Figure 4.1i - 4.3i: Meningioma case example: Note the rounded mass in the midline of these MR images. T2 weighted image (4.2i) shows no evidence of edema in surrounding parenchyma (a) and T1 weighted image (4.1i) shows the appearance of a circumscribed lesion. The mass is visible as a high density (bright) lesion on CT (4.3i).

CT imaging

- Figure 4.4i – CT image of displaced skull fracture secondary to trauma
- Figure 4.5i – CT image of foreign body: shotgun pellets both inside the skull and in the soft tissue of the face
- Figure 4.6i – 4.8i CT images showing intracranial blood secondary to hemorrhage. Blood appears as a hazy bright substance in the subarachnoid spaces at the base of the brain (4.6i) and in the sulcal spaces at a more superior level (4.7i) in a patient with diffuse hemorrhage. A focal intraparenchymal hemorrhage produces a more densely bright focus in the right frontal lobe of another patient (4.8i).
- Figure 4.9i – CT image showing subdural hemorrhage secondary to trauma with substantial midline shift of brain tissue.
- Figures 4.10i – 4.11i – CT image showing intracranial localization of electrodes (4.10i); each contact point on the electrode creates a metallic “spray” artifact. 4.11i shows a 3-dimensional CT reconstruction illustrating electrode placement superficially.
- Figure 4.12i – CT images of abnormal basal ganglia, thalamic, white matter and cerebellar calcification in a patient with Fahr’s syndrome.

MR imaging

Normal tissue contrasts

- Figures 4.13i – 4.15i – T1 Weighted MR images of normal brain in the axial, coronal, and sagittal planes.
- Figures 4.16i-4.18i – T2 (16), FLAIR (17), and Proton Density (18) axial images of a healthy brain showing normal tissue contrast features

Stroke

- Acute Stroke: 4.19i – 4.22i show images of a patient with new stroke affecting the left middle cerebral artery distribution. 4.19i and 4.20i are T2 and FLAIR images, which show only the most subtle indication of the lesion. 4.21i is a diffusion weighted image (DWI) and 4.22i is the corresponding apparent diffusion coefficient (ADC) scan. The abnormally bright signal on DWI and dark signal on ADC is indicative of restricted diffusion in the presence of acute CVA.
- Remote Stroke: 4.23i – 4.27i show images of the same patient as imaged in the acute stroke images, several months later. Note in image 4.23i that the area of infarction is dark on T1, whereas the T2 weighted image and FLAIR image are bright in the area of abnormality (4.24i and 4.25i). On DWI image (4.26i) the area of remote lesion is now dark and the ADC image (4.27i)
shows high signal, a reversal of the pattern seen in the acute phase of the infarct.

- Hemorrhagic stroke: 4.28i – 4.32i show images of acute intracerebral hemorrhage in the right occipito-temporal region. Note that the fresh blood appears bright on T1 and T2 images (4.28i and 4.29i). The FLAIR image reveals not only the blood as having a mildly hyperintense signal, but also surrounding parenchymal edema (4.30i). In this setting, DWI images show a mottled appearance, with a combination of so-called “T-2 shine through” reflecting the high T2 signal of fresh blood and edema, without clear evidence of true restricted diffusion (4.31i; compare this image to 4.21i for reference). Susceptibility weighted imaging (4.32i) reveals a dark area of image susceptibility due to the presence of fresh blood and related iron content.

Figures 4.33i – 4.36i: Traumatic hemorrhage is seen as a mottled area of signal in the right frontal pole on the T1 weighted image 4.33i, but shows a clear surrounding ring of edema around the hemorrhage, which appears bright on T2 and FLAIR images (4.34i and 4.35i). Compare with figures 4.6i – 4.8i to see the relatively similar sensitive of MRI and CT in the presence of intracranial blood. Susceptibility weight imaging (SWI) is very useful for revealing petechial hemorrhage in the context of head injury, often indicative of diffuse axonal injury (4.36i).

Figures 4.37i – 4.40i: Low grade brain tumor affecting the left mesial temporal lobe appears dark on T1 imaging (4.37i), bright on T2 and FLAIR (4.38i, 4.39i) and shows no enhancement following injection of the contrast agent (4.40i; One can confirm that contrast agent has been injected by examining for the presence of high signal in the draining sinuses and nasal mucosa as compared with 4.37i).

Figures 4.41i – 4.44.i: high grade brain tumor is seen in the right superior frontal lobe of this patient. On standard T1 coronal imaging (4.41i), the lesion is difficult to visualize, but T2 and FLAIR imaging (4.42i, 4.43i) show large areas of abnormal signal involving both frontal lobes. These broad regions show high signal reflecting a combination of pathology including focal brain tumor, infiltrative tumor, and likely post-treatment (radiation/chemotherapy) changes. Contrast enhanced T1 images show a focal region of blood-brain barrier breakdown (4.44i). Corresponding MR Perfusion imaging (4.45i) shows high cerebral blood flow (appearing red in this image) corresponding to the contrast enhancing focus, which suggests neovascularity and tumor.

- Radiation Necrosis: 4.46i – 4.48i show the value of MR Perfusion imaging for differentiating a high grade brain tumor from radiation necrosis. This problem often confronts neuro-oncologists who follow patients for treatment after brain radiation. This patient has a large area of abnormal appearing tissue in the left temporal lobe on FLAIR imaging (4.46i) and a focus of contrast enhancement on T1+contrast images (4.47i). This region could reflect either recurrent tumor or an area of blood-brain barrier breakdown due to radiation necrosis. The relatively
low level of cerebral blood flow on MR Perfusion imaging (4.48i; blue is low, red is high) suggests radiation necrosis.

Figures 4.49i - 4.52i: Multiple Sclerosis
- Multiple lesions of different ages are shown in 4.49i – 4.52i. Note that T1 images show dark areas of differing intensities corresponding to MS plaques 4.49i and T2 and FLAIR lesions show varying degrees of high signal intensity in the same regions (4.50i, 4.51i). With the use of a contrast agent, active demyelinating plaques show enhancement on the T1+contrast images (4.52i).
- Active lesions from MS: 4.53i – 4.56i appear dark on T1 (4.53i), bright on T2 and FLAIR (4.54i, 4.55i), and enhance with contrast agents (4.56i).

Figures 4.57i – 4.60i: Dementia
- Alzheimer’s disease: 4.57i shows hippocampal volume loss in a patient with AD, which is not a specific or diagnostic finding. It may be useful as a correlate in a patient with known dementia.
- Normal Pressure Hydrocephalus: 4.58i and 4.59i show T2 and FLAIR images respectively of a patient with NPH. Although these images are not diagnostic of the condition, the presence of disproportionately enlarged ventricles and minimal sulcal atrophy can be suggestive of the condition in the right clinical context.
- Small vessel disease and dementia: 4.60i shows a single FLAIR image with abnormal signal in a characteristic distribution around the lateral ventricles in a patient with vascular dementia.

Figures 4.61i – 4.64i: Hippocampal sclerosis in epilepsy is an important indicator of the likelihood of successful treatment by surgery. In this patient with intractable epilepsy, the reduced size of the head of the left hippocampus can be seen on T1 images (4.61i). T2 images show enlargement of the corresponding lateral ventricle (4.62i). On FLAIR images (4.63i, 4.64i), slightly increased signal intensity can be observed in the abnormal hippocampus.

Figure 4.65i: Major white matter fiber bundles are extracted from diffuse tensor imaging and displayed with a color code that corresponds to direction of passage: green= anterior-posterior, red=right-left, and blue=inferior-superior.

Figure 4.66i: Image and spectrum extracted from a Magnetic Resonance Spectroscopy scan showing several peaks of clinical relevance.

Figures 4.67i – 4.69i: Functional MRI. Images taken from clinical FMRI exams of single subjects that display activation during a memory task (4.67i), a bilateral hand motor task (4.68i) and a language comprehension task (4.69i).