



Transcranial Doppler assessment of patients with cerebral small vessel disease

Thesis

Submitted for the partial fulfillment of Master Degree of Neurology

By

Alaa Ebrahim Ata Ata Shaaban

(M.B.B.Ch)

Supervised by

Prof. Mahmoud Haroun Ebrahim

**Professor of Neurology
Faculty of Medicine
Ain Shams University**

Prof. Salma Hamed Mahmoud Khalil

**Professor of Neurology
Faculty of Medicine
Ain Shams University**

**Dr. Mohamed Mohamed Tawfik
Elbaghdady**

**Lecturer of Neurology
Faculty of Medicine
Ain Shams University**

**Faculty of Medicine
Ain Shams University
2019**

تقييم مرضى إعتلال الأوعية الدماغية الصغيرة باستخدام الموجات فوق الصوتية العابرة للجمجمة

رسالة توطئة للحصول على درجة الماجستير في طب المخ و الأعصاب و الطب
النفسي

مقدمة من

الطبيبة / آلاء إبراهيم عطا عطا شعبان

بكالوريوس الطب والجراحة

تحت اشراف :

الأستاذ الدكتور/ محمود هارون إبراهيم

أستاذ طب المخ والأعصاب
كلية الطب - جامعة عين شمس

الأستاذة الدكتورة/ سلمى حامد محمود خليل

أستاذ طب المخ والأعصاب
كلية الطب - جامعة عين شمس

الدكتور/ محمد محمد توفيق البغدادي

مدرس طب المخ والأعصاب
كلية الطب - جامعة عين شمس

كلية الطب
جامعة عين شمس

2019

Content

<i>Acknowledgement.</i>	
<i>List of tables.</i>	
<i>List of figures.</i>	
<i>List of abbreviations.</i>	
<i>Introduction.</i>	<i>1</i>
<i>Aim of the work.</i>	<i>8</i>
<i>Review of literature.</i>	
• <i>Chapter 1: Cerebral small vessel disease.</i>	<i>9</i>
• <i>Chapter 2: Transcranial Doppler.</i>	<i>20</i>
<i>Patients and methods.</i>	<i>30</i>
<i>Result.</i>	<i>37</i>
<i>Discussion and Conclusion.</i>	<i>64</i>
<i>Recommendations.</i>	<i>68</i>
<i>Summary.</i>	<i>69</i>
<i>References.</i>	<i>71</i>
<i>Arabic summary.</i>	<i>81</i>

Acknowledgment

First and forever, Thanks to ***Allah***, Almighty for giving me the strength and Faith to complete my thesis and for everything else.

I would first like to thank my thesis supervisors ***Prof. Mahmoud Haroun Ebrahim*** Professor of Neurology at Ain Shams University, ***Prof. Salma Hamed Mahmoud Khalil*** Professor of Neurology at Ain Shams University and ***Dr. Mohamed Mohamed Tawfik Elbaghdady*** Lecturer of Neurology at Ain Shams University For their patience, professional advices guidance and support.

Great thanks to all staff and my colleagues in ***neurology department*** at ***El-Sahel teaching hospital*** for their support and providing all supplies.

Last but not least, I like to thank my ***family*** for their kind care, help and encouragement.

List of tables

<i>NO</i>	<i>Title</i>	<i>Page</i>
<i>1</i>	Etiologic classification of cerebral SVD.	<i>14</i>
<i>2</i>	Typical adult intracranial arteries values.	<i>24</i>
<i>3</i>	Demographic data distribution of the study group.	<i>37</i>
<i>4</i>	History of old intracerebral hemorrhage distribution of the study group.	<i>39</i>
<i>5</i>	Risk factors distribution of the study group	<i>40</i>
<i>6</i>	MRI SVD score distribution of the study group.	<i>41</i>
<i>7</i>	Carotid duplex distribution of the study group.	<i>43</i>
<i>8</i>	Transcranial Doppler distribution of the study group.	<i>45</i>
<i>9</i>	Relation between Fazekas and risk factors among study group.	<i>47</i>
<i>10</i>	Relation between lacunes and risk factors among study group.	<i>48</i>
<i>11</i>	Relation between EPVS and risk factors among study group.	<i>49</i>
<i>12</i>	Relation between microbleeds and risk factors among study group.	<i>5</i>
<i>13</i>	Relation between total number of MRI (SVD	<i>51</i>

	score) and risk factors among study group.	
14	Relation between focal area and risk factors among study group.	52
15	Relation between diffuse atherosclerosis (diminished flow) and risk factors among study group.	53
16	Relation between increased PI of MCA and risk factors among study group.	54
17	Relation between vasomotor reactivity BHI and risk factors among stud group.	55
18	Relation between significant stenosis >50% and MRI (SVD) score.	57
19	Relation between diffuse atherosclerosis increased IMT and MRI (SVD) score.	58
20	Relation between focal area of stenosis and MRI (SVD) score.	59
21	Relation between diffuse atherosclerosis (diminished flow) and MRI (SVD) score.	60
22	Relation between increased PI of MCA and MRI (SVD) score.	61
23	Relation between vasomotor reactivity BHI area and MRI (SVD) score.	62

List of figures

<i>NO</i>	<i>Title</i>	<i>Page</i>
<i>Fig.1</i>	Pial arteries, penetrating, parenchymal arterioles, perivascular innervations and neurovascular unit.	<i>11</i>
<i>Fig.2</i>	A formulation describing small vessel injury and their neurovascular units.	<i>12</i>
<i>Fig.3</i>	MRI findings for lesions related to cerebral SVD (Wardlaw et al, 2013).	<i>16</i>
<i>Fig.4</i>	Windows for intracranial vessel location. There are four windows of insonation: temporal, orbital, suboccipital and submandibular.	<i>21</i>
<i>Fig.5</i>	Typical TCD spectra. The wave above baseline reflects flow towards the probe (normal MCA, transtemporal window).	<i>23</i>
<i>Fig.6</i>	The relationship between arterial stenosis, flow and velocity.	<i>25</i>
<i>Fig.7</i>	ultrasound criteria of an arterial steno-occlusive lesion	<i>26</i>
<i>Fig.8</i>	TCD waveform demonstrating microemboli	<i>28</i>
<i>Fig.9</i>	Bar chart age (years) distribution of the study group.	<i>38</i>
<i>Fig.10</i>	Pie chart sex (years) distribution of the study	<i>38</i>

	group.	
<i>Fig.11</i>	Pie chart History of old intracerebral hemorrhage distribution of the study group.	39
<i>Fig.12</i>	Bar chart risk factors distribution of the study group.	40
<i>Fig.13</i>	Bar chart MRI SVD score distribution of the study group.	42
<i>Fig.14</i>	Bar chart carotid duplex distribution of the study group.	44
<i>Fig.15</i>	Pie chart vasomotor reactivity BHI distribution of the study group.	46
<i>Fig.16</i>	Bar chart relation between vasomotor reactivity BHI and risk factors among study group.	56
<i>Fig.17</i>	Bar chart relation between vasomotor reactivity BHI area and MRI (SVD) score.	63

List of abbreviation

ACA	Anterior cerebral artery.
ACoA	Anterior communicating artery.
AF	Atrial fibrillation.
BA	Basilar artery.
BBB	Blood brain barrier.
BHI	Breath holding index.
CAA	Cerebral amyloid angiopathy.
CADASIL	Cerebral autosomal dominant arteriopathy with subcortical ischemic strokes and leukoencephalopathy.
CARASIL	Cerebral autosomal recessive arteriopathy with subcortical ischemic strokes and leukoencephalopathy.
CBF	Cerebral blood flow.
CMB	Cerebral microbleed.
CT	Computed tomography.
CTA	Computed tomography angiography.
CVS	Cerebrovascular stroke.
CSF	Cerebrospinal fluid.
DWI	Diffusion weighted images.
DWMH	Deep white matter hyperintensities.
EDV	End-diastolic velocity.

EPVS	Enlarged perivascular spaces.
FLAIR	Fluid attenuated inversion recovery.
GRE	Gradient recalled echo.
HITS	High intensity transient signals.
HTN	Hypertension.
ICA	Internal carotid artery siphon.
IMT	Intima media thickness.
LADIS	Leukoaraiosis and Disability.
MCA	Middle cerebral artery.
MES	Microembolic signals.
MFV	Mean flow velocity.
MRA	Magnetic resonance angiography.
MRI	Magnetic resonance imaging..
OA	Ophthalmic artery.
PCA	Posterior cerebral artery.
PCoA	Posterior communicating artery.
PI	Pulsatility index.
PSV	Peak systolic velocity.
PVH	Periventricular hyperintensities.
RI	Resistivity index.
SAH	Subarachnoid hemorrhage.

SBP	Systolic blood pressure.
SVD	Small vessel disease.
TCD	Transcranial Doppler.
TICA	Terminal segment of the internal carotid artery.
TOAST	Trial of Org 10172 in Acute Stroke Treatment
TPA	Tissue plasminogen activator.
VA	Vertebral arteries.
WMC	White matter changes.
WMH	White matter hyperintensities.
WHO	World Health Organization.
VMR	Vasomotor reactivity.