ANESTHETIC MANAGEMENT FOR SURGERY OF CEREBRAL ANEURYSM

Essay

Submitted for Partial Fulfillment of Master Degree in Anesthesia

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بسم الله الرحمن الرحيم

وَمَا تَوْفِيقِي إِلا بِاللَّه
عَلَيْهِ تَوَكَّلْتُ وَإِلَيْهِ أُنِيبُ

صدق الله العظيم

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Mohamed Hassan Ali El-Khatieb

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Abbreviations

- **(CBF)** Cerebral blood flow
- **(CMR)** Cerebral metabolic rate.
- **(CMRO2)** Cerebral metabolic rate of Oxygen.
- **(CNS)** Central nervous system.
- **(CPP)** Cerebral perfusion pressure.
- **(CSF)** Cerebro spinal fluid.
- **(CT)** Computed tomography
- **(CVP)** Central venous pressure
- **(CVR)** Cerebrovascular resistance
- **(ECG)** Electrocardiogram.
- **(EEG)** Ecephalography.
- **(EV)** Evoked potential
- **(GCS)** Glascow coma scale.
- **(ICA)** Internal carotid artery.
- **(ICP)** Intracranial pressure.
- **(MAC)** Minimum alveolar concentration
- **(MAP)** Mean arterial pressure
- **(MRI)** Magnetic resonance imaging.
- **(NICU)** Neuro intensive care unit.
- **(PaCO2)** Arterial partial pressure of carbon dioxide

- **(PaO2)** Arterial partial pressure of oxygen
- **(PAP)** Pulmonary artery pressure.
- **(SABP)** Systolic arterial blood pressure.
- **(SAH)** Subarachnoid hemorrhage
- **(SIADH)** Syndrome of inappropriate secretion of antidiuretic hormone

Introduction

Cerebral aneurysms are relatively common with a prevalence of about 2%. Rupture of a cerebral aneurysm is the most feared complication and the most common cause of spontaneous subarachnoid hemorrhage (SAH).

The overall risk of rupture per year is nearly 2%, while the annual bleeding risk in small (10 mm) aneurysms is about 0.7 % (***Rinkel et al; 2001***). Therefore, the operative management of small unruptured aneurysms remains controversial ***(Wiebers, 2002)***. The risk factors for development and rupture of cerebral aneurysms are hypertension, current or former smoking, over consumption of alcohol, familial disposition and autosomal dominant polycystic kidney disease.

There are three leading causes of death and disability: first, the direct effects of initial bleeding; second, rebleeding; third, cerebral vasospasm.

The incidence of SAH is highest between the ages of 40 and 60 years, and women are more affected than men **(*Teunissen et al; 2003)***.

Subarachnoid hemorrhage is followed by a marked stress response with elevated plasma Concentrations of catecholamines and electrolyte imbalance. Hypokalemia occurs frequently, whereas hyponatremia is a late finding in up to 56% of the patients ***(Sherlock et al; 2006).*** Dehydration can be a result of nausea and vomiting often present after ictus. Cardiopulmonary disturbances are common, presenting as cardiac arrhythmias, myocardial ischemia, cardiac failure, and neurogenic pulmonary edema. Also, in many cases, there is temporary loss of consciousness at the time of SAH,

predisposing to pulmonary aspiration of the gastric contents often resulting in severe pulmonary complication.

The aim of cerebral aneurysm treatment is to prevent future rupture and to facilitate the management of cerebral vasospasm. Craniotomy and clipping of the aneurysm ("clipping") is a proven and definitive treatment for cerebral aneurysms ***(Kassell, 2000)***. However, endovascular treatment ("coiling") is now rivaling clipping as a morbidity and mortality ***(Molyneux et al; 2002)***.

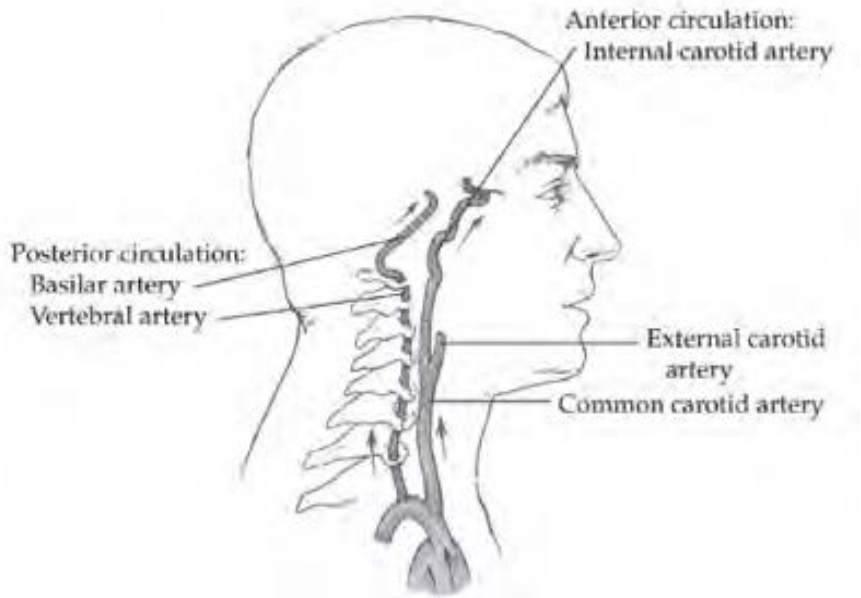
The role of the neuroanesthesiologist together with the neurosurgeon may begin in the emergency department to assess and stabilize the general medical and neurological status of the Patients, Early preoperative management of patients in the intensive care unit, prevention of rebleeding, and providing a slack brain during micro neurosurgical procedures are further steps. Postoperative management, prevention, and treatment of possible medical complications and cerebrovascular spasm are as necessary as high-quality microsurgery ***(Sherlock et al; 2006***).

Blood supply of the brain

Although the brain accounts for only 2% of the body weight its survival and functioning depend on continuously receiving 20% of the arterial blood flow from the heart, metabolizing 15-20% of the available oxygen.

Blood is supplied to the brain by the internal carotid arteries and the vertebral arteries. It is drained from the brain largely by the internal jugular vein. The cerebral arteries, venules, and veins do not differ structurally from vessels of similar size and function in other organs. However, the capillaries of the central nervous system (CNS) do differ significantly in ultra structure and physiology from capillaries of the general circulation ***(Brust , 2002)***.

ARTERIAL SUPPLY



The principal blood supply for the brain comes from two arterial systems that receive blood from different systemic arteries: the ***anterior circulation***, fed by the **internal carotid**

arteries ***(carotid circulation)***, and the ***posterior circulation***, which receives blood from the **vertebral_arteries** ***(vertebral-basilarcirculation) (Atwood and Lnenick, 1995)*.**

Figure (1): anterior (carotid) circulation, posterior (vertebral-basilar) circulation *(Walz, 1995).*

The anterior and posterior circulations are not independent but are connected by networks of arteries on the ventral surface of the diencephalon and midbrain and on the cortical surface. The cerebral hemispheres receive blood from both the anterior and posterior circulations, whereas the brain stem receives blood only from the posterior circulation ***(Atwood and Lnenicka;1995)*.**

Internal carotid arteries.

The internal carotid artery consists of four segments:

(1) The ***cervical Segment*** extends from the bifurcation of the common carotid (into the external and internal carotid arteries) to where it enters the carotid canal.

(2) The ***intrapetrosal segment*** courses through the petrous portion of the temporal bone.

(3) The ***intracavernous segment*** courses through the cavernous sinus (a venous structure overlying the sphenoid bone).

(4) The ***cerebral (supraclinoid) segment*** extends from the site of exit of the artery from the cavernous sinus to where the internal carotid artery bifurcates into the anterior and middle cerebral arteries.

(The ***intracavernous*** and ***cerebral segments*** are collectively known as the carotid siphon because of their characteristic S-shaped configuration).

The internal carotid arteries arise at the bifurcation of the common carotid arteries in the neck, ascend in front of the transverse processes of the upper three cervical vertebrae, and enter the base of the skull through the carotid canal. Within the

cranium, the internal carotid artery lies in the cavernous sinus. It then pierces the dura to begin its subarachnoid course ***(Rexed, 1996).***

The internal carotid artery gives rise to:

(1) ***Ophthalmic artery****:*

- It is the first intracranial branch of the internal carotid as it courses through the cavernous sinus.
- It supplies the optic nerve and gives rise to the central artery of the retina.

(2) ***Anterior choroidal artery:***

- It arises from the internal carotid artery after it emerges from the cavernous sinus.
- It passes ventral to the optic tract and supplies the optic tract, cerebral peduncles, lateral geniculate body, posterior part of the posterior limb of the internal capsule, tail of the caudate nucleus, uncus, amygdala, anterior hippocampus, choroid plexus of the temporal horn, and sometimes the globus pallidus.
- The anterior choroidal artery is prone to occlusion by thrombus because of its small caliber.

(3) ***Anterior cerebral artery:***

- It originates from the internal carotid artery lateral to the optic chiasma and courses dorsal to the optic nerve to reach the interhemispheric fissure, where it curves around the genu of the corpus callosum and continues as the pericallosal artery dorsal to the corpus callosum.
- As the two anterior cerebral arteries approach the interhemispheric fissure, they are joined by the anterior communicating artery.
- Its major branches are Recurrent Artery of Heubner (Medial Striate Artery), Orbitofrontal

Artery, Frontopolar Artery, Callosomarginal Artery and Pericallosal Artery.

(4) ***Middle cerebral artery:***

- The middle cerebral artery is a continuation or the main branch of the internal carotid artery.
- It courses within the lateral (sylvian) fissure and divides into a number of branches that supply most of the lateral surface of the hemisphere.
- The most important branches are Cortical Branches and Central (Perforating) Branches.

(5) ***Posterior communicating branches:***

- The posterior communicating artery connects the internal carotid artery with the posterior cerebral artery.
- Branches of the posterior communicating artery supply the genu and anterior part of the posterior limb of the internal capsule, the anterior part of the thalamus, and parts of the hypothalamus and subthalamus ***(Davies and Lumsden,2003).***

Vertebral Arteries.

The vertebral artery arises from the subclavian artery. It ascends within the foramina of the transverse processes of the upper six cervical vertebrae (intraosseous segment), curves backward around the lateral mass of the atlas (atlantoaxial segment), and enters the cranium through the foramen magnum (intracranial segment).

Within the cranium, the vertebral arteries lie on the inferior surface of the medulla oblongata, the two vertebral arteries join at the caudal end of the pons to form the basilar artery.

The vertebral artery gives rise to the:

(1) ***Posterior spinal artery:***

- It passes caudally over the medulla and the posterior surface of the spinal cord.

(2) ***Anterior spinal artery:***

- The anterior spinal artery starts as two vessels that join to form a single artery that descends on the ventral aspect of the medulla and into the anterior median fissure of the spinal cord.

(3) ***Posterior inferior cerebellar artery:***

- These arteries follow an S-shaped course over the olive and inferior cerebellar peduncle to supply the inferior surface of the cerebellum, dorsolateral surface of the medulla oblongata, choroid plexus of the fourth ventricle, and part of the deep cerebellar nuclei.

(4) ***Basilar artery:***

- Formed by the union of the two vertebral arteries at the caudal end of the pons.
- Branches include paramedian penetrating arteries, short circumferential arteries, long circumferential arteries *(Auditory (Labyrinthine) artery , Anterior inferior cerebellar artery (AICA)and Superior cerebellar artery)* ***(Rexed, 1996).***

(5) ***Posterior cerebral arteries:***

- These constitute the terminal branches of the basilar artery in 70 percent of cases.
- They pass around the cerebral peduncle and supply the medial surfaces of the occipital lobe.
- The main trunk of the posterior cerebral artery bifurcates into medial and lateral branches ***(Dunant, 1997).***

Circle of Willis