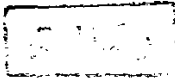


ROLE OF ENHANCED MR ANGIOGRAPHY IN EVALUATION OF CEREBRAL VASCULAR LESIONS



ESSAY

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Submitted for partial fulfillment of Master Degree Radiodiagnosis

BY

Tamer Hassan Abdel Hamid
(M.B.B.Ch.)

616.c7548

T. H

SUPERVISORS

Dr. Wahid Hussien Tantawy
Prof. of Radiodiagnosis
Faculty of Medicine, Ain Shams University

Dr. Hossam Abdel Kader
Lecturer of Radiodiagnosis
Faculty of Medicine, Ain Shams University

**Faculty of Medicine
Ain Shams University**



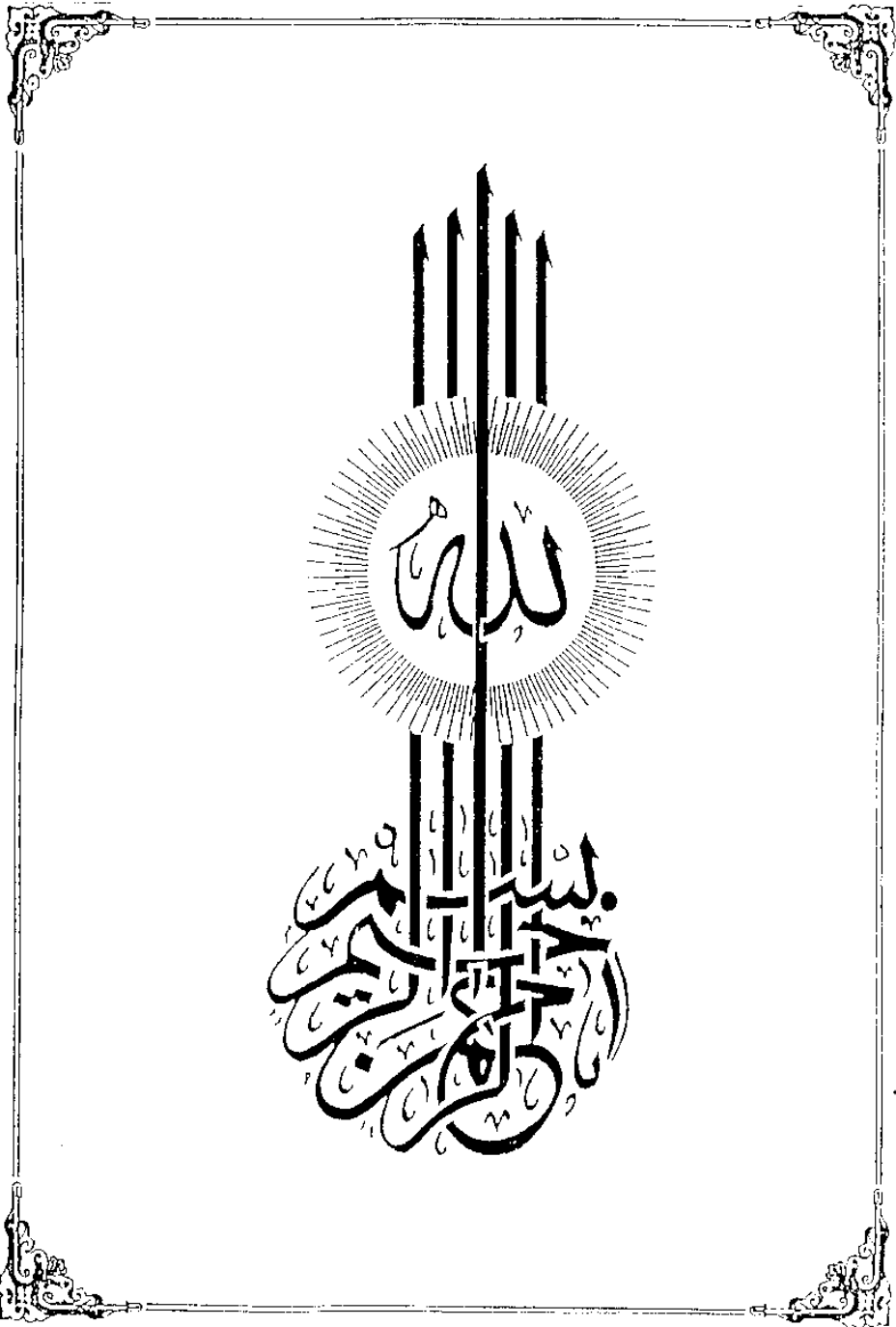
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Arabic Summary

List of Abbreviation

ACA	Anterior cerebral circulation
AICA	Anterior inferior cerebellar artery
AVF	Arterio-venous-fistula
AVM	Arterio-venous malformation
CT	Computed tomography
DSA	Digital subtraction angiography
ECA	External carotid artery
FA	Flip angle
FOV	Field of view
Gd	Gadolinium
GdDTPA	Diethylenetriaminepenta-acetic acid
ICA	Internal carotid artery
MCA	Middle cerebral artery
MOTSA	Multiple overlapping thin slab acquisition
MRA	Magnetic resonance angiography
MRI	Magnetic resonance imaging
MT	Magnetization transfer
NEX	Number of excitation
PC	Phase contrast
PCA	Posterior cerebral artery
PICA	Posterior inferior cerebellar artery
RF	Radio-frequency
SAH	Subarachnoid haemorrhage
SE	Spin echo
TE	Echo time
TOF	Time of flight
TR	Repetition time
US	Ultrasound
Venc	Velocity encoding
2D	Two dimensional
3D	Three dimensional

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INTRODUCTION AND AIM OF THE WORK



INTRODUCTION AND AIM OF THE WORK

Conventional angiography, computed tomography (CT) and CT angiography, transcranial Doppler, and magnetic resonance imaging (MRI) have all demonstrated efficacy for the identification and characterization of cerebral vascular lesions (*Noorbehes et al., 1997*).

Intra-arterial conventional angiography or intra-arterial digital subtraction angiography (DSA) is considered the standard reference in the depiction of intra-cranial vessels abnormalities. However, the examination is invasive and has a small risk of complications due to arterial puncture, injection of contrast media, and selective catheterization. Furthermore intra-arterial DSA does not provide enough information about the brain parenchyma, thus computed (CT) or MR imaging of the brain is often necessary (*Klaus et al., 1995*).

Magnetic resonance angiography (MRA) is defined as depiction and characterization of blood vessels and blood flow by magnetic resonance imaging. The term does not refer to a single technique or a sequence but to broad approaches whose mechanisms are based on physical properties of blood (*Dumoulin et al., 1986*).

MRA based on gradient echo technique can provide accurate, reproducible images of vascular anatomy and pathology in various clinical settings. Furthermore the TOF based methods are rapid and can be acquired as an additional pulse sequence in conjunction with conventional routine MR examination. Thus valuable clinical examination can be obtained in patient with a prior indication for routine MRI as well as in patient population in which risk of conventional angiography is considered too hazardous. Phase contrast (PC) MRA studies also have advantages such as the ability to quantify flow velocities and superior sensitivity to slow flow lesions over 3D time of flight (TOF) techniques (*Klaus et al., 1995*).

Abnormalities of cranial vessels have great clinical importance and therapeutic implication. Cerebral vascular lesions include: aneurysms, arteriovenous malformations (AVM) , carotid intra-cranial stenotic or occlusive disease, cerebral venous thrombosis and intra-cranial tumours as well as venous angiomas (*Klaus et al., 1995*).

The capabilities of MRA is superior than those of ultrasound (US). Although MRA provides flow velocities as does Doppler US, it surpasses US when it addresses intra-cranial, retroperitoneal, deep leg and other vessels, which are not acoustically accessible (*Dumoulin and Hart, 1986*).

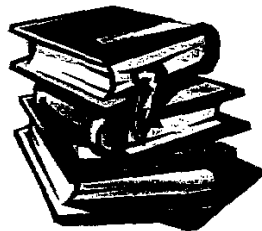
Contrast enhanced MR angiographic techniques, when performed properly provide magnify signal from blood this technique is called dynamic contrast MRA .

The combination of MRI, MRA and enhanced MRA is promising for the non invasive detection at one examination of both intracranial parenchymal lesions and possible underlying vessels abnormalities (*Klaus et al., 1995*).

AIM OF WORK

This work aims to investigate the clinical efficiency of enhanced MR angiography for vessels of the brain and to compare its reliability with that of MRA whenever possible and how enhanced MRA can minimize our needs to do the risky conventional angiography.

PHYSICAL BASES OF MRA



REVIEW OF LITERATURE

PHYSICAL BASES OF MRA

MR angiography is a term used to describe a class of MR imaging techniques designed to create angiographic images without the use of invasive techniques, or ionizing radiation (*Laub and Kaiser, 1988*).

BASIC PRINCIPLES OF MAGNETIC RESONANCE IMAGING AND THE EFFECTS OF FLOW

The basic MR imaging process consists of two essential (and relatively independent) components:

- 1- Excitation and saturation in the form of applied radio frequency (RF) pulse sequence.
- 2- Signal sampling and localization forming the MR image from the emitted RF through the use of *magnetic field gradients*.

The motion (blood flow) during either excitation or sampling results in two types of corresponding effects on the MR signal of moving spins:

- 1- Wash in/wash out or “flight” of spins relative to the timing and placement of RF pulse produces so called time of flight effect (TOF) effect.
- 2- Spins moving during the application of and in the direction of an imaging gradient produce a shift in signal phase dependent on type of flow (constant velocity, turbulent, etc.) and gradient in the flow direction, that is spin phase phenomenon.

There are many factors which should be considered when choosing sequences for MRA. These factors include presence of turbulent flow, sensitivity to flow in one direction, or the need to suppress bright stationary structures (*Anderson et al., 1990*).

TIME OF FLIGHT ANGIOGRAPHY

“Time of flight” (TOF) angiography is the most widely available, method of magnetic resonance angiography. The bases of this mechanism is the relationship between the saturation of stationary tissue magnetization and inflow of fully magnetized blood (*Laub and Kaiser, 1988*).

- TOF imaging has been used to depict the intracranial, extracranial thoracic, abdominal and peripheral arteries and veins (*Manning et al., 1993*).

BASIC MECHANISM

I- BACKGROUND TISSUE SUPPRESSION

Suppression of the background signal is done by saturating the spins with a rapid succession of radiofrequency (RF) pulse (using repetition time TR, that is short compared with the T1 of the stationary tissue) so that the spins don't have enough time to regain their longitudinal magnetization.

Saturation refers to the reduction in the longitudinal magnetization as a result of repeated RF excitations. Saturated spins produce a dim signal, whereas unsaturated spins produce bright signal. As intentional saturation of stationary tissues makes them appear dark (*Chien et al., 1996*).

PARAMETERS WHICH AFFECT THE DEGREE OF SATURATION

1- Repetition Time

When the repetition time (TR) is much shorter than T1. Magnetization becomes saturated, the shorter the TR, the greater the saturation is typically TR in TOF is between 20 and 90 ms which is shorter than any T1 (*Gullberg et al., 1987*).