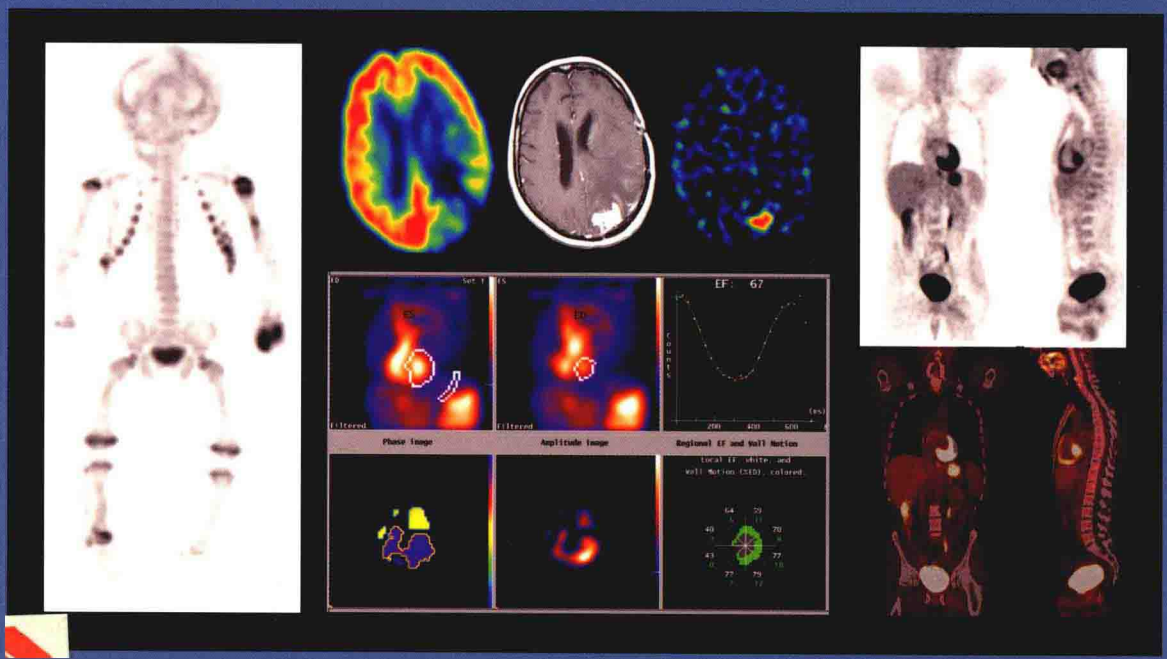
NUCLEAR MEDICINE AND PET/CT CASES

CASES IN RADIOLOGY



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Nuclear Medicine and PET/CT Cases

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To my parents, wife, and children for their love and support.

–Chun K. Kim

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Preface

This book presents general nuclear medicine and PET/CT imaging cases in a concise case format. While the book is primarily intended for radiology residents and nuclear medicine residents and fellows, any imagers performing and interpreting nuclear medicine studies will find it useful. The format of this book is unique in that individual cases are presented as unknown cases on the front page, with or without a brief history, along with images without arrows so that the readers can appraise the relevant findings and formulate possible differential considerations before turning over the page that simulates closely the reading room experience. On the top of the second page of each case, the diagnosis or the major point of the case and selected images with arrows pointing out the major findings, if felt to be helpful, are provided. Then, the type of radiopharmaceutical and dose, procedure, major findings, differential diagnosis, teaching points, and management are presented using easy-to-follow bullet points.

This book is intended not to offer exhaustive and often impractical discussion on individual cases, such as long lists of differential diagnoses that can be found in a typical "Gamut-type" textbook; only the differentials that are practical and that provoke useful thought processes or that contain valuable teaching points are listed in the Differential Diagnosis section. Many of the cases contain companion cases that augment comprehensive understanding of the particular subject. What is emphasized here is the relevant thought process and rationale that are necessary to arrive at the correct diagnosis, as outlined in the Teaching Points section. Some of the teaching points presented in this book are based on the authors' experience accumulated over 20–30 years, which the readers will find practical and useful.

I believe the readers will find this book easy and fun to read. Most radiology residents, for instance, will be able to finish reading it during their 4-week nuclear medicine rotation block. Most practitioners will find surprising depth of information in such a concise book that will stand them in good stead in the busy reading room. It is hoped that this book will serve as a foundation stone in preparation for board examinations and as a valuable reference guide in the practice.

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Contents

Part 1 Nuclear CNS Imaging

Laura L. Horky, Chun K. Kim

History

- A 42-year-old woman with refractory epilepsy and normal brain MRI.

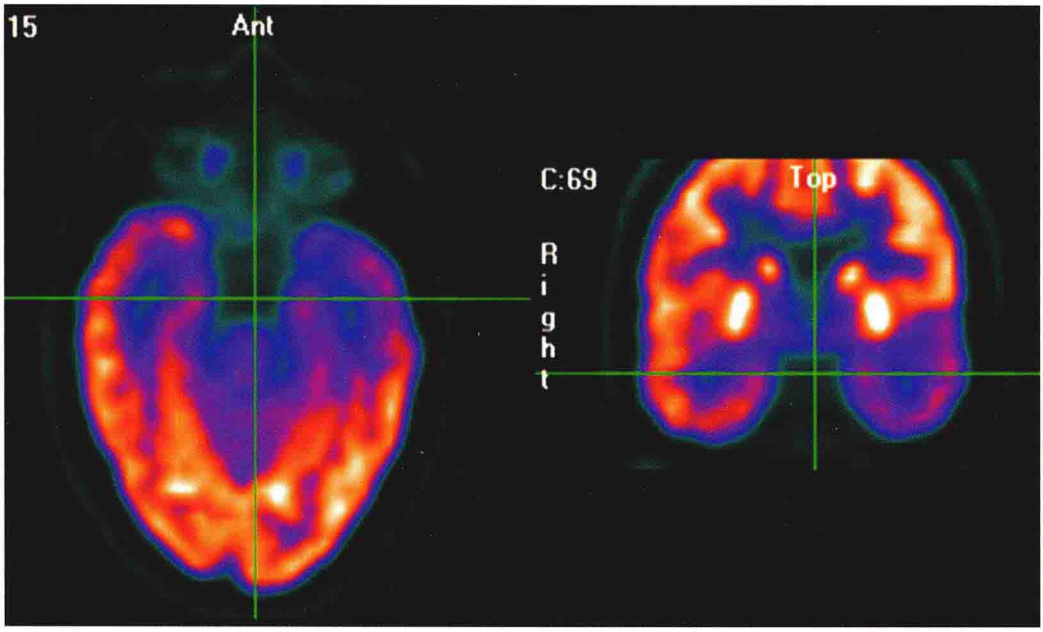

Figure 1.1

Case 1 Left Temporal Interictal Seizure Focus

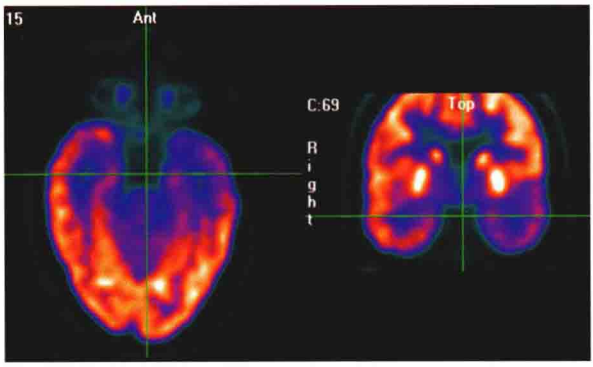

Figure 1.2

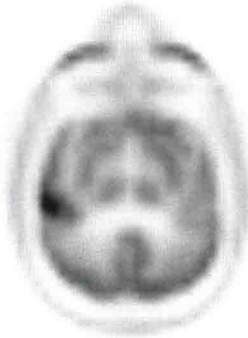

Figure 1.3

Radiopharmaceutical/Dose/Procedure: ^{18}F-FDG/5 mCi/PET imaging 1 hour after injection.

Findings

- Figure 1.2: Hypometabolism in the left temporal lobe.

Differential Diagnosis

- With history of epilepsy and a normal MRI, the PET finding is most consistent with a left temporal interictal seizure focus.

Teaching Points

- Interictal PET is useful in identifying the seizure focus.
- Ictal PET (seizure during FDG uptake period) and ictal SPECT studies (inject tracer within 15–30 seconds of ictal onset) typically reveal hypermetabolism/hyperperfusion at the seizure focus, as seen in a different patient in status epilepticus (Figure 1.3), whereas the interictal study will reveal hypoperfusion/hypometabolism, as in Figure 1.2.
- Ictal SPECT study, if properly performed, is more sensitive than interictal PET or interictal SPECT, but this study is more difficult to obtain. Furthermore, a delay in tracer injection (>30 seconds after electroclinical onset) may result in a false localization of the seizure focus. Therefore, some centers prefer interictal PET.
- Interictal PET is more sensitive than interictal SPECT.
- In temporal lobe epilepsy, MRI may be normal or may demonstrate hippocampal sclerosis.
- SPECT and PET studies are useful when surface EEG and MRI do not clearly identify a seizure focus. These studies may guide the surgeon to proceed with resection or further diagnostic procedures such as subdural electrode placement. When interictal PET demonstrates cortical left-right asymmetry of at least 15% (mean SUV), surgical outcomes are more likely to be successful (Theodore et al. 1992).

Management

- Findings were correlated with MRI (in this case normal) and EEG.
- The information was used to determine that the patient would be a candidate for temporal lobectomy.
- The patient subsequently underwent an anterior left temporal lobectomy and was seizure-free for at least 2 years afterward. Surgical pathology revealed mild gliosis.

Further Readings

Theodore WH, et al. Temporal lobectomy for uncontrolled seizures: the role of positron emission tomography. *Ann Neurol.* 1992;32:789–794.

Horky L, et al. PET and SPECT in brain tumors and epilepsy. *Neurosurg Clin N Am.* 2011;22:169–184.

History

- A 65-year-old comatose patient after head trauma; CT shows subdural and subarachnoid hemorrhage and transtentorial brain herniation.

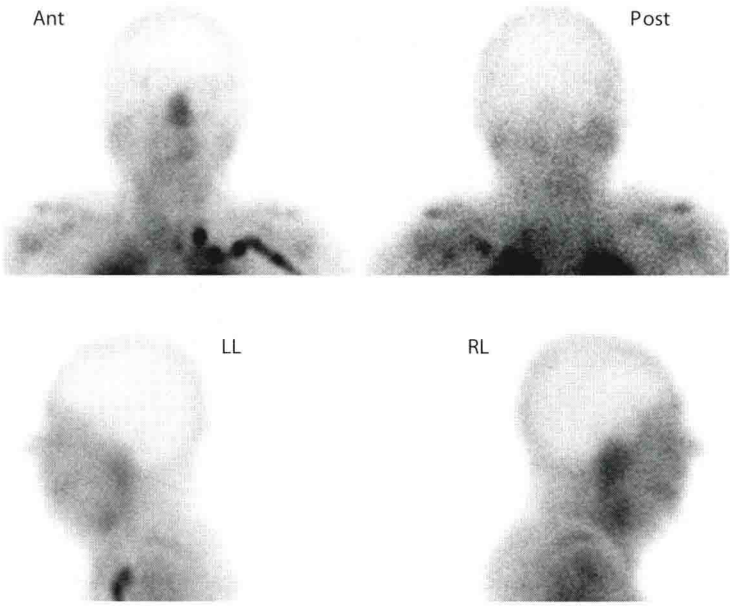

Figure 2.1

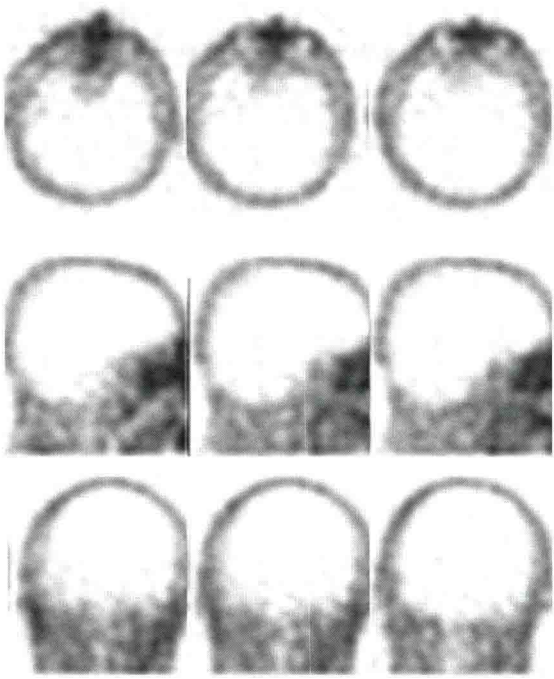

Figure 2.2

Case 2 Brain Death

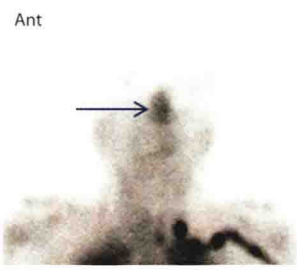

Figure 2.3

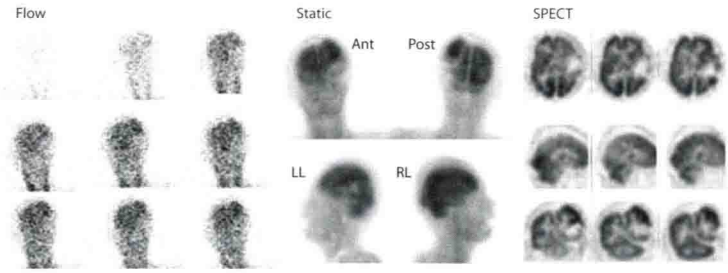

Figure 2.4

Radiopharmaceutical/Dose/Procedure: ^{99m}Tc-HMPAO/20 mCi/Dynamic imaging immediately after injection, static planar imaging 20 minutes after injection, and if necessary SPECT imaging.

Findings (Figures 2.1–2.3)

- No intracranial activity
- Hyperperfusion to the nose (hot nose sign) (arrow)

Differential Diagnosis

- The scan finding is consistent with brain death.

Teaching Points

- Perfusion tracers (^{99m}Tc-ECD and ^{99m}Tc-HMPAO) bind to the brain parenchyma.
- Absence of brain activity using these tracers is considered diagnostic of brain death. Activity in any part of the brain contradicts the diagnosis.
- If planar images are equivocal, consider obtaining SPECT images, if feasible.
- Figure 2.4: Example of case that is not brain dead.
- Brain may falsely appear viable if imaging within 6 hours of brain function cessation or if activity is present due to scalp or cerebral bleeding.
- If tracers that do not cross the blood-brain barrier (e.g., ^{99m}Tc-DTPA) are used, the following findings should be evaluated. However, if HMPAO or ECD is used (which is considered the current standard of care), these are merely ancillary findings and should not be solely used to diagnose brain death.
  - "Trident sign" during the arterial phase (composed of a vertical midline activity in the head extending superiorly, representing the right and left anterior cerebral arteries, and bilateral oblique linear activity extending superolaterally, representing right and left middle cerebral arteries) excludes brain death, if present, as seen in the first 4 frames of the flow phase in Figure 2.4. Images are not clear because perfusion tracer was used in this case, causing rapidly rising background brain uptake.
  - "Hot nose sign" signifies preferential external carotid artery circulation in the absence of internal carotid flow; present in approximately 50% of patients with brain death.
  - Absence of venous sinus activity during the venous phase is suggestive of brain death.

Management

- If the findings are consistent with brain death, notify the referring team and place a note in the patient's chart.
- If the findings are incompatible with brain death, the test may be repeated at a later date.

Further Readings

Donohoe K, et al. *SNM Procedure Guideline for Brain Death Scintigraphy*. version 1.0, 2003 (www.snm.org/guidelines).

History

- A 68-year-old man with bilateral internal carotid artery occlusion and left anterior circulation stroke, documented on carotid ultrasound and MR angiogram. Surgical planning for external to internal carotid artery (EC-IC) bypass.

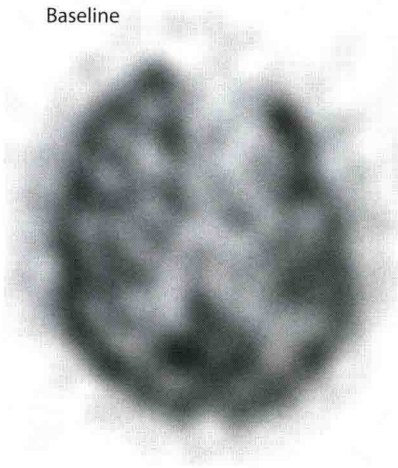

Figure 3.1

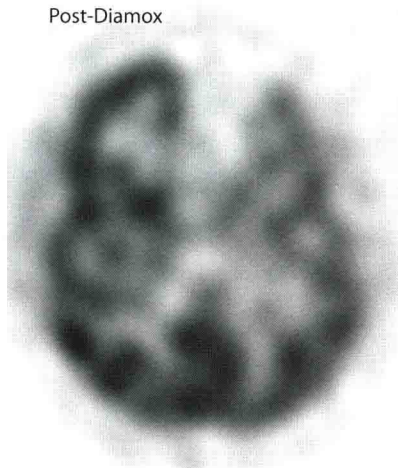

Figure 3.2