Brain and cardiovascular disease

Kobal Jan, MD, University clinical center Ljubljana, department of neurology
Normal angiogram and absence of blood flow in highly raised intracranial pressure (experimental animal) which leads to brain death.
Brain weights ~ 1400 g, 2% of total body mass

Brain perfusion: more than 15% of resting cardiac output (700-800ml) and about 20% of oxygen
• Blood brings to CNS: $O_2$, glucose, other nutrients

• Takes Away: $CO_2$, lactic acid, waste metabolites

• Brain blood vessels possess:
  – Special features in anatomy and physiology
  – Special mechanisms to keep blood flow constant

• Brain highly depends on supply of oxygenated blood (normal blood flow: about 50 ml/100g/min, grey substance 70ml, white substance 20ml)
At least 50% of the neurologic disorders in adults are due to cerebrovascular diseases.
Stroke

Time profile: sudden onset followed by gradual improvement of symptoms.

Neurological deficit depends on location and extent of the lesion, it is FOCAL

STROKE = Sudden non convulsive focal neurologic deficit
Ischemic stroke
Heart and brain are closely connected through blood vessels.
Cardiac diseases may cause stroke frequently. The stroke is due to cardiac embolism: 

**cardioembolic stroke**
Mural thrombosis after cardiac infarction
bacterial endocarditis
Atrial fibrillation due to cardiomyopathy
Stroke in principal brain arterial territories also might be due to atherosclerosis: atherothrombotic stroke
Grave atherosclerosis of the principal cerebral arteries
Large (eg. Carotid) to smaller (eg. medial) artery embolism
Principal pre-cerebral blood vessels
Circle of Willis is the most important arterial collateral pathway
Other arterial collaterals
Focal deficit in ischemic stroke respects distribution by the arterial territories
Anterior cerebral artery distribution
Anterior cerebral artery infarction affects foot and hip.
Middle cerebral artery distribution
Middle cerebral artery infarction affects: arm, hand, face, tongue.
Posterior cerebral artery distribution
Posterior cerebral artery infarction affects visual fields.
Stroke in Border zones or watershed areas might be due to a larger (eg. carotid) artery occlusion.
Small arteries disease – lypohialinosis is basis to brain hemorrhage or lacunar infarction
Lentikulostriatal arteries
Hipertensive cerebral hemorrhage due to rupture of a small cerebral artery
Lacunar cerebral infarctions
Cerebral blood flow (auto)regulation

• Within limits (50-150 mmHg) constant regional cerebral blood flow (rCBF) is maintained.

• Vascular endothelium, autonomic nerves and arteriolar wall muscles are involved. Within limits independent from metabolism.

• Metabolic regulation (NO, high energy phosphates, ion homeostasis)
Autoregulation of Cerebral Blood Flow

Blood flow ml/100g/min vs. MAP mmHg
Brain infarction development

• Normal rCBF: 50 ml/100g/min
• Under 23 ml/100g/min impaired neuronal function, function may be restored
• Under 10-12 ml/100g/min - brain infarction
• Critical level therefore lies between 23 and 12 ml/100g/min
Completed stroke: only conservative treatment is indicated
Early stroke (up to 4.5 hours: penumbra (blue line) may be recovered
To reestablish blood flow systemic thrombolysis or mechanical devices may be used
A good mechanical recanalization of middle cerebral artery (left arrow)
Subarachnoidal hemorrhage due to berry aneurism rupture
Most berry aneurisms are located on frontal side of circle of Willis.
Cerebral veins and venous sinuses disease occurs much more rarely than arterial disease.
Hemorrhagic infarct due to cerebral venous sinus thrombosis
Normal or low molecular heparin is first line therapy of cerebral venous sinus thrombosis.
Amyloid angiopathy may cause all kinds of vascular incidents mostly hemorrhagic in the elderly.
conclusions

• Cerebrovascular disease ranks first among neurologic disorders in adults
• Every physician will be required to examine patients with cerebrovascular disease at least occasionally
• Examining patients with cerebrovascular disease provides one of the most instructive approaches to neurology
From the department of neurology
University clinical center Ljubljana