Introduction To Head CT Imaging

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DISCLOSURES

- Financial Disclosure
  - Nothing to disclose

- Unlabeled/Unapproved Uses Disclosure
  - Nothing to disclose
- Some slides have been adapted from teaching modules at OU, UIC, and NSA

LEARNING OBJECTIVES

Upon completion of this course, participants will be able to:

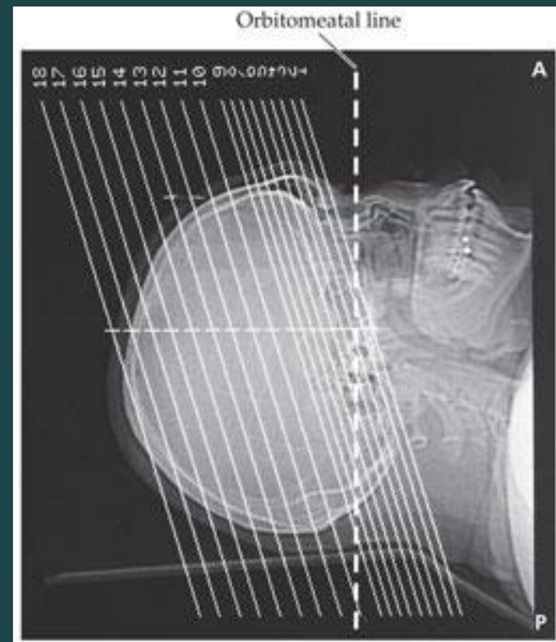
- Understand the basics of head CT imaging
- Identify and describe basic cerebral anatomy
- Develop an approach to head CT interpretation
- Identify pathologic lesions found on head CT

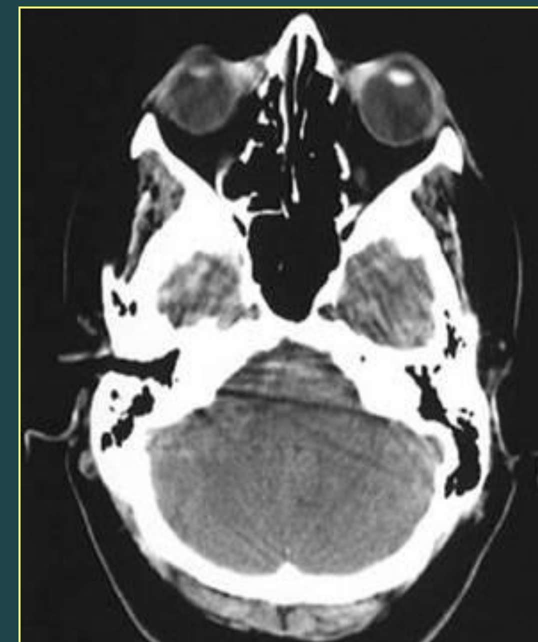
CT BASICS

- CT uses x-rays
- Provides axial brain view
- CT scan measures density of the tissue being studied

CT Brain axial view

- CT uses x-rays to make cross-sectional axial images
- Right is on left and left is on the right
- Patient lying on a stretcher with feet coming toward you and is slid through a large open ring (CT machine)





- Lateral view of skull is shown with imaging planes indicated by lines. The true horizontal plane is approximated by the orbitomeatal line, while the typical CT imaging plane is angled slightly upward anteriorly

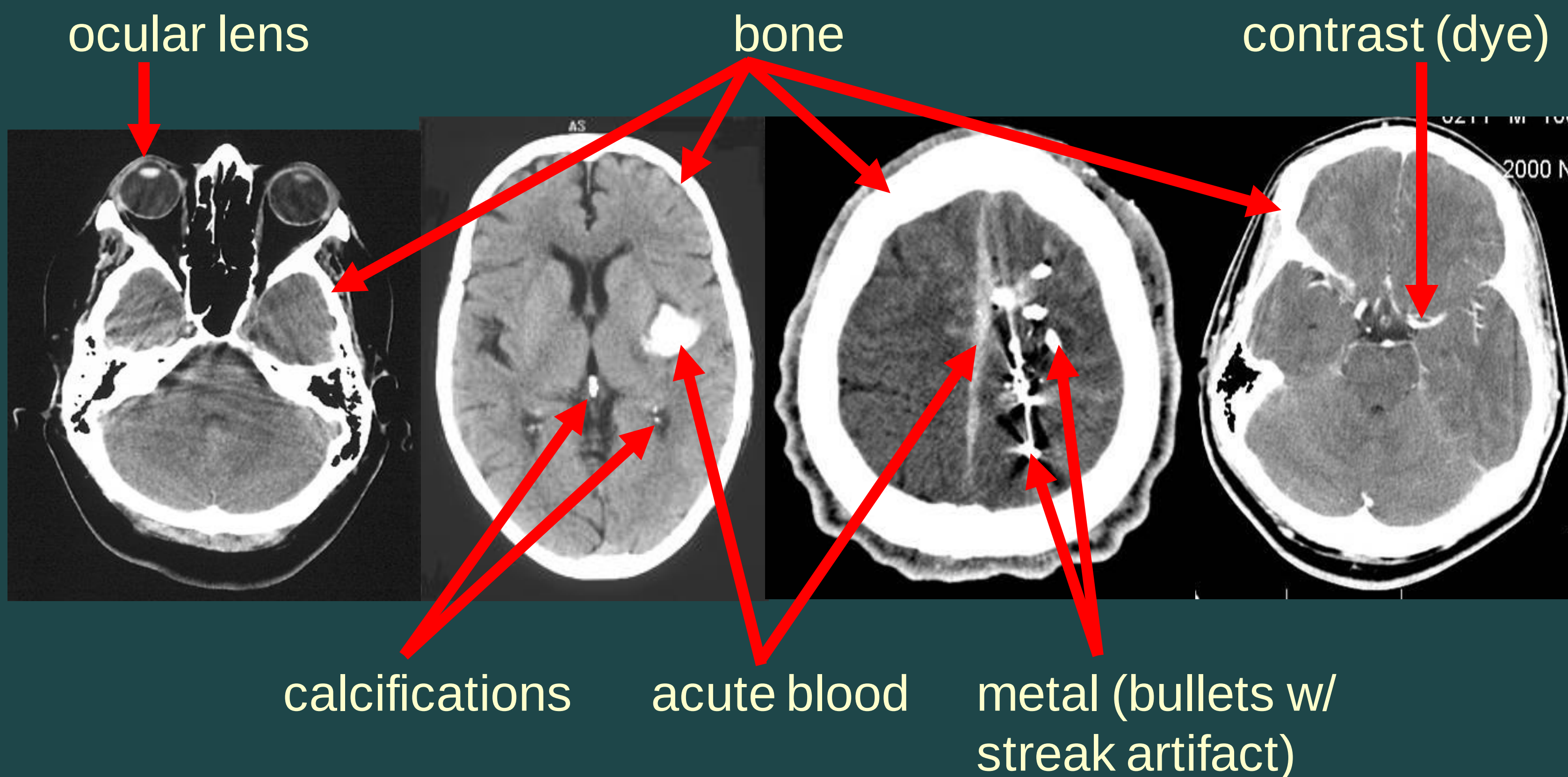
CT BASICS-density

- Black

Structure/ Tissue	Hounsfield units
Air	-1000 to -600
Fat	-100 to -60
Water	0
CSF	+8 to 18
White matter	+30 to 41
Gray matter	+37 to 41
Acute blood	+50 to 100
Calcification	+140 to 200
Bone	+600 to 2000

White

Hyperdense things on CT



Isodense things on CT

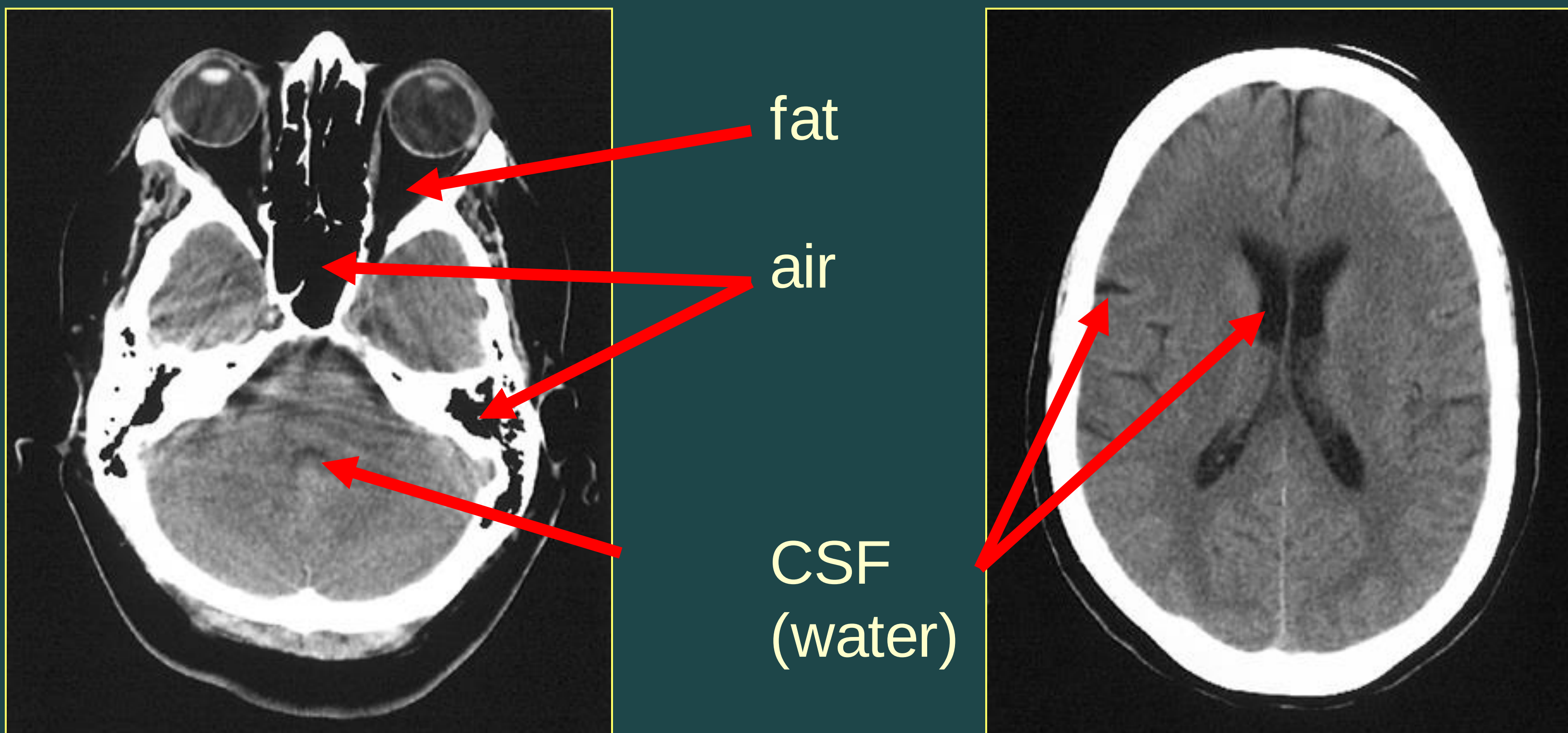
- *Note that white matter is less dense than gray matter and therefore: **white matter is <u>darker</u> than gray matter***

Gray matter (cerebral cortex)

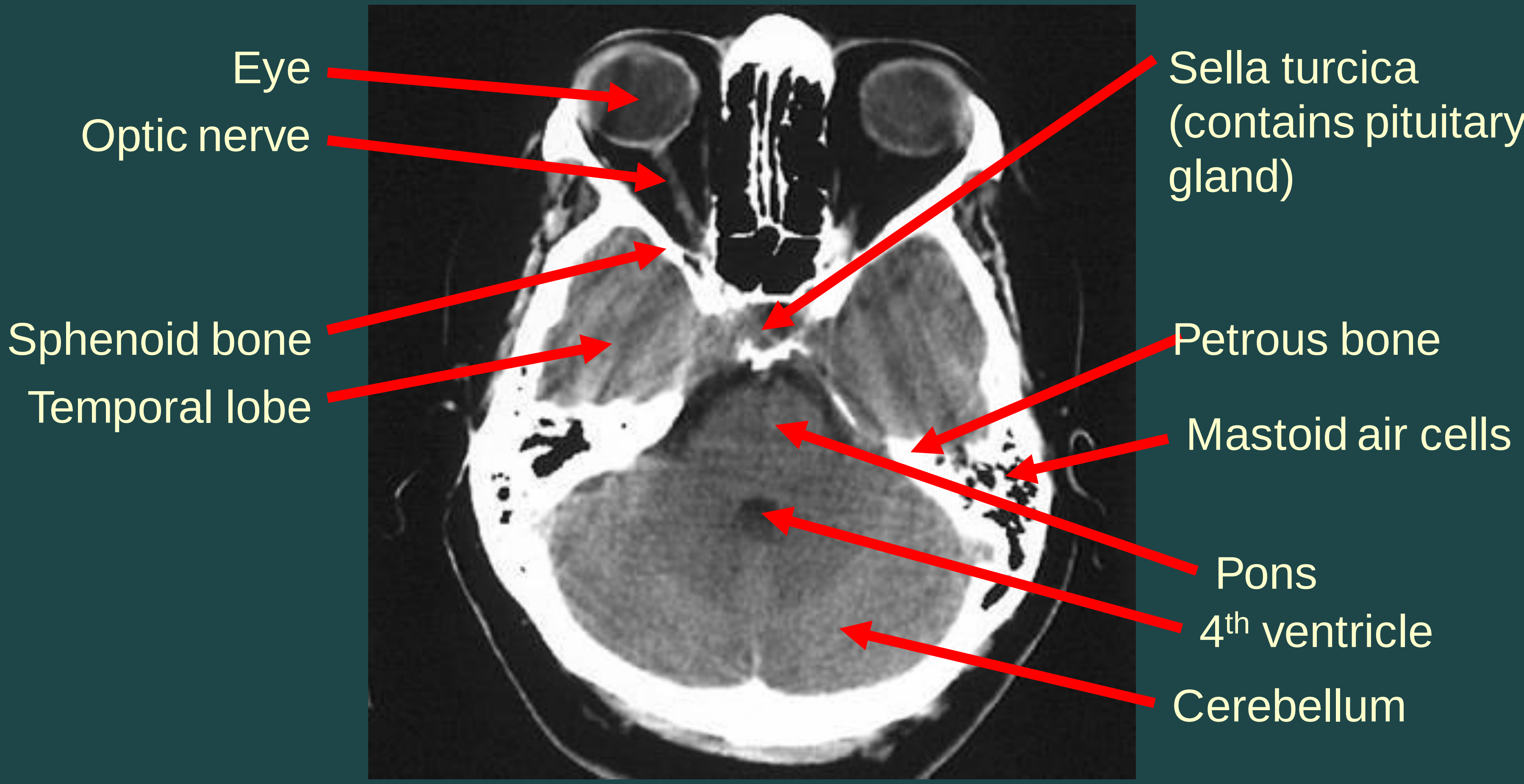
Gray matter (basal ganglia)

White matter

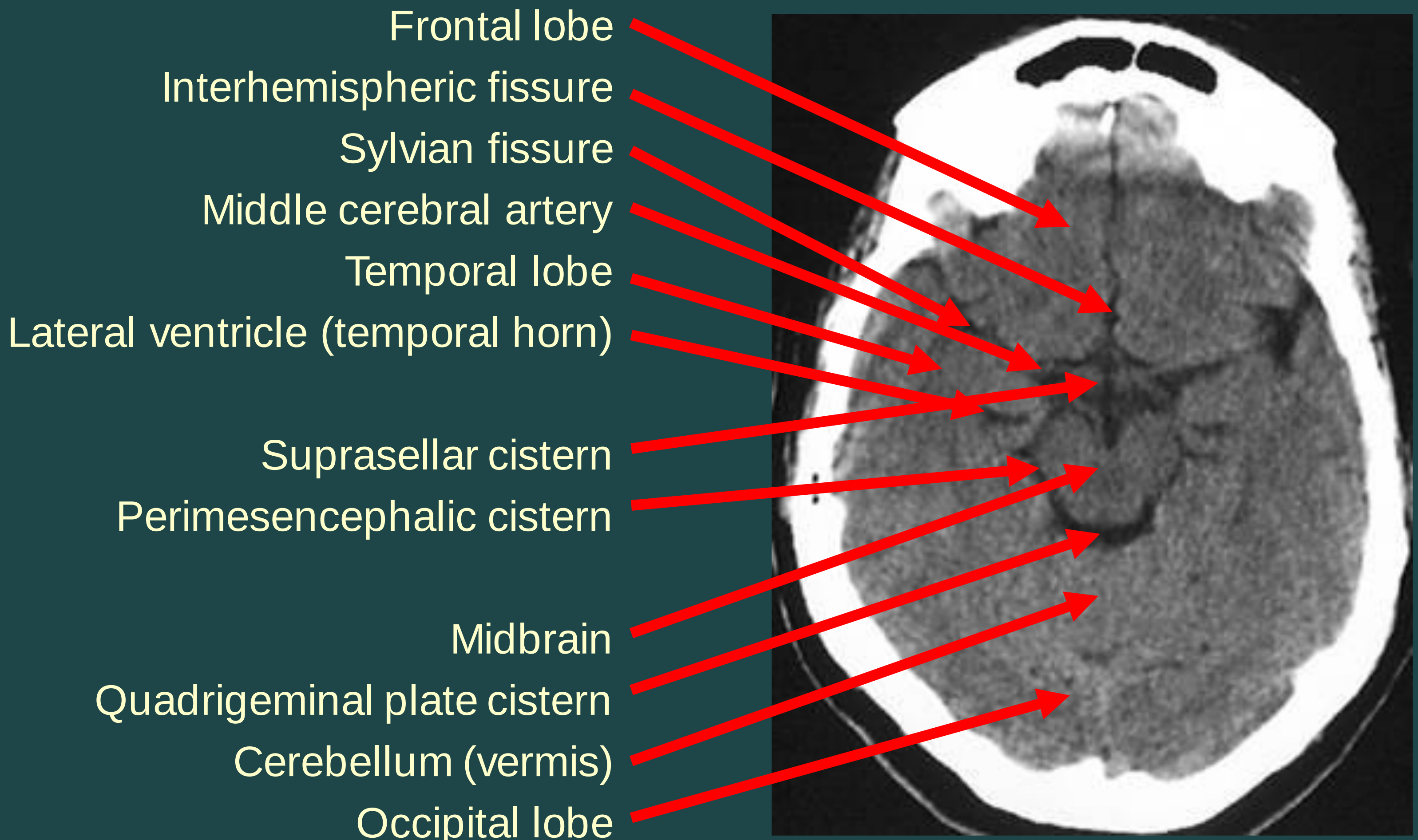
Hypodense things on CT



Normal Brain anatomy



Normal Brain Anatomy



Normal Brain Anatomy

Frontal lobe
Lateral ventricle (frontal horn)
Caudate nucleus (head)
Sylvian fissure
Insula (cortex)
Lentiform nucleus
Internal capsule (post. limb)
Thalamus
Pineal gland (calcified)
Choroid plexus (calcified)
Occipital lobe

Approach to Reading a CT scan- ABBBC

- A- Air-filled structures (sinuses, mastoid air cells)
- B- Bones (fractures)
- B- Blood (subarachnoid, intracerebral, subdural, epidural hematoma)
- B- Brain tissue (infarction, edema, masses, brain shift
- C- CSF spaces (sulci, ventricles, cisterns, hydrocephalus, atrophy)

A- Air-filled Structures

- Normal air spaces are black both on bone and brain window (frontal, maxillary, ethmoid, and sphenoid sinuses)
- Mastoids are spongy bone filled with tiny pockets of air When these pockets are opacified you will see a (gray or white) shade
- Air-fluid levels in the setting of trauma suggest a fracture
- Mastoid opacification without trauma indicates mastoiditis

B- Bones

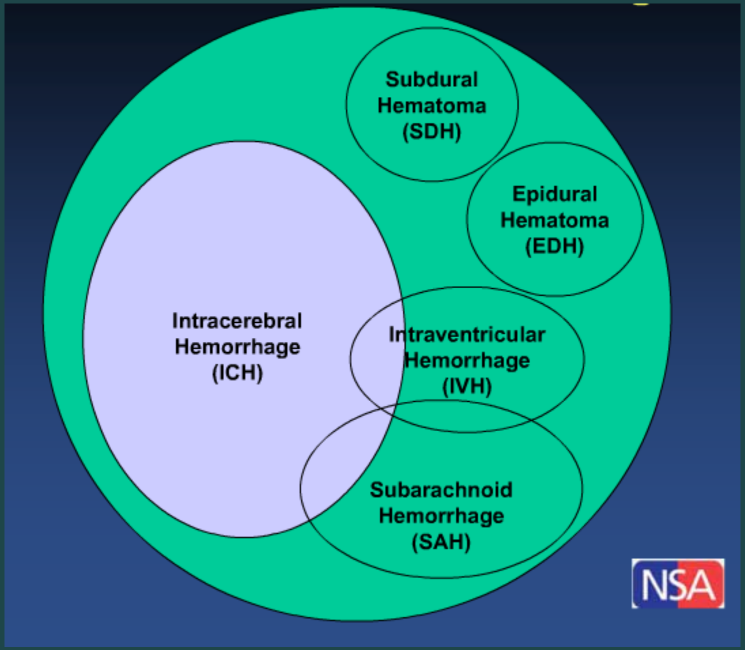
- Useful when trauma is suspected
- Window your image for bone reading
- Recognize normal suture structures (usually visible on both sides)
- If fracture suspected, inspect the opposite side for similar finding
  - If not present then look for abnormalities associated with the fracture (air/pneumocephalus, black spots within the hemorrhage)

B- Blood

Location and shape of the blood

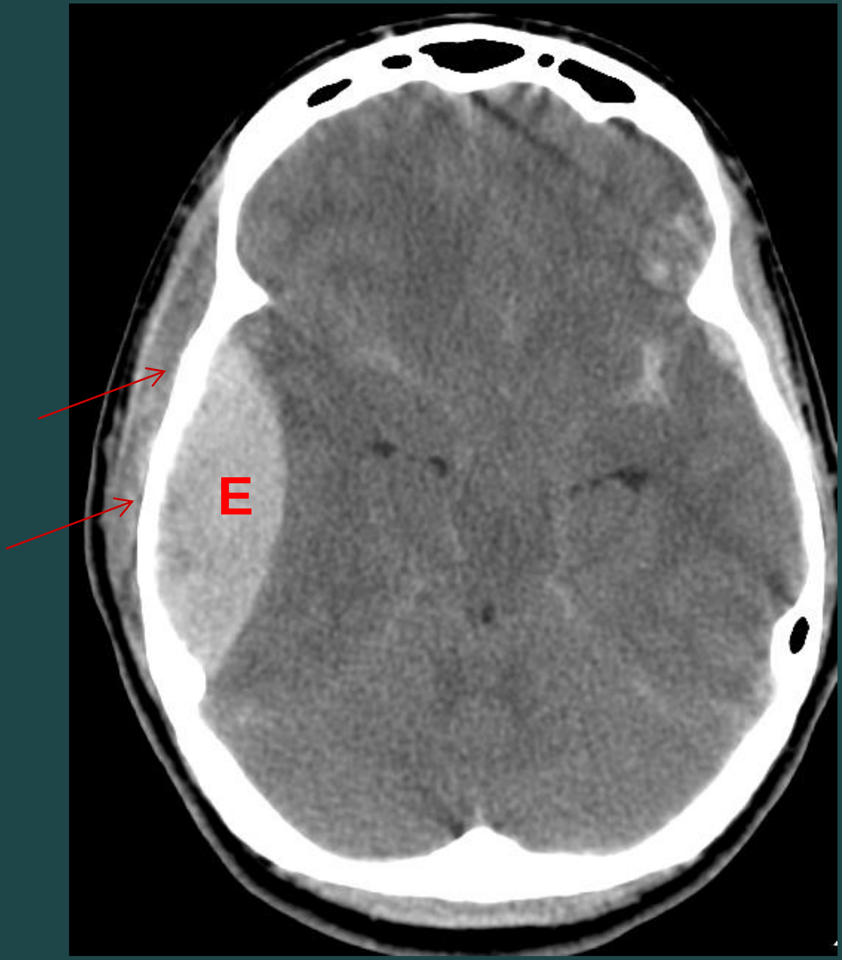
- Epidural hematoma: over brain convexity, not crossing suture line, lens shaped (biconvex).
- Subdural hematoma: over brain convexity, interhemispheric, along the tentorium, SDH will cross suture lines & it's crescent shaped.
- Intraparenchymal/Intracerebral hemorrhage: within the brain matter, sizes/shape varies dependent on etiology can be regular or irregular.
- Interventricular hemorrhage- inside ventricles, can be isolated and or secondary to SAH, ICH.
- Subarachnoid hemorrhage- blood within the subarachnoid spaces (sulci, sylvian fissure, cisterns). Usually assumes shape of the surrounding cerebral structure

Types of Intracranial Hemorrhage



Epidural Hematoma

- 20% will have a lucid period before clinical worsening
- Note the soft tissue swelling adjacent to the hematoma explaining the mechanism of the injury

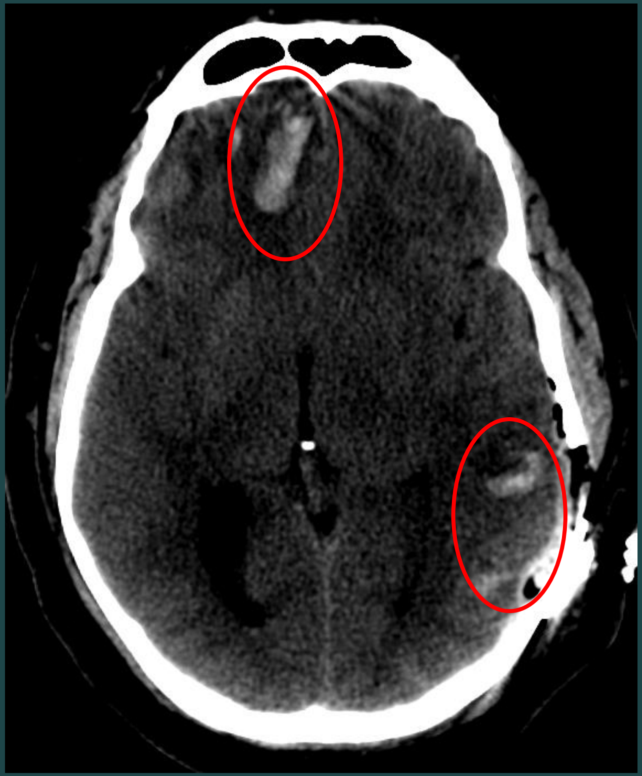


Epidural Hematoma

- Arterial injury following head trauma
  - Lens shaped
    - Confined between the sutures
  - Most commonly middle meningeal artery

Epidural Hematoma

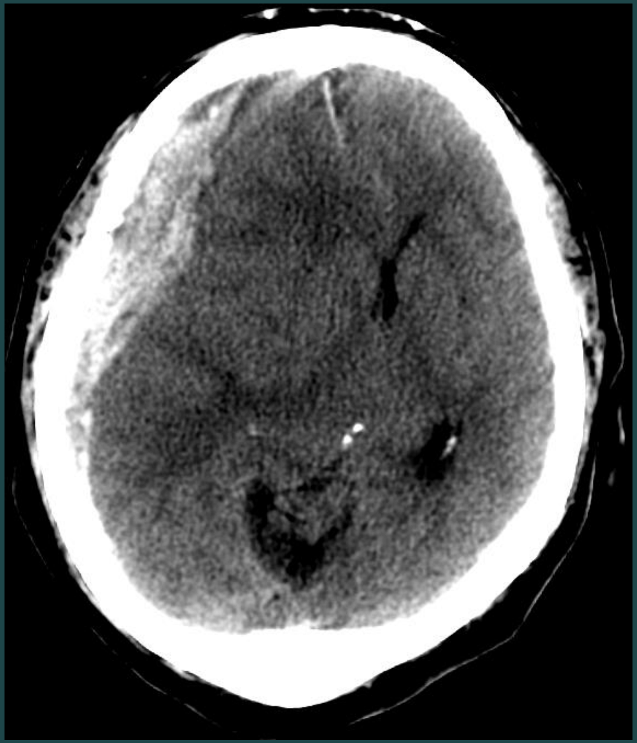
- Repeat CT brain (post-op)



Subdural Hematoma (SDH)

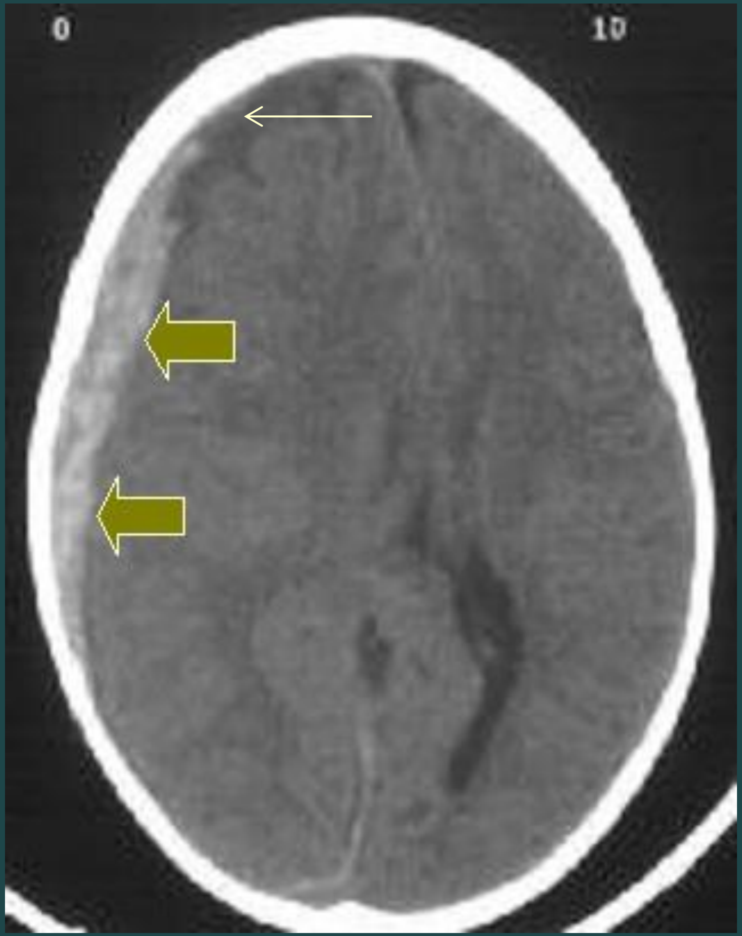
- Differentiate between acute, subacute, chronic, or acute on chronic
  - Acute SDH
    - Bright white on CT
    - Can only be removed with a craniotomy
    - Doesn’t always require surgery, depends on the patient’s neurological examination and comorbidities
    - Usually related to shearing of bridging veins between the dura and brain

Acute Subdural Hematoma

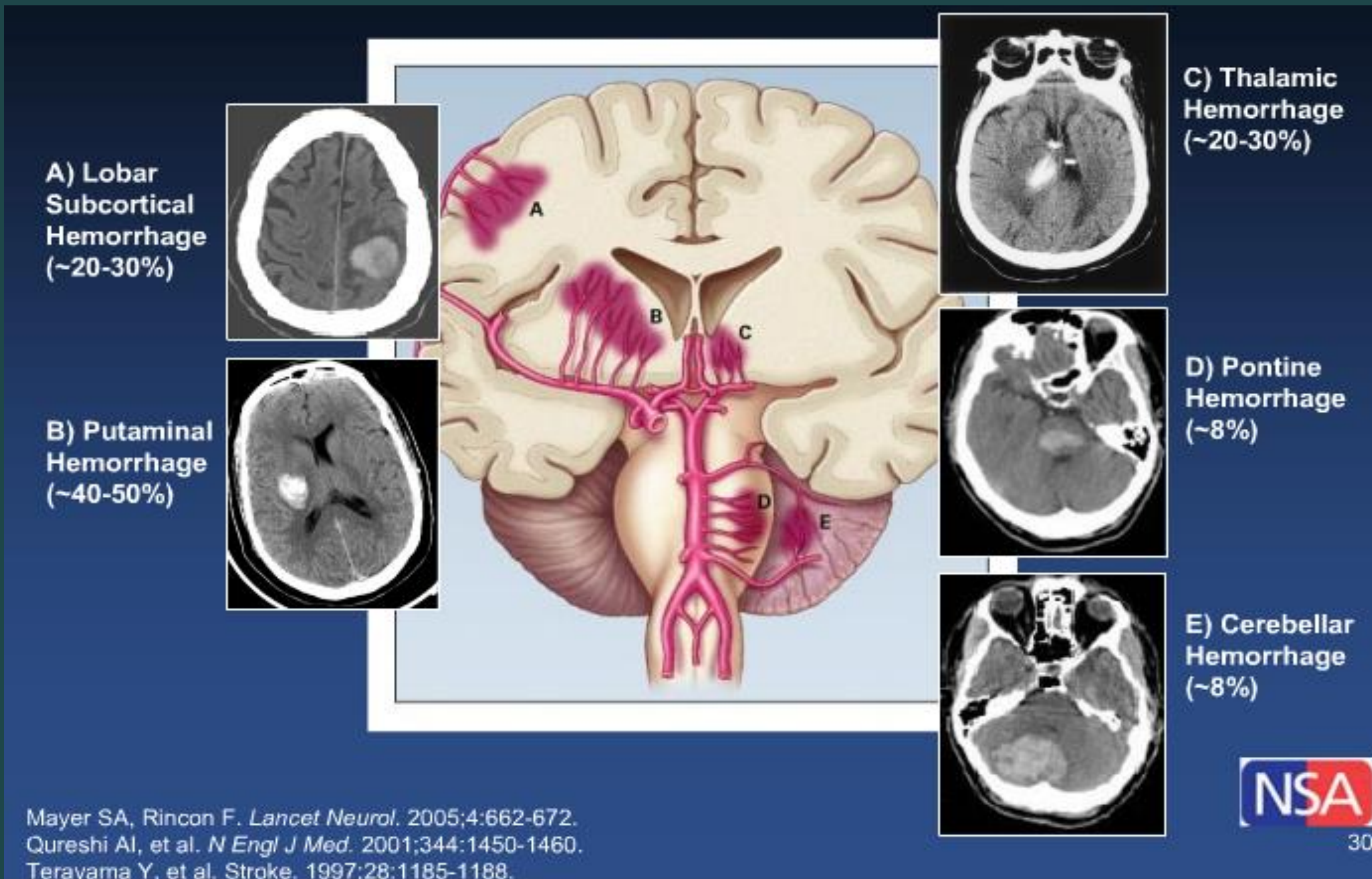


Acute and Chronic Subdural Hematoma

- Patient may be asymptomatic until the event leading to the acute component
- Chronic component can be drained using a bedside burr hole device such as the Subdural Evacuation Port System (SEPS)



ICH: Sites of Spontaneous ICH



CT Angiography "Spot Sign" Predicts Hematoma Expansion in Acute Intracerebral Hemorrhage

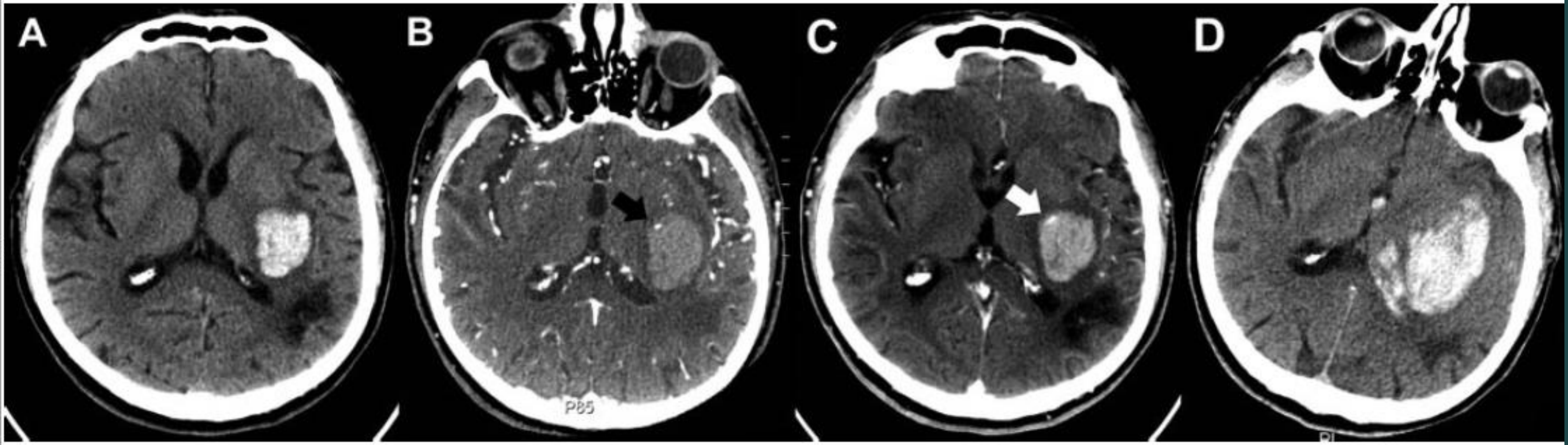


Figure 1. Patient with spot sign, demonstrating extravasation and hematoma expansion. CT slice selection has been optimized for hematoma configuration, not for head position. A, Unenhanced CT demonstrates left posterior putaminal and internal capsule hematoma with mild surrounding edema. An old parieto-occipital infarct is seen posterior to this. B, A small focus of enhancement is seen peripherally on CTA source images, consistent with the spot sign (black arrow). C, Postcontrast CT demonstrates enlargement of the spot sign, consistent with extravasation (white arrow). D, Unenhanced CT image 1 day after presentation reveals hematoma enlargement and intraventricular hemorrhage.

Calculating the ICH Volume

ICH volume on CT
can be estimated by

$$\frac{A \times B \times C}{2}$$

Select CT slice with largest ICH
A = longest axis (cm)
B = longest axis perpendicular to A (cm)
C = no. of slices x slice thickness (cm)

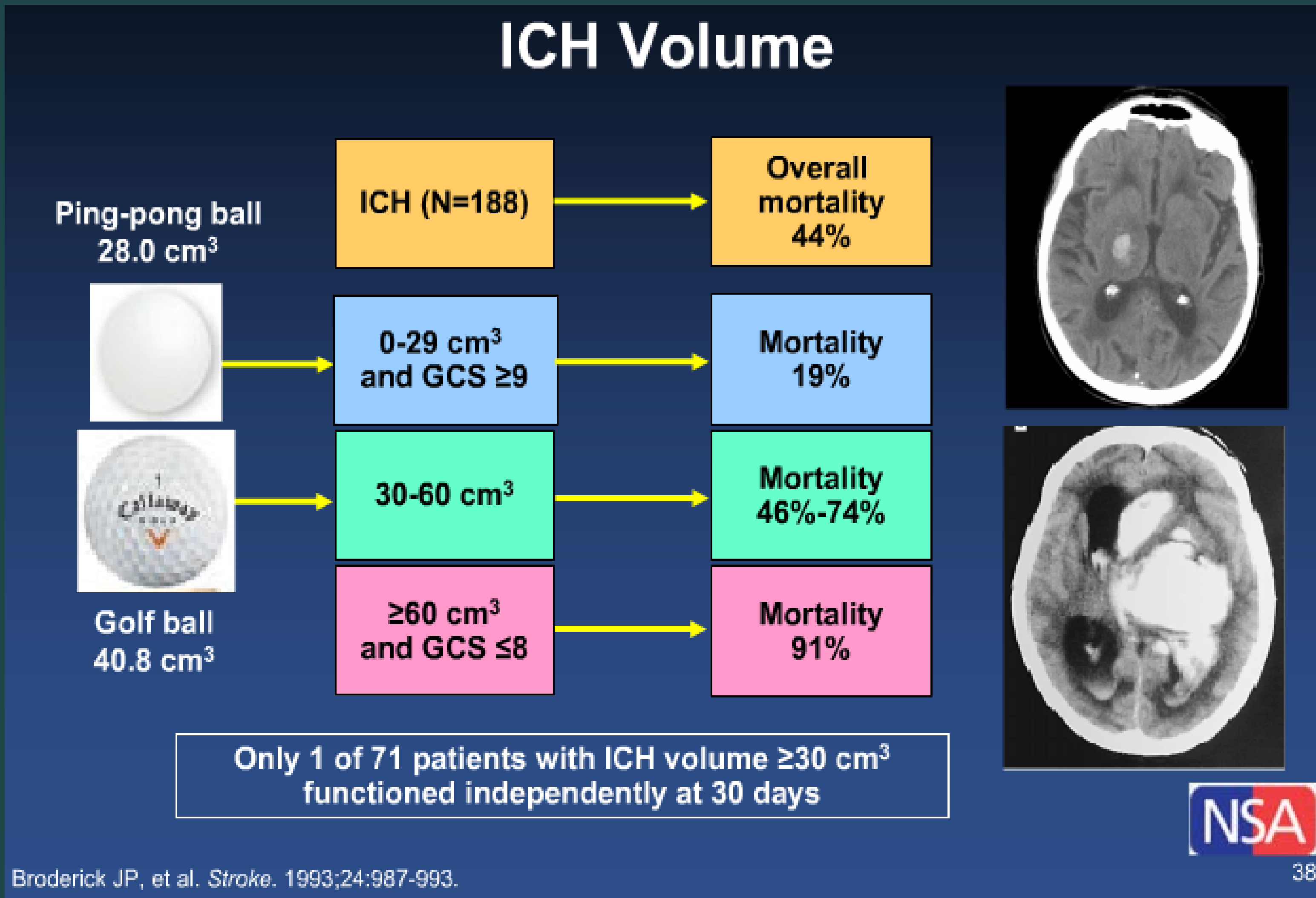
Estimated spheroid volume
correlates well with planimetric
CT analysis

For standard 0.5 cm slices: $\frac{A \times B \times C}{4}$

NSA

Kothari RU, et al. *Stroke*. 1996;27:1304-1305.

Predictor of Outcome

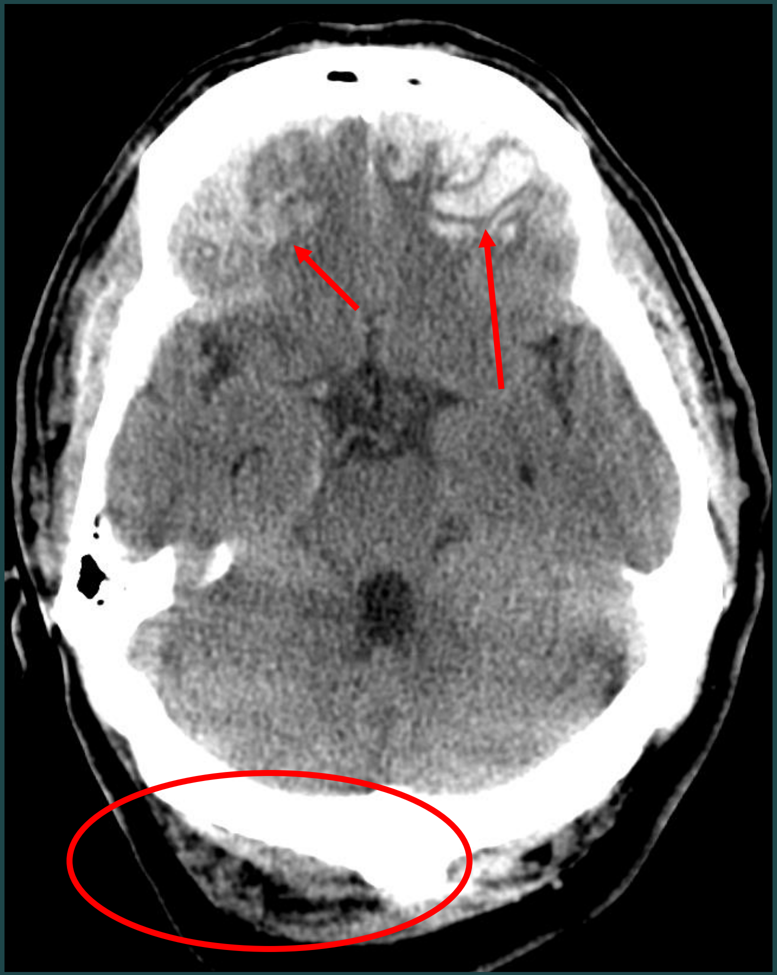


Traumatic Intracerebral hemorrhage

- Occurs at the time of impact
  - Diffuse axonal injury
    - Inertial forces cause deformation of the white matter, aka shear injuries
    - Most commonly leads to acute coma
    - CT (not very sensitive) may reveal petechial hemorrhages in the central 1/3 of the brain (subcortical white matter, corpus collosum, basal ganglia, brainstem, cerebellum)
    - MRI to evaluate extent of injury

Traumatic Intracerebral hemorrhage

- Focal parenchymal contusions
  - Coup, contra coup, intermediate coup
  - CT: hemorrhagic core surrounded by low density edema
  - Variable CBF in and around contusion



Intraventricular Hemorrhage

- Variety of etiologies
  - Anticoagulation
  - Hypertension
  - Aneurysm
  - Substance abuse
  - Trauma (less likely)
- Often will need an external ventricular drain with or without intraventricular tPA

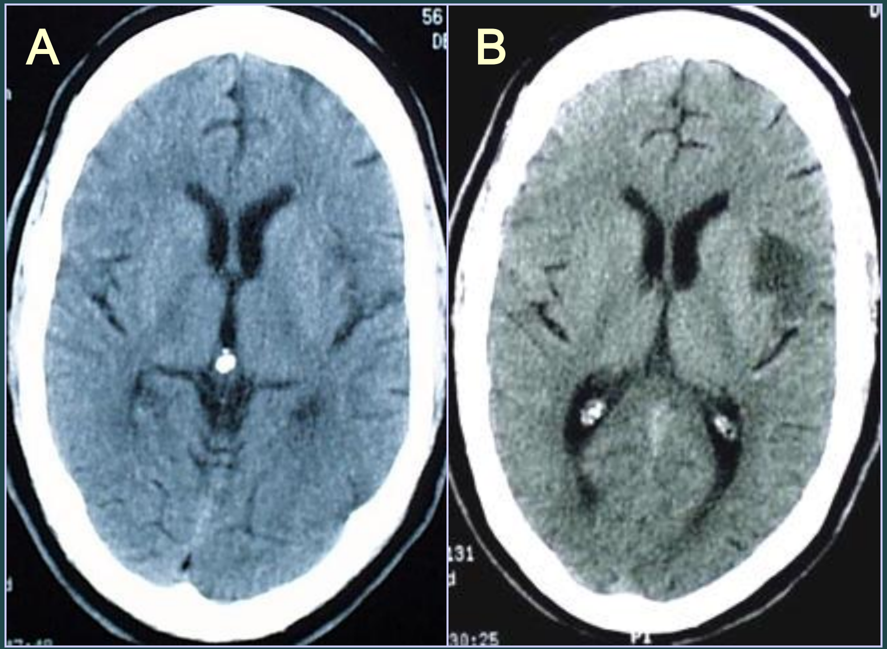
Subarachnoid Hemorrhage

- Always exclude an aneurysm even when head trauma is obvious
- Aneurysmal SAH has a poorer prognosis than traumatic subarachnoid hemorrhage
- Traumatic subarachnoid hemorrhage
  - Serially monitor the patient clinically
  - Rarely required surgical intervention
  - Usually has a good prognosis

Practice Reading CT scans-ABBBC
Brain tissue

A. In 1st few hours to day, CT usually normal (though may show blurring of gray-white junction & sulcal effacement as seen on next slide)

B. By day 2, CT shows dark area with mass effect (compression of surrounding structures)



Day 1
Acute infarction

Day 3
Subacute infarction

Herniation Syndromes

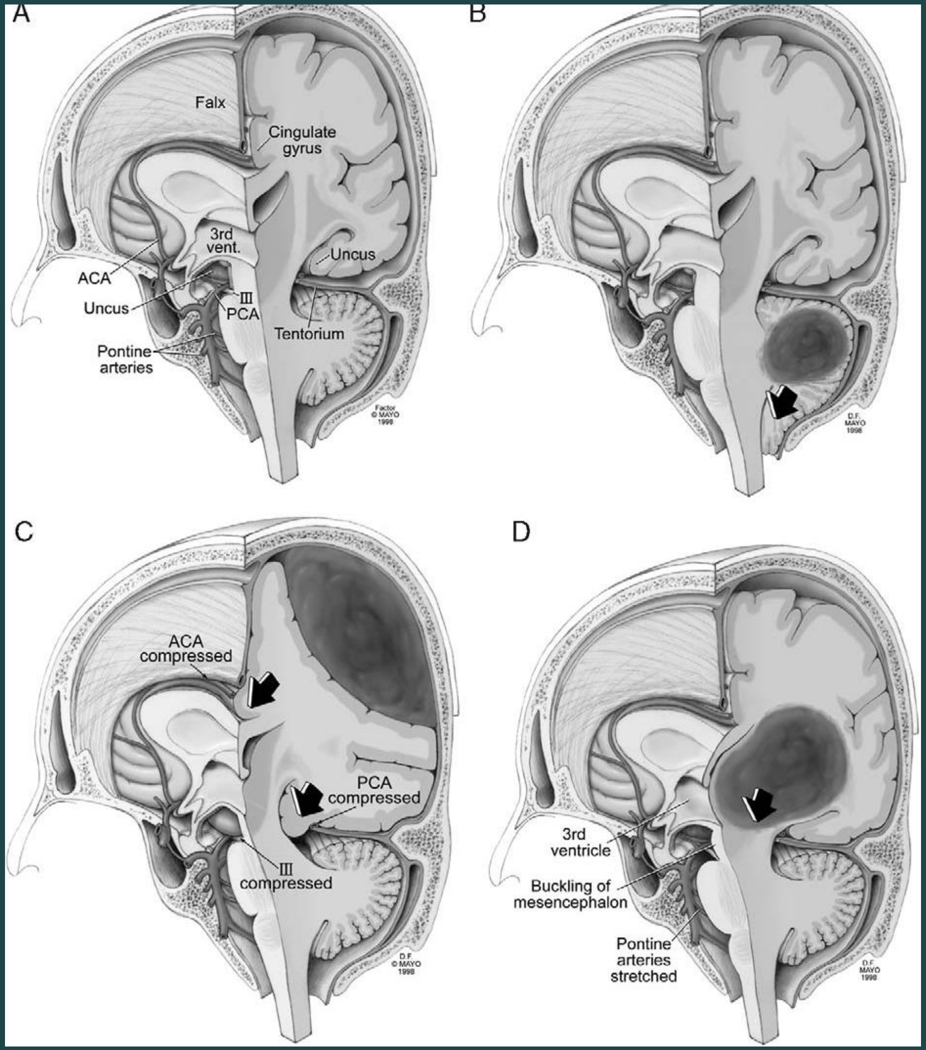


Figure 1.

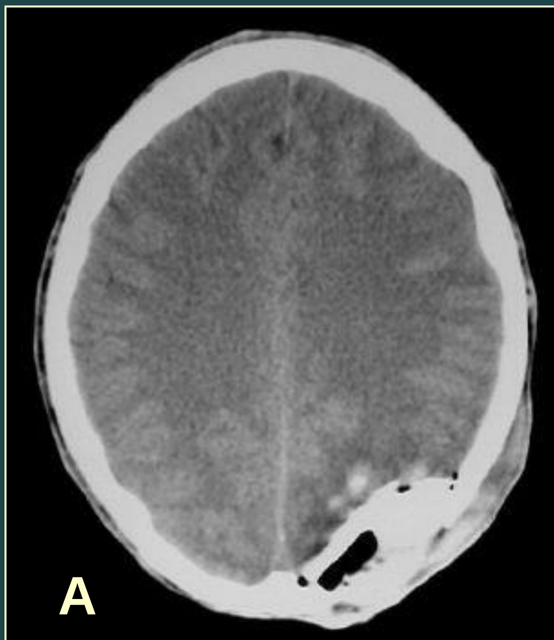
A. Normal anatomy;

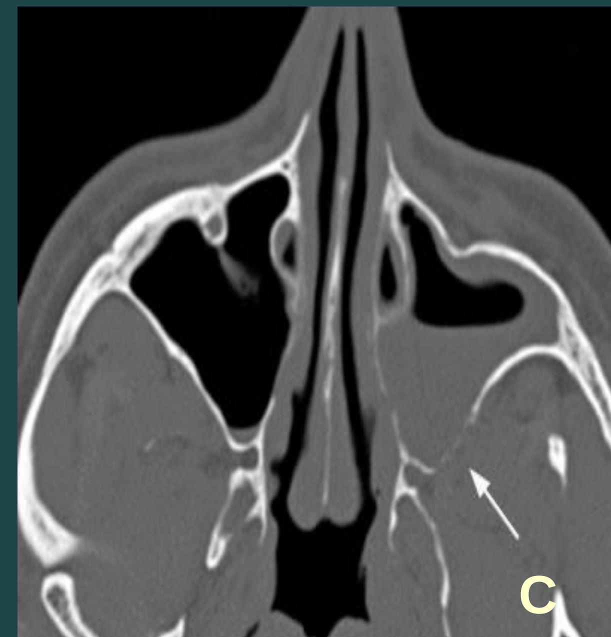
B. Tonsillar herniation;

C. Uncal and subfalcine herniation; and

D. Central herniation.

Practice Reading CT scans-ABBBC
Air filled structures





A. Left parietoocipital pneumocephalus post-op
B. Left temporal ICH
C. Left sinus air fluid level with associated sinus fracture

Thank you