The Role of Susceptibility Weighted Imaging (SWI) in Evaluation of Acute Stroke

Thesis

Submitted for Partial Fulfillment of Master Degree in Radiodiagosis

By

Maha Abdelhamed El Nouby

M.B.B.CH

Faculty of Medicine – Ain Shams University

Under Supervision of

Prof. Dr. Eman Ahmed Shawky Geneidi

Professor of Radiodiagnosis

Faculty of Medicine –Ain Shams University

Dr. Eman Ahmed Fouad Darwish

Lecturer of Radiodiagnosis

Faculty of Medicine –Ain Shams University

Faculty of Medicine

Ain Shams University

2018

بسم الله الرحمن الرحيم

قالوا

سبحانك لا علم لنا
إلا ما علمتنا إنك أنت
العليم الحكيم

صدق الله العظيم

سورة البقرة الآية: ٣٢

Acknowledgment

*First and foremost, I feel always indebted to **ALLAH**, the Most Kind and Most Merciful.*

*I'd like to express my respectful thanks and profound gratitude to **Prof. Dr. Eman Ahmed Shawky Geneidi,** Professor of Radiodiagnosis, Faculty of Medicine- Ain Shams University for her keen guidance, kind supervision, valuable advice and continuous encouragement, which made possible the completion of this work.*

*I am also delighted to express my deepest gratitude and thanks to **Dr. Eman Ahmed Fouad Darwish,** Lecturer of Radiodiagnosis, Faculty of Medicine, Ain Shams University, for her kind care, continuous supervision, valuable instructions, constant help and great assistance throughout this work.*

*I would like to express my hearty thanks to all **my family** for their support till this work was completed.*

Last but not least my sincere thanks and appreciation to all patients participated in this study.

Maha El Nouby

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List of Abbreviations

Abb.	Full term
ACA	*Anterior Cerebral Artery*
ACoA	*Anterior Communicating Artery*
ACOM	*Anterior Communicating Artery*
AICA	*Anteriorinferior Cerebellar Artery*
AIS	*Acute Ischemic Stroke*
AMPA	*Amino-3-hydroxy-5-methyl-4-propionate*
ASPECTS	*Alberta Stroke Programme early CT Score*
ATP	*Adenine Triphosphate*
BA	*Basilar Artery*
BBB	*Blood Brain Barrier*
BOLD	*Blood Oxygenation Level-Dependent*
Ca2+	*Calcium*
CBV	*Cerebral Blood Volume*
Cl-	*Chloride*
CMRO2	*Cerebral Metabolic Rate of Oxygen*
CPP	*Cerebral Perfusion Pressure*
CT	*Computed Tomography*
DWI	*Diffusion Weighted Imaging*
ECA	*External Carotid Artery*
EVT	*Endovascular Treatment*
FI	*Final Infarct*
FUP	*Follow Up*
HRBV	*High-Resolution Blood Oxygen Level Dependent Venography'*
ICA	*Internal Carotid Artery*
IG	*Infarct Growth*
IJV	*Internal Jugular Vein*
ILT	*Inferolateral Trunk*
IQR	*Inter-Quartile Range*

List of Abbreviations (Cont...)

Abb.	Full term
IVT	*Intravascular Thrombolysis*
K+	*Potassium*
LMA	*Leptomeningeal Anastomoses*
LMC	*Leptomeningeal Collateral*
MCA	*Middle Cerebral Artery*
mIPs	*Minimum Intensity Projections*
MMA	*Middle Meningeal Artery*
MR	*Magnetic Resonance*
MRI	*Magnetic Resonance Imaging*
MTT	*Mean Transit Time*
Na	*Sodium*
NIG	*Non-Infarct Growth*
NMDA	*N-methyl-d-aspartate*
OEF	*Oxygen Extraction Fraction*
PCA	*Posterior Cerebral Artery*
PCoA	*Posterior Communicating Artery*
PCV	*Prominent Cortical Veins*
PICA	*Posterior Inferior Cerebellar Artery*
PWI	*Perfusion Weighted Imaging*
SCA	*Superior Cerebellar Artery*
SPSS	*Statistical Package for Social Science*
SWI	*Susceptibility Weighted Imaging*
VA	*Vertebral Arteries*

Abstract

Background and Purpose: SWI provides information about blood oxygenation levels in intracranial vessels. Prior reports have shown that SWI focusing on venous drainage can provide noninvasive information about the degree of brain perfusion in arterialischemic stroke. We aimed to evaluate the influence of the SWI venous signal pattern in predicting stroke evolution.

Materials and Methods: A semiquantitative analysis of venous signal intensity on SWI and diffusion characteristics on DTI was performed in 2o adult patients with acute stroke of MCA vascular territories. The mismatch between areas with SWI-hypointense venous signal and restricted diffusion was correlated with stroke progression on follow-up.

Results: We included 2O patients with a confirmed diagnosis of arterial ischemic stroke. Follow-up images were available for. MCA stroke progression on follow-up was observed in 11/12 patient with DWI -SWI mismatch. Initial SWI hypointense venous signal and areas of restricted diffusion on DTI. This mismatch showed a statistically significant association (*P* _ 0.00188) for infarct progression.

Conclusion: SWI-DWI mismatch predicts stroke progression in arterial ischemic stroke.

Keywords: stroke, MRI, Susceptibility weighted imaging (SWI), (PWI), DWI.

INTRODUCTION

Stroke is caused by the interruption of the blood supply to the brain, usually because a blood vessel bursts or is blocked by a clot. This cuts off the supply of oxygen and nutrients, causing damage to the brain tissue ***(Cho et al., 2012).***

The effects of a stroke depend on which part of the brain is injured and how severely it is affected. A very severe stroke can cause sudden death, so predicting the risk of further infarct growth in stroke patients is critical to therapeutic decision making ***(Davis et al., 2005).***

Contemporary therapy for acute ischemic stroke is based on the concept of penumbra, which is an area with reduced blood flow but not to such a level that causes irreversible cell membrane failure. Although challenged by several limitations, mismatch between larger abnormal areas on MR perfusion-weighted imaging (PWI) and smaller restricted areas on diffusion-weighted imaging (DWI) is a widely accepted approach to detecting penumbra, predicting stroke evolution and determining patients with the greatest potential to benefit from thrombolytic therapy. However, PWI requires administration of a contrast agent, which is contraindicated in a variety of clinical conditions, such as renal insufficiency and previous reactions to contrast agents ***(Haacke et al., 2004).***

Susceptibility-weighted imaging (SWI) which is a high-resolution, three-dimensional, gradient-echo T2* MR technique with enhanced sensitivity for paramagnetic substances is a potential alternative for detecting ischemic penumbra and thus predicting infarct growth. In the ischemic brain, the increased oxygen extraction fraction and slow flow contribute to a higher level of deoxyhemoglobin and vein dilatation, which increases the conspicuity of vessels on SWI. As a result, SWI can show asymmetric prominent hypointense vessels potentially from different concentrations of deoxyhemoglobin between ischemic and normal brain areas. This potential metabolic information on SWI may help to delineate penumbra without contrast agent administration ***(Tsui et al., 2009).***

Recently, a study on pediatric arterial ischemic stroke has reported that SWI/DWI mismatch is useful in detecting penumbra in middle cerebral artery (MCA) infarct, thus predicting progression of infarction on follow-up images ***(Moeded et al., 2014).***

Aim of the Work

This study aims to assess the diagnostic value of SWI-DWI mismatch in detecting ischemic penumbra, and predicting early infarct growth in patients with acute MCA territory ischemic stroke.

Chapter 1
ANATOMY OF CEREBRAL ARTERIAL CIRCULATION

The brain is rich in blood supply, with a densely branching arterial network. It is supplied by two circulations **(Fig. 1).**

Anterior Circulation

- Internal carotid artery (ICA) and its branches as well as the anterior communicating artery (ACoA) and the posterior communicating artery (PCoA).

Posterior Circulation

- Basilar artery (BA) and its branches ***(Harnsberger et al., 2006).***

As this thesis discusses middle cerebral artery infarctions, this discussion will focus mainly on the anterior circulation, with a brief description of the posterior circulation.