CNS lecture 2

Cerebrovascular disease

DR H Awad

Cerebrovascular diseases

-a major cause of death .

-most common cause of neurologic morbidity.

-mechanisms: **thrombi**

emboli

vascular rupture

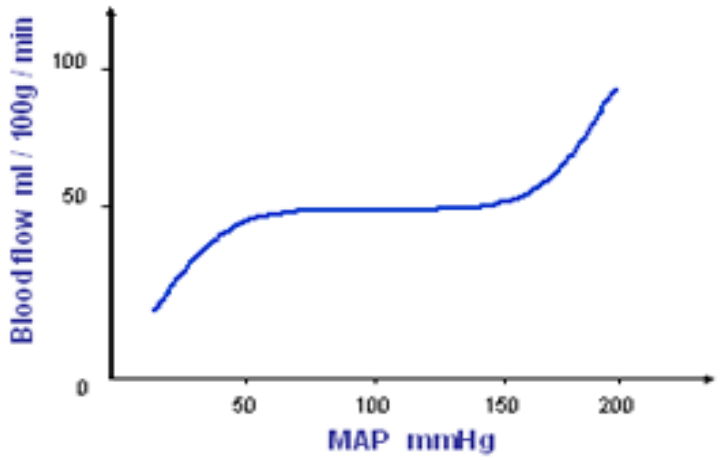
-**stroke**: clinical term applies to all three when symptoms are acute.

- Thrombi and emboli.. Occlusion.. **Ischemic** damage
- Vessel rupture: **hemorrhage**.

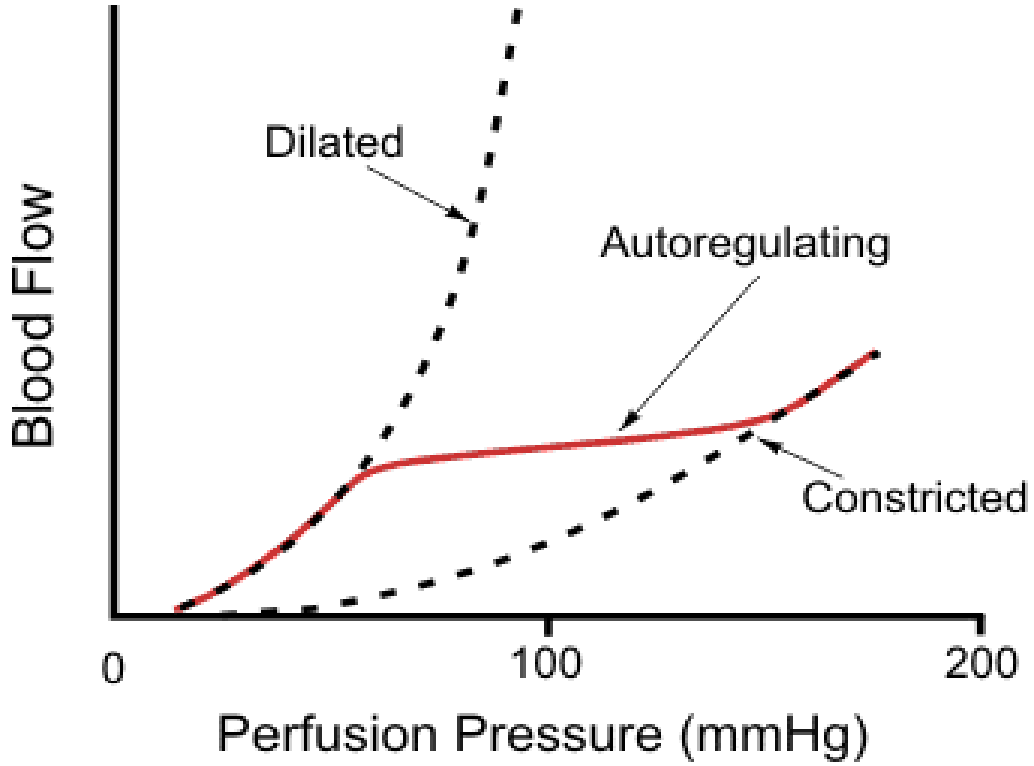
Hypoxia and ischemia

- Brain is highly oxygen dependent.
- Brain 2% of body weight but receives 15% of cardic output
- 20% of total body oxygen consumption.
- Autoregulation of vascular resistance allows stability of cerebral blood flow over a wide range of blood pressures and intracranial pressure.

Autoregulation of Cerebral Blood Flow



AnaesthesiaUK


Dilated
Autoregulating
Constricted
Blood Flow
0
100
200
Perfusion Pressure (mmHg)

Brain hypoxia

- Functional hypoxia.
- ischemic hypoxia

Functional hypoxia

- Low partial pressure of oxygen: high altitude
- Impaired oxygen carrying capacity: anaemia and CO poisoning
- Decreased oxygen use by tissues: cyanide poisoning

Ischemic hypoxia

- Hypo-perfusion due to hypotension or vascular obstruction

- Ischemia can be global or focal

Global cerebral ischemia

- Occurs due to severe hypotension, systolic below 50mm Hg.
- Cardiac arrest
- Shock
- Severe hypotension

- Outcome depends on severity and duration of insult

Global ischemia

- Neurons more susceptible to hypoxic injury than glial cells.
- Most susceptible neurons: **pyramidal cells** of hippocampus and neocortex + **Purkinje cells** of the cerebellum

ischemia

- If mild: transient confessional state
- severe : neural death, if survive: severely impaired neurologically
- Severest forms result in brain death.

Brain death

- Diffuse cortical injury with flat EEG (isoelectric EEG)
- Brain stem damage: No reflexes and no respiration
- If on mechanical support: autolysis of brain= respirator brain

Morphology of reversible global ischemia

- Swelling
- Wide gyri
- Narrow sulci
- Poor grey white matter demarcation

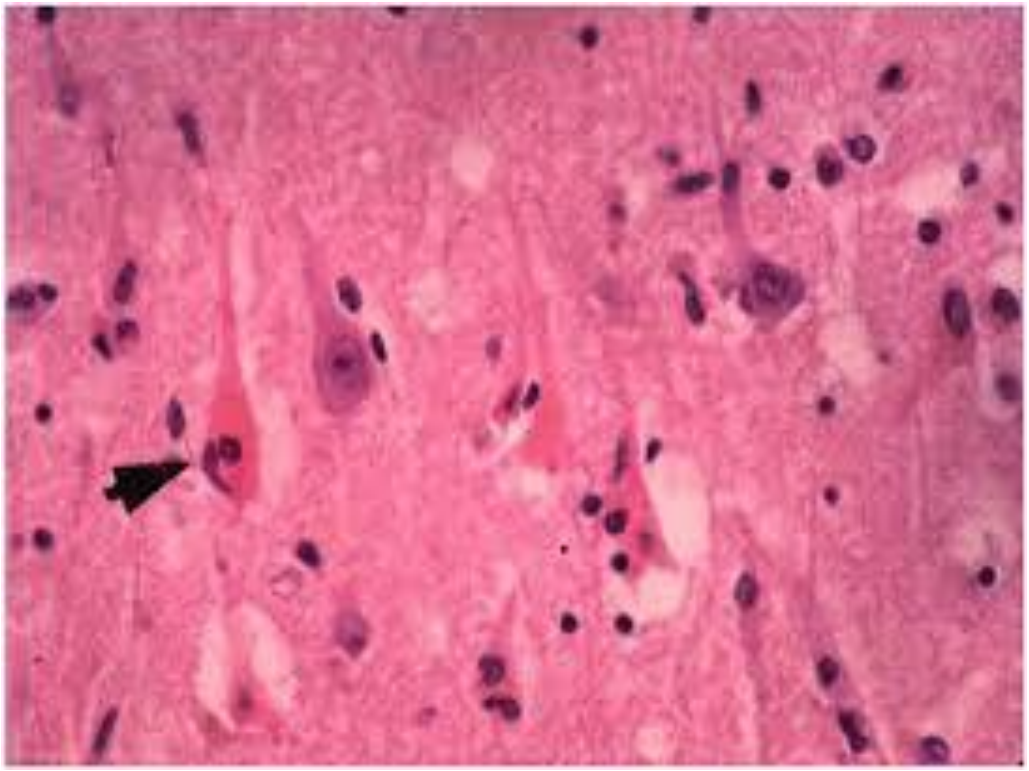
Infarction/ irreversible ischemia

- Early changes
- Subacute changes
- repair

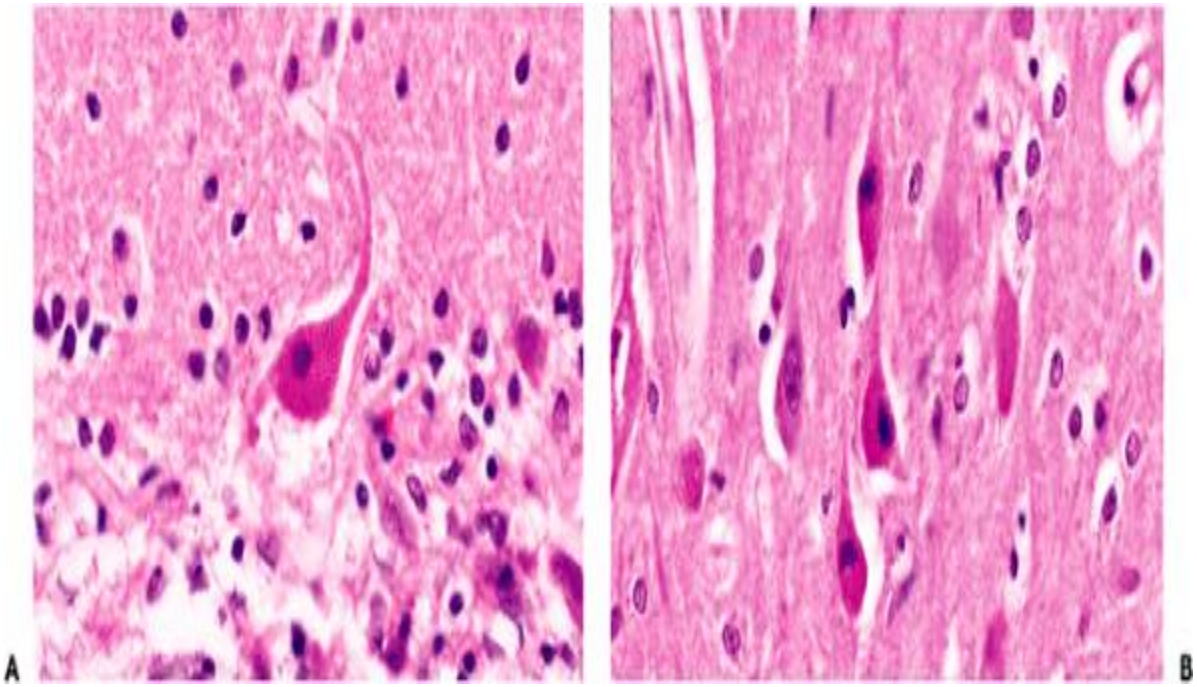
Early changes

- 12-24 hours after insult
- Acute neuronal cell damage= red neurons = micro-vaculations followed by cytoplasmic eosinophilia then pyknosis and karyorrhexis
- Similar changes later on glial cells
- Then: neutrophilic infiltrate.

Red neurones

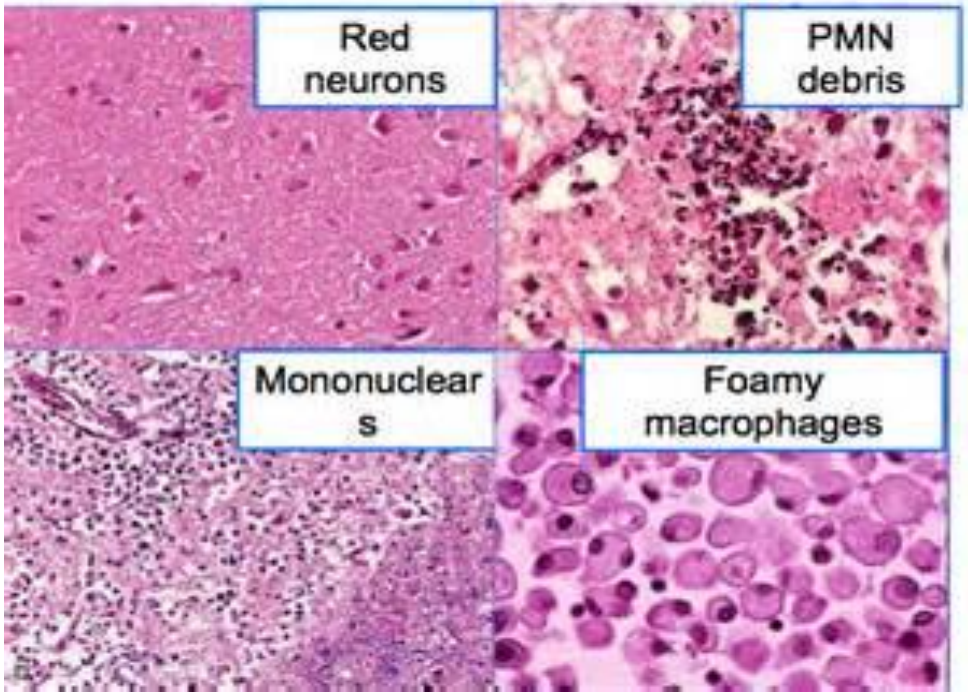


Red neurones



Subacute change

- 24 hours to 2 weeks
- Necrosis
- Macrophages
- Vascular proliferation
- Reactive gliosis


Red neurons
PMN debris
Mononuclear s
Foamy macrophages

repair

- After 2 weeks
- Removal of necrotic tissue
- Gliosis
- Loss of organised CNS structure
- Pesudo-laminar necrosis: uneven neuronal loss and gliosis in neocortex

repair

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

2. enlarged nuclei

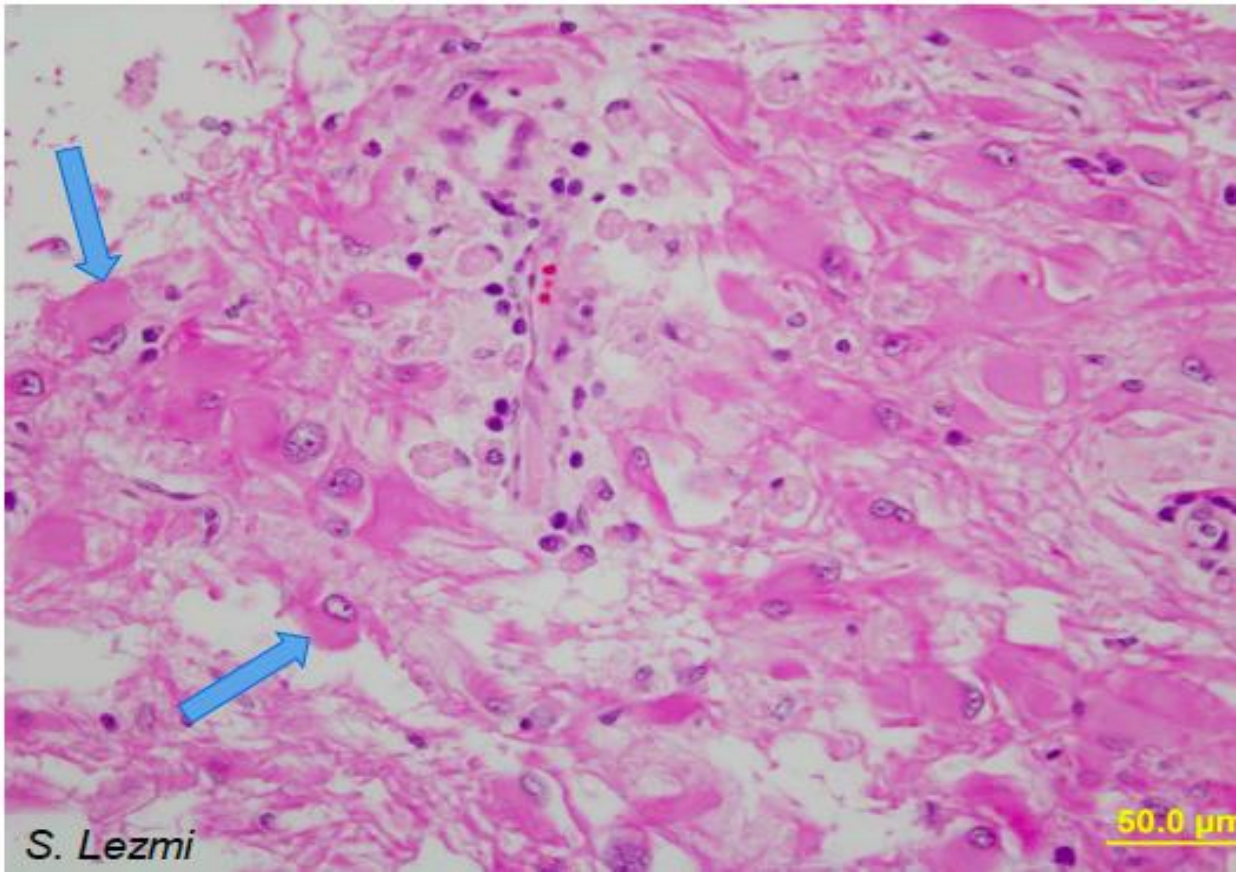
3. prominent nucleoli.

4. increased pink cytoplasm.

5. increased, ramifying processes

These changes in astrocytes: gemistocytic astrocyte.

gemistocytes



Border zone infarcts

- =Watershed infarcts
- Wedge shaped areas of infarction
- At most distal portions of arterial territories.
- Usually seen after hypotension episodes.
- Border between anterior and middle cerebral artery territories is most vulnerable

Focal cerebral ischemia

- Focal occlusion of a vessel.
- Occlusion: thrombi or emboli
- Size, location and shape of infarct depend on the vessel occluded and can be modified by collateral blood flow.
- Collateral flow in circle of Willis and cortico-leptomeningeal anastomoses can limit damage
- Little collaterals in : thalamus, basal ganglia, and dep white matter.

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, a direct extension of the internal carotid.
- Emboli lodge where vessels **branch** or in **stenotic** areas caused by atherosclerosis

Thrombotic occlusions

- Atherosclerosis

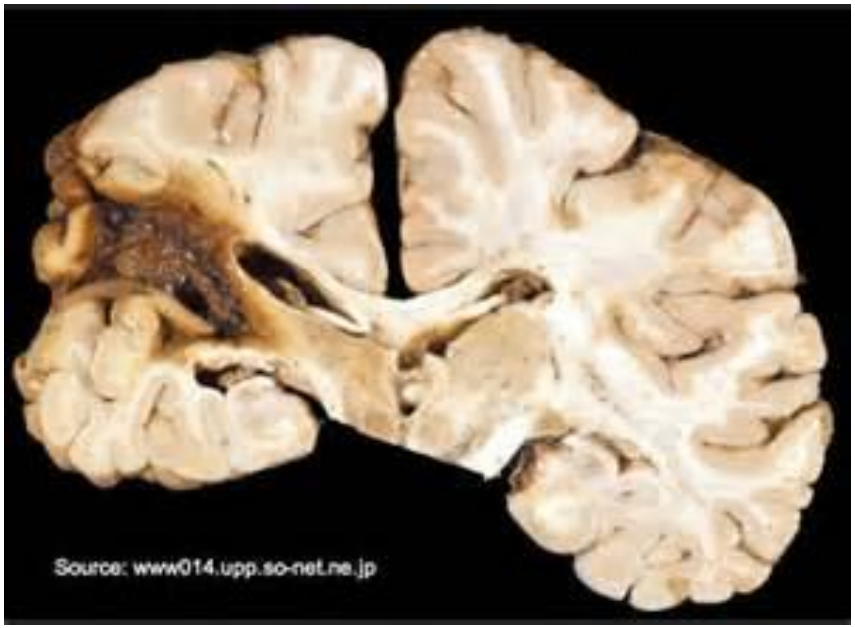
Common sites:

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

infarcts

- **Haemorrhagic** or **non haemorrhagic**
- Non haemorrhagic : due to acute vascular occlusion.. Treat with thrombolytic therapy
- Haemorrhagic: due to reperfusion through collaterals or after dissolution of emboli.

Brain infarct



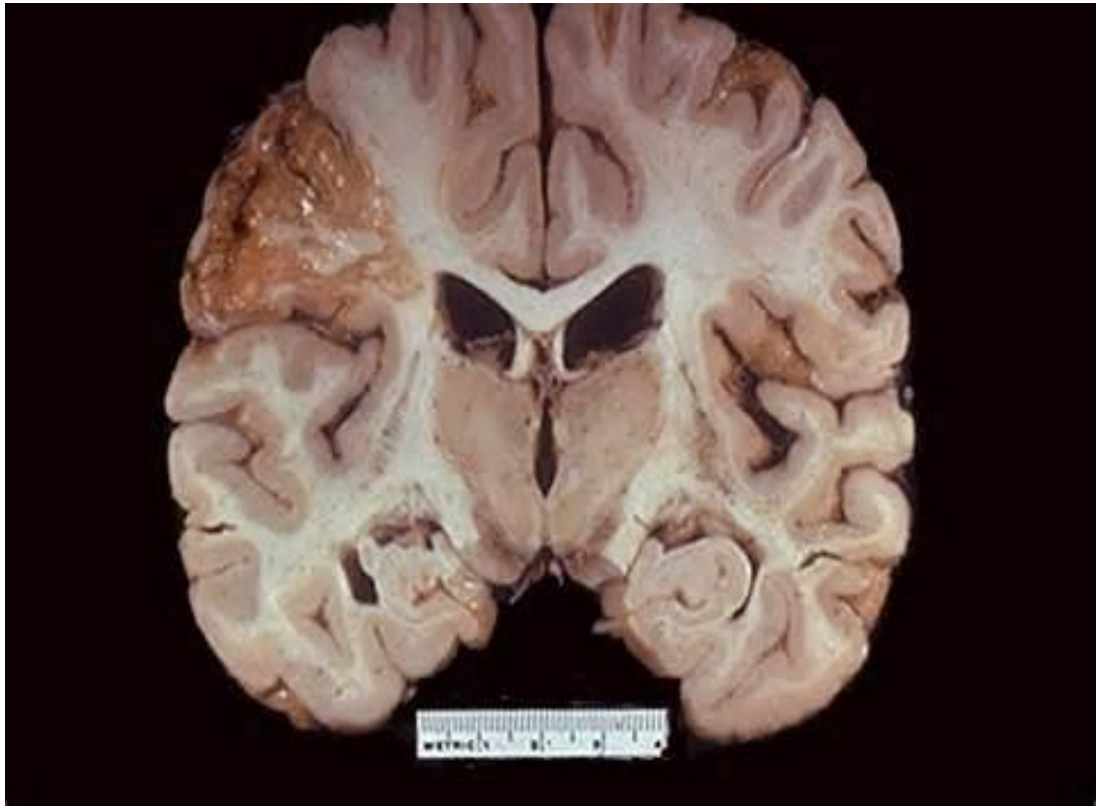
• Morphology/ non-hemorrhagic

- First macroscopic changes need more than 6 hours to develop.
- 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.

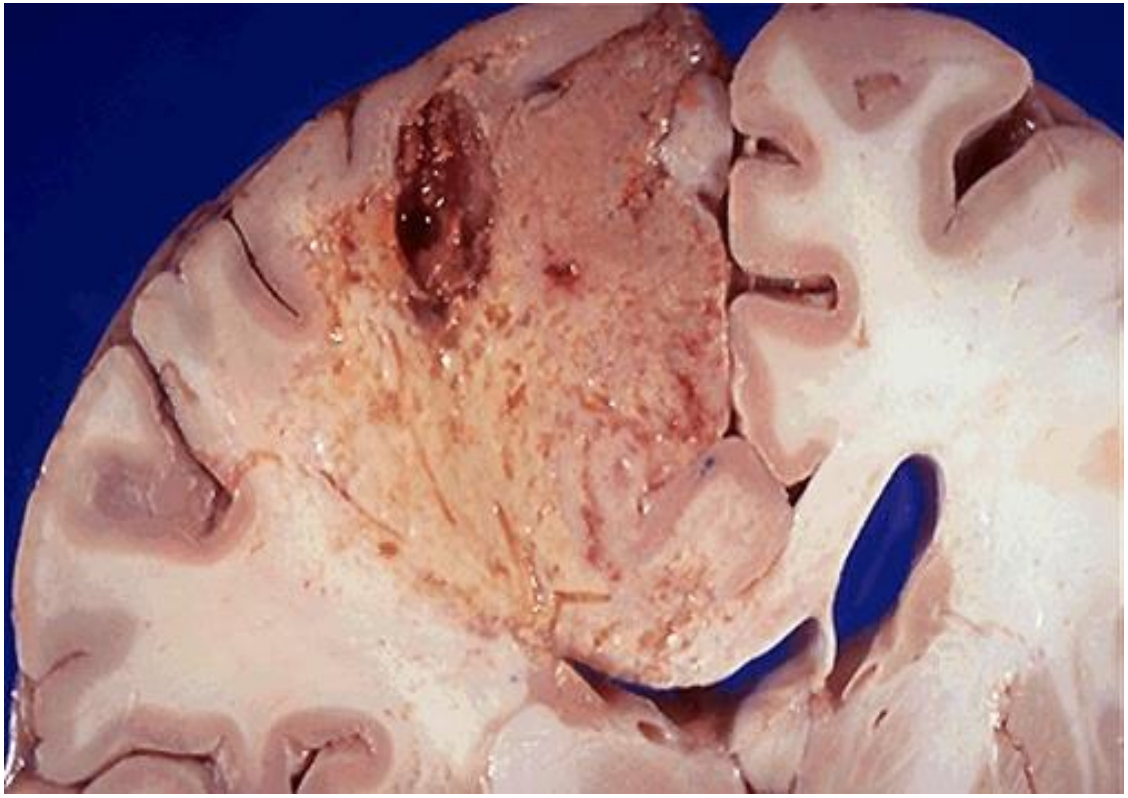
Morphology/ nonhemorrhagic

- After 12 hours: red neurons + edema
- Up to 48 hours: neutrophils
- 2-3 weeks: macrophages, gemistocytic astrocytes.
- Months: gemistocytes regress, cavity persists

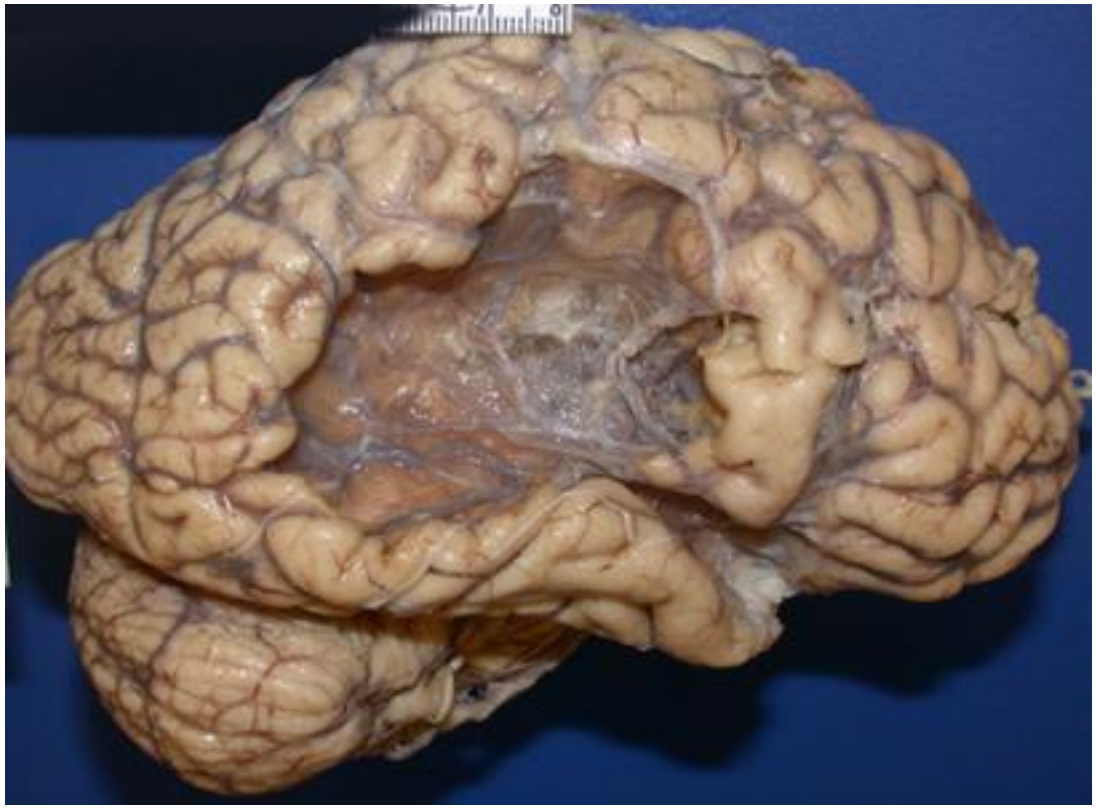
infarct



infarct



Old infarct



hemorrhagic infarct

- Same as non hemorrhagic but with blood extravasation.

Other cerebrovascular diseases

- Intracranial hemorrhage
- Hypertensive cerebrovascular disease
- vasculitis

Hypertensive cerebrovascular disease

- Hyaline arteriolar sclerosis.
- Weak arteioles, so.. Can rupture.
- Minute aneurysms can form (Charcot-Bouchard microaneurysms)

Hypertension/ effects

- Massive intracranial hemorrhage.
- Lacunar infarcts.
- Rupture of small penetrating vessels
- Acute hypertensive encephalopathy

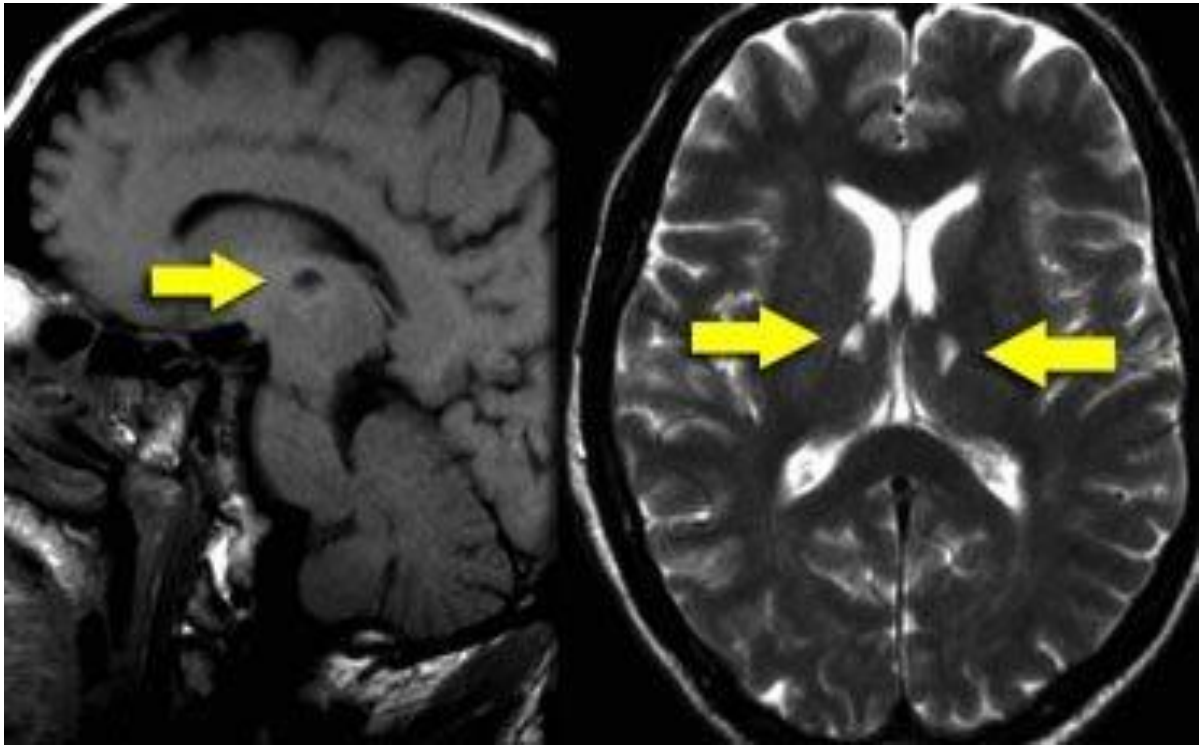
Massive intracranial hemorrhage

- Will be discussed in the next lecture!

Lacunar infarcts

- Small infarcts, mostly in deep grey matter (basal ganglia and thalamus), internal capsule, deep white matter and pons.
- Caused by occlusion of penetrating branch of a large cerebral artery.
- Effect: depends on site

Lacunar infarct



Vessel rupture

- Small penetrating vessels may rupture.
- Cause small hemorrhages.

Acute hypertensive encephalopathy

- Happen with sudden sustained rise of diastolic more than 130.
- Increased intracranial pressure , global cerebral dysfunction (headache, confusion, vomiting, convulsion, or coma)
- Rapid intervention to decrease intracranial pressure is essential.

vasculitis

Infectious arteritis:

- previously seen with syphilis and TB.
- Now in association with: CMV, herpes, aspergillosis….. immunosupression

Polyarteritis nodosa.

Primary angiitis of CNS cause diffuse encephalopathy with cognitive dysfuction.