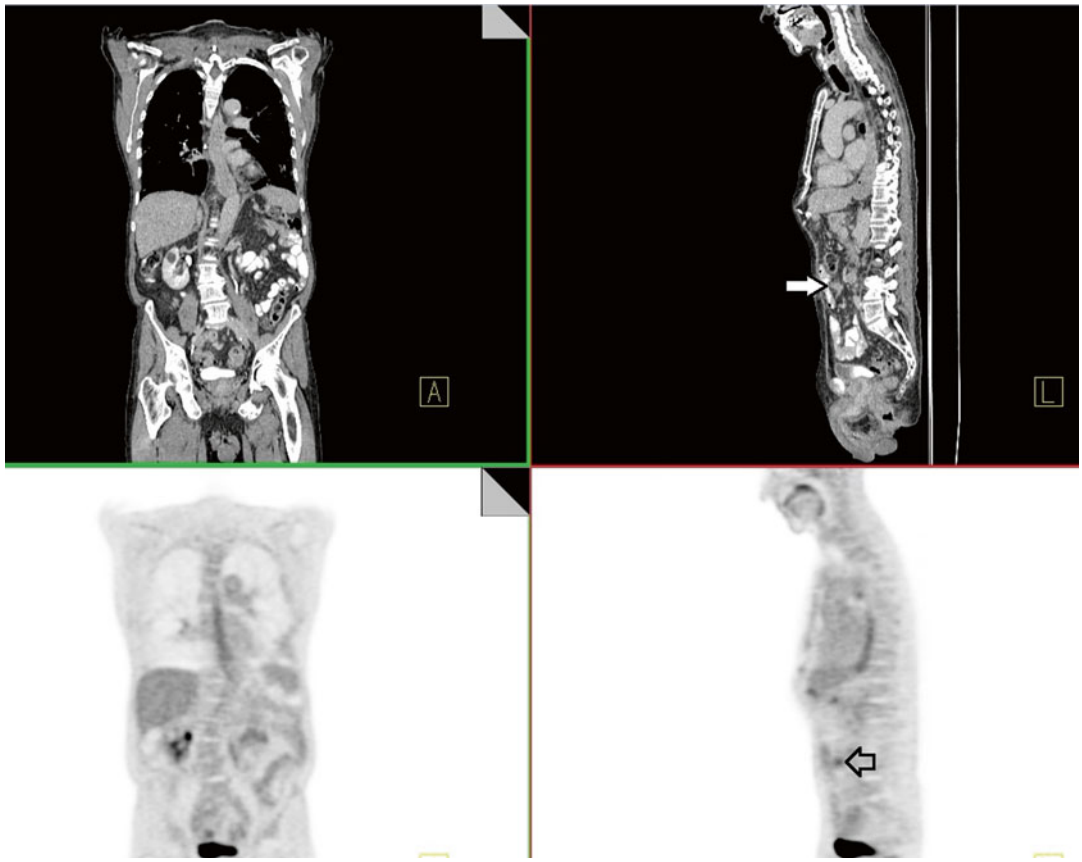

Fig. 4.10

Case 4.5

History

Patient with biopsy-proven well-differentiated adenocarcinoma of the esophagus.

Findings

There is a hypermetabolic mass in the mid to distal esophagus, protruding into the lumen, with generalized wall thickening at SUVmax of 7.4. There are inactive small paraesophageal nodes near the gastroesophageal junction (Fig. 4.11).

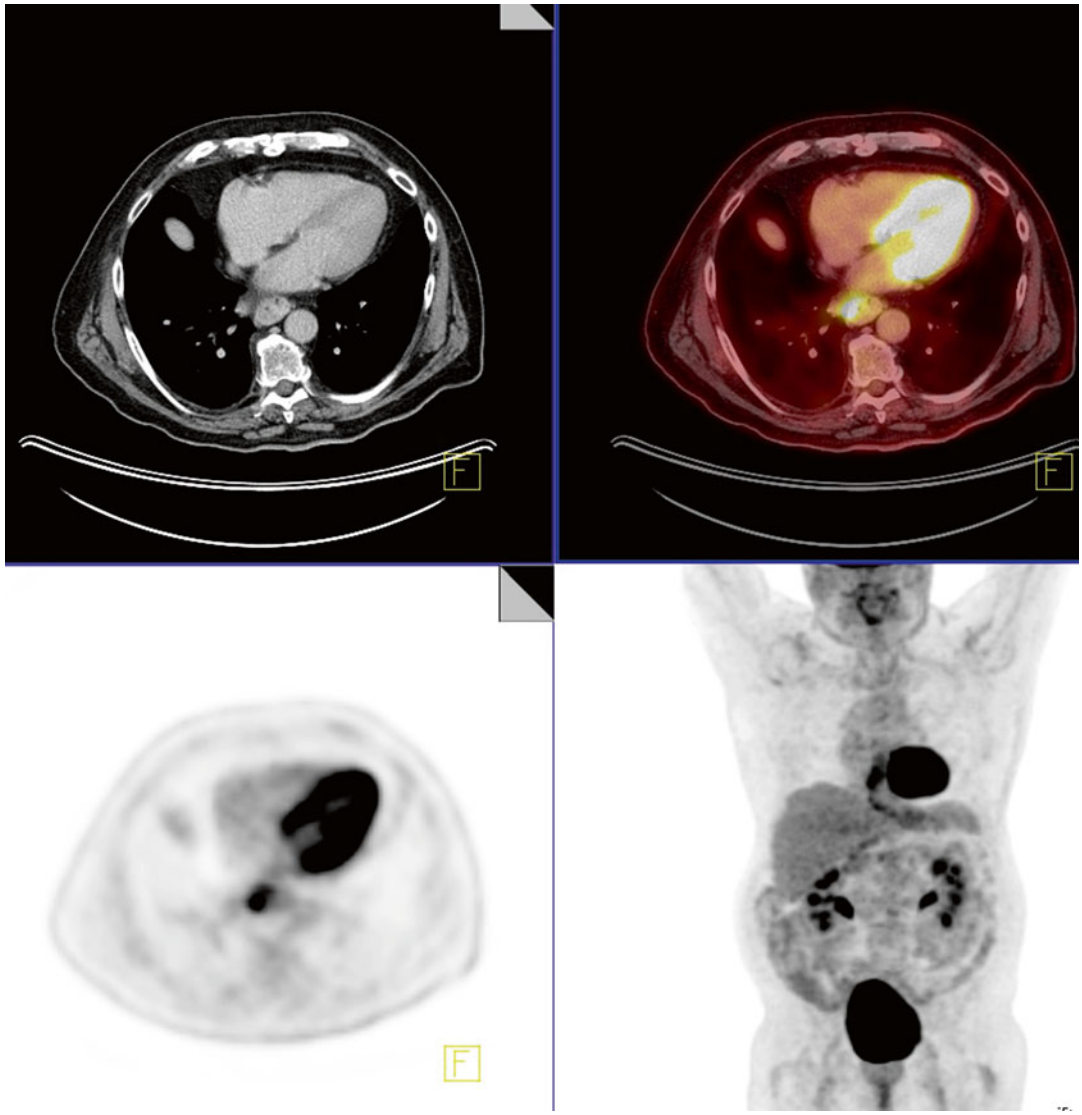

Fig. 4.11

Impression

Hypermetabolic mid to distal primary esophageal tumor with small adjacent nodes that despite being metabolically inactive can statistically be involved with tumor deposits.

Pearls and Pitfalls

Performance of PET in assessing N1 disease is not better than that of current staging methods. The sensitivity, specificity, and accuracy of FDG PET for nodal metastatic disease are 30 %, 90 %, and 82 %, respectively.

Discussion

^{18}F-FDG PET does not add much in the detection of regional nodes. The direct vicinity of the primary tumor, obscuring ^{18}F-FDG uptake, probably causes false-negative results in peritumoral N1 nodes. Moreover, small metastatic nodes could cause false negativity by limitations in the spatial resolution. Specificity of 71 % with PET in assessing regional metastases is comparable with that of other series. FDG PET is slightly less specific than CT for depicting metastases, but the difference in specificity between the two modalities is statistically significant. Both FDG PET and CT have low sensitivity for depicting nodal metastasis. The relatively low specificity of FDG PET for depiction of nodal metastasis compared with that of CT is caused mainly by a high rate of false-positive hilar node interpretations.

Case 4.6

History

A 50-year-old male with submucosal adenoid cystic carcinoma of esophagus.

Findings

There is a hypermetabolic low attenuating heterogeneous retrotracheal esophageal mass which appears to be arising from right anterior wall of the esophagus. The bulk of the mass is at the level of thyroid, extending inferiorly to the level of manubrium, compressing the trachea with SUVmax of 5.4, compatible with primary neoplasm (Fig. 4.12). Focal activity is also seen in the terminal ileum (Fig. 4.13) with prominent mucosal enhancement, demonstrating SUVmax of 4.2. Subsequent imaging revealed resolution of focal ileal activity.

Impression

1. Hypermetabolic retrotracheal esophageal mass, compatible with known primary neoplasm
2. No definite evidence of distant metastasis
3. Focal activity in the terminal ileum with prominent mucosal enhancement, likely inflammatory or physiologic

Pearls and Pitfalls

1. Sensitivities for ^{18}F-FDG PET imaging are between 91 % and 100 %. False-positive uptake can occur due to inflammation, and there can be normal mild FDG activity from muscular contractions.
2. Recurrence is most common near the esophagogastric anastomosis.

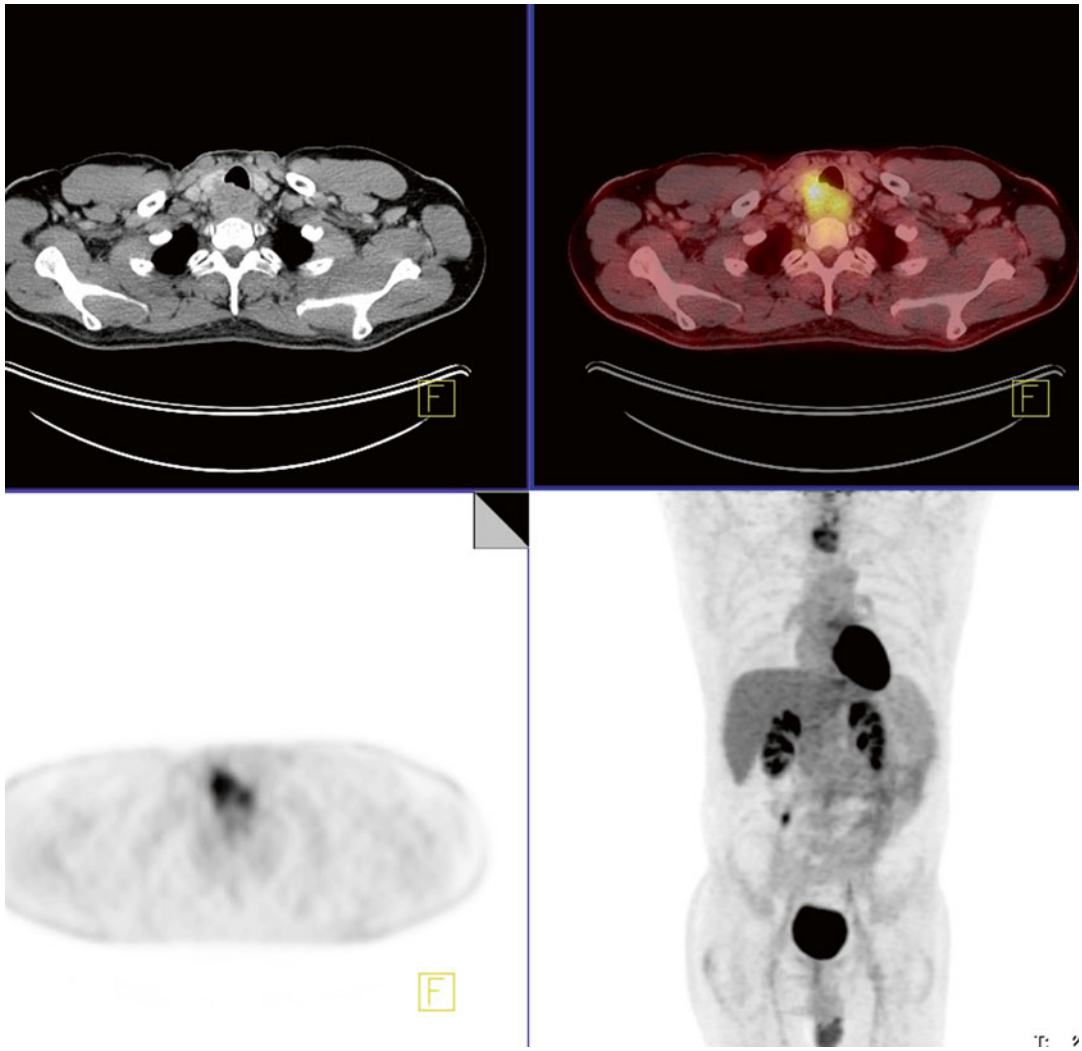

Fig. 4.12

Discussion

Esophageal adenoid cystic carcinoma (EACC) accounts for 0.1 % of esophageal malignancies. The clinical behavior of EACC is not well known due to the small number of reported cases. The average age of patients is 65 years, with a male-to-female ratio of 3.4:1. The most common symptom is progressive dysphagia. EACCs have most frequently been reported in the middle third of the esophagus (63 %), less often in the lower third (30 %), and rarely in the upper third (7 %). The most common endoscopic findings include a fungating or polypoid mass rather than an ulcerative or infiltrative growth pattern.

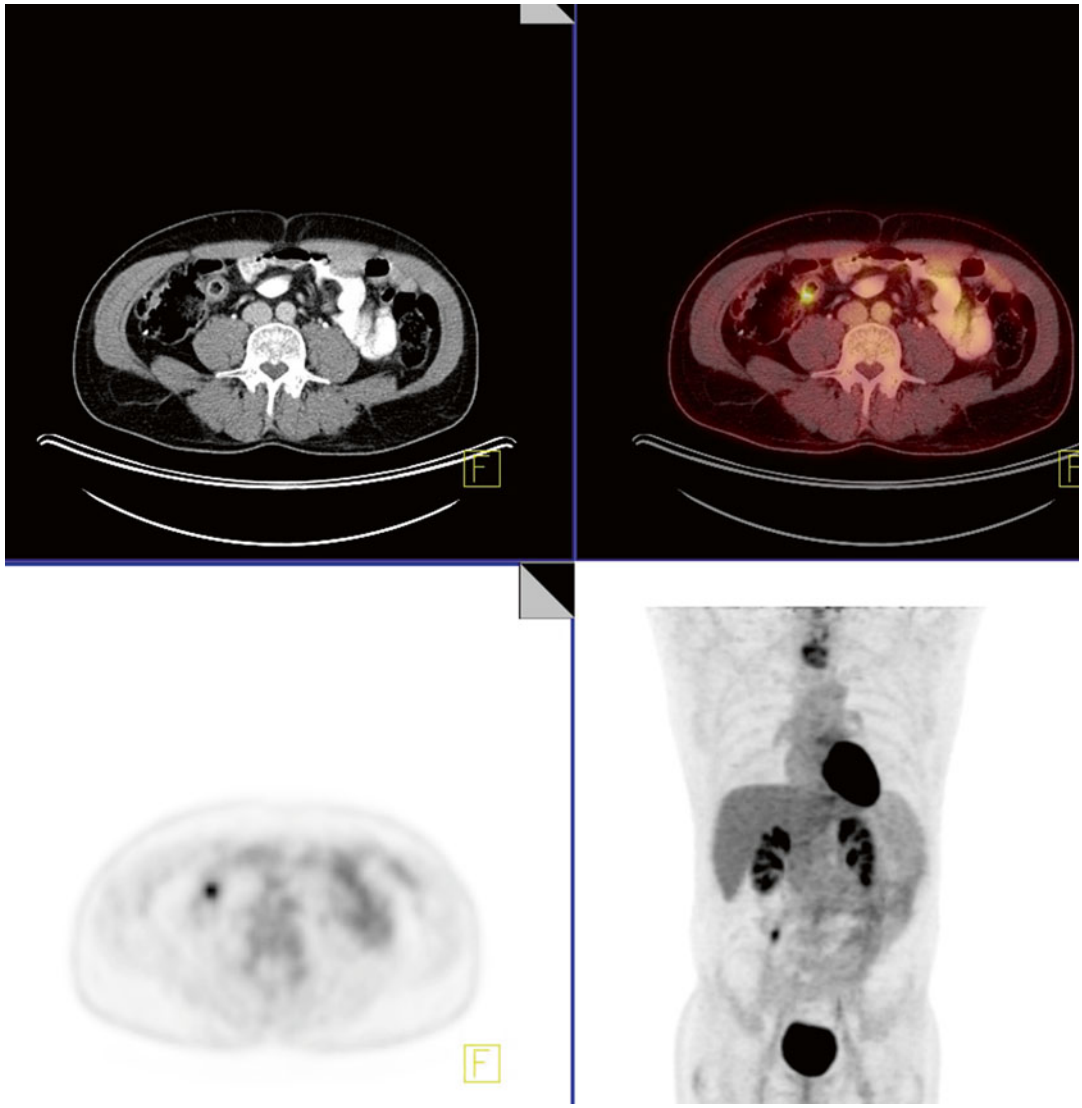

Fig. 4.13

The treatment of choice for EACC is radical excision. When the surgical margin is positive, postoperative radiotherapy is recommended. Chemotherapy is not usually chosen due to a poor response rate. The 5-year survival rate is approximately 35 %, and the long-term survival is poor. Eighty to 90 % of patients die of this disease within 10–15 years. Poor prognostic factors that influence survival include solid histological pattern, advanced clinical stage, and positive surgical margins. The role of chemotherapy, through either adjuvant or primary chemotherapy, is not clear. Postoperative radiotherapy may help the improvement of progressive dysphagia.

Case 4.7

History

Patient with distal esophagus/gastroesophageal junction mass with a superficial biopsy showing severe dysplasia and focal adenocarcinoma in situ.

Findings

There is a large area of fairly intense hypermetabolism with some necrosis in the distal esophagus and medial gastric fundus with SUVmax of 13.4 (estimated tumor volume of 148 cm^3 at a threshold of SUV 3, with mean SUV of 5.5, indicating significant tumor necrosis) (Fig. 4.14).

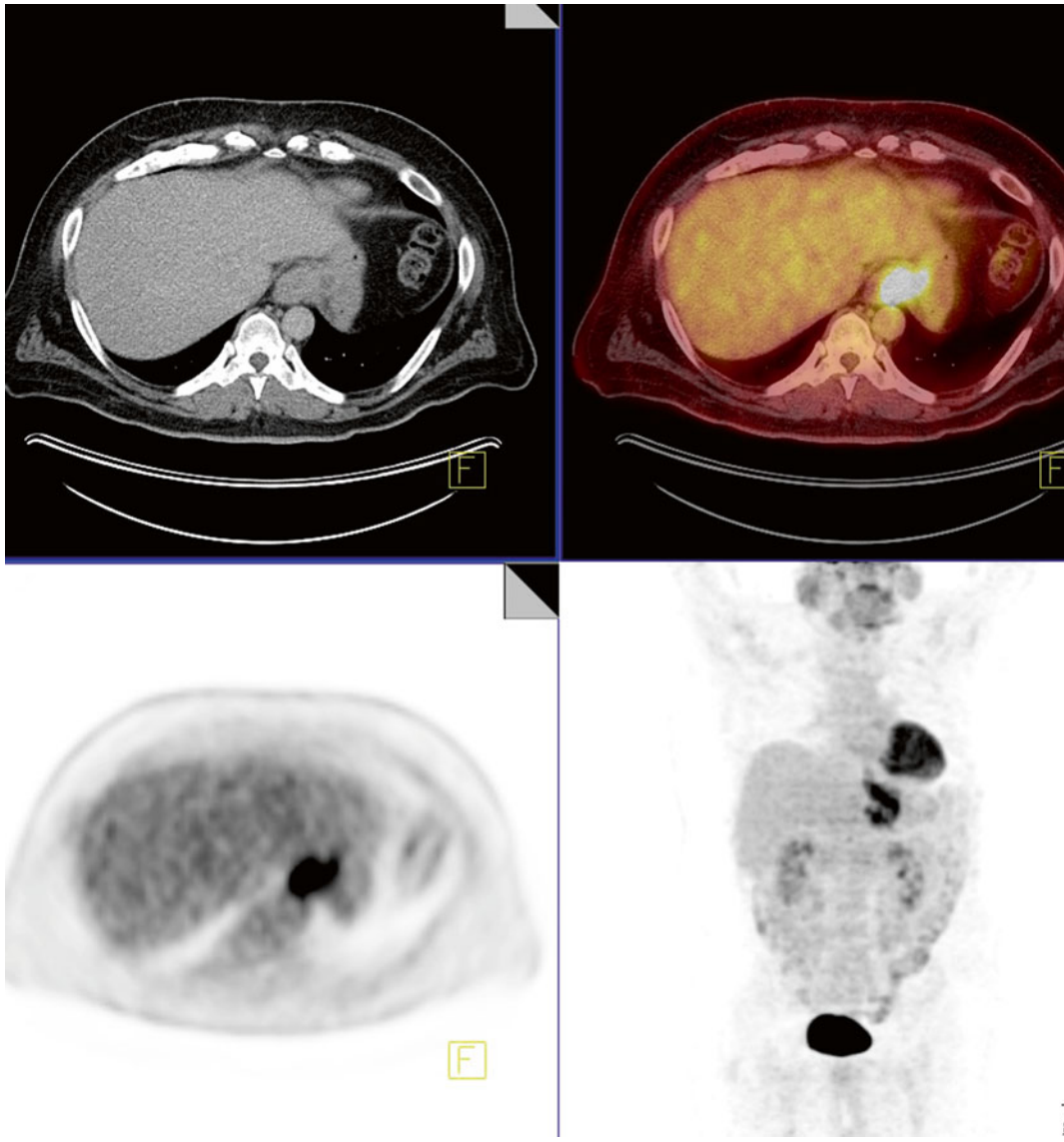

Fig. 4.14

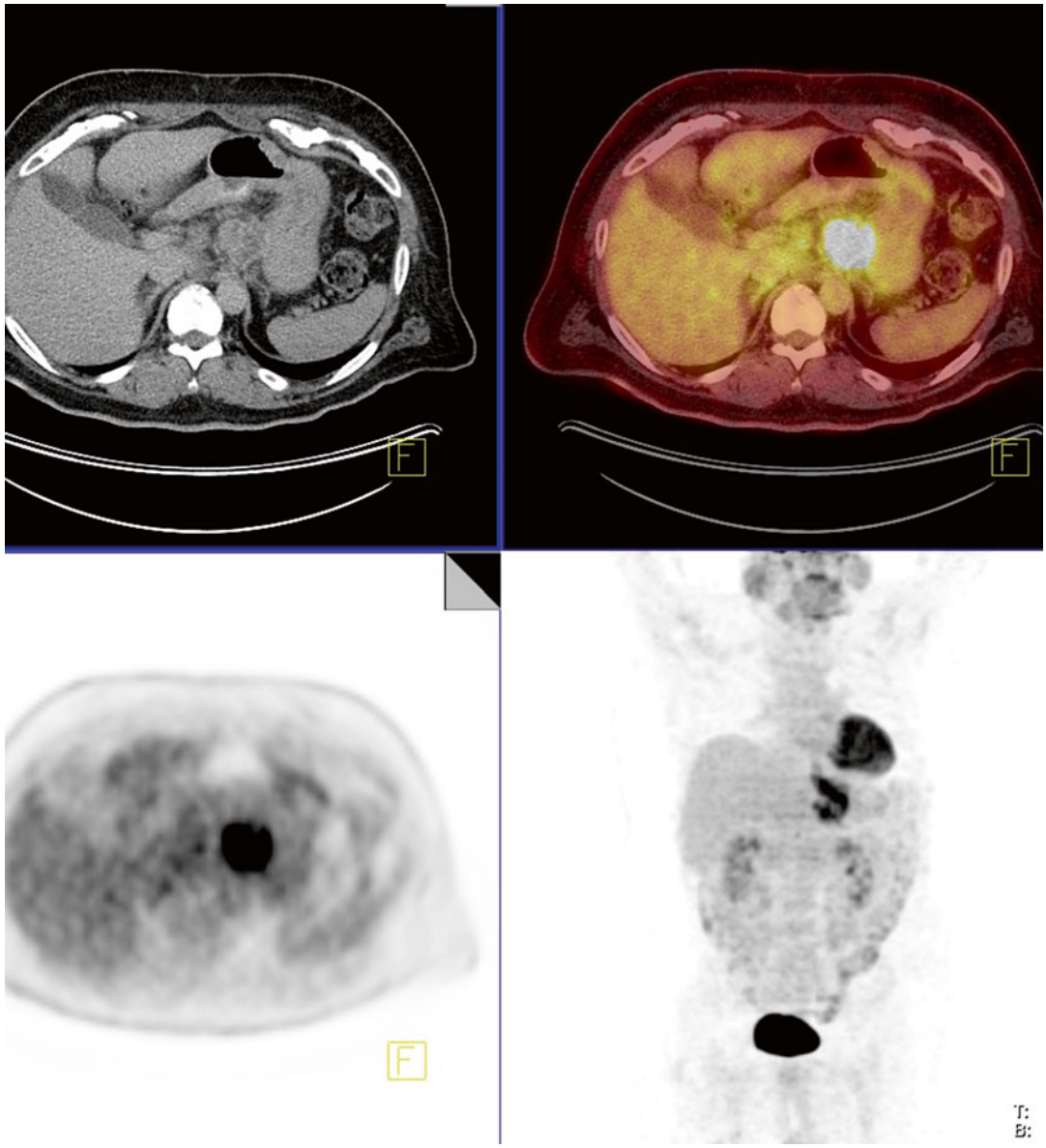

Fig. 4.15

There are regional perigastric/gastroduodenal nodes with SUVmax up to 9.2 (Fig. 4.15). There are no hypermetabolic or enlarged lymph node in the celiac axis or retroperitoneal stations.

Impression

Large hypermetabolic tumor involving the distal esophagus and medial gastric fundus with regional lymph node metastasis.

Pearls and Pitfalls

1. Sensitivities for FDG PET imaging are between 91 and 100 %. False-positive uptake can occur due to inflammation, and there can be normal mild FDG activity from muscular contractions.
2. Accuracy of FDG PET in the staging of regional lymph node metastases ranges from 24 to 90 %. The major limitation of FDG PET with regard to the detection of nodal metastases adjacent to the primary tumor is its relatively poor spatial resolution (approximately 6 mm for a dedicated PET scanner), which reduces sensitivity. The level of metabolic activity and pattern of mediastinal and hilar lymph nodes as well as coexisting nodal calcification is helpful in determining inflammatory versus metastatic etiology.
3. Recurrence is most common near the esophagogastric anastomosis.

Discussion

^{18}F-FDG PET does not add much in the detection of regional nodes. The direct vicinity of the primary tumor, obscuring ^{18}F-FDG uptake, probably causes false-negative results in peritumoral N1 nodes. Moreover, small metastatic nodes could cause false negativity by limitations in the spatial resolution. Specificity of 71 % with PET in assessing regional metastases is comparable with that of other series. FDG PET is slightly less specific than CT for depicting metastases, but the difference in specificity between the two modalities is statistically significant. Both FDG PET and CT have low sensitivity for depicting nodal metastasis. The relatively low specificity of FDG PET for depiction of nodal metastasis compared with that of CT is caused mainly by a high rate of false-positive hilar node interpretations.

Case 4.8

History

A 64-year-old male with history of esophageal adenocarcinoma.

Findings

There is long segmental hypermetabolic wall thickening of the esophagus from the T3 level to the gastroesophageal junction with SUVmax of 14.9. The segmental thickening is more pronounced and concentric as it reaches the gastroesophageal junction (Figs. 4.16 and 4.17). Several hypermetabolic cervical and supraclavicular lymph nodes were noted. Evaluation of the abdomen demonstrated innumerable hypermetabolic hepatic lesions (most active at the dome with SUVmax of 12.2), some of which correspond to hypodense lesions on transmission CT scan (Figs. 4.18 and 4.19). A nodule was identified within the right adrenal gland with intense increased metabolic activity. Enlarged lymph nodes were seen within the celiac axis that also demonstrated increased

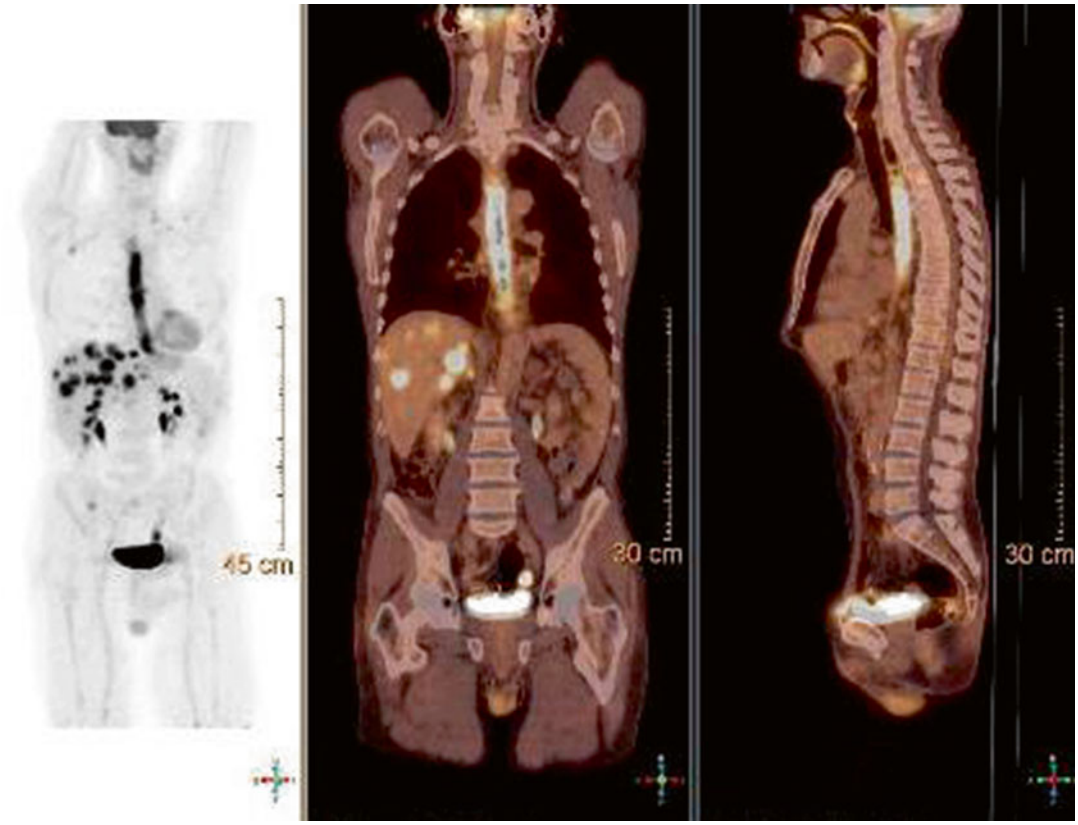

Fig. 4.16

metabolic activity. Numerous areas of increased metabolic activity were seen within skeleton, consistent with metastatic osseous disease. The majority of these lesions do not demonstrate any lytic or cortical disruption on CT (Figs. 4.20 and 4.21).

Impression

1. Esophageal wall thickening with intense increased metabolic activity, consistent with known esophageal adenocarcinoma
2. Metastatic disease to the liver, skeleton, and right adrenal gland
3. Metastatic nodal disease as described above

Pearls and Pitfalls

1. F-FDG PET is sensitive and accurate in the preoperative staging of distant metastases in patients with cancer of the esophagus and leads to upstaging. Though performance of PET in assessing N1 disease is not better than that of current staging methods, there is a significant advantage in detection of M1 disease, avoiding unnecessary surgery.
2. Sensitivity to identify locoregional metastases was highest for EUS (69 %) but was not different for CT and PET (44 % and 55 %, respectively).

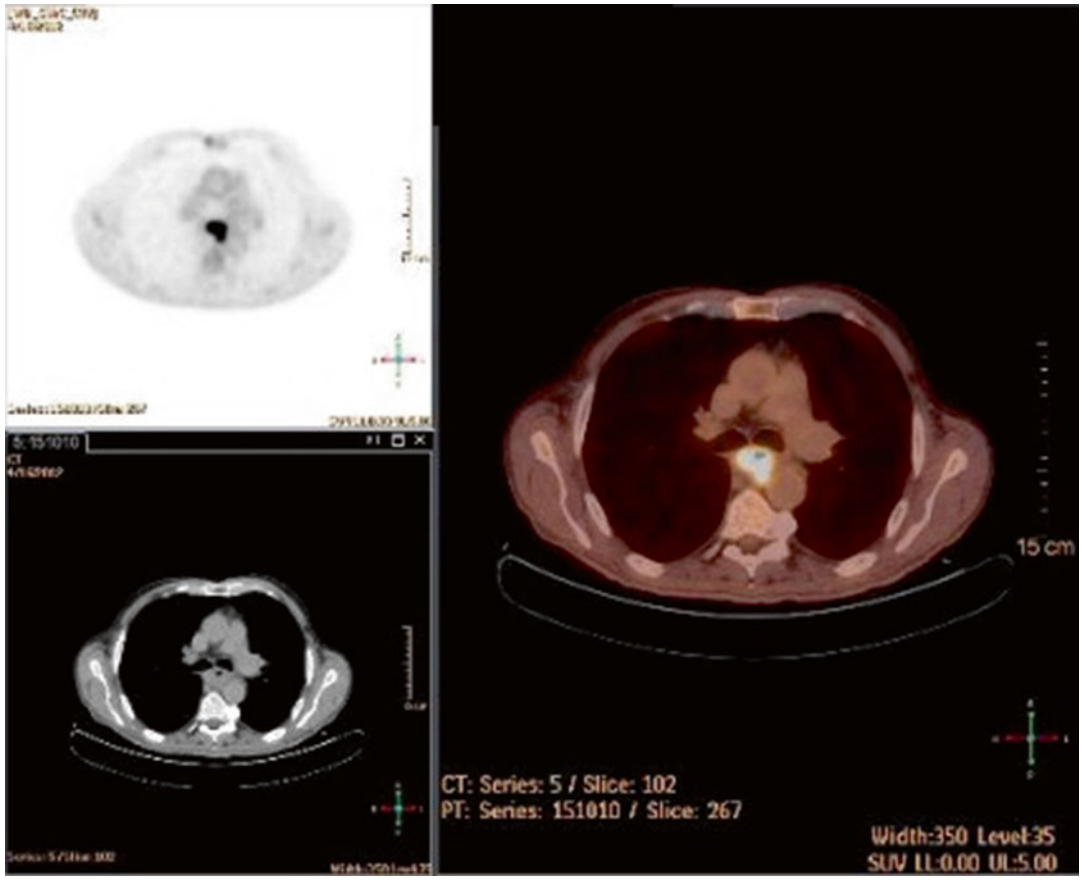

Fig. 4.17

Discussion

This study clearly shows the additional value of ^{18}F-FDG PET in staging carcinoma of the esophagus and GE Junction. Though performance of PET in assessing N1 disease is not better than that of current staging methods, there is a significant advantage in detection of M1 disease, avoiding unnecessary surgery.

To identify unsuspected M1 disease, ^{18}F-FDG PET performed better than the combination of CT/EUS. The rate of M1 metastases only detected by ^{18}F-FDG PET in conventionally staged tumors is 10–20 %. ^{18}F-FDG PET upstaged the disease in about 20 % as M1 disease. A combination of all three modalities increased the accuracy for detecting M1 disease up to 92 % as was the result of a more sensitive detection of both distant node and organ metastases. PET improves the currently applied staging of esophageal and GEJ tumors, particularly by ameliorating the detection of M1 disease.

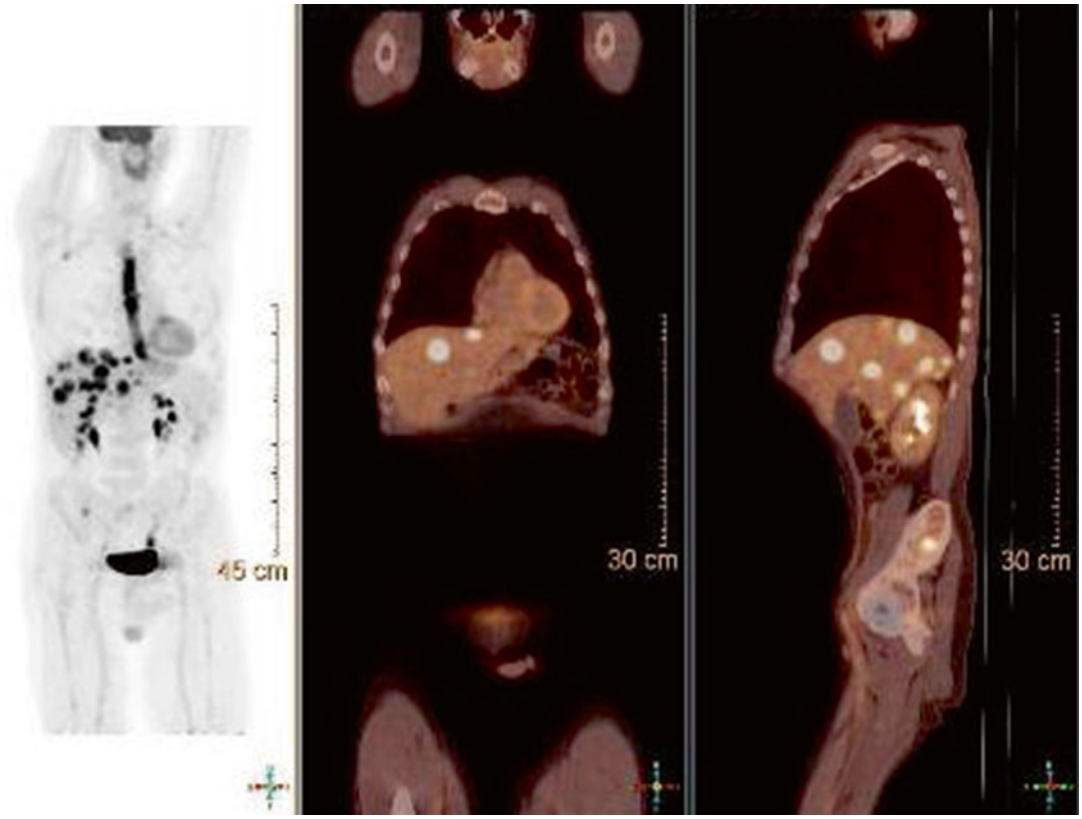

Fig. 4.18

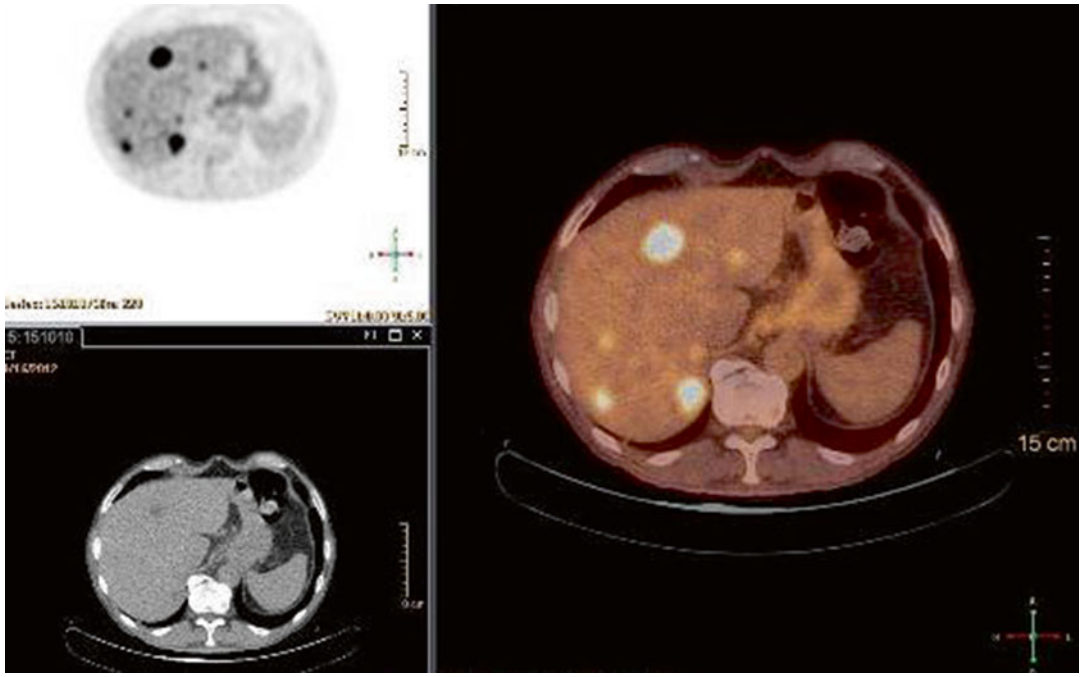

Fig. 4.19

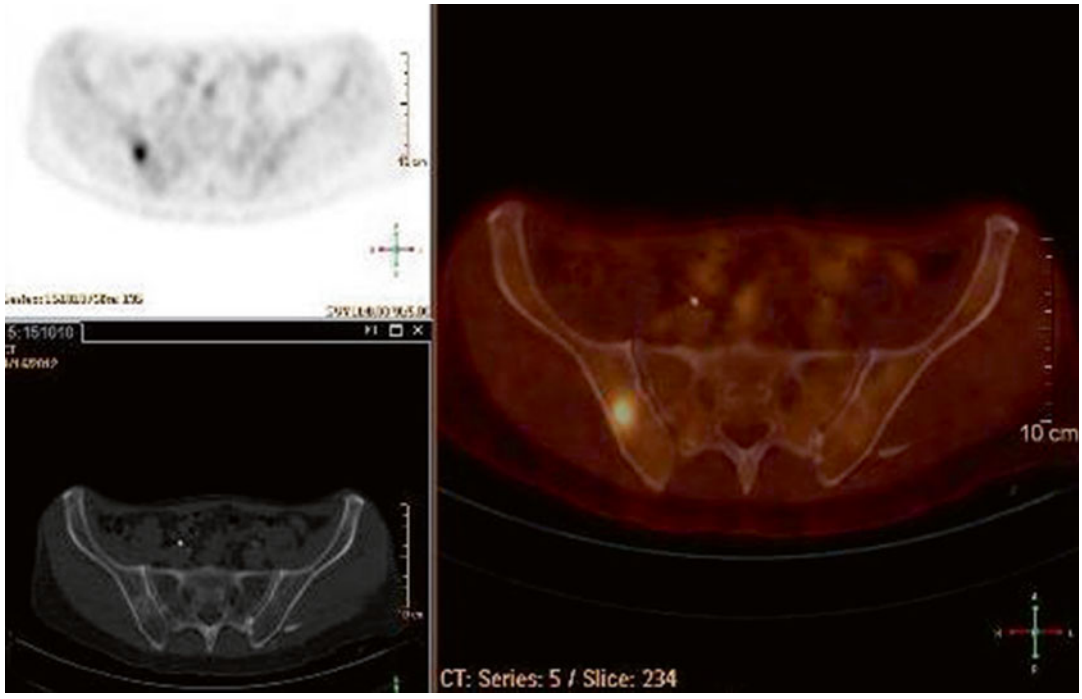

Fig. 4.20

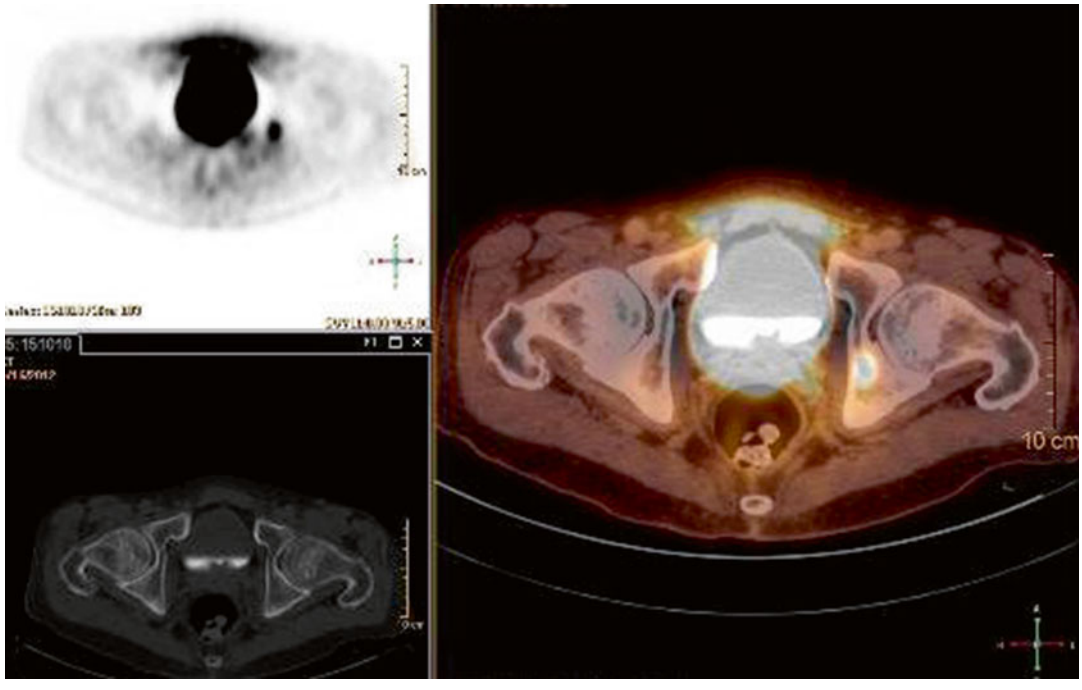

Fig. 4.21

Case 4.9

History

Patient with esophageal cancer.

Findings

There is a hypermetabolic right paratracheal node with SUVmax of 10, consistent with metastatic node (Fig. 4.22, white arrow). There is a hypermetabolic distal esophageal circumferential thickening extending to the gastroesophageal junction with SUVmax of 22 consistent with known

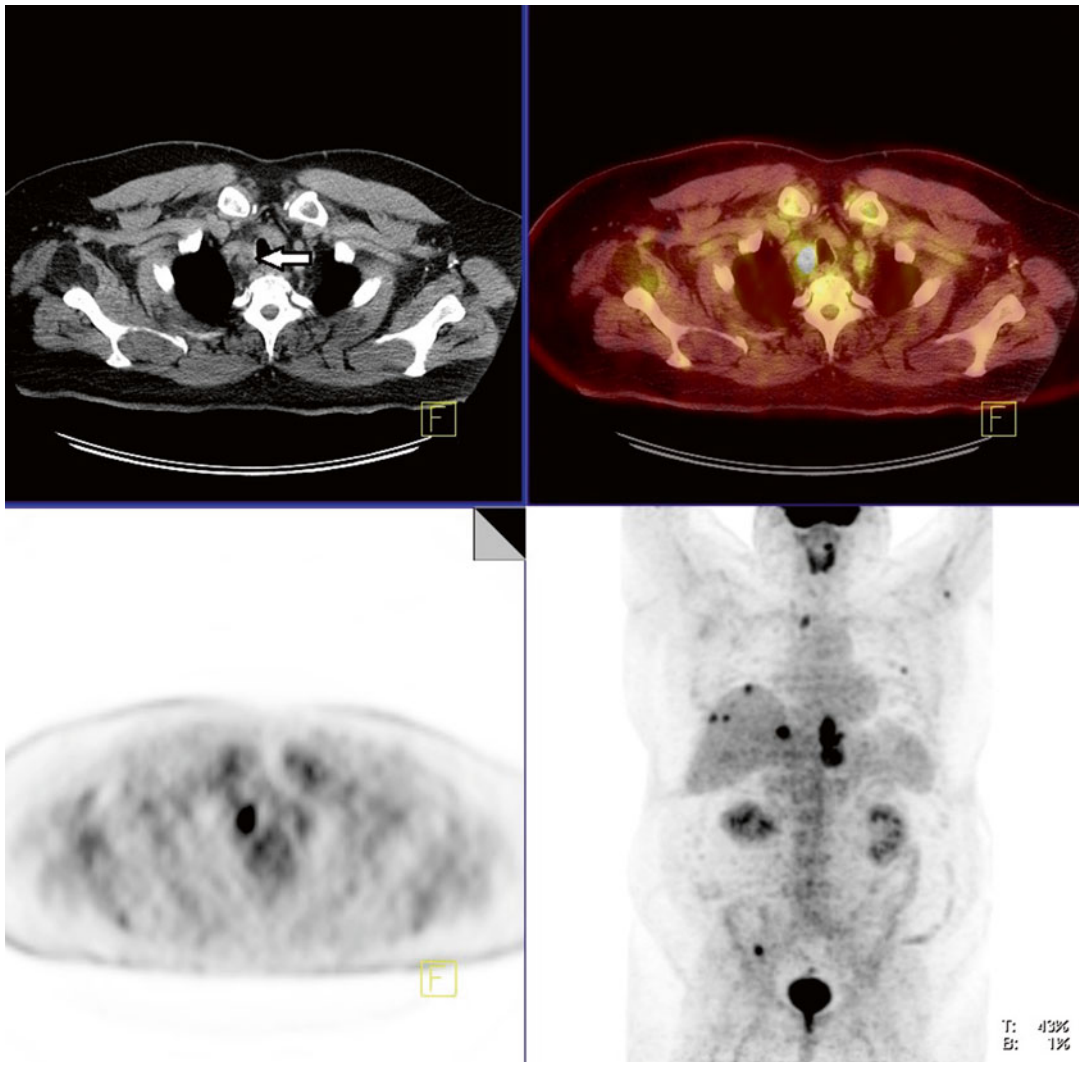

Fig. 4.22

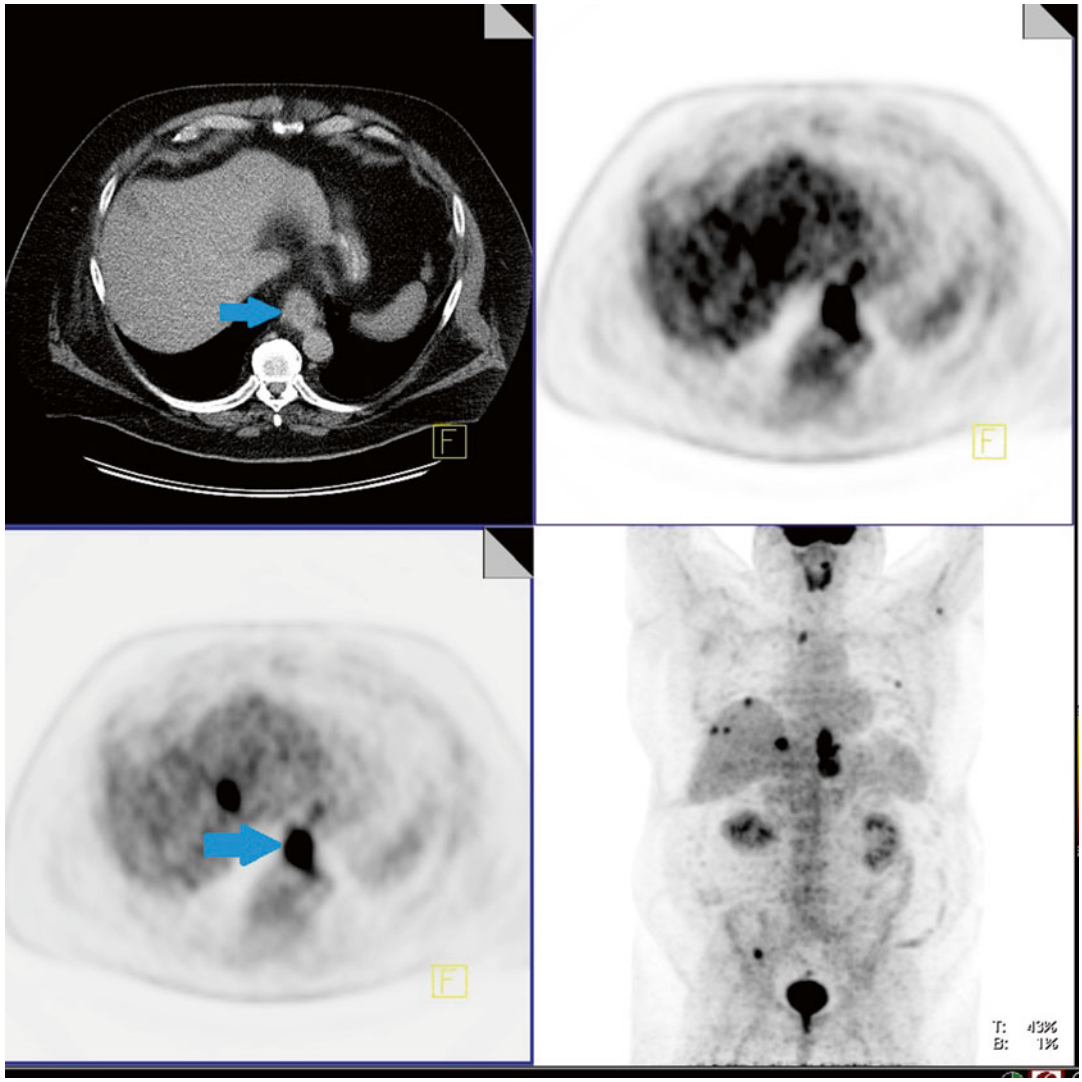

Fig. 4.23

esophageal tumor with a hypermetabolic lymph node at gastroesophageal junction with SUVmax of 16.4 (Fig. 4.23, blue arrow). There are multiple hypoattenuating, hypermetabolic foci within hepatic parenchyma consistent with metastases (Figs. 4.24 and 4.25, red arrow). There is focal activity in the right iliacus muscle with SUVmax of 15.9 with slight adjacent osseous erosion, also consistent with metastasis (Fig. 4.26, green arrow).

Impression

1. Hypermetabolic distal esophageal mass extending to gastroesophageal junction, consistent with known primary tumor with adjacent regional nodal metastasis
2. Mediastinal nodal disease

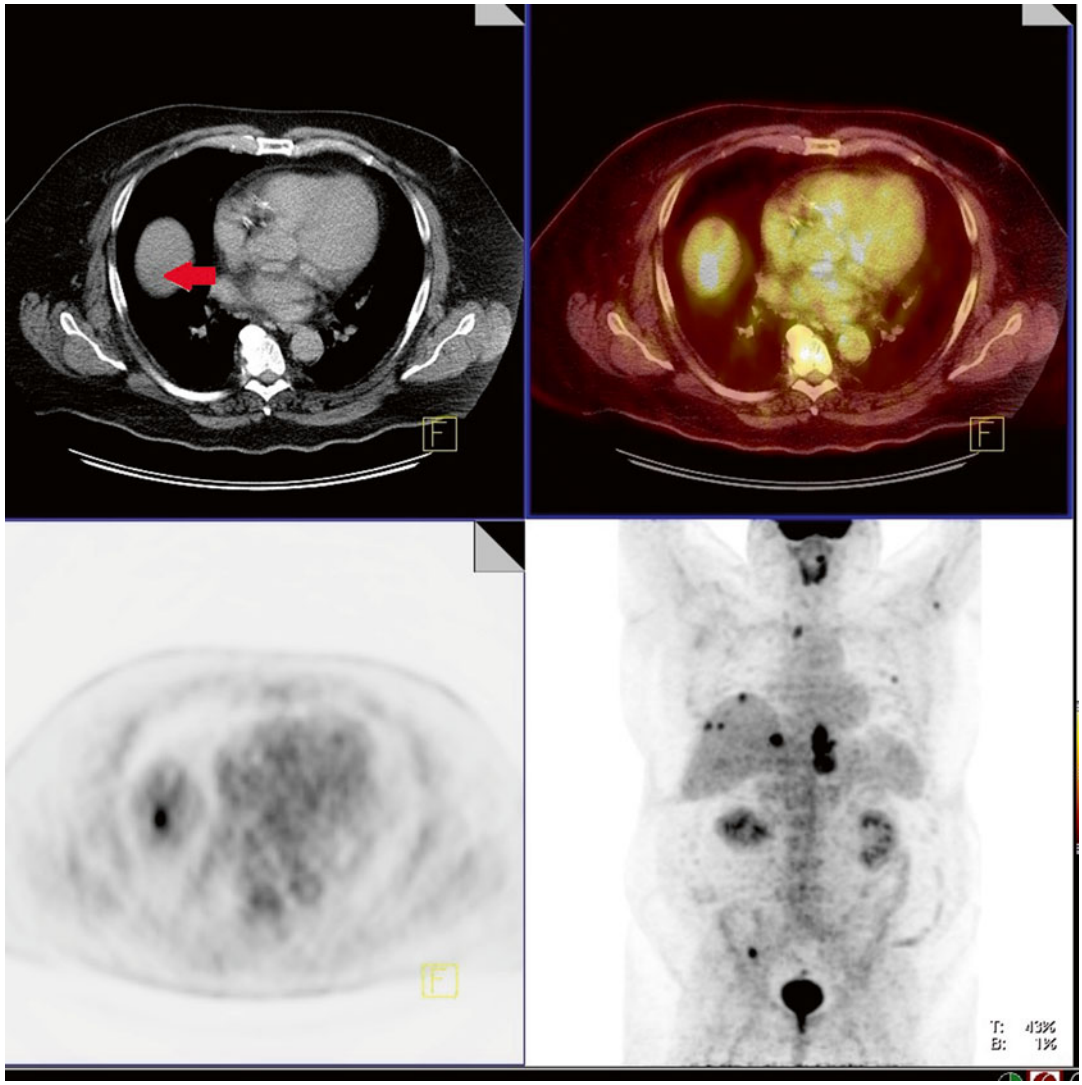

Fig. 4.24

3. Hepatic metastatic disease
4. Multiple osseous metastases
5. Right iliacus muscular metastasis with adjacent osseous erosion

Pearls and Pitfalls

1. ^{18}F-FDG PET is sensitive and accurate in the preoperative staging of distant metastases in patients with cancer of the esophagus and leads to upstaging. Though performance of PET in assessing N1 disease is not better than that of current staging methods, there is a significant advantage in detection of M1 disease, avoiding unnecessary surgery.
2. Sensitivity to identify locoregional metastases is highest for EUS (69 %) but is not different for CT and PET (44 % and 55 %, respectively).

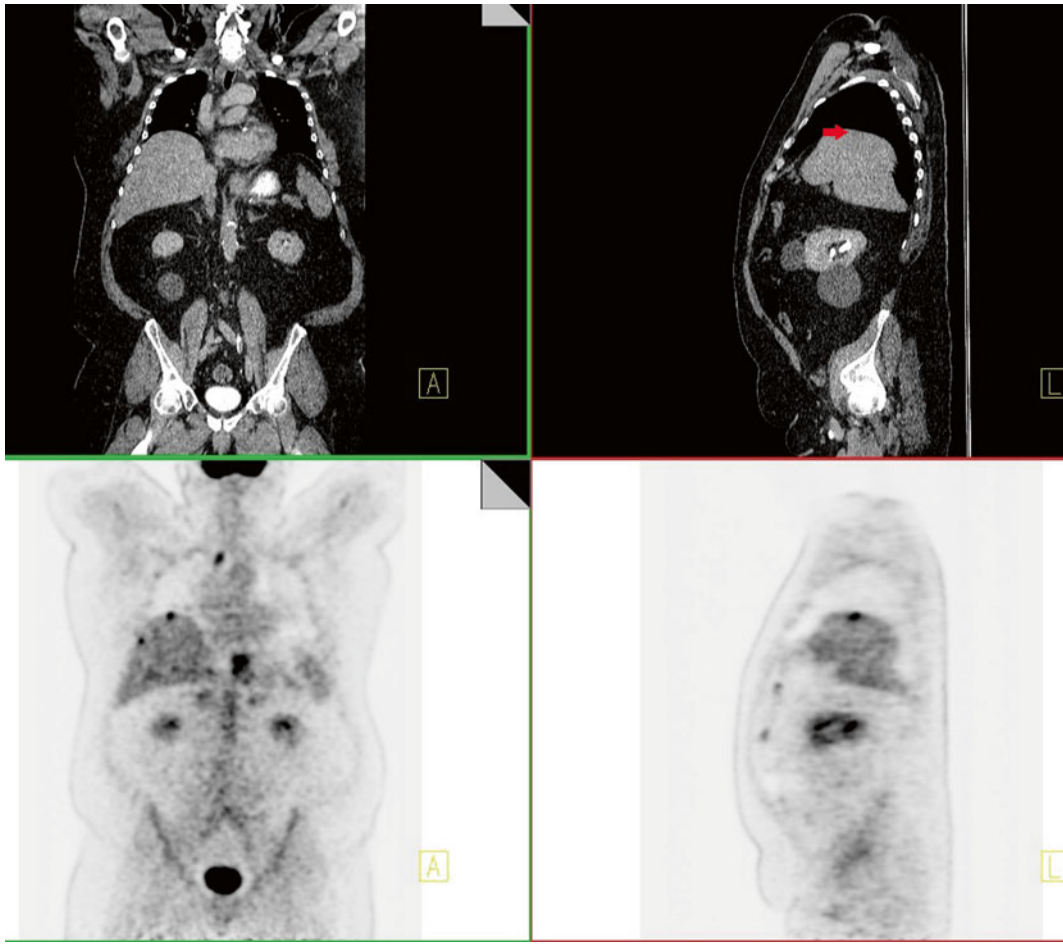

Fig. 4.25

Discussion

This study clearly shows the additional value of ^{18}F-FDG PET in staging carcinoma of the esophagus and gastroesophageal junction. Though performance of PET in assessing N1 disease is not better than that of current staging methods, there is a significant advantage in detection of M1 disease, avoiding unnecessary surgery.

To identify unsuspected M1 disease, ^{18}F-FDG PET performed better than the combination of CT/EUS. The rate of M1 metastases only detected by ^{18}F-FDG PET in conventionally staged tumors is 10–20 %. ^{18}F-FDG PET upstaged the disease in about 20 % as M1 disease. A combination of all three modalities increased the accuracy for detecting M1 disease up to 92 % as was the result of a more sensitive detection of both distant node and organ metastases. PET improves the currently applied staging of esophageal and gastroesophageal junction tumors, particularly by ameliorating the detection of M1 disease.

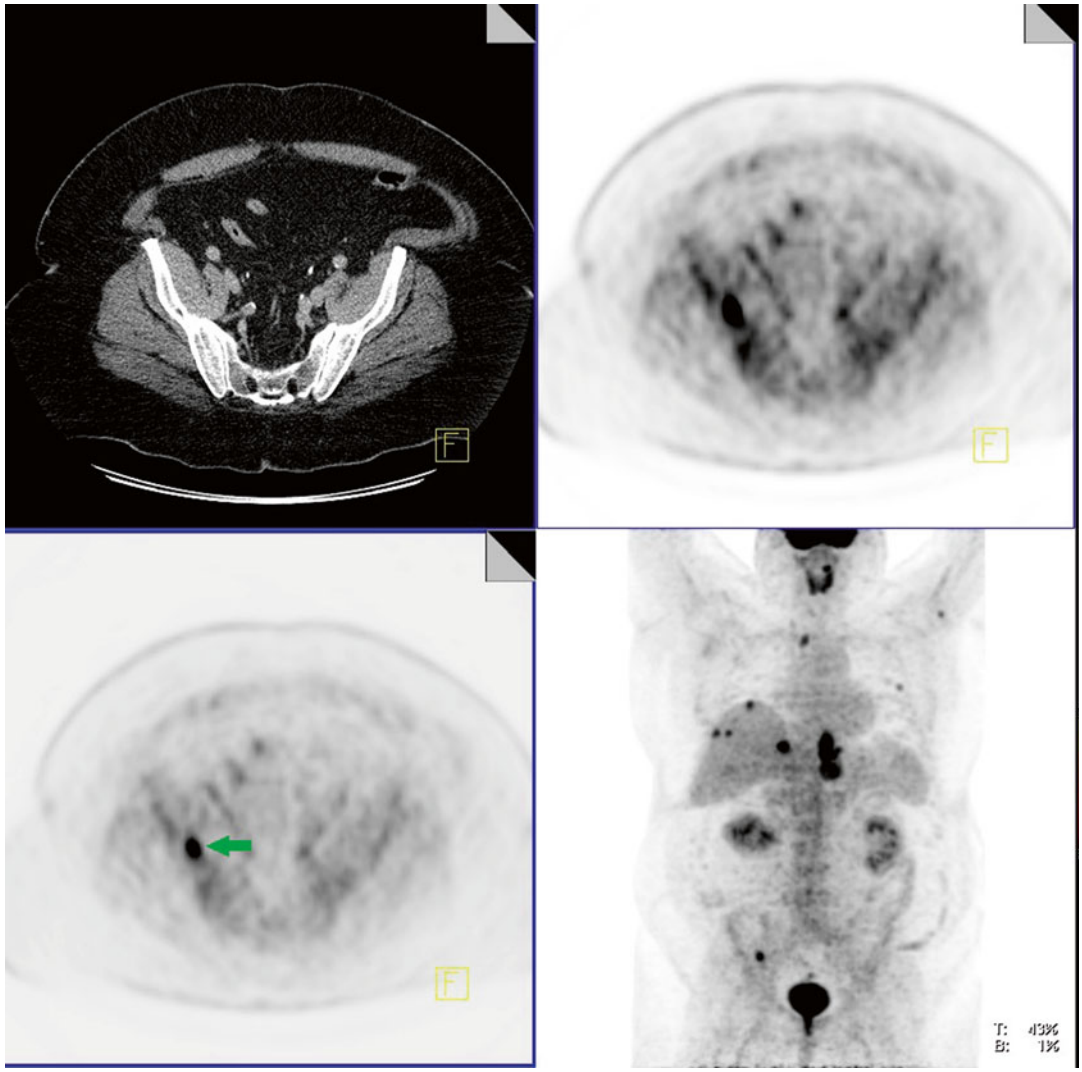

Fig. 4.26

Suggested Reading

Barber TW, Duong CP, Leong T, Bressel M, Drummond EG, Hicks RJ. ^{18}F-FDG PET/CT has a high impact on patient management and provides powerful prognostic stratification in the primary staging of esophageal cancer: a prospective study with mature survival data. J Nucl Med. 2012;53:864–71.

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