Marshall Scale for Head Trauma

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History of Marshall scale

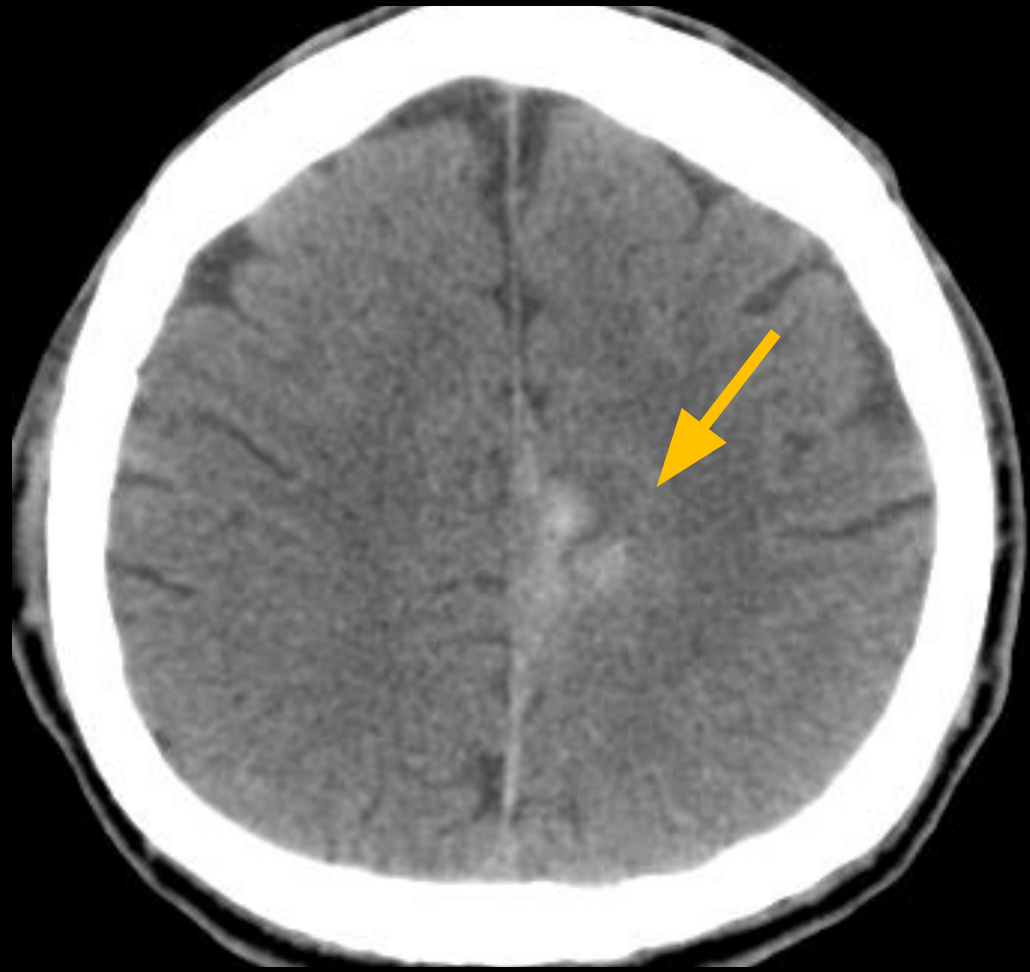
- Proposed by Marshall, et al in 1991 to classify head injury
- Used to identify patients at higher risk for mortality
- Evaluates 3 imaging findings
  - Basilar cisterns
  - Midline shift
  - High/mixed density mass lesions
- Correlation shown between category and mortality
  - Category 1: 10% mortality
  - Category 4: >50% mortality

Imaging findings seen in Head Trauma

- Subarachnoid hemorrhage
- Subdural hemorrhage
- Epidural hemorrhage
- Herniation
- Edema
- Intra-parenchymal Hemorrhage
- Fracture

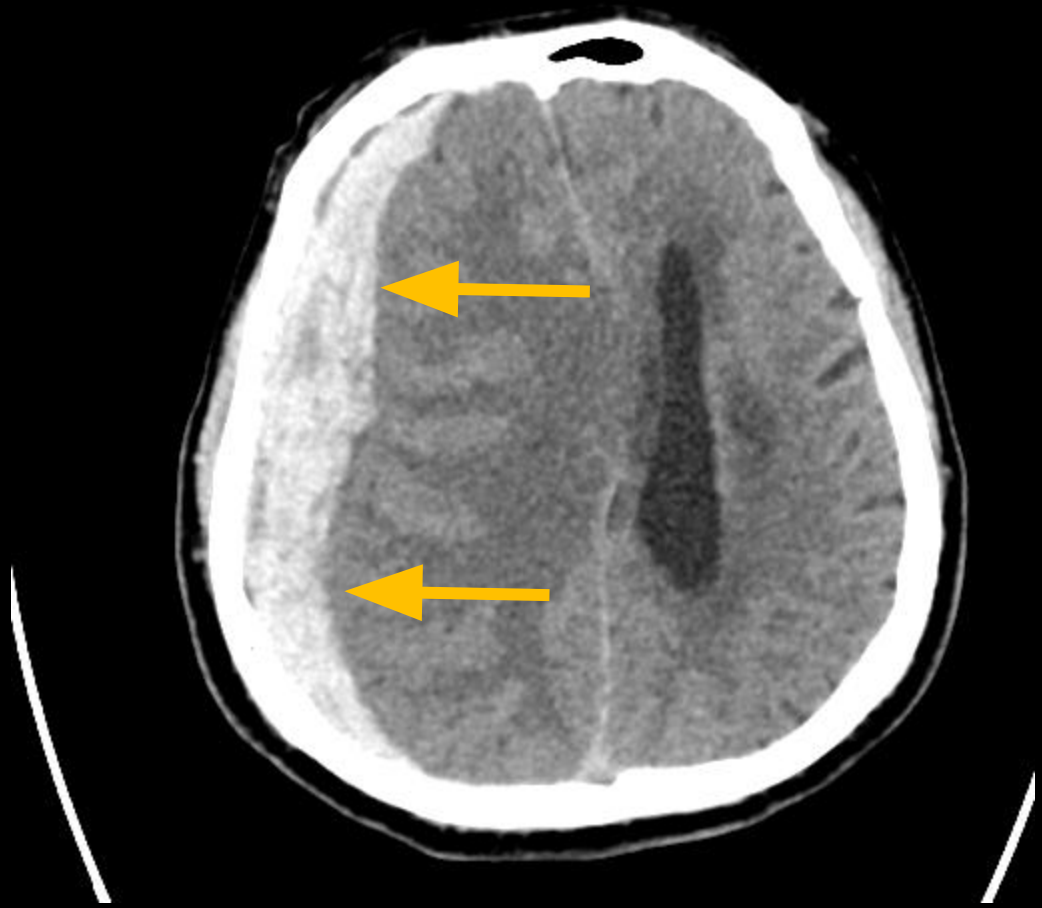
Subarachnoid hemorrhage

- Trauma is most frequent cause of SAH
- Complications include vasospasm and hydrocephalus
- May require CTA to differentiate from aneurysmal SAH



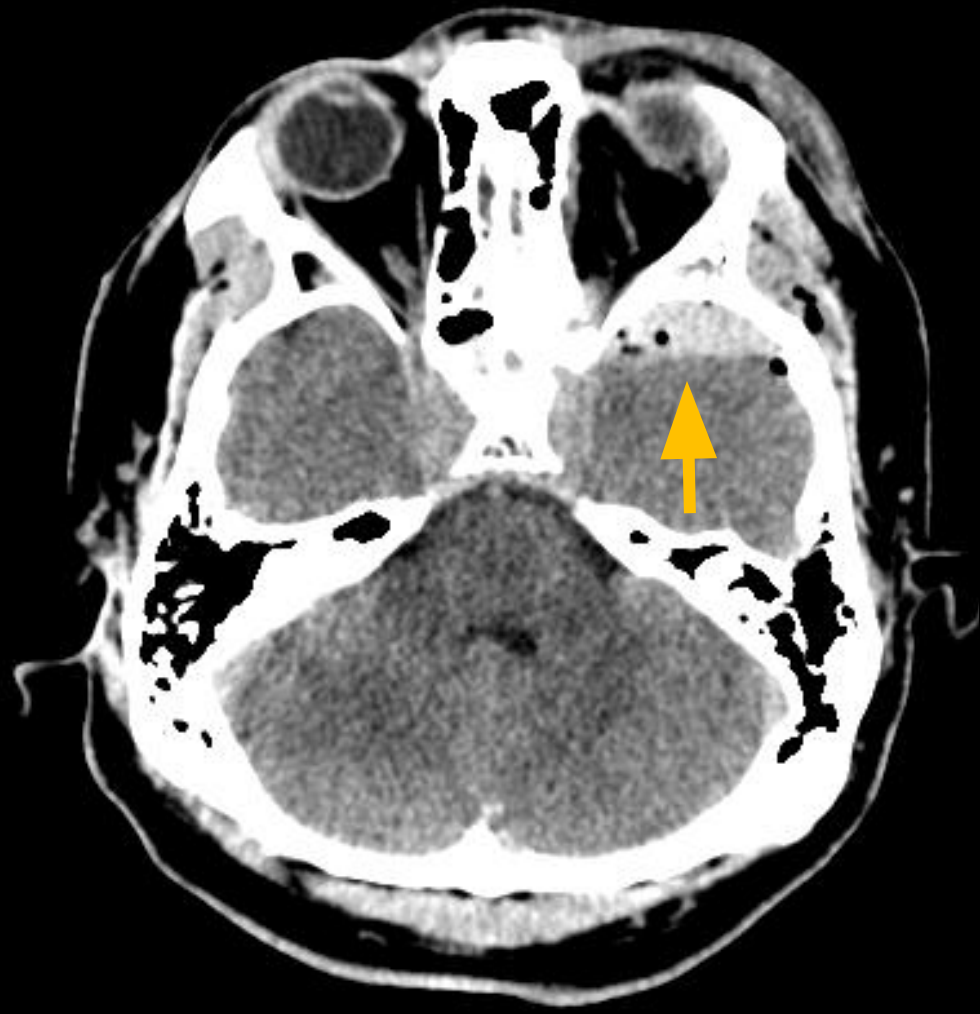
Subdural hemorrhage

- Prognosis depends on size and chronicity
- Increased density in acute SDH
- May require surgical drainage if large and/or acute



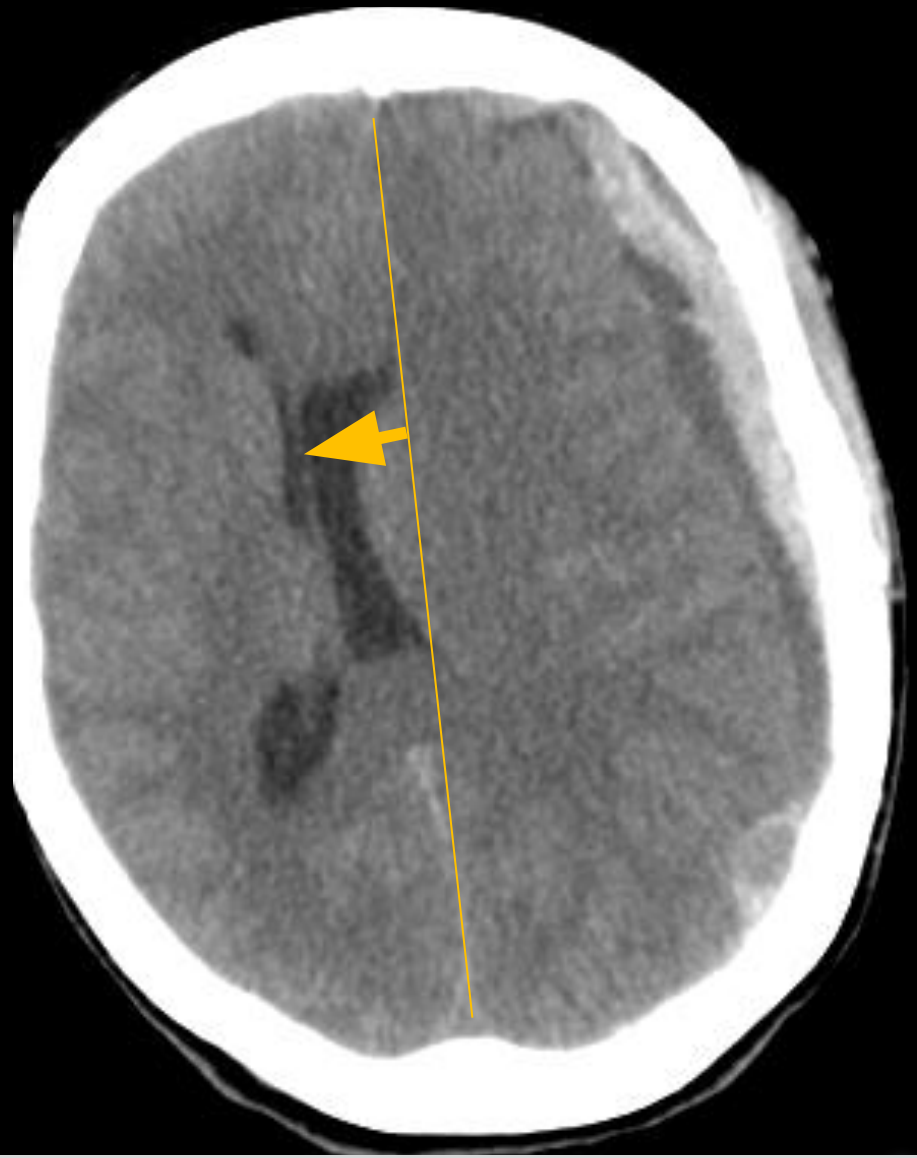
Epidural hemorrhage

- Usually associated with fracture
- Require urgent surgical drainage if enlarging (arterial bleed)
- Small EDH often managed conservatively



Herniation

- Subfalcine herniation (midline shift)
- Measure shift of septum pellucidum from midline
- Can result in hydrocephalus or infarction



Edema

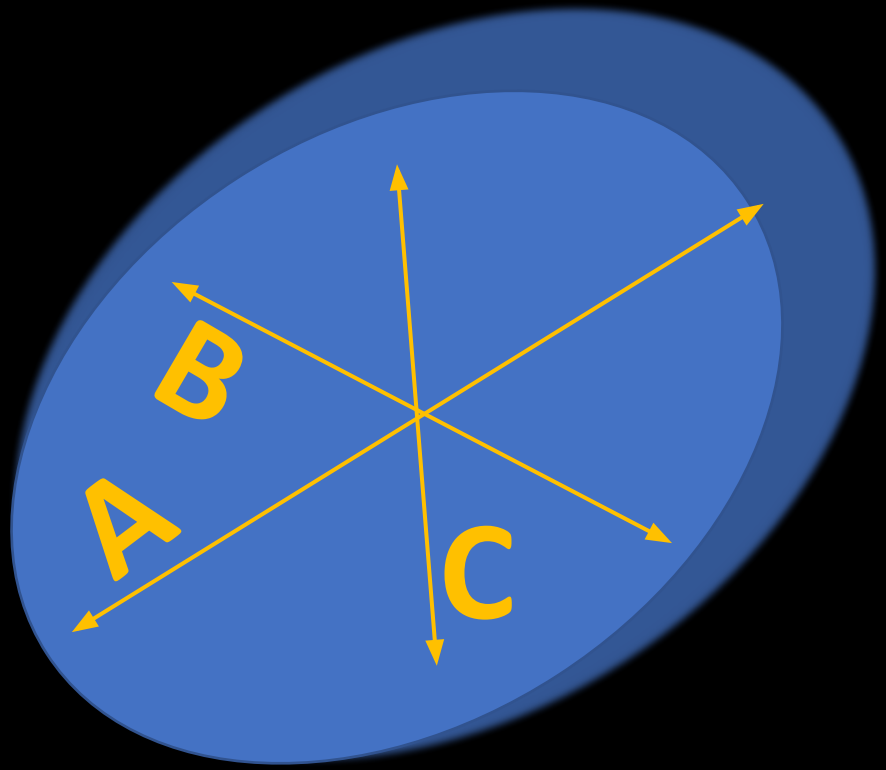
- Loss of normal sulci
- Loss of gray-white differentiation
- May be associated with hypoxic-ischemic injury

Intra-parenchymal Hemorrhage

- High/mixed density mass
- Most common in frontal and temporal lobes
- Small lesions frequently seen with traumatic axonal injury

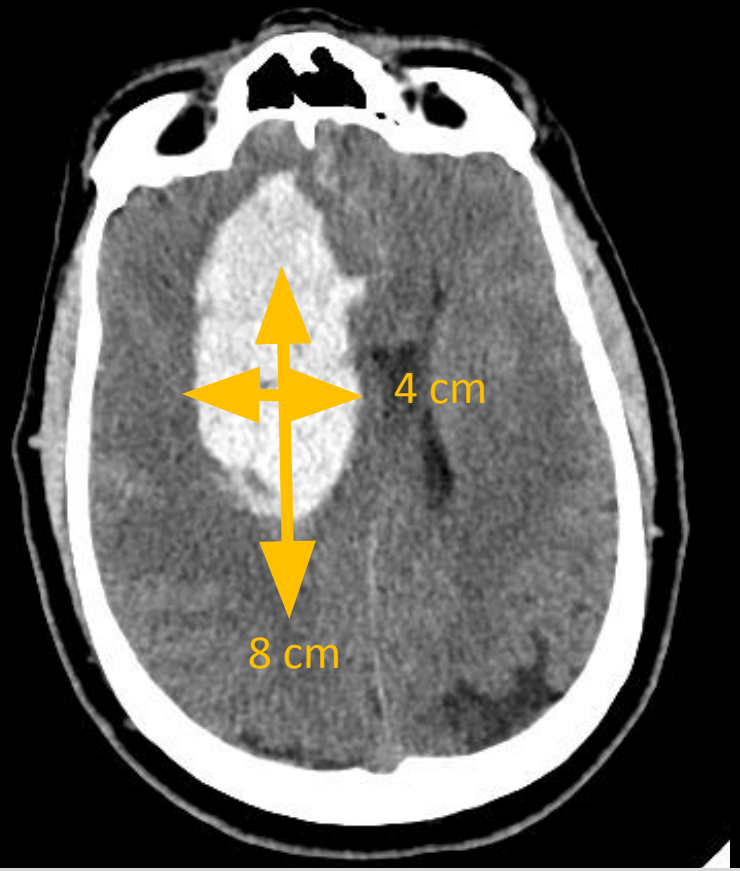
Measurement of high/mixed density masses

- Measure maximum transverse, anterior-posterior, and cranio-caudal dimensions (A, B, C)
- Volume of ellipsoid is calculated by formula:
  - Volume = (A * B* C) / 2
- Newman G, Stroke. 2007;38:862

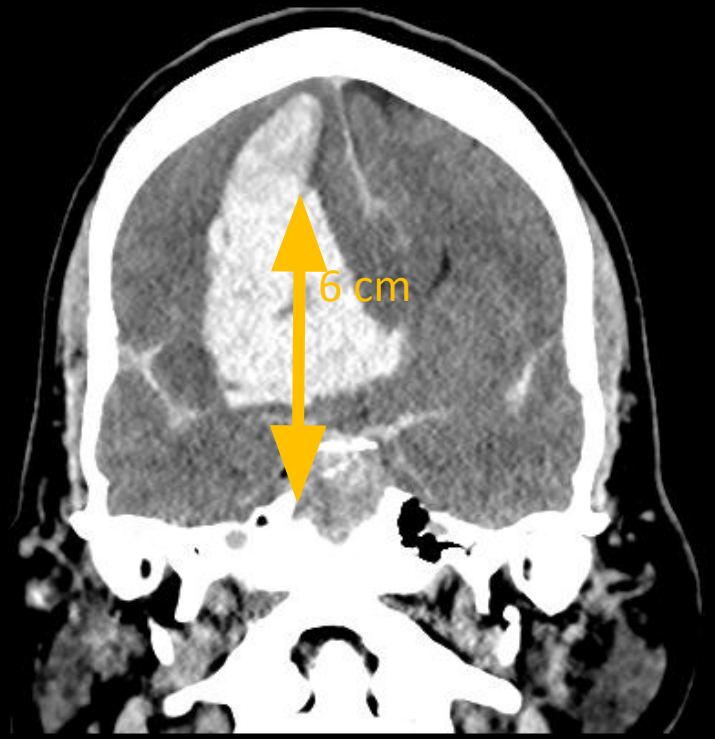


Measurement of hemorrhage volume

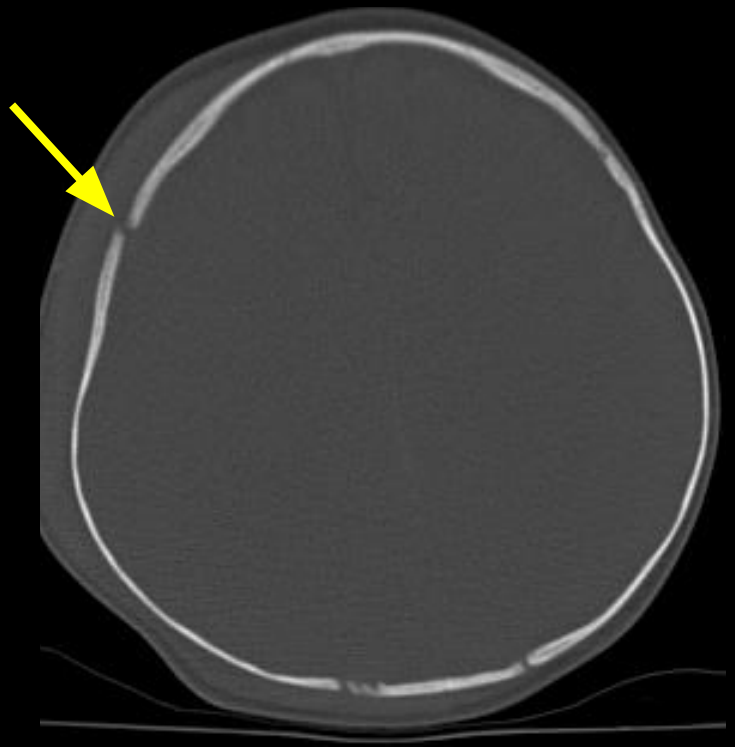
A = 4cm, B = 8 cm, C = 6 cm

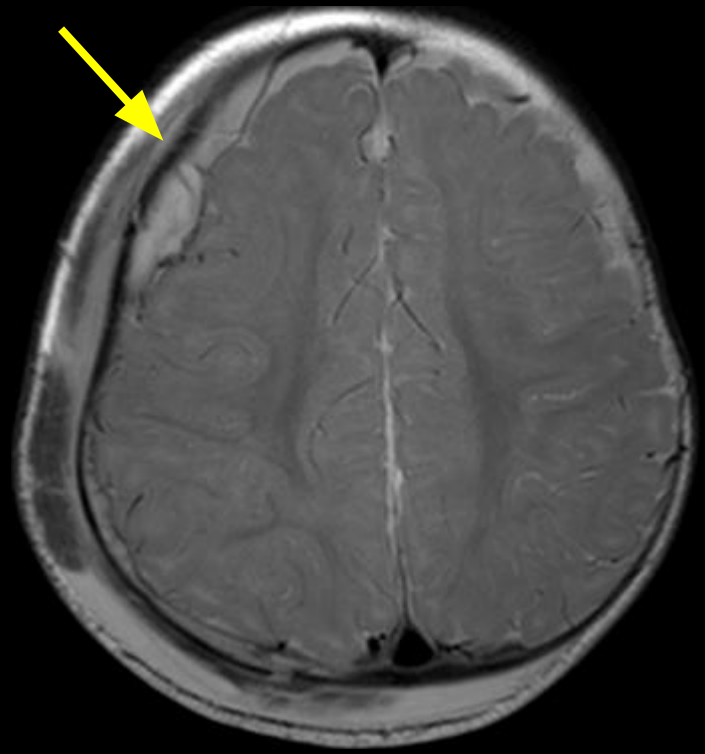


Volume = (4 * 8 * 6) / 2 = 96 cc



Fracture





Categories of Marshall scale

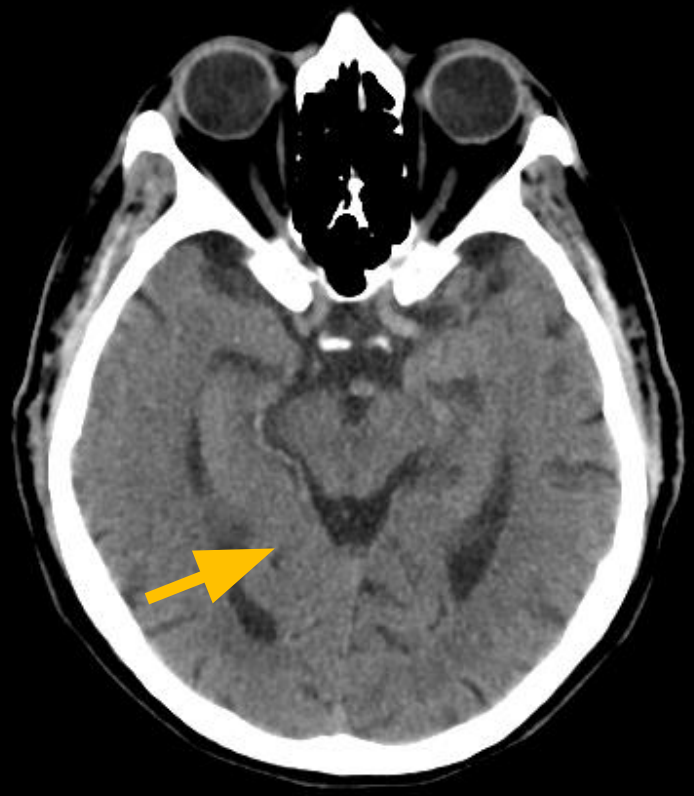
- 1: Normal for age
- 2: High/mixed density mass less than 25cc, midline shift less than 5mm, basilar cisterns preserved
- 3: Basilar cisterns effaced
- 4: Midline shift greater than 5mm
- Evacuated mass lesion: High/mixed density mass >25cc which was surgically evacuated
- Non-evacuated mass lesion: High/mixed density mass >25cc not surgically treated

Examples of each category

- Findings to evaluate for Marshall score:
  - Volume of high/mixed density mass
  - Basilar cisterns
  - Midline shift
- Other findings:
  - Fracture
  - Pneumocephalus
  - Subarachnoid hemorrhage

Category 1

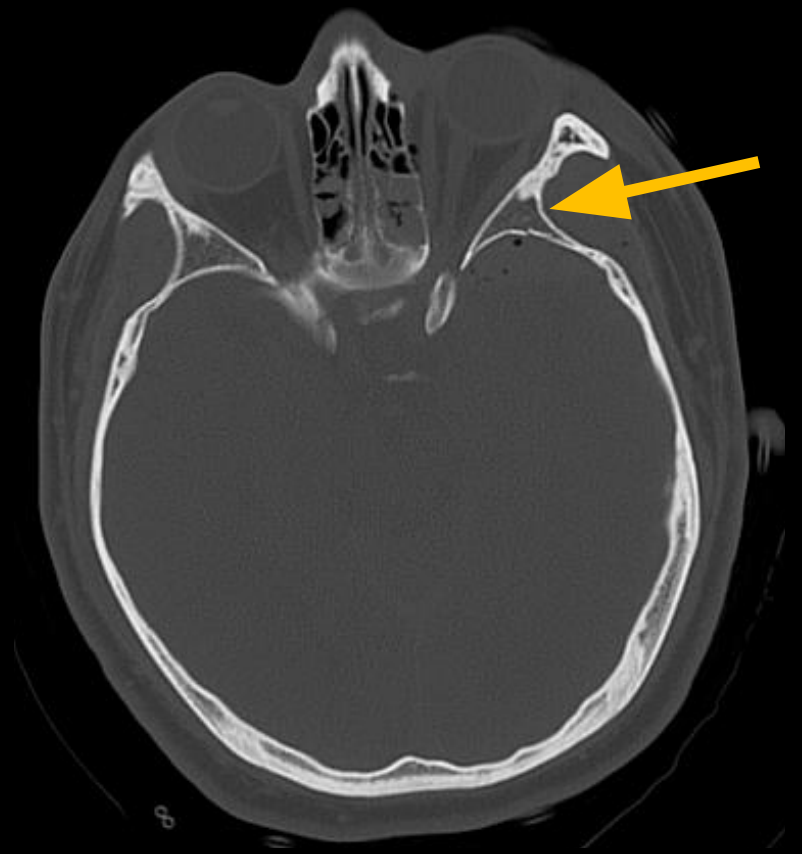
Basilar cisterns patent



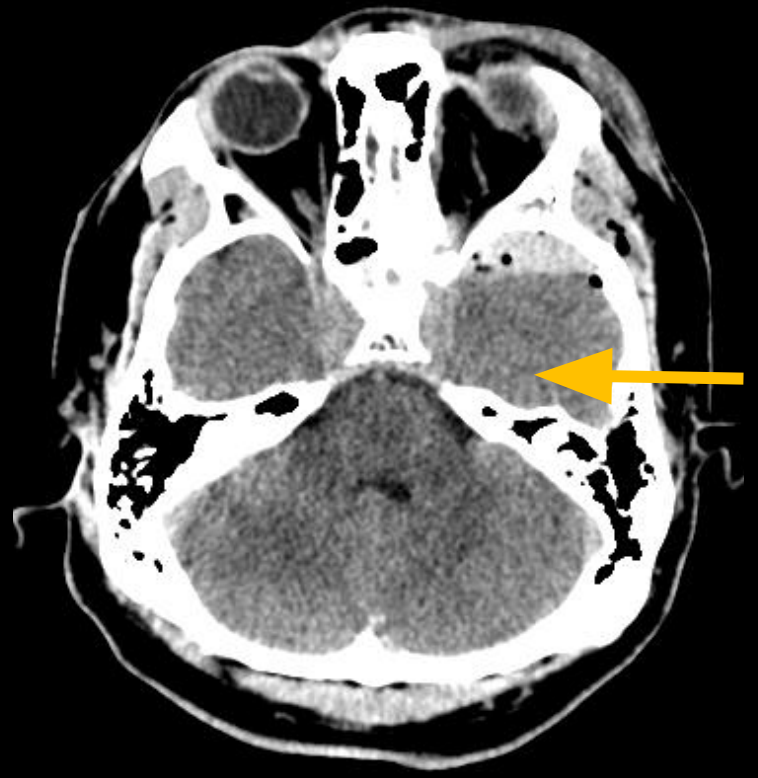
No midline shift

Category 2

Sphenoid fracture and pneumocephalus

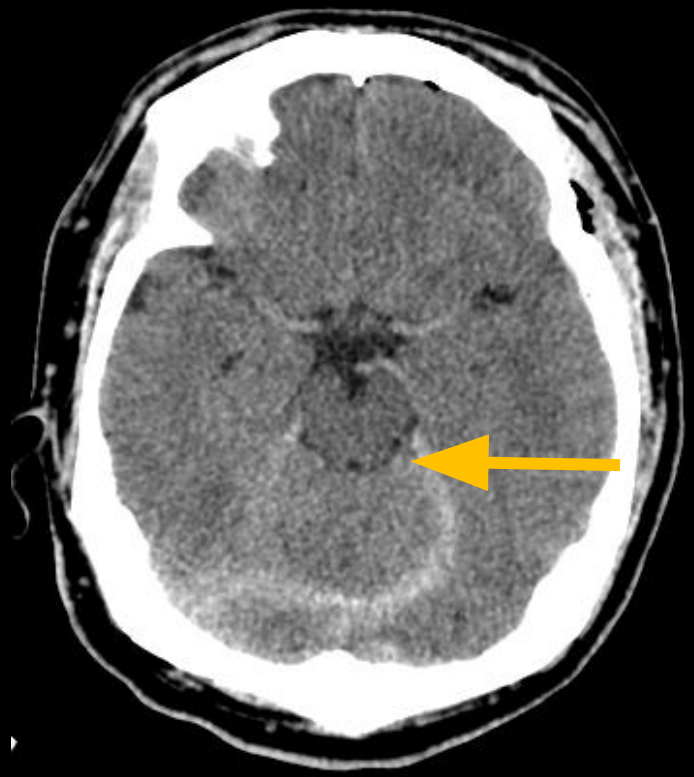


Epidural hemorrhage

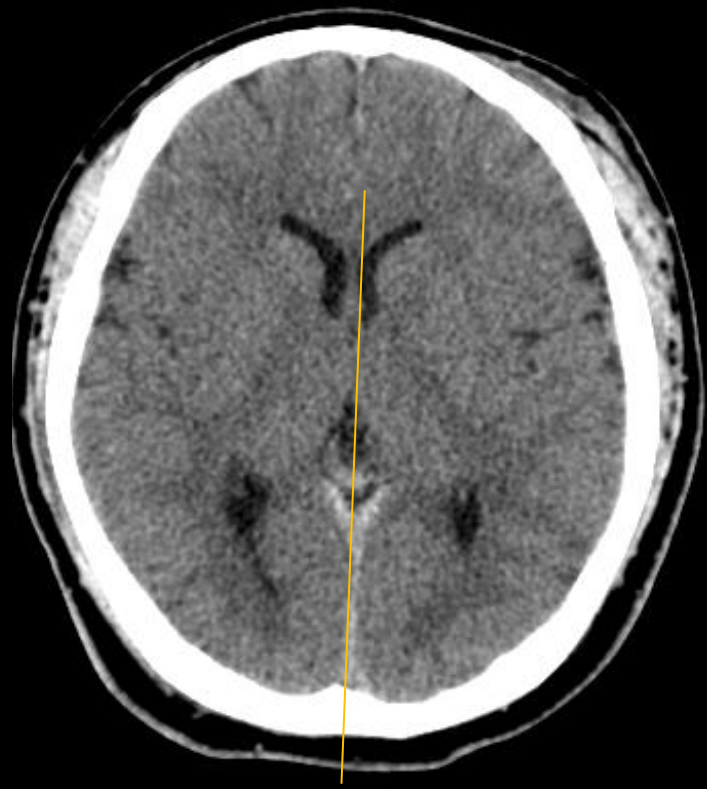


Category 2

Basilar cisterns patent

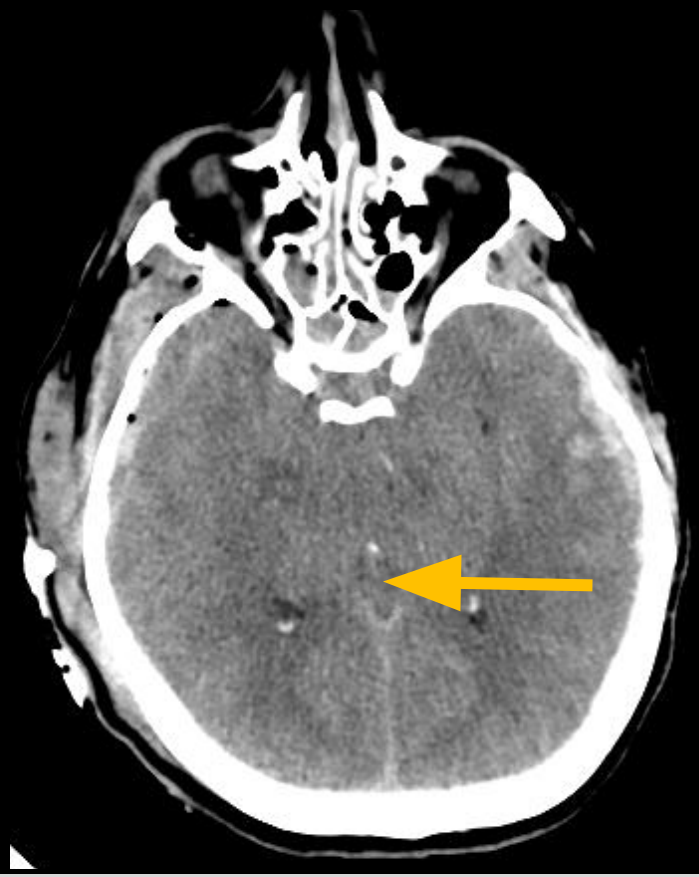


No midline shift



Category 3

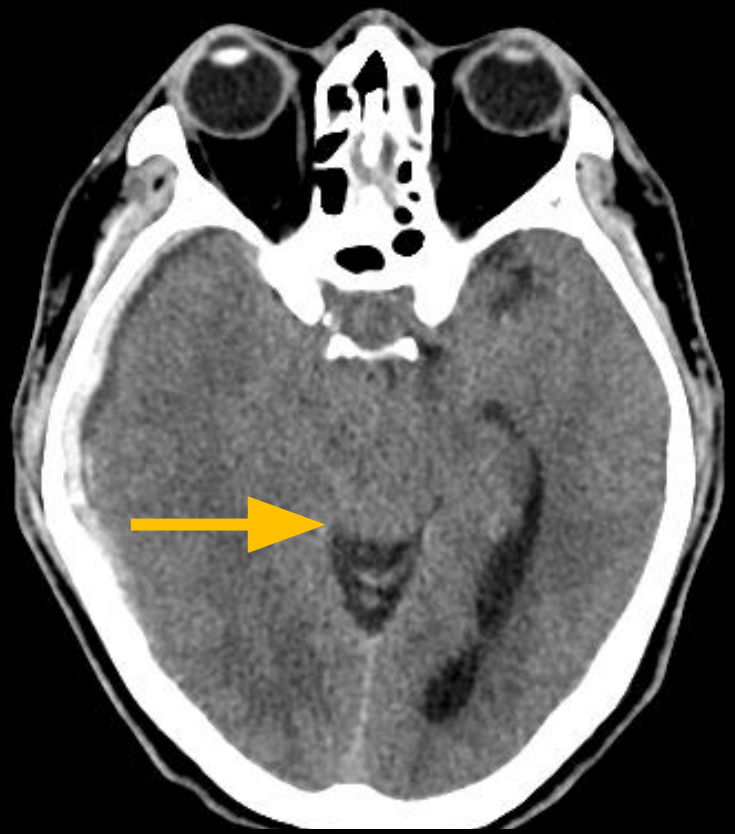
Basilar cisterns compressed



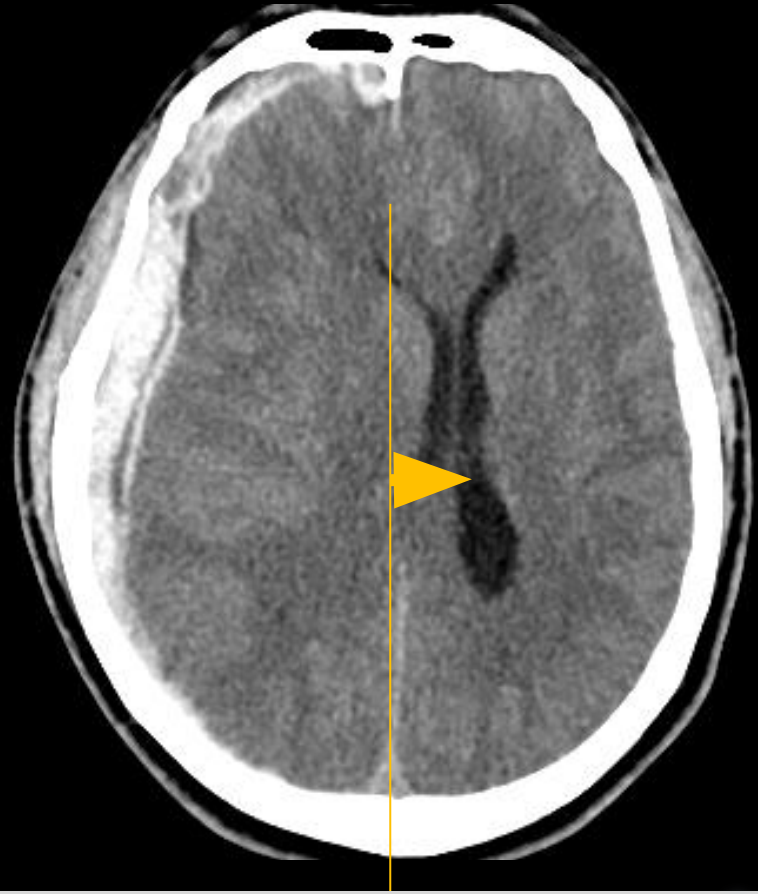
No midline shift

Category 4

Basilar cisterns compressed



Midline shift > 5mm



Evacuated mass

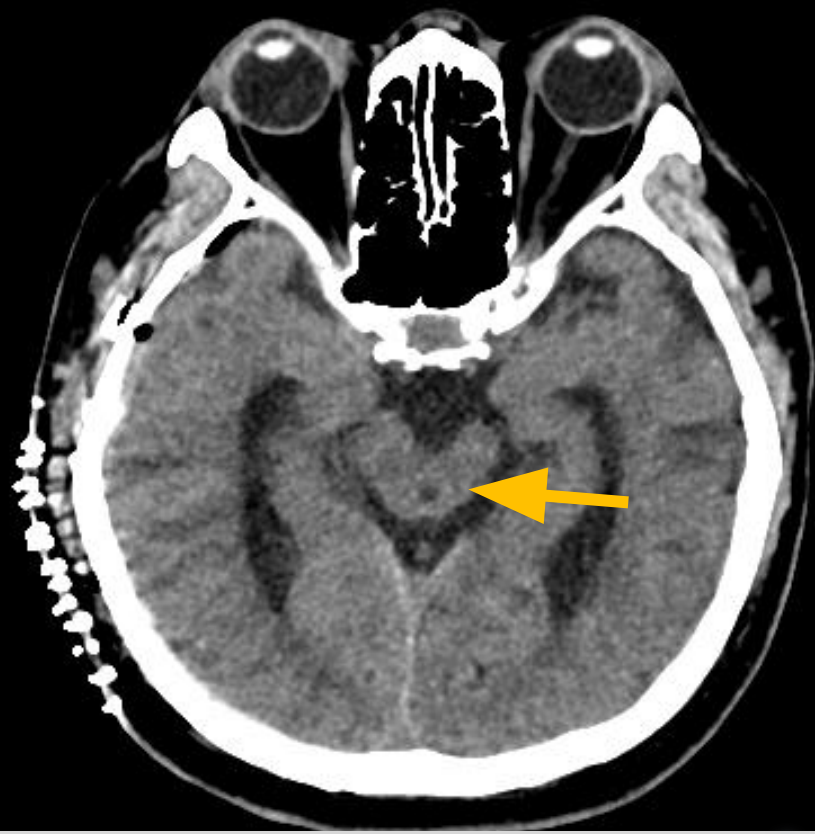
Subdural hemorrhage greater than 25cc volume

Midline shift resolved after surgical drainage

Evacuated mass

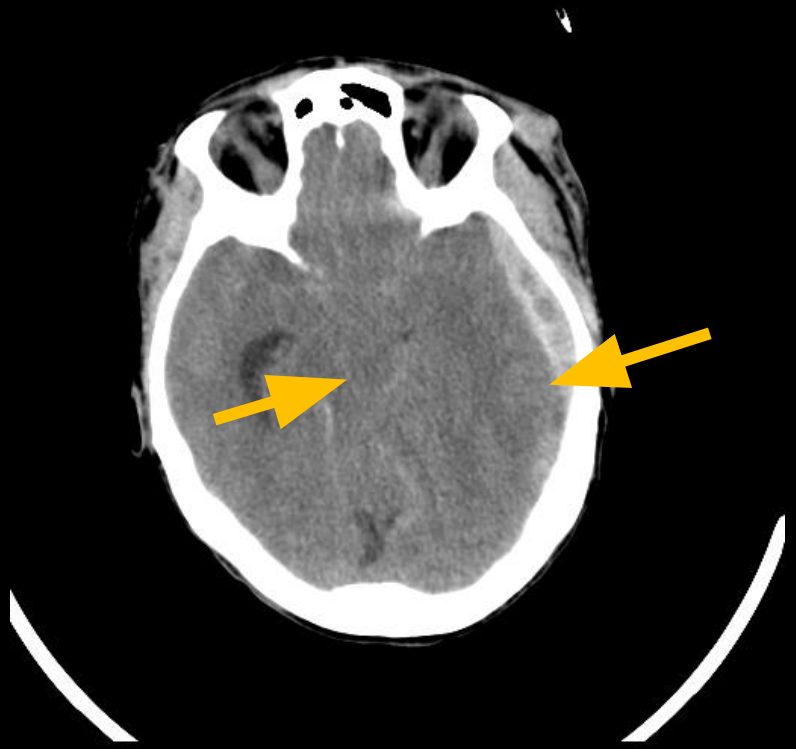
Subdural hemorrhage greater than 25cc volume

Basilar cistern compression resolved after surgical drainage

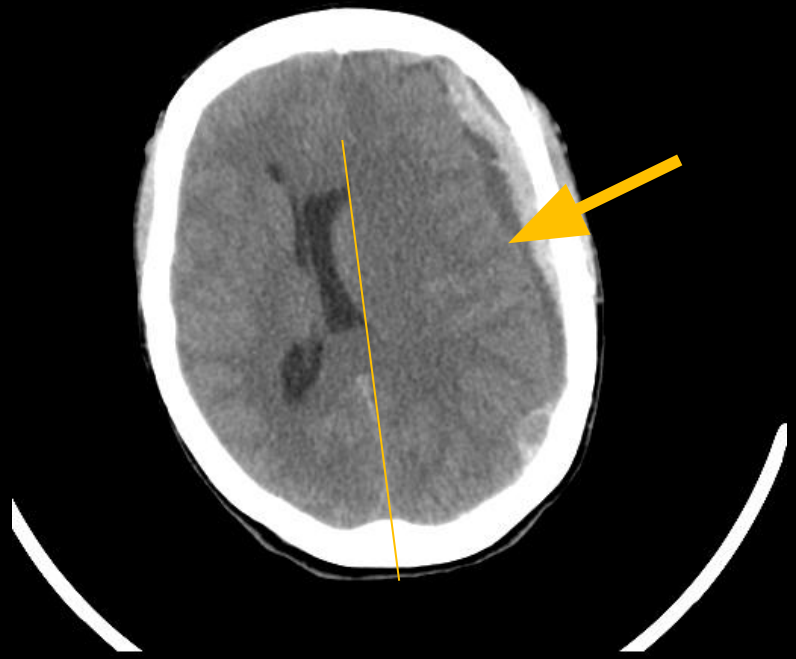


Unevacuated mass

Subdural hemorrhage > 25cc



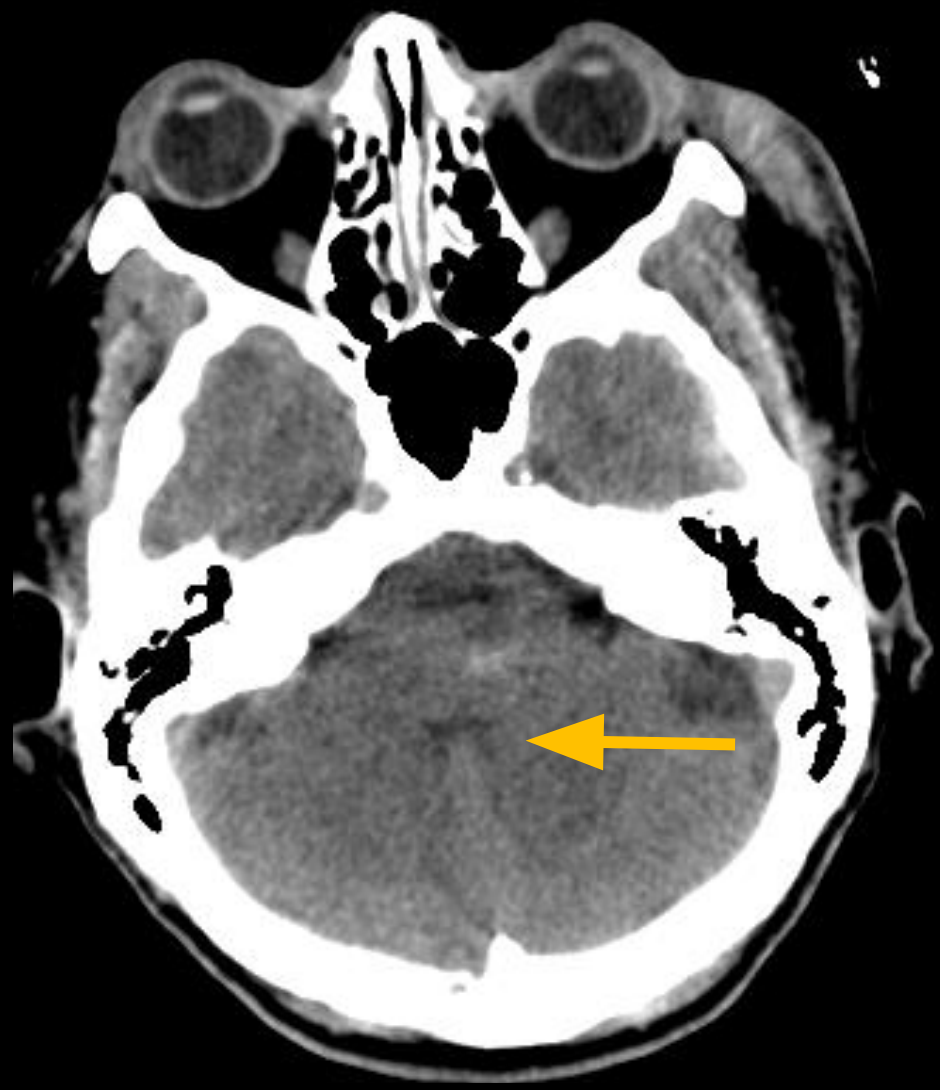
Midline shift with compression of basilar cisterns



Unevacuated mass

Patient was not surgical candidate due to neurologic examination

Duret hemorrhage in brainstem



HCMC Marshall scale template

Marshall Traumatic Brain Injury Scale:

MARSHALL DIAGNOSTIC CATEGORIES OF ABNORMALITIES VISUALIZED ON CT SCANNING FOR TRAUMATIC BRAIN INJURY:

Diffuse Injury 1: No visible intracranial pathology seen on CT scan.

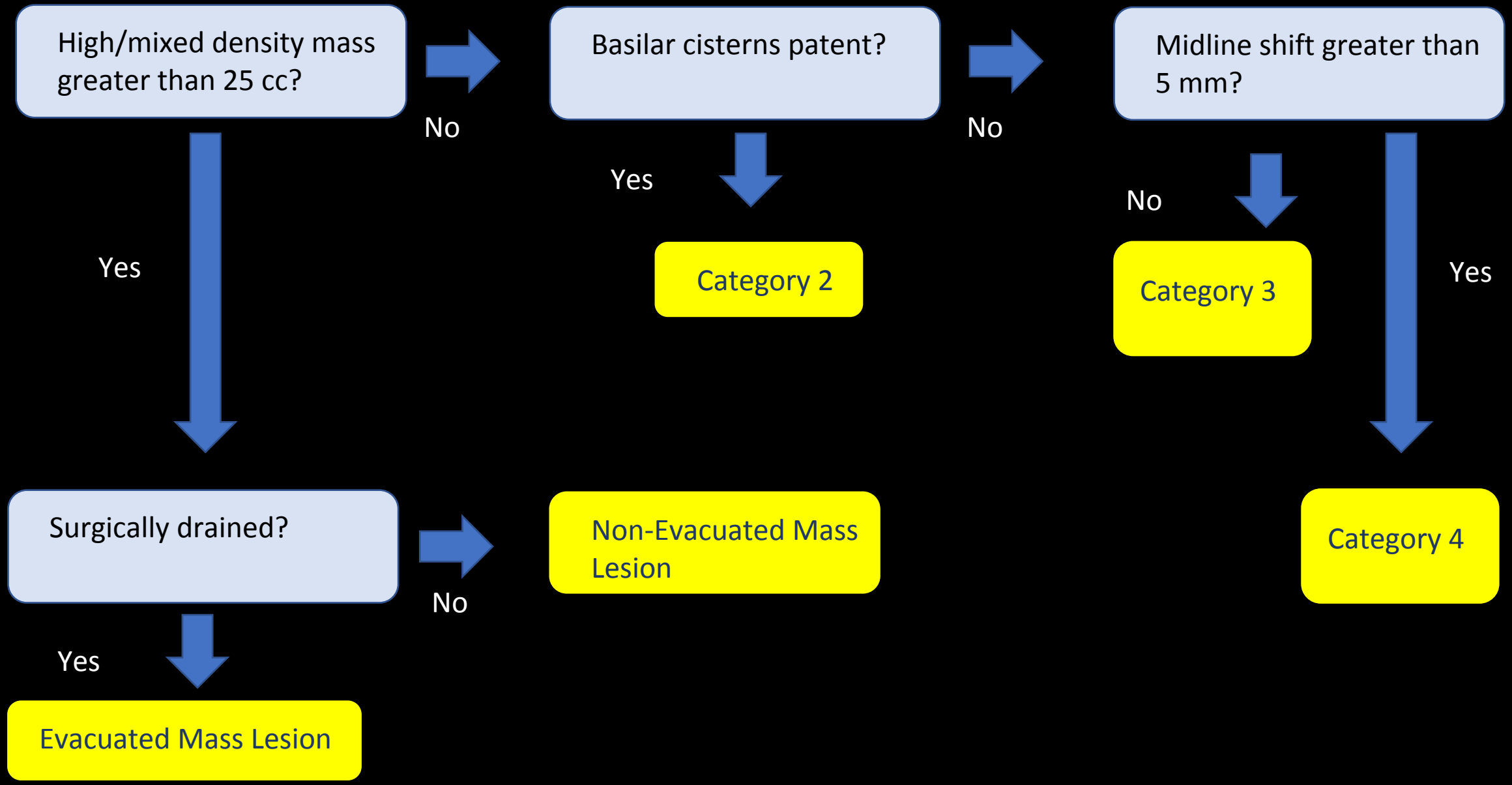
Diffuse Injury 2: Cisterns are present with shift 0-5 mm and/or lesion densities present. No high or mixed density lesion>25ml. May include bone fragments and foreign bodies.

Diffuse Injury 3 (swelling): Cisterns compressed or absent with shift 0-5mm. No high or mixed density lesion>25ml.

Diffuse Injury 4 (shift): Shift>5mm. No high or mixed density lesion>25ml.

Evacuated mass lesion: Any surgically evacuated lesion.

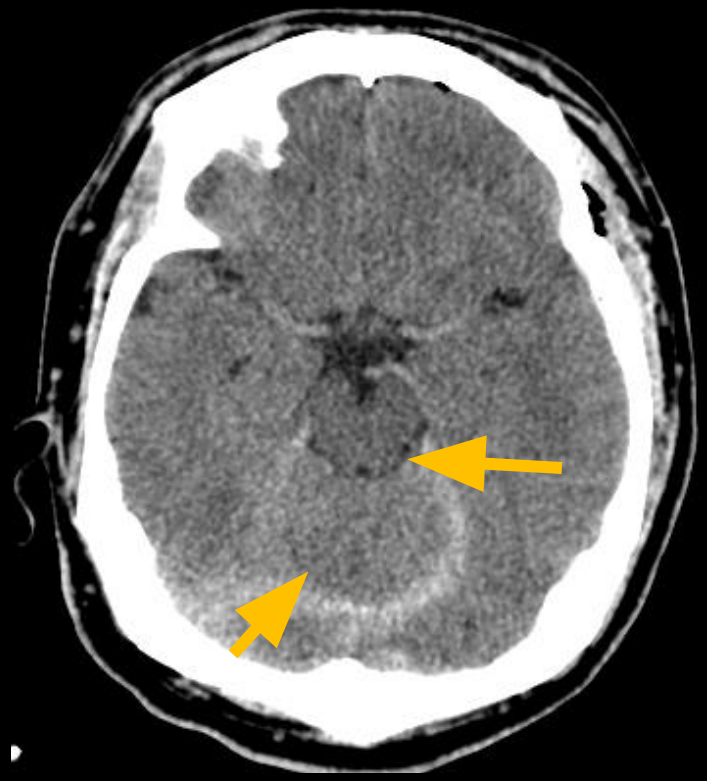
Non evacuated mass lesion: High or mixed-density lesion>25ml. Not surgically evacuated.


High/mixed density mass greater than 25 cc?
No
Basilar cisterns patent?
No
Midline shift greater than 5 mm?
Yes
No
Category 2
Yes
Category 3
Yes
Category 4
Surgically drained?
No
Non-Evacuated Mass Lesion
Yes
Evacuated Mass Lesion

Differentiating Category 2 & 3

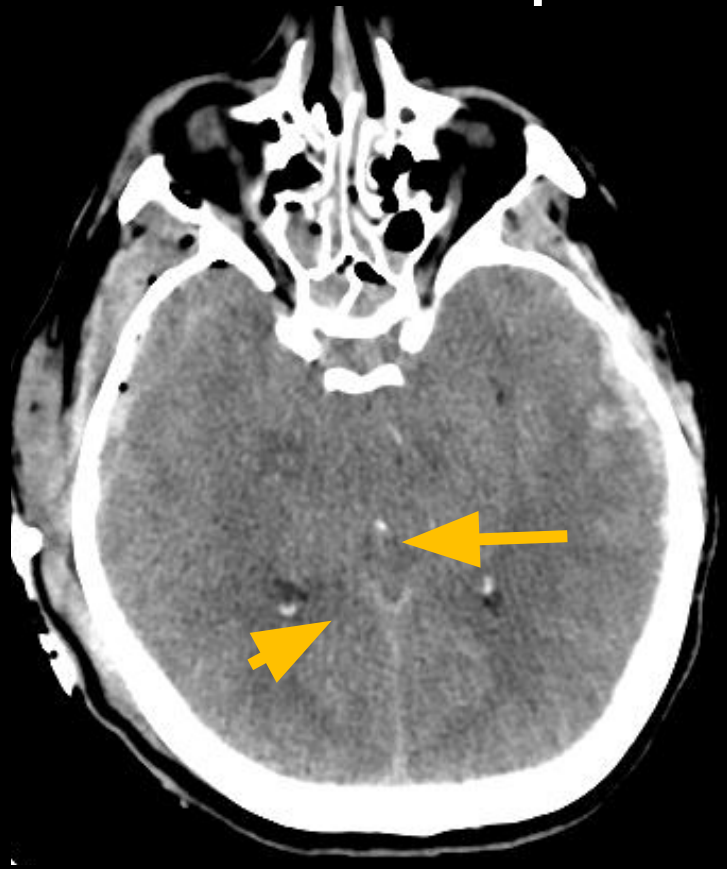
Category 2:

Basilar cisterns patent



Category 3:

Basilar cisterns compressed



Prognosis from Marshall scale

- Prognosis depends on:
  - Age
  - Motor function
  - Pupil reactivity
  - CT scan findings including subarachnoid hemorrhage
- Marshall scale score can be used as one component of prognosis
- Marshall score alone is poor predictor of functional outcome

Limitations of Marshall scale

- Does not consider location of hemorrhage: subarachnoid, subdural, epidural, parenchymal
- Does not evaluate for traumatic axonal injury
- Does not differentiate degree of subfalcine or uncal herniation
- Intended to measure mortality, not likelihood of functional recovery

Alternatives to Marshall scale

- Rotterdam
- Stockholm
- Helsinki
- Use additional information from subarachnoid hemorrhage, intraventricular hemorrhage, degree of midline shift, location of high density mass
- May be more accurate in predicting prognosis
- More complicated to use with more interobserver variability

References

- 1: Thelin EP, Nelson DW, Vehviläinen J, Nyström H, Kivisaari R, Siironen J,Svensson M, Skrifvars MB, Bellander BM, Raj R. Evaluation of novel computerizedtomography scoring systems in human traumatic brain injury: An observational,multicenter study. PLoS Med. 2017 Aug 3;14(8).
- 2: Charry JD, Tejada JH, Pinzon MA, Tejada WA, Ochoa JD, Falla M, Tovar JH,Cuellar-Bahamón AM, Solano JP. Predicted Unfavorable Neurologic Outcome IsOverestimated by the Marshall Computed Tomography Score, CorticosteroidRandomization After Significant Head Injury (CRASH), and International Missionfor Prognosis and Analysis of Clinical Trials in Traumatic Brain Injury (IMPACT)Models in Patients with Severe Traumatic Brain Injury Managed with EarlyDecompressive Craniectomy. World Neurosurg. 2017 May;101:554-558.
- 3: Steyerberg EW, Mushkudiani N, Perel P, Butcher I, Lu J, McHugh GS, Murray GD,Marmarou A, Roberts I, Habbema JD, Maas AI. Predicting outcome after traumaticbrain injury: development and international validation of prognostic scores basedon admission characteristics. PLoS Med. 2008 Aug 5;5(8):e165; discussion e165.
- 4: Marshall LF, Marshall SB, Klauber MR, Van Berkum Clark M, Eisenberg H, JaneJA, Luerssen TG, Marmarou A, Foulkes MA. The diagnosis of head injury requires aclassification based on computed axial tomography. J Neurotrauma. 1992 Mar;9Suppl 1:S287-92.