Vascular diseases of the CNS

strokes:

1-introduction:

-**stroke: neurological injury** resulting from an **abnormality** in the **blood vessels** supplying the **CNS.**

-**risk factors: medical conditions** and **behavioral** predisposition **(HTN, DM, hyperlipidemia, sedentary lifestyle, smoking, cardiac disease, heavy alcohol use)**

-prevention:

* by 1-addressing **risk factors** 2-**lifestyle** modification (counseling) 3-appropriate **medication**

* **Types** of prevention: 1-**primary** > prevent the first stroke 2-**secondary** >prevent stoke recurrence

* Usually, **subsequent strokes** are of the same subtype as the **initial** (importance of identifying the **etiology**)

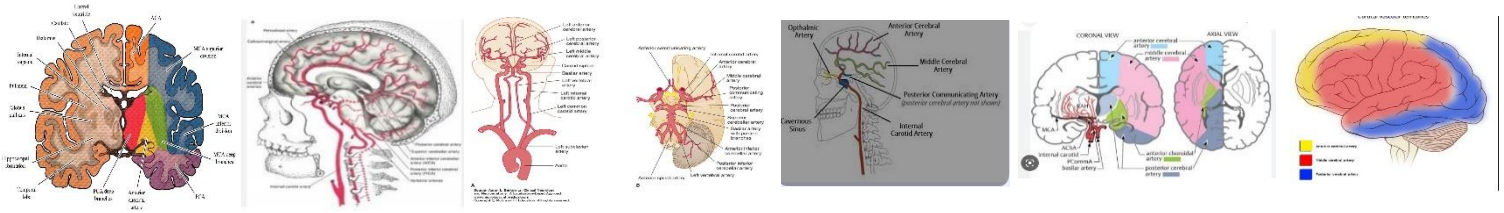
-stroke every 40 sec + death every 4 min, 5th cause of death, cause of prolonged disability, huge economic social, and psychological cost (in US)

2-vascular anatomy:

-cerebral vasculature is divided into:

Anterior circulation (carotid)	Posterior circulation (vertebrobasilar)
-supply the **cerebral hemispheres** except for the median temporal lobes and a portion of occipital lobes	-supplying **brainstem, thalami, cerebellum, posterior portion of the cerebral hemispheres** (median temporal lobes and a portion of occipital lobes)
-right CCA from innominate artery, left CCA from the aorta -CCA split into ICA and ECA -ICA travels behind the pharynx, forming a carotid siphon, then penetrating the dura mater. **Branches:** 1-ophthalmic artery (carotid siphon) 2-anterior choroidal + posterior communicating arteries (penetration of dura matter) 3- **ACA +MCA** (bifurcation) **ACA** -supply: 1-anterior medial cerebral hemisphere 2-caudate nuclei 3-basal frontal lobes -Two ACA are connected by the anterior communicating artery **MCA** -supply:1-basal ganglia + internal capsule (lenticlostriate A) 2-lateral cerebral hemisphere above the Sylvian fissure (STA) 3-temporal + inferior parietal lobe (ITA) -trifurcate into: small anterior temporal branches, superior and inferior divisions.	**Vertebral Artery (VA):** - First branch of each subclavian artery. -Enters spinal column via transverse foramina of C5 or C6 -Exits to course behind atlas before piercing dura mater to enter foramen magnum. **Intracranial VAs and Basilar Artery:** -Join to form basilar artery at ponto-medullary junction. - Gives off posterior and anterior spinal artery branches, penetrating arteries to medulla, and posterior inferior cerebellar artery (PICA). **Branches of Basilar Artery:** - Runs along clivus, giving off bilateral anterior inferior cerebellar artery (AICA) and superior cerebellar artery (SCA) branches. -Divides at pontomesencephalic junction into posterior cerebral arteries (PCA). **Brainstem Vascular Supply:** -Small penetrating arteries at basilar artery bifurcation supply medial midbrain and thalami. -Large paramedian arteries and smaller circumferential arteries supply brainstem. -Long circumferential arteries give off branches to lateral tegmentum. **Path of PCA:** -Gives off penetrating arteries to midbrain and thalamus. - Courses around cerebral peduncles, supplies occipital lobe, and inferior surface of temporal lobe

Circle of Willis
1-connect the anterior circulation of each side > **anterior communicating artery** 2-connect the anterior and posterior circulation > **posterior communicating artery** -each carotid artery supplies four-fifths of the brain, vertebrobasilar circulation one-fifth



3-brain ischemia:

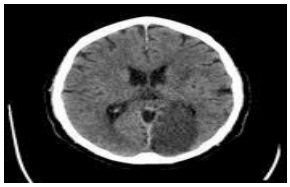
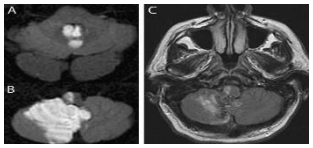
-80% ischemic stroke, 10% subarachnoid and ICH

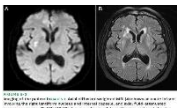
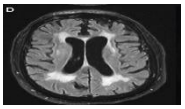
-ischemic strokes are divided into:

thrombotic	Embolic	Systemic hypoperfusion
Localized occlusive process within one or more vessels that leads to obstruction of blood flow	**Clot material formed elsewhere** within the vascular system lodges in a vessel and blocks blood flow.	**Low systemic perfusion pressure** leads to Decreased blood flow to brain tissue
Causes: **1-atherosclerosis** (MC, plaque formation, affecting large cervical and intracranial arteries) **2-microtheroma** (obstruct penetrating artery origin) **3-primary hemolytic problem** (polycythemia, thrombocytosis, hypercoagulability, less common) **4-vessel wall pathology** (vasoconstriction, arterial dissection, fibromuscular dysplasia)	**clot origin:** **1-heart** (mc, from the heart valves, endocardium, and tumors within atrial or ventricular cavities) **2-major arteries** (artery to artery emboli (seen in large arteries eg. aorta, ICA, VAs + arterial dissection)) **3-systemic veins** (paradoxical embolism: travel to the brain through cardiac defects) **4-air, fat cholesterol crystals, bacteria, foreign bodies** (occasionally) High-Risk Sources ◆ Atrial fibrillation/flutter ◆ Sick sinus syndrome ◆ Recent myocardial infarction ◆ Previous myocardial infarction and akinesia ◆ Left ventricular thrombus ◆ Left atrial cavity thrombus ◆ Left atrial appendage thrombus ◆ Congenital heart diseases[a] ◆ Cardiomyopathies[b]	**Causes:** **1-cardiac pump failure** (MI, arrhythmias) **2-systemic hypoperfusion** (blood loss or hypovolemia) -more **generalized** and affects brain **diffusely** and **bilaterally** -most critical in **watershed** regions (between ACA and **MCA** or PCA and **MCA**)

Common ischemic stroke syndromes:

Anterior circulation	Posterior circulation	Lacunar syndromes
A-left cerebral hemisphere stroke: 1-Ahpasia 2-right **hemiparesis** (arm, hand, face **>** leg) 3-right **hemisensory** loss 4- in large lesions: a-**conjugated deviation** of the eye to the left b-right **hemianopia** c-**hemi-inattention**	**A-left PCA territory stroke:** 1-**amnesia** (not in all cases) 2-**alexia** (read) without agraphia (writing) (occurred if the splenium of the CC is involved) 3-right **homonymous hemianopia**	Definition: occlusion of **penetrating artery** in either **anterior** or **posterior** circulation. -cause a limited range of presentations. -lacunar stroke syndromes include the following

5-**amaurosis fugax** (left **monocular visual loss** caused due to ICA occlusive disease)		
B-right cerebral hemisphere strokes: 1-poor drawing and coping 2-neglect of the left visual field 3-left **hemiparesis** (arm, hand, face **>** leg) 4-left right **hemisensory** loss 5-in large lesions: a-**conjugated deviation** of the eye to the right b-left **hemianopia** c-**hemi-inattention** (hemineglect) 5-**amaurosis fugax** (right **monocular visual loss** caused due to ICA occlusive disease) -usually **caused** by: 1-carotid artery occlusion 2-embolism to MCA or its branches 3-basal ganglionic intracerebral hemorrhage	**B-Right PCA territory stroke:** 1-left sided visual neglect (not in all cases) 2-left **homonymous hemianopia** *PCA territory infarcts are usually cased by embolisms that originate form the heart, aorta, VAs. 	**A-pure motor stroke:** -location includes **corona radiata**, **posterior limb of the internal capsule** -**contralateral weakness** of arm, face, and leg *No sensory, visual, or cognitive/behavioral signs.
conjugated eye deviation  hemianopia  amaurosis fugax: temporary blindness in one eye	**C-Lateral medullary stroke:** (Wallenberg syndrome) -due to intracranial **VAs** or **PICA** occlusion  **1-ipsilateral:** a-facial pain, or reduce pain and temperature sensation (ipsilateral face or both) b-Horner syndrome c-arm incoordination **2-contralateral:** a-loss of pain and temperature (body) 3-**nystagmus** 4-**gait ataxia** (leaning and veering while sitting or walking) 5-**dysphagia** and **hoarseness** (in deep lesions)	**B-pure sensory stroke:** -location: **ventral posterior thalamus** -**contralateral paranesthesia** of body, limbs, and face *no motor, visual, or cognitive abnormalities **C-sensory motor stroke** -**combination of motor and sensory lacunes** -location **ventral posterior thalamus** and adjacent **posterior limb of the internal capsule**
	D-Bilateral pontine base and often medial tegmentum stroke: -due to **basilar A occlusion** or **pontine hemorrhage** 1-**Quadriplasia** 2-eye: a-unilateral or bilateral **conjugate gaze paresis** (weakness or paralysis in moving their eyes horizontally in one or both directions) b-**intranuclear ophthalmoplegia** c-**6th nerve palsy** **3- coma** (bilateral involvement of medial tegmentum)	**D-Dysarthria-clumsy hand syndrome** -location: **base of the pones** 1-**slurred speech** 2-contralateral **hand clumsiness**

	E-cerebellar infarction -due to embolism to **PICA** or **SCA,** or cerebellar **hemorrhage** 1-**dysarthria** 2-**Gait ataxia** 3-ipsilateral arm **dysmetria** 	**E-Ataxic hemiparesis:** -location: **base of the pones**, **posterior limb of internal capsule** and **corona radiata** -contralateral **limb weakness and ataxia** (greater in the leg and foot than in the arm and hand)  

Arterial dissection: (leads to ischemic stroke)

1-carotid dissection:

-ipsilateral severe **retro-orbital headache**

-stroke involves the **anterior** circulation

-Px:1-ipsilateral **Horner syndrome** (ascending oculosympathetic tract)

2-**perspiration is preserved** (because they ascend with the carotid artery

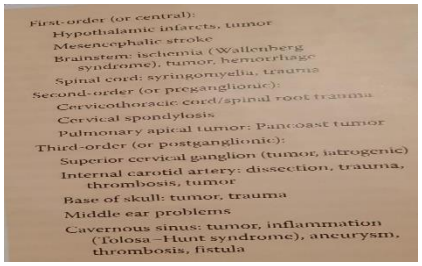
2-VA dissection:

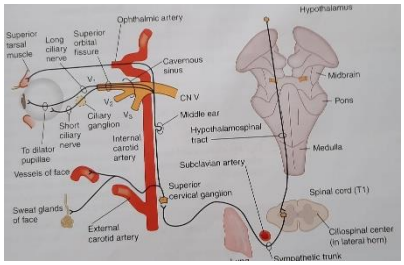
-caused by: **neck manipulation or trauma**

-ipsilateral **neck pain**

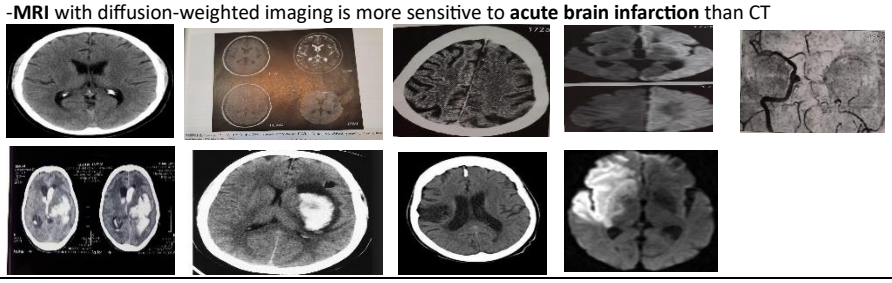
-stroke in the **posterior** circulation

Causes of Horner syndrome:





4-Diagnostic evaluation:

1-clinical	-**Hx and general examination** >focusing on **cardiac and vascular health** -**neurological examination**> detailed exam to assess the extent and nature of the neurological defect
2-brain imaging	-use **CT and MRI** to separate **infarction from hemorrhage** -**MRI** with diffusion-weighted imaging is more sensitive to **acute brain infarction** than CT 
3-vascular imaging	-using **echocardiography**, **Doppler ultrasound**, CT angiography **(CTA)**, and MR angiography **(MRA)** to perform imaging of the heart, aorta, and neck and intracranial arteries. -in anterior circulation case (imaging for ICAs) and in posterior circulation case (imaging for VAs) -when arterial dissection is suspected (CTA or MRA with fat-suppressed imaging (fat salt) is used to evaluate ICA and VA) 
4-blood test	-**CBC**, **platelet count**, and **PT/INR** (to check erythrocyte, leukocyte, and coagulation) -intensive investigation for coagulopathy (is necessary in some cases)

5-Treatment:

-**Hyper- or hypoglycemia** must be excluded before Tx because it may **mimic** the symptoms and signs of acute stroke

-reperfusion therapy: used when **a large artery is occluded** and if a **large portion** of the brain area supplied by that artery is **not already infarcted (penumbra)**
-reperfusion therapy can be an attempt using:

A-intravenous thrombolysis:	-called recombinant tissue plasminogen activator (tPA), Alteplase -improve outcomes if given **within 4.5 hours** **-SE: cerebral hemorrhage** (should **evaluate** the factor that would increase the risk e.g. thrombocytopenia, recent surgery, bleeding diatheses)
B-intra-arterial tPA:	-used for patients with symptoms **longer than 4.5-hour** (window for IV tPA) and with a **well-defined occlusion** (visualized by CTA and angiography)
C-mechanical thrombectomy:	-using **clot-retrieving stent devices** -used in patients who are **not tPA candidates** (with ICA and proximal MCA occlusion)

-prevention of further ischemia focuses on **maximizing cerebral blood flow** without **lowering BP** unless there is evidence of **organ failure** (pulmonary edema, cardiac ischemia)

-for **secondary prevention** > using antithrombotic agents (antiplatelet +anticoagulant)

-for **most patients antiplatelet drugs** e.g. aspirin, clopidogrel, combination of aspirin + modified-release dipyridamole)

-for **intracranial atherosclerosis** > **dual antiplatelet** (aspirin +clopidogrel)

-**anticoagulant** 1- **warfarin** (used in **A-fib**, cerebral venous sinus thrombosis, inherited hypercoagulable state)

2-**newer oral** e.g. apixaban, dabigatran, edoxaban, rivaroxaban (more effective and better safety profile than warfarin) used with **A-fib**

-control of stroke risk factors through lifestyle modifications, nutrition, exercise, and medication is crucial.

Transient ischemic attack (TIA)

-definition: **focal neurological** syndrome produced by **brain ischemia** that lasts **24 hours or less**

-increase risk for **stroke** (10% risk in 90 days, greatest risk within first 24 hours)

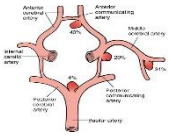
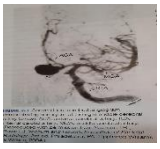
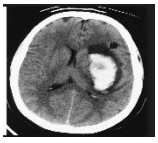
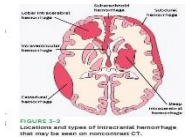
-**evaluation:** is identical to stroke.

Include **MRI** with diffusion-weighted imaging (in 50% of patients abnormal), **lipid** profile, **echocardiography**, **cardiac telemetry**, **carotid artery imaging**

-prevention +treatment +mechanisms > similar to stroke

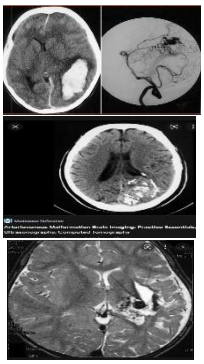
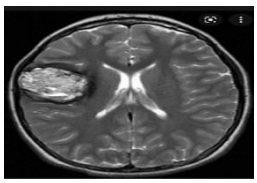
7-intracranial hemorrhage:

-Bleeding inside the skill (subarachnoid, intracerebral (epidural, subdural>usually traumatic))

subarachnoid hemorrhage (SAH)	Intracerebral hemorrhage (ICH)
-signs and symptoms: 1-sudden-onset, severe headache 2-vomit 3-cease what they are doing 4-death or coma (increase ICP or affect the insulae) **-causes:** 1-traumatic (often) 2-bleeding from an **aneurysm** located along the circle of Willis (serious) **-Treatment:** **Aim:** prevent rebleeding and vasoconstriction that follow SAH 1-aneurysm can be **clipped surgically** or **coiled** by interventional techniques 2-**Ca++ channel blocker nimodipine** used to minimize vasoconstriction and delay brain ischemia   	-bleeding directly from brain **parenchyma** **-signs and symptoms:** 1-headache 2-neurological sign (location dependent) **-causes:** 1-**hypertension** leading to Charcot-Bouchard microaneurysms (MC) 2-cerebral amyloid angiopathy (in elderly, in parietal and occipital lobes) 3- bleeding diatheses (patient taking anticoagulant) 4-trauma, vascular malformations **-treatment:** 1-correcting any **coagulopathy** 2-**surgical decompression** (used in cerebellar hemorrhages) -risk factor management to prevent the recurrence -MC locations:(basal ganglia, internal capsule, caudate nucleus, thalamus, pons and cerebellum) -devastating condition of high mortality rate  

8-vascular malformation:

-Variety of congenital and acquired vascular anomalies that have the potential to bleed, either within the brain (ICH) or around it

Arteriovenous malformation (AVMs)	Cavernous angiomas	Developing venous anomalies (DVAs)	Telangiectasias
-lack of normal **capillary bed**, consisting of arteries connected directly to veins -Causes: **ICH** and **seizures** -treatment: **embolization** and **surgical resection** 	-consist of compact mass of **sinusoidal vessels** without intervening brain parenchyma(normal) -causes: **bleeding** and **seizures** but not threatening as AVMs -followed by serial **neuroimaging** studies -treatment: **surgery** (rarely), **antiseizure drug** (recurrent seizures development) 	-**MC** vascular malformation of the brain -**anomalous veins** that are separated with **normal** brain parenchyma -**rarely** causes **hemorrhage** -usually **not treated surgically** or followed up with **imaging**	-**dilated capillaries** within the brain -Detected **incidentally** and do **not require treatment**

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