CNS pathology 2025

Dr Heyam Awad

Lecture 1:

Stroke and Iincreased intracranial pressure.

- This lectures covers two topics
- First we will discuss stroke (cerebrovascular accident)
- Then we will discuss the definition and causes of increased intracranial pressure.

Cerebrovascular diseases = CVA= stroke

-CVA is a major cause of death .

-CVA is the most common cause of neurologic morbidity.

-mechanisms: **thrombi**

emboli

vascular rupture

-**Stroke**: clinical term applies to all three when symptoms are acute.

Definition

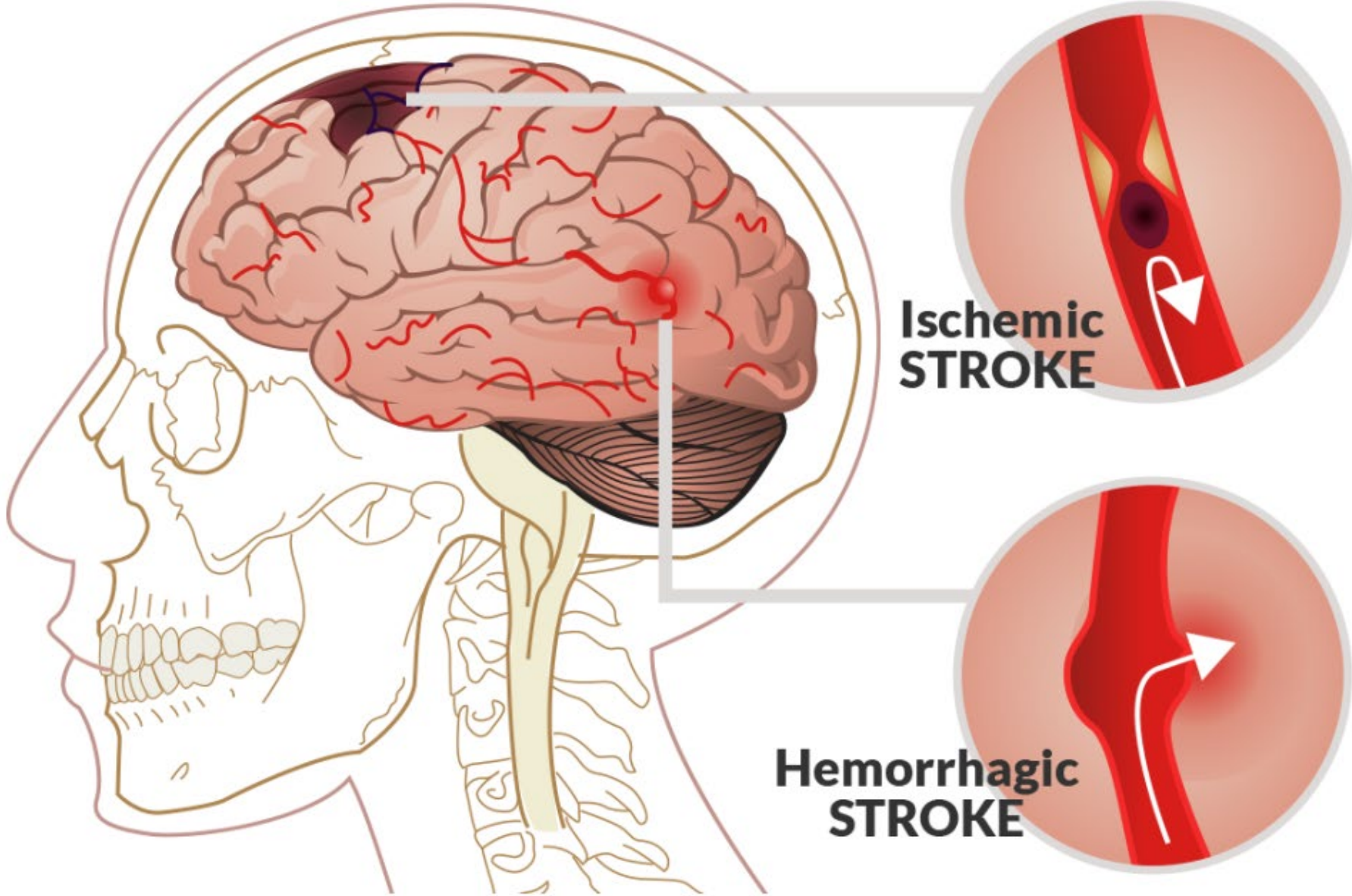
- Stroke: rapidly developing symptoms and signs of loss of focal CNS function lasting for 24 hours or leading to death.
- So: symptoms develop quickly (within seconds or minutes) but they persist for at least 24 hours.
- If the symptoms last for less than 24 hours, it is called: transient ischemic attack (TIA).

Types of stroke

- THERE ARE TWO TYPES OF STROKE:
- 1. Ischemic stroke caused by vascular obstruction by a thrombus or an embolus
- 2. Hemorrhagic stroke caused by vessel rupture secondary to several vascular diseases, like hypertension or vasculitis.

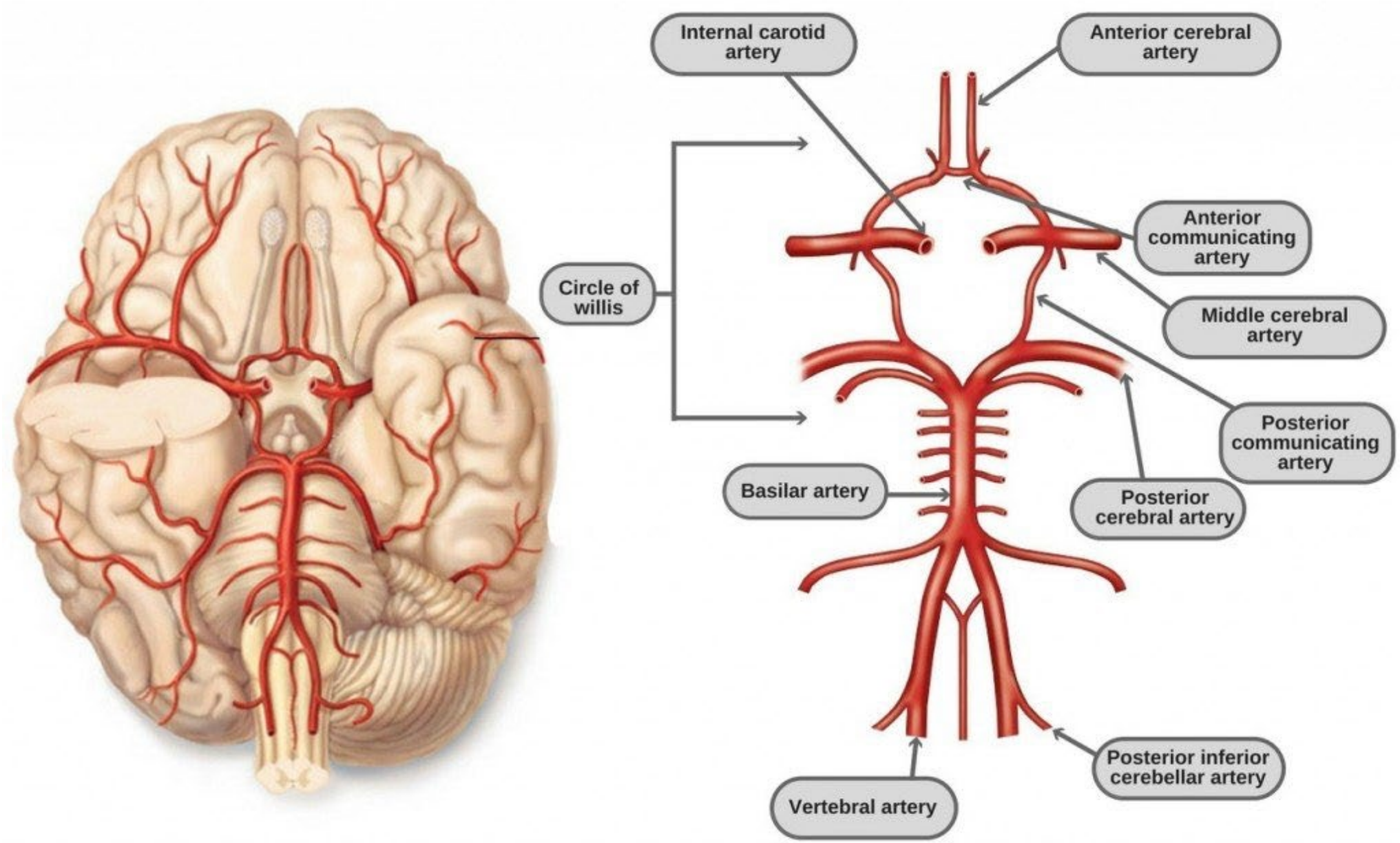
- Ischemic strokes account for 85% of strokes.

- It’s very important to distinguish between the two types because ischemic stroke is treated by anticoagulants, whereas if you use anticoagulants in hemorrhagic stroke you might kill the patient



BRAIN **STROKE**

Brain blood supply



Ischemic stroke : 1. Thrombotic occlusions

- Atherosclerosis of cerebral arteries causing thrombosis.

  <u>Common sites:</u>

1. Carotid bifurcation
2. Origin of middle cerebral artery
3. Ends of basilar artery

Ischemic stroke; 2. Embolic infarcts

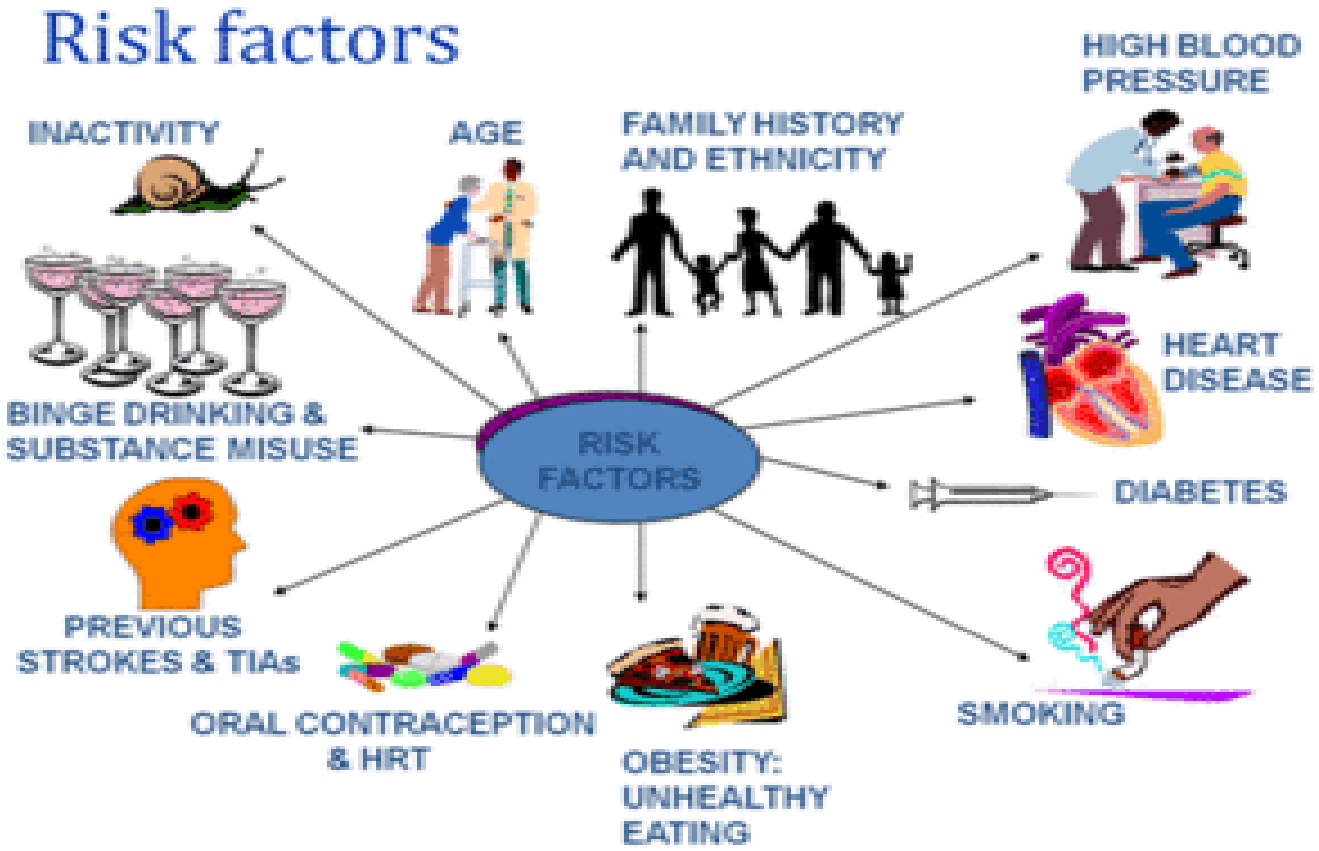
- More common than thrombotic infarcts
- Source: 1. **cardiac mural thrombi**, arise due to myocardial dysfunction, valvular disease, and atrial fibrillation
- 2. **arterial atheroma** in carotid arteries or aortic arch
- 3. **venous** thrombi crossing to arterial circulation through cardiac defects = paradoxical embolism. DVT, fat emboli

- Most common site of embolic occlusion : middle cerebral artery,which is a direct extension of the internal carotid.
- Emboli lodge where vessels **branch** or in **stenotic** areas caused by atherosclerosis

Hemorrhagic stroke causes hemorrhagic infarcts

- Can be caused by haemorrhage from a ruptured vessel.
- Causes of haemorrhage will be discussed in the next lecture.

Stroke: risk factors; basically, these are the same risk factors of atherosclerosis



Clinical features of stroke

- **Signs and symptoms= FAST**
- The main symptoms of stroke can be remembered with the word FAST: Face-Arms-Speech-Time.
- **Face** – the face may have dropped on one side, the person may not be able to smile or their mouth or eye may have dropped.
- **Arms** – the person with suspected stroke may not be able to lift both arms and keep them there because of arm weakness or numbness in one arm.
- **Speech** – their speech may be slurred or garbled, or the person may not be able to talk at all despite appearing to be awake.
- **Time** – it is time to dial emergency team immediately if you see any of these signs or symptoms.

Stroke –
there's treatment if you act FAST.

F*ace* Face look uneven?

A*rm* One arm hanging down?

S*peech* Slurred speech?

T*ime* Call 911 NOW!

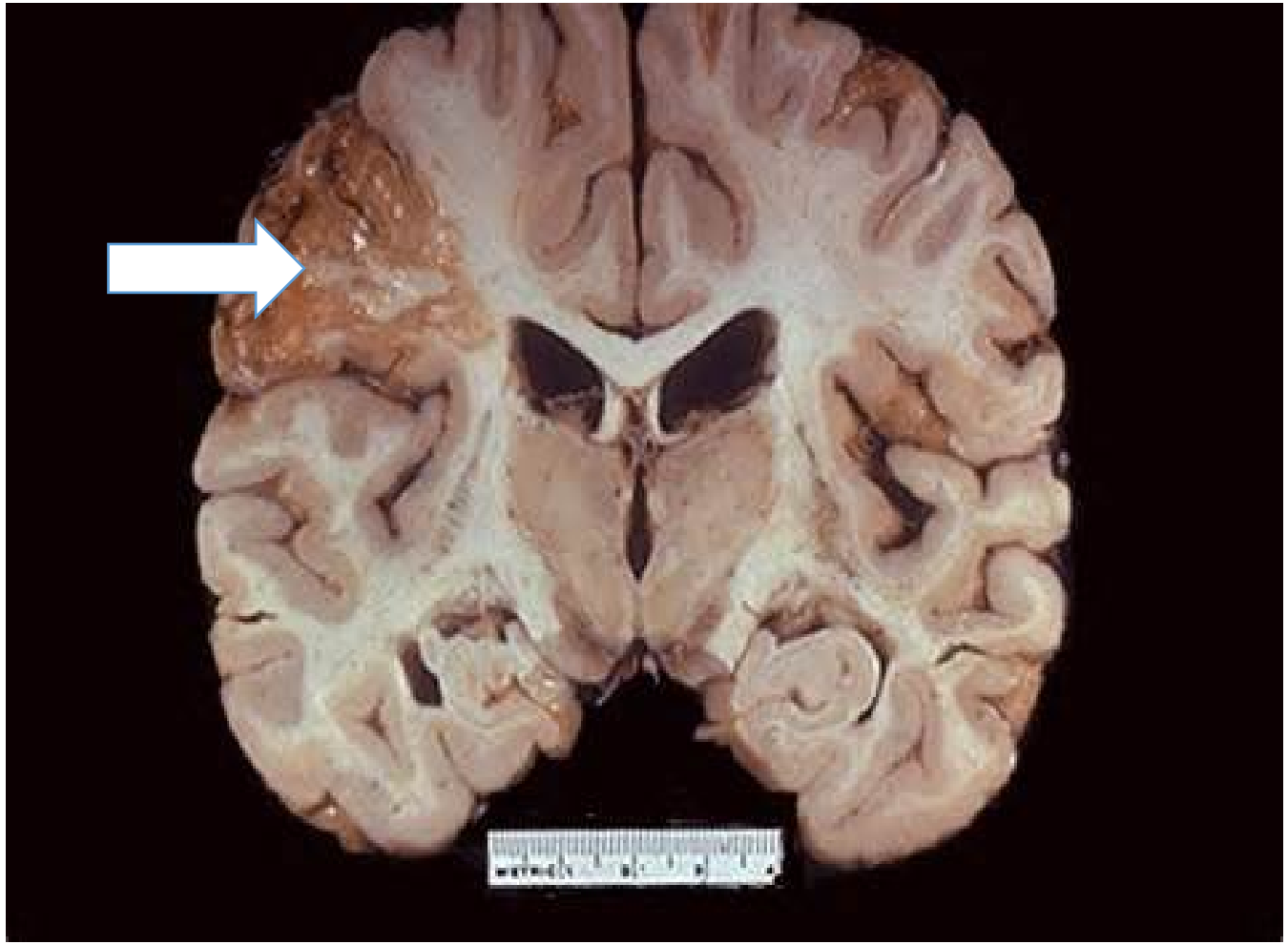
Transient ischemic attack (TIA),

- Sometimes, stroke is preceded by transient ischemic attacks TIA.
- These are important to be recognized clinically because they are a warning sign that a full-blown stroke is imminent
- TIA means that the supply of blood to the brain is temporarily interrupted, causing a "mini-stroke" often lasting between 30 minutes and several hours.
- TIAs should be treated seriously as they are often a warning sign that there is risk of having a full stroke in the near future

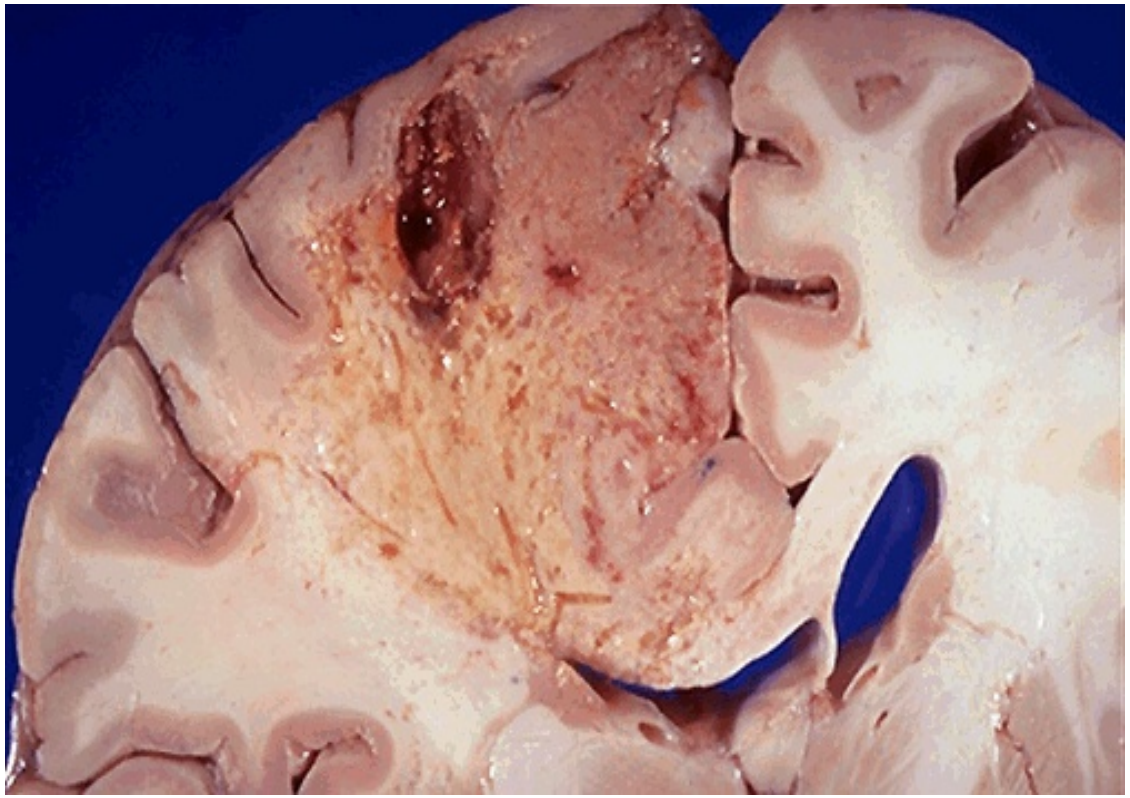
- Morphology/ non-haemorrhagic infarcts macroscopic appearance

- By 48 hours: pale, soft swollen area.
- Day 2-10: gelatinous and friable.
- Day 10 to week 3: liquefaction ending in a fluid filled cavity.

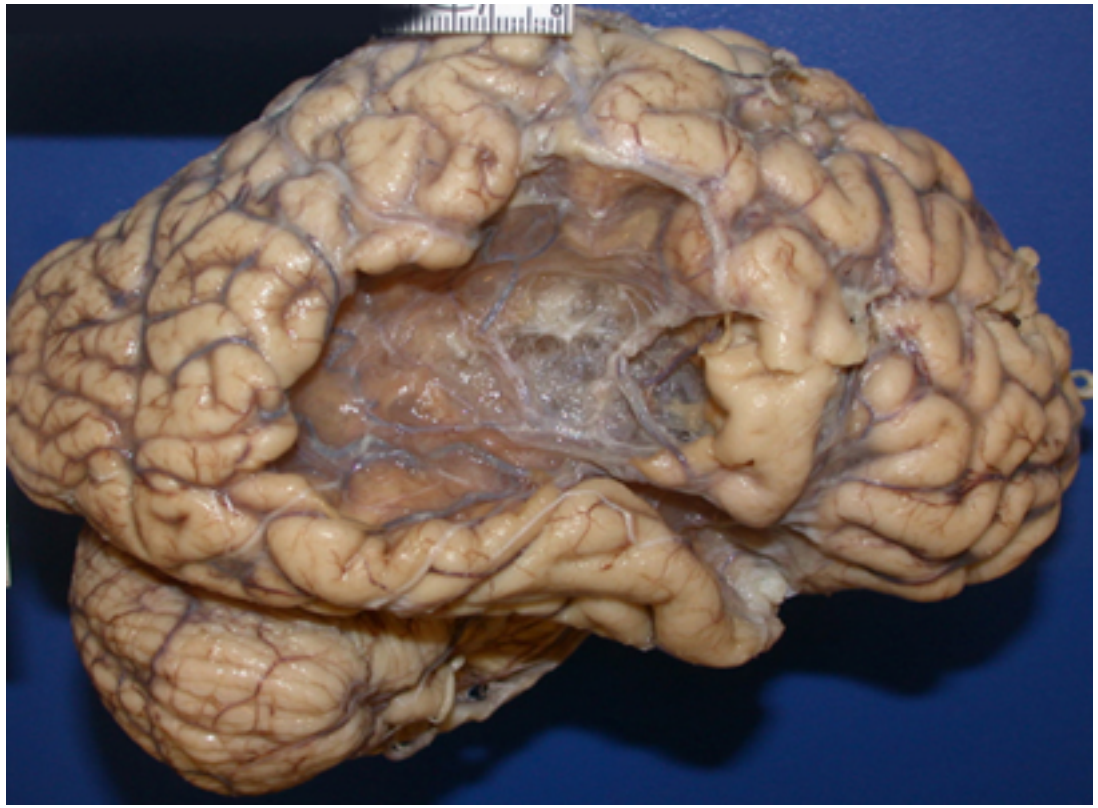
Infarct



infarct: note the cavity and liquefaction.
Ischemic damage to the brain causes liquefactive necrosis.



Old infarct: the infarct is resolved leading a cavity.



Morphology / non-hemorrhagic microscopic appearance

- microscopic appearance of brain infarcts is divided into:

- Early changes
- Subacute changes
- Repair

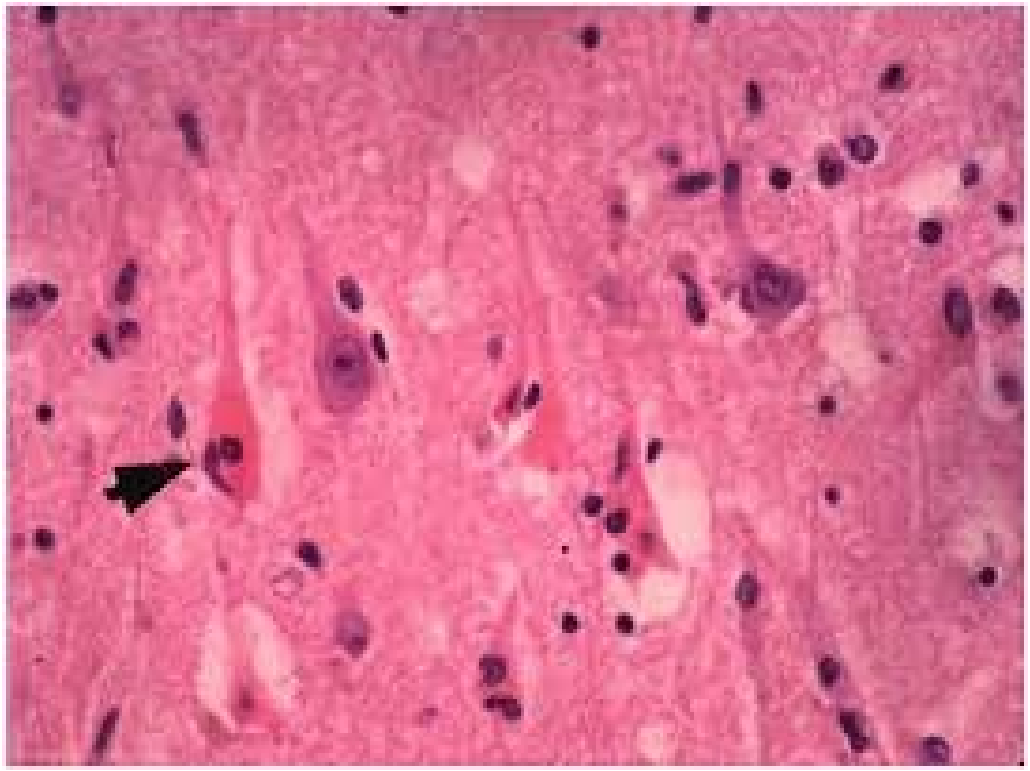
Morphology/ non-hemorrhagic

- early (first 24 hours): red neurons + edema + neutrophils
- subacute (24 hours to 2 weeks): macrophages, gemistocytic astrocytes.
- repair (after 2 weeks): gemistocytes regress, cavity persists

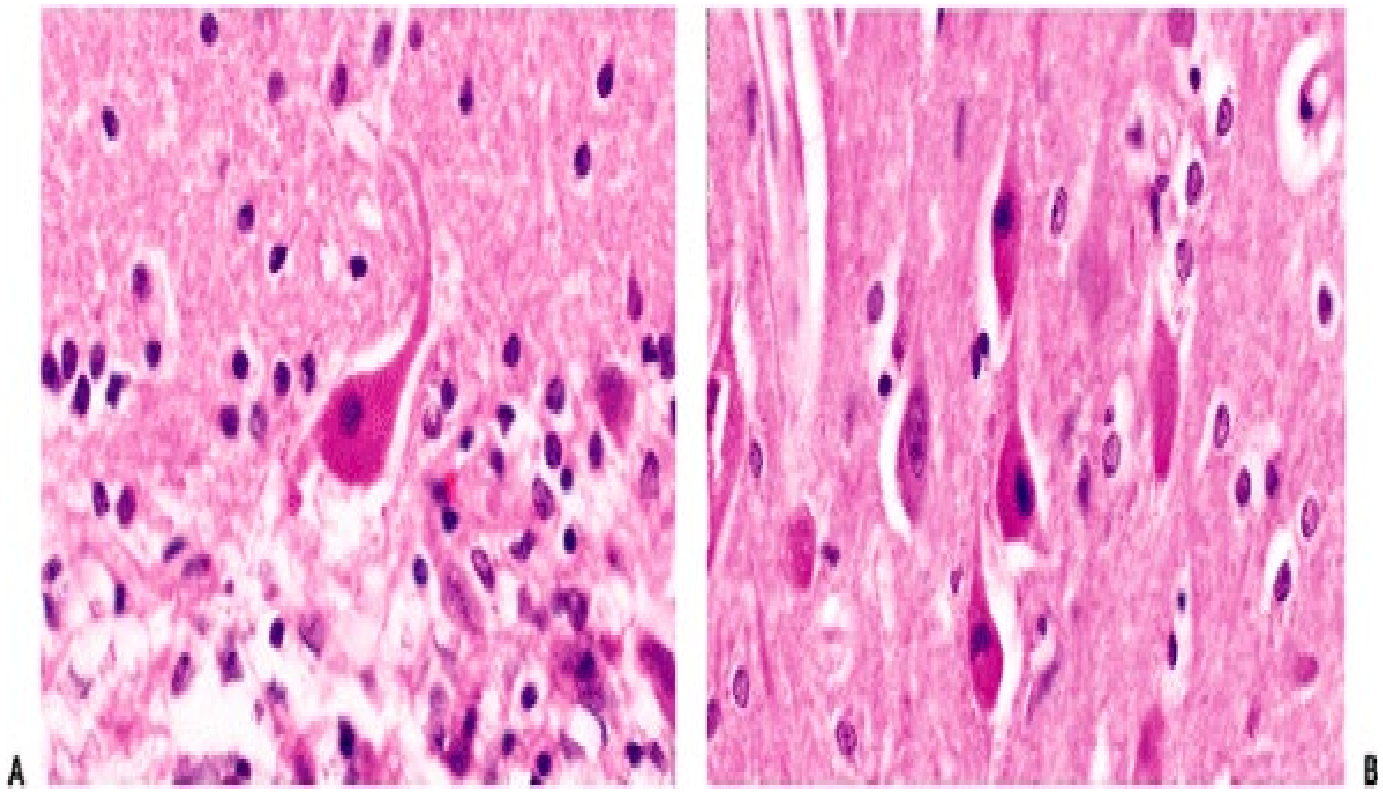
Early changes

- Acute neuronal cell damage= red neurons ,followed by cytoplasmic eosinophilia then pyknosis and karyorrhexis
- Then: neutrophilic infiltrate.

Red neurones



Red neurones



Subacute change

24 hours to 2 weeks

- Necrosis
- Macrophages
- Reactive gliosis

Repair

- After 2 weeks
- Removal of necrotic tissue
- Gliosis
- Loss of organised CNS structure

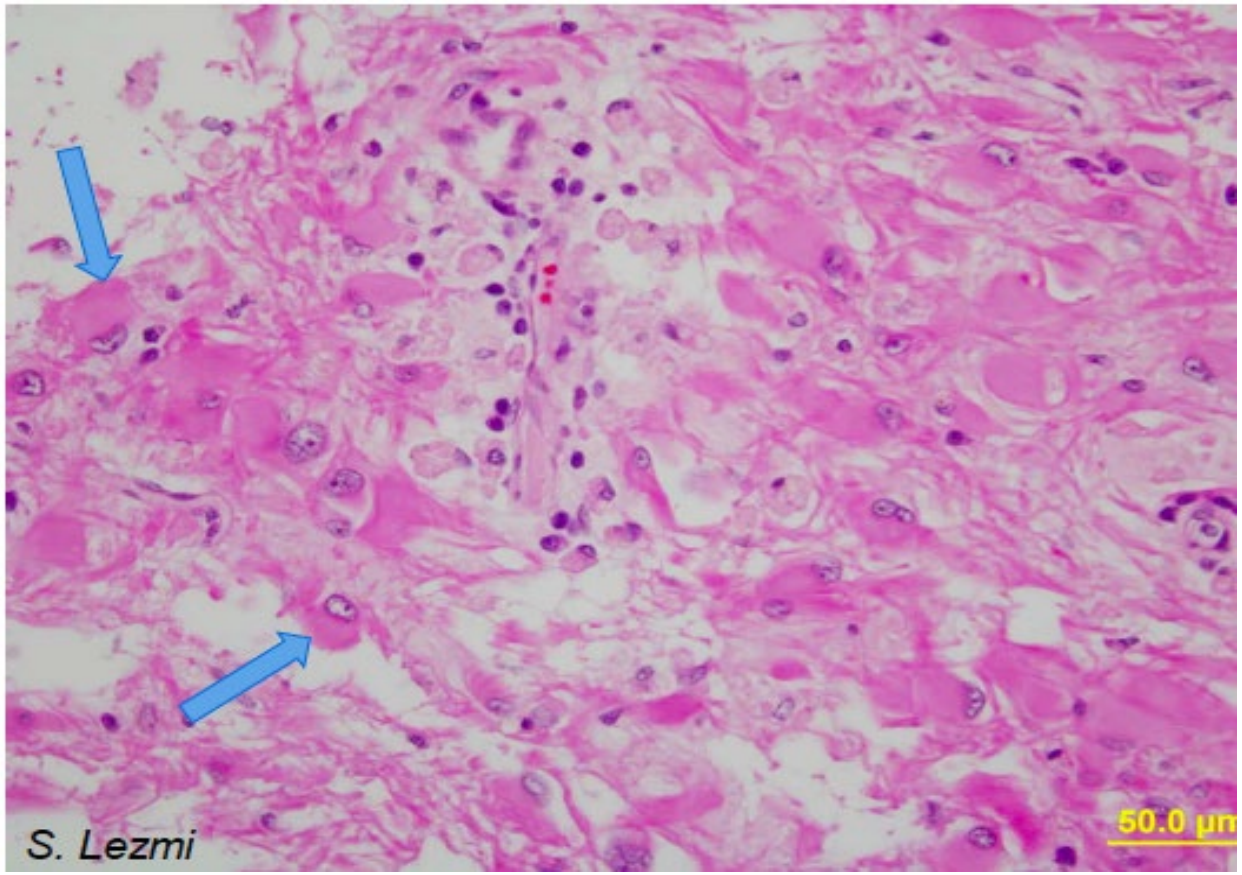
repair

- Astrocytes are the main cells responsible for repair and scar formation (gliosis).
- Injury.. Causes 1. hypertrophy and hyperplasia in astrocytes.

2. enlarged nuclei
3. prominent nucleoli.
4. increased pink cytoplasm.
5. increased, ramifying processes

These changes in astrocytes: gemistocytic astrocyte.

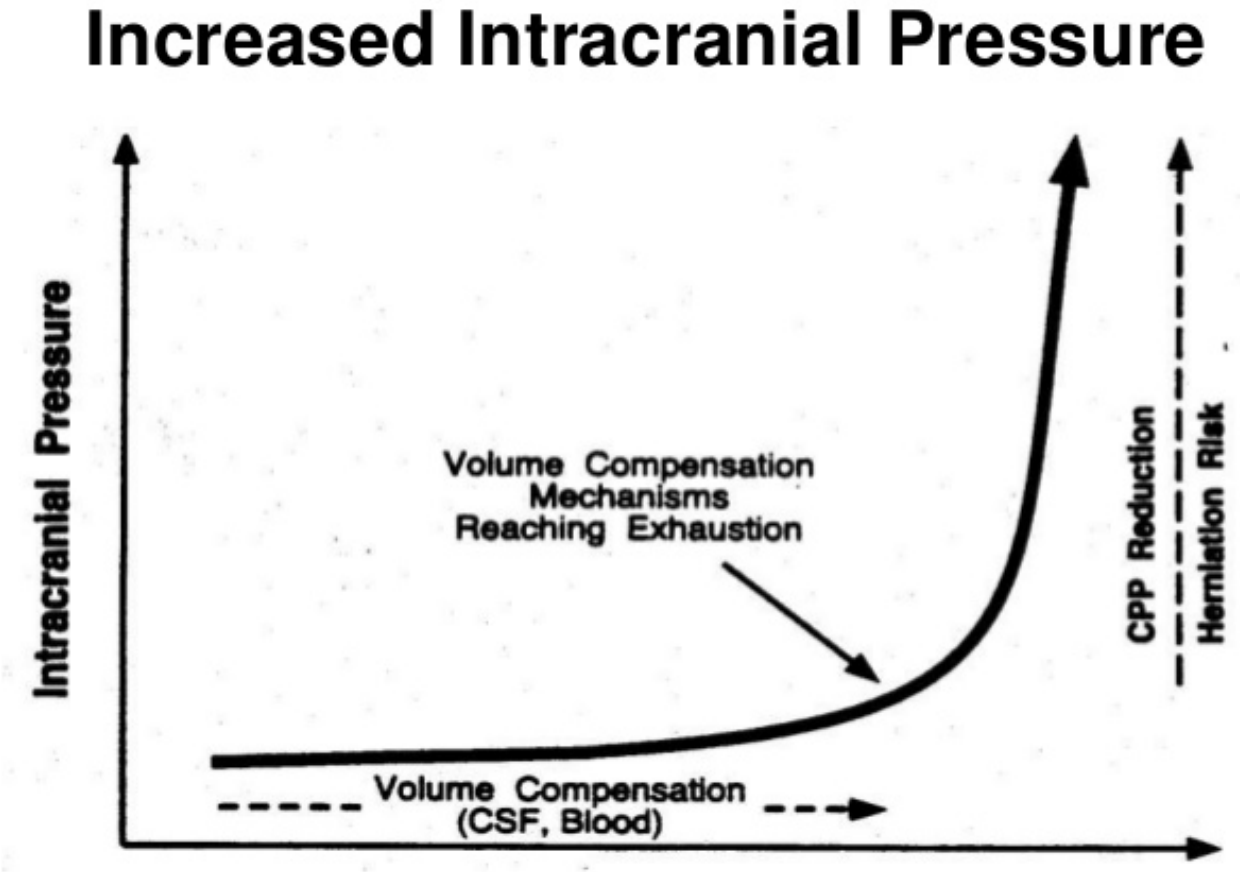
gemistocytes



Summary regarding Stroke.

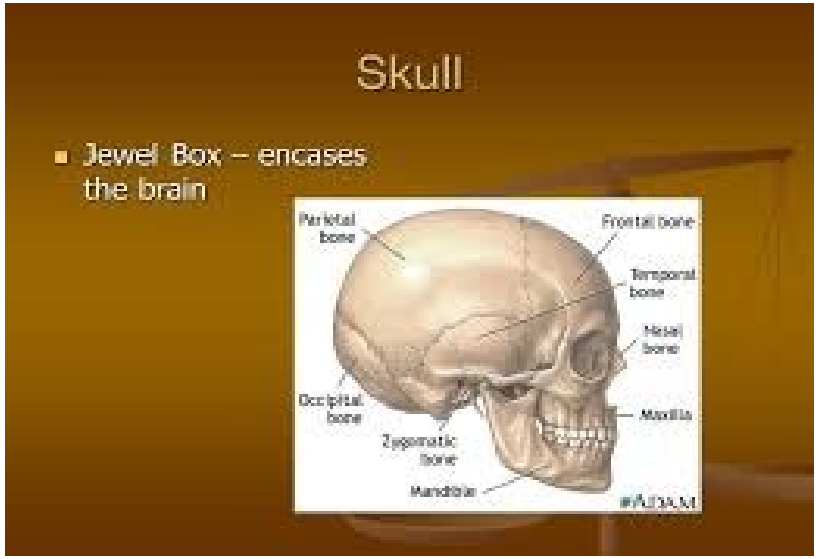
- Stroke = CVA, is a clinical term describing acute neurological symptoms caused by vascular disease.
- Stroke can be ischemic or hemorrhagic. Ischemic is commoner
- Ischemic stroke can be embolic or thrombotic. Embolic is commoner.
- Most common site of embolic occlusion is the middle cerebral artery.
- Ischemic strokes might be preceded by TIA= vascular occlusion causing symptoms lasting from minutes to several hours.
- TIAs predict a full stroke and should be treated promptly.
- Ischemic infarcts in the brain cause liquefactive necrosis.
- In the acute stage we see red neurones and neutrophilic infiltrate
- In subacute stage we see macrophages ,gemistocytes and gliosis.
- In the late stages, gemistocytes disappear leaving a cavity behind.

Intracranial pressure



The cranium..

- The brain is enclosed within the skull, which is a rigid box that protects it.
- In adults, skull bones cannot expand
- So if the material within the cranium increases.. Pressure will increase= increased intracranial pressure



What's inside the cranium?

- ROUGHLY:
- 80% brain tissue (including intracellular and interstitial fluid which is around 75% of brain weight)
- 10% blood
- 10% CSF (cerebrospinal fluid)

If any of these components increases, the intracranial pressure increases.

Monro- Kellie hypothesis

- Monro- Kellie hypothesis: intracranial volume= V_{CNS} +V_{CSF} + V_{Blood} + V_{lesion}
- V= volume.

- This hypothesis indicates that any space occupying lesion in the brain will increase the volume inside the cranium and this will result in increased intracranial pressure.
- Space occupying lesions occur with all major brain diseases (except degenerative diseases). Examples: brain tumours, trauma, stroke, haemorrhage.

OK, so what is intracranial pressure (ICP)???

- It is the pressure inside the skull and is measured in millimetres of mercury
- At rest, it is normally 7–15 mmHg for a supine adult.

- **If pressure in the cranium is higher than this upper limit= increased intracranial pressure (= intracranial hypertension.**

Causes of increased intracranial pressure

- Mass effect : brain tumor, hematoma, or abscess.
- Generalized brain swelling :ischemia, hypertension
- Increase in venous pressure : heart failure
- Obstruction to CSF flow and/or absorption or increased CSF production: hydrocephalus.
- Idiopathic or unknown

- In this lecture we will discuss two of the causes of increased ICP : ischema and hydrocephalus

Clinical presentation of increased intracranial pressure.

- In the early stages patients will have non-specific symptoms like headache and vomiting.
- Also, in the early stages patients might have Cushing reflex (Cushing response or Cushing triad) which manifests by increased blood pressure, bradycardia and irregular breathing.

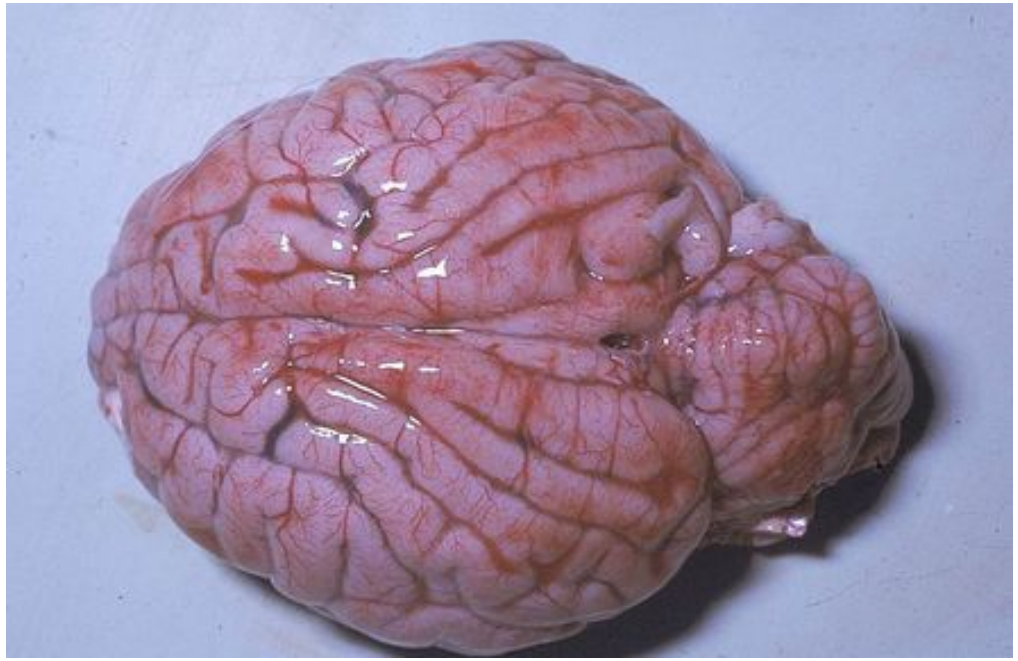
- In more advances cases patients have neurological manifestations including disturbed level of consciousness.

- Later, complications can occur, mainly herniation and seizures.

Brain edema= cerebral edema

- = accumulation of excess fluid within the brain parenchyma.
- Two types: vasogenic and cytotoxic edema.. Usually coexist

Brain edema: note that the distinction between gyri and sulci is diminished because the sulci are filled with fluid making them narrow and the gyri are widened by the fluid



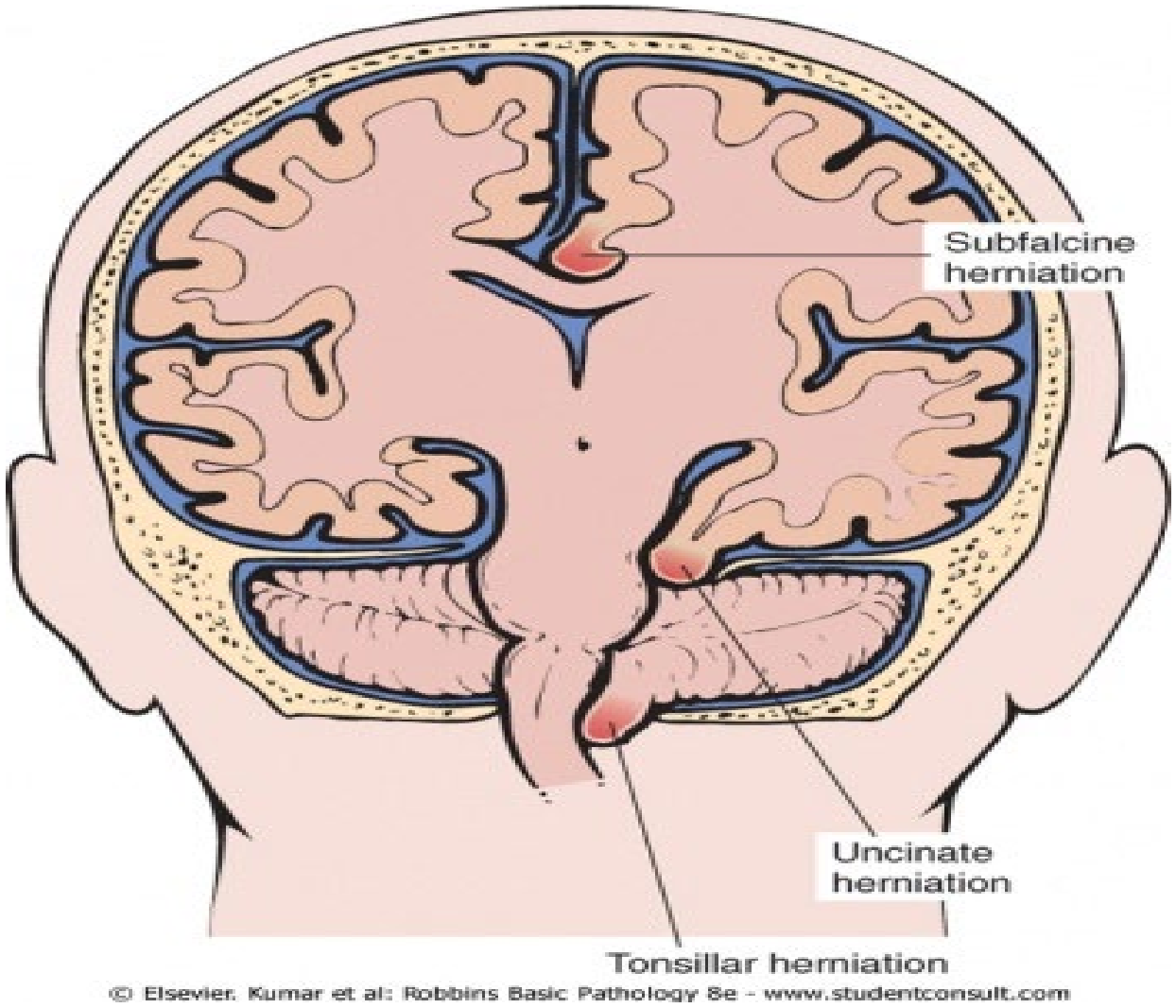
Herniation : a complication of brain edema

- Increased volume of tissue inside the skull causes Increased intracranial pressure which causes focal expansion of the brain tissue .
- Because the cranial vault is subdivided by rigid dural folds (falx and tentorium)…. The expanded brain tissue is displaced in relation to these folds.
- Expansion= herniation
- SO: herniation is a complication of increased intracranial pressure and it occurs in relation to margins of the dural folds.

herniation: 3 types

- Subfalcine = cingulate
- Transtentorial = uncinate
- Tonsillar.

herniation


Subfalcine herniation
Uncinate herniation
Tonsillar herniation
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Cingulate herniation= subfalcian herniation

-Cingulate gyrus displaced under edge of falx

-Can cause compression of anterior cerebral artery; so the territory supplied by this artery can suffer ischemic damage and infarction if severe.

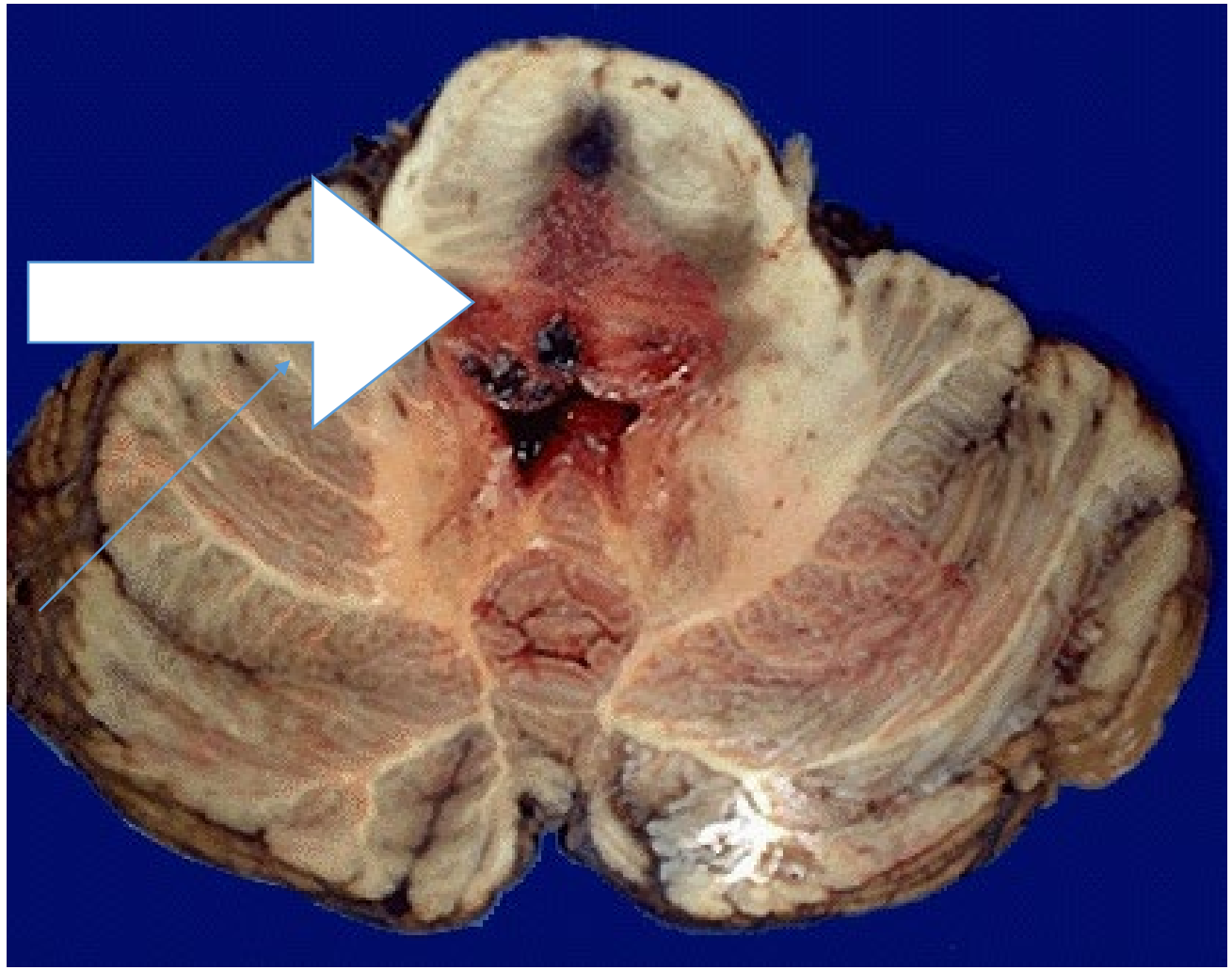
Transtentorial herniation

- Medial aspect of temporal lobe compressed against the free margin of the tentorium.
- So the brain tissue is forced from supra-tentorial towards the infra-tentorial compartment.
- Complications:
- 1. Third cranial nerve compressed causing dilated pupil, impaired ocular movement on the side of the lesion (ipsilateral side)
- 2. Posterior cerebral artery can be affected causing ischemic injury to tissues supplied by it including visual cortex.
- **3. Transtentorial herniation can cause hemorrhage in the midbrain and pons (Duret haemorrhage) which is usually fatal.**

Duret hemorrhage

The end result of temporal medial lobe (transtentorial) herniation is compression of the brainstem (midbrain and pons) and stretching of small arterial branches to cause Duret haemorrhages

Duret haemorrhages are small lineal areas of **bleeding** in the midbrain and upper pons of the brainstem. They are caused by downward displacement of the brainstem. They are named after Henri **Duret**.



Tonsillar herniation

- Displaced cerebellar tonsils through foramen magnum
- Causes brain stem compression so the respiratory and cardiac centres in the medulla are compromised.
- LIFE THREATENING

Summary

- The skull protects the brain but leaves little space to accommodate for any increase of the cranial contents.
- increased cranial contents cause increased intracranial pressure. This can be due to increased brain tissue (tumours), fluid (edema due to hypoxia or inflammation or other causes), CSF (hydrocephalus) or blood (haemorrhage)
- increased ICP manifests as headache and vomiting, Cushing triad (hypertension, bradycardia, irregular slow breathing)) and can progress to coma.
- increased ICP can be complicated by herniation; which is a displacement of brain tissue from a compartment to another.
- Subfalcian herniation displaces the cingulate gyrus under edge of falx, it causes compression of anterior cerebral artery
- Transtentorial herniation displaces the medial aspect of temporal lobe against the free margin of the tentorium. This compresses the third cranial nerve, posterior cerebral artery and can cause Duret haemorrhage in the midbrain which is usually fatal.
- Tonsillar herniation displaces the cerebellar tonsils through foramen magnum causing brain stem compression, which is usually fatal.

Question

- A 54 year old man complained of severe headache and vomiting. imaging studies showed a large subdural hematoma. Two days later he had dilated pupil of the right eye with and his visual acuity decreased. Which of the following is incorrect about his condition?
- A. Can be complicated by haemorrhage in the pons.
- B. His eye symptoms could be related to ischemic injury to the visual cortex
- C.The medial aspect of his temporal lobe is compressed against the free margin of the tentorium
- D. The dilated pupil indicated damage of the left third cranial nerve
- E. He might develop fatal brain stem complications.

Answer

- The scenario describes increased ICP due to hematoma. The complications he had indicate herniation, and the symptoms are those of transtentorial herniation.
- the answer is D: the lesion is related to the ipsilateral nerve (at the same side of the lesion).. so his right third cranial nerve is compressed.
- A is correct, it describes Duret hemorrage . Also E is correct , again it describes Duret haemorrhage.
- C :correct, it simply describes his main complication: transtentorial herniation
- note that the decreased visual acuity is due to effect on the visual cortex (ischemic damage due to compression on the posterior cerebral artery) , however, the dilated pupil and impaired ocular movement are effects of compression on the third cranial nerve.


سكر الجزيرة