

Nervous System Disorders

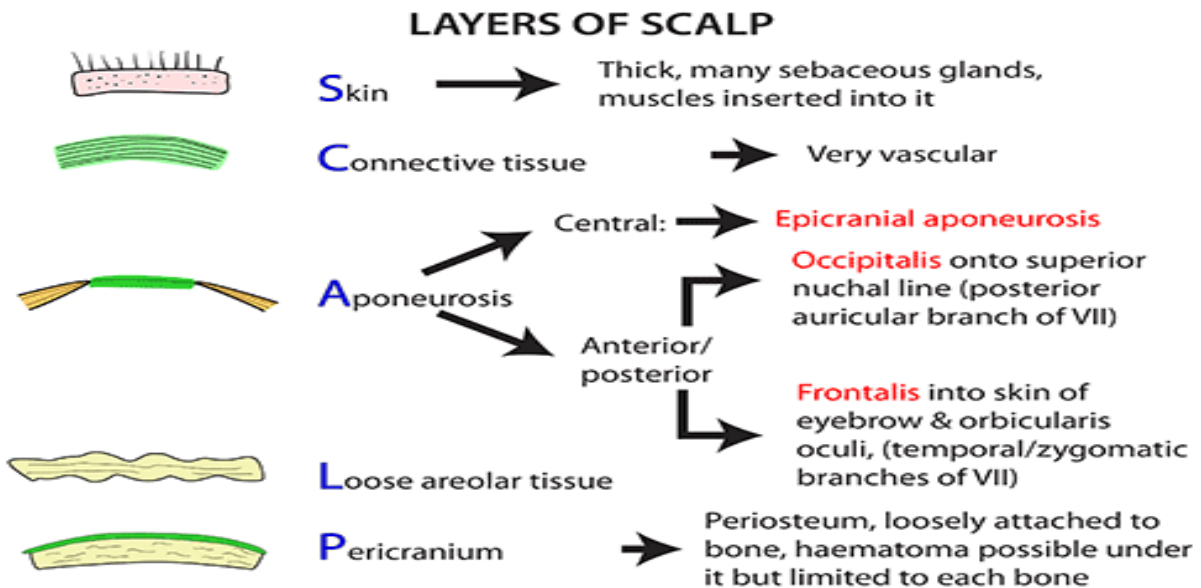
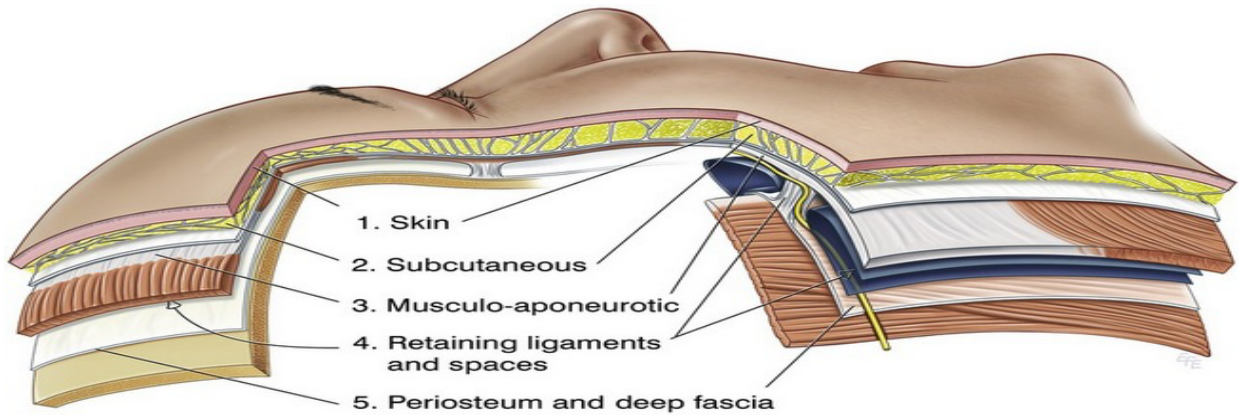
Dr. Gary Mumaugh

Protection of the Brain

- Scalp - 5 layers
- Skull - Encloses and protects the brain and special senses
- Meningeal Protection
 - Cerebrospinal fluid provides cushion for brain and is a shock absorber

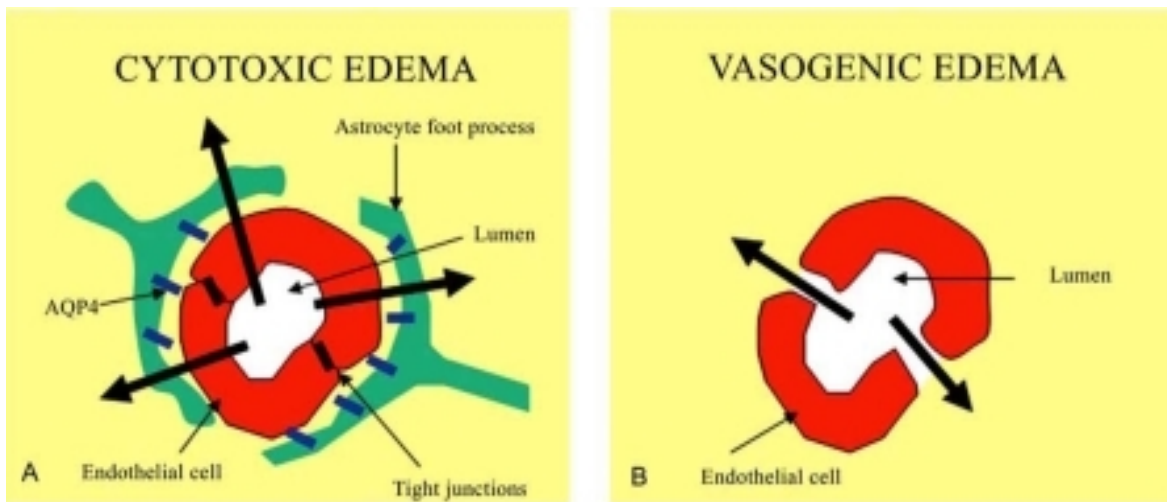
Protection of the Spinal Cord - Vertebral Column

- Protects spinal cord
- Articulates with the head, rib, pectoral and pelvic girdles
- Hemopoietic and immune system roles
- Points of attachment for muscles
- Avenue for vertebral arteries



Edema in the CNS

- **Edema**
 - An increase in tissue mass due to excess fluid
- **Vasogenic Edema**
 - Largely confined to white matter of brain & spinal cord
 - The blood brain barrier is compromised
 - Due to infection, toxic agent, abnormally permeable capillaries
- **Cytotoxic Edema**
 - The blood–brain barrier remains intact
 - A disruption in cellular metabolism impairs functioning of the sodium and potassium pump in the glial cell membrane, leading to cellular retention of sodium and water
 - Typically due to hypoxia or ischemia due to cardiac arrest
 - Swelling largely cellular



Circulation of CSF

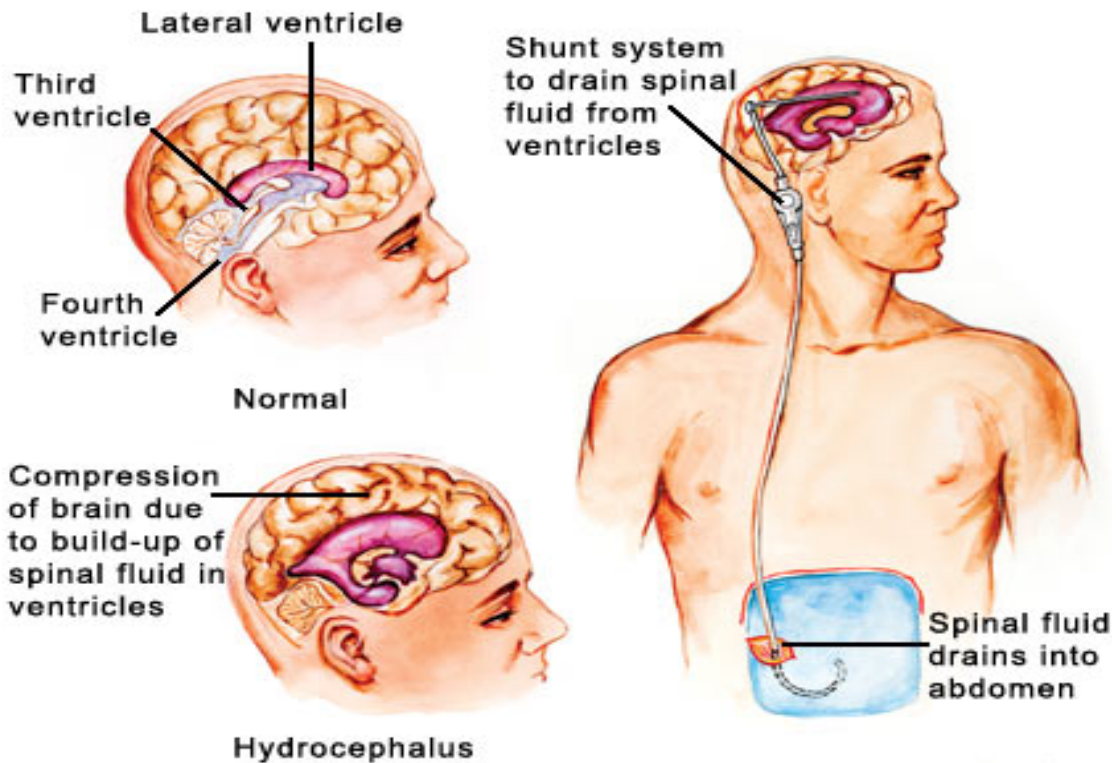
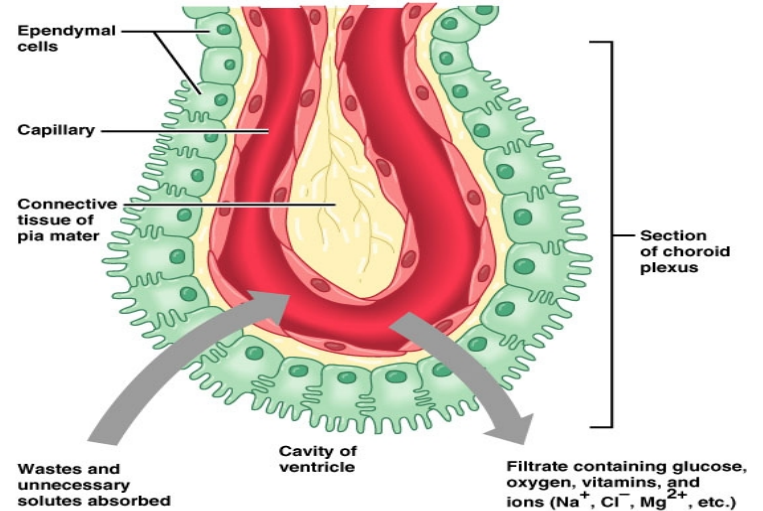
- The CSF starts in the bloodstream and returns to the bloodstream
- Starts in the ventricles of the brain
 - 10% goes into the central canal of the spinal cord and travels down the spine before ending in the subarachnoid space at the bottom of the spine.
- 90% goes through the Foramen of Magendje (Median Aperature) and flows directly into the subarachnoid space

Reabsorption of CSF

- Reabsorbed through the arachnoid villa
- Reabsorb about 20 ml/hour = rate of production

Hydrocephalus

- Excess fluid within the cranial vault, subarachnoid space, or both
- 3 mechanisms for hydrocephalus
 - Over secretion of CSF: rare
 - Impaired absorption of CSF: many ways, anything that raises venous pressure
 - Obstruction of CSF pathways: due to tumor or fibrosis
- Hydrocephalus can occur due to birth defects or be acquired later in life.
- Other causes include meningitis, brain tumors, traumatic brain injury, intraventricular hemorrhage, and subarachnoid hemorrhage.

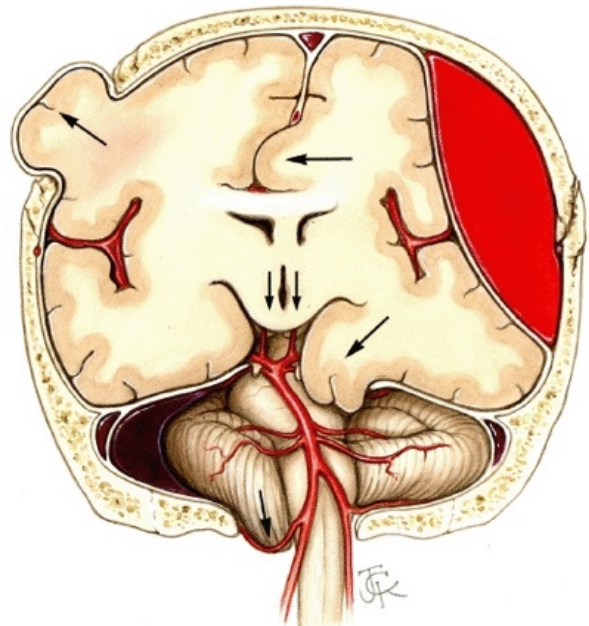


Increased Intracranial Pressure (ICP)

- **Normal ICP = 5-15 mmHg**
- **What can exacerbate ICP?**
 - CNS edema & tumor masses
 - Blocked venous return
 - Heart failure
 - Hemorrhage into tissue
 - Subdural/extradural hematoma
 - Increased CSF and hydrocephalus
- **What can decrease ICP?**
 - Expansion of spinal dural sac
 - Decreased CSF & blood volume
 - Bone erosion
 - Atrophy of neural tissue
- **How can high ICP be treated?**
 - Depends on if treatable or reversible
 - Pressure transducer by hole in skull measures ICP
 - Drugs (barbituates)- slow brain metabolism
 - Diuretics- lowers blood volume
 - Emergency craniotomy

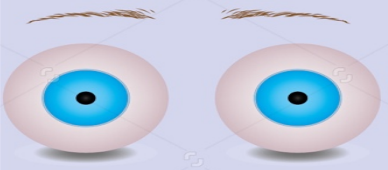


Herniation Syndromes

- A brain herniation is when brain tissue, cerebrospinal fluid, and blood vessels are moved or pressed away from their usual position inside the skull.
- Brain herniation occurs when something inside the skull produces pressure that moves brain tissues. This is most often the result of brain swelling from a head injury, stroke, or brain tumor.
- Brain herniation can occur:
 - Between areas inside the skull, such as those separated by a rigid membrane like the tentorium or falx
 - Through a natural opening at the base of the skull called the foramen magnum
 - Through openings created during brain surgery



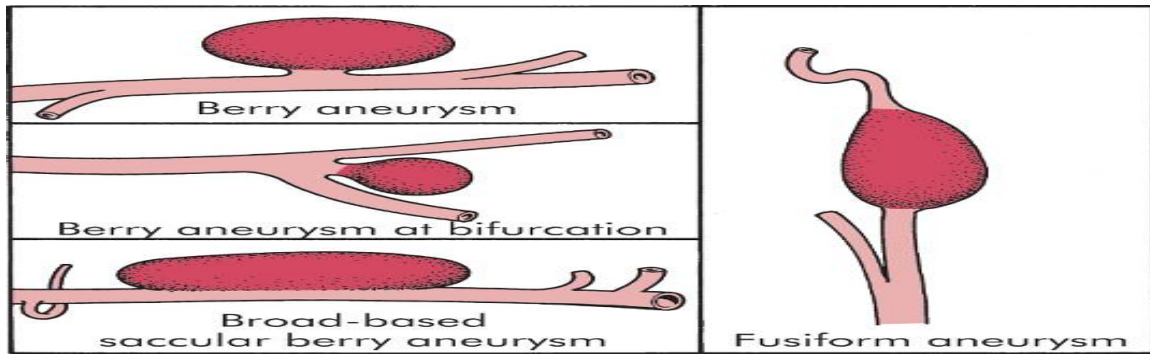
Coma - lowest level of consciousness

- **Glasgow Coma Scale:** determine level of consciousness
 - 3 = deep coma 15 = normal consciousness
- **Babinski sign:** sharp object pressed firmly to lateral surface of sole of foot – reaction gives depth of coma

Behaviour	Response
 <p data-bbox="207 751 570 783">Eye Opening Response</p>	<ol style="list-style-type: none"> 4. Spontaneously 3. To speech 2. To pain 1. No response
 <p data-bbox="253 1010 518 1035">Verbal Response</p>	<ol style="list-style-type: none"> 5. Oriented to time, person and place 4. Confused 3. Inappropriate words 2. Incomprehensible sounds 1. No response
 <p data-bbox="253 1255 518 1281">Motor Response</p>	<ol style="list-style-type: none"> 6. Obeys command 5. Moves to localised pain 4. Flex to withdraw from pain 3. Abnormal flexion 2. Abnormal extension 1. No response

Cerebrovascular Disorders - Cerebral Aneurysm

- Distention of cerebral arterial wall
 - Berry aneurysm: appear at points of bifurcation
 - Fusiform aneurysm: elongated dilations developing along artery
- Signs & symptoms
 - Cranial nerve dysfunction
 - Headaches
 - Lethargy
 - Neck pain
 - Bruit: noise detectable over aneurysm due to turbulence



Cerebrovascular Disorders

- **Subarachnoid Vasospasm**
 - Transitory restriction or narrowing of artery or branch
 - Often experienced with subarachnoid hemorrhage
 - Signs & symptoms - vary due to territory and duration
- **Arteriovenous Malformations (AVM)**
 - A tangled mass of dilated blood vessels that pass from large or medium sized arteries directly into a vein or venous sinus, bypassing normal capillary beds
 - Signs & symptoms - ischemia, seizures, headaches, bruit, xanthochromia (yellow color of CSF)
- **Intracranial Thrombophlebitis**
 - Inflammation & clot formation in the dural venous sinuses and perhaps cerebral veins
 - Often caused by infections of middle ear, mastoid air cells, paranasal sinuses, scalp, skin around upper lip, nose & eyes
 - Signs & symptoms - dependent on site and history of site infection
 - General headache
 - Papilledema (swelling of retina at optic nerve)
 - Eye movement abnormalities and pain
 - Edema of eyelids

Cerebrovascular Accidents – “Stroke”

- Sudden onset is due directly & indirectly to deficiency in blood supply
- 3rd most common cause of death in the USA
- Over 600,000 strokes per year
- 160,000 deaths per year
 - 30% die in acute stage
 - 30% - 40% severely disabled
- Ischemic stroke – 80%
- Hemorrhagic stroke – 20%

Who is at risk?

- Increases with age, men more than women, oral contraceptive use
- Cigarette smoking, obesity, genetic predisposition
- Hypertension, diabetes mellitus, heart disease

Cerebrovascular Accidents – “Stroke”

S & S of Strokes

- The actual precise symptoms depend on *where* the CVA was and *how large* it is
- Sudden weakness, numbness or paralysis of one side of the body
- Loss of consciousness
- Seizure may sometimes occur
- Sudden change in mental status, confusion
- Slurred speech, dysarthria, aphasia
- Prognosis is more guarded if:
 - loss of consciousness
 - if a large part of the left side of the brain is affected
 - This is the dominant side for 95% of people

What to do if you suspect a stroke

- Ask the person to say a complete sentence
- Ask the person to raise both hands above their heads
- Ask the person to walk across the room
 - Walk behind them to catch if unsteady
- If any of the above are present – CALL 911

Preventing Stroke

- Controlling hypertension
- Manage and control diabetes
- Lower blood pressure
- Proper diet and exercise
- Stop smoking
- Anticholesterol drugs if lipids levels high
- 83mg ASA per day
- Any history of TIA
 - Mini-stroke lasting 1-3 minutes with involvement of face and speech
 - Referral to vascular surgeon for carotid arteriography

Diagnosis of Strokes

- History is most important
- CT scans present with 95% accuracy
- Lumbar puncture if CT normal
- CT with LP is 100% accurate diagnostically
- MRI are used only if the diagnosis is still uncertain
 - Open MRI is preferred
 - Many patients have died in and older style MRI scanner which is enclosed and takes a long time for the test

Transient Ischemic Attack (TIA)

- Short episodes of sudden neurological dysfunction that clear up completely
- Causes: hypotension, vasospasms, anemia, polycythemia
- Symptoms: depends on arteries involved- aphasia, drop attacks, vertigo, nausea, dysarthria, amaurosis fugax (fleeting blindness)
- Therapy: anticoagulant drug (ex. Aspirin)

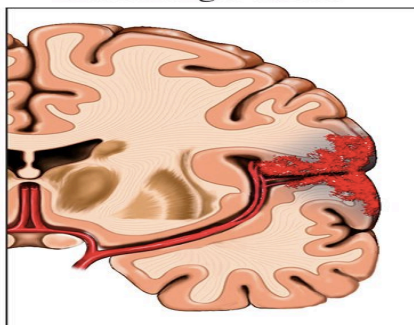
Thrombotic Stroke (most common) - Ischemic Strokes

- 80% of strokes
- Occlusion of an artery supplying blood to the brain
- Ischemic CVA will be localized to the area of occlusion
- Two types of ischemic stroke:
 - Thrombus
 - Atherosclerosis with occlusion of the carotid artery, vertebral artery or within the brain
 - Embolism from outside the brain
- Permanent damage to part of brain due to ischemia
- Thrombosis usually due to atherosclerosis
- “stroke-in-evolution” – may progress over weeks
- Symptoms: depends on affected area

Embolic Stroke – Ischemic Strokes

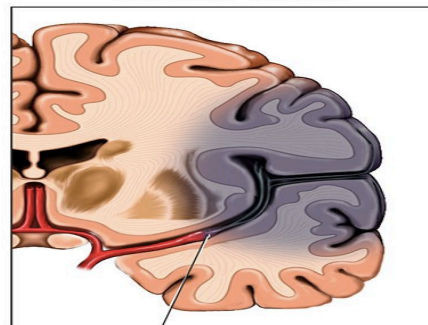
- Embolic Stroke
- Embolus lodges in brain artery and creates ischemia that leads to an infarct
- Often associated with atrial fibrillation
- Symptoms: ischemia, broad function loss, edema, infarction
- Rapid development of symptoms with no immediate warning signs
- Possible Sources of Emboli
 - Blood clot from heart
 - Platelets & fibrous debris from carotid artery
 - Clumps of myoglobin can break from over exerted muscle in extreme sports
 - Fat can break off from a large bone fracture
 - Nitrogen bubbles may build up in bloodstream from scuba divers who decompress too fast
 - Amniotic fluid can get into the blood during childbirth

Hemorrhagic Stroke



Hemorrhage/blood leaks into brain tissue

Ischemic Stroke



Clot stops blood supply to an area of the brain

Hemorrhagic Stroke

- Infarction by interrupting blood flow to region downstream from hemorrhage
- Damage from expanding hematoma (increased ICP)
- Symptoms: fairly rapid onset, increased blood pressure
- 20% of strokes
- Caused by a rupture in a cerebral artery
- Ruptured artery causes inflammation of brain tissue = increased intracranial pressure = damage to both cerebral hemispheres
- Because of wide spread damage often fatal
- This type of CVA occurs suddenly
- Results from arteriosclerosis or severe hypertension

Varieties of Hemorrhagic Stroke

- Intracerebral bleeding
 - Seen in elderly with high blood pressure and fragile vessels, or in patients with bleeding disorders and those on anticoagulants
- Subarachnoid bleeding
 - Seen in 30-40 year olds and are mostly due to congenital arteriovenous malformations
- Subdural bleeding
 - Often occurs in elderly who fall and strike their head
- Epidural bleeding
 - Usually from a ruptured temporal artery and is usually caused by major head trauma

Treatment of Strokes

- Ischemic strokes
 - Thrombolytic therapy - rtPA – recombinant tissue plasma activator has revolutionized CVA treatment
 - Must be administered within 3 hours
 - Cerebral edema often follows post-stroke
 - Treated with IV steroids
 - Heparin used after the initial three hours
- Hemorrhagic strokes
 - IV sodium nitroprusside to control blood pressure
 - IV Vitamin K and fresh plasma if patient on Coumadin
 - If ruptured aneurysm, then high risk brain stent is used (50/50 chance of surgical)

CNS Infections

- What are 5 locations of CNS infection?
 1. Meningitis: subarachnoid space
 2. Meningoencephalitis: meninges & adjacent brain tissue
 3. Encephalitis: brain tissue
 4. Myelitis: spinal cord
 5. Abscesses: focal

Acute Bacterial Meningitis

- 50-60% fatal if untreated
- Infection in subarachnoid space
- Treatment: rapid antibiotics
- Persistent meningitis can lead to cranial nerve damage, abscess, tissue infarct, and extension into subdural space

Chronic Bacterial Meningoencephalitis

- **Syphilis** - plug and inflame tiny vessels of the meninges
- **Lyme Disease** - variety of symptoms
- **Tuberculosis** - produces fibrinous exudate in the subarachnoid space

Meningeal signs

- Light sensitivity
- Acute: fever, vomiting, drowsiness, stiff neck, muscle aches, back aches
- Rapid development
- **Brudzinki's sign**: abrupt flexion of neck leads to involuntary flexion of knees (if supine)
- **Kernig's sign**: attempt to extend knee while thigh flexed results in resistance and pain in hamstring

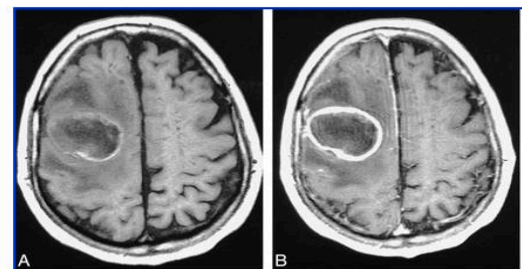
Reye's Syndrome

- Potentially fatal post - viral condition
- Symptoms
 - Renewed vomiting & lethargy
 - [3/4] clouded consciousness, hyperexcitability → recovery
 - [1/4] progressive brain edema → deepening coma → death
- Pathophysiology not understood
 - Aspirin is suspected to play a part

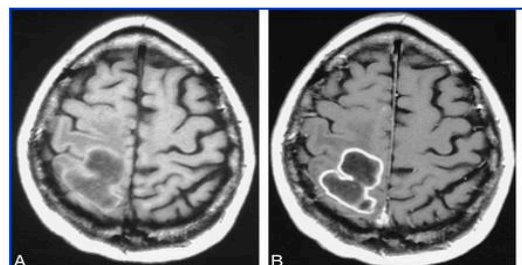
Brain Abscesses

- An area of necrosis and pyogenic (pus forming) bacterial infection
- No distinct symptoms → may resemble CVA
- Treatment- antibiotics and surgical excision or drainage
- Infection introduced at same time as an area of infarct – 2 possible ways:
 - Septic embolism
 - Chronic infection

Brain Abscess



MRI before (A) and after (B) contrast injection



CNS Tumors

- 2% of all cancer cases in adults
 - 70% above tentorium (w/in cerebral hemisphere, thalamus, etc.)
- 20% of all cancer cases in children
 - 70% subtentorial (brain stem, cerebellum, 4th ventricle)
- Mitotically active cells are capable of tumorigenesis
- **Astrocytes**: contribute to blood-brain barrier, structural support
- **Oligodendrocytes**: provide myelin sheaths
- **Ependymal cells**: line ventricles & central canal of spinal cord
- **Schwann cells**: provide myelination in PNS
- Treatment - excision or radiation
- Benign can be just as bad as malignant if inoperable
- **Spinal Cord Tumors**
 - Meningioma- tumor of cells of arachnoid membrane
 - Schwannoma- tumor of Schwann cells
- **Primary brain tumors**
 - **Gliomas**- 70%; most rise from astrocytomas
 - **Meningioma**- benign slow-growing tumor, arise from arachnoid membrane
 - **Acoustic neuroma**- most peripheral nerve tumors in cranial vault
 - **Oligodendrogliomas**- develop in cortex and subcortically
- **Secondary brain tumors**
 - Typically metastasize through blood to brain
 - Sources- lung, breast, skin, kidney & intestine

Pituitary gland - Pituitary adenoma – 2 types

- “Secreting type” (less common)- secretes excess hormones
- “Null cell”- goes undetected until there is damage
 - Symptoms: “tunnel vision,” cranial nerve compression, hypopituitarism
 - Treatment - surgery or radiation

