Imaging of Traumatic Brain Injury

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DISCLOSURES

- None

- Traumatic brain injury affects approximately 1.7 million Americans per year, 275,000 hospitalizations and 52,000 deaths each year.
- TBI contributes to one-third of all injury-related deaths in the United States.
- Annual economic cost of TBI estimated at $76.3 billion
- Neuroimaging plays an important role in both acute and chronic stages of TBI
- In Acute TBI: Imaging studies determine the presence and extent of injury and guide surgical planning
- In Chronic TBI: Sequelae of prior injury, determining prognosis and guiding rehabilitation

OBJECTIVES

1. Discuss the basic principles of Neuroimaging (CT and MRI)
2. Overview of normal brain anatomy
3. Imaging findings and prognostic implications in TBI

BASICS OF CT IMAGING

How far have we come?

- In the 1970-80s, it took 120 minutes to perform a CT head
- 1990s, it took about 15-20 minutes
- Today: ?

How far have we come?

- In the 1970-80s, it took 120 minutes to perform a CT head
- 1990s, it took about 15-20 minutes
- Today: 5 seconds

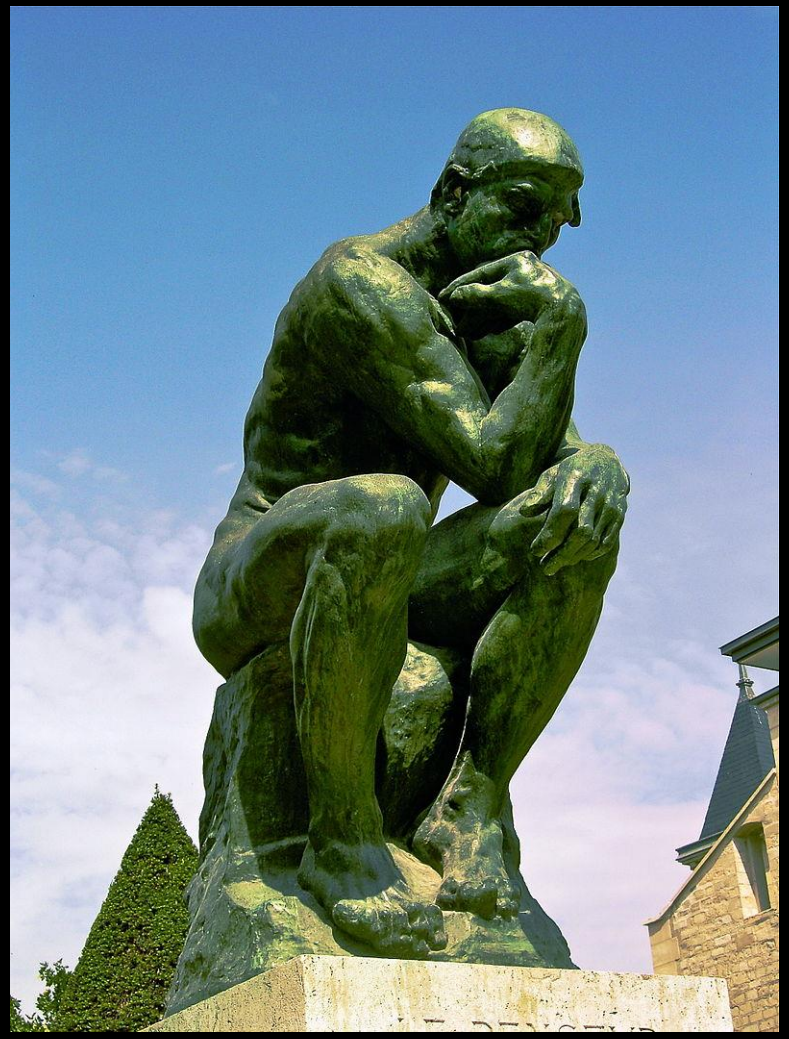
How is the CT image generated?

- An X-Ray beam passes through the patient
- Based on the densities of different tissues, the X-rays get differentially absorbed.
- Complex mathematical algorithms finally generate the CT image based on the absorption spectrum of the detectors.
- CT MEASURES DENSITY

BASICS of MRI

- The MR machine houses a powerful magnet (x1000s compared to Earth's magnetic field)
- Complex interplay of exciting hydrogen atoms in the body tissues via radiofrequency pulses and analysing signals based on repeated excitation and deexcitation of protons
- MRI does not involve use of radiation

What test to order?



- CT or MRI
- CT without contrast
- CT without and with contrast
- MRI without/MRI with
- CTA
- MRA

Some general rules:

- For any ACUTE neurological condition: Head CT
- For SUBACUTE/CHRONIC cases: Brain MRI
- CT Brain is almost always performed without IV contrast
- Plain radiographs of the skull: OBSOLETE

CT

- Fast
- Readily available
- No screening
- Excellent for detecting hemorrhage and fractures
- Poor soft tissue resolution
- Ionizing radiation

MR

- Exquisite anatomical detail
- No radiation
- Longer scan time
- Screening(Pacemaker, metallic implant, orbital foreign body….)
- Claustrophobia
- Challenging with unstable patients

BASIC ANATOMY

- 3 main imaging planes:

i. Axial

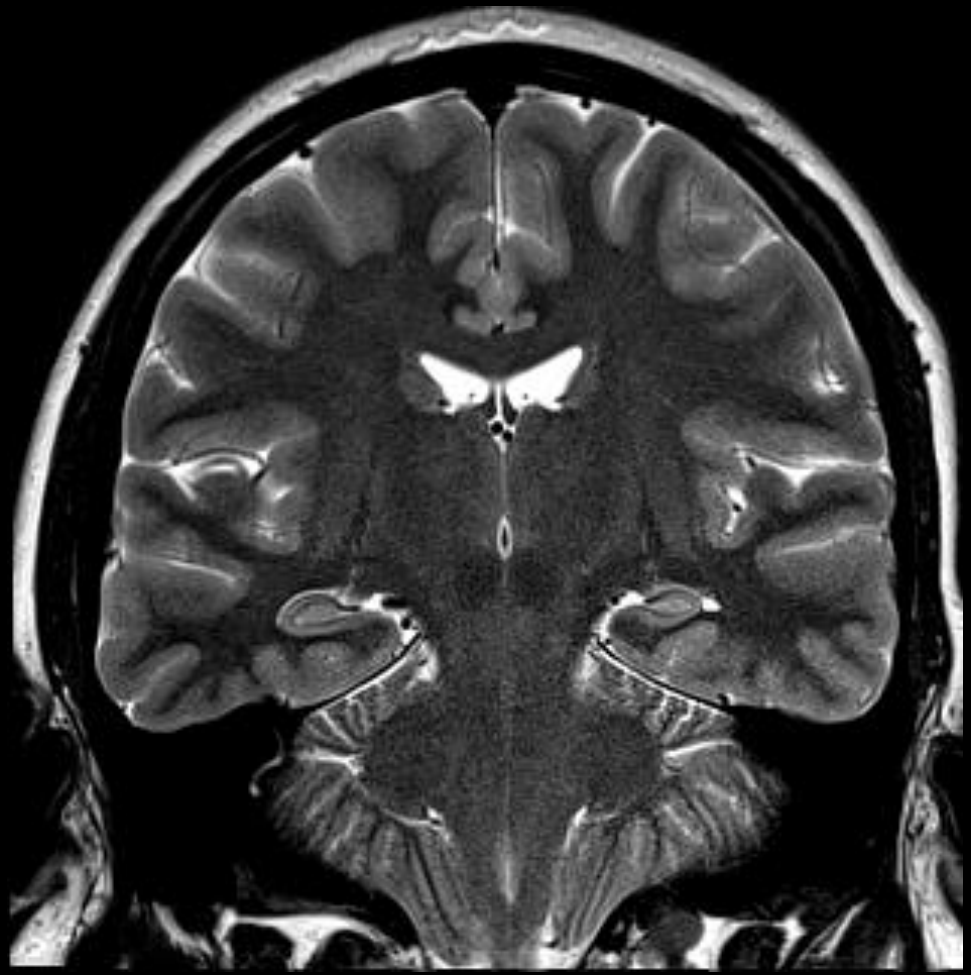
ii. Coronal

iii. Sagittal

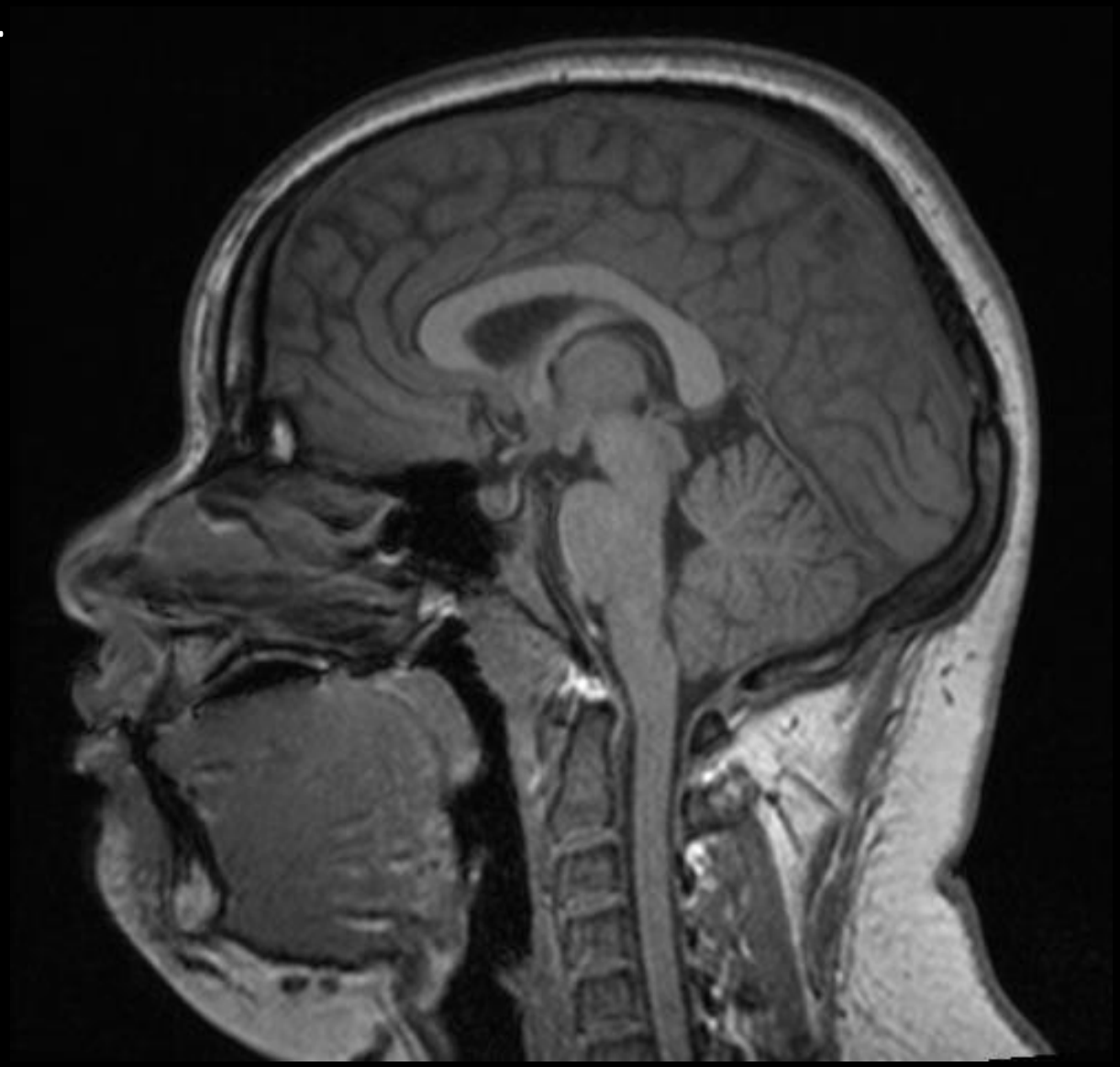
- CT images are acquired in the axial (transverse) plane
- MRI images can be acquired in any plane

AXIAL ‘SLICE’

CORONAL



SAGITTAL



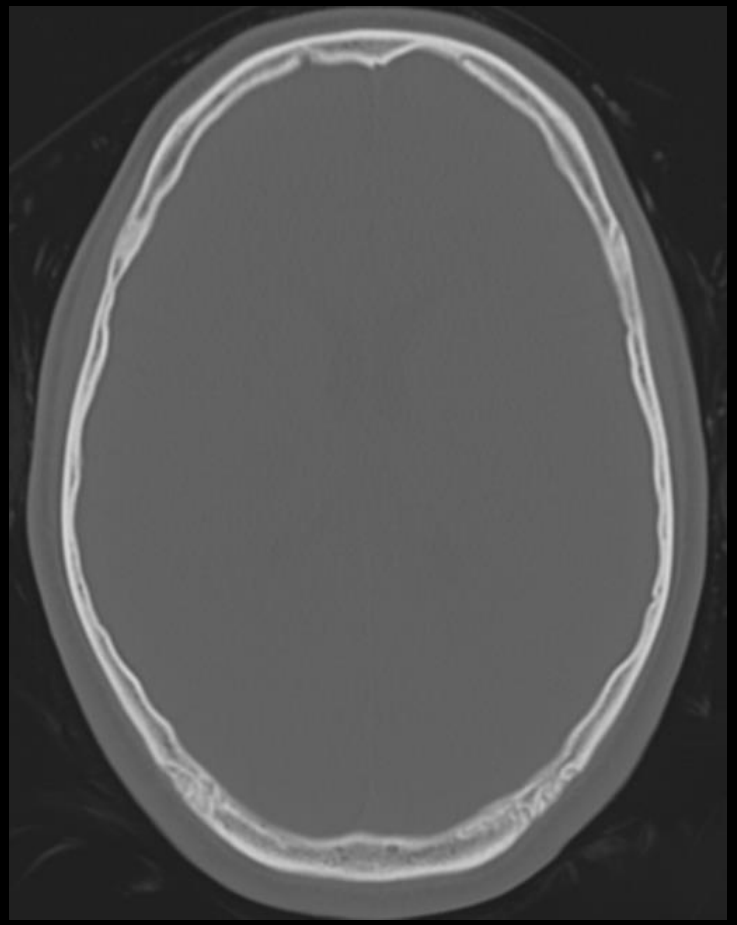
Brain Anatomy

- Cerebral hemispheres:
  - Frontal
  - Parietal
  - Temporal
  - Occipital

- Cerebellum
- Brainstem
- Ventricles
- CSF spaces
- Calvarium

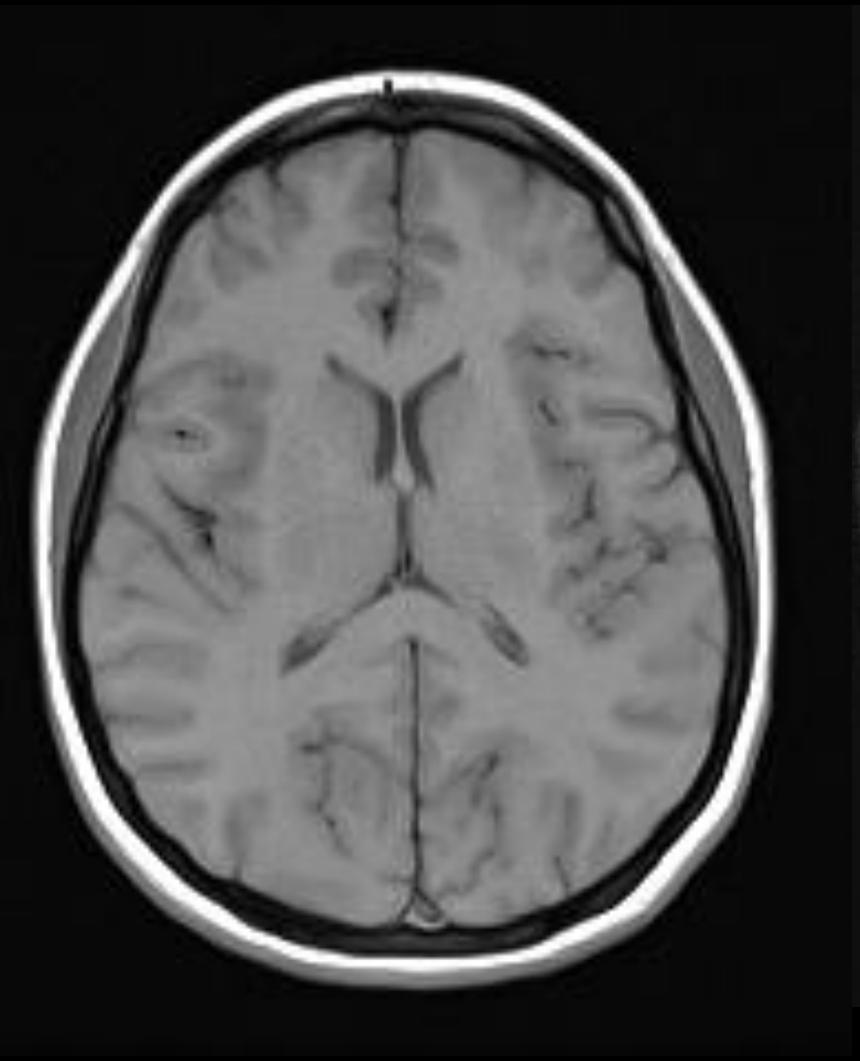
CT Windows

BRAIN WINDOW

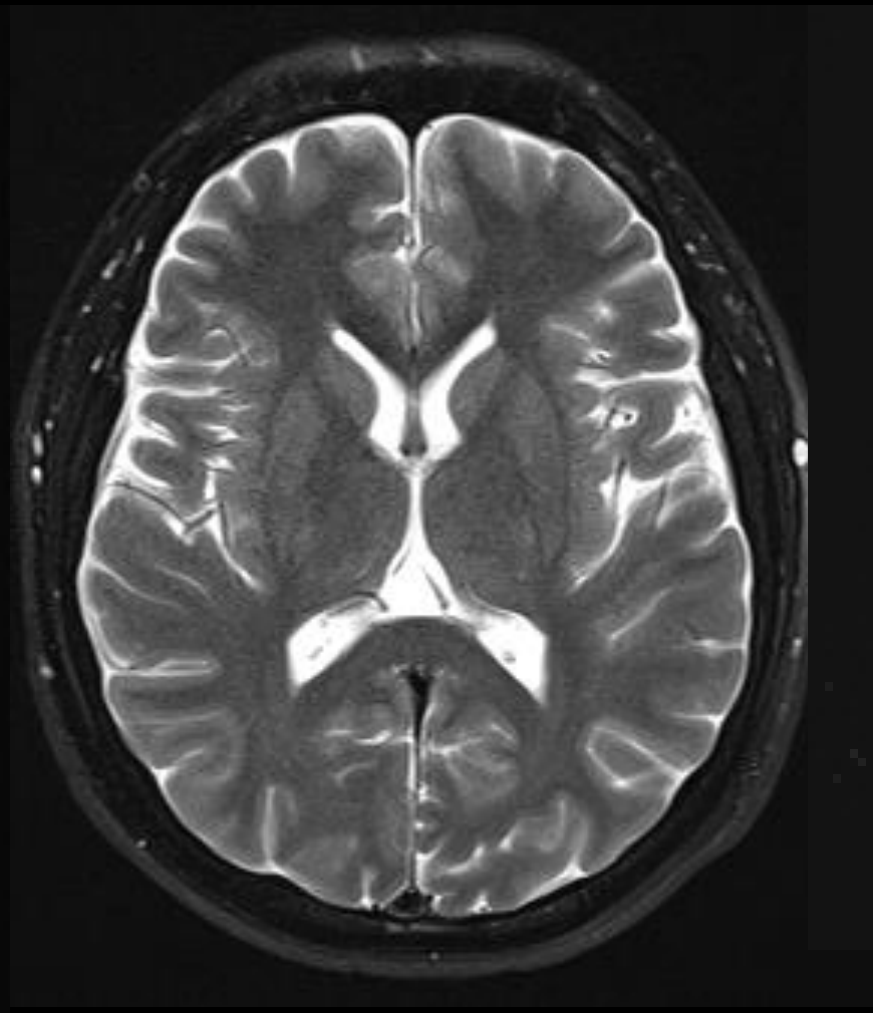


BONE WINDOW

MRI WINDOWS/SEQUENCES



AXIAL T1



AXIAL T2

AXIAL DIFFUSION

Important principles:

- SYMMETRY is key
- Midline structures should always be in midline
- CSF spaces should be preserved
- Ventricle size