The Nervous System

Anatomy

Introduction

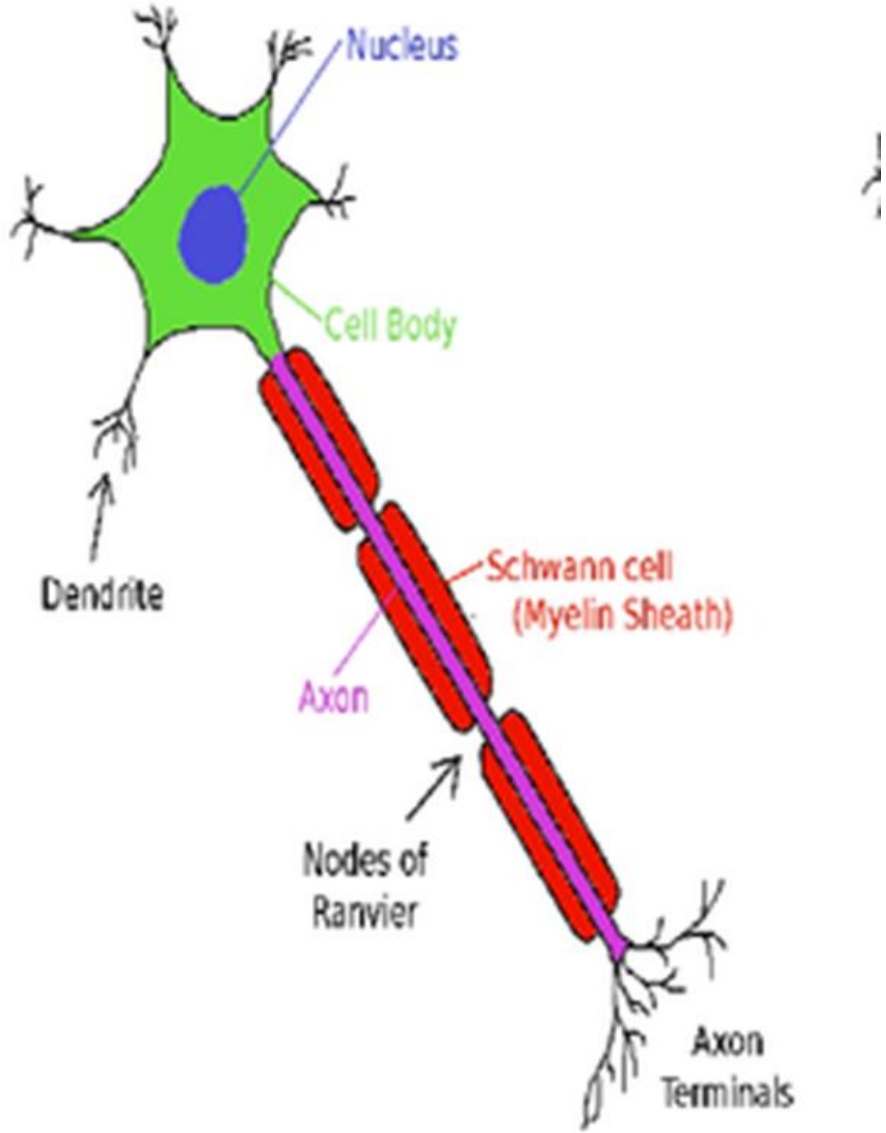
- The nervous system consists from CNS and PNS
- CNS consists from brain and spinal cord
- PNS consists from somatic and autonomic nerves

- The neuron is the functional unit of the nervous system. Each neuron has a cell body and axon terminating at a synapse, supported by astrocytes and microglial cells.

- **Astrocytes** provide the structural framework for the neuron, control their biochemical environment and form the **blood–brain barrier**.

- **Microglial** cells are blood-derived mononuclear macrophages **with immune and scavenging functions.**

- In the CNS, myelin is produced by oligodendrocytes. In the PNS, myelin is produced by Schwann cells.


Nucleus
Cell Body
Dendrite
Schwann cell
(Myelin Sheath)
Axon
Nodes of
Ranvier
Axon
Terminals

Meninges

- Brain and spinal cord are covered with three membranous layers called the meninges: dura mater next to the bone, arachnoid and pia mater next to the nervous tissue.

CSF

- The subarachnoid space between the arachnoid and pia is filled with cerebrospinal fluid (CSF) produced by the choroid plexuses.

- The total volume of CSF is between 140 and 270 mL and there is a turnover of the entire volume 3–4 times a day

- Rate of production 700 mL per day

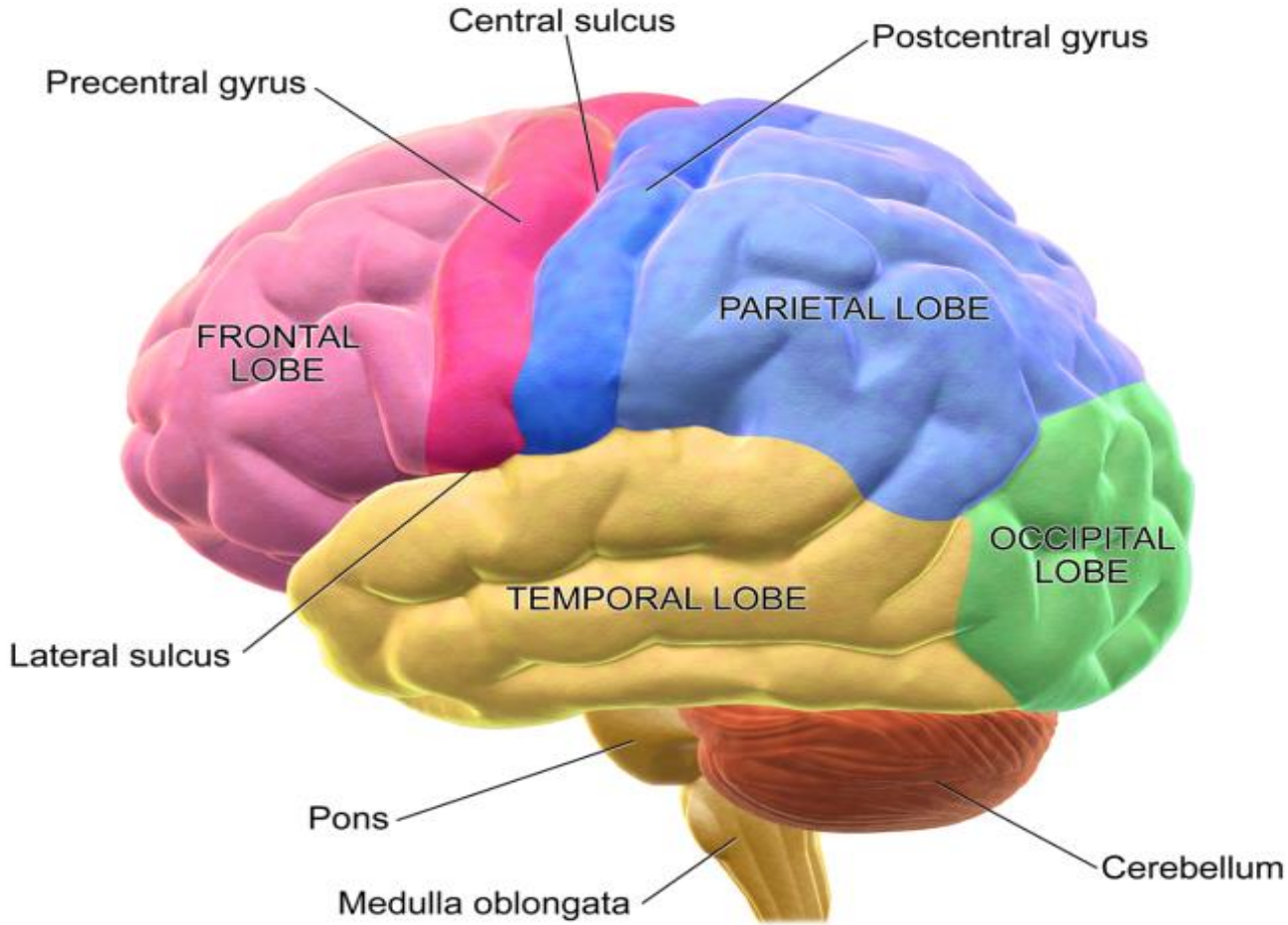
Brain

- Two cerebral hemispheres, each with four lobes (frontal, parietal, temporal and occipital), the brainstem and the cerebellum.

- The brainstem comprises the midbrain, pons and medulla.

- The cerebellum has two hemispheres and a central vermis attached to the brainstem by three pairs of cerebellar peduncles

Lateral View of the Brain



Spinal cord

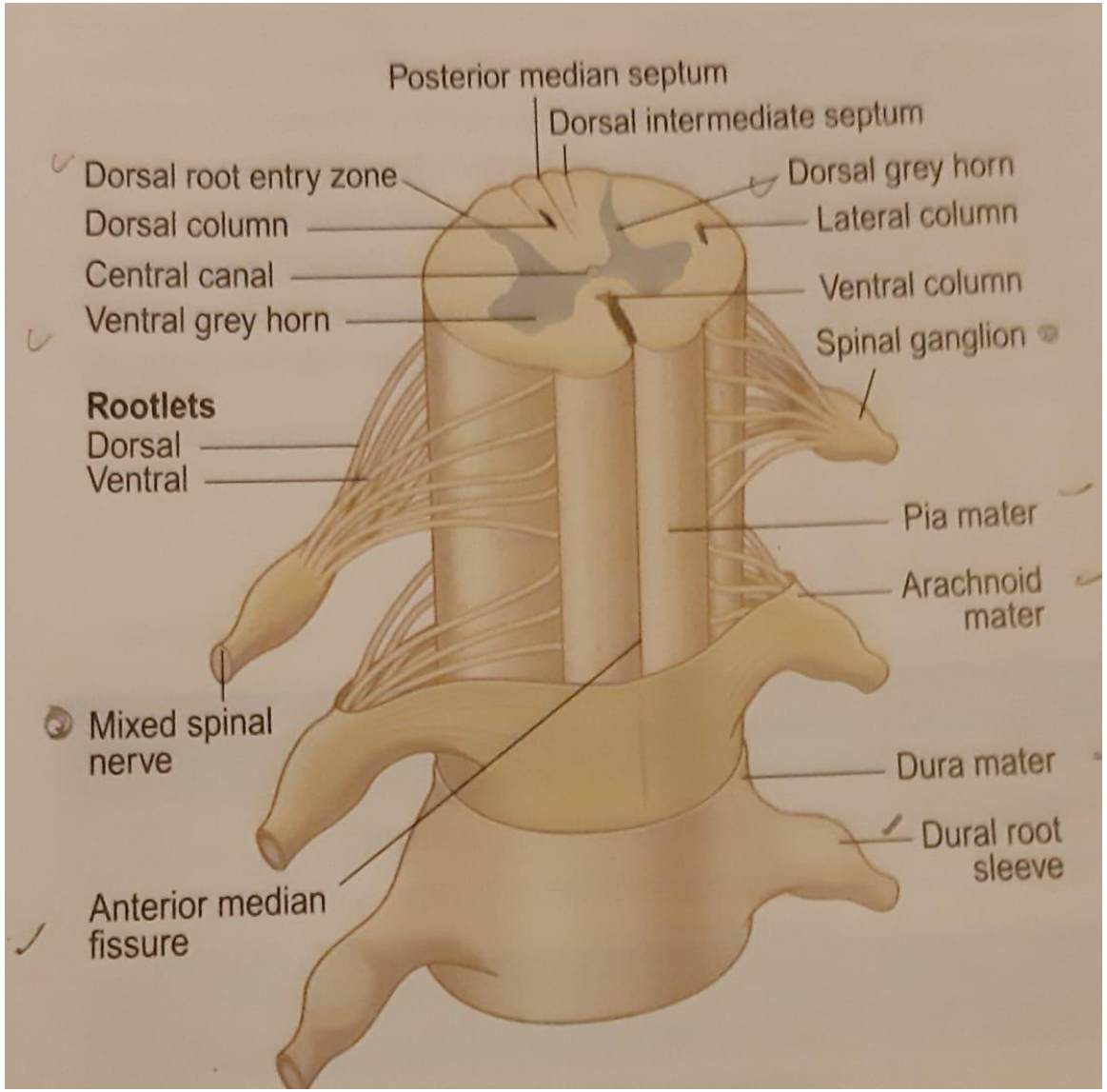
- The spinal cord is the main pathway for information connecting the brain and PNS.

- It contains the ventral grey horn and dorsal grey horn

- Ventral roots consist of efferent fibers that arise from motor neurons found in ventral grey horns.

- The dorsal roots are afferent fibers, receiving sensory information from organs to be transmitted to brain through sensory neurons found in dorsal grey horn.

Nerve root and meninges



Spinal cord

- The spinal cord contains multiple tracts

1. Dorsal column (fasciculus gracilis and fasciculus cuneatus) : responsible for propioception , vibration and half touch

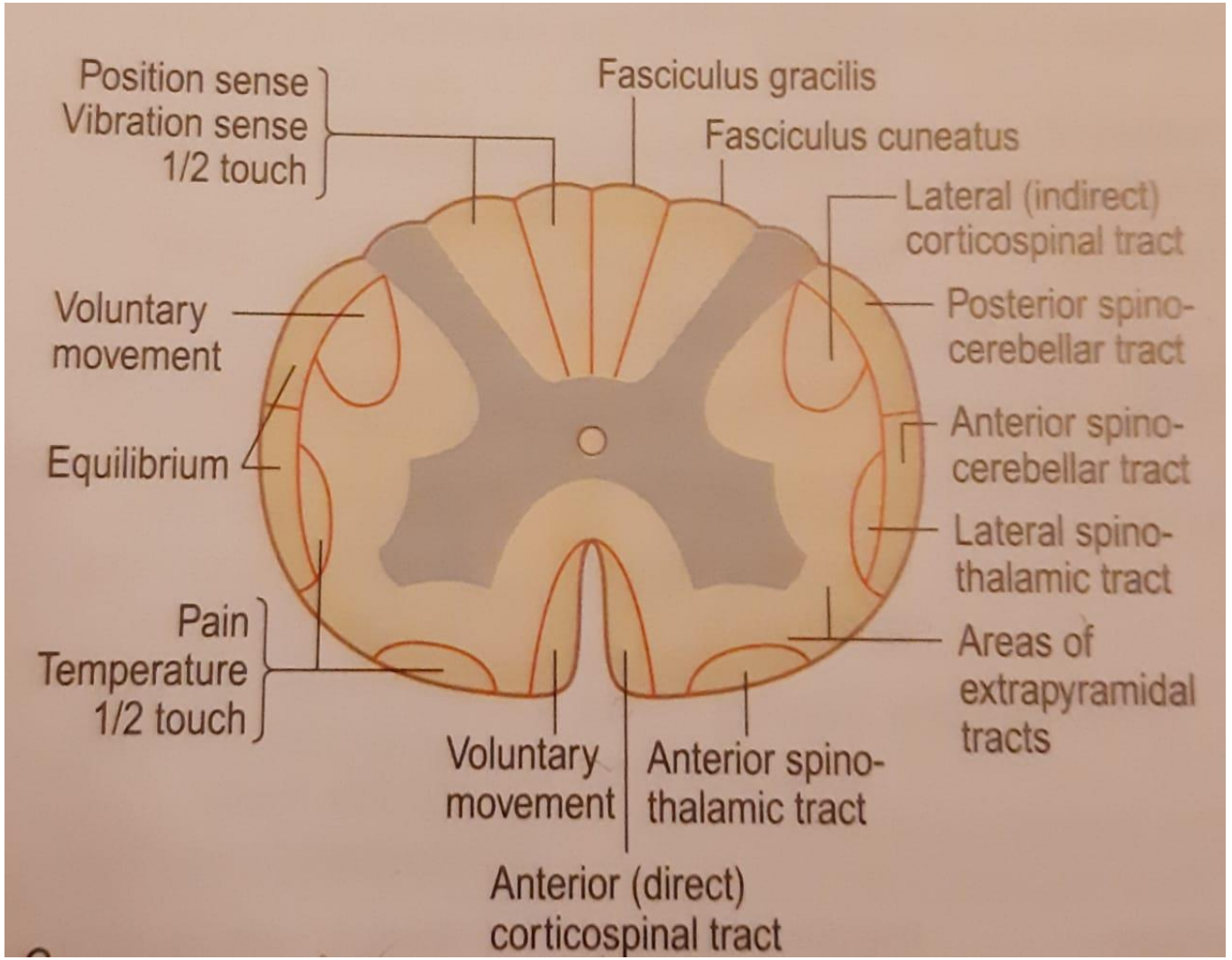
2. Anterior and lateral corticospinal tracts: voluntary movements

Spinal cord

3. Anterior and lateral spinothalamic tracts: pain , tempertaure and half touch

4. Spinocerebellar tract: equilibrium

Cross-section spinal cord



Peripheral nervous system

- Peripheral nerves may have myelinated or unmyelinated axons
- Contains somatic and autonomic nerves
- Somatic nerves: consist of sensory and motor nerves

History

- The history is a the key for diagnosis as physical exam maybe normal or unhelpful.

- In cases of amnesia or loss of consciousness we need additional witness history.

- We should clarify exactly what the patient means by any neurological symptom.

- Ask the patient what they fear might be wrong.

- For any neurological symptom ask about onset , duration , pattern , exacerbating , relieving factors and associated symptoms.

Symptoms

1- Headache

- May be either primary or secondary.
- Use SOCRATES to analyze it
- Isolated headache with a truly abrupt onset may represent a potentially serious cause such as subarachnoid haemorrhage or cerebral vein thrombosis, whereas recurrent headache is much more likely to be benign primary headache.

Primary (idiopathic) causes

1. migraine
2. tension headache
3. trigeminal autonomic cephalalgias (including cluster headache)
4. primary stabbing headache
5. cough, exertional or sex headache
6. primary thunderclap headache

Migraine

- Recurrent attacks of moderate to severe headaches
- Mostly unilateral
- Evolve over 30 minutes to 2 hours , lasting up to 72 hours, with weeks to months of symptoms free.
- Classified into classic (with aura) and common (without aura)

Migraine

- Associated with nausea/vomiting, photophobia/phonophobia
- During the attack the patient prefers to be in a dark room .

Cluster headaches

- Abrupt onset , Attacks last up to 2 hours
- Recurrent attacks 1-4 times within 24 hours , lasting weeks to months , with months to years of remission
- Awake the patient from sleep
- Orbital/retro-orbital; always same side during cluster, may switch sides between clusters

Cluster headache

- Autonomic features, including conjunctival injection, tearing, nasal stuffiness, ptosis, miosis, agitation

- During the attack the patient keep pacing around the room in an agitated state, or even head banging

Stabbing headache

- Abrupt onset
- Last very briefly , seconds or less
- Anywhere
- Common in patients with migraine

Secondary (or symptomatic) headaches

- **Meningitis:** associated with neck stiffness, fever, rash, signs of raised intracranial pressure and false localizing signs, meningism

- **Subarachnoid hemorrhage:** Abrupt onset, maybe fatal at onset , associated with nausea/ vomiting, reduced consciousness, false localising signs, III nerve palsy

- **Temporal arteritis:** usually occur in patients more than 55 yrs, presents with jaw pain on chewing, visual symptoms , and tender temporal arteries, elevated ESR and CRP

2- Disturbances of consciousness

*****Causes:**

- Postural hypotension
- Neurocardiogenic syncope (vasovagal)
- Hypersensitive carotid sinus syndrome (pressure over carotid sinus may lead to reflex bradycardia and syncope)
- Cardiac syncope due to arrhythmias or mechanical obstruction of cardiac output

✓**Syncope**

- Most common cause of transient loss of consciousness
- Due to inadequate cerebral perfusion
- Maybe due to vasovagal(reflex) or cardiac syncope

Vasovagal syncope

- It occurs due to stimulation of parasympathetic system due to pain , emotion or illness or in people forced to stand in warm environment. Leads to vasodilation and bradycardia
- Often preceded by light-headedness, vision dimming, tinnitus, and nausea
- Lasts 1-2 minutes
- It causes pale or grey skin

- Maybe associated with myoclonic jerks
- If kept flat, recovery is rapid

Cardiac syncope

- Syncope with no previous alarm or trigger or exercise

- Causes: hypertrophic cardiomyopathy, severe aortic stenosis or arrhythmia.

✓ **Postural hypotension**

Could be due to

1- drugs (levodopa or anti hypertensive drugs) or

2- autonomic diseases such as DM

3- in people more than 65 years

4- hypovolemia

How to ask about syncope ??

- Ask about witness
- any preceding symptoms (palpitation, chest pain, lightheadedness, nausea, tinnitus, sweating and visual disturbance)
- Duration of loss of consciousness
- Appearance of the patient while unconscious
- Any injuries sustained.
- Time to recovery to full consciousness and normal cognition

3- Epileptic Seizures

- paroxysmal electrical discharges from either the whole brain (generalized) or part of the brain (focal).

- The history from the **patient** and **witnesses** can help distinguish epilepsy from syncope

- Usually triggered by sleep deprivation or alcohol or drugs

- Types

1. Generalized: tonic–clonic seizure is the most common form
2. Focal (partial)

Tonic clonic seizure

- Tonic phase: typically follows a **stereotyped** pattern with early loss of consciousness associated with body stiffening

- clonic phase: rhythmical jerking crescendoing and subsiding over 0.5 – 2 minutes

- postictal phase: period of unresponsiveness often with heavy breathing, the patient appears to be deeply sleep and finally confusion as the patient awakes.

How to differentiate epilepsy from vasovagal??

- Trigger: alcohol , sleep deprivation or drugs
- Prodrome: May have focal (aura) prodrome
- Convulsion and loss of consciousness lasts for 1-2 minues
- Full recovery occurs over 30 minutes

- Cyanosed skin

- Lateral tongue biting, headache, generalized myalgia, back pain (vertebral compression fractures), shoulder fracture/ dislocation may occur

Focal seizure

- Simple (consciousness is preserved) or complex (impaired conciousness)
- Characterized by whichever part of the brain is involved
- frontal lobe seizures: focal motor seizure
- temporal lobe seizures characterised by autonomic and/or psychic symptoms, often associated with automatisms such as lip smacking or swallowing.

Functional dissociative attacks (non-epileptic or psychogenic attacks or pseudoseizures)

- difficult to distinguish from epileptic seizures, clues to differentiate psychogenic seizures:

1. occurring multiple times in a day
2. may last considerably longer
3. symptoms waxing and waning

4. asynchronous movements

5. pelvic thrusts , side-to-side rather than flexion/extension movements

6. absence of postictal confusion

- The widespread availability of videophones allows witnesses to capture such events

4- Stroke symptoms

- STROKE is a focal neurological deficit of rapid onset that is due to a vascular cause , maybe ischemic or hemorrhagic

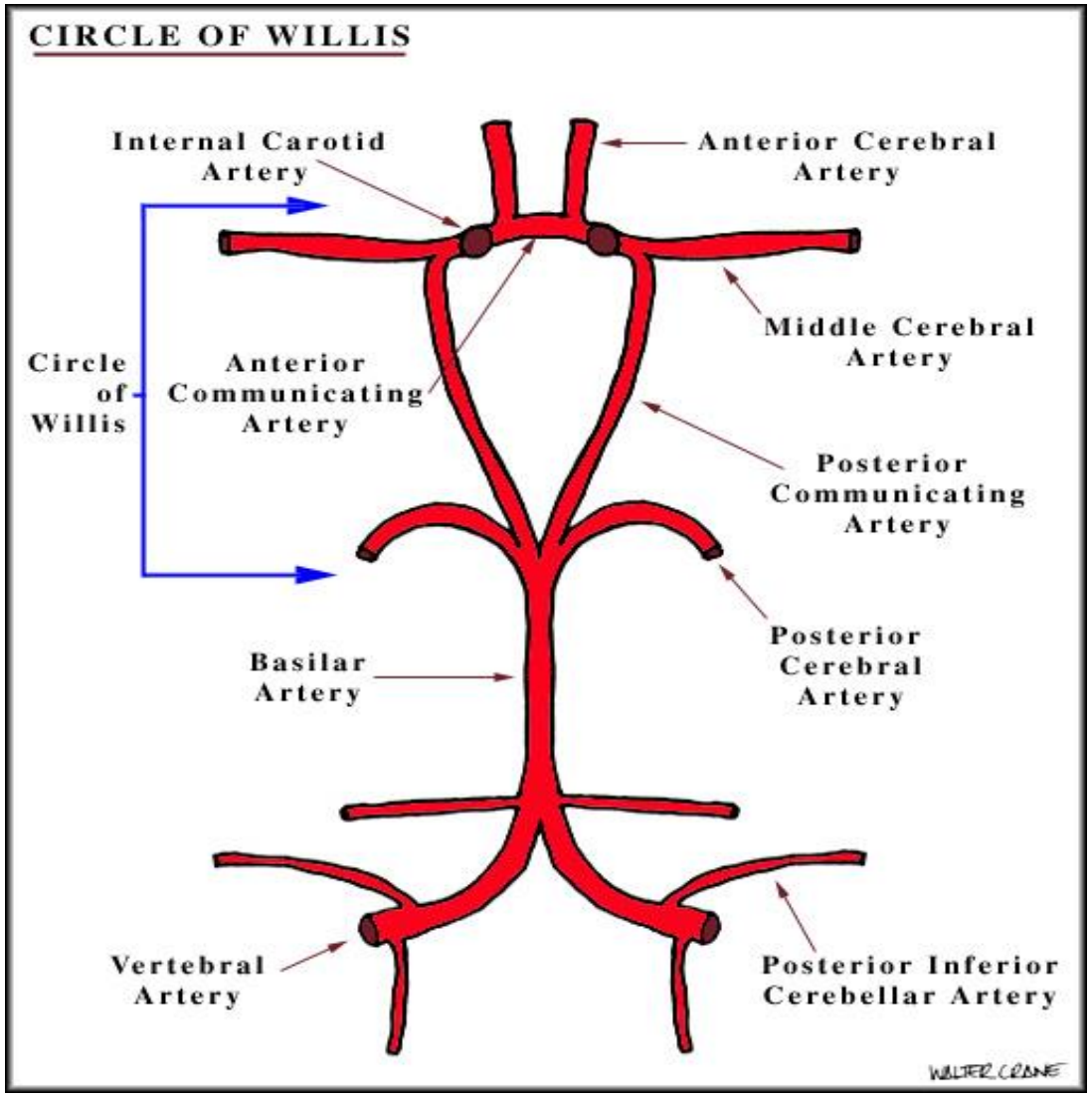
- A transient ischaemic attack (TIA) is the same but symptoms resolve **within 1 hour**.

- TIAs are an important risk factor for impending stroke and demand urgent assessment and treatment.

- Symptoms are dictated by the vascular territory involved

- **Much of the cerebral hemispheres** are supplied by the **anterior circulation** (the anterior and middle cerebral arteries which are derived from the internal carotid artery) , while **the occipital lobes and brainstem** are supplied by the **posterior circulation** (posterior cerebral artery which is derived from vertebrobasilar circulation)

Arterial blood supply of brain



Ischemic and hemorrhagic stroke

- 80% of strokes are ischemic

- Hemorrhagic stroke is much more frequent in Asian populations.

- Factors in the history or examination that increase the likelihood of haemorrhage include: use of anticoagulation, headache, vomiting, seizures and early reduced consciousness.

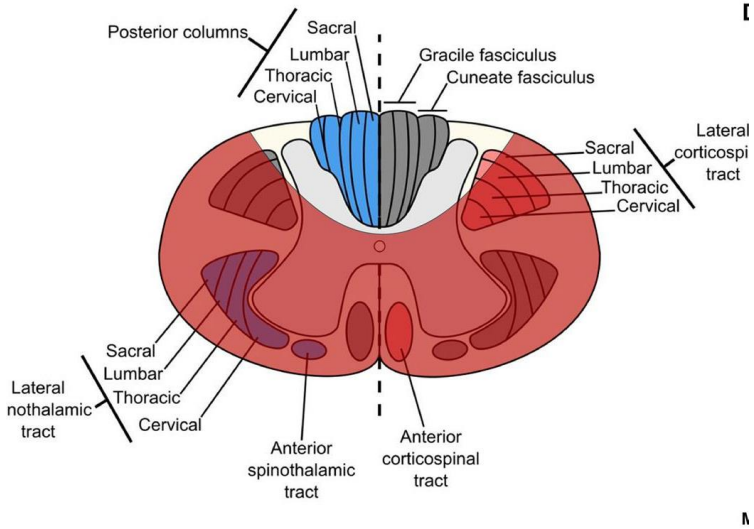
- **We have to do brain CT without contrast to differentiate between them**

- Isolated vertigo, amnesia or TLOC are rarely, if ever, due to stroke

Spinal strokes

Spinal strokes are very rare; patients typically present with abrupt onset , depending on the level of spinal cord affected.

The anterior spinal artery syndrome is most common and causes loss of motor function and pain/temperature sensation, with relative sparing of joint position and vibration sensation below the level of the lesion (sparing dorsal column)



Clinical classification of stroke

- Total anterior circulation syndrome (TACS)

  Hemiparesis plus

  hemianopia and

  higher cortical deficit (e.g. dysphasia or visuospatial loss)

- Partial anterior circulation syndrome (PACS)

  1-Two of the three components of a TACS

  2-OR isolated higher cortical deficit

  3- OR motor/sensory deficit more restricted than LACS

- Posterior circulation syndrome (POCS): one of the following:

1- Ipsilateral cranial nerve palsy with contralateral motor and/or sensory deficit

2-bilateral motor and/or sensory deficit

3-disorder of conjugate eye movement

4-cerebellar dysfunction without ipsilateral long-tract deficits

5-isolated homonymous visual field defect

- Lacunar syndrome (LACS):

ONE OF:

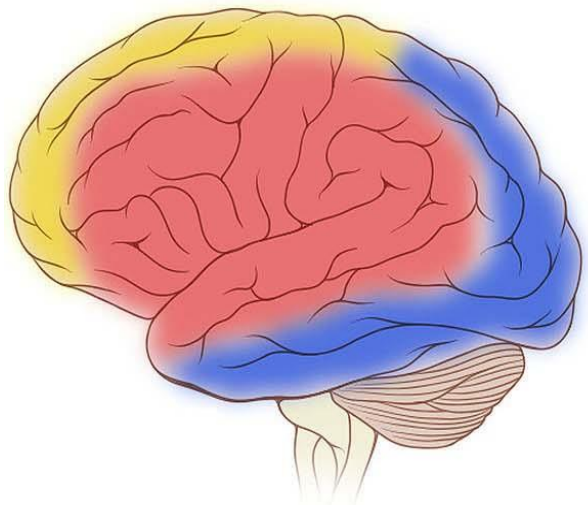
1- Pure motor > 2 out of 3 of face, arm, leg

2- Pure sensory > 2 out of 3 of face, arm, leg

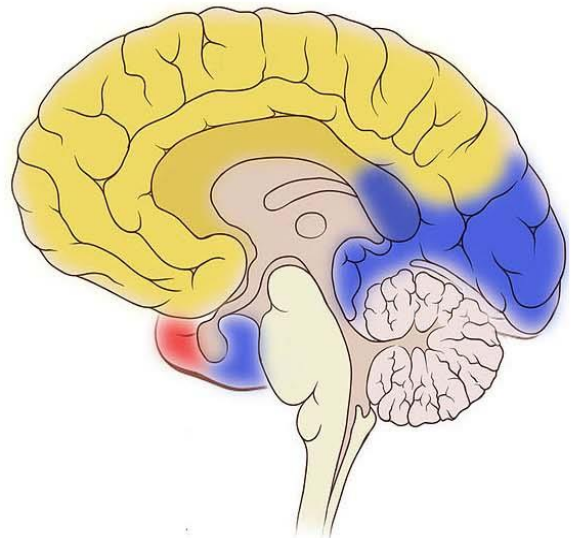
3- Pure sensorimotor > 2 out of 3 of face, arm, leg

4- ataxic hemiparesis

Lateral Brain



Medial Brain



Anterior Cerebral Artery

Middle Cerebral Artery

Posterior Cerebral Artery

5-Dizziness and Vertigo

✓**Dizziness** :

- Recurrent dizzy spells affect approximately 30% of those over 65 years.

- Causes

1-postural hypotension

2-cerebrovascular disease

3-cardiac arrhythmia

4-hyperventilation induced by anxiety and panic.

✓**<u>Vertigo</u>**:

- the illusion of movement

- specifically indicates a problem in the vestibular apparatus (most common) or the brain (central)

Peripheral causes of vertigo

- **Benign paroxysmal positional vertigo (BPPV):** recurrent episodes of vertigo lasting a few seconds , attacks increased when sleeping on the affected side or with movement

- **Meniere disease:** vertigo lasting minutes or hours, associated with hearing loss, tinnitus, nausea and vomiting

Central causes of vertigo

- Migrainous vertigo (with or without headache)
- Stroke
- Multiple sclerosis
- **TIAs do not cause isolated vertigo.**

Functional/psychogenic/hysterical/ somatisation/conversion disorder

- Not due to a true neurological disease

- Presentations include blindness, tremor, weakness and collapsing attacks, and patients will often describe numerous other symptoms, with fatigue, lethargy, pain, anxiety and other mood disorders commonly associated.

Continue

- **Clues include**

1- symptoms not compatible with disease (such as retained awareness of convulsing during non-epileptic attacks, or being able to walk normally backwards but not forwards)

2- considerable variability in symptoms (such as intermittent recovery of a hemiparesis)

3- **multiple symptoms** with numerous visits to other specialties and **multiple unremarkable investigations**, leading to numerous different diagnoses

- Beware of labeling symptoms as functional simply because they appear odd.

- Most functional neurological disorders follow recognizable patterns, so be cautious when the pattern is atypical.

Past medical history

- History of previous visual loss (optic neuritis) in someone presenting with numbness suggests multiple sclerosis.

- Birth history and development may be significant, as in epilepsy.

- If considering a vascular cause of neurological symptoms, ask about important risk factors, such as other vascular disease, hypertension, family history and smoking.

Drug history

- **Always enquire about drugs, including prescribed, over-the counter, complementary and recreational/illegal ones**

- phenytoin toxicity causes ataxia

- excessive intake of simple analgesia causing medication overuse headache; use of cocaine provoke convulsions.

Family history

- Parental consanguinity is common, increasing the risk of autosomal recessive conditions
- Single-gene defects: such as myotonic dystrophy or Huntington’s disease.
- Polygenic influences, as in multiple sclerosis or migraine.

- Charcot–Marie–Tooth disease may be autosomal dominant, autosomal recessive or X-linked.

- **Mitochondria** uniquely have their **own DNA**, and abnormalities in this DNA can cause a range of disorders that manifest in many different systems (such as **diabetes**, **short stature** and **deafness**), and may cause common neurological syndromes such as **migraine** or **epilepsy**.

- Some diseases, such as Parkinson’s or motor neuron disease, may be either due to single-gene disorders or sporadic

Social history

- How are patients coping with their symptoms? Are they able to work and drive?

- What are their support circumstances, and are these adequate?

- Ask about **alcohol** as it affects CNS (ataxia, seizures, dementia) and PNS (neuropathy)

- Ask about **diet**

- **Vitamin deficiency** may occur in alcoholism or dietary exclusion
- Vegetarians may be susceptible to vitamin B12 deficiency (subacute combined degeneration of the spinal cord)

- Ask about **recreational drugs**

- **nitrous oxide inhalation** causes subacute combined degeneration of the cord due to dysfunction of the vitamin B12 pathway
- **smoking** contributes to vascular and malignant disease.

- A **travel** history may give clues to the underlying diagnosis such as:

- Lyme disease (facial palsy)
- neurocysticercosis: parasitic infection (brain lesions and epilepsy)
- malaria (coma)

- Always consider **sexually transmitted or blood-borne infection**, such as human immunodeficiency virus (HIV) or syphilis, as both can cause a wide range of neurological symptoms and are treatable

Occupational history

- lead exposure :motor neuropathy
- manganese causes Parkinsonism.
- Some neurological diagnoses may adversely affect occupation, such as epilepsy in anyone who needs to drive or operate dangerous machinery

- For patients with cognitive disorders, particularly dementias, it may be necessary to patients to stop working.

Thank you