Recent Advances In Cerebral Protection After Resuscitation From Cardiac Arrest

An Essay

Submitted for Partial Fulfillment of Master Degree in Anesthesiology

By
Ahmed Mohamed El-Sayed Ibrahim
M. B. B. Ch., Ain Shams University

Supervised by

Prof. Dr. Mohamed Abdel Galil Sallam
Professor of Anesthesia and Intensive Care
Faculty of Medicine, Ain Shams University

Dr. Mohamed Anwar El-Shafaey
Assistant Professor of Anesthesia and Intensive Care
Faculty of Medicine, Ain Shams University

Dr. Waleed Abdel Mageed Mohamed El-Taher
Lecturer of Anesthesia and Intensive Care
Faculty of Medicine, Ain Shams University

Faculty of Medicine
Ain Shams University

٢٠٠٨

Acknowledgement

First, thanks are all due to **ALLAH** for blessing this work until it has reached its end, as a part of his generous help throughout our life.

I am deeply grateful to **Prof. Dr. Mohamed Abdel Galil Sallam**, Professor of Anesthesia and ICU, Faculty of Medicine, Ain Shams University, for sponsoring this work, his super leadership and keen supervision. It's great honor to work under his supervision.

I am also greatly indebted to **Prof. Dr. Mohamed Anwar El-Shafaey**, Assistant Professor of Anesthesia and ICU, Faculty of Medicine, Ain Shams University, for his supervision, sincere help and continuing encouragement throughout the whole work.

I would like to direct my special thanks to **Dr. Waleed Abdel Magid Mohamed El-Taher**, Lecturer of Anesthesia and ICU, Faculty of Medicine, Ain Shams University, for his help, useful advice, continuous support offered to me and guidance step by step till this essay was finished.

Ahmed Mohamed El-Sayed

List of Contents

	Page

List of Tables

List of Figures

Abbreviations

AA .... Arachidonic acid

ABG .... Arterial blood gas

ACA .... Anterior cerebral artery

ACLS .... Advanced cardiac life support

ADJO٢ ...... Arterio-jugular difference in oxygen content

AED .... Automated external defibrillator

AF .... Atrial fibrillation

AICA .... Anterior inferior cerebellar artery

ALS .... Advanced life support

AMPA .... Alpha-amino-hydroxy-٥-methyl-٤- isoxazole proprionic acid

ATP .... Adenosine tri-phosphate

BAEPs ...... Brain stem auditory evoked potentials

BBB .... Blood brain barrier

BLS .... Basic life support

CA .... Cardiac arrest

Ca$^{٢+}$ .... Calcium

CBC .... Complete blood count

CBF .... Cerebral blood flow

CBF .... Cerebral blood flow

CBV .... Cerebral blood volume

CHF .... Congestive heart failure

CK-BB ...... Creatinine kinase-bb

CMR .... Cerebral metabolic rate

$CMRO_2$ ....Cerebral metabolic rate for oxygen

CNS .... Central nervous system

CO_2 ....Carbon dioxide

CoBRA ..... Conditioned blood reperfusion application

CPP ....CEREBRAL Perfusion pressure

CPR ....Cardiopulmonary resuscitation

CSF .... Cerebrospinal fluid

CT .... Computed tomography

CVF ....Cobra venom factor

CVP ....Central venous pressure

CXR ....Chest x-ray

DNR ....Do not resuscitate

EAA ....Excitatory amino acid

ECF ....Extracellular fluid

ECG ....Electro-cardiography

ED .... Emergency department

EDRF .... Endothelium derived relaxing factor

EEG .... Elctroencephalogram

EEG ....Electroencephalogram

EPO ....Erythropoitin

EPs ....Evoked potentials

$EtCO_2$ ...... End tidal carbon di-oxide

FFAs .... Free fatty acids

GCS .... Glascow coma score

HCP .... Health care provider

HMABI ..... Hypothermic modulation of acute brain injury

ICA .... Internal carotid artery

ICAM-١ .... Intracellular adhesion mlecule ١

ICP .... Intracranial pressure

IL-٨ .... Interleukin ٨

K .... Potassium

LFTs .... Liver function tests

MAC .... Membrane attack complex

MAP .... Mean arterial pressure

MASP .... Mannan binding lectin associated serine proteases

MAT .... Multifocal atrial tachycardia

MBL .... Mannan binding lectin

MCA .... Middle cerebral artery

MCP-١ ...... Monocyte chemoattractant protein ١

MEPs .... Motor evoked potentials

Mg .... Magnesium

MRI .... Magnetic resonance imaging

MTT .... Mean transit time

NGT .... Naso-gastric tube

NIRS .... Near infra red spectroscopy

NMDA ...... N-methyl-d-aspartate

NO .... Nitric oxide

NO .... Nitric oxide

NSAID ...... Non-steroidal anti-inflammatory drug

O۲ ....Oxygen

PAOP ....Pulmonary artey occlusion pressure

PCA ....Posterior cerebral artery

PEA ....Pulseless electrical activity

PECAM-۱ Platelet endothelial cell adhesion molecule-۱

Phos. ....Phosphorus

PICA ....Posterior inferior cerebellar artey

PT ....Prothrombin time

PTT ....Partial prothrombin time

PUFAs ......Poly unsaturated fatty acids

PWI ....Perfusion weighted imaging

ROC ....Receptor operated channels

ROS ....Reactive oxygen species

ROSC ....Return of spontaneuos circulation

rso۲ ....Regional oxygen saturation

SCA ....Sudden cardiac arrest

SCA ....Superior cerebellar artery

SEPs ....Sensory evoked potentials

SjvO۲ ....Jugular bulb oxygen saturation

SOD ....Super oxide dismutase

SSEPs ....Somatosensory evoked potentials

SVT ....Supraventricular tachycardia

TCD ....Trans-cranial doppler

TNF-α ....Tumor necrosis factor α

VF ....Ventricular fibrillation

VOC .... Voltage operated channels

VT .... Ventricular tachycardia

WPW .... Wolf parkinson white

XO .... Xanthine oxidase

Introduction

During the past few decades, tremendous technological advances in resuscitation medicine have occurred.

Despite such advances as early initiation of cardiopulmonary resuscitation (CPR). By bystanders and the use of advanced cardiac life support in both prehospital and in-hospital settings, the survival rates for prehospital cardiac arrest to hospital discharge are less than ٢٠%. As if the high mortality were not dismal enough, more than half the survivors experience significant neurologic deficits.

Only ٣% to ١٠% of resuscitated patients are finally able to resume their pre-cardiac-arrest lifestyles. It has become well recognized that ischemic and postischemic events can cause significant neuronal damage. The focus of research today is to further elucidate the pathophysiology of ischemic brain damage and to test strategies to successfully resuscitate the brain.

This essay introduces advances in resuscitation medicine, with a specific focus on cerebral resuscitation.

Because of the rapid changes in resuscitation research, clinicians can anticipate an ever-evolving change in practice into the next century as scientific evidence serves either to support current practice or to radically alter it ***(White et al., ١٩٩٣)***.

Vascular Supply of The Brain

The brain, though representing ٢% of the total body weight, it receives one fifth of the resting cardiac output. This blood supply is carried by the two internal carotid arteries and the two vertebral arteries that anastmose at the base of the brain to form the circle of Willis.

I-Arterial supply:

A-Anterior circulation:

- It consists of carotid arteries and their branches.
- It supplies anterior portion of the brain.

B-Posterior circulation:

- It consists of vertebrobasilar system.
- It supplies posterior portion of the brain.

(Sheldon, ١٩٨١)

The arterial supply to the brain is derived from the two internal carotid arteries (ICAs) and the two vertebral arteries, which divide again to form the two posterior cerebral arteries (PCAs). These vessels and the two internal carotid arteries form an anastmotic system known as the circle of Willis at the base of the brain. The main arteries supplying the cerebral hemispheres are the anterior, middle and posterior cerebral artery for each hemisphere. the majority of cerebral aneurysms are of vessels that are part of, or very close to, the circle of Willis. other important vessels supplying the brainstem and cerebellum are branches from the basilar artery ***(Alan et al., ٢٠٠٧)***.

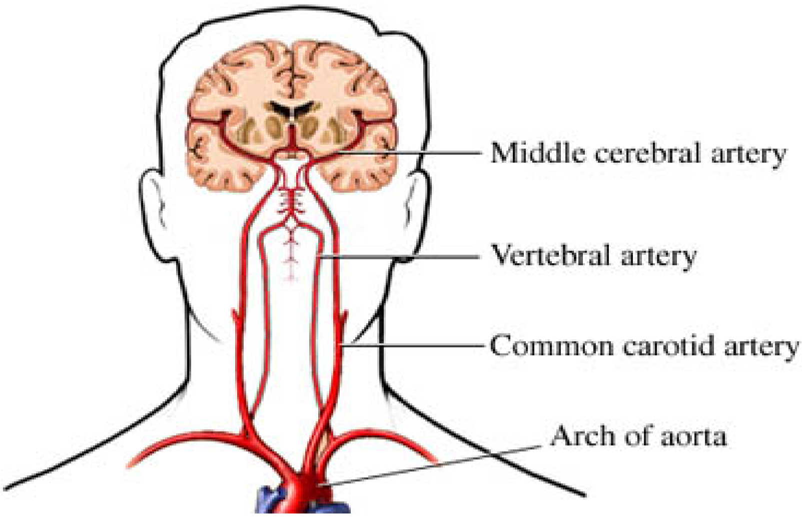

Fig. (١.١): The blood vessels supplying the brain.
(www. medicalook. com, ٢٠٠٧)

١-Carotid arterial system:

a-ICA:

i. Course:

Each ICA ascends along one side of the neck then they pass behind the ear in the temporal lobe and enter the subarachnoid space. then, they run posteriorly to the medial end of the fissure of Sylvius where they bifurcates into two main branches, the anterior cerebral artery (ACA) and the middle cerebral artery (MCA) ***(Fitz Gerald, ١٩٩٦).***

ii. Branches:

-The ACA:

It goes above the optic chiasma to the medial surface of the cerebral hemispheres. it arches around the genu of corpus callosum. it supplies blood to the medial cortex, including medial aspect of motor strip and the sensory strip. this means that damage to the anterior cerebral artery can cause sensory and motor impairment in the lower body.

The ACA also delivers blood to some parts of the frontal lobe and corpus striatum. so a blockage in this artery can affect cognition and cause motoric problems.

-The MCA:

This large artery has-tree like branches that bring blood to the entire lateral aspect of each hemisphere. this means that this artey supplies blood to the cortical areas involved in speech, swallowing and language, including the lateral motor strip, lateral sensory strip, Broca`s area, Wernicke`s area, Heschl`s gyrus, and the angular gyrus. in addition it provides most of the blood supply of corpus striatum.

If a patient has a blockage in the middle cerebral artey, it is probable that s/he will have aphasia. s/he will probably have impaired cognition and corticohyposthesia, or numbness, on the opposite side of the body. problems with hearing and the sense