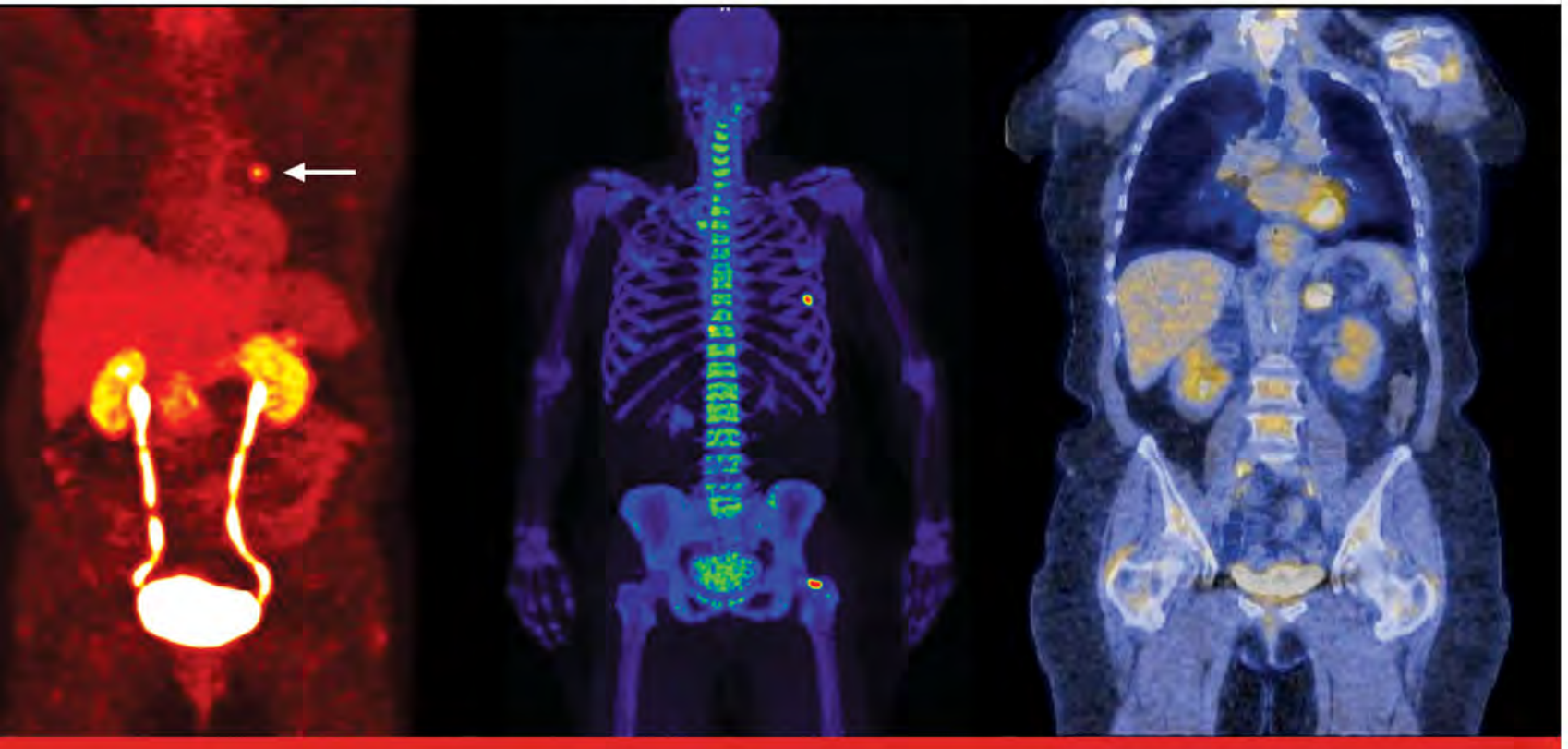
NUCLEAR MEDICINE

A CASE-BASED APPROACH



Editor-in-Chief
Munir Ghesani

Section Editors
Nasrin Ghesani
E Gordon DePuey
Amir Kashefi
Yi Chen Zhang

Foreword
Satoshi Minoshima

JAYPEE

Contents

Section 1: General Nuclear Medicine

Nasrin Ghesani, Yi Chen Zhang, Munir Ghesani

Section 2: Nuclear Cardiology

E Gordon DePuey, Munir Ghesani

Section 3: PET/CT

Amir Kashefi, Munir Ghesani

Section 3

PET/CT

Amir Kashefi, Munir Ghesani

Chest Cases

CASE 1: DETECTION OF DISTANT METASTASES IN ESOPHAGEAL CANCER WITH RADIOGRAPHICALLY OPERABLE DISEASE

Brief History

A 51-year-old male with adenocarcinoma of the gastroesophageal junction underwent neoadjuvant chemoradiation therapy prior to surgical resection. Positron emission tomography/computed tomography (PET/CT) imaging was then pursued for surveillance of response to therapy and preoperative restaging.

Findings

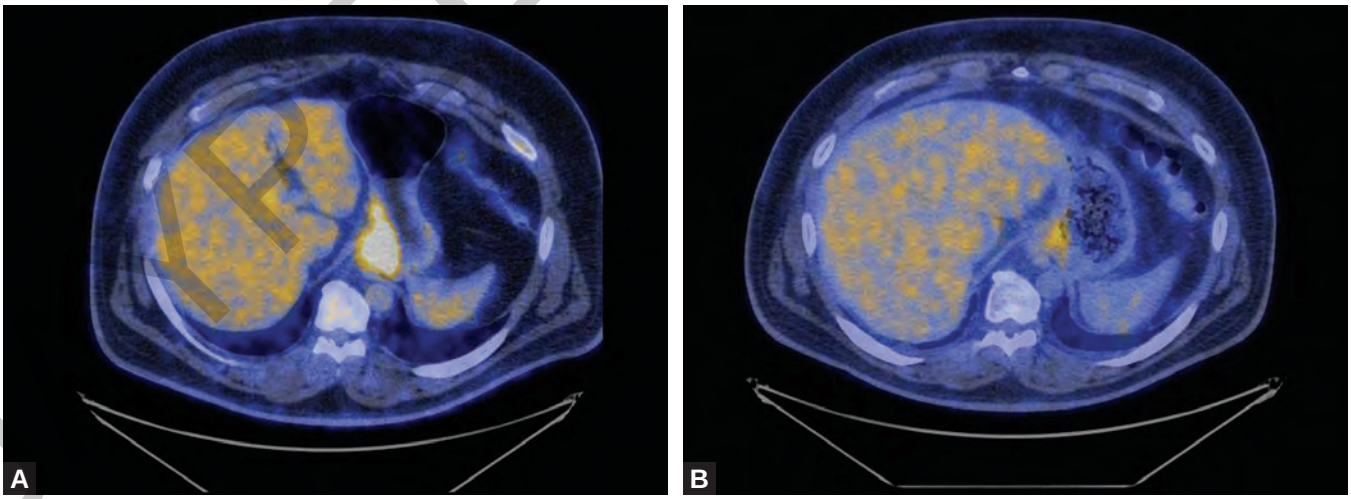
Findings are shown in Figures 1 to 3.

Due to evolution of distant metastatic disease, the patient was no longer a surgical candidate and continued on to pursue a more aggressive chemotherapy regimen.

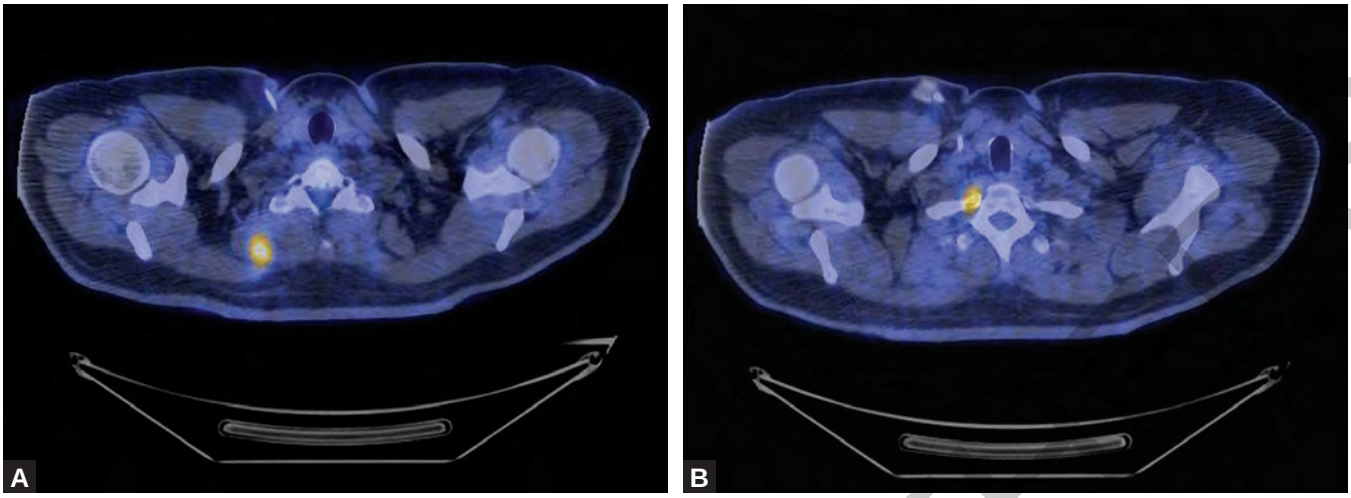
Main Teaching Point

- Positron emission tomography imaging is a powerful adjunct to anatomical modalities in identifying metastatic disease, especially when little anatomic correlation is seen.

Fig. 1: Maximum intensity projection whole body image demonstrates two intense foci of radiotracer accumulation projecting over the right upper chest.



Figs. 2A and B: PET/CT images demonstrate significant interval improvement in both size and metabolic activity of the primary tumor as well as associated gastric thickening, indicating a favorable response to chemoradiation therapy. (A) Baseline study prior to radiation therapy; (B) Postradiation therapy.



Figs. 3A and B: A new focus of ^{18}F fluorodeoxyglucose (FDG) accumulation is identified within the right posterior paraspinal musculature, which is highly concerning for metastasis. Additionally, a new hypermetabolic lytic rib lesion is observed that represents osseous metastasis with high certainty. (A) Paraspinal muscular metastasis; (B) Rib metastasis.

CASE 2: ASSESSMENT OF RECURRENCE OF PULMONARY MALIGNANCY

Brief History

A 69-year-old female with stage IA squamous cell carcinoma of the right lower lung lobe, status post video-assisted thoracoscopic resection, was found to have two new right upper lobe pulmonary nodules by surveillance computed tomography (CT). She subsequently underwent positron emission tomography (PET/CT) imaging as scintigraphic assessment of these lesions and for restaging of her primary disease.

Findings

Findings are shown in Figures 1 to 3.

Two pulmonary nodules are identified within the right upper lobe. The larger nodule measures 0.8 cm and has SUV maximum of 3.5 g/mL, which is highly suspicious for recurrent metastatic disease. The smaller 0.4 cm nodule demonstrates no visibly elevated radiotracer accumulation, but is below threshold for reliable characterization by PET imaging.

Main Teaching Points

- Approximately 25% of patients treated for stage IA non-small cell lung cancer can develop recurrence of disease.
- Lesions less than 0.8 cm are too small to fully characterize by PET imaging and cannot be excluded as malignancy even when demonstrating background metabolic activity.

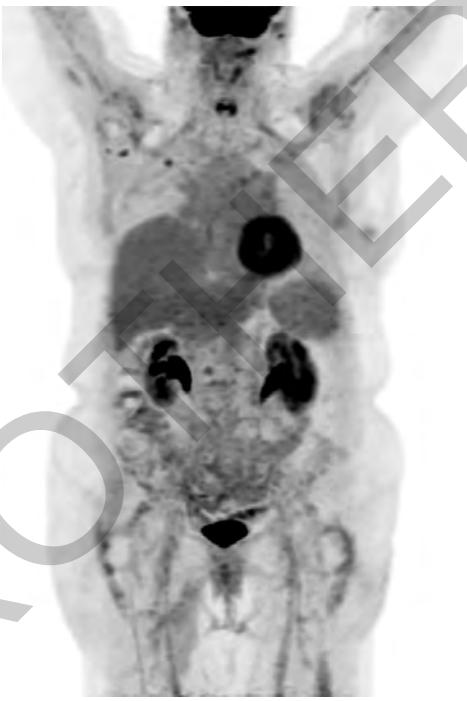


Fig. 1: Maximum intensity projection whole body image demonstrates abnormal foci of radiotracer activity projecting over the right chest and axilla.

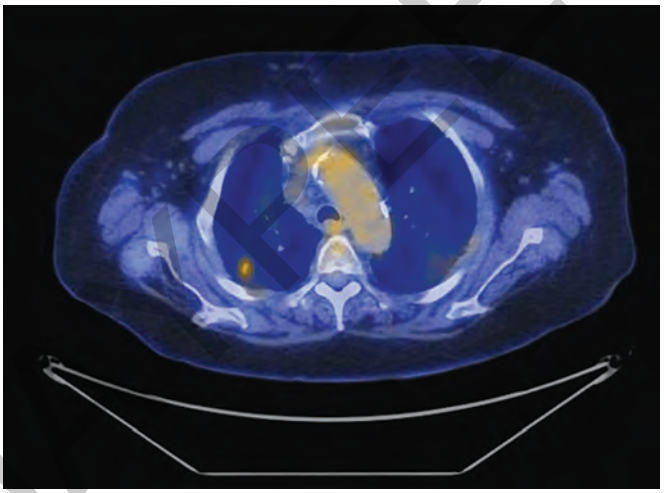


Fig. 2: The largest 0.8 cm nodule is identified in the posterior right upper lobe.

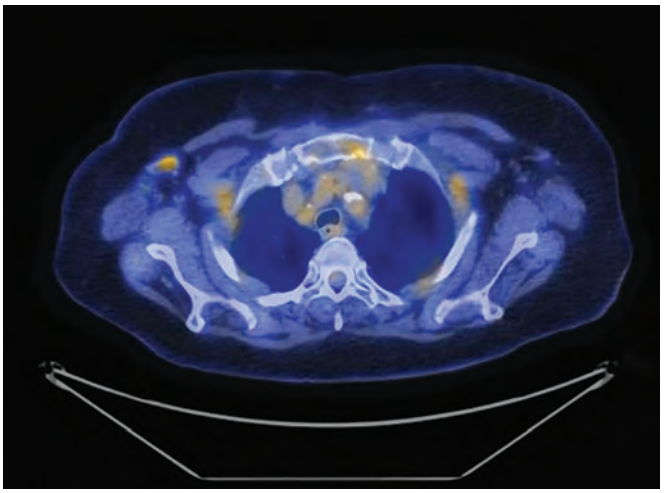


Fig. 3: Low-grade hypermetabolic lymphadenopathy is observed within the mediastinum and right axilla.

CASE 3: INCIDENTAL CANCER WHILE STAGING NEW PULMONARY MALIGNANCY

Brief History

A 74-year-old female with a history of pulmonary large cell neuroendocrine tumor, status post left upper lobectomy, was recently diagnosed with a new right upper lobe pulmonary squamous cell carcinoma. She underwent ^{18}F fluorodeoxyglucose (FDG) positron emission tomography/computed tomography (PET/CT) for initial staging of her disease.

Findings

Findings are shown in Figures 1 to 4.

Main Teaching Point

- Adrenal glucose metabolism greater than that of liver is worrisome for malignant involvement of either primary or metastatic nature.

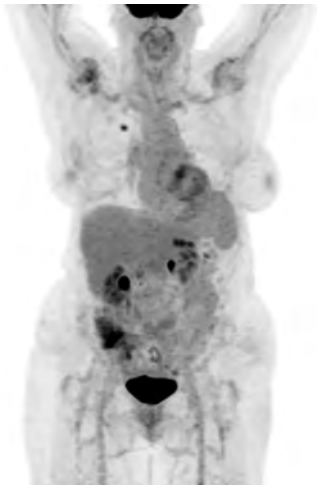


Fig. 1: Maximum intensity projection whole body image demonstrates the known right upper lobe squamous cell carcinoma. Additionally, focally increased radiotracer activity is noted within the right pelvis.

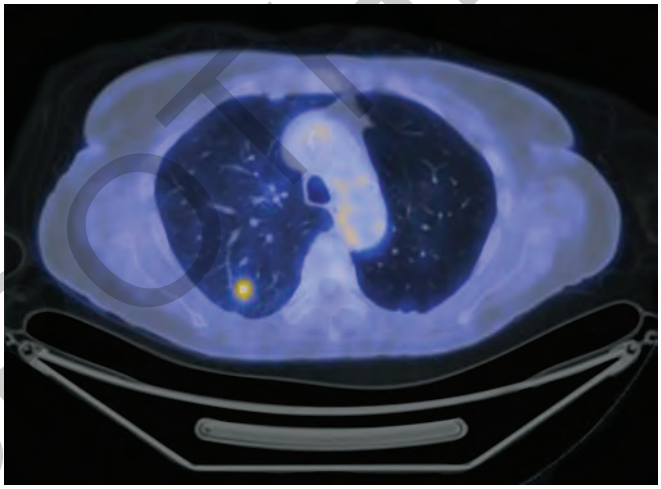
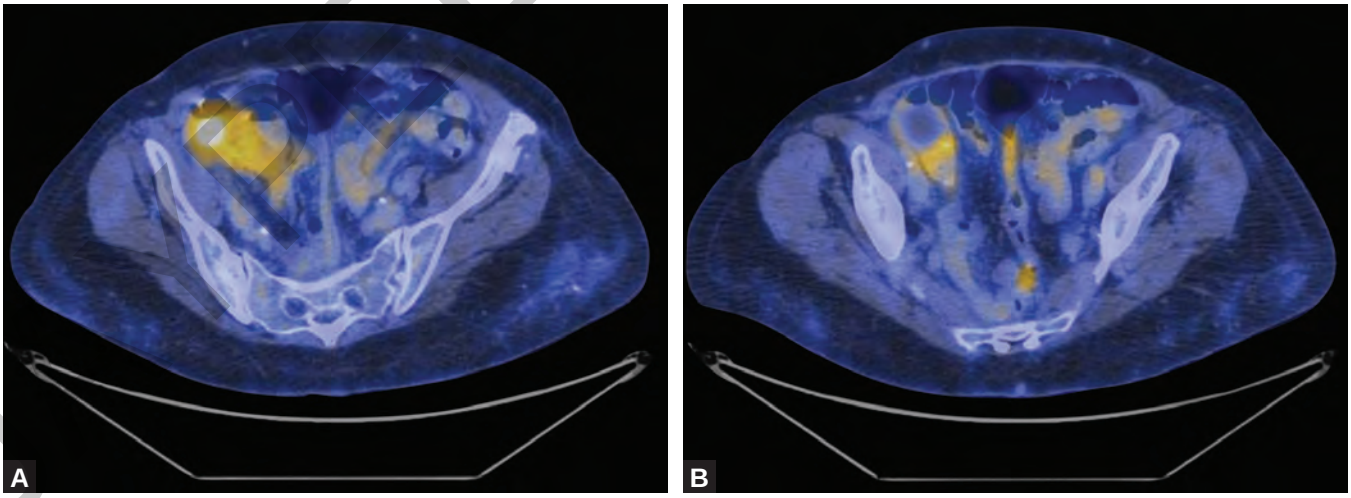


Fig. 2: A hypermetabolic right upper lobe nodule correlates to the biopsy-proven squamous cell carcinoma.



Figs. 3A and B: A large, variably hypermetabolic, mixed solid-cystic ovoid mass is identified in the right pelvis. The right ovary is not visualized and the mass directly abuts the cecum. Histologic origin could either be gastrointestinal or ovarian. (A) The inferior and solid portion of the mass is adjacent to the cecum. (B) Superiorly, a cystic component is seen with decreased radiotracer activity centrally and a hypermetabolic rim.

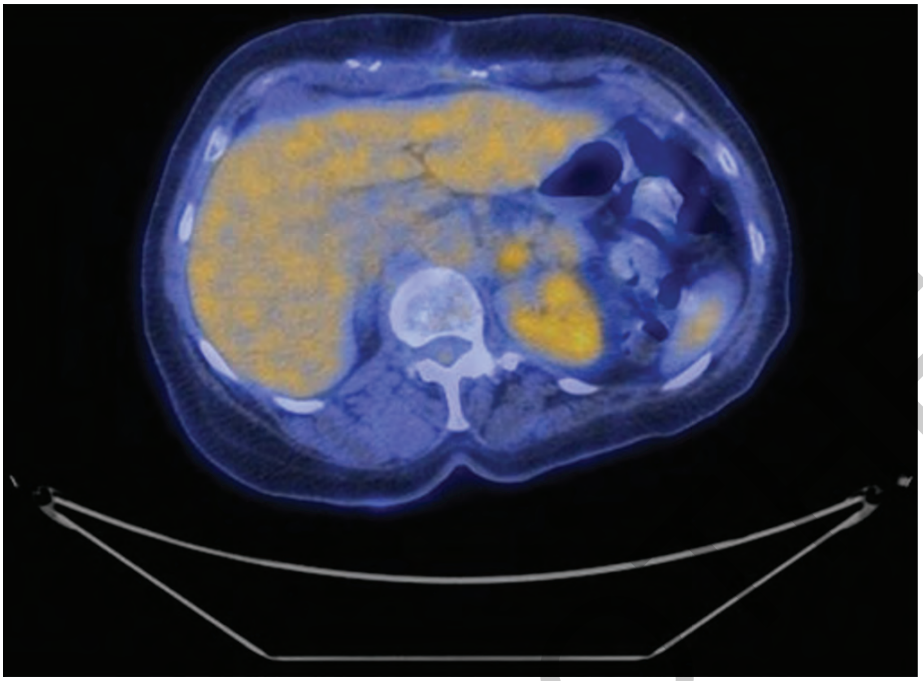


Fig. 4: Hypermetabolic fullness of the left adrenal gland demonstrates FDG avidity greater than normal adjacent liver parenchyma, which raises concern for malignant involvement.

CASE 4: MONITORING RESPONSE TO LUNG CANCER THERAPY

Brief History

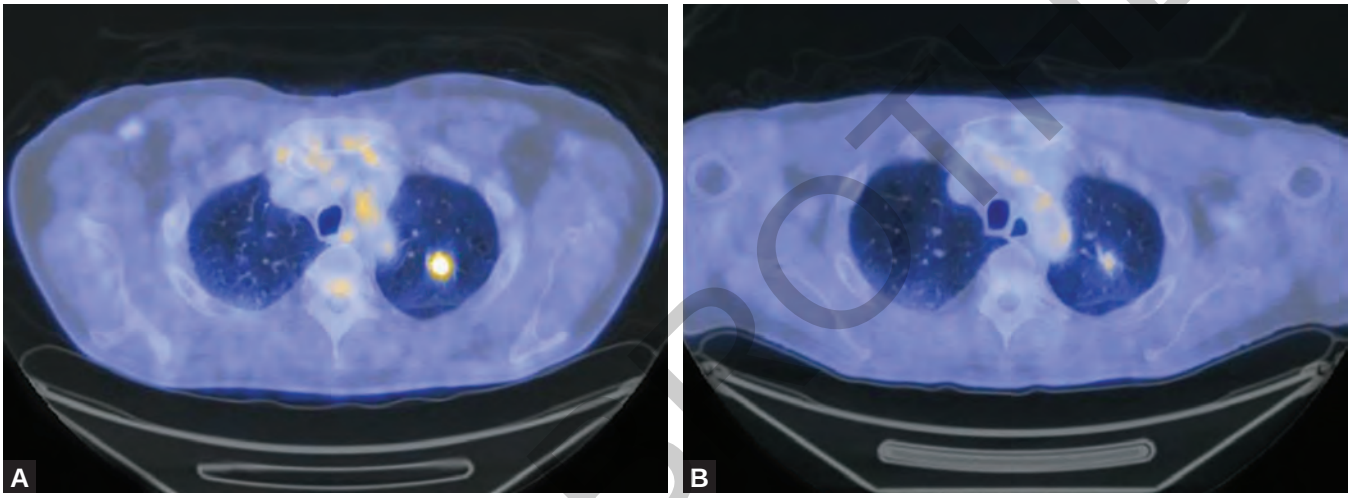
A 67-year-old male with a history of laryngeal cancer was incidentally found to have lung cancer by baseline positron emission tomography/computed tomography (PET/CT) evaluation. He subsequently underwent definitive stereotactic body radiation therapy and required reimaging for evaluation of response.

Findings

Findings are shown in Figures 1A and B.

Main Teaching Points

- Radiotherapy-treated pulmonary masses can persist as scarred parenchymal lesions.
- Comparison of ^{18}F fluorodeoxyglucose (FDG) uptake of a treated pulmonary mass to adjacent or contralateral background lung activity can help to determine if it has been adequately treated.



Figs. 1A and B: Interval decrease in metabolic activity in the left upper lobe pulmonary mass is appreciated. The lesion was originally a spiculated soft tissue density, but developed a more scarred, fibrotic appearance following radiation therapy. Visually, the metabolic activity has noticeably decreased, and the standard uptake value (SUV) maximum measurement has fallen from 5.6 g/mL to 1.8 g/mL. Adjacent background lung activity has a SUV maximum of 1.6 g/mL. (A) Baseline appearance prior to treatment; (B) Post-radiotherapy.

CASE 5: CHARACTERIZATION OF A SUSPICIOUS PULMONARY NODULE

Brief History

A 65-year-old female presented with computed tomography (CT) evidence of multiple pulmonary nodules, one of which had increased in size with a mildly spiculated appearance. She required ^{18}F fluorodeoxyglucose (FDG) positron emission tomography (PET)/CT imaging to evaluate the functional status of this lesion.

Findings

Findings are shown in Figures 1 and 2.

Main Teaching Points

- Positron emission tomography is a useful tool to assess the metabolic activity of a newly discovered lesion, especially when limited prior imaging is available.
- Pulmonary nodules on the border of PET resolution (0.8–1.0 cm) that demonstrate background activity favor benign etiology, but should still be followed with repeat imaging in 2–3 months.

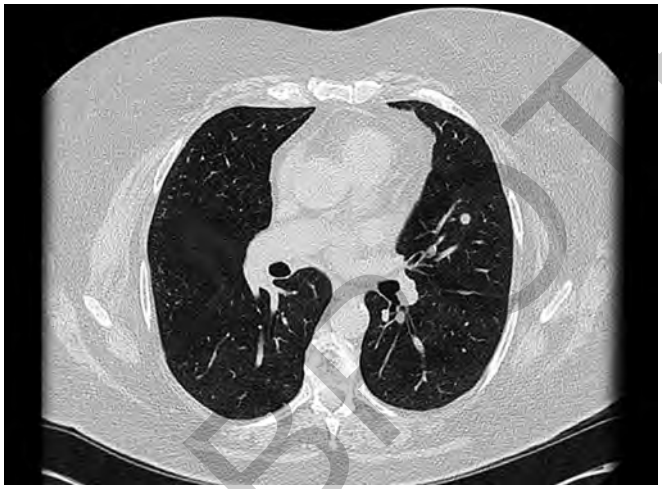
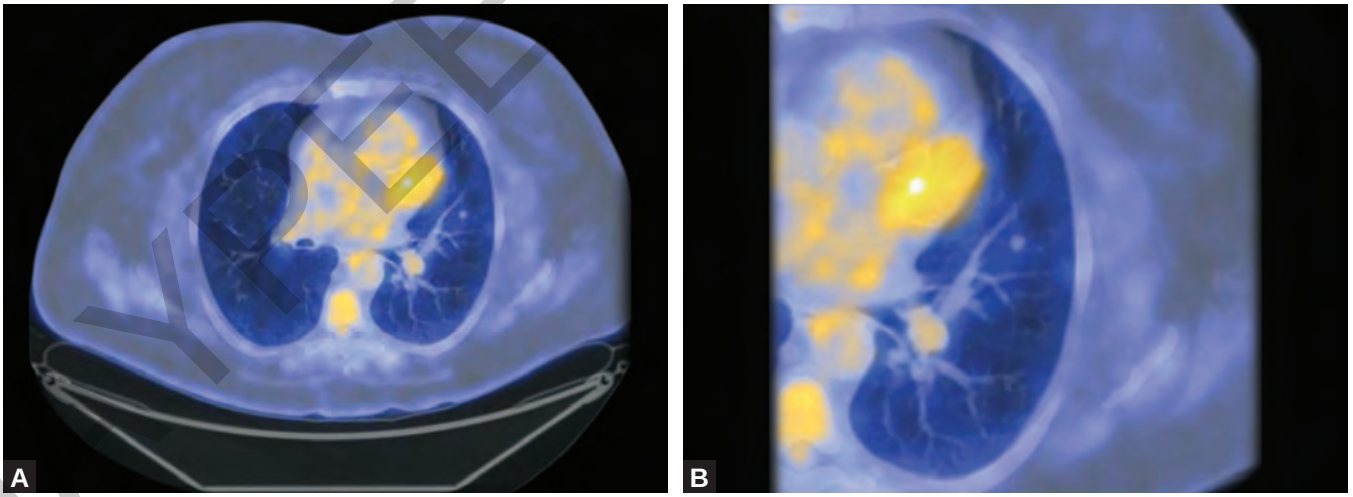


Fig. 1: Initial chest CT demonstrates an 8 mm pulmonary nodule within the lingual.



Figs. 2A and B: By PET/CT, the lesion of question demonstrates no abnormal FDG accumulation; however, the size of this lesion is on the border of reliable detection by PET resolution and should be followed with future imaging.

CASE 6: INITIAL STAGING OF PATHOLOGICALLY PROVEN PULMONARY MALIGNANCY

Brief History

A 65-year-old female presented with recently diagnosed pulmonary adenocarcinoma and required ^{18}F fluorodeoxyglucose (FDG) positron emission tomography/computed tomography (PET/CT) imaging for initial staging of her disease.

Findings

Findings are shown in Figures 1 to 6.

Main Teaching Points

- Tumoral encroachment on the spinal canal is an urgent finding, and the patient should be assessed clinically for neurologic impingement.
- Positron emission tomography/computed tomography can be used to identify hypermetabolic biopsy targets to help establish metastatic pathology.

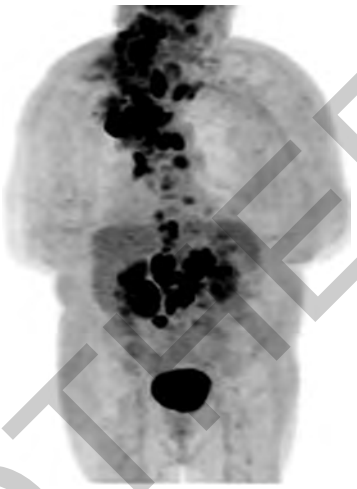


Fig. 1: Maximum intensity projection whole body image demonstrates extensive hypermetabolic metastases projecting of the right chest, right neck, and central abdomen.

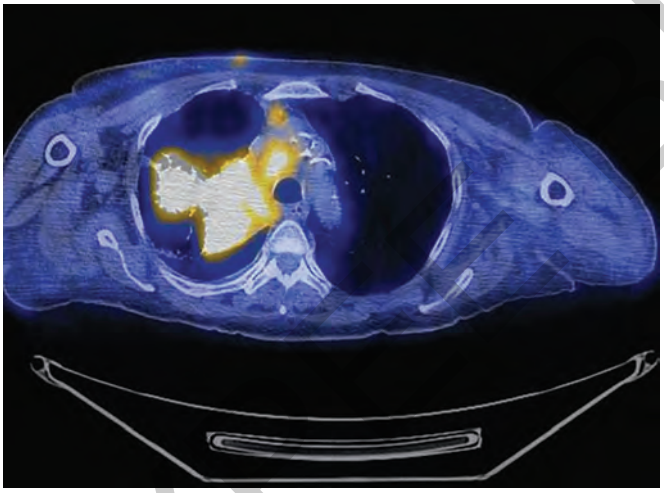


Fig. 2: A large hypermetabolic right upper lobe pulmonary mass is identified.

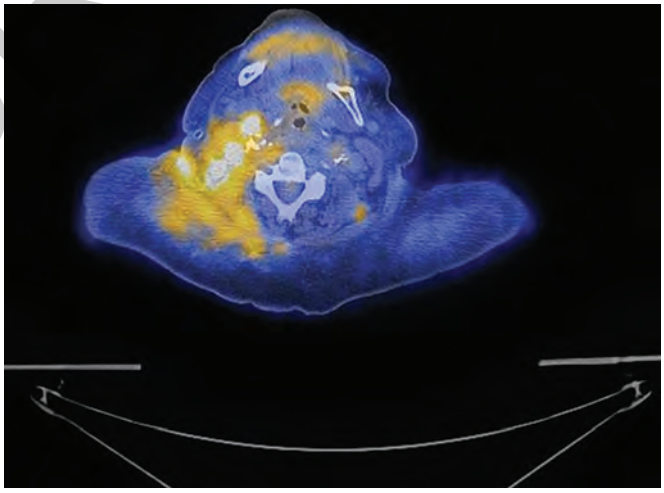


Fig. 3: Extensive conglomerate lymphadenopathy is seen throughout nearly all nodal stations of the mediastinum and neck.

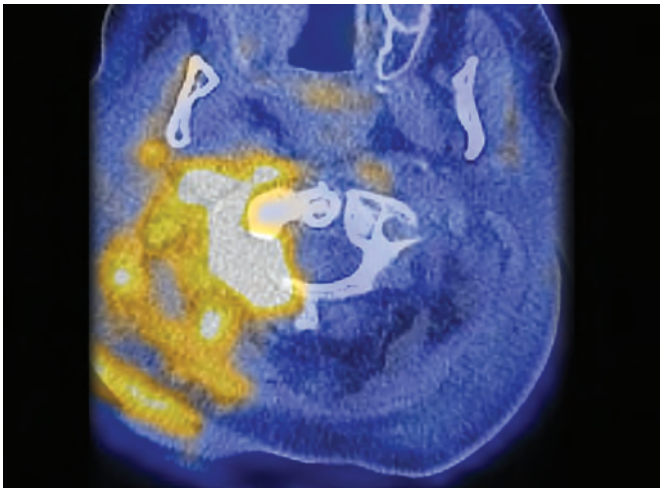


Fig. 4: Thickening of hypermetabolic right lateral paraspinal musculature is seen with direct extension between the C1/C2 interface with effacement of the thecal sac. No osseous destruction was appreciated at this location.

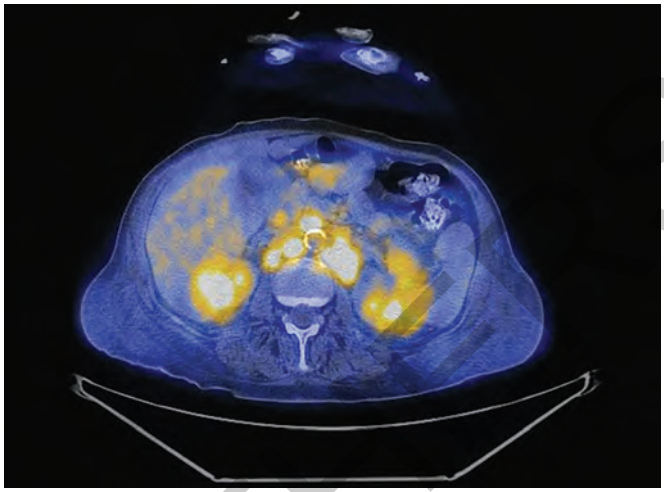


Fig. 5: Bulky retroperitoneal hypermetabolic lymphadenopathy represents significant metastatic spread inferior to the diaphragm.

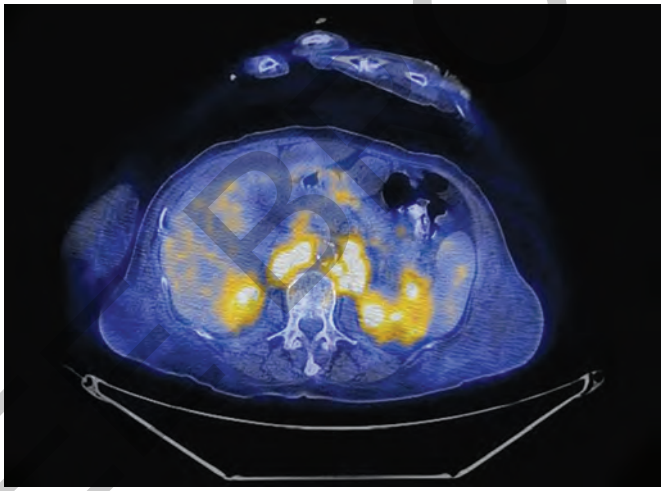


Fig. 6: A hypermetabolic left-sided retroperitoneal lymph node is identified that would be particularly amenable to image-guided biopsy, if clinically indicated.

CASE 7: BREAST CANCER EVALUATION AND RESPONSE TO THERAPY

Brief History

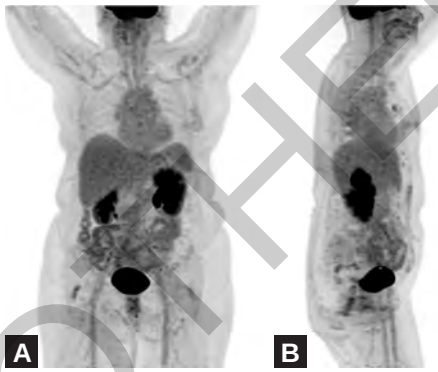
A 64-year-old female with stage IIIA breast cancer was treated with modified radical mastectomy, reconstruction, and adjuvant chemotherapy with good clinical response. She was without evidence of recurrent disease for over 10 years until she presented with cardiac chest pain and computed tomography (CT) imaging revealed incidental mediastinal lymphadenopathy. Subsequent ^{18}F fluorodeoxyglucose (FDG) positron emission tomography (PET/CT) confirmed abnormal hypermetabolism, and lymph node biopsy was consistent with recurrence of breast primary malignancy. She was initiated on chemotherapy and underwent repeat PET/CT imaging to evaluate response to treatment.

Findings

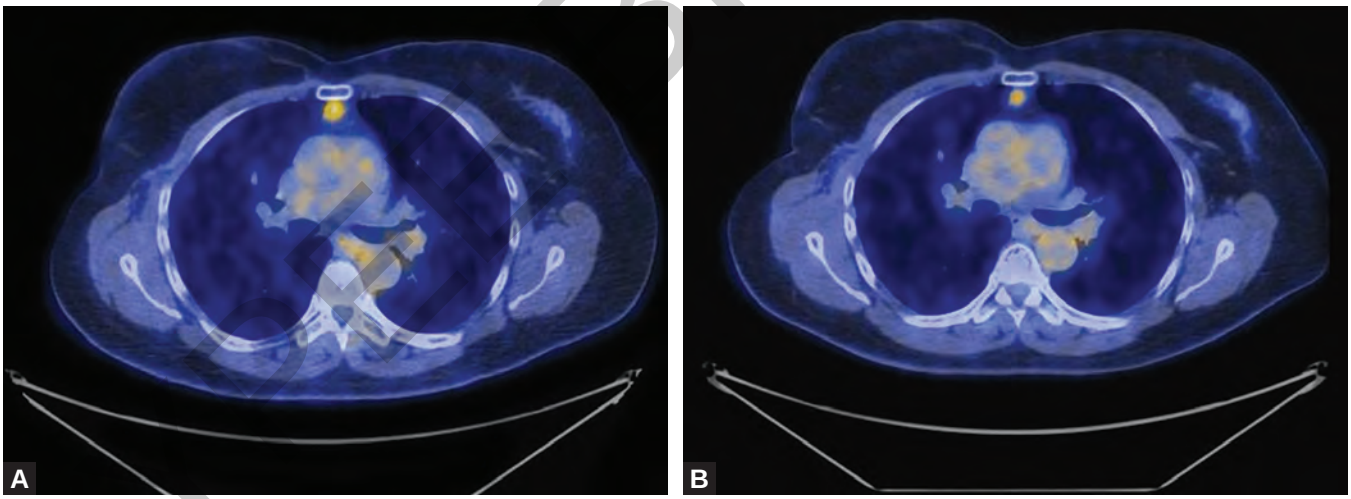
Findings are shown in Figures 1 to 4.

Main Teaching Points

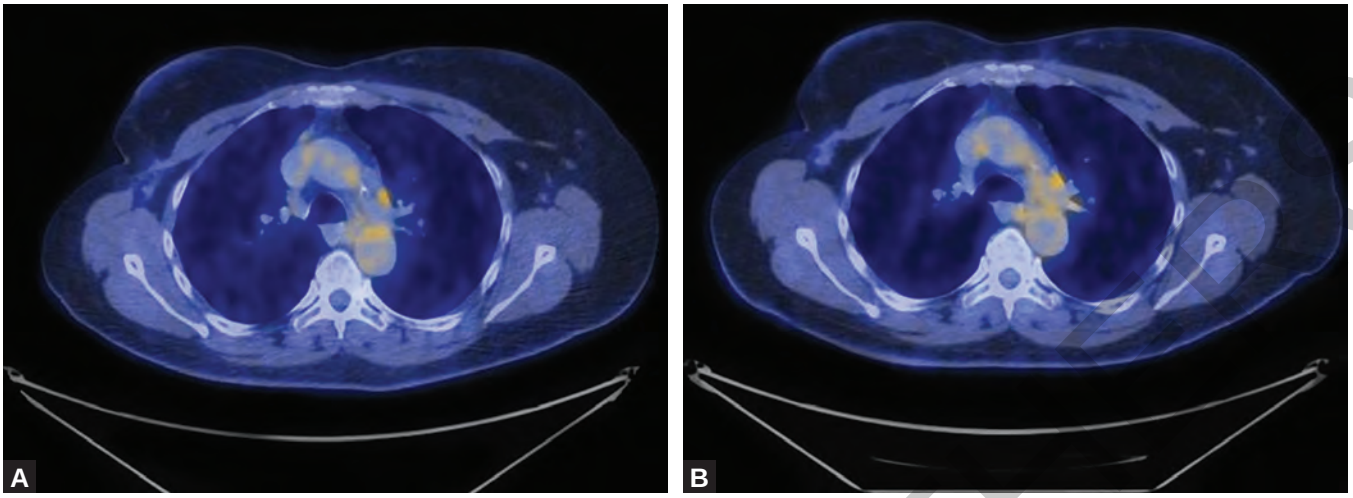
- Direct comparison of Standard Uptake Value (SUV) maximum measurements for select index lesions can be used to assess interval response to therapy.
- Stable or improving metabolic activity with no newly identified lesions indicates favorable response to therapy.



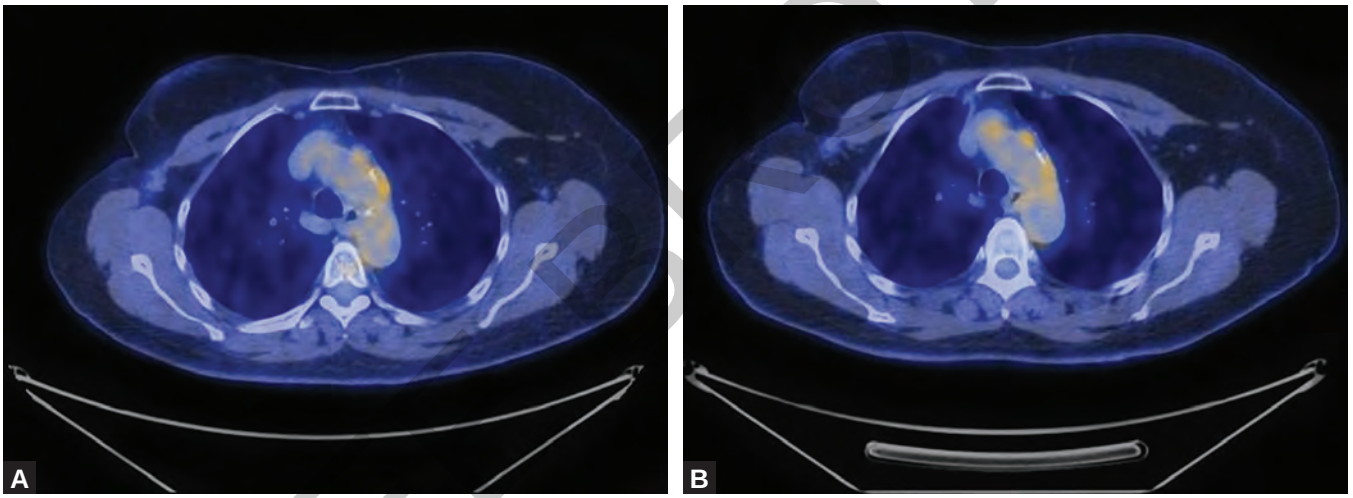
Figs. 1A and B: Maximum intensity projection whole body images demonstrate small subtle radiotracer-avid mediastinal lymph nodes. (A) The anterior view shows lymph nodes projecting over the central mediastinum. (B) The lateral view shows the most intense lesion is within the substernal anterior mediastinum.



Figs. 2A and B: A hypermetabolic retrosternal anterior mediastinal lymph node has decreased in size from 1.1 x 1.5 cm to 0.8 x 1.1 cm. The SUV maximum measurement has also decreased from 4.7 g/mL to 2.4 g/mL. (A) Baseline study prior to chemotherapy. (B) Post-chemotherapy.



Figs. 3A and B: A persistent hypermetabolic lymph node in the left perihilar region is stable in both size and metabolic activity. (A) Baseline study prior to chemotherapy. (B) Post-chemotherapy.



Figs. 4A and B: An aortopulmonary window hypermetabolic lymph nodes has decreased in standard uptake value (SUV) maximum measurement from 3.5 g/mL to 2.5 g/mL and visually appears slightly less intense. Anterior to this lesion is a hypermetabolic prevascular lymph node that has remained stable. (A) Baseline study prior to chemotherapy. (B) Post-chemotherapy.

NUCLEAR MEDICINE

A Case-Based Approach

This book is designed to meet the learning needs of the residents in training as well as to serve as a resourceful case-based review for imaging professionals. It provides pertinent, up-to-date information on general nuclear medicine, nuclear cardiology and PET-CT in a popular case-based format. In order to stimulate gradual learning, each section is divided in three progressive phases by providing increasing complexities of the cases from introductory to intermediate to difficult levels.

Munir Ghesani MD FACNM has been practicing clinical nuclear medicine for the past two decades, USA. He has served as Associate Director of the Radiology Residency Program at St Luke's-Roosevelt Hospital Center in New York City, USA for more than 10 years and is currently serving as Program Director of PET-CT Fellowship at NYU, Langone Medical Center, New York, USA. He has been an educator for nuclear medicine technology students and medical students for 20 years. He has held various leadership positions, including President of a hospital-based radiology practice and CEO of a private practice radiology group. In the past, he has received the "Teacher of the Year" award given by diagnostic radiology residents. Outside of the institutional responsibilities, Dr Ghesani has held leadership positions in several organizations, including current Chairman of the Government Relations Committee (SNMMI), current co-chairman of the Membership Task Force (SNMMI), current Vice-Chair (ABNM) and former President (ACNM).

Nasrin Ghesani MD completed her medical school training at Government Medical School, Surat, India and completed residency training in nuclear medicine at Hahnemann University Hospital and at Hospital of University of Pennsylvania, Philadelphia, USA. After completing residency training, she joined New Jersey Medical School. She is currently an Associate Professor in Radiology and Medicine at Rutgers New Jersey Medical School, Newark, New Jersey, USA, and Director of Nuclear Medicine at University Hospital, Newark, New Jersey, USA. She has received several research grants from state and national foundations to pursue research in nuclear medicine and molecular imaging and has published her work in peer-reviewed journals.

E Gordon DePuey MD completed his medical school training at Baylor College of Medicine, Houston, Texas, USA and completed residencies in Internal Medicine and Nuclear Medicine and Fellowship in Nuclear Cardiology also at Baylor College of Medicine. He is Board Certified by the ABIM, ABNM, and the CBNC and a fellow of the ACC. After holding faculty positions at Baylor, Emory and Columbia Universities, he is now a Clinical Professor of Radiology at Icahn School of Medicine at Mount Sinai and Director of Nuclear Medicine at Mount Sinai St. Luke's-Roosevelt Hospital in New York City, New York, USA. He is a Past-President of the Cardiovascular Council of the SNM, presently serves on the Board of Directors of the Cardiovascular Council of the SNMMI, served for five years as Chairman of the Quality Assurance Committee of ASNC, served as Vice-President and President of ASNC, and is now Immediate Past President of ASNC. He has authored over 150 publications in peer-reviewed journals, many book chapters, and two textbooks in Nuclear Cardiology. His current major focus of research involves Nuclear Cardiology image processing software to streamline imaging and improve image quality and diagnostic accuracy.

Amir Kashefi MD graduated from Tehran University of Medical Sciences, Tehran, Iran and moved to the United States to pursue a career in radiology. He completed his chief residency in Nuclear Medicine and PET-CT fellowship at UC Davis Medical Center in Sacramento, California, USA. He subsequently went on to a radiology residency at Harlem Hospital, an affiliate of Columbia Medical Center. He has recently joined Massachusetts General Hospital, Boston, MA, USA, where he is focusing on abdominal imaging and interventional radiology as a Fellow. He has written two chapters in "Fundamentals of Diagnostic Radiology, 4th edition" including a chapter on molecular imaging. He has considerable research experience in molecular imaging and the results of his studies have been published in peer-reviewed journals. In addition, he has presented his research at many national and international medical conferences.

Yi Chen Zhang MD completed her Bachelor of Arts degree in Biochemistry at Harvard University, Cambridge, Massachusetts, USA, and her medical school training at Albert Einstein College of Medicine, New York, USA. She is currently completing her chief residency in Radiology and her residency in Nuclear Medicine at the Mount Sinai St Luke's-Roosevelt Hospital System in New York, NY, USA. She has published eight peer-reviewed research articles ranging from benchwork immunology research to neuroradiology. Previously, she has worked for the World Health Organization, MIT Lincoln Labs, and Center for Blood Research at Harvard Medical School, Boston, Massachusetts, USA.

Available at all medical bookstores or buy online at www.jaypeebrothers.com

JAYPEE BROTHERS
Medical Publishers (P) Ltd.
www.jaypeebrothers.com

Join us on facebook.com/JaypeeMedicalPublishers

Shelving Recommendation
MEDICINE