Assessment of Vertebrobasilar Insufficiency using duplex ultrasonography and neurophysiological tools

Thesis Submitted in partial fulfillment of the MD degree in
Clinical neurophysiology

Investigator
Radwa Mahmoud Azmy Mohammed
(M.B., B.Ch, M.Sc in clinical neurophysiology)
Faculty of medicine
Cairo University

Supervisors

Prof. Dr. Saher El Sayed Hashem
(Principal supervisor)
Professor of Neurology
Faculty of medicine
Cairo University

Prof. Dr. Seyam Saeed Ahmed
Professor of Clinical Neurophysiology
Faculty of medicine
Cairo University

Dr. Soha Talaat Hamed
Assistant Professor of Radiology
Faculty of medicine
Cairo University

Faculty of Medicine
Cairo University
2008

To My Family

Abstract

This study was carried on was conducted on two groups; 30 patients presenting with cerebrovascular insufficiency within the territory of the vertebrobasilar system and 20 normal control subjects. Of the patients group, 22 presented with established stroke and 8 with TIAs.

Duplex sonography showed positive findings in 60% of our patients. Color-coded ultrasonography allows detection of vertebral artery (VA) hypoplasia, site of occlusion and vertebrobasilar hemodynamic assessment. The extracranial VA was occluded in 26.7% and hypoplastic in 6.7 % of our patients. VA was occluded distally (intracranially) in 23.3 % of our patients.

Blink reflex and Brainstem auditory evoked potential studies have proved to be sensitive methods of detection of posterior circulation territory dysfunction, with 73.3% and 63.3% agreement with MRA respectively.

Keywords: vertebrobasilar insufficiency, color-coded duplex, TCCS, evoked potentials.

Acknowledgement

First and foremost, I would like to express my sincerest gratitude and gratefulness to Allah, who fills me with faith, hope, patience, ambition, and desire to finish this work.

I would like to express my deepest gratitude and appreciation to Professor Dr. Saher Hashem, Professor of Neurology department, Cairo University for giving me the privilege of working under his supervision and for his valuable advice, faithful guidance, precious time, and continuous support.

I am deeply indebted to Professor Dr. Seyam Saeed, Professor of Clinical Neurophysiology, Cairo University, for his most generous help, valuable advice and support throughout this work.

I would like to express my deep gratitude to Professor Dr. Soha Talaat, Assistant Professor of Radiodiagnosis, Cairo University, for her kind supervision and encouragement.

I would like also to express my deep gratitude to Professor Dr. Ann Ali Abdel Kader Professor and head of Clinical Neurophysiology unit, Cairo University for her kindness, encouragement, and continuous support,

My profound gratitude and appreciation goes to Professor Dr. Fouad Abd Allah, Assistant Professor of Neurology, Cairo University, for his fruitful teaching, generous guidance and precious time.

I would like to express my deep gratitude to Professor Dr. Ahmed Abu Mousa, Assistant Professor of Neurology, for his continous support and valuable advice.

I would like also to thank my professors, friends, and colleagues in the clinical neurophysiology unit and neurology departments for their help and encouragement.

It is with greatest pride and pleasure that I thank my beloved family, with whom I have been blessed and honored, and to whom I owe everything.

Radwa Azmy

Table of Contents

List of Abbreviations

A1:	Pre-communicating segment of anterior cerebral artery
A2:	Post-communicating segment of anterior cerebral artery
ACA:	Anterior cerebral artery
AcoA:	Anterior communicating artery
ADMA:	Asymmetric dimethylarginine
AICA:	Anterior inferior cerebellar artery
ASICs :	Acid-sensing ion channels
AVMs:	Arteriovenous malformations
BA:	Basilar artery
BAEPs:	Brain-stem auditory evoked potentials
B mode:	Brightness mode
BR:	Blink reflex
CaMKII:	Ca^{2+}-calmodulin-dependent protein kinase II
CAVATAS:	The Carotid And Vertebral Artery Transluminal Angioplasty Study
CBF:	Cerebral blood flow
CDU:	Color doppler ultrasonography
CI:	First segment of internal carotid artery
CRP:	C-reactive protien
CT:	Computed tomography
CTA:	Computed tomography angiography
CVAs:	Cerebral vascular accidents
CW:	Circle of Willis
DESs:	Drug-eluting stents
DLPN:	Dorsolateral pontine nucleus
DSA:	Digital subtraction angiography.

ENG: Electronystagmography

FTP: Fetal-type PCA

FV: Flow volume

I_0: Intensity threshold

ICA: Internal carotid artery

IL: Interleukin

ICP: Intracranial pressure

INO: Internuclear ophthalmoplegia

ISVT: Interstitial nucleus of the spinal trigeminal tract

LDL: Low density lipoprotein

LT: Left

LTM: Low-threshold mechanoreceptive

MCA: Middle cerebral artery

MEPs: motor evoked potentials

MHz: Motor hemiparesis

MHz: Mega hertz

MIR: Masseter inhibitory reflex

MLAEPs: Middle-latency auditory evoked potentials

M mode: Motion mode

MPO: Myeloperoxidase

MRA: Magnetic resonance angiography

MRI: Magnetic resonance imaging

NMDA: N-methyl D- aspartate

NS: Nociceptive-specific

OA: Ophthalmic artery

P1: Pre-communicating segment of posterior cerebral artery

P2: Post-communicating segment of posterior cerebral artery

PAPP-A: Pregnancy-associated plasma protein A

PCA: Posterior cerebral artery

PoCA: Posterior communicating artery

PcTX: Picrotoxin

PICA: Posterior inferior cerebellar artery

PMD: Power motion mode Doppler

PPRF: Paramedian pontine reticular formation

PSN: Principal sensory nucleus

PSV: Peak systolic velocity

PTX-3: Pentraxin 3

R1: Early response of the blink reflex

R2c: Contralateral late response of the blink reflex

R2i: Ipsilateral late response of the blink reflex

RT: Right

SA: Subarachnoid hemorrhage

SCA: Superior cerebellar artery

sCD40L: Inflammatory cytokine soluble CD40L

SD: Standard deviation

SEPs: Somatosensory evoked potentials

SP: Supression period

SP1: Early masseter inhibitory reflex

SP2: Late masseter inhibitory reflex

STN: Spinal trigeminal nucleus

SNc: **S**ubnucleus caudalis

SNi: **S**ubnucleus interpolaris

SNo: **S**ubnucleus oralis

TAV: Time-averaged velocity

TCCS: Transcranial color-coded sonography

TCD: Transcranial doppler

TIAs:	Transient ischemic attacks
TICA:	Terminal internal carotid artery
TNF:	Tumor necrosis factor
TSTN:	Trigeminal spinal tract and nucleus
US:	Ultrasonography
VA:	Vertebral artery
VAD:	Vertebral arterial dissection
VBD:	Vertebrobasilar disorders
VBI:	Vertebrobasilar insufficiency
VICA:	Velocity of internal carotid artery
VMCA:	Velocity of middle cerebral artery
VN sens:	Trigeminal sensory root
VN mot:	Trigeminal motor root
VOR:	Vestibulo-ocular reflex
VORC:	Vestibulo-ocular reflex cancellation
VSCIs:	Very small cerebellar infarcts
WASID:	Warfarin- Aspirin Symptomatic Intracranial Disease
WDR:	Wide dynamic range

List of Figures

List of Tables

Introduction

Cerebrovascular disease occupies second place amongst the causes of mortality in the world ***(Yepes, 2001).*** Atherosclerotic occlusive disease of the vertebral artery affects a significant proportion of patients with cerebrovascular disease and can cause significant morbidity and mortality despite maximal medical therapy ***(Wehman et al., 2004).***

Approximately one-quarter of ischaemic strokes involve the posterior or vertebrobasilar circulation. Stenosis of the vertebral artery can occur in either its extra- or intracranial portions, and may account for up to 20% of posterior circulation ischaemic strokes. Stenotic lesions, particularly at the origin of the vertebral artery, are not uncommon ***(Cloud and Markus, 2003).*** Obstructive lesions of proximal vertebral arteries probably occur in about 30% of stroke patients ***(De Bray et al., 2001).*** The diagnosis of VBI is a clinical challenge because its manifestations are subjective and difficult to quantify ***(Kizilkilic et al., 2004).***

Sonography is a noninvasive technique; however the consequences of erroneous diagnosis must be taken into account. It could be argued that transcranial color-coded duplex sonography (TCCS) scanners are more expansive and less portable than conventional TCD scanners, but intensive care units are now equipped with sophisticated sonographic machines for general purposes, so adding transcranial probes increases the cost only a little ***(Krejza and Baumgartner, 2004).***

TCCS, in contrast to "blind" conventional transcranial Doppler sonography (TCD), enables a sonographer to outline the intracranial bony and parenchymal structures, visualize the basal cerebral arteries in color, and measure angle-

corrected blood flow velocities in a specific site of the artery in question. This makes measurements of flow velocity more valid than those obtained with conventional TCD ***(Krejza, 2004)***.

Simultaneous insonation of intracranial parenchymal structures by B-mode and cerebral artery blood flow by color-coded flow imaging allows visualization of vertebrobasilar arteries directly and continuously. Measurements of vessel length, as well as the hemodynamic assessment, are possible ***(Schulte-Altedorneburg et al., 2000).***

Ultrasound of the extracranial vertebral artery (VA) is a valuable technique, providing direct or indirect evidence of abnormal VA circulation, including lesions that lie proximal or distal to the VA itself. It is possible to insonate the V1 and V2 sections of the VA with relative ease in most patients. Transcranial color-coded duplex US can confirm intracranial occlusion of the V4 segment ***(Stolz et al., 2002).***

Transnuchal TCCS allows visualization of the proximal two thirds of the BA length. A tortuous BA might confound an accurate measurement, and variations of the superior bifurcation of BA may make it harder to identify distal segments of the BA transnuchally. This confirms a rule of sonography that the transtemporal insonation of the origin of both posterior cerebral arteries is an unavoidable step for a reliable judgment of the vertebrobasilar system ***(Schulte-Altedorneburg et al., 2000).***

Evoked potentials have proved to be a sensitive method of detection of even slight cerebral dysfunction. Brainstem auditory evoked potentials (BAEPs) is a non-invasive and reliable electrophysiological method to assess the function of brainstem structures traversed by auditory pathyways. BAEP data provide a functional evaluation of the brain-stem and some cranial nerves, which is lacking in imaging studies. Functional investigations may be useful in the long-term