PET-CT in Chest Infective Inflammatory Pathologies

6

Key Points

PET-CT is the hybrid imaging modality, which is a well-established diagnostic imaging modality for Oncological Pathologies and with the advent of the newer radiotracers and advancements in the PET-CT and in the radiotracers newer applications are seen in the form of infection and inflammation. 18 FDG is the most widely used radiotracer, which demonstrates the metabolic activity in various tissues. In these inflammatory cells are activated which metabolites the glucose as source of energy and with this concept FDG is being used to detect various infective and inflammatory conditions and many newer pathologies an be evaluated.

6.1 Introduction

PET-CT is a well-established imaging modality and has the capacity to image the labelled compounds in the body [1]. With the same principle of FDG uptake, various nonmalignant conditions can be evaluated like lung, pleura, and mediastinal lesions. In the infective and inflammatory pathologies chain of reactions happen due to release of the various local factor's cytokines, interleukins, and prostaglandins [2, 3]. These pro-inflammatory mediators regulate the cascade of reactions with migration of the neutrophils, monocytes, and mast cells. The inflammatory response is mediated and facilitating glucose metabolism [4]. With this accumulation of all these cells and increased capillary permeability in the infection the inflammatory cells like granulocytes, leukocytes, and macrophages. This is the basis of the FDG uptake in the infective and inflammatory lesions [5].

PET-CT shows diffuse increased uptake secondary to the glucose metabolism triggered by various cascades of the inflammatory reactions. This increased FDG uptake is also dependent on the neutrophil activity, which takes the FDG uptake due to the activation of the pulmonary alveolar and interstitial macrophages [6].

S. Shaikh, *PET-CT in Infection and Inflammation*,
https://doi.org/10.1007/978-981-15-9801-2_6

FDG PET-CT has an important role in the evaluation of various pulmonary and extrapulmonary lesions. PET-CT helps to differentiate benign and malignant lesions. Recent technical advancements in PET-CT have increased the barrier of diagnostic work-up of various chest pathologies.

With this 18F FDG PET-CT is the important imaging modality, which has shown a significant increase in accuracy, advantage of noninvasive imaging modality, and most important differentiating between benign and malignant pulmonary lesions. Some benign lesions may appear as false positive and or non-specific. The objective of this study is to characterize the different pulmonary lesions, pleural lesions, and associated systemic pathology, which involve the pulmonary, pleural, and other chest lesions [7]. Thus, plays an important role in the differential diagnosis of benign pulmonary lesions.

6.2 PET-CT Acquisition

6.2.1 Acquisition Protocol

18F FDG PET-CT images were obtained using the Somaton Siemens biograph PET-CT machine with 16 slice CT scanner and high-resolution PET component [8]. All patients were injected with 18F FDG 1 h before the examination as per the weight and patient requirement. A contrast whole-body CT scan was done followed by PET. Delayed PET-CT scans were taken wherever required depending on the patient basis. A dedicated lung window was also acquired in the full inspiratory phase (Fig. 6.1).

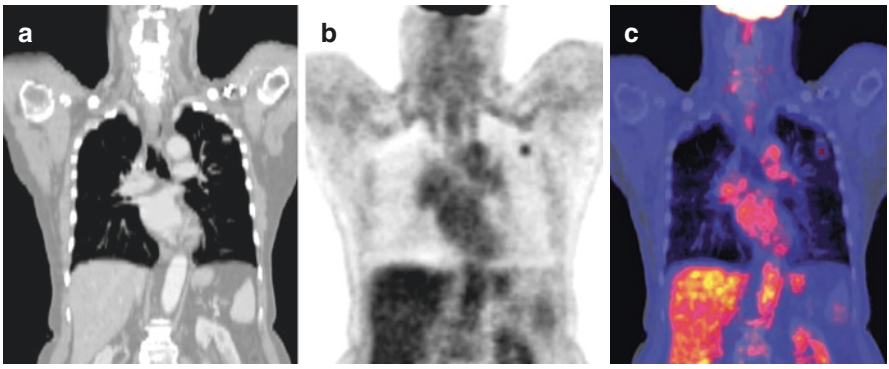

Fig. 6.1 Limited PET-CT chest showing tiny nodule in the left upper lobe. This nodule in CT image (**a**), PET image (**b**), and fused image (**c**). The fused image shows misregistration of this nodule due to technical aspect. CT taken in full inspiration and PET done in normal breathing. Sometimes this will appear as there are two nodules

6.2.2 Image Analysis

The quantification of 18F FDG PET is based on the semiquantitative analysis measured by standardized SUV max values. The usual method of quantification is to set the ROI at the location of lung lesions. With the modern PET-CT systems, this SUV max can be quantified automatically. The anatomical measurements can be done routinely.

6.3 Lung Lesions

6.3.1 Primary Lung Lesions

PET-CT has evolved as an important imaging modality with the rapid development of structural and functional components. With the extensive use of PET in the oncological settings, a lot of concurrent nonmalignant lesions were also evaluated with different imaging parameters and characteristics. This has led to a keen interest in the evaluation of nonmalignant lesions. Initially, it was difficult and had to be confirmed by histopathology. But now with newer imaging techniques and protocols, it has become easier to distinguish between benign and malignant lesions and infective inflammatory and malignant lesions. With this scenario, many PET-CT scans are being advised for evaluation of various infective inflammatory, granulomatous, and benign pathologies of the lung. Various lung pathologies which are affected in various infective inflammatory pathologies and can be evaluated. The varied presentations of lung pathologies are solitary pulmonary nodule, patchy infiltrates, patchy parenchymal nodules, cavitary lesions, ground glass opacities, alveolar opacities, interstitial lesions, reticulonodular lesions, interstitial thickening, mass lesion with or without collapse consolidation, and combination of the components mentioned above [5, 9]. The malignant pathologies also most of the times have similar presentations that can be difficult to differentiate between malignant and nonmalignant entities. Other lesions like granulomatous, metabolic, and sometimes traumatic and most important tuberculosis also have to be ruled out or confirmed [10–14]. With the SUV max quantification, it is difficult to distinguish between the two, especially when there is no significant difference or disparity in the clinical findings between the two (Figs. 6.2, 6.3, 6.4, and 6.5).

Larger lesions cavitation's, patchy consolidations involving a segment or extending into another segment which can be evaluated further, and the differentials will depend on the clinical settings can be tuberculosis or malignant lesions or collagen granulomas. The alveolar and ground glass opacities are mostly related to the perilesional component [15]. However, exclusive alveolar opacities can be seen in bronchoalveolar carcinomas [16], which have to be differentiated between the two (Figs. 6.6, 6.7, and 6.8).

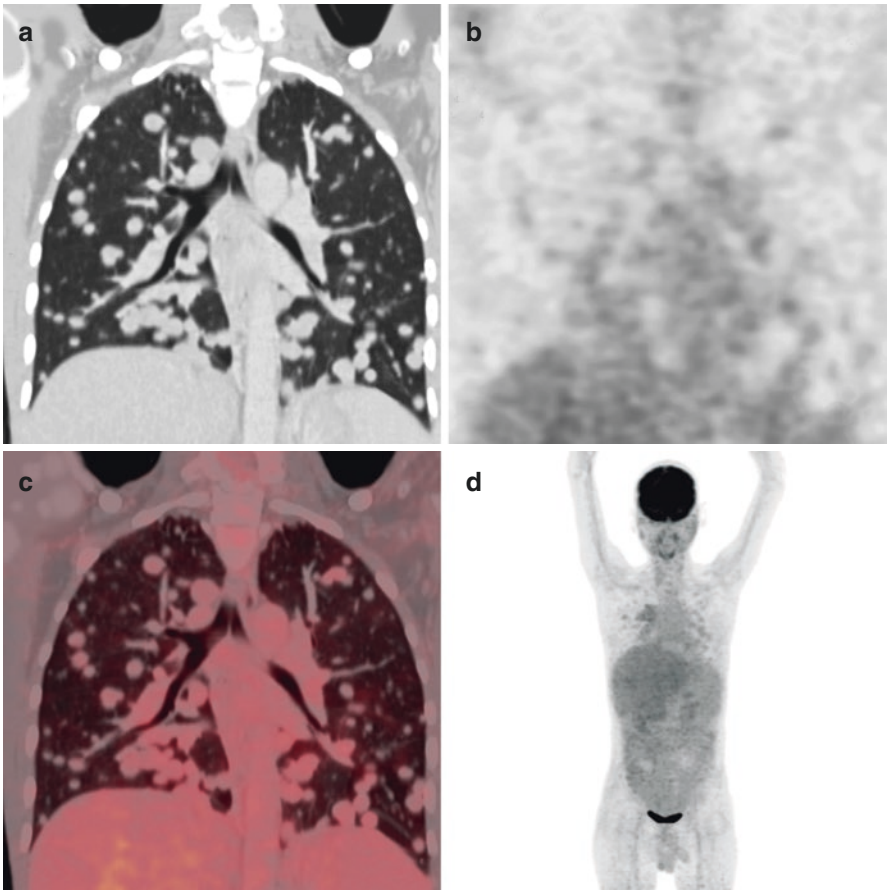

Fig. 6.2 Whole-body PET-CT done CT image (**a**) showing multiple rounded lesions in the bilateral lung parenchyma. PET (**b**, **d**) and fused PET-CT images (**c**) showing multiple nodular lesions in both lungs with no FDG activity suggestive of multiple inactive granulomas

6.3.2 Protocol of Evaluation

The newer protocol for the evaluation is dual time point imaging. Here, the delayed PET is done after 1 h of the primary PET scan or it can be after 2 or 3 h of the primary PET scan. The concept of this delayed scan is the metabolically active tracer activity is dependent on the malignant potential in which the radiotracer will be retained in delayed scan causing SUV max to be static. However, in nonmalignant, infective inflammatory, and other benign entities, the SUV max in the region of interest significantly reduces compared to the primary PET scan [17]. However, this does not apply in all cases. However, with this protocol a lot of fallacies are there.

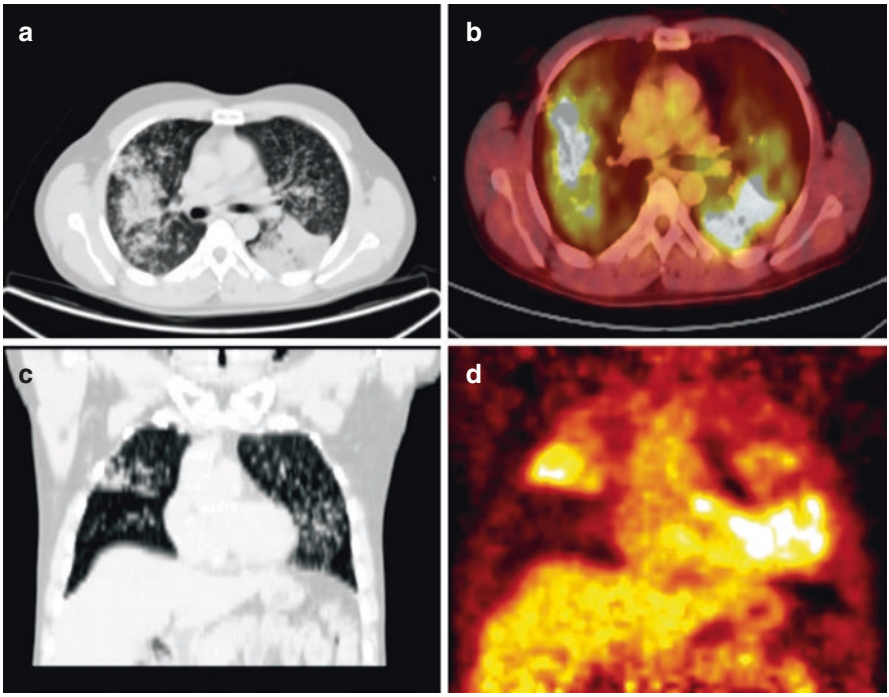

Fig. 6.3 Limited PET-CT chest done showing bronchioalveolar opacity in both lungs with associated tiny nodular opacities (**a**, **c**) with increased FDG uptake in PET-CT (**b**) and PET-CT (**d**) both lungs of SUV max of 4.5 suggestive of bronchioalveolar pathology. Histopathology confirmed consolidation

The other infective inflammatory conditions of the chest are fungal lesions, granulomatous infections, fibrosing mediastinitis, organizing pneumonia, granulomatosis with polyangiitis, and histiocytic processes like Erdheim-chester disease. One of another important indications is to monitor the lesions or disease after the treatment. If there is an infective inflammatory cavitatory lesion, then can be evaluated after the antibiotic therapy [18]. But this is not routinely used protocol for post-therapy evaluation in infective inflammatory pathologies as this can be done easily with the routine conventional imaging modalities like radiographs, CT chest, or MRI. Sometimes, it is difficult to evaluate the associated concurrent infective inflammatory lesions in malignant settings or immunocompromised status of a patient or it can be a superadded infection, which is secondary to the malignant therapy complications. Here, PET-CT has a significant role because the metabolic activity there is in the primary lesion and adjacent secondary lesion. Other than FDG PET newer radiotracers are in pipeline for the evaluation.

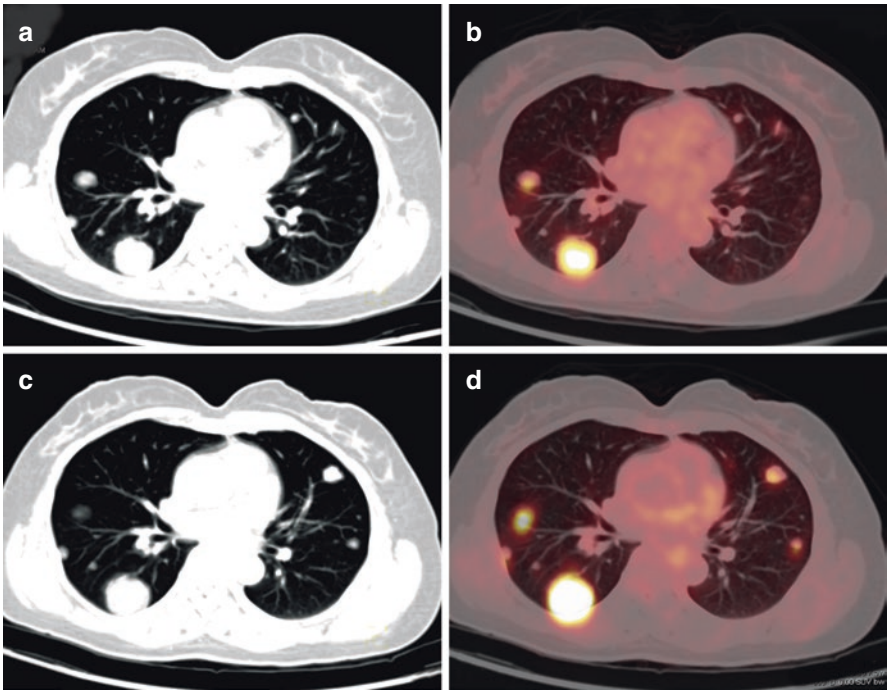

Fig. 6.4 Whole-body PET-CT at the level of chest showing multiple nodular lesions (**a**, **c**) with significant metabolic activity in PET-CT (**b**, **d**) with largest one in right lower lobe with SUV max of 8.9 suggestive of active granulomas. Rest of the whole body appears normal

6.3.3 Noninfectious Lung Lesions

PET-CT is also helpful in the evaluation of the many noninfectious lung diseases like COPD, Asthma, Pneumoconiosis, Sarcoidosis, and many miscellaneous conditions.

COPD is chronic obstructive pulmonary disease due to Smoking or Asthma. One of the important aspects is to differentiate COPD due to Smoking and Asthma, the criteria here is inflammation in the smoking, which will show increased uptake [19, 20]. Another aspect is the respiratory muscle uptake due to increased effort for respiration. To quantify the respiratory muscle uptake, which shows the efforts in respiration and to diagnose the complication of COPD like corpulmonale.

6.3.4 Pneumoconiosis

Pneumoconiosis is the parenchymal reaction to the inhalation of the toxic materials for those working in occupational exposure. A good deal of Pneumoconiosis like Coal workers, silicosis, Asbestosis, and Berylliosis. Here the inhalation of the toxic dust will cause the inflammatory reaction that progresses to the loss of function and

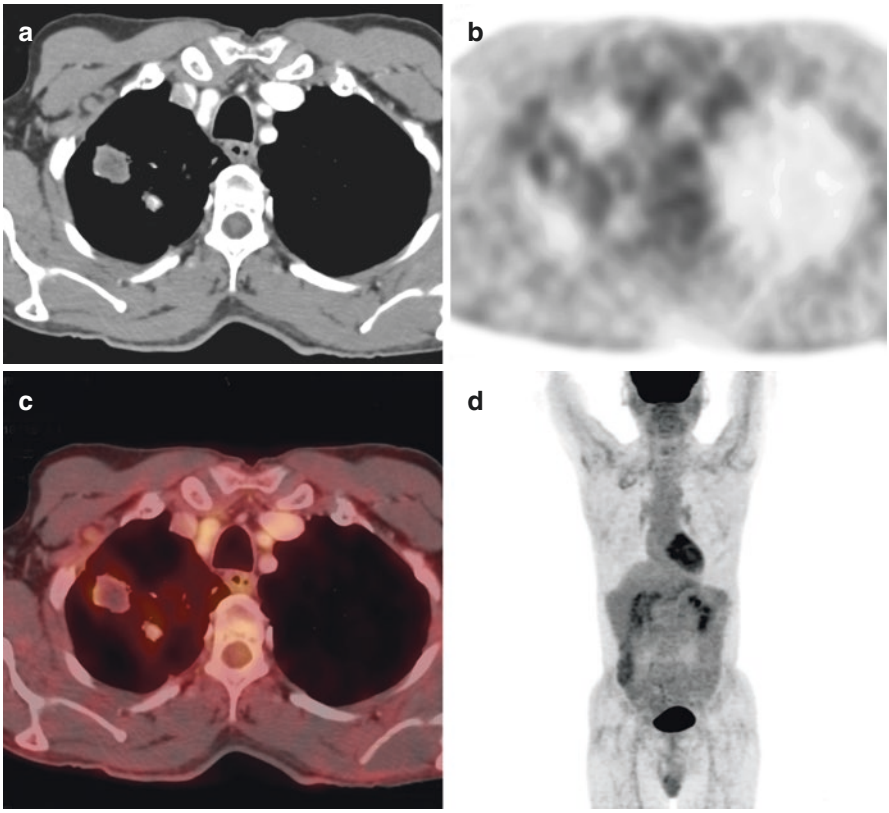

Fig. 6.5 Whole-body PET-CT showing a small nodular lesion in the right upper lobe of the lung (**a**) with minimal uptake (**b**–**d**) with SUV max of 1.8 suggestive of benign solitary pulmonary nodule

permanent scarring. Here the PET-CT plays an important role in monitoring the progress of these diseases by quantifying the amount of the FDG uptake [21].

6.3.5 Sarcoidosis

Sarcoidosis is the multisystem noncaseating granulomatous disease of unknown etiology affecting any organ of the body. The commonest involvement will be the mediastinal lymphadenopathy followed by lung parenchymal involvement. Here the basis of the uptake is the activated leukocytes, macrophages, lymphocytes with giant cells, which shows proportional uptake to the amount of the activity in these cells. FDG PET-CT is useful for the evaluation depending on the amount of inflammatory activity, the various organs involved, for monitoring the treatment response. Thus, PET-CT is relevant in the morphology–and functional mapping of active inflammatory sites like angle or multiple sites [22–31] (Fig. 6.9).

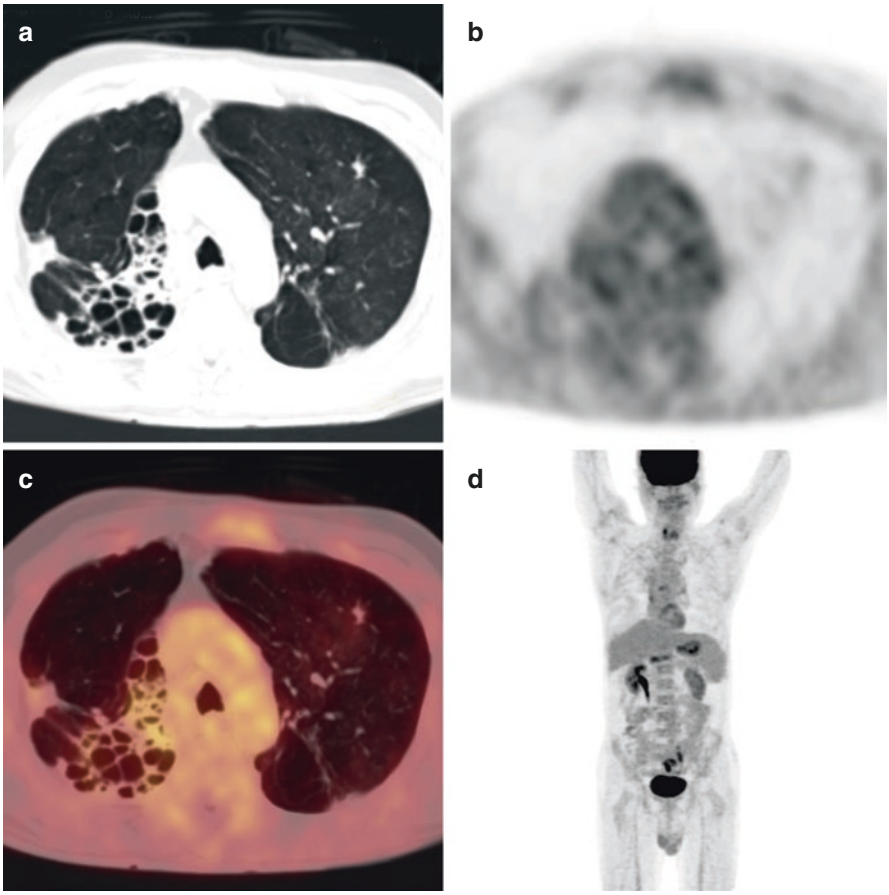

Fig. 6.6 Whole-body PET-CT with chronic cough on and off in last 3 months showing ectatic changes with focal pleural thickening in right upper lobe (**a**) with mild uptake with SUV max of 2 (**b**–**d**). Rest of the whole body is normal

6.3.5.1 Cystic Fibrosis

Cystic fibrosis is a condition where the neutrophil and macrophage activities are inappropriate and by secreting the pro-inflammatory mediators. This forms the basis of the amount of FDG uptake in this condition. Another aspect of the role of the FDG PET-CT is to identify, quantify, and monitor the airway inflammation [32].

6.3.5.2 Acute Lung Injury and Acute Respiratory Distress Syndrome

Acute lung injury is mostly associated with acute respiratory distress syndrome (ARDS). Here the basis is the neutrophil inflammation due to tissue injury. FDG PET is helpful in giving the information related to the inflammatory response to various stimuli and can demonstrate the pathophysiology of ARI/ARDS [33] (Fig. 6.10).

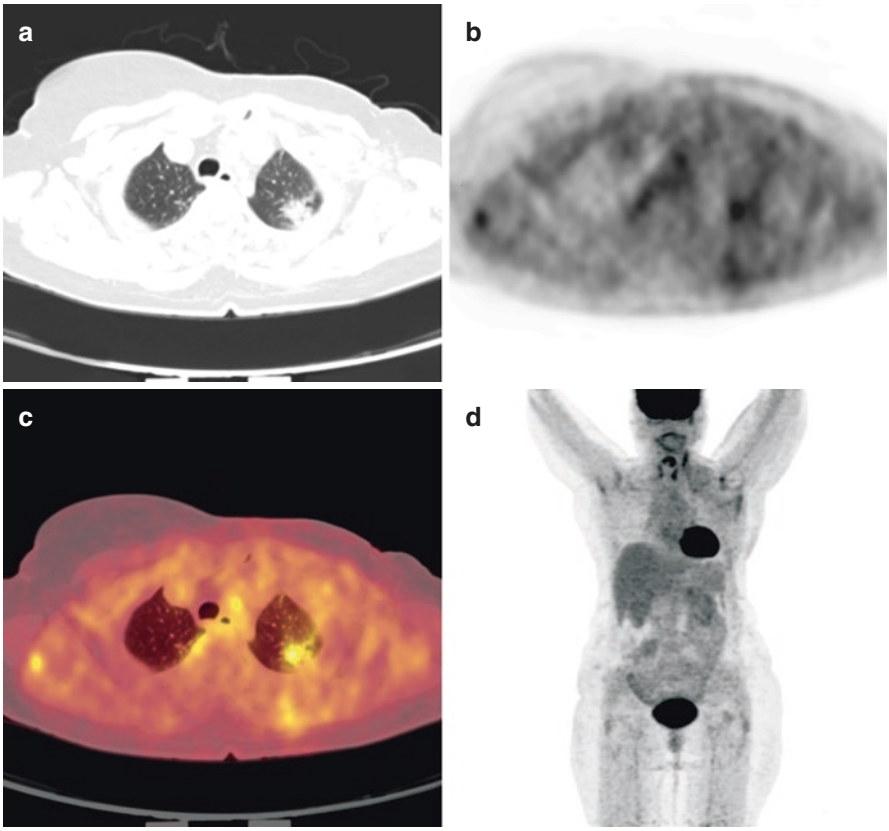

Fig. 6.7 Whole-body PET-CT with fever and weight loss in last 2 months. CT showing small left apical nodular lesion with focal pleural thickening (**a**) consistent with Pulmonary Koch's. PET (**b**, **d**) and fused images (**c**) show mild tracer activity with SUV max of 3.2 noted

6.3.6 Pulmonary Langerhans Cell Histiocytosis

Langerhans Cell Histiocytosis (LCH) is a rare disease. The etiology is presumed to be abnormal T cell, macrophage, and/or cytokine-mediated process. In this condition, there is releasing of the vascular endothelial growth factor in LCH that leads to the inflammatory changes. Thus, FDG PET-CT is helpful for the evaluation of the LCH for clinical assessment and for monitoring the response to therapy [34].

6.4 Pleural Lesions

This same concept applies to pleural-based lesions. Pleural-based lesions are mostly focal pleural thickening or pleural nodules, pleural mass lesions. The commonest causes of this pleural lesions are tuberculosis, infective

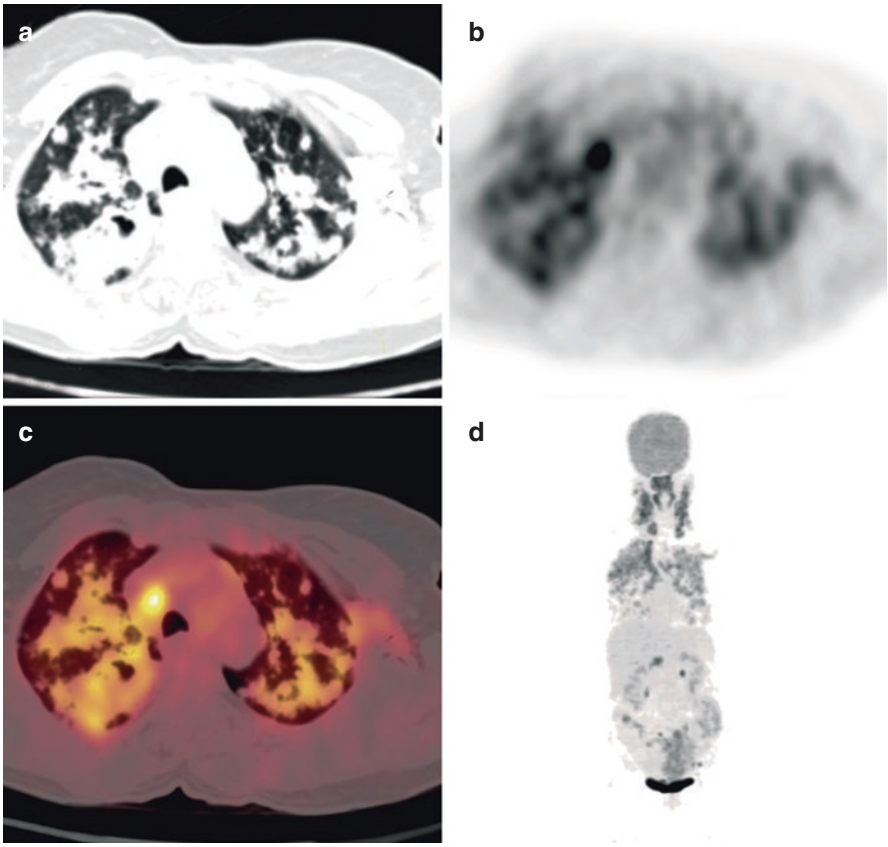

Fig. 6.8 Whole-body PET-CT, CT showing diffuse conglomerate nodular lesions in both lungs with small air bronchogram (**a**) and PET (**b**, **d**) and fused images (**c**) showing mild metabolic activity with SUV max of 6.4. Histopathologically turned out to be Sarcoidosis

inflammatory, collagen diseases, or benign and malignant primary pleural-based lesions. The sensitivity of the pleural-based lesions is again based on SUV max values [35]. The concept is to distinguish between benign and malignant lesions is dual point imaging which distinguishes malignant vs. nonmalignant lesions. FDG PET is equally important in the evaluation of pleural effusions, especially when there is no obvious malignant focus or infective inflammatory focus. Hereby FDG PET-CT subtle focal pleural nodularities can be quantified by SUV max values (Figs. 6.11, 6.12, and 6.13).

The various pathologies in the chest are confined to mediastinum, chest wall, or any concurrent lesions involving chest from the neck or abdomen.

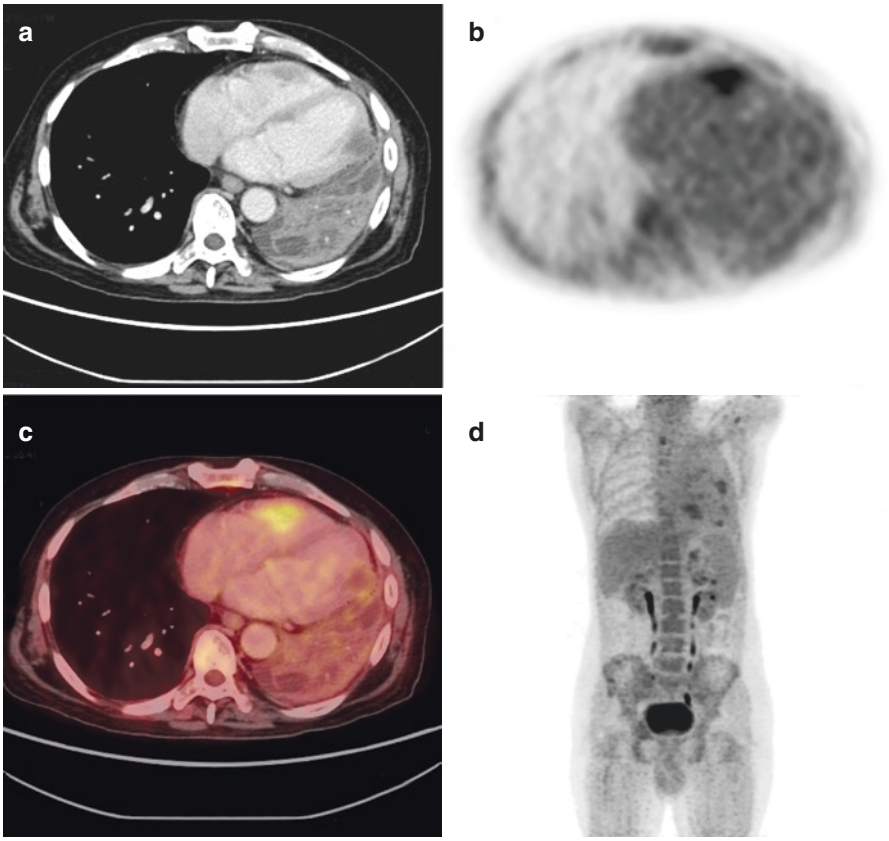

Fig. 6.9 Whole-body PET-CT showing significant collapse consolidation on CT image (**a**) with no metabolic activity on PET images (**b**) and (**d**) and fused image (**c**)

6.5 Mediastinal Lesions

The mediastinal component is either in the form of mediastinal lesions which can be primary mass lesions arising from the mediastinal structures and involving the adjacent structures or vice versa adjacent lesions infiltrating the mediastinum. The other important mediastinal entity is mediastinal nodes. Here mostly the nodes are confined to the drainage areas from the chest. Here the lesions again can be the mediastinal lesions can be primary malignant lesions, secondary malignant lesions in the form of lymphadenopathy. Benign lesions which can be benign neoplasms, collagen diseases, granulomatous diseases, and tuberculosis, and various infective inflammatory pathologies. FDG PET-CT has very important role for evaluation of these lesions and characterizing them depending on the metabolic activity and SUV max values. And the classical presentations of the PET depend on classical features of malignant etiology like mediastinal uptake, necrotic areas, and calcifications. The

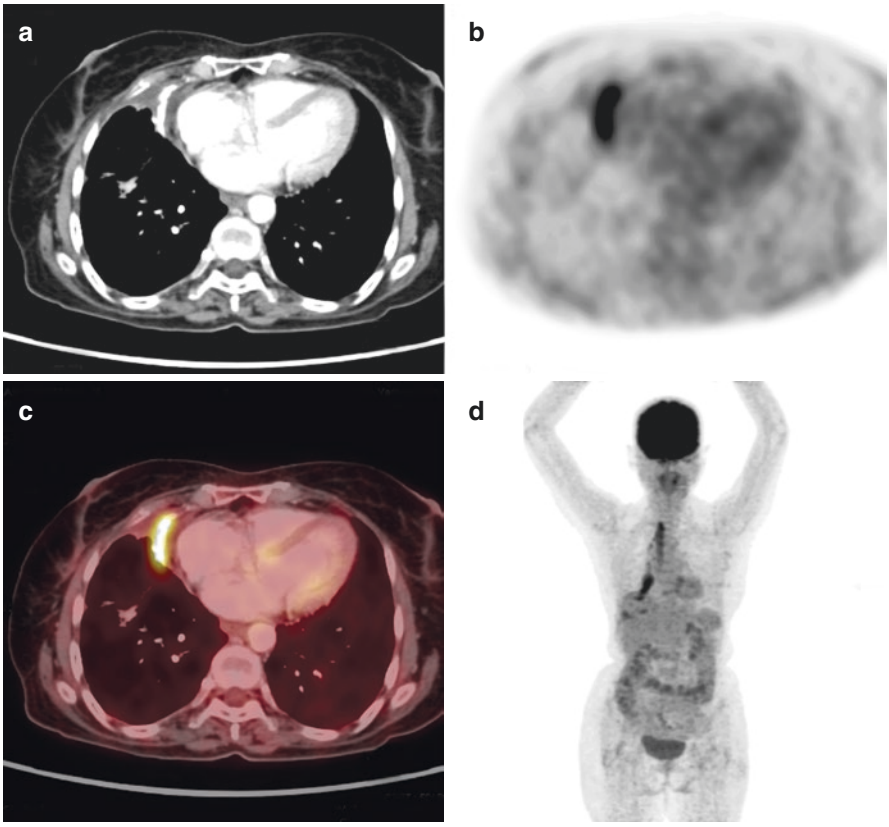

Fig. 6.10 Whole-body PET-CT with mild right-sided chest pain CT image (**a**) showing calcified mediastinal pleural thickening with significant FDG uptake on PET images (**b**) and (**d**) and fused PET-CT image (**c**) with SUV max of 8.6 suggestive of focal chronic calcified pleuritis

same applies here with dual point imaging to differentiate between malignant and nonmalignant pathologies. Most of the oncological work up shows concurrent malignant as well as nonmalignant mediastinal nodes. Here PET-CT plays important role in the evaluation of these structures [36, 37] (Fig. 6.14).

6.6 Chest Wall Lesions

Chest wall lesions comprise again of multiple pathologies like malignant, infective inflammatory, tuberculosis, granulomatous, and significant pathological entities involving skin and subcutaneous planes, muscles, and bones. Separate evaluation of breast parenchyma in females and also in males. The commonest infective inflammatory pathology involving the breast parenchyma is mastitis, gynecomastia in

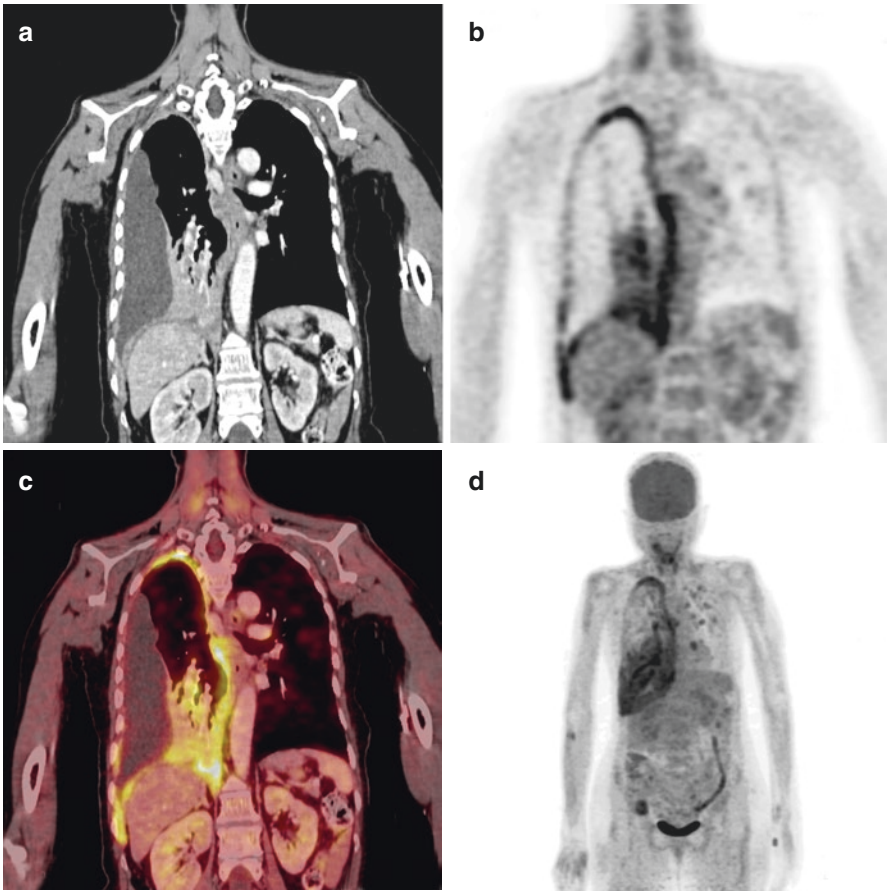

Fig. 6.11 Whole-body PET-CT done CT image (**a**) showing diffuse irregular right costal and mediastinal pleural thickening with moderate pleural effusion and collapse consolidation right lower lobe. PET images (**b**) and (**d**) and fused images (**c**) showing significant uptake with SUV max of 7.7 along the mediastinal pleura in the right lower lobe

males, and to differentiate between benign and malignant nodular lesions involving breast parenchyma (Fig. 6.15). The important infective inflammatory entity involving the chest wall is subcutaneous edema, cellulitis, and focal collection or abscesses in a particular region. FDG PET-CT has an important role in differentiating and evaluating pathologies in the chest wall and sensitive [38–42]. New radiotracers octreotide imaging with or without SPECT CT scan can be useful for the evaluation and monitoring response to therapy (Fig. 6.16).

In the advent PET-MR, the resolution of the chest wall and mediastinal lesions is more defined. One of the biggest advantages of PET-MR is usefulness in the pediatric age group, which we will be discussing in a separate chapter.

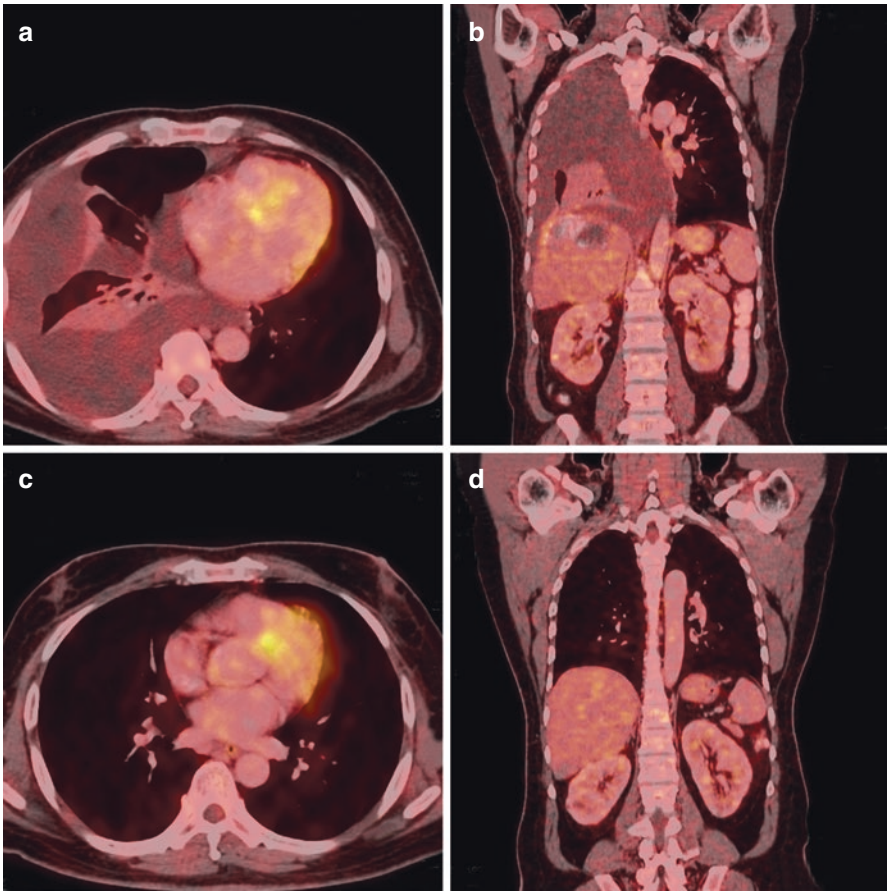

Fig. 6.12 Whole-body PET-CT all (**a**), (**b**), (**c**), and (**d**) fused images of chest showing moderate right pleural effusion with collapse of the lung and no metabolic activity suggestive of nonmalignant pleural effusion

FDG PET is also important for the evaluation of different kinds of pneumoconiosis like silicosis, asbestosis, fibrosis, and other occupational diseases. The basic principle of FDG uptake here is radiotracer deposition in a particular location due to fibroblasts and inflammatory cells [43, 44]. Again, any associated infective inflammatory lung changes can also be diagnosed as a concurrent lesion or as complications due to occupational diseases.

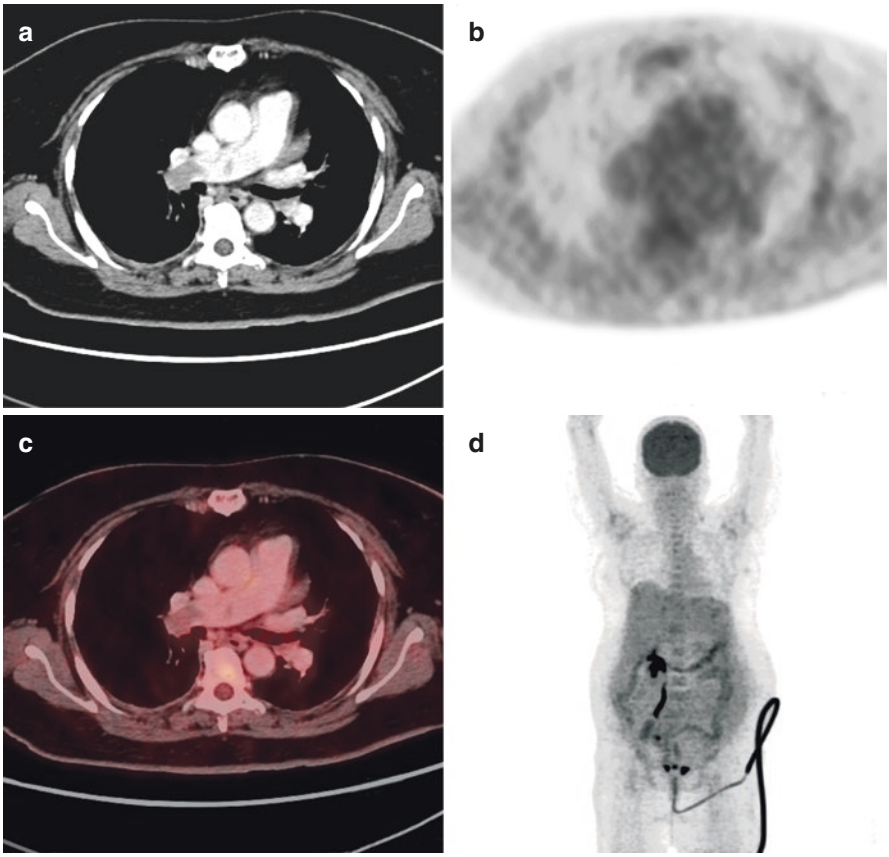

Fig. 6.13 Whole-body PET-CT with chest sections CT image showing intraluminal thrombus in main right pulmonary artery (**a**) with no FDG uptake on PET images (**b**) and (**d**) and fused images (**c**) suggestive of chronic nonreactive pulmonary thromboembolism

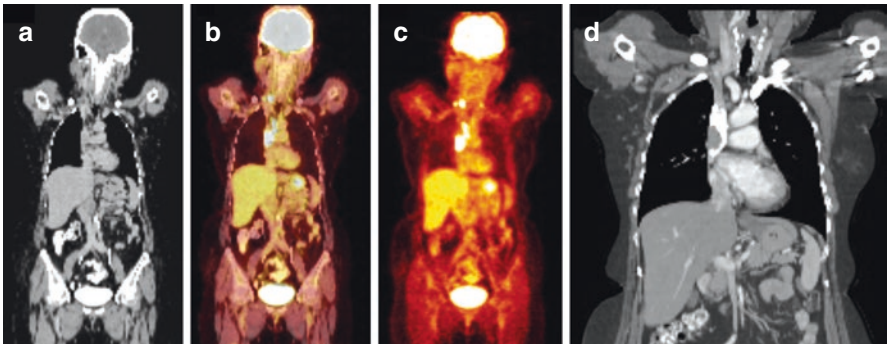

Fig. 6.14 Whole-body PET-CT showing intraluminal thrombus in superior vena cava in Contrast CT image (**a**, **d**), which is corresponding with the uptake on FDG in PET image (**c**) and fused image (**b**). Image (**a**) Non-contrast CT image does not show any specific thrombus

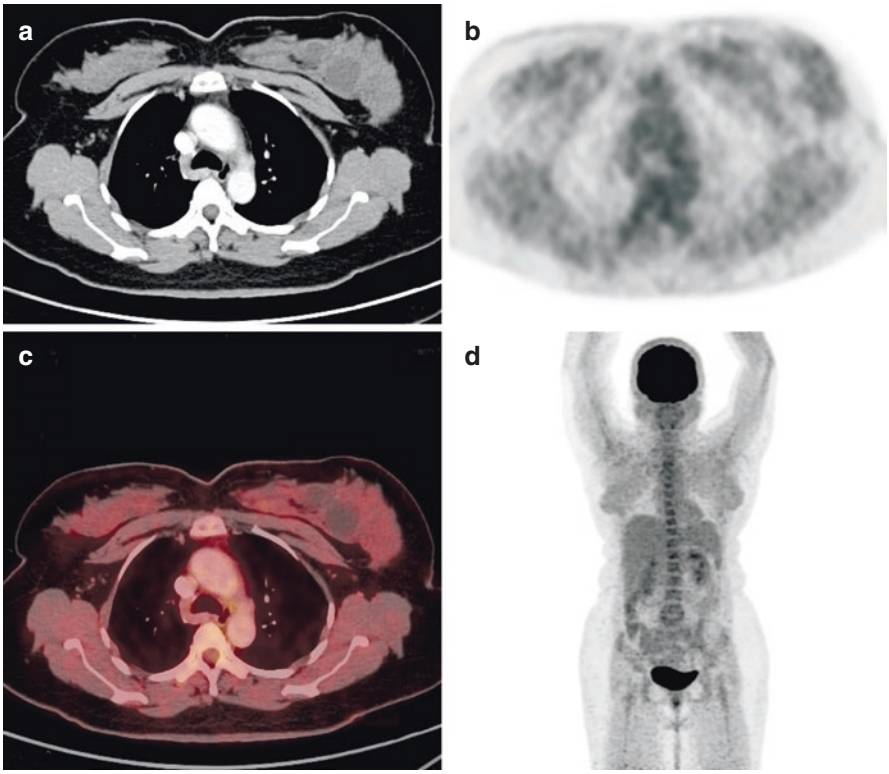

Fig. 6.15 Whole-body PET-CT of 43-year-old female CT image (**a**) showing lobulated cystic lesions in the left breast. PET images (**b**) and (**d**) and fused image (**c**) showing FDG uptake. Features suggestive of fibrocystic disease left breast

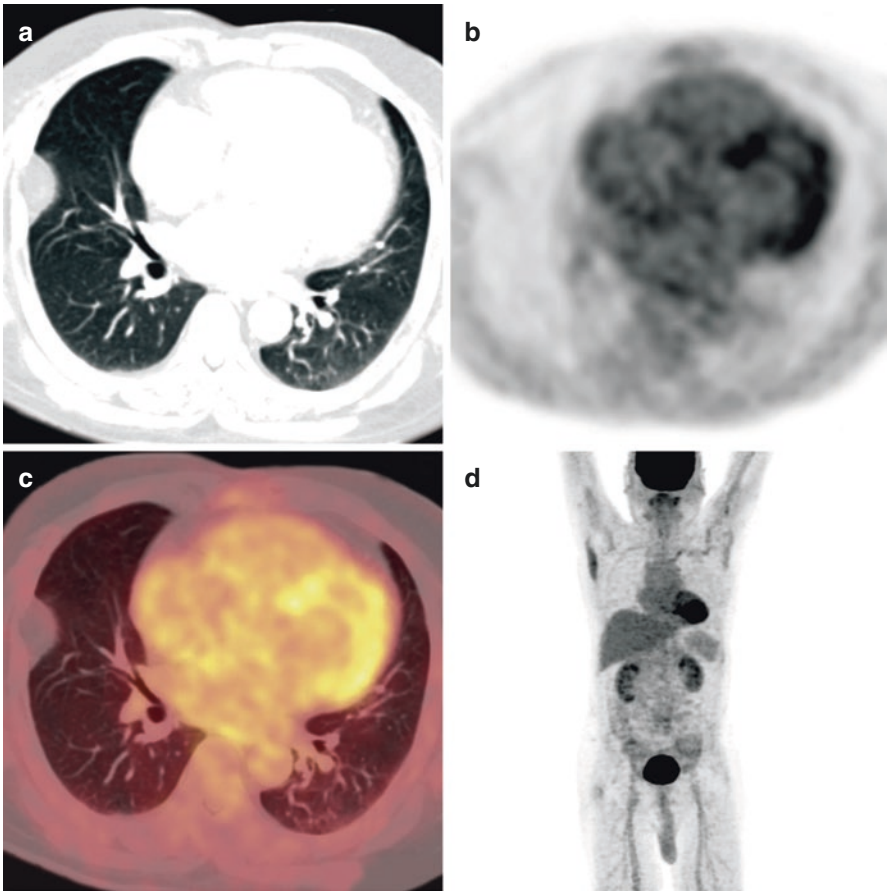

Fig. 6.16 Whole-body PET-CT CT image (**a**) showing focal nodular pleural-based lesion with the erosion of rib along the right costal pleura with no FDG uptake on PET image (**b**) and (**d**) and fused image (**c**) suggestive of chronic infective inflammatory nodule

References

1. Basu S, Hess S, Braad P-EN, et al. The basic principles of FDG-PET/CT imaging. PET Clin. 2014;9(4):355–70, v.
2. Akdis M, Burgler S, Crameri R, Eiwegger T, Fujita H, Gomez E, et al. Interleukins, from 1 to 37, and interferon-gamma: receptors, functions, and roles in diseases. J Allergy Clin Immunol. 2011;127(e1–70):701–21.
3. Scheller J, Garbers C, Rose-John S. Interleukin-6: from basic biology to selective blockade of pro-inflammatory activities. Semin Immunol. 2014;26:2–12.
4. Petho G, Reeh PW. Sensory and signaling mechanisms of bradykinin, eicosanoids, platelet-activating factor, and nitric oxide in peripheral nociceptors. Physiol Rev. 2012;92:1699–775.
5. Cochran BJ, Ryder WJ, Parmar A, et al. Determining glucose metabolism kinetics using 18F-FDG micro-PET/CT. J Vis Exp. 2017;(123):55184.
6. Jones HA, Cadwallader KA, White JF, et al. Dissociation between respiratory burst activity and deoxyglucose uptake in human neutrophil granulocytes: implications for interpretation of 18F-FDG PET images. J Nucl Med. 2002;43:652–7.
7. Kubota R, Yamada S, Kubota K, Ishiwata K, Tamahashi N, Ido T. Intratumoral distribution of fluorine-18-fluorodeoxyglucose in-vivo: high accumulation in macrophages and granulation tissues studied by micro-autoradiography. J Nucl Med. 1992;33:1972–80.
8. Dimastromatteo J, Charles EJ, Laubach LE. Molecular imaging of pulmonary diseases. Respir Res. 2018;19:1–17.
9. Kim IJ, Lee JS, Kim SJ, et al. Double-phase 18F-FDG PET-CT for determination of pulmonary tuberculoma activity. Eur J Nucl Med Mol Imaging. 2008;35:808–14.
10. Abe M, Kobashi Y, Mouri K, et al. Solitary pulmonary nodule due to Mycobacterium kansasii. Intern Med. 2011;50:775–8.
11. Soussan M, Brillet PY, Mekinian A, et al. Patterns of pulmonary tuberculosis on FDG-PET/CT. Eur J Radiol. 2012;81:2872–6.
12. Demura Y, Tsuchida T, Uesaka D, et al. Usefulness of 18F-fluorodeoxyglucose positron emission tomography for diagnosing disease activity and monitoring therapeutic response in patients with pulmonary mycobacteriosis. Eur J Nucl Med Mol Imaging. 2009;36:632–9.
13. Sathekge MM, Maes A, Pottel H, Stoltz A, van de Wiele C. Dual time-point FDG PET-CT for differentiating benign from malignant solitary pulmonary nodules in a TB endemicarea. S Afr Med J. 2010;100:598–601.
14. Shin L, Katz DS, Yung E. Hypermetabolism on F-18 FDG PET of multiple pulmonary nodules resulting from bronchiolitis obliterans organizing pneumonia. Clin Nucl Med. 2004;29:654–6.
15. Gambhir S, Ravina M, Rangan K, Dixit M, Barai S, Bomanji J. International atomic energy agency extra-pulmonary TB consortium. Imaging in extrapulmonary tuberculosis. Int J Infect Dis. 2017;56:237–47.
16. Chiu C-F, Liu Y-Y, Hsu W-H, et al. Shorter-time dual-phase FDG PET/CT in characterizing solid or ground-glass nodules based on surgical results. Clin Imaging. 2012;36:509–14. https://doi.org/10.1016/j.clinimag.2011.11.032.
17. Lee HY, Lee KS, Han J, Kim BT, Cho YS, Shim YM, et al. Mucinous versus non-mucinous solitary pulmonary nodular bronchioloalveolar carcinoma: CT and FDG PET findings and pathologic comparisons. Lung Cancer. 2009;65:170–5.
18. Nakajo M, Jinguji M, Aoki M, et al. The clinical value of texture analysis of dual-time-point ^{18}F-FDG-PET/CT imaging to differentiate between ^{18}F-FDG-avid benign and malignant pulmonary lesions. Eur Radiol. 2020;30(3):1759–69.
19. Sheikhbahaei S, Mena E, Marcus C, et al. ^{18}F-FDG PET/CT: therapy response assessment interpretation (Hopkins criteria) and survival outcomes in lung cancer patients. J Nucl Med. 2016;57:855–60.
20. Jones HA, Marino PS, Shakur BH, et al. In vivo assessment of lung inflammatory cell activity in patients with COPD and asthma. Eur Respir J. 2003;21:567–73.
21. Kothekar E, Borja AJ, Gerke O, Werner TJ, Alavi A, Revheim ME. Assessing respiratory muscle activity with 18F-FDG-PET/CT in patients with COPD. Am J Nucl Med Mol Imaging. 2019;9:309–15.

22. Reichert M, Bensadoun ES. PET imaging in patients with coal workers pneumoconiosis and suspected malignancy. J Thorac Oncol. 2009;4:649–51.
23. Nishiyama Y, Yamamoto Y, Fukunaga K, Takinami H, Iwado Y, Satoh K, Ohkawa M. Comparative evaluation of 18F-FDG PET and 67Ga scintigraphy in patients with sarcoidosis. J Nucl Med. 2006;47:1571–6.
24. Norikane T, Yamamoto Y, Maeda Y, Noma T, Dobashi H, Nishiyama Y. Comparative evaluation of 18F-FLT and 18F-FDG for detecting cardiac and extra-cardiac thoracic involvement in patients with newly diagnosed sarcoidosis. EJNMMI Res. 2017;7:69.
25. Palestro CJ, Schultz BL, Horowitz M, Swyer AJ. Indium-111-leukocyte and gallium-67 imaging in acute sarcoidosis: report of two patients. J Nucl Med. 1992;33:2027–9.
26. Rizzato G, Blasi A. A European survey on the usefulness of 67Ga lung scans in assessing sarcoidosis. Experience in 14 research centers in seven different countries. Ann N Y Acad Sci. 1986;465:463–78.
27. Israel HL, Albertine KH, Park CH. Whole-body gallium 67 scans. Role in diagnosis of sarcoidosis. Am Rev Respir Dis. 1991;144:1182–6.
28. Sulavik SB, Spencer RP, Weed DA, Shapiro HR, Shiue HR, Castriotta RJ. Recognition of distinctive patterns of gallium-67 distribution in sarcoidosis. J Nucl Med. 1990;31:1909–14.
29. Sulavik SB, Spencer RP, Palestro CJ, Swyer AJ, Teirstein AS, Goldsmith SJ. Specificity and sensitivity of distinctive chest radiographic and/or 67 Ga images in the non-invasive diagnosis of sarcoidosis. Chest. 1993;103:403–9.
30. Braun JJ, Kessler R, Constantinesco A, et al. ^{18}F-FDG PET/CT in sarcoidosis management: review and report of 20 cases. Eur J Nucl Med Mol Imaging. 2008;35:1537–43.
31. Kiatboonsri C, Resnick SC, Chan KM, et al. The detection of recurrent sarcoidosis by FDG-PET in a lung transplant recipient. West J Med. 1998;168:130–2.
32. Keijsers RG, Verzijlbergen FJ, Oyen WJ, et al. ^{18}F-FDG PET, genotype-corrected ACE and sIL-2R in newly diagnosed sarcoidosis. Eur J Nucl Med Mol Imaging. 2009;36:1131–7.
33. Konstan MW, Berger M. Current understanding of the inflammatory process in cystic fibrosis: onset and etiology. Pediatr Pulmonol. 1997;24:137–42.
34. Braune J, Hofheinz F, Bluth T, Kiss T, Wittenstein J, Scharffenberg M, Kotzerke J, Gamade Abreu M. Comparison of static 18F-FDG-PET/CT (SUV, SUR) and dynamic 18F-FDGPET/CT(Ki) for quantification of pulmonary inflammation in acute lung injury. J Nucl Med. 2019;60:1629–34.
35. Kannourakis G, Abbas A. The role of cytokines in the pathogenesis of Langerhans cell histiocytosis. Br J Cancer Suppl. 1994;23:S37–40.
36. Kaira K, Serizawa M, Koh Y, Takahashi T, Hanaoka H, Oriuchi N, et al. Relationship between 18F-FDG uptake on positron emission tomography and molecular biology in malignant pleural mesothelioma. Eur J Cancer. 2012;48:1244–54.
37. Hara T, Inagaki K, Kosaka N, Morita T. Sensitive detection of mediastinal lymphnode metastasis of lung cancer with 11C-choline PET. J Nucl Med. 2000;41:1507–13.
38. Tatci E, Ozmen O, Dadali Y, et al. The role of FDG PET/CT in evaluation of mediastinal masses and neurogenic tumors of chest wall. Int J Clin Exp Med. 2015;8(7):11146–52.
39. Moore SL, Rafii M. Imaging of musculoskeletal and spinal tuberculosis. Radiol Clin North Am. 2001;39:329–42.
40. Yago Y, Yukihiro M, Kuroki H, et al. Cold tuberculous abscess identified by FDG PET. Ann Nucl Med. 2005;19:515–51.
41. Harkirat S, Anana SS, Indrajit LK, Dash AK. Pictorial essay: PET/CT in tuberculosis. Indian J Radiol Imaging. 2008;18:141–7.
42. Litmanovich D, Gourevich K, Israel O, Gallimidi Z. Unexpected foci of 18F-FDG uptake in the breast detected by PET/CT: incidence and clinical significance. Eur J Nucl Med Mol Imaging. 2009;36(10):1558–64.
43. O'Connell M, Kennedy M. Progressive massive fibrosis secondary to pulmonary silicosis appearance on F-18 fluorodeoxyglucose PET/CT. Clin Nucl Med. 2004;29(11):754–5.
44. Choi EK, Park HL, Yoo IR. The clinical value of F-18 FDG PET/CT in differentiating malignant from benign lesions in pneumoconiosis patients. Eur Radiol. 2020;30(1):442–51.