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Atlas and Anatomy of PET/MRI, PET/CT and SPECT/CT

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Preface

Since we published *Sectional Anatomy: PET/CT and SPECT/CT* in 2007, there has been a significant increase in the use of hybrid imaging in clinical practice and also reports of higher sensitivity and specificity than those of the single imaging modality, thus making the integrated approach a more accurate imaging test.

The precise lesion localization within the anatomic context, which frequently is critical, may not be possible in PET or SPECT. It is not easy to consider three dimensions in our mind's eye and view the relationship of the pathology with surrounding normal organs in axial, coronal, and sagittal imaging. With gradual improvement of instruments as well as software for attenuation corrections, we have used new PET/CT and SPECT/CT images and also added PET/MRI images.

In all hybrid imaging, a good workflow is paramount for cost-effectiveness in clinical practice. Since data acquisition on emission systems can only be dynamic or static, the major variations of imaging protocols are on the anatomic imaging side. This atlas intends to provide educational information on sectional anatomy and illustrate common pathologies for trainees and practitioners in the fields of nuclear medicine, radiology, oncology, neurology, cardiology, and general medicine.

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Contents

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1 Atlas and Anatomy of PET/MR

After the huge success of hybrid positron emission tomography/computed tomography (PET/CT), there has been a continuous effort to develop a hybrid positron emission tomography/magnetic resonance image (PET/MR) machine. Recently, a magnetic field–compatible PET component has been developed by a substituting photomultiplier tube (PMT) for an avalanche photodiode (APD) or silicon multiplier (SiPM). This enables development and commercialization of PET/MR. Commercial simultaneous PET/MR is now seeking clinical validation. A simultaneous PET/MR system has several intrinsic advantages over a PET/CT system, including a lower radiation dose, higher soft tissue resolution of anatomic images, and the possibility of using a novel multifunctional PET/MR probe. In addition, there is the potential for the simultaneous acquisition of an anatomic image and PET. PET/MR has a higher soft tissue resolution than PET/CT; therefore the image reader should be well trained in reading normal anatomy and abnormal findings in MR for the proper reading of PET/MR. There are many MR books and atlases available to help understand and read MR images; however, there are few PET/MR atlases. This chapter includes typical PET/MR cases of patients with malignant tumors in the area of the brain, head and neck, chest, abdomen, pelvis, and musculoskeletal system. In each case, pathologic findings and essential surrounding normal structures for interpretation are indicated and named [1–4].

1.1 Brain

1.1.1 Case 1

A male patient, age 75, presented with worsening dizziness and weakness in both legs for 1 month. A tumorous condition in the brain was suspected on brain CT and therefore ^{18}F-Fludeoxyglucose (FDG) PET/MR was used.

Brain FDG PET/MR revealed a well-enhanced mass with intense metabolic activity involving the body of the corpus callosum. There was no abnormal lesion with increased metabolic activity in the rest of the imaged body. Primary central nervous system (CNS) lymphoma was suspected, and stereotaxic biopsy revealed a diffuse large B-cell lymphoma [5, 6] (Figs. 1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.7, and 1.8).

1.1.2 Case 2

A 74-year-old female patient suffering from a tingling sensation in her right hand and aphasia for 10 days was examined. A tumorous condition in the brain was suspected on brain CT, and FDG PET/MR was performed.

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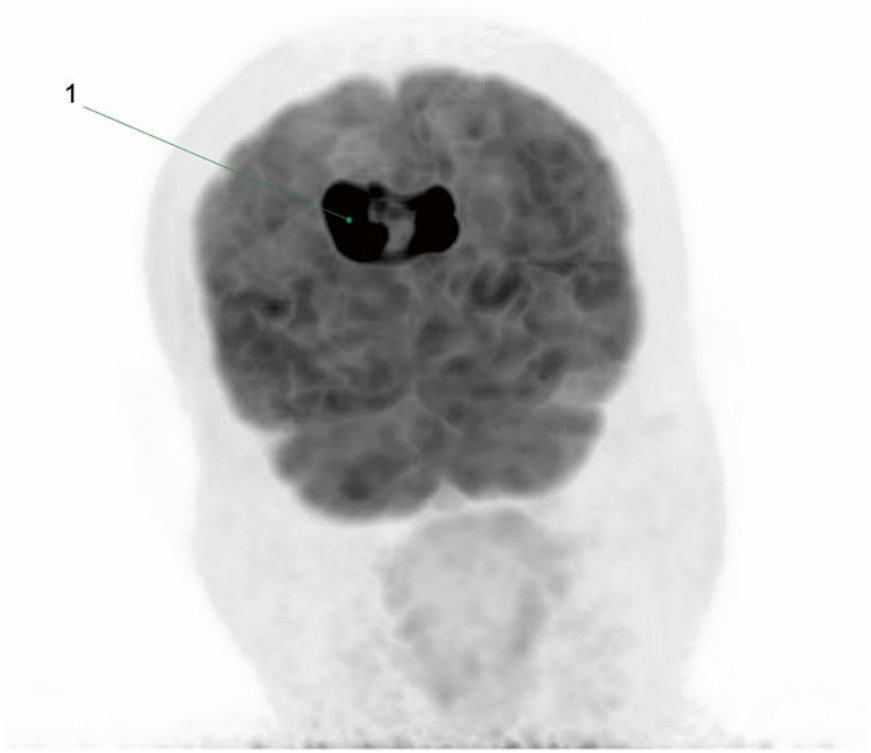

Fig. 1.1 (1) Primary central nervous system lymphoma

Brain FDG PET/MR revealed multiple round-shaped enhancing hypermetabolic nodules with peritumoral edema in the left frontal parietal lobes and cerebellum that were appeared to be metastases. In whole-body FDG PET/MR, hypermetabolic bone spinal lesions were found in C7 and L5, suggesting bone metastases. Also, an infiltrative lesion with increased metabolic activity was found in the sigmoid colon. Subsequent colonoscopy and colonoscopic biopsy revealed sigmoid colon cancer. The metastatic lesions were considered to have originated from the colon cancer [7] (Figs. 1.9, 1.10, 1.11, 1.12, 1.13, 1.14, 1.15, 1.16, 1.17, 1.18, 1.19, 1.20, and 1.21).

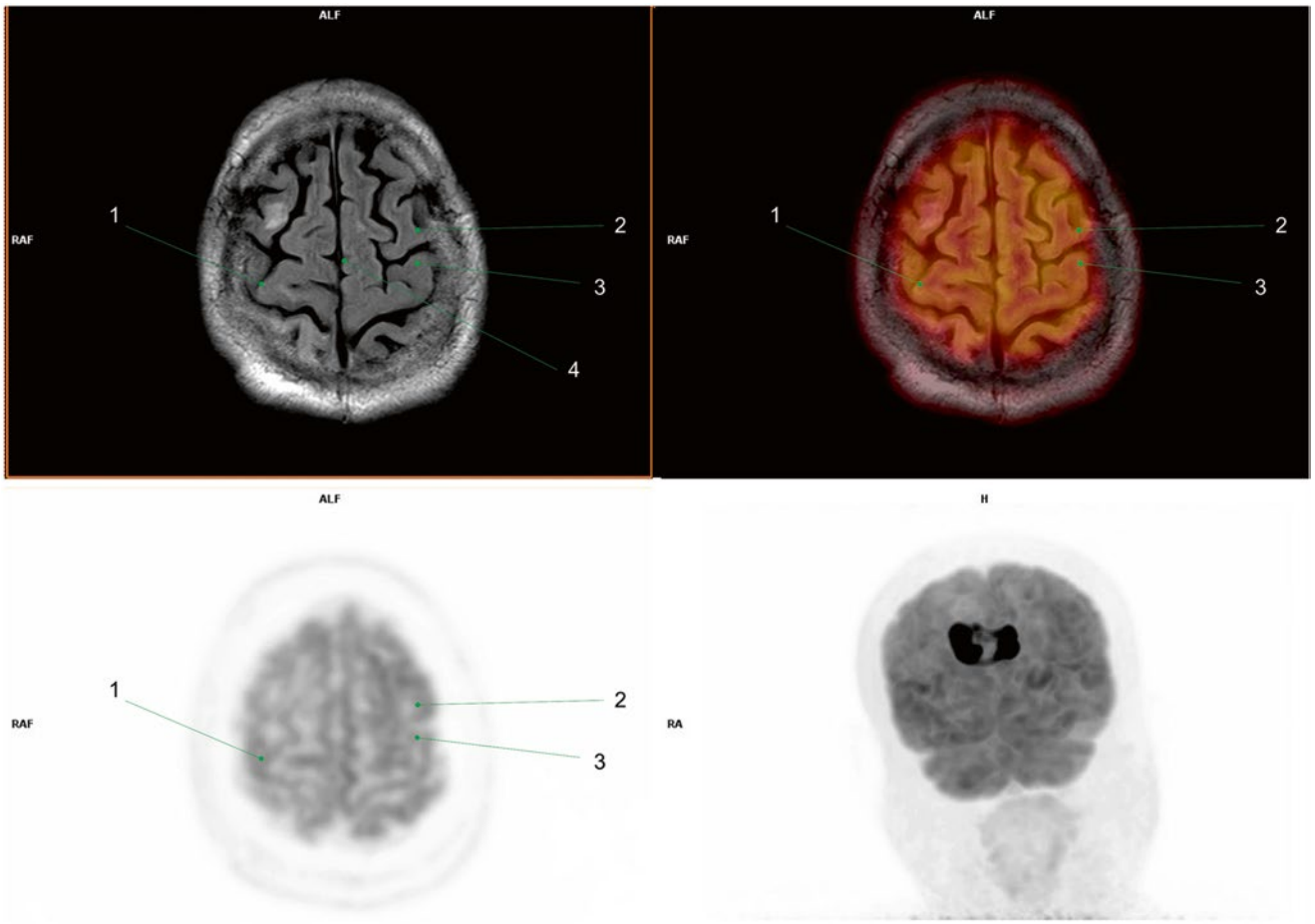

Fig. 1.2

(1) Right postcentral gyrus
(2) Left precentral gyrus
(3) Left postcentral gyrus
(4) Falx cerebri

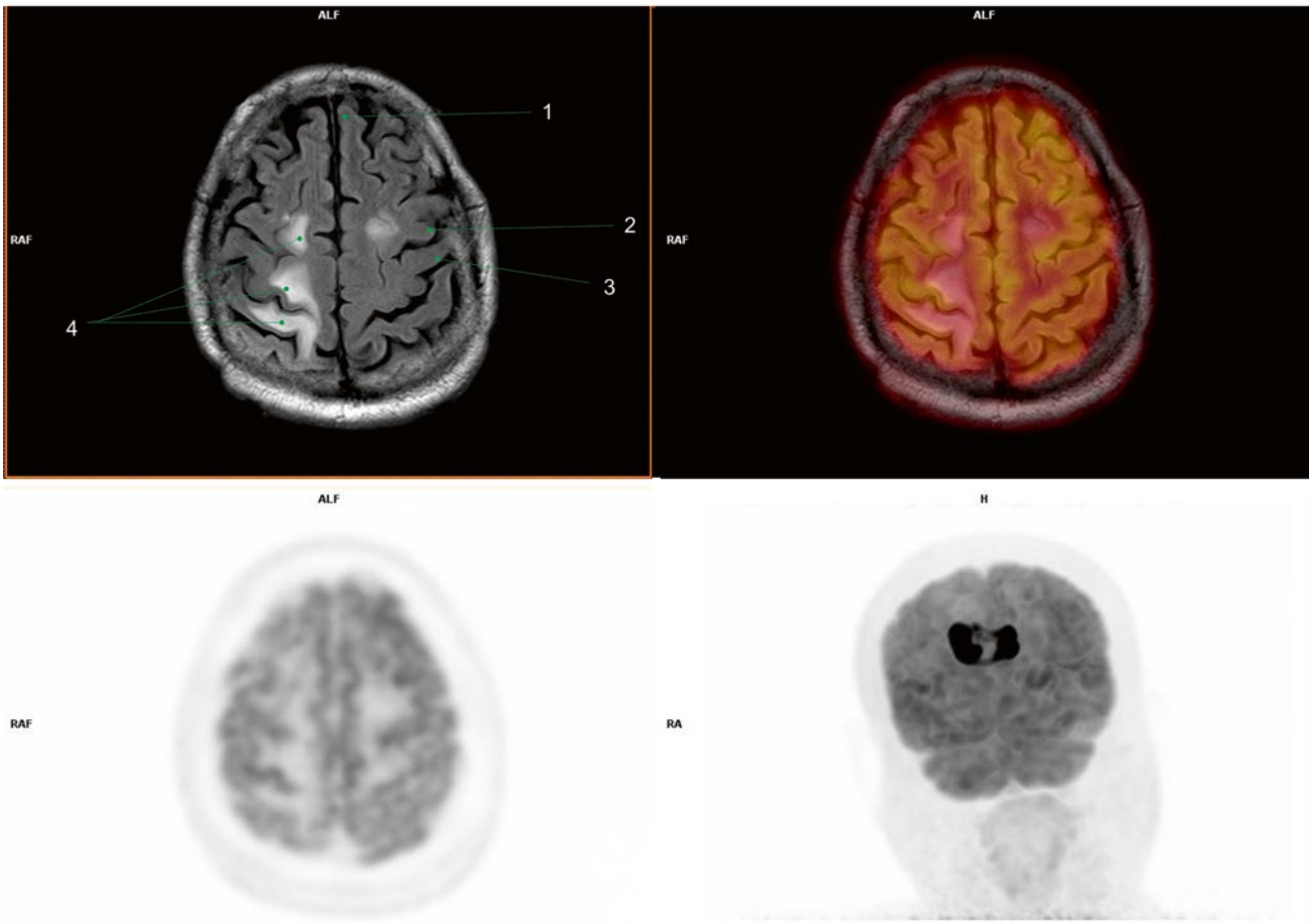

Fig. 1.3

(1) Left superior frontal gyrus
(2) Left precentral gyrus
(3) Left postcentral gyrus
(4) Peritumoral edema

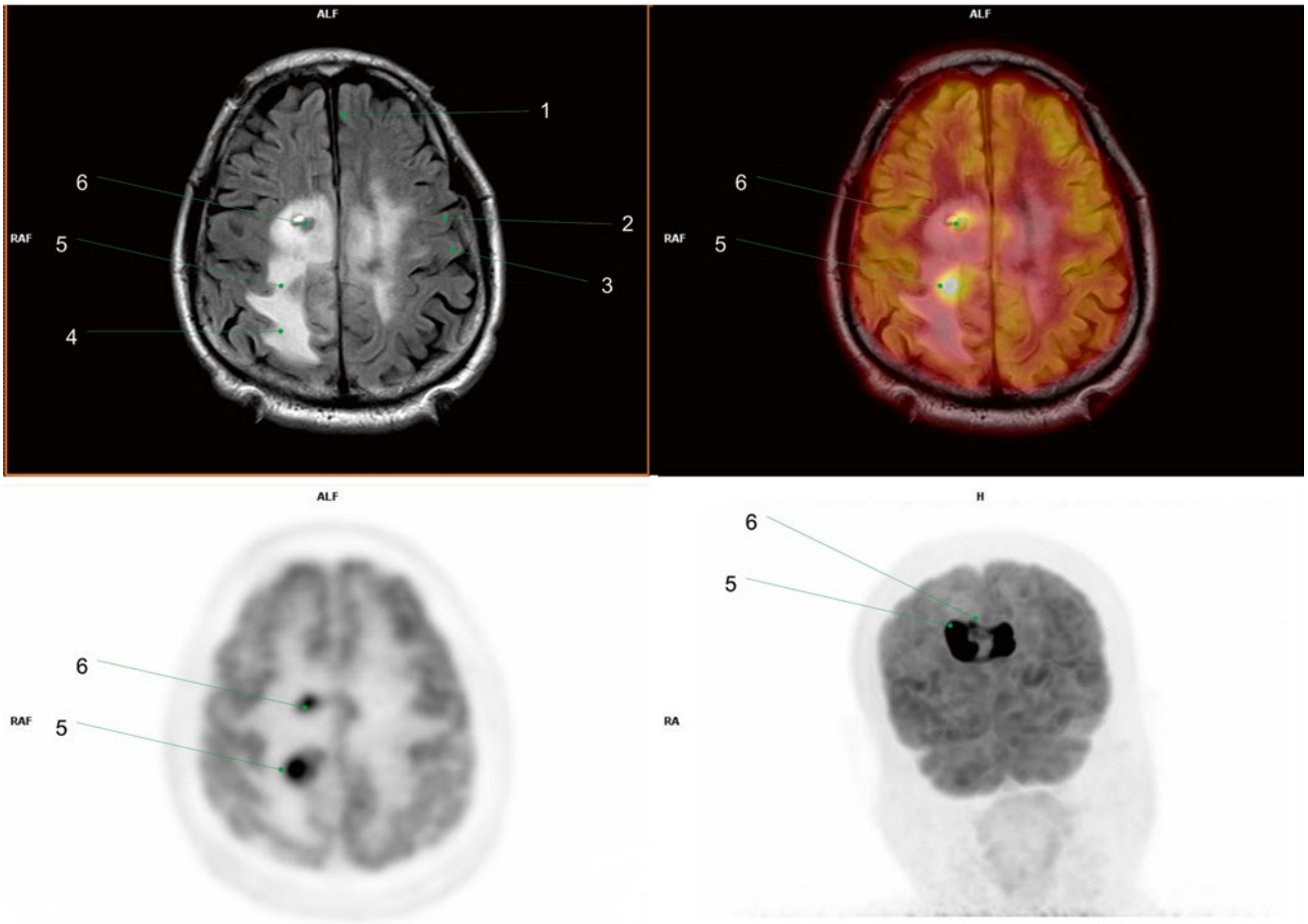

Fig. 1.4

(1) Left superior frontal gyrus
(2) Left precentral gyrus
(3) Left postcentral gyrus
(4) Peritumoral edema
(5) Primary central nervous system lymphoma in right parietal white matter
(6) Primary central nervous system lymphoma in right frontal white matter

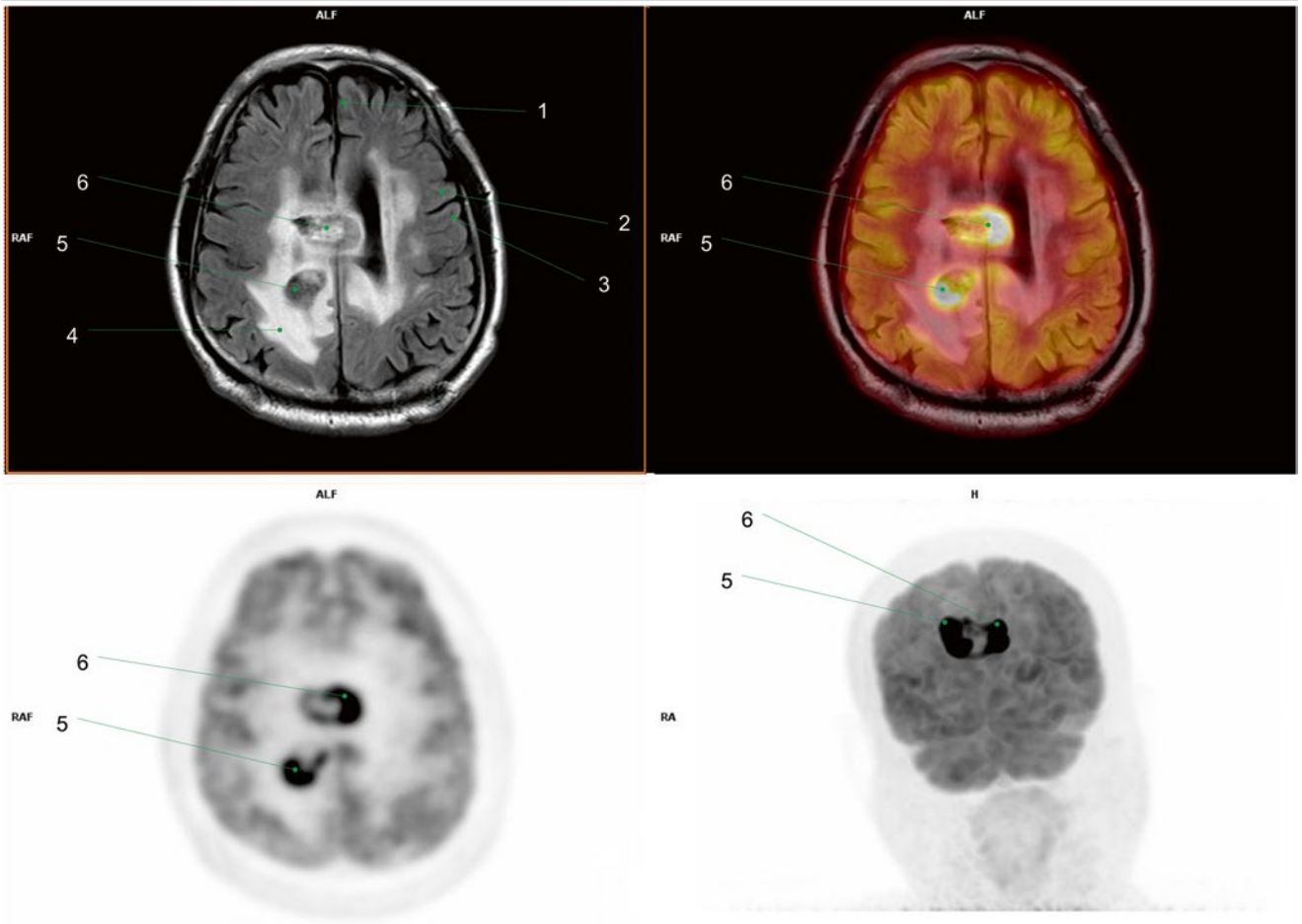

Fig. 1.5

(1) Left superior frontal gyrus
(2) Left precentral gyrus
(3) Left postcentral gyrus
(4) Peritumoral edema
(5) Primary central nervous system lymphoma involving right parietal white matter
(6) Primary central nervous system lymphoma involving corpus callosum

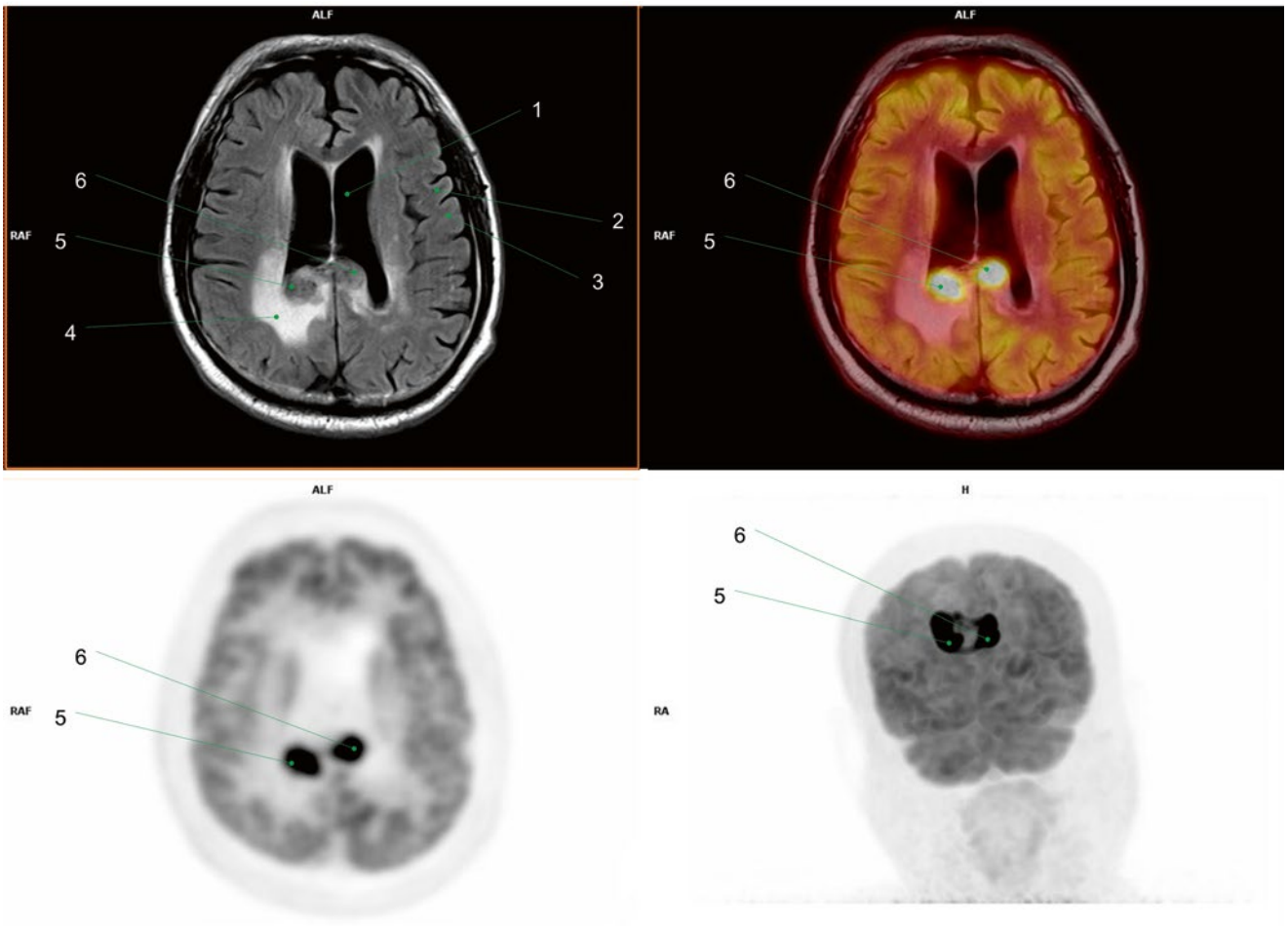

Fig. 1.6

(1) Left lateral ventricle
(2) Left precentral gyrus
(3) Left postcentral gyrus
(4) Peritumoral edema
(5) Primary central nervous system lymphoma involving posterior corpus callosum
(6) Primary central nervous system lymphoma involving posterior corpus callosum

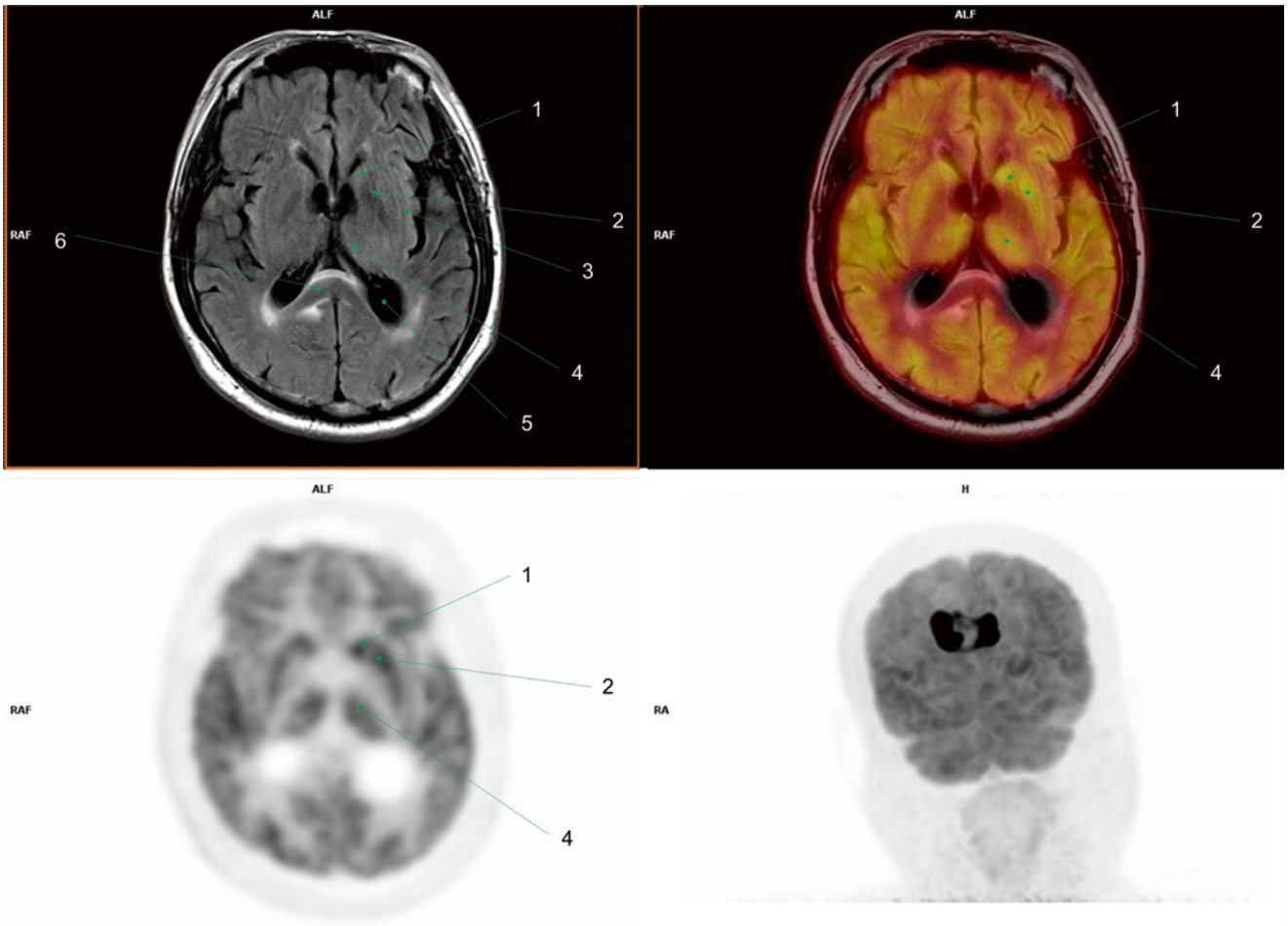

Fig. 1.7

(1) Left caudate nucleus	(3) Left insular cortex	(5) Left lateral ventricle trigone
(2) Left putamen	(4) Left thalamus	(6) Corpus callosum (splenium)

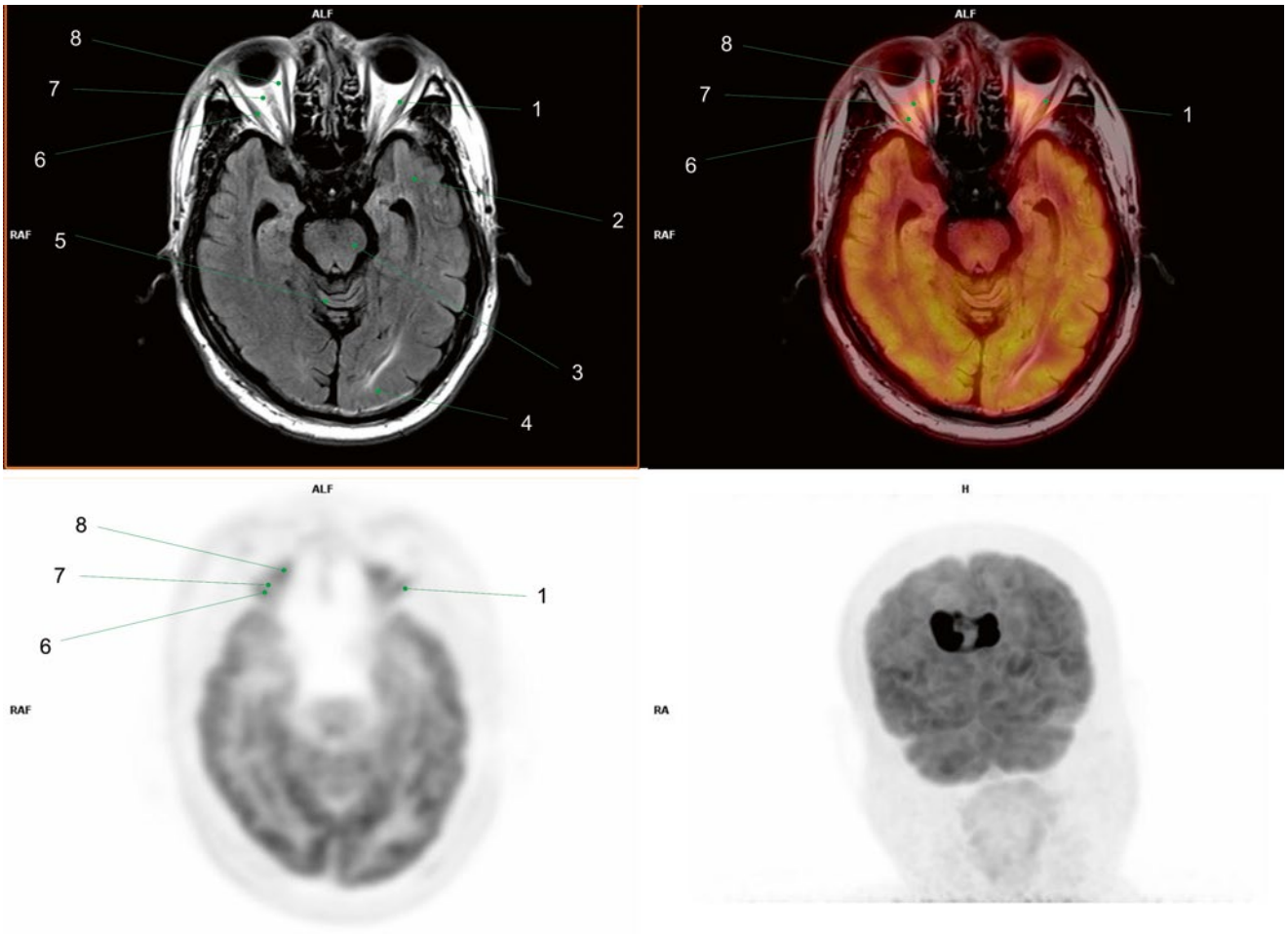

Fig. 1.8

(1) Left lateral rectus muscle
(2) Left temporal cortex
(3) Midbrain
(4) Occipital cortex
(5) Cerebellar vermis
(6) Right lateral rectus muscle
(7) Optic nerve
(8) Right medial rectus muscle

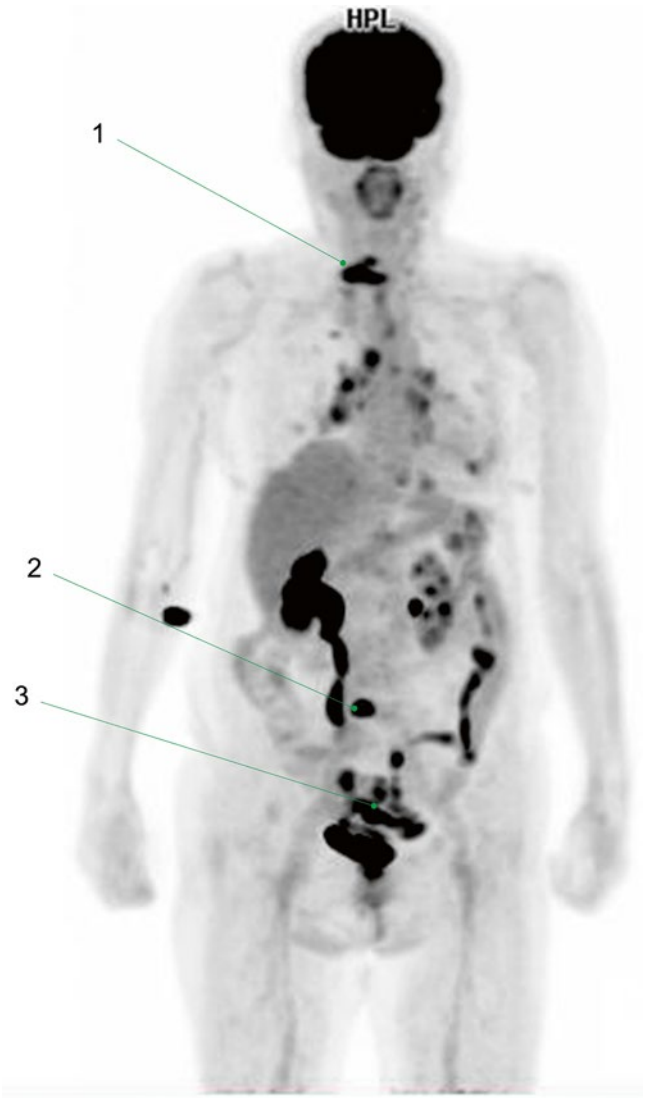

Fig. 1.9

(1) Bone metastasis in cervical spine
(2) Bone metastasis in lumbar spine
(3) Sigmoid colon cancer

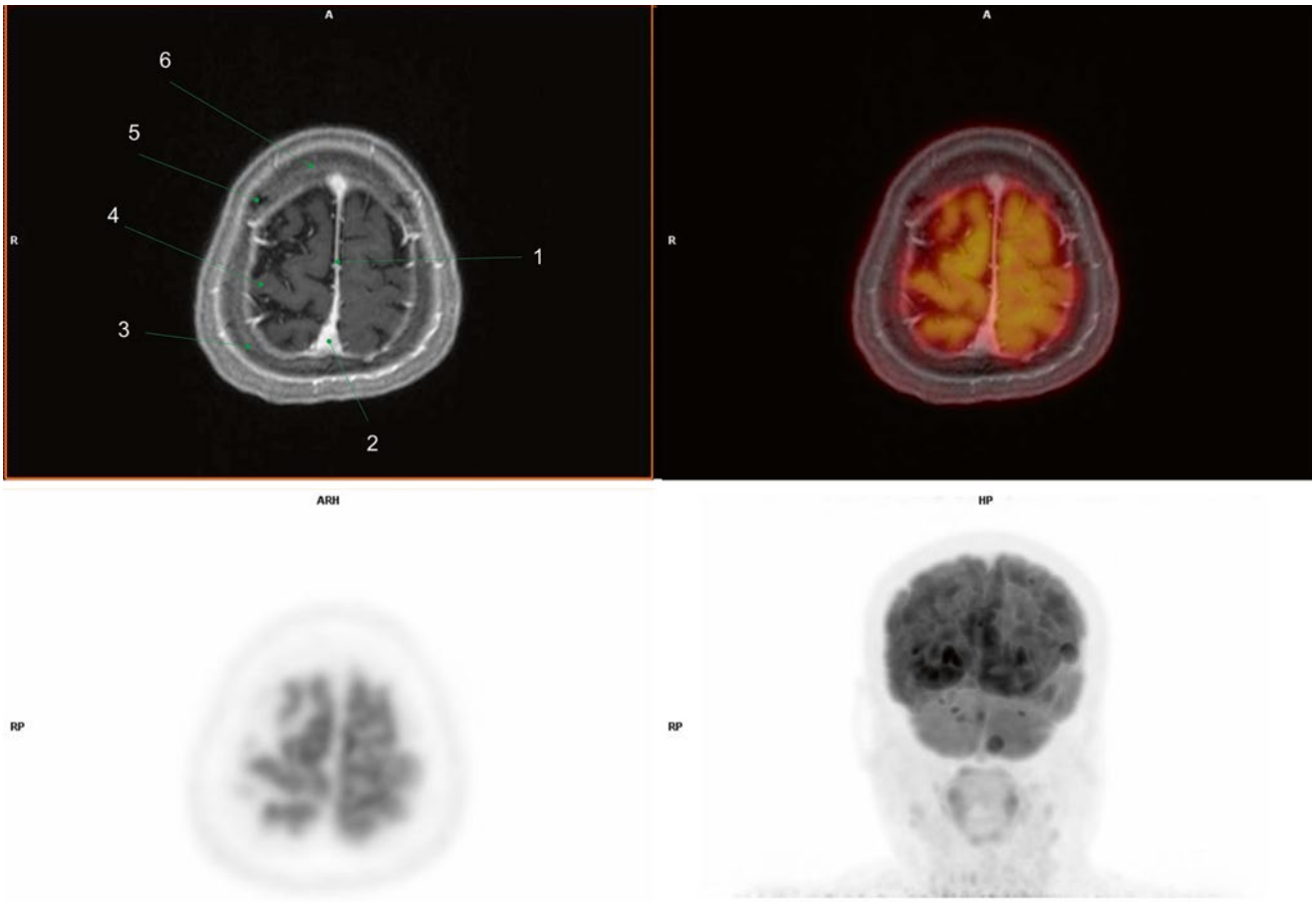

Fig. 1.10

(1) Falx cerebri
(2) Superior sagittal sinus
(3) Right parietal bone
(4) Right postcentral gyrus
(5) Right coronal suture
(6) Frontal bone

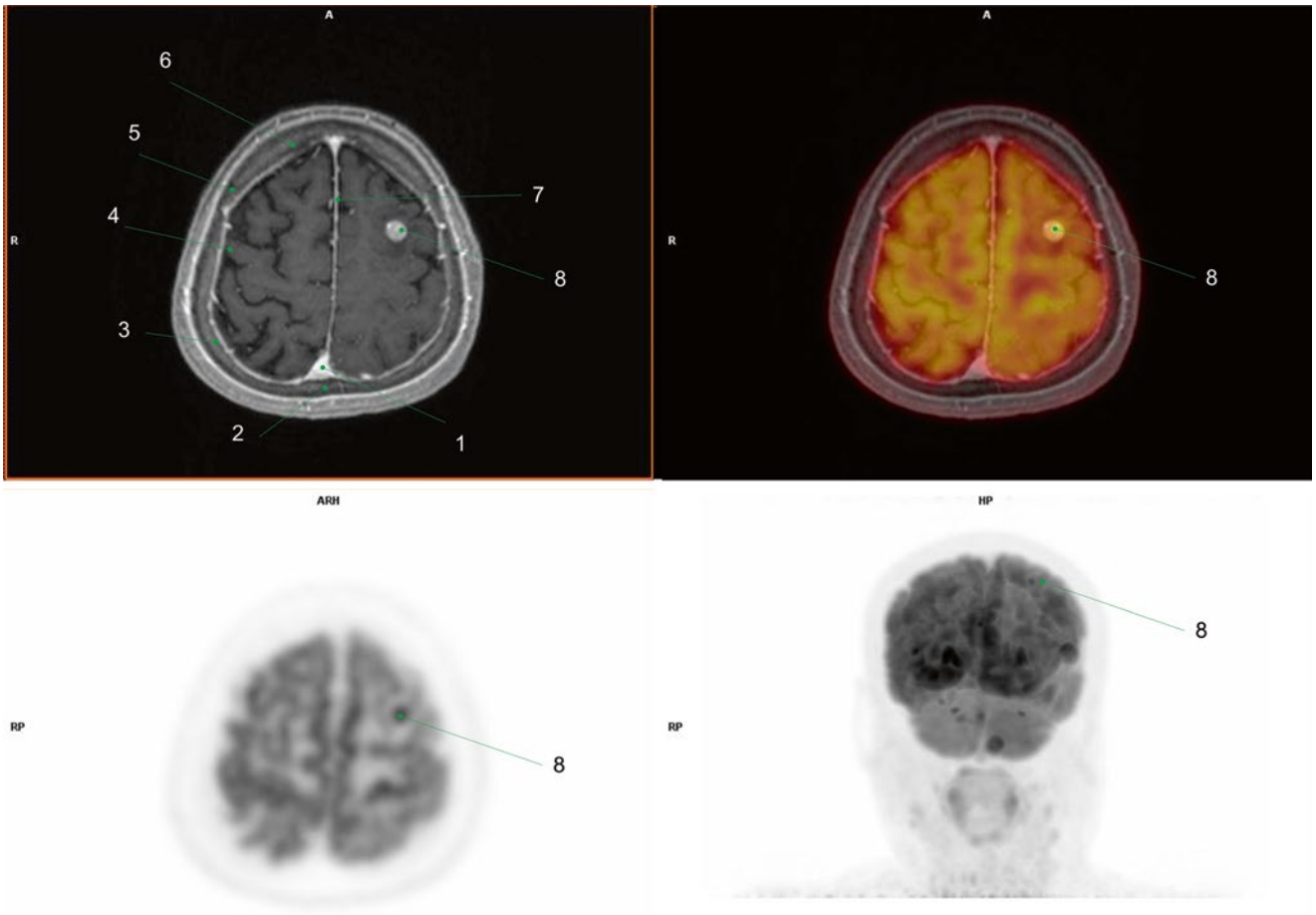

Fig. 1.11

(1) Superior sagittal sinus
(2) Sagittal suture
(3) Right parietal bone
(4) Right postcentral gyrus
(5) Right coronal suture
(6) Frontal bone
(7) Falx cerebri
(8) Metastasis in left frontal lobe

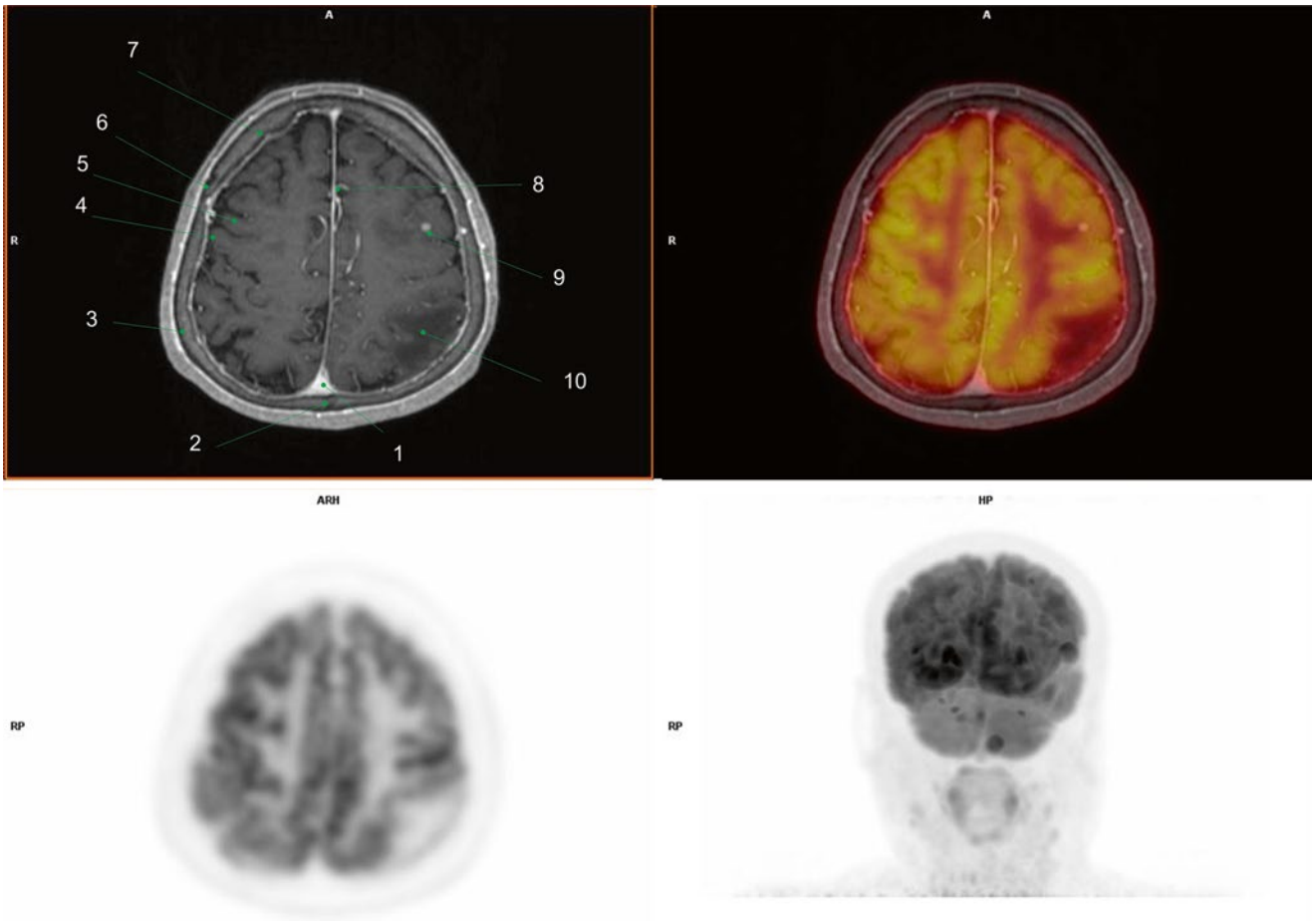

Fig. 1.12

(1) Superior sagittal sinus
(2) Sagittal suture
(3) Right parietal bone
(4) Right postcentral gyrus
(5) Right precentral gyrus
(6) Right coronal suture
(7) Right frontal bone
(8) Falx cerebri
(9) Metastasis in left frontal lobe
(10) Peritumoral edema in left parietal lobe