Role of Diffusion MRI Imaging in Assessment of Ischemic Brain Lesions

Thesis

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List of Abbreviations

Abb.	Full term
ADC	Apparent diffusion coefficient
ASA	Atrial septal aneurysm
CABG	Coronary artery bypass graft
CSF	Cerebrospinal fluid
CT	Computed tomography
CVA	Cerebrovascular accidents
DWI	Diffusion-weighted image
FLAIR	Fluid attenuation inversion recovery
ICA	Internal carotid arteries
ICH	Intracerebral hemorrhage
MRA	Magnetic resonance angiography
MRV	Magnetic resonance venography
NIHSS	National Institutes of Health Stroke Scale
RF	Radio-frequency
T2WI	T2 weighted imaging
TIA	Transient ischemic attack
TOAST	Trial of ORG 10172 in Acute Stroke Treatment
VA	Vertebral arteries

INTRODUCTION

Strokes, or cerebrovascular accidents (CVA), occur when blood vessels carrying oxygen and other nutrients to the brain become blocked or suddenly rupture. Brain cells served by these vessels become starved and begin to die off. The resulting damage may impair behavior or bodily functions controlled by the affected parts of the brain, although medical intervention can sometimes reduce stroke damage. Strokes are closely linked with cardiovascular diseases such as atherosclerosis, heart rhythm disorders, heart attacks, heart valve disorders, and especially hypertension. Additional risk factors include age, gender, race, and family history. Two thirds of strokes occur in people over the age of sixty five. Men are more likely to have strokes than women, Brain Ischemia is one of the leading causes of death worldwide, especially in the elderly population and along term of disability, it's classified as the most second cause of death ***(WU et al., 2001)***.

Annually, 5.7 million deaths worldwide as abroad clinical term it includes patients with arterial ischemic infarcts, intracranial hemorrhage, subarachnoid hemorrhage and venous infarction ***(Alessandra, 2014).*** With the advantage of therapy for acute ischemic stroke the primary goal in stroke management is to reach an early accurate diagnosis for the patients, who will affect the choice of the treatment lines ***(Chul-Ho Sohn, 2017))***.

MRI allows the evaluation of the size, location, and vascular distribution of the infarction; the presence of bleeding, the severity of the ischemic stroke, and/or the presence of large-vessel occlusion ***(Mariana Lopez, 2013)***. Recent advances in MR now enable rapid identification of ischemic tissue in acute stroke. Techniques such as diffusion weighted imaging (DWI) appear to delineate infarcted tissue DWI is established as useful and is considered more useful than non-contrast CT for the diagnosis of acute ischemic stroke within 12 hours of symptom onset. DWI should be performed for the most accurate diagnosis of acute ischemic stroke ***(Zhen, 2014).*** Diffusion MRI detects abnormalities due to ischemia within 3 to 3o minutes of onset when NCCT still appears normal ***(Lieberman, 2011).***

Aim of the Work

The aim of this work is to highlight the role of MRI diffusion imaging in assessment of ischemic brain lesions.

Chapter 1

ANATOMY OF THE BRAIN

The brain is one of the largest and most complex organs in the human body. It weighs approximately one pound at birth, and grows to about two pounds during childhood. The average female adult brain weighs about 2.7 pounds, while the average adult male brain weighs approximately three pounds. The bony covering of the brain is referred to as the cranium. When combined with the bones that make up the face, the entire structure is called the skull. The three main structures of the brain are the cerebrum, the cerebellum, and the brainstem ***(Neil et al., 2016).***

The brain is composed of the cerebrum, cerebellum, and brainstem (Fig. 1).

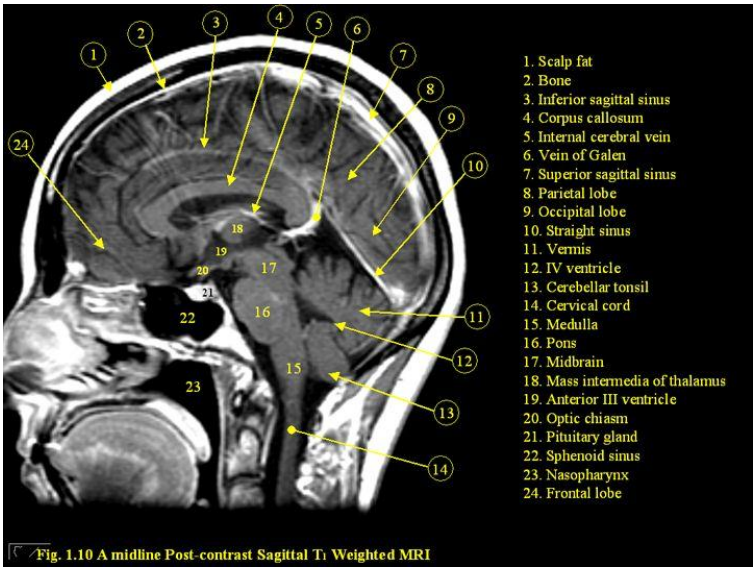

Figure (1): The brain is composed of three parts: the brainstem, cerebellum, and cerebrum. The cerebrum is divided into four lobes: frontal, parietal, temporal, and occipital ***(Neil et al., 2016).***

The cerebrum is the largest part of the brain and is composed of right and left hemispheres. It performs higher functions like interpreting touch, vision and hearing, as well as speech, reasoning, emotions, learning, and fine control of movement ***(Mori et al., 2005)***.

The cerebellum is located under the cerebrum. Its function is to coordinate muscle movements, maintain posture, and balance ***(Mori et al., 2005).***

The brainstem includes the midbrain, pons, and medulla. It acts as a relay center connecting the cerebrum and cerebellum to the spinal cord. It performs many automatic functions such as breathing, heart rate, body temperature, wake and sleep cycles, digestion, sneezing, coughing, vomiting, and swallowing. Ten of the twelve cranial nerves originate in the brainstem ***(Neil et al., 2016).***

Right brain – left brain

The right and left hemispheres of the brain are joined by a bundle of fibers called the corpus callosum that delivers messages from one side to the other. Each hemisphere controls the opposite side of the body. If a brain tumor is located on the right side of the brain, your left arm or leg may be weak or paralyzed ***(Neil et al., 2016)***.

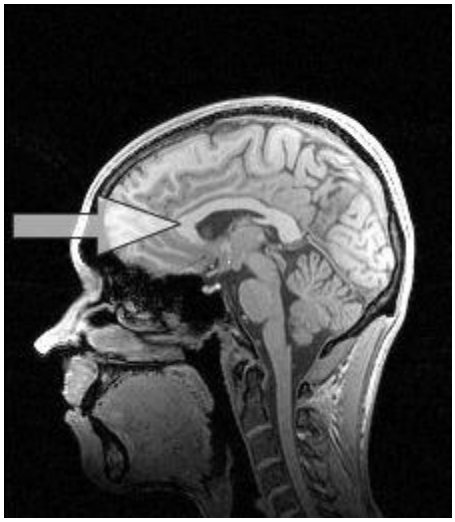

Figure (2): Sagital section in the brain showing the corpus callousm.

Lobes of the brain

The cerebral hemispheres have distinct fissures, which divide the brain into lobes. Each hemisphere has 4 lobes: frontal, temporal, parietal, and occipital (Fig. 2). Each lobe may be divided, once again, into areas that serve very specific functions. It's important to understand that each lobe of the brain does not function alone. There are very complex relationships between the lobes of the brain and between the right and left hemispheres ***(Neil et al., 2016).***

Frontal lobe

- Personality, behavior, emotions.
- Judgment, planning, problem solving.
- Speech: speaking and writing (Broca's area).
- Body movement (motor strip).

- Intelligence, concentration, self awareness ***(Mori et al., 2005)***.

Parietal lobe

- Interprets language, words.
- Sense of touch, pain, temperature (sensory strip).
- Interprets signals from vision, hearing, motor, sensory and memory.
- Spatial and visual perception ***(Mori et al., 2005).***

Occipital lobe

- Interprets vision (color, light, movement) ***(Mori et al., 2005).***

Temporal lobe

- Understanding language (Wernicke's area).
- Memory.
- Hearing.
- Sequencing and organization ***(Mori et al 2005).***

Deep structures

Hypothalamus - is located in the floor of the third ventricle and is the master control of the autonomic system. It plays a role in controlling behaviors such as hunger, thirst, sleep, and sexual response. It also regulates body temperature, blood pressure, emotions, and secretion of hormones.