Anesthetic Considerations in Acute Traumatic Head Injury

Essay

Submitted for the Partial Fulfillment of Master Degree in Anesthesia

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2014

الإعتبارات التخديرية في حالات الإصابات الحادة للرأس

رسالة

توطئة للحصول على درجة الماجستير فى التخدير

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Acknowledgement

First of all thanks to Allah who helped me to do this work.

I would like to express my sincere appreciation and gratitude to Prof. Dr. **Bahaa El Din Ewiss Hassan**, *Professor of Anesthesia, Faculty of medicine, Ain Shams University for his generous supervision and kind guidance to make the realization of this work much easy.*

I am deeply grateful to Prof. Dr. **Ahmed Nagah El Shaer**, *Professor of Anesthesia, Faculty of Medicine, Ain Shams University, for his guidance and supervision.*

Deepest gratitude to Dr. **Amr Sobhy Abd El Kawy** *Lecturer of Anesthesia, Faculty of medicine, Ain Shams University for his eager share , his kind support and guidance.*

Thanks to my parents and my wife for their sincere encouragement.

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List of Abbreviations

ABP	Arterial blood pressure
ACA	Anterior cerebral artery
AIS	Abbreviated Injury Scale
ATP	Adenosine triphosphate
BBB	Blood brain barrier
CBF	Cerebral blood flow
CBV	Cerebral blood volume
CMR	Cerebral metabolic rate
CMRO2	Cerebral metabolic rate of oxygen
CO2	Carbon dioxide
CPP	Cerebral perfusion pressure
CSF	Cerebrospinal fluid
CSI	Cervical spine injury
CT	Computed tomography
CVP	Central venous pressure
D5W	5% dextrose
DAI	Diffuse axonal injury
DBP	Diastolic blood pressure
DNA	Deoxyribonucleic acid
ECG	Electrocardiography
ED	Emergency Department
EDH	Epidural hematoma
EEG	Electroencephalogram
GCS	Glasgow coma scale
HCT	Hematocrit
ICA	Internal carotid artery
ICAM	Intercellular adhesion molecules
ICP	Intracranial pressure
ICU	Intensive care unite
IJV	Internal jugular vein

ISP	Intracerebral steal phenomenon
ISS	Injury Severity Score
LMA	Laryngeal mask airway
MAC	Minimum alveolar concentration
MAP	Mean arterial pressure
mmHg	Millemetre mercury
MRI	Magnetic resonance imaging
MCA	Middle cerebral artery
MV	Mechanical Ventilation
N2O	Nitrous Oxide
NCCU	Neurocritical care unit
NMDA	N-Methyl-D-Aspartate
$PaCO_2$	Arterial carbon dioxide tension
PaO_2	Arterial oxygen tension
PCA	Posterior cerebral artery
PEEP	Positive end expiratory pressure
$PtiO_2$	Brain tissue oxygen tension
rCBF	Regional cerebral blood flow
SAH	Subarachnoid haemorrhage
SaO2	Arterial oxygen saturation
SBP	Systolic blood pressure
SCI	Spinal cord injury
$SjvO_2$	Jugular venous oxygen saturation
SpO2	Oxygen saturation
TCD	Transcranial Doppler
TBI	Traumatic brain injury
U.S.	United States
UK	United Kingdom
VCAM	Vascular adhesion molecules

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Introduction

Traumatic brain injury (TBI) is the leading cause of death among adults younger than 45 years and in children (1–15 years). The majority of TBI is classified as mild, and around 8–10% is classified as moderate or severe **(Yates *et al*., 2006).**

TBI has been divided into two distinct periods: primary and secondary brain injury. The primary injury is the result of the initial, mechanical forces, resulting in shearing and compression of neuronal, glial, and vascular tissue. Axonal tissue is more susceptible to the injury than vascular tissue. Thus, focal injuries are usually superimposed upon more diffuse neuronal injury. The consequences of the initial injury include physical disruption of cell membranes and infrastructure, and disturbance of ionic homeostasis secondary to increased membrane permeability **(Stiefel *et al*., 2005).**

The modern management of severe TBI has fallen into the domain of a multidisciplinary team led by neurointensivists, neuroanaesthetists, and neurosurgeons and is based on the avoidance of secondary injury, maintenance of cerebral perfusion pressure (CPP), and optimization of cerebral oxygenation (**Czosnyka *et al*., 2005).**

Anesthetic agents have widely variable effects on the blood supply to the brain and, therefore, choice of anesthetic agent can influence neurological outcome. Although in the past, anesthetic agents have been selected for their neuroprotective properties, it is increasingly being recognized that the support of cerebral perfusion during anesthesia contributes more significantly to a positive outcome for these patients. Support of cardiorespiratory function is, therefore, highly important when anesthetizing patients with TBI **(Elizabeth *et al*., 2007).**

Aim of the Work

This review is focused on the perioperative anaesthetic management of acute head injury, with particular emphasis on recent developments.

Anatomy of Cerebral Circulation

Cerebral circulation refers to the movement of blood through the network of blood vessels supplying the brain. The arteries deliver oxygenated blood, glucose and other nutrients to the brain and the veins carry deoxygenated blood back to the heart, removing carbon dioxide, lactic acid, and other metabolic products. Since the brain is very vulnerable to compromises in its blood supply, the cerebral circulatory system has many safeguards. Failure of these safeguards results in cerebrovascular accidents, commonly known as strokes. The amount of blood that the cerebral circulation carries is known as cerebral blood flow. The presence of gravitational fields or accelerations also determine variations in the movement and distribution of blood in the brain, such as when suspended upside- down **(Bond *et al*., 2003)**.

Arterial cerebral circulation

The arterial cerebral circulation is normally divided into anterior cerebral circulation and posterior cerebral circulation. There are two main pairs of arteries that supply the cerebral arteries and the cerebrum: Internal carotid areries and vertebral arteries. The anterior and posterior cerebral circulations are interconnected via bilateral posterior communicating arteries. They are part of the Circle of Willis, which provides backup circulation to the brain. In case one of the supply arteries is occluded, the Circle of Willis provides interconnections between the anterior and the posterior cerebral circulation along the floor of the cerebral vault, providing blood to tissues that would otherwise become ischemic **(Scanlon, 2011)**.

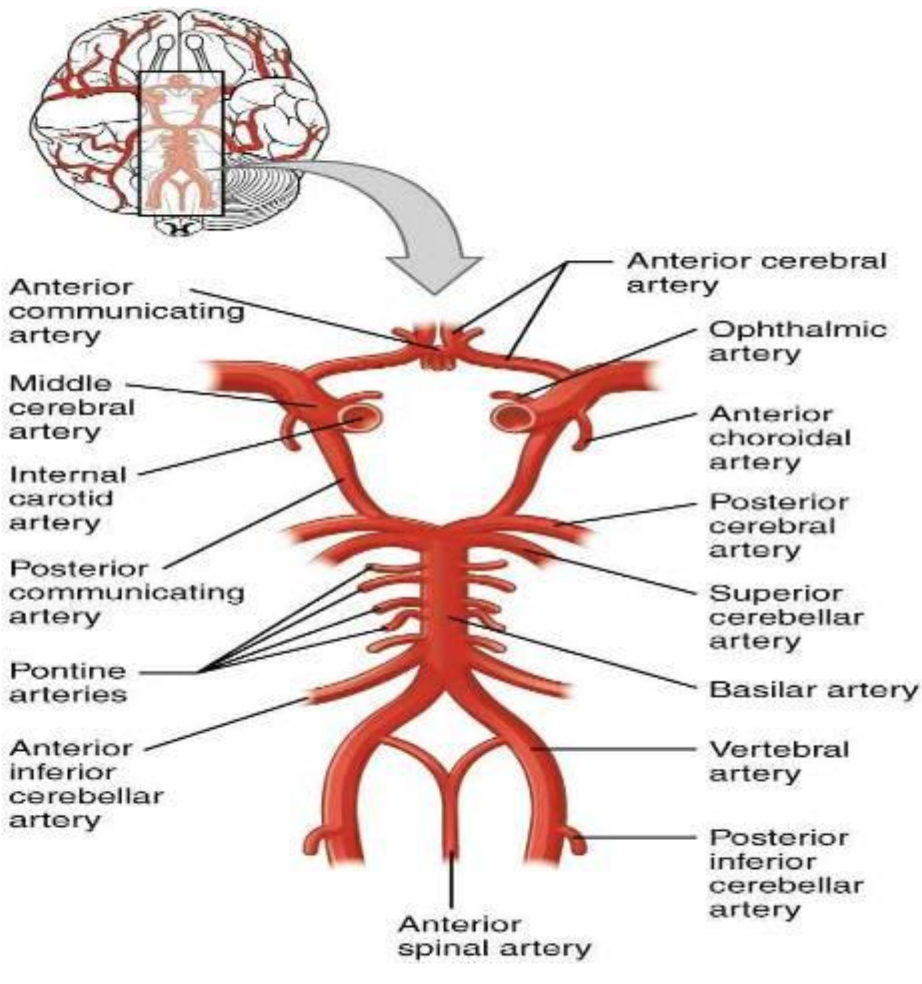

Figure (1): The blood supply to the brain enters through the internal carotid arteries and the vertebral arteries, eventually giving rise to the circle of Willis **(Scanlon, 2011).**

Cerebral venous drainage

The venous drainage of the cerebrum can be separated into two subdivisions: superficial and deep. The superficial system is composed of dural venous sinuses, which have wall composed of dura mater as opposed to a traditional vein. The dural sinuses are, therefore located on the surface of the cerebrum. The most prominent of these sinuses is the superior sagittal sinus which flows in the sagittal plane under the midline of the cerebral vault, posteriorly and inferiorly forming the confluence of sinuses. From here, two transverse sinuses bifurcate and travel laterally and inferiorly in an S-shaped curve that forms the sigmoid sinuses which go on to form the two jugular veins. In the neck, the jugular veins parallel the upward course of the carotid arteries and drain blood into the superior vena cava **(Affifi and Bergman, 2005).**

The deep venous drainage is primarily composed of traditional veins inside the deep structures of the brain, which join behind the midbrain to form the vein of Galen. This vein merges with the inferior sagittal sinus to form the straight sinus which then joins the superficial venous system mentioned above at the confluence of sinuses **(Affifi and Bergman, 2005).**

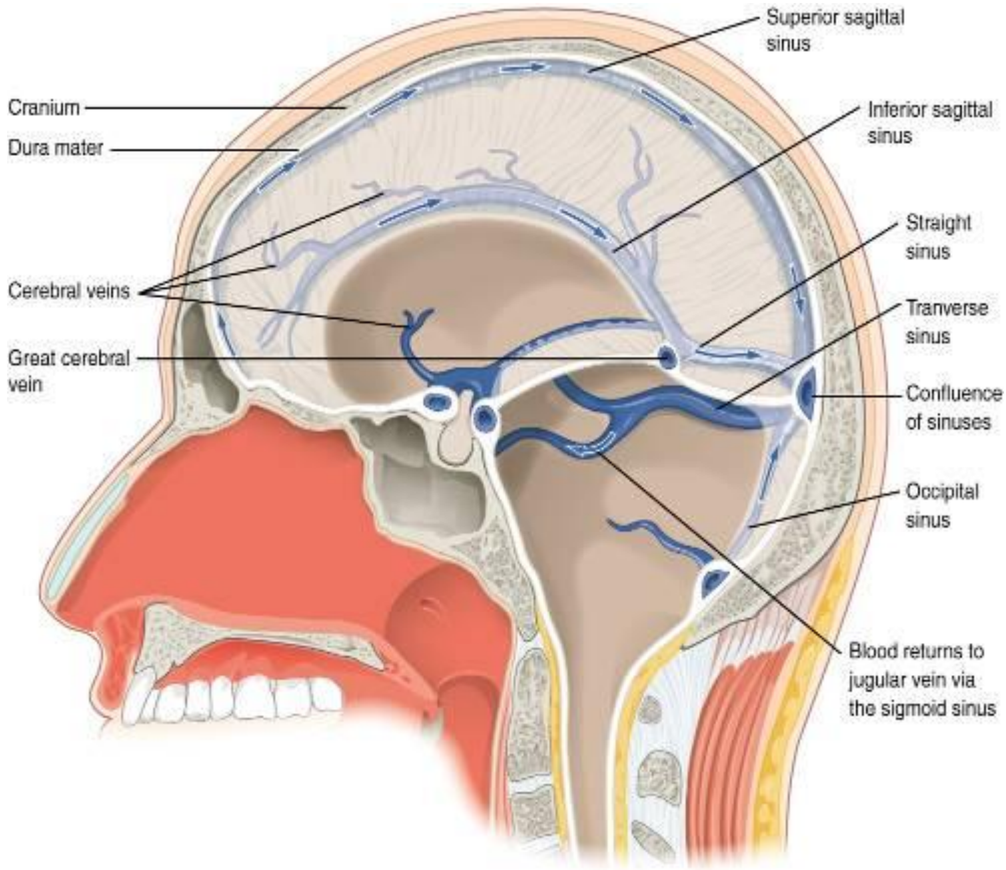

Figure (2): Blood drains from the brain through a series of sinuses that connect to the jugular veins **(Scanlon, 2011).**