Anaesthetic Challenges in Endovascular Neurosurgery

Essay

Submitted for partial fulfillment of the Master Degree in Anaesthesia

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2013

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التحديات التخديرية للقسطره التداخليه فى جراحات المخ والأعصاب

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ACKNOWLEDGEMENT

First of all, I want to thank our **Holly God** almighty for giving me the strength and motivation to pursue this degree.

I am heartily thankful to my great supervisor, **Professor Mohammed Ali Ahmed Zaghloul** , whose encouragement, guidance and support enabled me to finish this subject.

I offer my regards to **Doctor Safaa Ishak Ghaly** who provided me with the support and valuable information I needed to complete this subject.

I give many great thanks to **Doctor Mostafa Mahran**, who provided me with the new papers and latest available information about my work, and for the meticulous revision of this work.

I also want to thank my colleagues who gave me help and advice during the completion of the subject.

Lastly, I offer many thanks for my family, God bless them all.

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List of Abbreviations

Abb.	Full name
CNS	Central Nervous System.
INR	Interventional Neuroradiology.
AVM	Arterio-Venous Malformation.
ICA	Internal Carotid Artery.
ACA	Anterior Cerebral Artery.
MCA	Middle Cerebral Artery.
ACOM	Anterior Communicating Artery.
PCA	Posterior Cerebral Artery.
PCOM	Posterior Communicating Artery.
CBF	Cerebral Blood Flow.
ICP	Intra-Cerebral Pressure.
CMR	Cerebral Metabolic Rate.
$PaCO_2$	Partial Pressure Of Carbon dioxide.
PaO_2	Partial Pressure Of Oxygen.
N_2O	Nitrous Oxide.
EEG	Electro-Encephalo Gram.

List of Abbreviations (cont.,)

Abb.	Full name
ECF	Extra Cellular Fluid.
BBB	Blood Brain Barrier.
DSA	Digital Subtraction Angiography.
GDC	Gujlielmi Detachable Coil.
PVA	Polyvinyl Alcohol.
MAP	Mean Arterial Pressure.
IV	Intravenous.
MAC	Monitored Anaesthesia Care.
LMA	Laryngeal Mask Airway.
ECG	Electro Cardio Gram.
BP	Blood Pressure.
SAH	Subarachnoid Haemorrhage.
NPM	Neuro Physiological Monitoring.
SSEPs	Somato-Sensory Evoked Potentials.
BAEP	Brain stem Auditory Evoked Potentials.
AVM	Arterio-Venous Malformation.
ADP	Adenosine Di-Phosphate.

List of Abbreviations (cont.,)

Abb.	Full name
ACT	Activated Clotting Time.
tPA	tissue Plasminogen Activator.
ISAT	International Subarachnoid Aneurysm Trail.
BAVMs	Brain Arterio-Venous Malformations.
GA	General Anaesthesia.
AV	Atrio-Ventricular.
MMP	Matrix Metallo-Proteinase.

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INTRODUCTION

Recent advances in the field of interventional neuroradiology have resulted in more patients to be managed in the neuroradiological suites. The optimal conduct of anaesthesia in the neuroradiology suite requires forethought and planning for each procedure. Detailed patient evaluation and an understanding of the underlying neuropathology are essential components for a successful anaesthetic. The establishment of an open channel of communication among the neuroradiologist , anaesthesiologist , nurses and radiogragher is essential for routine care but crucial for the management of disasters that may occur. Adherence to the basic principles of neuroanaesthesia should continue in the management of patients in the neuroradiology suite. This includes the optimization of cerebral blood flow , perfusion pressure , control of intracranial pressure , careful monitoring of the blood pressures , fluid status and temperature of the patient. The question of cerebral neuroprotection during periods of ischaemia should also be considered. A smooth and rapid recovery from the procedure is desirable for early neurological assessment and safe transfer of the patient ***(Jee and Pirjo , 2005).***

Neuroradiological techniques and expertise in the diagnosis and treatment of diseases of the central nervous system (CNS) have undergone significant advances in the past decade and have introduced new diagnostic and therapeutic radiological procedure. Interventional neuroradiology (INR) or endovascular neurosurgery , a hybrid of traditional neurosurgery and neuroradiology, has emerged as a speciality and has established its role in the management of a variety of neurosurgical conditions, particularly neurovascular diseases. INR can be broadly defined as treatment by endovascular access for the purpose of delivering therapeutic drugs and devices. The number, variety, and complexity of conditions treated using this route is increasing and this creates challenges for the anaesthetist involved in such procedures

(Varma et al. , 2007).

The anaesthesist has a crucial role in facilitating neuroradiological procedures and this requires an understanding of these specific procedures , their potential complications and their management. Procedures amenable to INR can be broadly classified on the basis of the aim of treatment . Closing or occluding procedures include embolization of aneurysm, arterio-venous malformation

(AVM) and fistula of the brain and spine, preoperative embolization of vascular tumors such as meningiomas, temporary or permanent occlusion of arteries intra- or extra-cranially. Opening procedures include treatment of vasospasm or stenosis by angioplasty and stenting , chemical and mechanical thrombolysis in stroke. The most common INR procedures in the UK are endovascular treatment of aneurysms, AVM and preoperative embolization of tumors ***(Varma et al. , 2007)***.

It is vital for the anaesthesia provider to be keenly aware of the endovascular techniques and their potential complications in order to effectively tailor the anaesthetic to both the needs of the patient and the requirements of the neurointerventionalist. With anaesthetized patients undergoing neuroendovascular treatments, the anaesthesiologist needs to provide safe patient transport, airway protection, patient immobility, haemodynamic control, anticoagulation management and rapid recovery from anaesthesia ***(Rocco et al. , 2006)***.

AIM OF WORK

The aim of this work is to provide an overview of the recent developments in the anaesthetic management of patients undergoing procedures in endovascular neuro-surgery suite

CEREBRAL BLOOD FLOW

The adult human brain weighs approximately 1.350 Kg and therefore represents about 2% of the total body weight. However, it receives 12 to 15% of the cardiac output. At rest, the brain consumes oxygen at an average rate of approximately 3.5 ml. O_2 per 100 gm. of brain tissue per minute. Whole brain O_2 consumption represents about 20% of total body O_2 utilization **(*Drummand and Patel*, 2000).**

Anatomy Of Cerebral Blood Flow

The circle of Willis **(circulus arteriosus cerebri)** is an anastomotic system of arteries that sits at the base of the brain. The circle of Willis encircles the stalk of the pituitary gland and provides important communications between the blood supply of the forebrain and hindbrain (ie, between the internal carotid and vertebrobasil systems following obliteration of primitive embryonic connections). A complete circle of Willis is present in most individuals, although a well-developed communication between each of its parts is identified in less than half of the population **(*Krabbe et al.,* 1998).**

The circle of Willis is formed when the internal carotid artery **(ICA)** enters the cranial cavity bilaterally and divides into the anterior cerebral artery **(ACA)** and middle cerebral artery **(MCA).** The anterior cerebral arteries are then united by an anterior communicating **(ACOM)** artery. These connections form the anterior half (anterior circulation) of the circle of Willis. Posteriorly, the basilar artery, formed by the left and right vertebral arteries, branches into a left and right posterior cerebral artery **(PCA),** forming the posterior circulation. The PCAs complete the circle of Willis by joining the internal carotid system anteriorly via the posterior communicating **(PCOM)** arteries **(*Krabbe et al.,* 1998).**

Pathophysiologic Variant

Asymmetry of the circle of Willis results in significant asymmetry of flow and is an important factor in the development of intracranial aneurysms and ischaemic stroke. Patients with aneurysms are more likely to have asymmetry or an anomaly of the circle, and the presence of a nonfunctional anterior collateral pathway in the circle of Willis in patients with **ICA** occlusive disease is strongly associated with ischaemic stroke. Uncommonly, persistence of foetal anastomoses involving the circle of Willis is found, including persistent trigeminal, otic, hypoglossal, and proatlantal arteries. These arteries more or less unite the internal carotid and vertebrobasilar systems **(*Hendrikse et al.,*2005).**