Overview

Development of CNS Vasculature

Anatomy & Structure of Brain Blood Vessels

Cerebrovascular Diseases (CVD)

Cases

A CVD Autopsy
Development of CNS Vasculature
Anatomy & Structure of Brain Blood Vessels
WATER-SHED ZONES
**Structural Differences**

- Endothelial cells are joined by tight junctions; No fenestrations
- Muscle coat is thinner than in the extracranial arteries of corresponding size
- External elastic lamina is lacking
- Adventitia is very thin
Cerebrovascular Diseases
Atherosclerosis & Small Vessel Disease
Hypertensive Angiopathy
Vasculitis
Aneurysms & Vascular Malformations
Cerebral Amyloid Angiopathy
CADASIL, Moyamoya Syndrome, FMD
Haematological disorders (Thrombosis, APLA syndrome, Anticoagulation)
Focal & Global Brain Ischaemia
Brain Haemorrhages
Vascular Dementia
Hypoglycaemic Brain Damage, Gas & Fat Embolism
Spinal Cord Vascular Disorders
ISCHAEMIA

HAEMORRHAGE
CASE 1
A 62-year-old man noted a mild bi-parietal **headache** and slight **weakness** in his right arm and hand when he went to bed one evening. The following morning, his wife found him unable to speak or to move his right arm or leg.

Neurological examination revealed expressive **dysphasia** but normal comprehension, right **hemiparesis** (more marked in the arm than the leg), a mild loss of position and vibratory senses on the right and astereognosis in the right hand. Angiography revealed **stenosis** of the left carotid artery at the bifurcation and **occlusion** of the left MCA.
Evolution of cerebral infarct

- Normal neurons

- Shrunken neurons

- Polymorphonuclear leukocytes

- Encrusted neurons

- Cystic cavity

- Macrophages

- Astrocytes

[hours → 1–3 days]

[from 3–5 days]

[weeks → months]
Cerebral Infarction

- DWI
- PM - Unfixed (24hrs); Fixed (12hrs)
- Fixed brain - Blurred GW junction; Palpation
- Histology - Eosinophilia (4-12h)
  - PMN (15-24h)
  - Foam cells (2 days)
  - PMN disappear (5 days)
  - Astrocyte proliferation (1 wk)
CEREBRAL ATHEROSCLEROSIS WITH A LARGE MCA TERRITORY INFARCT
SEVERITY OF ATHEROSCLEROTIC LESIONS IN THE ARTERIAL CERVICOCEREBRAL TREE

EVOLUTION OF LESIONS CAUSED BY ATHEROMATOUS CAROTID STENOSIS
CASE 2
A 49-year-old hypertensive man had a severe bi-frontal headache as he was returning home from work one evening. His wife noted that he was confused and went straight to bed. One hour later, she was unable to rouse him.

Neurologic examination revealed a comatose patient breathing deeply, with dilated, fixed pupils. There was little spontaneous movements of the left extremities; the right extremities failed to move, even when supraorbital pressure was applied. A CT scan confirmed the diagnosis.
a) Normal

- Adventitia
- Smooth muscle media
- Internal elastic lamina

b) Arteriosclerosis

- Lipid-bearing macrophage

(c) Charcot-Bouchard aneurysm

- Thrombus
- Old haemorrhages
HYPERTENSIVE ANGIOPATHY WITH INTRACEREBRAL HAEMORRHAGE
Pathogenesis of Cerebral changes in Hypertension

Hypertension → ↑ Intraluminal pr. → ↑ Vasocon. → abrupt BP↑ → Forced vasodilatation (breakthrough of autoregulation) → BBB breakdown
BBB breakdown

STAGE 1
- Localized
  - Focal oedema

STAGE 2
- Widespread
  - Diffuse oedema
  - HTN Encephalopathy
  - Macrophages, Astrocytes, SMCs & Necrosis

STAGE 3
- Remote focal necrosis
  - (lacunae)
  - Multiple
  - Cognitive impairment
  - dementia
  - SURVIVAL
  - DEATH

Cognitive impairment
dementia
CEREBRAL / MENINGEAL HAEMORRHAGE

Traumatic
- Arteriolar change
  - Hypertensive
  - Amyloid angiopathy
- Rupture of vascular malformation
  - Aneurysms
  - AVM

Non-traumatic
- Blood dyscrasias
- others
  - Leukaemia
  - Platelet disorders
  - Tumour
  - Herniation
CASE 3
A 65-year-old man complains of intense focal headache usually in the temporal or occipital region. He notices scalp tenderness especially on resting his head on the pillow. He also has difficulty in chewing, early morning body aches and weight loss.

The neurologic examination revealed a palpable, tender, swollen and non-pulsatile artery just in front of the ear, coursing distally into the hairline. A biopsy of the artery was performed.
TEMPORAL / GIANT-CELL ARTERITIS
VASCULITIS

Non-infectious

Primary
- TA
- GCA
- PACNS
- Kawasaki

Secondary
- SLE, PAN
- WG, CSA, SS
- Behcet, Malig.

Drug-induced

Infectious

- Bacterial
- Viral
- Fungal
- others
CASE 4
A 36-year-old house wife developed a sudden acute generalised headache, nausea and vomiting. By the time she reached the emergency department, she was in a semi-conscious state.

The neurologic examination revealed dilated pupils, nuchal rigidity, a positive Kernig sign and a flaccid paralysis of all four extremities. A CT scan confirmed the diagnosis of sub-arachnoid haemorrhage. Cerebral angiography revealed an aneurysm of the left MCA that had ruptured.
INTRACEREBRAL & SUBARACHNOID HAEMORRHAGE SECONDARY TO RUPTURED MCA ANEURYSM
CASE 5
A 35-year-old previously healthy man is being referred to a neurologist with symptoms of recent-onset complex partial seizures and headaches. He also has difficulties carrying out tasks that require planning and occasional episodes of dizziness and hallucinations.

The neurologic examination revealed only a mild weakness involving the right arm and leg. The CT/ MRI scans and the angiography confirmed a well-circumscribed highly vascular malformative lesion.
ARTERIO-VENOUS MALFORMATION (AVM)
A 70-year-old man presented acutely with severe bi-frontal **headache**, **vomiting** and **seizures**. He lapsed into **coma** an hour later. Previously he had experienced one similar episode of acute headache and vomiting for which he was hospitalised and discharged a week later. No other clinical details are available.

The CT/ MRI scans revealed a large **hematoma** in the right posterior frontal region with significant oedema and mass effect. A **old** **cystic** lesion was also noted in the left temporal lobe.
CEREBRAL AMYLOID ANGIOPATHY (CAA)
CAA

• ‘The pathological process during which one of the amyloid proteins that are known to be associated with CNS disease in the humans, progressively deposits in the walls of cerebral blood vessels and is followed by degenerative vascular changes’.

• Syn: congophilic angiopathy, dyshoric angiopathy

• Now recognised as a major cause of non-hypertensive lobar cerebral haemorrhage in the elderly.
CAA

- overlaps with AD biologically; 80% of AD pts. have CAA.

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**Table 10-1 Molecular Pathogenesis of Amyloid Angiopathies:**

- **TYPE OF CAA:** Sporadic or AD-associated Familial Forms

- **FAD**: HCHWA-D

- **HCCAA (HCHWA-I)**

- **MVA**

- **PrP-CAA**

- **FAF**

- **FBD**

- **FDD**
A 62-year-old man presented with a 3-year history of progressive mental decline, including deterioration in memory and speech. He also experienced frequent attacks of migranous headaches. He had a family history significant for several relatives who had similar problems, some of whom died secondary to this condition. The patient had no significant past medical history and had been otherwise healthy. A neurologic examination was significant for decreased short-term memory, slurred speech and visual field defects.

MRI showed diffuse, multicentric cerebral white matter enhancement, most prominently noted in both temporal lobes. He underwent an excision of a portion of the anterior temporal lobe and inferior temporal gyrus.
CEREBRAL AUTOSOMAL DOMINANT ARTERIOPATHY WITH SUB-CORTICAL INFARCTS AND LEUKOENCEPHALOPATHY (CADASIL)
CASE 8
A 28-year-old woman presented to her GP with persistent **headaches**. They were worse first thing in the morning when she also felt nauseous. Past medical history was unremarkable and she was not on any medication except for the **oral contraceptive**. Her mother died at the age of 46, after developing a DVT following a hysterectomy.

She was mildly obese. Heart rate 72 beats/minute, regular. BP 130/80 mmHg. Neurological examination was unremarkable, although the **optic discs** looked swollen. A CT scan of the head was arranged, which was reported as normal. However, her condition deteriorated rapidly 5 days later with increasing headaches, **vomiting and drowsiness**. She was admitted to hospital, but died within a few hours.
CEREBRAL VENOUS SINUS THROMBOSIS
CASE 9
A 26-year-old woman, with history of peptic ulcer and family history of cerebrovascular disease was referred to medicine clinic with asthenia and generalized discomfort. She reported a cerebrovascular accident manifesting as a right arm and leg weakness ten months ago, almost completely receded at observation time; she also complained of recurrent episodes of proximal deep venous thrombosis (DVT) of lower limbs in the last seven months.

The laboratory investigations showed increased blood levels of anti-cardiolipin (ACA) and lupus anticoagulant (LA) antibodies.
ANTI-PHOSPHOLIPID ANTIBODY SYNDROME
CASE 10
VASCULAR DEMENTIA
A Cerebrovascular Disease Autopsy

- Whole brain, spinal cord (if clinically involved).
- Circle of Willis- aneurysms; dissection under water.
- Vertebral A- check patency/ dissect out. C1/ f.magnum.
- Dural sinuses - thrombosis; microbiology.
- Aorta, Myocardium, cardiac valves, visceral organs.
- Blood, urine samples.
- Fresh brain, skeletal muscle.
Review

Autopsy approach to stroke
Seth Love
Histopathology 2011; 58 (3): 333-351.