

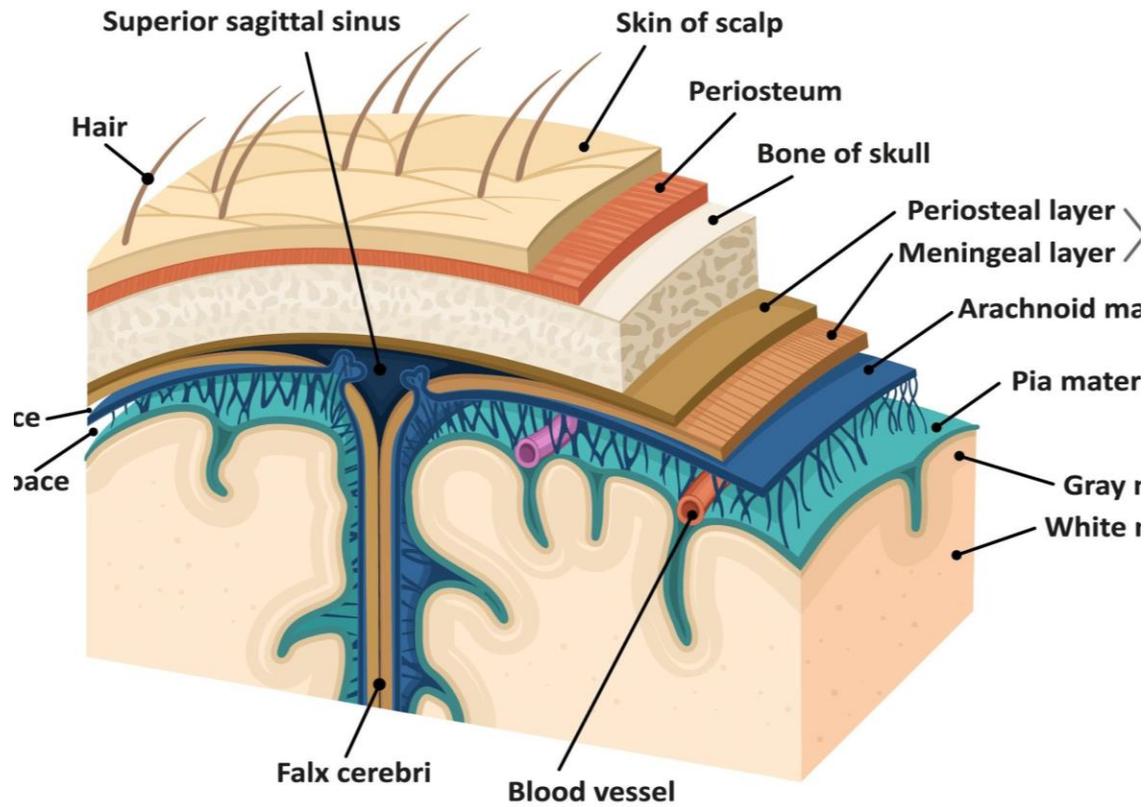
Introduction to neurosurgical emergencies

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Relevant Anatomy of the CNS

- Content:
- The Scalp: Highly vascular; a source of significant blood loss in trauma.
- The Skull: Rigid, non-expansile; protects the brain but limits volume expansion.
- The Meningeal Spaces:
 - Epidural Space: Potential space between skull and dura (Arterial source).
 - Subdural Space: Between dura and arachnoid (Venous source).
 - Subarachnoid Space: Contains CSF and major cerebral arteries.
- The Tentorium Cerebelli: A dural fold dividing the brain into Supratentorial and Infratentorial compartments (Crucial for understanding herniation).

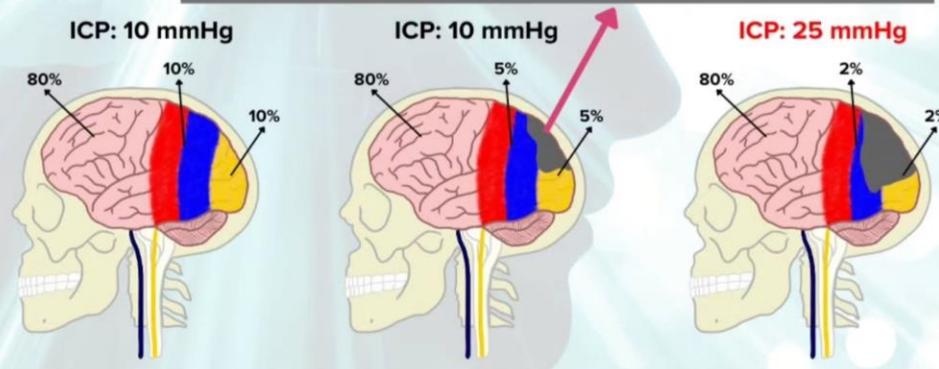


Kelly Monroe doctrine

- Concept:
- Total intracranial volume is constant:
- $V_{\text{brain}} + V_{\text{blood}} + V_{\text{CSF}} = \text{Constant}$
- Details:
- - The adult skull is a rigid, non-expandable structure.
- - Any increase in one component must be compensated by a decrease in another.
- Compensation:
- 1. CSF displacement into the spinal canal (first).
- 2. Venous blood outflow from intracranial compartment.
- Decompensation:
- - Once compensatory mechanisms fail, ICP rises exponentially.
- - Leads to reduced CPP, ischemia, and brain herniation.

- **Rigid cranial vault consists of** →
 - Brain tissue (80%)
 - Venous & arterial blood (10%)
 - CSF (10%)
- The sum of these volumes is *constant*
- Total volume creates intracranial pressure
- **Normal ICP ≤ 20 mmHg**
- An \uparrow in one will cause \downarrow in the others...**when compensation is intact**
- An \uparrow in total volume leads to \uparrow ICP

New volume (i.e. cerebral edema, tumor, SDH, ect...)



Primary vs Secondary Brain Injury

- Primary Brain Injury:
 - - Occurs at the moment of impact ($T = 0$).
 - - Includes contusions, lacerations, hematomas, axonal disruption.
 - - Irreversible damage.
- Secondary Brain Injury:
 - - Occurs minutes to days later.
 - - Causes: hypoxia, hypotension, ischemia, edema, inflammation.
- Clinical Goal:
 - - Prevent secondary injury by maintaining oxygenation and cerebral perfusion.

Clinical Assessment Overview

- Principle:
 - - Neurological emergencies are time-sensitive.
 - - Early deterioration can be fatal.
- Focus:
 - - Rapid assessment.
 - - Frequent reassessment.
 - - Early imaging and intervention.

ABCD in Neurosurgery

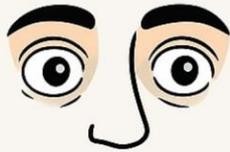
- Airway:
 - - GCS \leq 8 = Intubate.
 - - Prevent hypoxia.
- Breathing:
 - - Hypercapnia (\uparrow PaCO₂) causes cerebral vasodilation \rightarrow \uparrow ICP.
 - - Target PaCO₂: 35–40 mmHg.
 - - Hyperventilation is temporary only.
- Circulation:
 - - Avoid hypotension.
 - - CPP = MAP – ICP.
 - - Target CPP \geq 60–70 mmHg.
- Disability:
 - - Rapid neurological assessment (GCS, pupils, motor).

Glasgow Coma Scale

- Eye Opening (1–4):
 - 4 Spontaneous
 - 3 To speech
 - 2 To pain
 - 1 None
- Verbal Response (1–5):
 - 5 Oriented
 - 4 Confused
 - 3 Inappropriate words
 - 2 Incomprehensible sounds
 - 1 None
- Motor Response (1–6):
 - 6 Obeys commands
 - 5 Localizes pain
 - 4 Withdraws
 - 3 Abnormal flexion (Decorticate)
 - 2 Extension (Decerebrate)
 - 1 None
- Pearl:
 - - Motor score is the most prognostic component.

Glasgow Coma Scale

EYE OPENING



Spontaneous 4
To sound 3
To pressure 2
None 1

VERBAL RESPONSE



Oriented 5
Confused 4
Words 3
Sounds 2
None 1

MOTOR RESPONSE



Obey commands 6
Localizing 5
Normal flexion 4
Abnormal flexion 3
Extension 2

GLASGOW COMA SCALE SCORE

Mild
13-15

Moderate
9-12

Severe
3-8

Pupillary Examination

- Assess:
 - - Size
 - - Symmetry
 - - Light reactivity
- Blown Pupil:
 - - Fixed, dilated pupil → CN III compression.
 - - Parasympathetic fibers affected first.
- Significance:
 - - Usually ipsilateral to the mass lesion.
 - - Suggests uncal herniation.

Pupillary change

Possible causes

Unilateral, dilated (4 mm), fixed, and nonreactive



- Uncal herniation with oculomotor nerve damage
- Brain stem compression
- Increased intracranial pressure
- Tentorial herniation
- Head trauma with subdural or epidural hematoma
- Normal in some people

Bilateral, dilated (4 mm), fixed, and nonreactive



- Severe midbrain damage
- Cardiopulmonary arrest (hypoxia)
- Anticholinergic poisoning

Bilateral, midsize (2 mm), fixed, and nonreactive



- Midbrain involvement caused by edema, hemorrhage, infarctions, lacerations, contusions

Bilateral, pinpoint (<1 mm), and usually nonreactive



- Lesions of pons, usually after hemorrhage

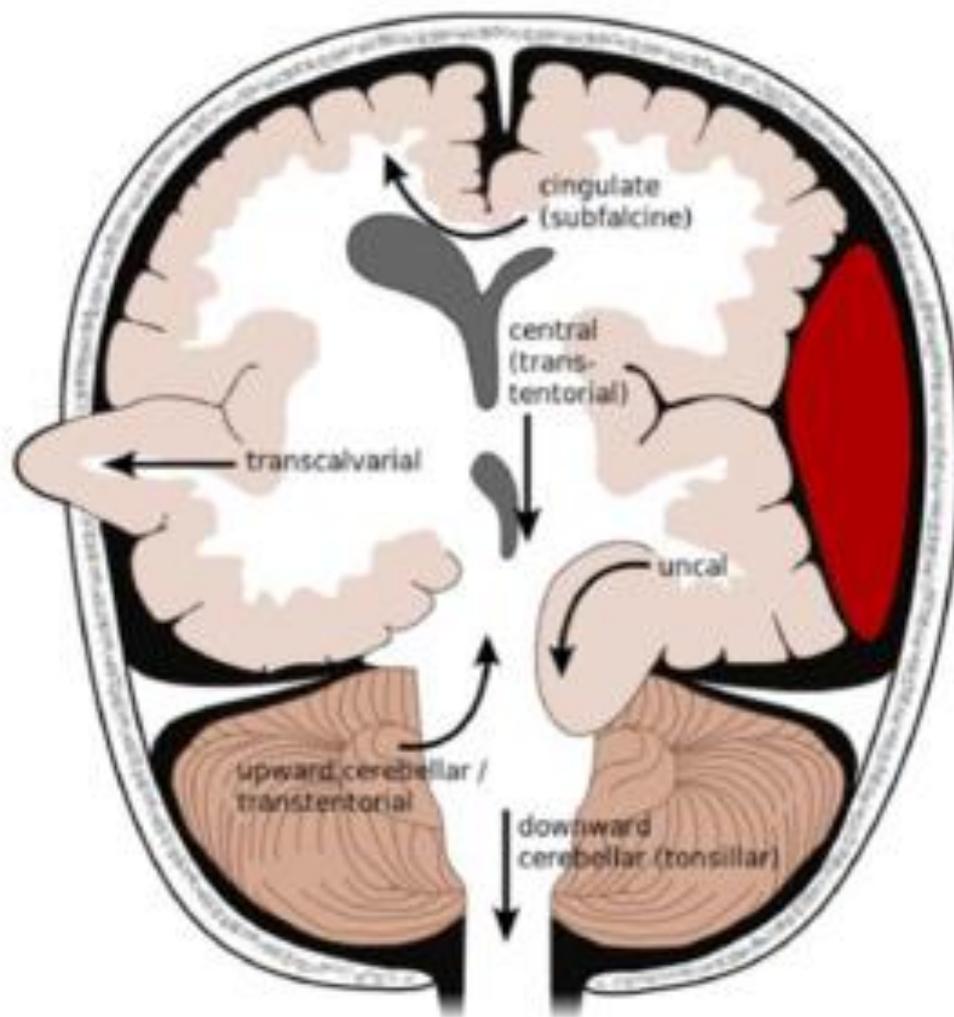
Unilateral, small (1.5 mm), and nonreactive



- Disruption of sympathetic nerve supply to the head caused by spinal cord lesion above the first thoracic vertebrae

Focal Deficits & Lateralizing Signs

- Hemiparesis:
 - - Weakness usually contralateral to lesion.
- False Localizing Sign:
 - - Kernohan's notch phenomenon:
 - Ipsilateral pupil dilation + ipsilateral weakness.
- Rule:
 - - Always correlate motor findings with pupils.



- Kernohan's notch phenomenon:
- Caused by compression of the cerebral peduncle in UNCAL herniation.
- It causes symptoms IPSILATERAL to the initial herniation syndrome due to compression of the CONTRALATERAL peduncle. It also compresses the IPSILATERAL midbrain and CN III and can cause an IPSILATERAL blown pupil.
- Thus, this patient has uncal herniation on the right.
- You shouldn't be taking this long to localize it, FYI, because you'll probably kill the patient.

Cushing's Triad

- Components:
 - 1. Hypertension (wide pulse pressure)
 - 2. Bradycardia
 - 3. Irregular respirations
- Meaning:
 - - Significantly elevated ICP.
 - - Indicates impending brainstem compression.
- Note:
 - - Late and ominous sign.

Traumatic Brain Injury Classification

- Mild TBI:
 - - GCS 13–15
 - - Concussion, brief LOC.
- Moderate TBI:
 - - GCS 9–12
 - - Requires admission and observation.
- Severe TBI:
 - - GCS 3–8
 - - Requires ICU, ICP monitoring, often surgery.

Epidural Hematoma (EDH)

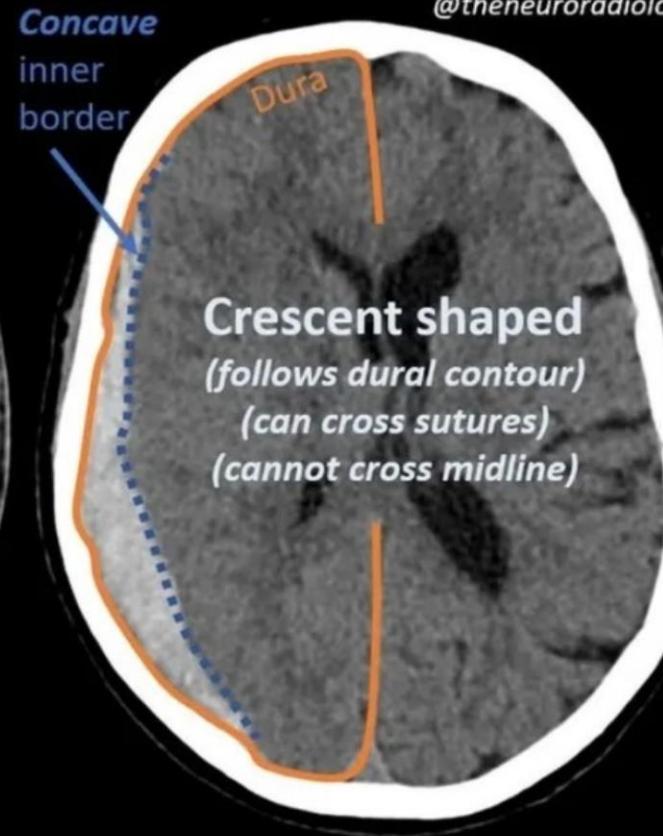
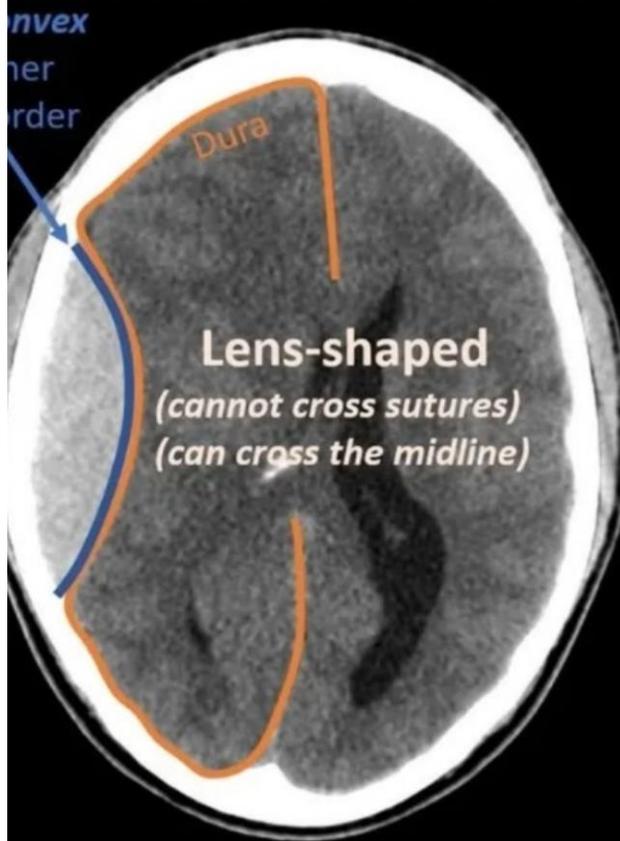
- Source:
 - - Arterial bleeding (Middle Meningeal Artery).
- Classic History:
 - - Lucid interval followed by rapid deterioration.
- CT Findings:
 - - Biconvex (lens-shaped).
 - - Does not cross suture lines.
- Management:
 - - Neurosurgical emergency.

Subdural Hematoma (SDH)

- Source:
 - - Venous bleeding (bridging veins).
- Risk Factors:
 - - Elderly
 - - Alcoholics
 - - Anticoagulation
- CT Findings:
 - - Crescent-shaped.
 - - Crosses suture lines.
- Course:
 - - Acute, subacute, or chronic.

hematoma?

@theneuroradiolo



Epidural hematoma

Between the skull and the dura

Subdural hematoma

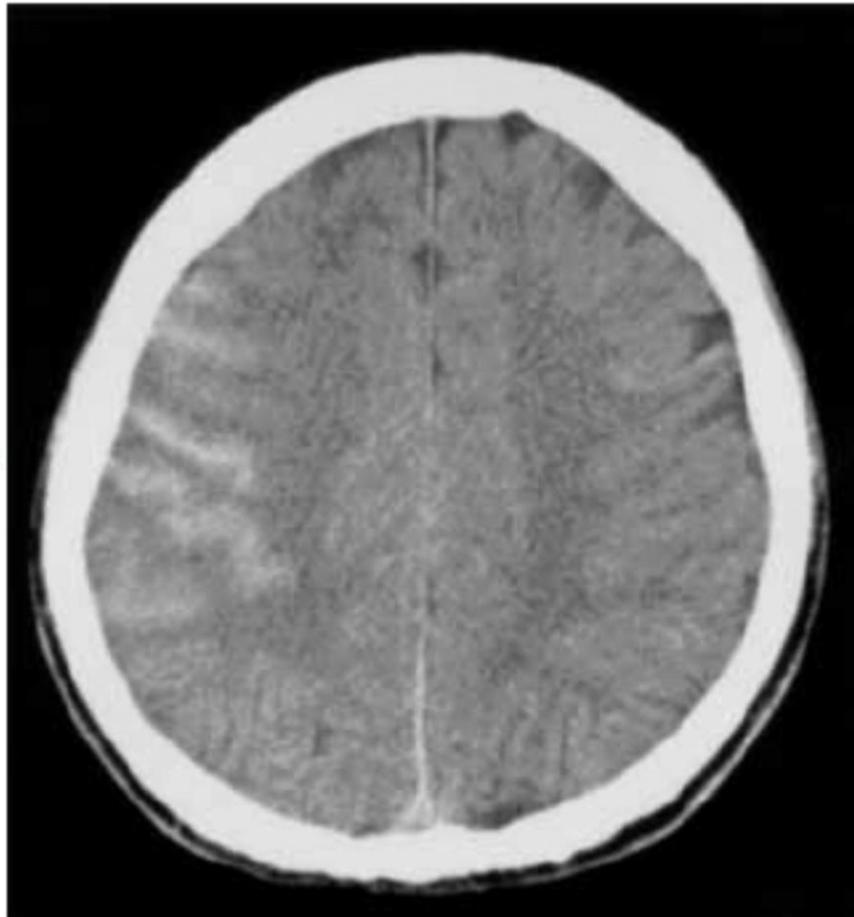
between dura and arachnoid

Traumatic Subarachnoid Hemorrhage (tSAH)

- Definition:
 - - Most common traumatic intracranial hemorrhage.
- CT Findings:
 - - Hyperdense blood in cortical sulci and basal cisterns.
- Clinical Features:
 - - Severe headache
 - - Photophobia
 - - Meningeal irritation
- Significance:
 - - Marker of significant head injury.
 - - Increases risk of vasospasm and hydrocephalus.

Cerebral Contusion

- Mechanism:
 - - Coup injury (at site of impact).
 - - Contrecoup injury (opposite side).
- Common Locations:
 - - Frontal lobes
 - - Temporal lobes
- Risk:
 - - Contusions may "blossom" over 24–48 hours.
 - - Repeat CT imaging is essential.



Traumatic subarachnoid hemorrhage. Axial non-enhanced CT shows high-density hematoma in the superficial sulci at the right side.

Diffuse Axonal Injury

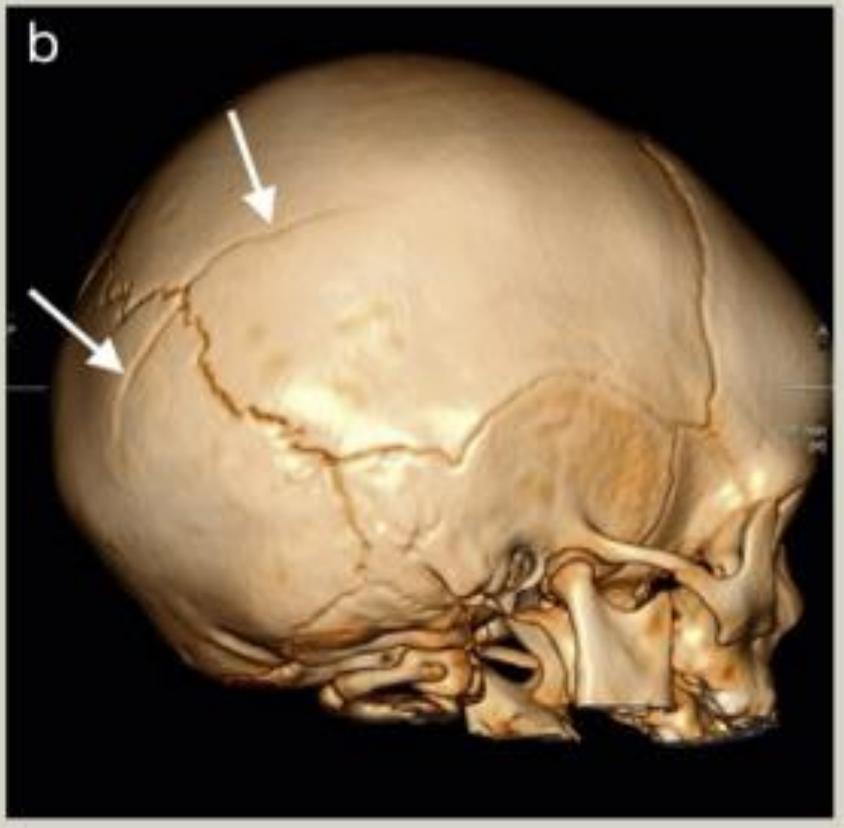
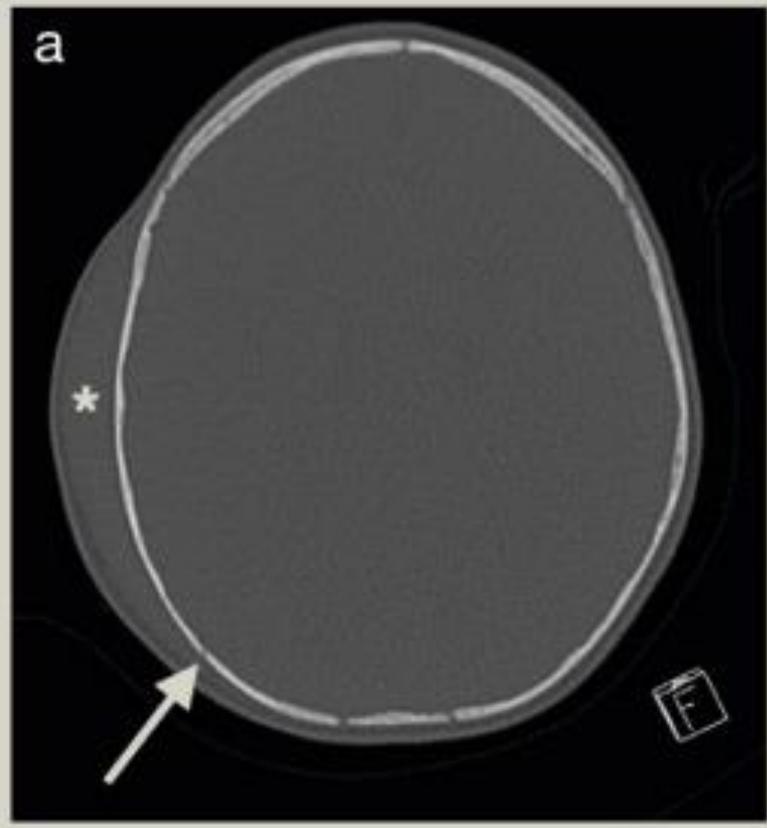
- Mechanism:
 - - Rotational acceleration causing axonal shearing.
- CT:
 - - Often normal or shows small punctate hemorrhages.
- MRI:
 - - Most sensitive modality for diagnosis.
- Clinical Clue:
 - - Severe loss of consciousness with minimal CT findings.



Diffuse axonal injury. Non-enhanced CT shows multiple punctate hemorrhages in right hemispheric

Skull Fractures

- Types:
- - Linear
- - Depressed
- - Basilar
- Basilar Skull Fracture Signs:
- - Raccoon eyes
- - Battle sign
- - CSF rhinorrhea or otorrhea
- Important:
- - Avoid nasal instrumentation if CSF leak suspected.



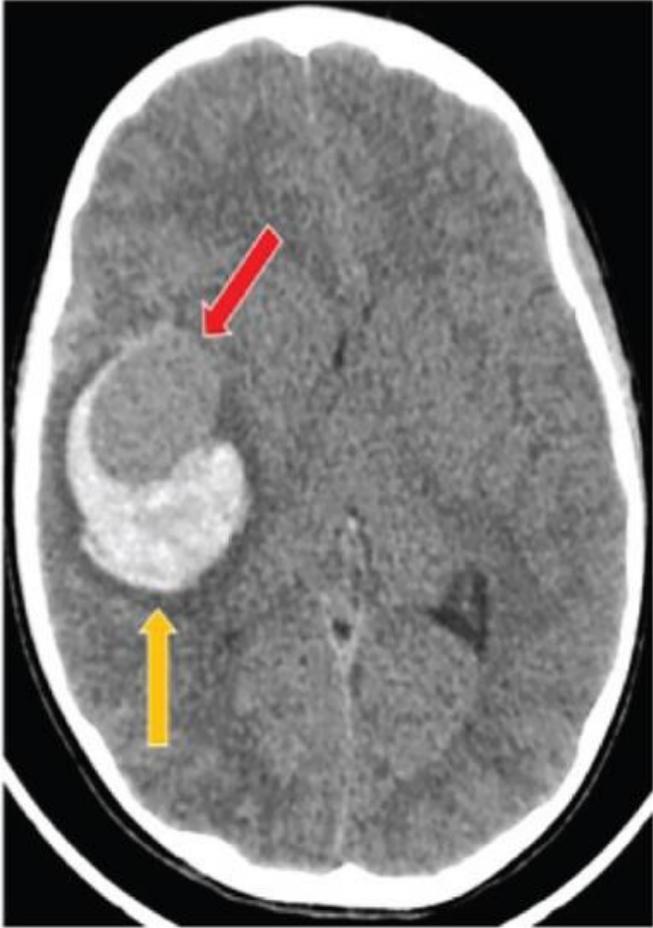
Spontaneous Subarachnoid Hemorrhage

- Etiology:
 - - Rupture of saccular (berry) aneurysm.
- Classic Presentation:
 - - "Worst headache of life"
 - - Sudden onset, severe intensity.
- Diagnosis:
 - - Non-contrast CT head.
 - - If CT negative → Lumbar puncture (xanthochromia).

Aneurysm Management

- Definitive Treatment:
 - - Surgical clipping
 - - Endovascular coiling
- Major Complication:
 - - Cerebral vasospasm (day 4–14).
- Prevention:
 - - Nimodipine for 21 days.

A



B

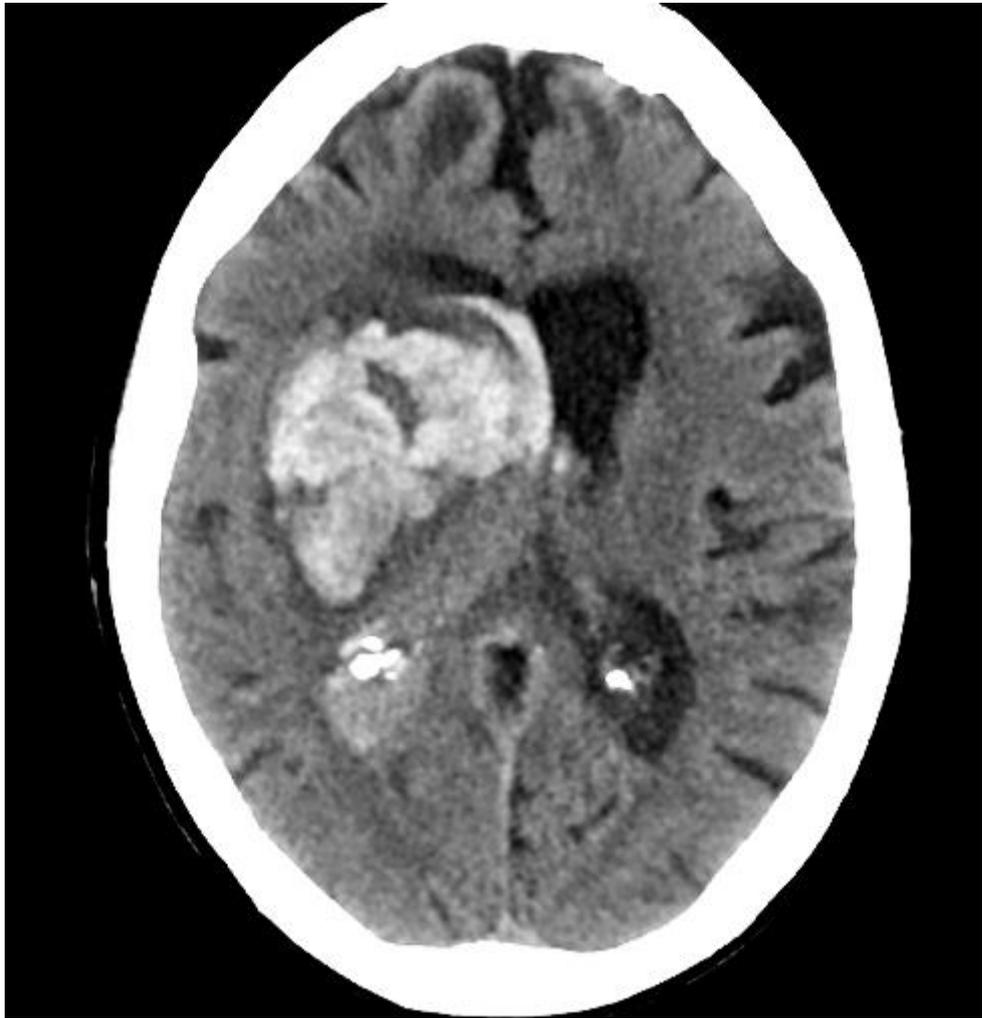


TBI Emergency Management

- Primary Targets:
 - - SBP \geq 100–110 mmHg
 - - Oxygen saturation $>$ 90%
- ICP Control:
 - - Head elevation 30°
 - - Adequate sedation and analgesia
 - - Mannitol or hypertonic saline
 - - External ventricular drainage if indicated

Intracerebral Hemorrhage

- Common Cause:
 - - Chronic hypertension.
- Common Location:
 - - Basal ganglia.
- Management:
 - - Blood pressure control (target SBP ~140).
 - - Reverse anticoagulation.
 - - Surgical evacuation in selected cases.

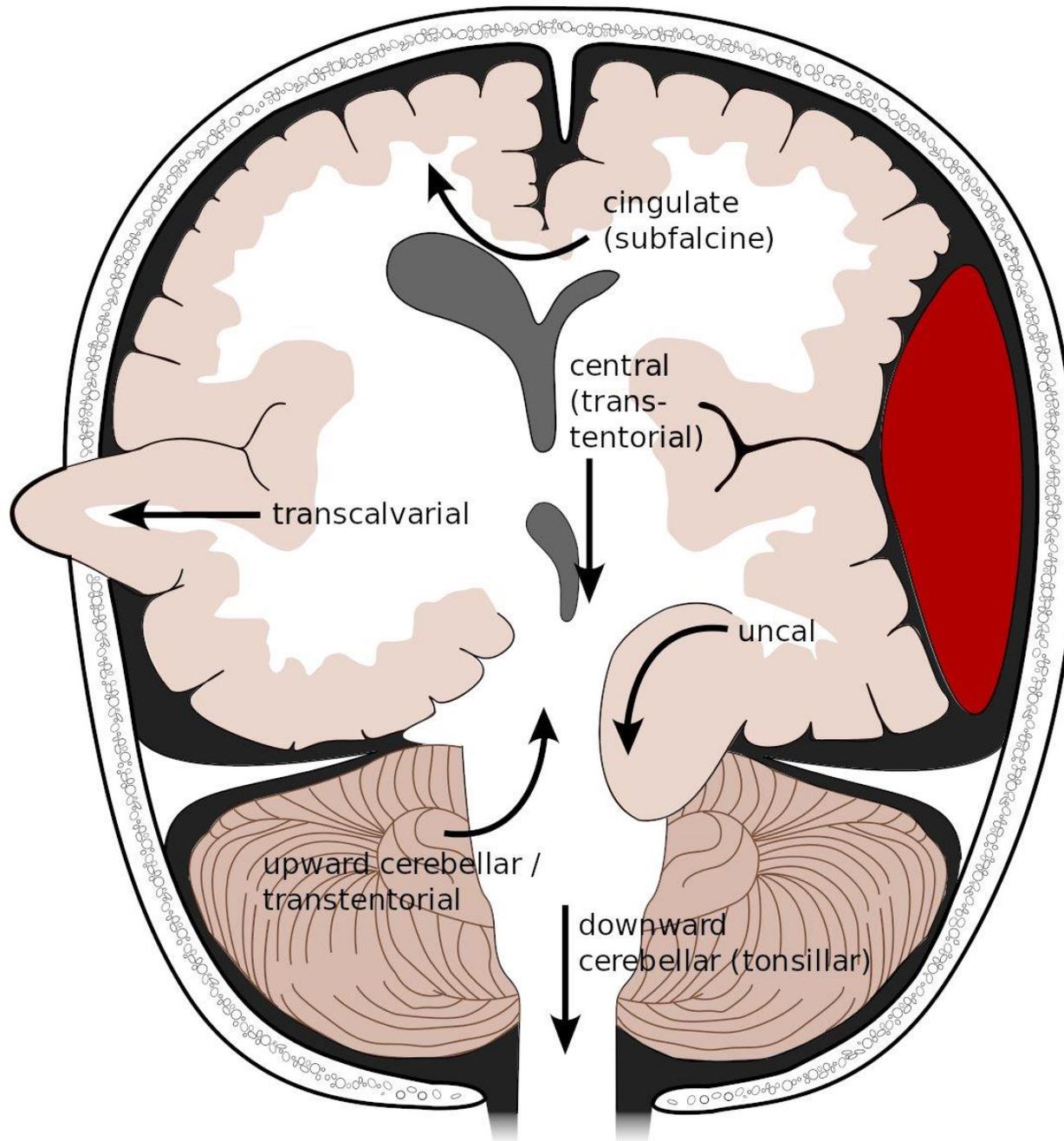


Brain Herniation Syndromes

- Definition:
- Brain herniation is the displacement of brain tissue across rigid intracranial structures due to increased ICP.
- Key Mechanism:
 - - Raised ICP overcomes pressure gradients.
 - - Brain shifts through falx, tentorium, or foramen magnum.
- Common Triggers:
 - - Intracranial hematoma
 - - Tumor
 - - Cerebral edema
 - - Hydrocephalus
- Clinical Importance:
 - - Life-threatening emergency.
 - - Rapid progression leads to brainstem ischemia and death.

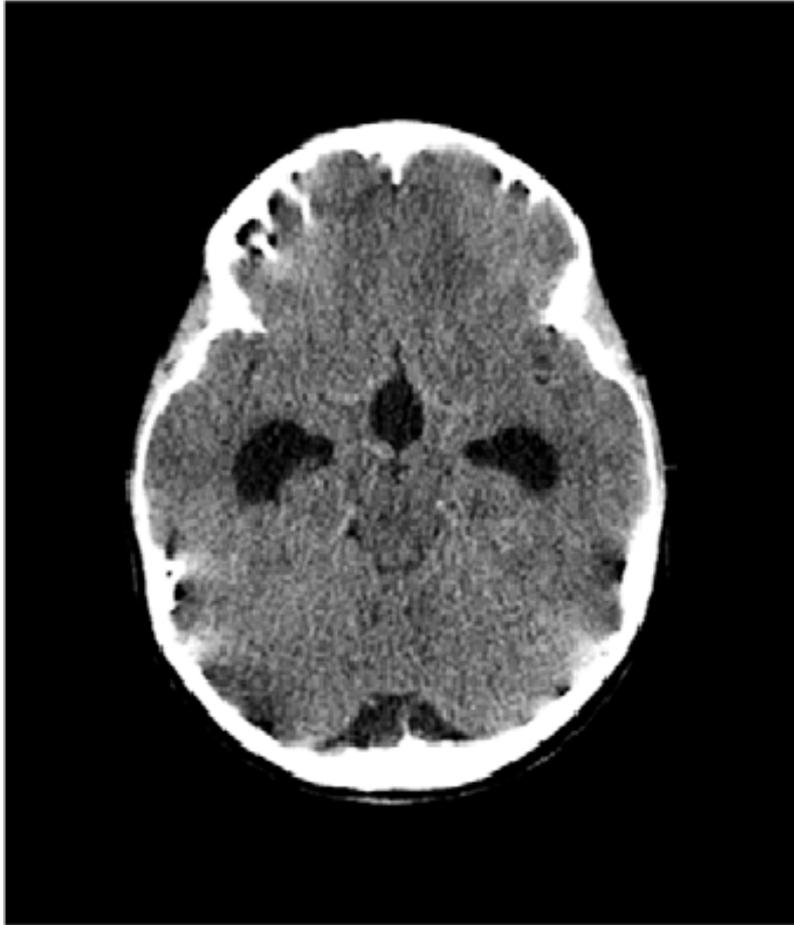
- Subfalcine (Cingulate):
 - - Brain shifts under falx cerebri.
 - - Risk: ACA compression → contralateral leg weakness.
- Uncal (Transtentorial):
 - - Temporal lobe herniation.
 - - Ipsilateral blown pupil (CN III).
 - - Contralateral hemiparesis.
 - - Most common and most tested.
- Central (Downward):
 - - Bilateral downward brain shift.
 - - Progressive coma, abnormal posturing.
- Tonsillar:
 - - Cerebellar tonsils through foramen magnum.
 - - Respiratory arrest and sudden death.

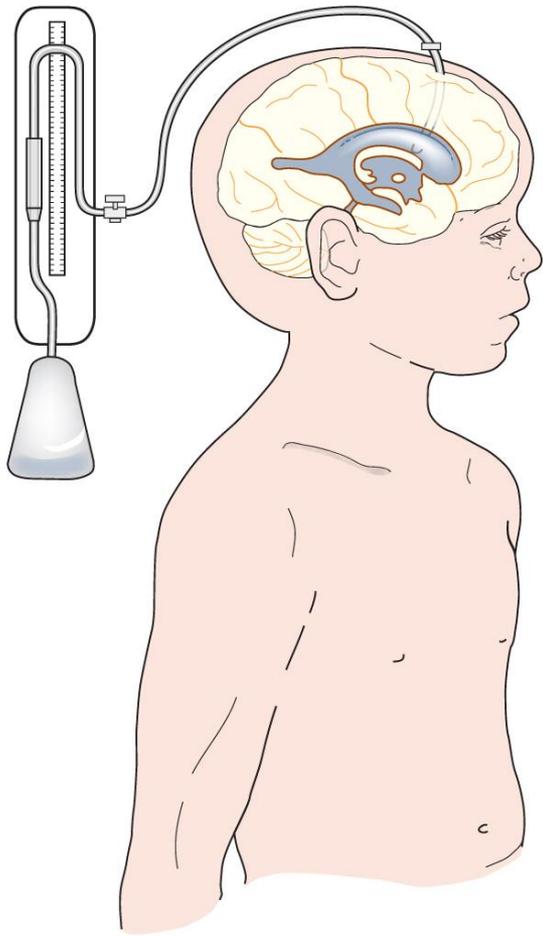
- Clinical Red Flags:
 - - Rapid drop in GCS.
 - - New pupillary asymmetry.
 - - Abnormal posturing.
 - - Cushing's triad.
- Immediate Management:
 - - Secure airway and oxygenation.
 - - Elevate head 30°.
 - - Maintain CPP (CPP = MAP – ICP).
 - - Mannitol or hypertonic saline.
 - - Urgent neurosurgical decompression.
- Golden Rule:
 - Any acute neurological deterioration = assume herniation until proven otherwise.



Acute Hydrocephalus

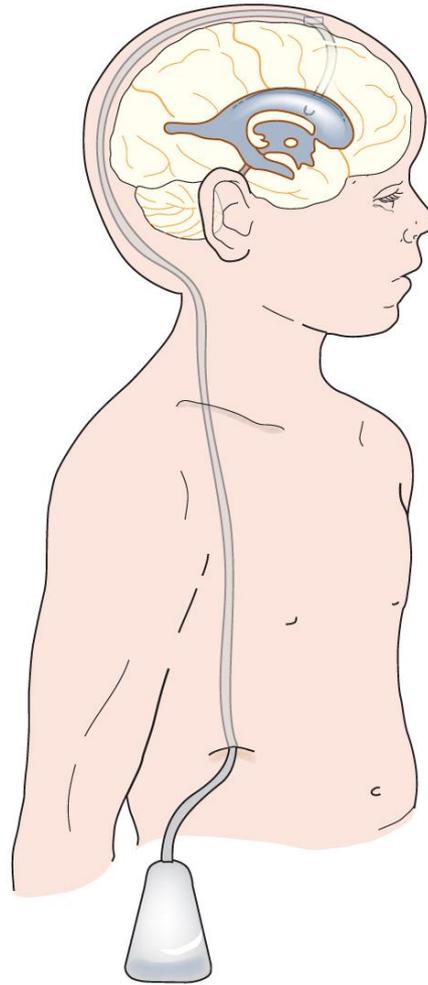
- Presentation:
 - - Rapid decline in consciousness.
 - - Headache and vomiting.
 - - Upward gaze palsy (Parinaud syndrome).
- CT Findings:
 - - Dilated ventricles.
 - - Enlarged temporal horns.
- Management:
 - - Emergency external ventricular drain (EVD).





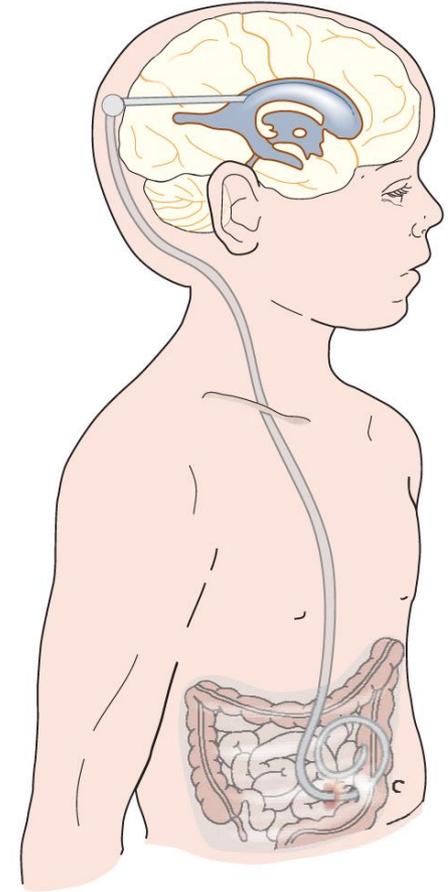
(A) External ventricular drain

The external ventricular drain (EVD) is a 'straw-like' tube. It is usually tunnelled under the skin to exit the skin around 5 cm away from the burr hole made in the skull to access the ventricle during surgery.



(B) Long tunnelled external ventricular drain

A long tunnelled external ventricular drain (LTEVD) involves tunnelling the tubing much further away from the wound, usually to the chest or abdomen



(C) Ventriculo-peritoneal shunt

A ventriculo-peritoneal shunt (VPS) is a completely internalised system, comprising a proximal tube that accesses CSF from the ventricle, a valve that regulates the flow of CSF depending on pressure/flow and patient positioning, and a distal tube that allows CSF to be drained into the peritoneum of the abdomen

Medical vs Surgical Treatment

- Medical Management:
 - - Osmotherapy
 - - Sedation
 - - Controlled ventilation
- Surgical Management:
 - - Hematoma evacuation
 - - Aneurysm securing
 - - Decompressive craniectomy

Spinal Trauma Basics

- Initial Rule:
 - - Assume spinal injury until proven otherwise.
- Immediate Action:
 - - Immobilize cervical spine with a collar.
- Assessment:
 - - Check motor power in all limbs.
 - - Identify sensory level.
 - - Assess sphincter tone.

Spinal Shock vs Neurogenic Shock

- Spinal Shock:
 - - Temporary loss of reflexes below level of injury.
 - - Flaccid paralysis and areflexia.
 - - Resolves over days to weeks.
- Neurogenic Shock:
 - - Loss of sympathetic tone.
 - - Hypotension + bradycardia.
 - - Warm, dry skin.

Central Cord Syndrome

- Typical Patient:
 - - Elderly with cervical spondylosis.
 - - Hyperextension injury.
- Clinical Features:
 - - Motor weakness: arms > legs.
 - - Variable sensory loss.
- Prognosis:
 - - Often favorable with conservative management.

Anterior Cord Syndrome

- Mechanism:
 - - Injury to anterior spinal artery.
- Clinical Features:
 - - Loss of motor function.
 - - Loss of pain and temperature sensation.
- Preserved:
 - - Proprioception and vibration (dorsal columns intact).

Brown-Séquard Syndrome

- Cause:
 - - Hemisection of the spinal cord.
- Findings:
 - - Ipsilateral motor weakness.
 - - Ipsilateral loss of proprioception.
 - - Contralateral loss of pain and temperature.

Spinal Cord Injury Infographic

Types of Spinal Cord Injury

Prepared and designed by
www.apparelyzed.com
 spinal cord injury peer support

Complete Spinal Cord Injury

Complete loss of motor and sensory function below the spinal cord injury.



Paraplegia



Tetraplegia

Incomplete Spinal Cord Injury

Partial random preservation of motor or sensory function below the spinal cord injury.



Paraplegia



Tetraplegia

Common Types of Incomplete Spinal Cord Injuries

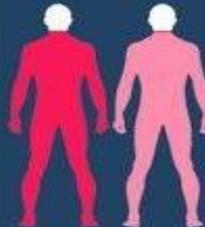
Brown-Séquard Syndrome



Example level: cervical spinal injury

Below injury level, motor weakness or paralysis on one side of the body (hemiparaplegia). Loss of sensation on the opposite side (hemianesthesia).

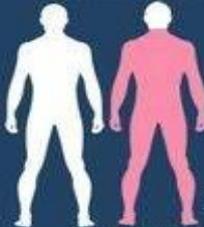
Anterior Cord Syndrome



Example level: cervical spinal injury

Below injury level, motor paralysis and loss of pain and temperature sensation. Proprioception (position sense), touch and vibratory sensation preserved.

Posterior Cord Syndrome



Example level: cervical spinal injury

Below injury level, motor function preserved. Loss of sensory function: pressure, stretch, and proprioception (position sense).

Central Cord Syndrome



Results from cervical spinal injuries. Greater motor impairment in upper body compared to lower body. Variable sensory loss below the level of injury.

Cervical Nerves:

Diaphragm
 Deltoids
 Biceps
 Wrist extensors
 Rotates arm
 Triceps
 Bends fingers

C1

C2

C3

C4

C5

C6

C7

T1

T2

T3

T4

T5

T6

T7

T8

T9

T10

T11

T12

L1

L2

L3

L4

L5

S1

S2

S3

S4

S5

Cervical

Thoracic

Lumbar

Sacral

Thoracic Nerves:

Spread fingers
 Chest muscles
 Abdominal muscles
 Muscles in the back

Lumbar Nerves:

Hip muscles
 Thigh muscles
 Knee Muscles
 Foot muscles

Sacral Nerves:

Bladder and bowel
 Sexual function

Sources: www.apparelyzed.com
www.wikipedia.org
sci.rutgers.edu

Key:



■ Normal Function

■ Impaired Motor Function

■ Impaired Sensory Function

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 spinal cord injury peer support

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Spinal Cord Compression

- Red Flags:
 - - Back pain with neurological deficit.
 - - Rapid neurological deterioration.
- Investigation:
 - - Urgent MRI of the spine.
- Management:
 - - Neurosurgical emergency.

Spinal Metastasis

- Clinical Features:
 - - Progressive back pain.
 - - Pain worse at night or when lying flat.
- Common Primary Tumors:
 - - Breast
 - - Lung
 - - Prostate
- Emergency Treatment:
 - - High-dose dexamethasone.



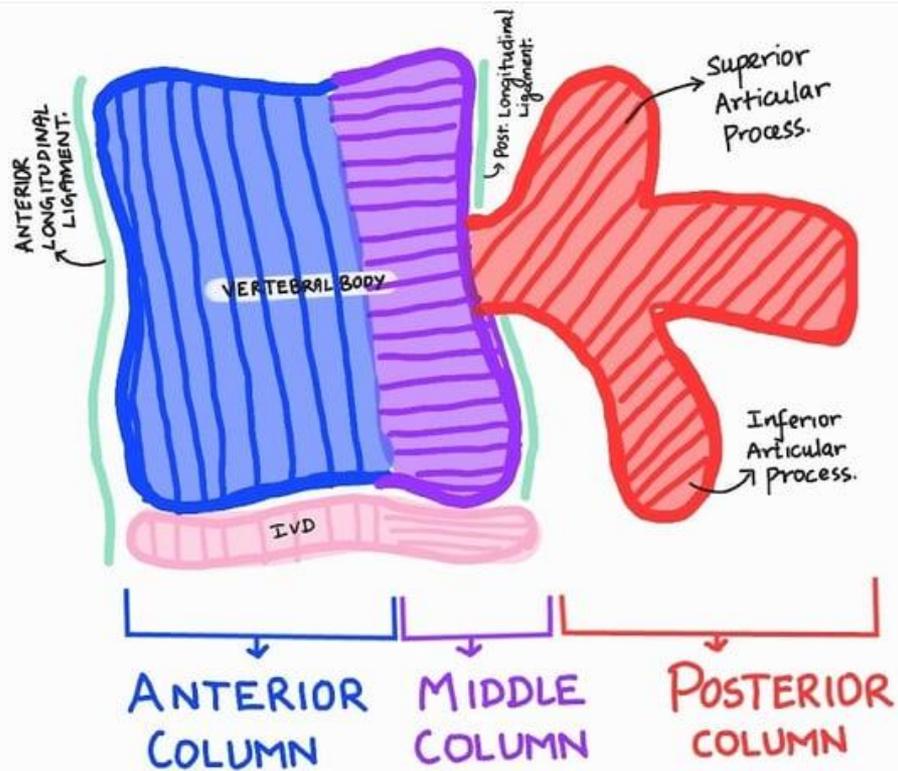
Cauda Equina Syndrome

- Key Symptoms:
 - - Saddle anesthesia.
 - - Urinary retention (early sign).
 - - Bilateral leg weakness.
- Action:
 - - Urgent MRI.
 - - Surgical decompression within 24–48 hours.



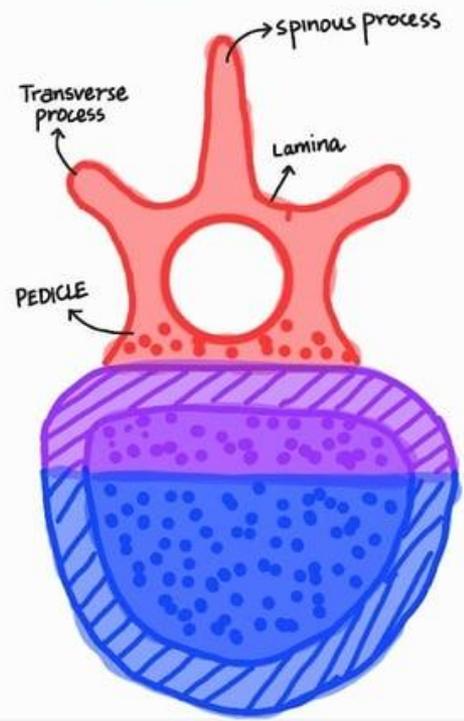
Spinal Fractures

- Assessment:
 - - Determine fracture stability.
- Rule:
 - - Two-column or more involvement = unstable fracture.
- Management:
 - - Unstable fractures require surgical fixation.



DENIS THREE COLUMNS OF SPINE

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<ul style="list-style-type: none"> → ANT. LONGITUDINAL LIGAMENT → ANT. 2/3 OF VERTEBRAL BODY → ANT. 2/3 OF INTERVERTEBRAL DISC. 	<ul style="list-style-type: none"> → POST. LONGITUDINAL LIGAMENT. → POST. 1/3 OF VERTEBRAL BODY → POST. 1/3 OF INTERVERTEBRAL DISC. 	<ul style="list-style-type: none"> → POST. LIGAMENT COMPLEX → NEURAL ARCH <ul style="list-style-type: none"> - PEDICLE - TRANSVERSE PROCESS - SUPERIOR ARTICULAR PROCESS - INFERIOR ARTICULAR PROCESS - LAMINA - SPINOUS PROCESS.
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Spinal Epidural Abscess

- Classic Triad:
 - - Fever
 - - Back pain
 - - Neurological deficit
- Risk Factors:
 - - IV drug use
 - - Diabetes
 - - Immunosuppression
- Management:
 - - Urgent MRI.
 - - Antibiotics ± surgery.



Steroids in Spine Injury

- Background:
 - - High-dose methylprednisolone was previously standard.
- Current Practice:
 - - No longer routine.
 - - Risk of infection and GI bleeding..