بسم الله الرحمن الرحيم

Sudan University of Science and Technology
College of Graduate study
M.sc Diagnostic Radiological imagine

Study of Ischemic Stroke using Magnetic Resonance Diffusion-Weighted Images in Khartoum State

دراسة السكتة الدماغية الإقفارية باستخدام صور الرنين المغناطيسي الأنتشارية بولاية الخرطوم

A Thesis submitted for partial fulfilment of the requirement of
M.Sc. Degree in Medical Diagnostic Radiology

Submitted by

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أعوذ بالله من الشطان الرجيم

بسم الله الرحمن الرحيم

"وَمَن يَتَّقِ اللَّهَ يَجْعَل لَّهُ مَخْرَجًا (2) وَيَرْزُقْهُ مِنْ حَيْثُ لَا يَحْتَسِبُ وَمَن يَتَوَكَّلْ عَلَى اللَّهِ فَهُوَ حَسْبُهُ إِنَّ اللَّهَ بَالِغُ أَمْرِهِ قَدْ جَعَلَ اللَّهُ لِكُلِّ شَيْءٍ قَدْرًا (3)"

سورة الطلاق

I seek refuge with Allah from the accursed Satan

In the name of of Allah the Merciful

"And whoever fears Allah - He will make for him a way out (2) and will provide for him from where he does not expect. And whoever relies upon Allah - then He is sufficient for him. Indeed, Allah will accomplish His purpose. Allah has already set for everything a [decreed] extent. (3)"

Sura At-Talaaq

Dedication

With my love appreciation I dedicate this Research to:

My father MR: Hussam Abdalraouf

My mother MRS: Sanaa Abdalwahab

My grandmother MRS: Aisha Alsafiy

My brother and my sisters

My all friends, family and to all people those I love and respect.

Acknowledgment

Firstly thanks to **Allah** for giving me strength and patience to do this work. I would like to offer my thanks and gratitude to my supervisor: DR. MONA AHMED MOHAMED for encouragement and guidance made it possible for this theses to be written.

Secondly a big thank to my family for all their hard work to stand beside me and give me the hope. And finally to all my friends for their support and everyone who helped me and support me while I was making this study.

Abstract

This is statistical analysis study and was conducted in five months during the period from July 2018, to November 2018 in the neurological department of Alamal National Hospital. Stroke is the third leading cause of death in the Sudan. (WHO & UN, 2012) The treatment Should start within 4.5 to 48 hours if it's not treated will cause brain damage that will lead to death.

The aim of this thesis to Study of Ischemic Stroke using Magnetic Resonance Diffusion-Weighted Images in Khartoum State, to evaluate the gender relation with ischemic stroke, to determine the most clinical findings for brain stroke, to assess the time of scan form symptoms onset.

In this study we have 50 patients well known as Ischemic Stroke had (56%) male to (44%) female in range of (26 - 95) age we used MRI machines Philips 1.5 Tesla, Data collected from findings which appear in different brain MRI, data were analysed by using Microsoft Office Excel 2016. The result taken from every one of the patients allowed to Doctors facility clinic with neurological side effects speculated ischemic stroke.

On this study we found males more affected than female by (56%) male to (44%) female, most of them (54%) are (56-75) years old same result as (Noman, 2016), and most clinical findings for ischemic stroke found are aphasia (47%) and right hemiparesis (31.65%) same result as (Noman, 2016), (58%) of patients came at the first 10 hour of stroke symptoms onset same result as (Jun Ma, 2004), we found Middle cerebral circulation is most site of infarction by (60%) same result as (Jun Ma, 2004). And we found Diffusion-weighted imaging (DWI) is best image for detection of ischemic stroke for all stages.

We recommend in next studies to study using Perfusion weighted imaging (PWI) in ischemic stroke imagine ass main protocol.

ملخص الدراسة

هذه دراسة تحليلية إحصائية أجريت في خمسة أشهر خلال الفترة من يوليو 2018 إلى نوفمبر 2018 في قسم الأعصاب بمستشفى الأمل الوطني. السكتة الدماغية هي السبب الثالث للوفاة في السودان(*WHO & UN,* 2012) . يجب أن يبدأ العلاج في غضون 4.5 إلى 48 ساعة إذا لم يتم علاجه سيؤدي إلى تلف في الدماغ مما يؤدي إلى الوفاة.

الهدف من هذه الأطروحة هو دراسة السكتة الدماغية الإقفارية باستخدام صور الرنين المغناطيسي الأنتشارية بولاية الخرطوم، لتقيم العلاقة بين الجنس و الاصابة بالسكنة الدماغية الإفقارية، لتحديد ما هي اكثر الاعراض المصاحبة للسكتة الدماغية، لتقيم زمن الفحص من وقت ظهور الاعراض علي المريض.

في هذه الدراسة ، لدينا 50 مريضًا مصابين ب السكتة الدماغية الإقفارية وكان الذكور (56٪.) إلى (44٪.)من الإناث تتراوح أعمارهم بين (26 - 95) استخدمنا جهاز التصوير بالرنين المغناطيسي *Philips* 1.5 *Tesla* ، تم جمع البيانات التي من النتائج التي تظهر في صور الرنين المغناطيسي مختلف للدماغ ، تم تحليل البيانات باستخدام *Microsoft Office Excel* 2016. و تم الحصول علي النتايج من كل واحد من المرضى الذين قامو بزيارة عيادة أطباء الاعصاب مع اعراض الجانبية للسكتة الدماغية.

في هذه الدراسة وجدنا أن الذكور أكثر تأثراً من الإناث بنسبة (56 ٪.) من الذكور إلى (44 ٪.) من الإناث، (54٪.) من المرضي في الفئة العمرية (56-75 سنة), وكانت هذه النتائج ممثلة لـ (نعمان 2016)، ووجد ان عدم القدرة علي الكلام والقراءة والكتابة هو من اكثر اعراض السكتة الدماغية شيوعاً بنسبة (47٪.) ثم يليه شلل جزئ فى الجانب الايمن من الجسم بنسبة (31.65٪.) وكانت هذه النتائج ممثلة لـ (نعمان 2016)، (58٪.) من المرضى ياتون في أول 10 ساعات من ظهور أعراض السكتة الدماغية وكانت هذه النتائج ممثلة لـ (*Jun Ma*، 2004)، وجدنا أن الدورة الدموية الدماغية المتوسطة هي أكثر مواقع الاحتشاء بنسبة (60٪.) وكانت هذه النتائج ممثلة لـ (*Jun Ma*، 2004). ووجدنا أن التصوير المنتشر الموزع (*DWI*) هو أفضل صورة للكشف عن السكتة الدماغية في جميع المراحل.

نوصي في الدراسات القدمة بدراسة استخدام *Perfusion weighted imaging* (*PWI*) في البروتوكول الرئسي لتصوير السكتة الدماغية.

List of Tables

List of Figures

Table of Contents

Chapter Three: Materials and Methods

Chapter Four: Results

Chapter Five: Discussion, Conclusion and Recommendations

References

Appendices

List of abbreviations

ACA Anterior Cerebral Artery

ADC Apparent Diffusion Coefficient

CSF Cerebro Spinal Fluid

CT Computerized Tomography

CNS Central Nervous System

CVA Cerebral Vascular Attack

DWI Diffusion Weighted Image

DSC dynamic susceptibility contrast

EPI Echo Planner Imaging

FLAIR Fluid Attenuation Inversion Recovery

FSE Fast Spin Echo

GRE Gradient Echo

IR Inversion Recovery

MCA Middle Cerebral Artery

MRI Magnetic Resonance Imaging

MT Magnetization Transfer

PACS Picture Archiving and Communication System

PCA Posterior Cerebral Artery

PD Proton Density

PNS Peripheral Nervous System

SE Spin echo

SNR Signal to Noise Ratio

TIA Transient Ischemic Attack

Chapter One

Introduction and Objective

Chapter One

1.1 Introduction:

Stroke is the third leading cause of death in the Sudan. According to the World Health Organization 16000 patients dead from stroke in 2012 (WHO & UN, 2012) The ischaemic stroke come on the first type of stroke it occur by 80% (Davis & Donnan2012 ،)

Over the last 50 years, the field of medical imaging has undergone tremendous changes and advancements. The development and refinement of different non-invasive 5 imaging modalities have enabled physicians to peer inside the human body without making a single incision, thanks to such technologies as x-ray, ultrasound, computed tomography (CT), nuclear imaging, and magnetic resonance imaging (MRI). The application of magnetic resonance imaging (MRI) has evolved rapidly since its clinical development in the early 1980s. MRI boasts several features which make it highly useful for medical imaging. Its image quality is far superior to ultrasound, and unlike CT, x-ray, or nuclear imaging, MRI does not expose the patient to potentially harmful radiation. Perhaps most importantly, MRI is able to quantitatively characterize tissues based on a range of biochemical and cellular properties. MRI is becoming one of the most important diagnostic tools in clinical decision making for the treatment and management of acute and chronic stroke. Diffusion-weighted imaging (DWI) in which image contrast is based on water motion is remarkably sensitive to ischemic brain injury (i.e., within minutes) (Slichter, 1978)

Diffusion-weighted magnetic resonance (MR) imaging provides image contrast that is different from that provided by conventional MR techniques. It is particularly sensitive for detection of acute ischemic stroke and differentiation of acute stroke from other processes that manifest with sudden neurologic deficits. (Pamela, et al., 2000) The technique takes less than 2 minutes to apply using a standard 1.5-tesla scanner in the clinical setting. diffusion-weighted imaging revealed the infarcts sooner than conventional T2-weighted spin-echo imaging did. (Warach S, et al., 1992 Sep)

1.2 Problem of the study:

CT is the technique of choice to distinguish between hemorrhagic and nonhemorrhagic stroke. However, with CT 30% to 60% of the ischemic lesions are still invisible in the acute stage. During the first 24 hours after an ischemic stroke, proton density–weighted (PD-w) and T2-w MRI have 20% to 30% false-negative results. This percentage increases to 30% to 50% during the first 3 to 6 hours after stroke. As a consequence, CT or conventional MRI is not generally used to predict the presence and extent of ischemic damage in the acute stage after stroke. (K.J. van, et al., 1998)

1.3 Objectives

1.3.1 General objectives:

Study of Ischemic Stroke using Magnetic Resonance Diffusion-Weighted Images in Khartoum State.

1.3.2 Specific objectives:

To evaluate the gender relation with ischemic stroke

To determine the most clinical findings for brain stroke.

To correlate the findings with the time of scan and gender

To find the most site of infarction

To assess the best magnetic resonance (MR) imaging protocol in the for stroke

1.4 Over view of the study

Chapter 1: Introduction, objectives.

Chapter 2: Theoretical background and previous studies.

Chapter 3: Methodology.

Chapter4: Results.

Chapter5: Discussion, Conclusion, Recommendations.

References, Appendices.

Chapter Two

Theoretical background

and Previous studies

Chapter Two

2.1 Theoretical Background

2.1.1 Anatomy

2.1.1.1 The Brain

The brain is that part of the central nervous system that lies inside the cranial cavity. It is continuous with the spinal cord through the foramen magnum. (Richard, 2012)
The brain is composed of the cerebrum, cerebellum, and brainstem

2.1.1.1.1 The cerebrum

is the largest component of the brain. It is divided into right and left hemispheres. The corpus callosum is the collection of white matter fibers that joins these hemispheres. Each of the cerebral hemispheres is further divided into 4 lobes: the frontal lobe, the parietal lobe, the temporal lobe, and the occipital lobe. The medial temporal lobe structures are considered by some to be part of the so-called limbic lobe. (Anand, 2015)
Briefly, the frontal lobe is distinguished from the parietal lobe posteriorly by the central sulcus (see Figure 2.1). The frontal lobe and parietal lobes are divided inferiorly from the temporal lobe by the lateral sulcus. The parietal lobe is distinguished from the occipital lobe by the parieto-occipital sulcus on the medial surface. The cerebrum is further divided into the telencephalon and diencephalon. The telencephalon consists of the cortex, the subcortical fibers, and the basal nuclei. The diencephalon mainly consists of the thalamus and hypothalamus. The telencephalon of the cerebrum is disproportionately well-developed in humans as compared with other mammals. (Anand, 2015)

2 .1.1.1.2 The cerebellum

Occupies the posterior fossa, dorsal to the pons and medulla. It is involved primarily in modulating motor control to enable precisely coordinated body movements. Similar to the cerebrum, which has gyri and sulci, the cerebellum has finer folia and fissures that increase the surface area. (Anand, 2015)

The cerebellum consists of 2 hemispheres, connected by a midline structure called the vermis. In contrast to the neocortex of the cerebrum, the cerebellar cortex has 3 layers: molecular, Purkinje, and granular. There are 4 deep cerebellar nuclei: the fastigial, globose, emboliform, and dentate nuclei, in sequence from medial to lateral. The afferent and efferent pathways to and from the cerebellum exist within the 3 cerebellar peduncles. (Anand, 2015)

2.1.1.1.3 The brainstem

is comprised of the midbrain, pons, and medulla.

The midbrain is often considered the smallest region of the brain. It acts as a sort of relay station for auditory and visual information. The midbrain controls many important functions such as the visual and auditory systems as well as eye movement. Portions of the midbrain called the red nucleus and the substantia nigra are involved in the control of body movement. The darkly pigmented substantia nigra contains a large number of dopamine-producing neurons are located. The degeneration of neurons in the substantia nigra is associated with Parkinson’s disease. (Cherry, 2018)

The medulla is located directly above the spinal cord in the lower part of the brain stem and controls many vital autonomic functions such as heart rate, breathing, and blood pressure.

The pons connects the medulla to the cerebellum and serves a number of important functions including playing a role in several autonomic functions such as stimulating breathing and controlling sleep cycles. (Cherry, 2018)

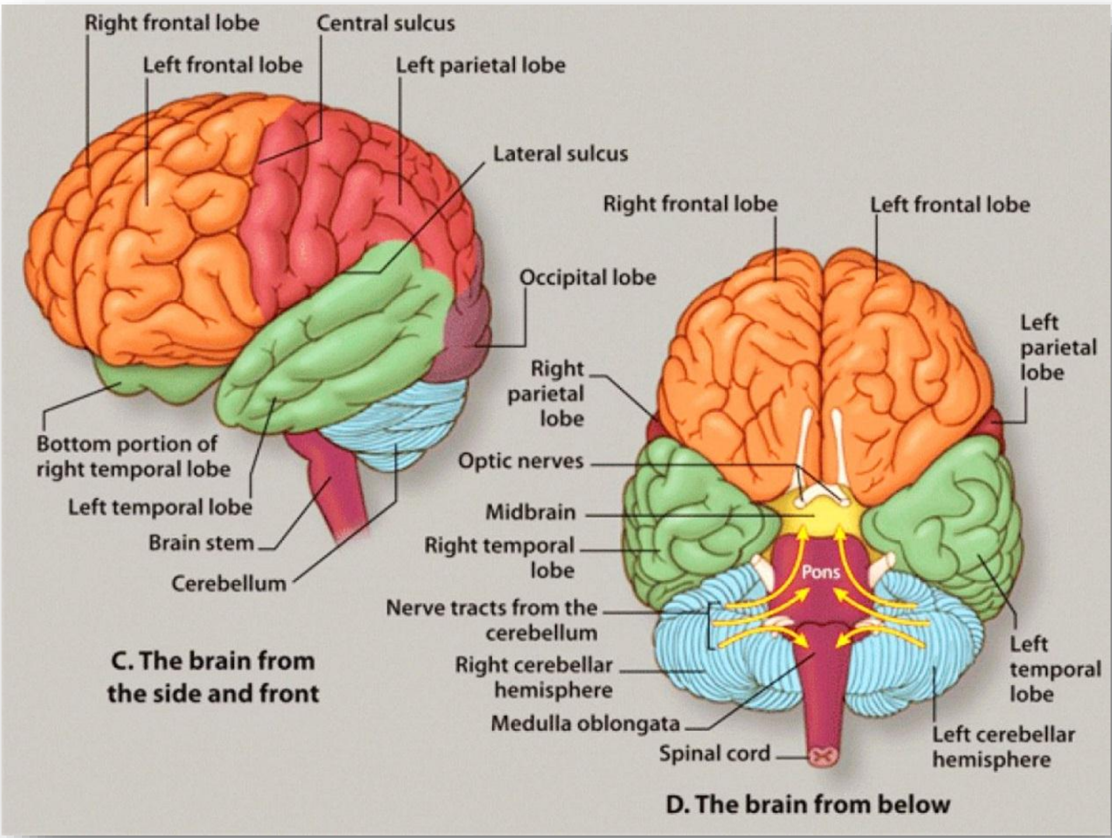


Figure 2.1: Presenting the part of Brain
(www.topsimages.com)

2.1.1.2 Blood Vessels of Brain

Arteries supply blood to the brain via 2 main pairs of vessels: the internal carotid artery and the vertebral artery on each side. The internal carotid artery on each side terminates into the anterior cerebral artery, the middle cerebral artery, and the posterior communicating artery. The vertebral arteries on each side join to form the basilar artery. The basilar artery then gives rise to the posterior cerebral arteries and the superior cerebellar arteries. The basilar artery, the posterior cerebral arteries, the posterior communicating arteries, and the anterior cerebral arteries, along with the anterior communication artery, form an important collateral circulation at the base of the brain termed the cerebral arterial circle (of Willis). These vessels lie within the subarachnoid space and are a common location for cerebral aneurysms to form.

Venous return to the heart occurs through a combination of deep cerebral veins and superficial cortical veins. The veins then contribute to larger venous sinuses, which lie within the dura and ultimately drain through the internal jugular veins to the brachiocephalic veins and then into the superior vena cava. (Anand, 2015)

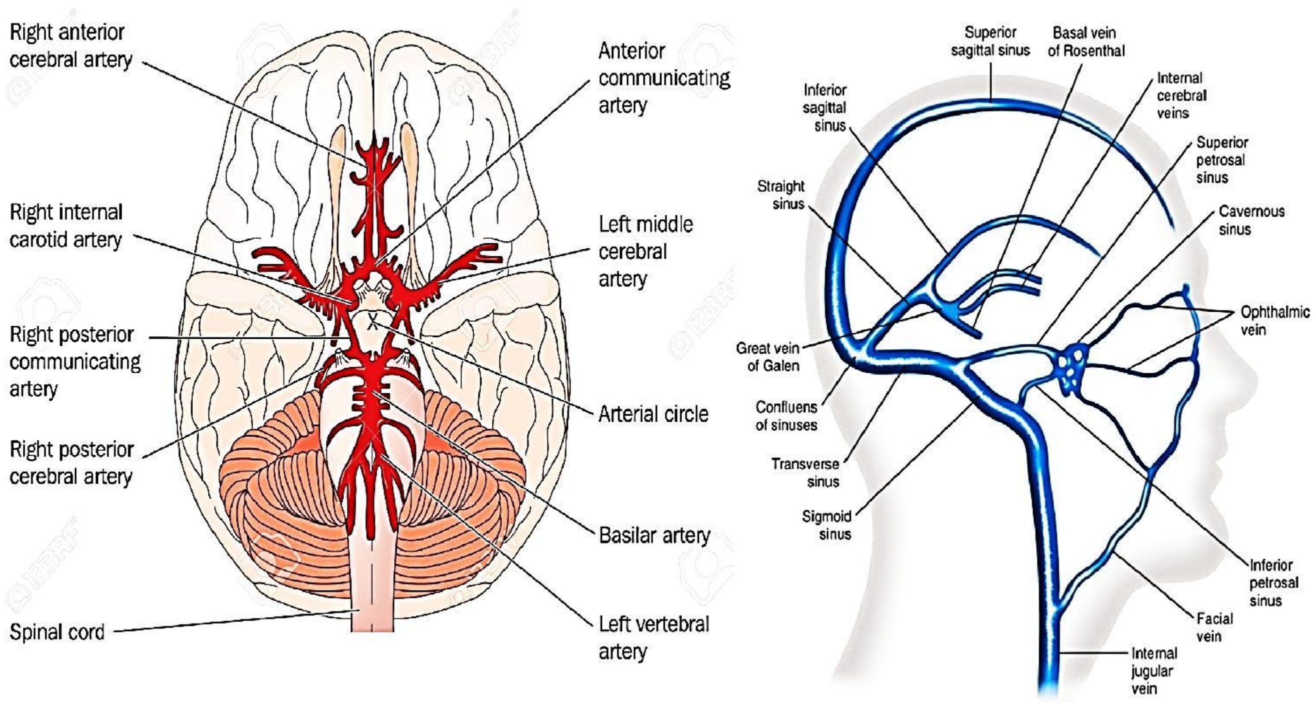
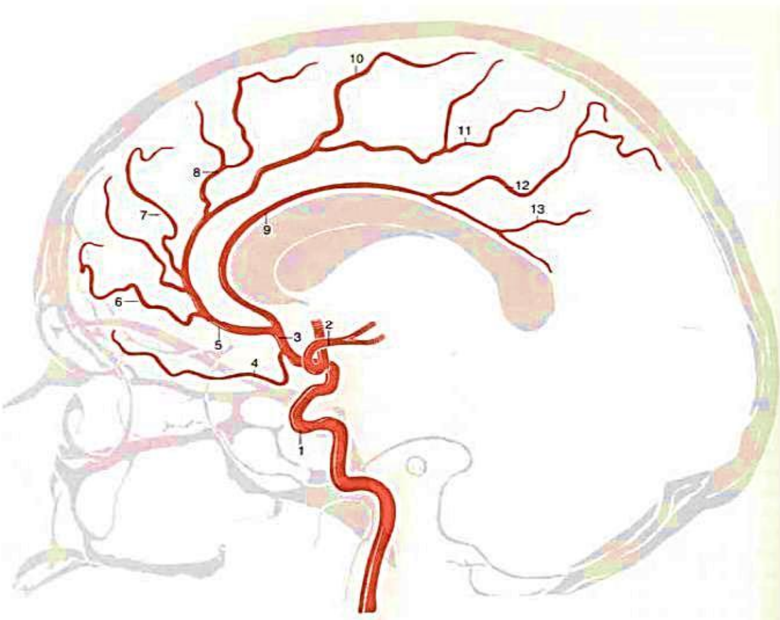


Figure 2.2: Presenting circle of Willis and vein of Brain

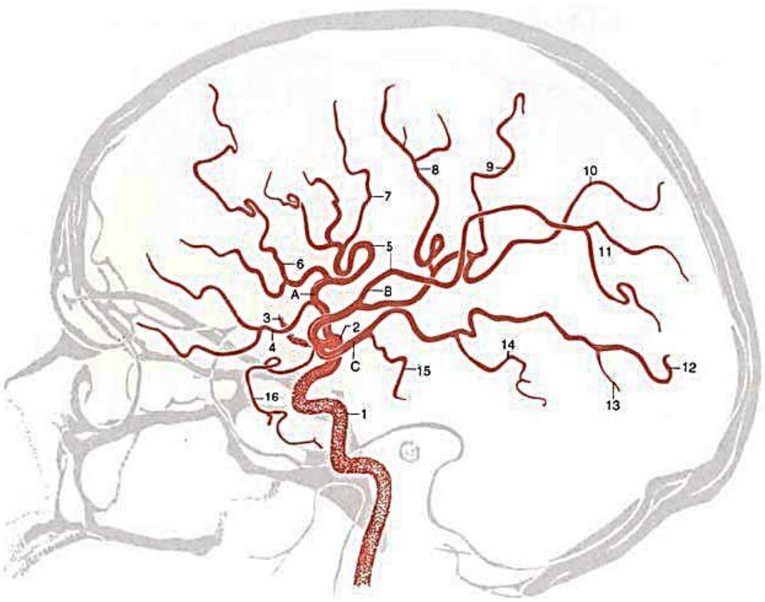
A

1. A. Carotis interna
2. Äste der A. Cerebri media
3. A. Cerebri anterior
4. A. frontobasalis medialis
5. A. callosomarginalis (A. cingulomarginalis)
6. A. frontopolaris
7. A. frontalis anteromedialis (A. frontalis interna anterior)
8. A. frontalis mediomedialis (A. frontalis interna media)
9. A. pericallosa
10. A. frontalis posteromedialis (A. frontalis interna posterior)
11. A. paracentralis
12. A. precunealis superior (A. parietalis interna superior)
13. A. precunealis inferior (A. parietalis interna inferior)



B

1. A. carotis interna
2. A. cerebri media, orthograd verlaufend
3. Abgang der A. cerebri anterior
4. A. frontobasalis lateralis
5. Aa. Insulares
6. Aa. Prefrontales
7. A. sulci precentralis (A. praerolandica)
8. A. sulci centralis (A. rolandica)
9. A. parietalis anterior
10. A. parietalis posterior
11. A. gyri angularis
12. A. temporooccipitalis (A. occipitotemporalis)
13. A. temporalis posterior
14. A. temporalis intermedia (A. temporalis media)
15. A. temporalis anterios
16. A. temporopolaris



C

1. A. vertebralis
2. Abgang der A. cerebelli inferior posterior
3. A. basilaris
4. Abgang der A. cerebelli inferior anterior
5. Abgang der A. cerebelli superior
6. A. cerebri posterior
7. Aa. centrales posteromedialis und posterolateralis (Aa. thalamoperforantes anteriores und posteriors)
8. Aa. choroideae posteriors medialis und lateralis
9. A. occipitalis medialis (A. ocipitalis interna)
10. A. parietooccipitalis
11. A. calcarina
12. A. occipitalis lateralis (A. temporooccipitalis, A. occipitotemporalis)
13. Aa. temporales
14. A. communicans posterior
15. A. carotis interna

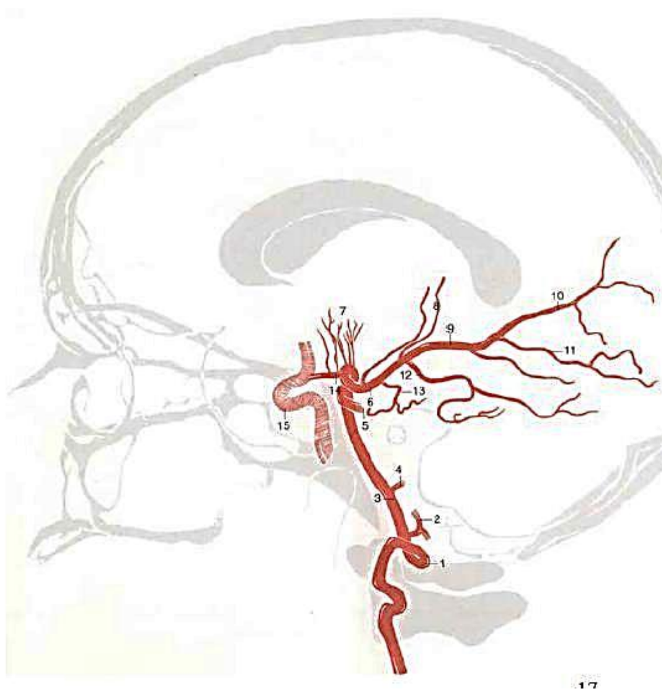


Figure 2.3: Presenting **A** anterior communicating arteries, **B** Middle communicating arteries and **C** posterior communicating arteries (Kretschmann & , 2003)

2.1.2 Physiology

2.1.2.1 Brain Physiology

Nearly every vital activity necessary for survival, as well as all emotion—anger, fear, joy, love and happiness—originates inside the brain. The brain also receives and interprets a multitude of signals sent to it by other parts of the body and by the environment. Weighing in at a mere three pounds, the brain resembles a gray sea sponge—hence the term "gray matter" and it is the central control system for the entire body.

Four Main Parts

The four main parts of the brain are the cerebrum, the cerebellum, a central core region called the "between brain," and the brain stem.

The cerebrum: is the rippled tissue commonly imaged as the brain. It is both the largest and most developed area of the human brain. It has two sides, or hemispheres—right and left—and includes four pairs of lobes: frontal, parietal, temporal, and occipital .

- The frontal lobes control thinking, planning, organizing, problem solving, short-term memory and movement.
- The parietal lobes interpret sensory information, such as temperature and touch.
- The occipital lobes process images from your eyes and link that information with images stored in memory.
- The temporal lobes process information from your senses of smell, taste and sound. They also play a role in memory storage.

The cerebrum is the most recent part of the brain to evolve, and positioned on top of the more evolutionarily ancient portions of the brain, such as the brain stem. The "star" of the cerebrum is the cerebral cortex—the outermost layer of the brain .

The cerebral cortex: is like the bark on a tree—it forms the surface of the cerebral hemispheres. Despite a thickness of less than 0.2 inch (5 mm), the cortex is responsible for most higher brain functions, including language, memory, and consciousness .

One of the most visible features of the brain is the division between the left and right hemispheres of the cerebral cortex. This division applies to function as well. The left hemisphere is specialized to control language skills, such as talking, reading, writing, spelling, and speech communication. The right hemisphere is associated with spatial processing, such as perception of faces and patterns .

The cerebellum: is the second largest area of the brain. The cerebellum's primary function involves the coordination of voluntary and involuntary body movements. The cerebellum guides body movements in a smooth and coordinated fashion. (Society, 2017)

2.1.3 Pathology

2.1.3.1 Stroke

A stroke is a sudden interruption in the blood supply of the brain. Most strokes are caused by an abrupt blockage of arteries leading to the brain (ischemic stroke). Other strokes are caused by bleeding into brain tissue when a blood vessel bursts (hemorrhagic stroke). stroke is also called a brain attack. (Stroke, 2018) A stroke causes brain cells to die. This damage can cause paralysis, speech problems, loss of feeling، memory and reasoning problems, coma, and possibly death. Fortunately, there are effective ways to prevent stroke. If you have a stroke, seeking immediate medical attention can help reduce your chances of death and disability (Dominic & Steven , 2013)

2.1.3.1.1 Signs and symptoms

The main symptoms of stroke can be remembered with the word FAST: Face-Arms-Speech-Time.

Face – the face may have dropped on one side, the person may not be able to smile or their mouth or eye may have dropped.

Arms – the person with suspected stroke may not be able to lift both arms and keep them there because of arm weakness or numbness in one arm.

Speech – their speech may be slurred or garbled, or the person may not be able to talk at all despite appearing to be awake.

Time – it is time to call an ambulance immediately if you see any of these signs or symptoms. (Stroke, 2018)

2.1.3.1.1.1 Some Signs of Stroke:

Sudden numbness or weakness of the face, arm or leg especially on one side of the body, sudden confusion, trouble speaking or understanding sudden trouble seeing in one or both eyes, sudden trouble walking, dizziness or loss of balance, sudden severe headache with no known cause (V.Shah, 2008)

2.1.3.1.1.2 Transient Ischemic Attack:

When the symptoms of a stroke last only a short time (less than an hour), this is called a transient ischemic attack (TIA) or mini-stroke. (Stroke, 2018)

2.1.3.1.2 Types of stroke:

Ischemic Stroke - The most common type of stroke, accounting for almost 80 percent of all strokes, is caused by a clot or other blockage within an artery leading to the brain. An Ischemic stroke can be cause due to four reasons: Thrombosis: (Refers to the 50% of all strokes and it is caused by obstruction of a blood vessel by a blood clot). Embolism: (Caused by obstruction due to an embolus from elsewhere in the body). Systemic hypoperfusion: (Caused by general decreased in blood supply). Venus thrombosis: (Is rare and caused by thrombosis of the dural venous sinuses).

Intracerebral Hemorrhage - is a type of stroke caused by the sudden rupture of an artery within the brain. Blood is then released into the brain compressing brain structures.

Subarachnoid Hemorrhage - is also a type of stroke caused by the sudden rupture of an artery. A subarachnoid hemorrhage differs from an intracerebral hemorrhage in that the location of the rupture leads to blood filling the space surrounding the brain rather than inside of it. (Stroke, 2018)

2.1.4 Physics and Equipment

2.1.4.1 Diagnosis of stroke

Magnetic Resonance Imaging is one of the most helpful tests in the diagnosis of stroke because it can detect strokes within minutes of their onset. Its images of the brain are also superior in quality by comparison with Computed Tomography images. Because of this, MRI is the test of preference in the diagnosis of stroke. Diffusion-weighted MRI (magnetic resonance imaging) is a type of MRI sequence used to identify areas of an organ, such as the brain, which have recently been damaged or injured, often by a stroke. During a diffusion-weighted MRI, the MRI machine is set to detect small restrictions in the movement of water molecules inside the injured areas. These small changes, which are commonly referred to as "areas of restricted diffusion," are detected by the MRI machine and ultimately appear as bright spots inside the organ being investigated. Areas of acute stroke look like bright spots on DWI MRI.

DWI is a better imaging method than conventional MRI in detecting early ischemic lesions in stroke patients. In a study of diffusion-weighted MRI, researchers concluded that DWI is a better imaging method than conventional MRI in detecting early ischemic lesions in stroke patients. Lesion size as measured on DWI scans is potential parameters for predicting clinical outcome in acute stroke patients. (Keir S, 2004)

2.1.4.1.1 Role of Magnetic Resonance Imaging in Stroke Imaging

The primary goals of neuroimaging are to determine the presence of infarction and to distinguish between hemorrhagic and ischemic stroke. The secondary goals of stroke imaging, largely applied to ischemic strokes, are to identify the location and extent of intravascular clot as well as the presence and extent of penumbra (hypoperfused tissue at risk for infarction).To be effective, comprehensive stroke protocols should be able to address the aforementioned primary and secondary goals in a timely manner. Although CT is the most commonly used modality for stroke imaging, partly because of its wide availability and faster acquisition time, some comprehensive stroke centers choose MR imaging rather than CT for 2 major reasons. First, higher sensitivity and specificity of MR imaging for delineation of hyperacute ischemia. Diffusion-weighted imaging (DWI) provides the most specific way to image acute infarction and perfusion imaging can help in delineation of ischemic penumbra. The advent of MR imaging has redefined stroke syndromes such as acute ischemic infarction and TIA from an all-or-none process to a dynamic and evolving process, providing meaningful physiologic and functional information. Second, the absence of radiation. A comprehensive CT stroke protocol delivers a mean effective dose of 16.4mSv which is approximately 6 times the dose of an unenhanced CT head. This difference is particularly important for patients who need repeat examinations following treatment or have a change in their neurologic examination, in which the repeated CT scans can be prohibitive because of the accumulated radiation dose. (Kambiz & Wayn, 2016)

2.1.4.2 Physics of MRI

Magnetic resonance imaging MRI also commonly abbreviated as MR imaging can be defined as the use of magnetic fields and radio waves to obtain a mathematically reconstructed image. This image represents differences among various tissues of the patient in the number of nuclei and in the rate at which these nuclei recover from stimulation by radio waves in the presence of a magnetic field. The MR imaging system is more sensitive to the molecular nature of tissue and thus allows excellent contrast resolution. (Bushong, 2005)

2.1.4.2.1 Physical Principles of MRI

Certain nuclei in the body will absorb and reemit radio waves of specific frequencies when those nuclei are under the influence of a magnetic field. These reemitted radio signals contain information about the patient that is captured by a receiver or antenna. The electrical signal from the antenna is transmitted through an "analog-to-digital" (A to D) converter and then to a computer, where an image of the patient is reconstructed mathematically. The interaction of nuclei with magnetic fields the basis of MRI, radiographic imaging involves the interaction of x-rays with the electrons surrounding the nuclei of atoms, whereas MRI involves the interaction of radio waves and static magnetic fields with the nuclei alone. Not all nuclei respond to magnetic fields. A list of the nuclei found in the body that are magnetic themselves those having odd numbers of protons or neutrons and thus suitable for magnetic resonance studies. Although theoretically a number of such suitable nuclei exist, at present most imaging is performed with hydrogen nuclei single protons.

One reason for this preference is that a great deal of hydrogen is present in most tissues. This is evident by the fact that there are two hydrogen atoms in each water molecule and the body is roughly 85% water. Hydrogen is also contained within many other molecules. The body may contain approximately 1022 hydrogen atoms, each of which is capable of sending and receiving radio signals. Other nuclei do not exist in such abundance and therefore will not provide such a strong signal. (Bushong, 2005)

2.1.4.2.1.1 Precession

MRI is possible because a magnetic nucleus will precess about a strong static magnetic field. The phenomenon of precession occurs whenever a spinning object is acted upon by an outside force. Three examples of precession are shown in (Fig. 2.4) a spinning top, when acted upon by the force of gravity, precess, or wobbles about the line defined by the direction of gravitational force. In MRI application, a spinning proton (hydrogen nucleus) prcesses when placed in a strong magnetic field. A third example is the earth itself, which precess because of the interplay between the forces of the sun and the planets. The rate of precession of a proton in a magnetic field increases as the strength of magnetic field increases. The rate of precession of protons in an MRI system is difficult to imagine. Protons in a low field system may precess at 5,000,000 cycles per second (Fig. 2.5). The spinning top is shown to precess at a rate of one cycle per second, and the earth at only 0.004 cycles per century.

Sending a radio signal to precession nuclei after the static magnetic field has been applied, the precession of nuclei in the patient can be further influenced by radio waves, because a radio wave contains a time-varying magnetic field. One effect of the radio wave is to cause the nucleus to precess at a greater angle. The longer the radio wave is applied to the patient, the greater the angle of precession. In the example shown in (Fig. 2.9), the radio wave has been applied long enough to cause the nucleus to change from near vertical parallel to the static magnetic field to horizontal at right angles to the static magnetic field. Even this duration of the radio waves sufficient to change the precession of the nuclei to a near horizontal position seems short in relation to events in everyday life. The radio wave is applied to the patient in a pulse that may last for a fraction of a second during the "send" phase of the MRI process. (Bushong, 2005)

2.1.4.2.1.2 Resonance

Radio waves affect the precessing nuclei, because the time-varying magnetic field of the radio wave changes at the same rate as the nuclei precess. This means that as the nucleus rotates, the magnetic field appears at just the proper time to have maximum effect in pushing the nucleus away from the static magnetic field. This timing of a force and a periodically changing system is an example of the concept of resonance. Another common example of resonance is the pushing of a child on a swing. When we push a child on a swing, we naturally push the child in resonance. That is, we apply force to the swing at a frequency that matches the frequency with which the swing returns to us (Fig.2.6).

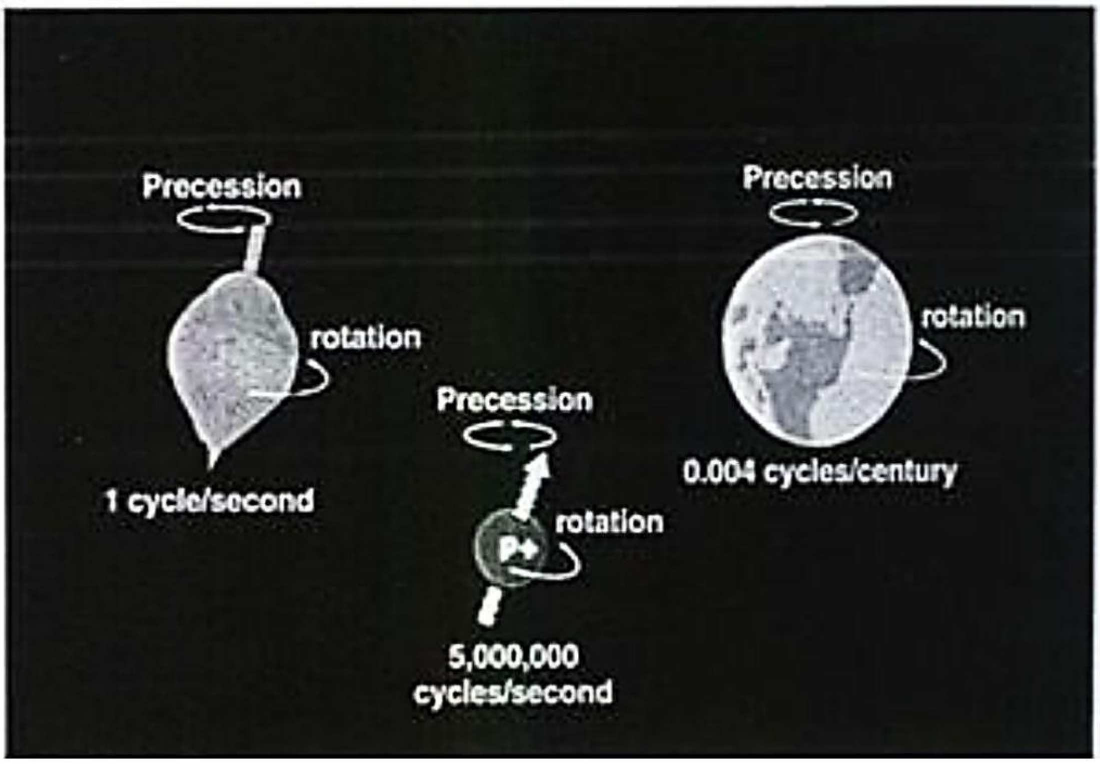
Receiving the MRI signal from body tissues because the nucleus is itself a tiny magnet, as it rotates, it emits electromagnetic waves. These emitted waves from nuclei within body tissue are picked up by an antenna or receiver coil during the "receive" phase of the MRI process (Fig. 2.7). This electric signal obtained from the receiver coil is sent to a computer. The image of the patient is then reconstructed by the computer. Various mathematic techniques may be used to build up an image from the received radio waves. Some techniques are similar to those used in CT. The received signal is described relative to random superimposed signals that are also picked up by the antenna. These random signals are called noise. The signal-to-noise ratio SNR or S/N is used to describe the relative contribution of the true signal from the tissue and random noise. (Bushong, 2005)

2.1.4.2.1.3 Relaxation

When the radiofrequency pulse that was sent to the nuclei is over, the nuclei are processing together in phase. As soon as the radiofrequency pulse is turned off, the nuclei begin to return to a more random configuration in a process called relaxation. As the nuclei relax, the MRI signal received from the processing nuclei diminishes.

The rate of relaxation gives us information about normal tissue and pathologic process in the tissues. Thus relaxation influences the appearance of the MR image. Relaxation may be divided into two categories, as shown in (Fig 2.8)

These are commonly referred to as T1 and T2 relaxation. (Bushong, 2005)



Figuer.2.5: Example of precession (Bushong, 2005)

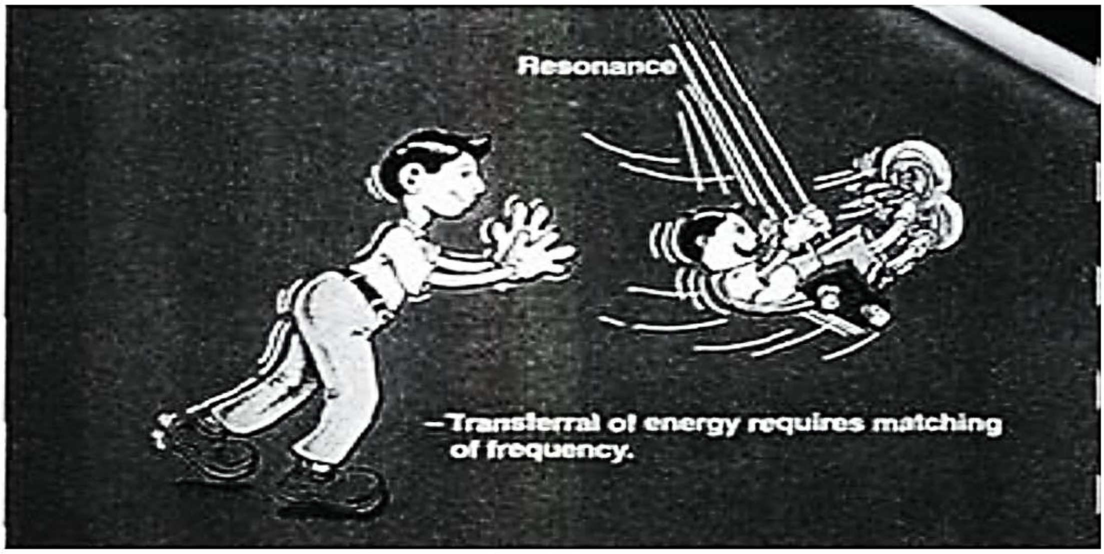


Figure.2.6: radio waves increase angle of precession
(Bushong, 2005)

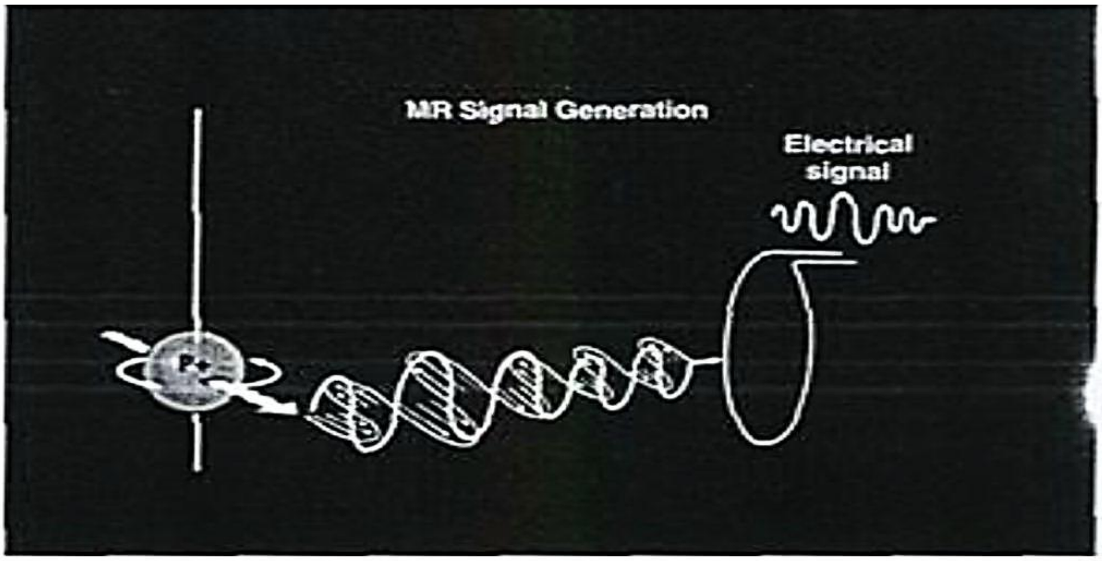
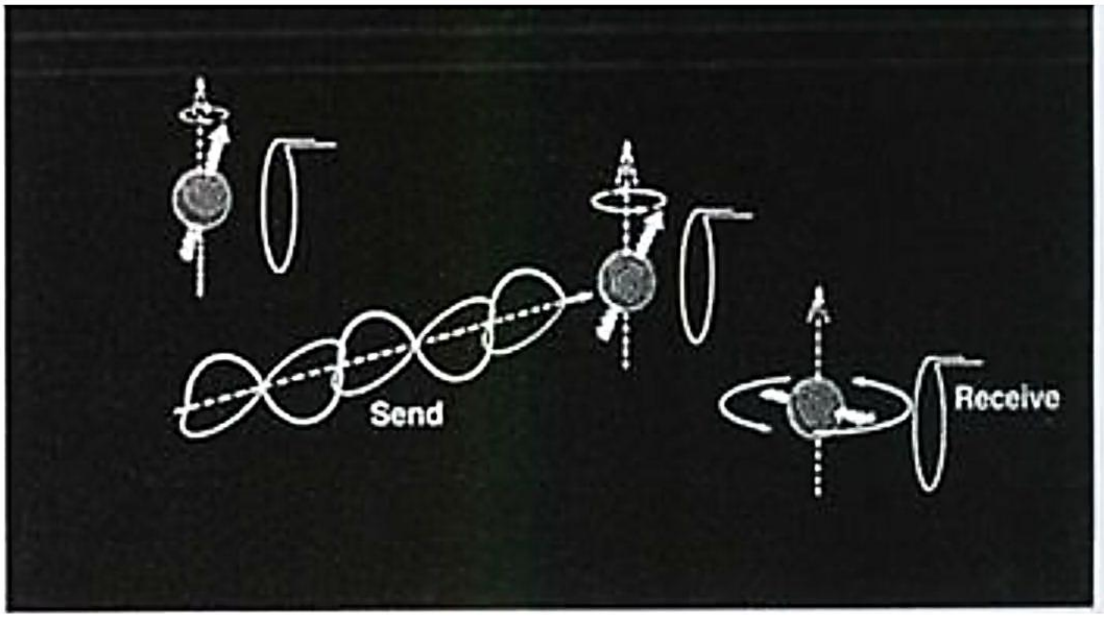
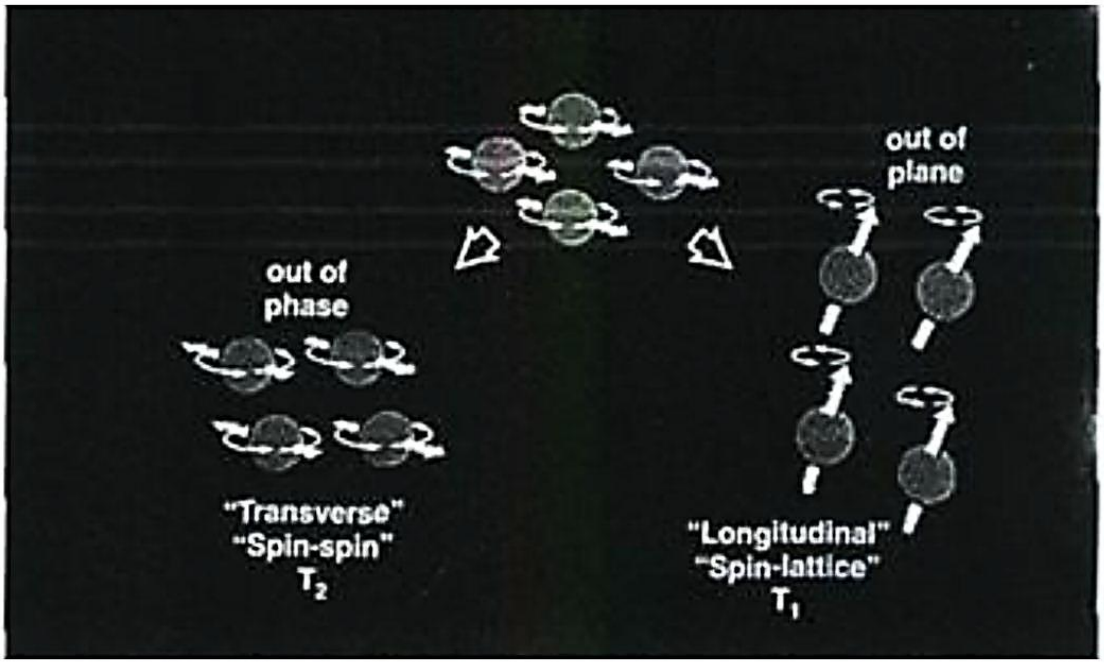


Figure 2.7: Example of resonance (Bushong, 2005)



Figuer2.8: MRI signal generation and receiver coil sending electrical signal to computer. (Bushong, 2005)



Figuer 2.9: Two categories of relaxation. (Bushong, 2005)

2.1.4.3 The equipment of MRI

The traditional MRI unit is a large cylinder-shaped tube surrounded by a circular magnet and moveable examination table that slides into the center of the magnet. Some MRI units, called short-bore systems, are designed so that the magnet does not completely surround you. Some newer MRI machines have a larger diameter bore which can be more comfortable for larger size patients or patients with claustrophobia. Other MRI machines are open on the sides open MRI. Open units are especially helpful for examining larger patients or those with claustrophobia.
Newer open MRI units provide very high quality images for many types of exams; older open MRI units may not provide this same image quality. Certain types of exams cannot be performed using open MRI. The computer workstation that processes the imaging information is located in a separate room from the scanner. (Bushong, 2005)

2.1.4.3.1Magnets

The most visible and probably the most often discussed component of the MRI system is the magnet. The magnet provides the powerful static constant strength magnetic field about which the nuclei precess. Several types of MRI system magnets exist, and they share a common purpose, that of creating a very strong magnetic field measured in units of Tesla, abbreviated as T. Field strengths most commonly used clinically vary from 0.1 to 3.0 Tesla. One Tesla equals 10,000 Gauss. (Bushong, 2005)

2.1.4.3.1.1 Resistive Magnets The resistive magnet works on the principle of the electromagnet. A magnetic field is created by passing an electric current through a coil of wire. Resistive magnets require large amounts of electric power, I the high electric currents produce heat, which must be dissipated with a cooling system. The heat is produced by the resistance of the wire to the flow of electricity. This resistance acts as a type of friction that produces heat and ultimately limits the amount of current that can be produced. Typical resistive systems produce magnetic field strengths of up to 0.3 Tesla. (Bushong, 2005)

2.1.4.3.1.2 Permanent Magnets A second type of magnet that can be used with MRI is the permanent magnet, the electric power and cryogens are avoided in the permanent magnet system. Certain materials can be given permanent magnetic properties. For MRI use, certain very large permanent magnets may be made with field strengths up to 0.3 Tesla, the same as the resistive type magnet.
A disadvantage of this type of magnet is the inability to turn off the power of the magnetic field. If metal objects accidentally become lodged in the bore of the magnet, they must be removed against the full power of the magnetic field. (Bushong, 2005)

2.1.4.3.1.3 Superconducting Magnets The third and most common type of large magnet in use is the superconducting magnet, which also uses the `principle of the electromagnet. In addition, it uses a property that is demonstrated by some materials at extremely low temperatures, the property of superconductivity. High magnetic field strengths are possible with the superconducting magnet, with values as high as 2.0 or 3.0 Tesla for clinical use. The strong magnetic field allows for a high signal-to-noise ratio, which optimizes brain mapping and real-time brain acquisitions. (Bushong, 2005)

2.1.4.3.2 MRI coils

The main RF transmitter coils in most systems are: A body coil usually located within the bore of the magnet itself A head coil which is coupled to a receiver coil The body coil is the main RF transmitter and transmits RF for most examinations that are a acquired without a transmit receive coil. Typical transmit receive coils are head, extremity and some breast coils. (Westbrook, 2008)

2.1.5 MRI Technique

MRI is highly effective in demonstrating key tissues of the brain, including gray matter, white matter, nerve tissue, basal ganglia, ventricles, and the brain stem. Pathologic conditions best demonstrated with MRI include white matter diseases, multiple sclerosis and other demyelinating disorders, neoplasm, infectious diseases including those associated with AIDS and herpes, hemorrhagic disorders, CVA, and ischemic disorders. (Bushong, 2005)

2.1.5.1 Patient Preparation

Ask the patient if have inner ear implants, artificial joints, pacemaker, brain aneurysm clips, vascular stents, or any metallic objects. All of these things contraindications of MRI. Also tell the patient to remove anything that contains metal including jewelry, glasses, hair pins, watch, braces. Explain the exam in detail and ensure that the patient is comfortable. (Bushong, 2005)

2.1.5.2 Patient positioning

The patient lies supine on the examination couch with their head within the head coil. The head is adjusted so that the interpapillary line is parallel to the couch and the head is straight. The patient is positioned so that the longitudinal alignment light lies in the midline, and the horizontal alignment light passes through the nasion. Straps and foam pads are used for immobilization. (Westbrook, 2008)

2.1.5.3 MR protocol

2.1.5.3.1 Conventional T1- and T2-MRI

Conventional T1 and T2 MRI (T1WI and T2WI) are part of standard imaging protocol in stroke imaging and, along with normal non-contrast CT, have been used in acute stroke primarily to rule out hemorrhage. While both T1WI and T2WI identify vasogenic edema at later times during stroke, 90% of infarctions are visible on T2WI at 24 hours, relative to only 50% on T1WI, and thus T2WI is the ‘gold standard’ in clinical settings for imaging cerebral infarction. However, both normal non-contrast CT and conventional MRI have shown sensitivities of < 50% in imaging ischemic stroke within 6 hours of onset despite the fact that T2WI has signal changes as early as 30 minutes post-stroke in cats and primates. In addition, T1WI and T2WI have shown high false negative rates during the first day after stroke onset.

While T2WI alone is unable to distinguish necrotic tissue from salvageable tissue subacutely, combined with Diffusion-weighting imaging (DWI) it is able to identify salvageable tissue at a much earlier time point. Also, combined T1WI, T2WI, and DWI data is highly correlated with tissue histology. (Wey, et al., 2013)

2.1.5.3.2 Multiparametric MR protocol

Comprehensive MR stroke protocols used routinely in major stroke centers have 3 essential components: (1) parenchymal imaging, which identifies the presence and size of an irreversible infarcted core, determines presence of hemorrhage، and helps to age the ischemic event; (2) MR angiogram to determine the location of arterial occlusion and presence of an intravascular thrombus that can be treated with thrombolysis or thrombectomy; (3) perfusion imaging to determine the presence of hypoperfused tissue at risk for subsequent infarction if adequate perfusion is not restored. (Kambiz & Wayn, 2016)

2.1.5.3.2.1 Diffusion-weighted imaging (DWI)

Diffusion-weighted imaging (DWI) is a form of MR imaging based upon measuring the random Brownian motion of water molecules within a voxel of tissue. In general simplified terms, highly cellular tissues or those with cellular swelling exhibit lower diffusion coefficients. Diffusion is particularly useful in tumor characterization and cerebral ischemia. (Aniket & Usman , 2019) It can detect ischemic tissue within minutes of ictus and has emerged as the most sensitive and specific imaging technique for acute ischemia, far beyond nonenhanced CT or any other type of MR imaging sequences.12 In addition, the pattern of the DWI abnormalities provides insight into the underlying cause and stroke subtype. For example، visualization of multiple small bright lesions on DWI sequences within different vascular territories may indicate an embolic stroke mechanism. (Kambiz & Wayn, 2016)

2.1.5.3.2.2 Apparent diffusion coefficient (ADC)

ADC is a measure of the magnitude of diffusion (of water molecules) within tissue, and is commonly clinically calculated using MRI with diffusion weighted imaging (DWI). DWI is widely appreciated as an indispensable tool in the examination of the CNS. It is considered useful not only for the detection of acute ischemic stroke but also for the characterization and differentiation of brain tumors and intracranial infections. DWI exploits the random motion of water molecules. The extent of tissue cellularity and the presence of intact cell membrane help determine the impedance of water molecule diffusion. This impedance of water molecules diffusion can be quantitatively assessed using the apparent diffusion coefficient (ADC) value. This assessment can be done using different b values via changing gradient amplitude (Francis & Mohammad , 2019)

2.1.5.3.2.3 Fluid-attenuated inversion recovery (FLAIR)

Fluid-attenuated inversion recovery (FLAIR) helps to determine the age of the infarction, permits detection of subtle cerebral subarachnoid hemorrhage، and can add diagnostic value to gradientecho (GRE) images for detecting intra-arterial clot. The most important use of FLAIR imaging in the setting of acute stroke is to identify acute ischemic infarcts that lie within the thrombolytic time window in patients with symptoms first noted on awakening (wake-up stroke), or patients with unwitnessed onset who are unable to provide an accurate history. As a rule, lesion visibility on FLAIR increases as time passes from the stroke onset and up to 93% of acute stroke lesions can have positive FLAIR findings at greater than 6 hours. FLAIR sequences may also show hyperintense vessels following a proximal occlusion even in the absence of parenchymal signal changes. These findings may indicate slow flow in the collateral circulation. In our 6-minute stroke protocol we have replaced conventional FLAIR with echo planar imaging EPI-FLAIR. We have shown that EPI-FLAIR has similar diagnostic performance and quantitative and qualitative results to conventional FLAIR (Fig. 2), but only requires one-third of the acquisition time.20 Because of the shorter acquisition time, EPI-FLAIR may provide better image quality with less motion artifact, particularly in uncooperative patients (Fig. 3). (Kambiz & Wayn, 2016)

2.1.5.3.2.4 Gradient-echo imaging (GRE)

GRE imaging is used to detect intracranial haemorrhage and intraluminal thrombus formation (Fig. 4). Although CT is the standard method used to rule out intracranial haemorrhage, GRE has been shown to be at least as accurate as CT for the detection of acute intraparenchymal haemorrhage. Both FLAIR and specificity. Again, in our 6-minute stroke protocol, EPI-GRE has replaced conventional GRE with similar diagnostic performance but only a fraction of the acquisition time8 (see Fig. 2).

GRE is significantly more sensitive for detection of chronic intracerebral microhemorrhages, which may be the sequelae of amyloid antipathy or chronic hypertension. The clinical importance of these micro bleeds is unknown. At present, there is no statistically significant increased risk of ICH when patients with a small number of chronic microhemorrhages (5>) are treated with thrombolysis. However, the risk of haemorrhage in patients with more than 5 chronic microhemorrhages is unknown.

Haemorrhagic transformation (HT) of an ischemic infarction is a common occurrence, and can be seen in 30% to 74% of patients, particularly in patients with embolic strokes and those treated with thrombolytic or mechanical revascularization therapies. Although CT is equally sensitive for detection of parenchymal hematomas, petechial haemorrhages on the subtler spectrum of HT are detected by GRE with significantly higher GRE images have been used to detect intra-arterial clot with variable sensitivity and sensitivity. The clinical significance of petechial haemorrhage is unknown. (Kambiz & Wayn, 2016)

2.1.5.3.2.5 Magnetic Resonance Angiogram (MRA)

The magnetic resonance angiography (MRA) techniques often used in stroke imaging include the noncontrast time-of-flight (TOF) technique and contrast-enhanced MRA (CE-MRA). Limitations of TOF-MRA include long acquisition times and overestimation of arterial stenosis caused by spin saturation and phase dispersion secondary to slow, in-plane, turbulent, or complex flow. An improved CE-MRA technique with higher spatial resolution and faster acquisition time afforded by advances in technology such as multicoil technology and parallel imaging can now be used in acute stroke imaging for complete evaluation of both the extra cranial and intracranial (see Figs. 2 and 4) supra-aortic arteries, resulting in significant improvement in the performance of stroke protocols in terms of image quality and speed. (Kambiz & Wayn, 2016)

2.1.5.3.2.6 Magnetic Resonance Perfusion

Bolus dynamic susceptibility contrast (DSC) and arterial spin labelling are two methods of measuring cerebral perfusion using MR imaging, each with different strengths and limitations. Faster image acquisition and the ability to generate perfusion maps in a few minutes have made DSC a more robust and widely accepted technique to measure cerebral perfusion in patients with acute stroke. The gadolinium contrast dose is approximately 0.1 moll/kg. Perfusion imaging in patients with presentation of acute stroke syndromes can be used in the following scenarios:

1. Defining ischemic penumbra
2. Collateral flow status (Kambiz & Wayn, 2016)

Table 2.1 Appearance of Arterial Infarcts on Conventional Magnetic Resonance Imaging

Stage	T1	T2	FLAIR	GRE T2*
Hyperacute (0–6 h)	Postcontrast may show vessel enhancement no parenchymal	Absence of flow void Little to no parenchymal abnormality	Hyperintense vessels Little to no parenchymal abnormality	Susceptibility in region of clot
Acute (6–24 h)	Postcontrast vessel enhancement No parenchymal enhancement	Gyriform high signal, sulcal effacement Persistent vascular findings from hyperacute stage	Gyriform high signal, sulcal effacement Persistent vascular findings from hyperacute stage	Can show gyriform susceptibility from petechial hemorrhage
Subacute (1 day to 2 weeks)	Gyriform high signal due to petechial blood, Arterial meningeal, parenchymal enhancement	Gyriform high signal, sulcal effacement	Gyriform high signal, sulcal effacement	Susceptibility from petechial hemorrhage
Chronic	Low signal from cavitation	High signal from gliosis and wallerian degeneration	High signal from gliosis and wallerian degeneration	Susceptibility from petechial hemorrhage

(Bernard , et al., 2011)

2.2 Previous studies

Noman Mawdah Rafat, (2016), Performed study to evaluate of the diffusion magnetic resonance imaging with clinical findings for brain stroke patients in Khartoum state. The study found that most clinical findings for brain stroke are the right/left side weakness (32%) and the right/left side hemiplegia (28%) and the male are more likely to have a stroke by (58%) to (42%) female. Also found the most affected age group (60-80) years by (80%).

Alejandro M. Brunser, (2012), detect the accuracy of diffusion-weighted imaging (DWI) for the diagnosis of acute cerebral ischemia among patients with suspected ischemic stroke arriving to an emergency room has not been studied in depth. The study found that DWI demonstrated a sensitivity of 90% and specificity of 97%, a positive likelihood ratio of 31 and a negative likelihood ratio of 0.1 for detecting AIS. The overall accuracy was 95%. Of those patients who demonstrated abnormal DWI studies, 99.5% were AIS patients, and of those patients with normal DWI studies 63% were stroke mimics.

Fergus N Doubal, (2009), performed study to determine the rate of negative MRI (including DWI) and associated features in patients presenting to hospital with minor strokes, the study found there is a high rate of negative MRI and DWI among patients with minor stroke (a third) which has important management and research implications. A negative MRI or DWI does not exclude the diagnosis of stroke.

Steven Warach, (2007), performed study to prospectively compare CT and MRI for emergency diagnosis of acute stroke, the study found that MRI (with diffusion-weighted imaging) is better than CT for detection of acute ischemia, and can detect acute and chronic hemorrhage; therefore, it should be the preferred test for accurate diagnosis of patients with suspected acute stroke. Because our patient sample encompassed the range of disease that is likely to be encountered in emergency cases of suspected stroke, our results are directly applicable to clinical practice.

Jun Ma, (2004), Performed study to find if the diffusion and perfusion mismatch can predict the outcome of ischemic stroke data showed that relative cerebral blood flow value were useful in prediction of the stroke outcome. also result shows the time between ictus to MRI scan ranged from 0.9 to 72 hours. There were (60%) patients examined by MRI within 6 hours, and (40%) patients between 6 and 72 hours. and Between the good and poor outcome groups, time to scan (17.1±22.1 versus 11.1±12 hours), DW/PW volume ratio (0.40±0.15 versus 0.36±0.11), age (59.6±16.7 versus 63.2±13.5 years) and female/male ratio (9/10 versus 6/10) did not show significant differences.

Johanna Helenius, (2002), Performed study to show the absolute apparent diffusion coefficient (ADC) values in the normal human brain and the effect of aging on diffusion and determine whether the average ADC (ADC) values in the various regions of the brain differ with age, sex, or hemisphere and to establish reference values of the absolute ADC for further studies, the study found that the ADC values did not significantly change with aging, except for an increase in the lateral ventricles. No difference was observed between women and men or between the hemispheres.

R. Gilberto Gonza´lez, (2000), performed study to evaluate the diagnostic accuracy of diffusion-weighted magnetic resonance (MR) imaging performed within 6 hours of the onset of stroke symptoms, this study found diffusion-weighted MR imaging is highly accurate for diagnosing Stroke within 6 hours of symptom onset and is superior to CT and conventional MR imaging.

K.J Van Everdingen, (2000), performed study to compare the sensitivity of DWI with that of conventional MRI techniques. Furthermore, investigated the prognostic value of the volume of ischemic lesions on DWI scans and of the apparent diffusion coefficient (ADC), the study found the DWI is a better imaging method than conventional MRI in detecting early ischemic lesion in stroke patients.

Chapter Three

Materials and Methods

Chapter Three

3.1 Materials

3.1.1 Patients

All patients who came to MRI department for brain imagine with neurological defect of Alamal National Hospital with symptoms of ischemic stroke between July 2018 and November 2018 were reviewed. Approximately 50 patients underwent brain MR imaging.

3.1.2 Machine used

MRI machines Philips 1.5 Tesla, made in Holland in 2011
The coil that used for the study: Head coil.

3.2 Methods

3.2.1 Image interpretation

Data collected from MRI findings which appear in DWI MRI and the data represented in tables and graphs. The data included the general patient's data (Age, gender) and accompanied by the related to symptoms and clinical information such as clinical signs (aphasia, hemiparesis recuts, right hemiparesis, left hemiparesis, weakness of left leg, weakness of right side and weakness of left arm) and time of scan from symptoms onset

3.2.2 The techniques used in the study

3.2.2.1 Patient Preparation:

Ask the patient if have inner ear implants, artificial joints, pacemaker, brain aneurysm clips, vascular stents, or any metallic objects, all of these things are contraindications of MRI. Also tell the patient to remove anything that contains metal including jewelry, glasses, hair pins, watch, braces. Explain the exam in detail and ensure that the patient is comfortable.

3.2.2.2 Patient positioning

Patient supine with his head within the head coil and the longitudinal alignment light lies in the midline and the horizontal alignment light passes through the nasal, Straps and foam pads are used for immobilization.

3.2.2.3 Protocols that used for study

Axial T1 weighted, T2 weighted and FLAIR images
Axial Diffusion weighted image
Coronal T2 weighted image
Sagittal T1 weighted image

3.2.3 Data analysis

The data were analysed by using frequency tables and were present in tables and figures by Microsoft Office Excel 2016.

Chapter Four

Results

Chapter Four

4.1 Results

Table 4.1: Presenting the frequency and the percentage of gender.

Gender	Frequency	Percentage
Female	22	44.00%
Male	28	56.00%
Total	**50**	**100.00%**

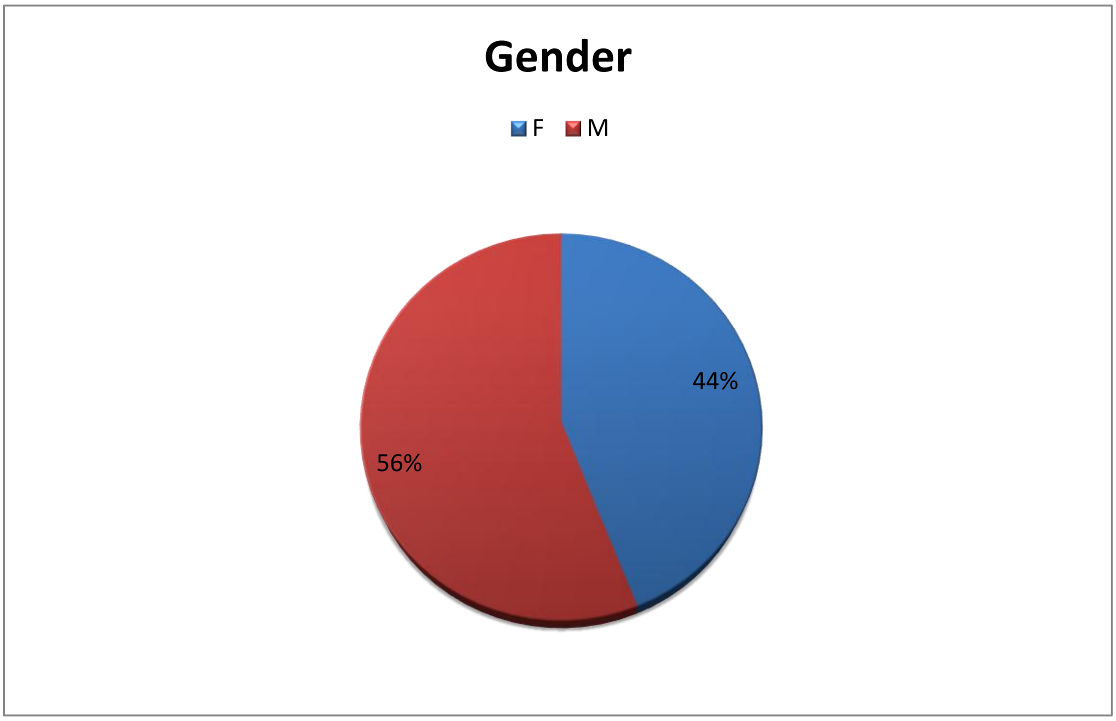


Figure 4.1: Presenting the relation between age group and the percentage.

Table 4.2: Presenting the frequency and the percentage of age group.

Age	Frequency	Percentage
26-35	1	2.00%
36-45	6	12.00%
46-55	6	12.00%
56-65	12	24.00%
66-75	15	30.00%
76-85	8	16.00%
86-95	2	4.00%
Grand Total	**50**	**100.00%**

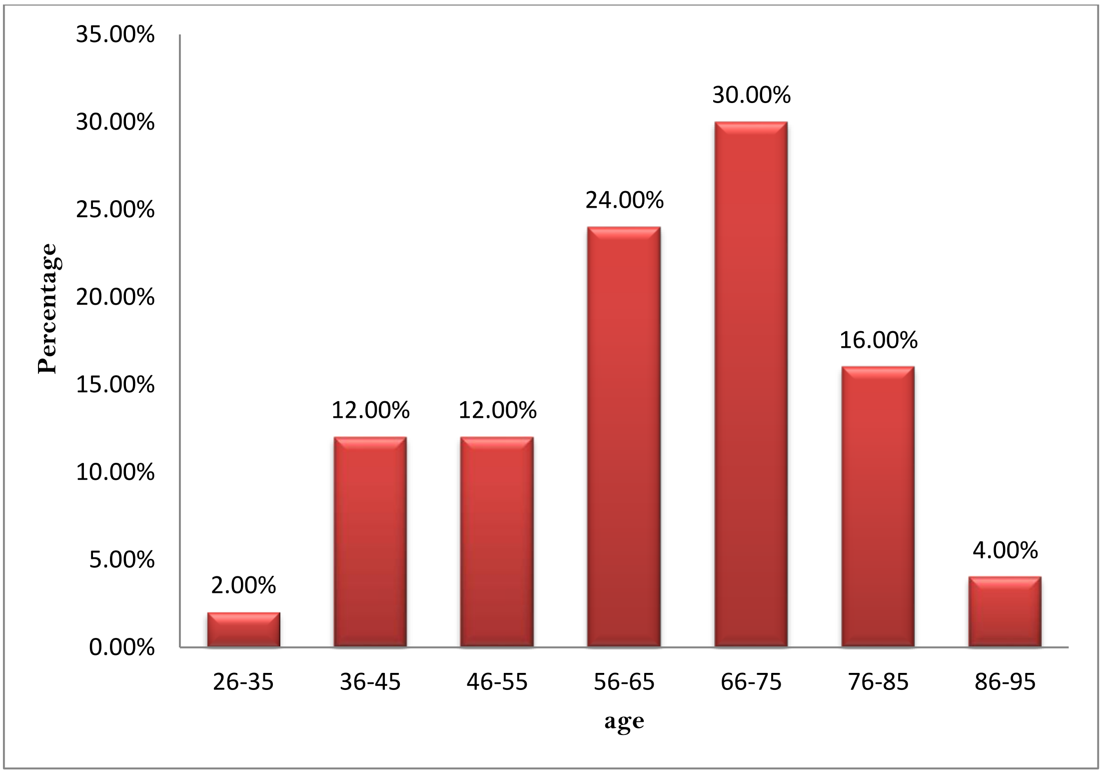


Figure 4.2: Presenting the relation between age group and the percentage.

Table 4.3: Presenting Symptoms, frequency and percentage of the patients

Symptoms	frequency	percentage
aphasia	36	47%
hemiparesis recuts	2	2.78%
right hemiparesis	23	31.65%
left hemiparesis	12	13.57%
weakness of left leg	2	2%
weakness of right side	1	1%
weakness of left arm	2	2%

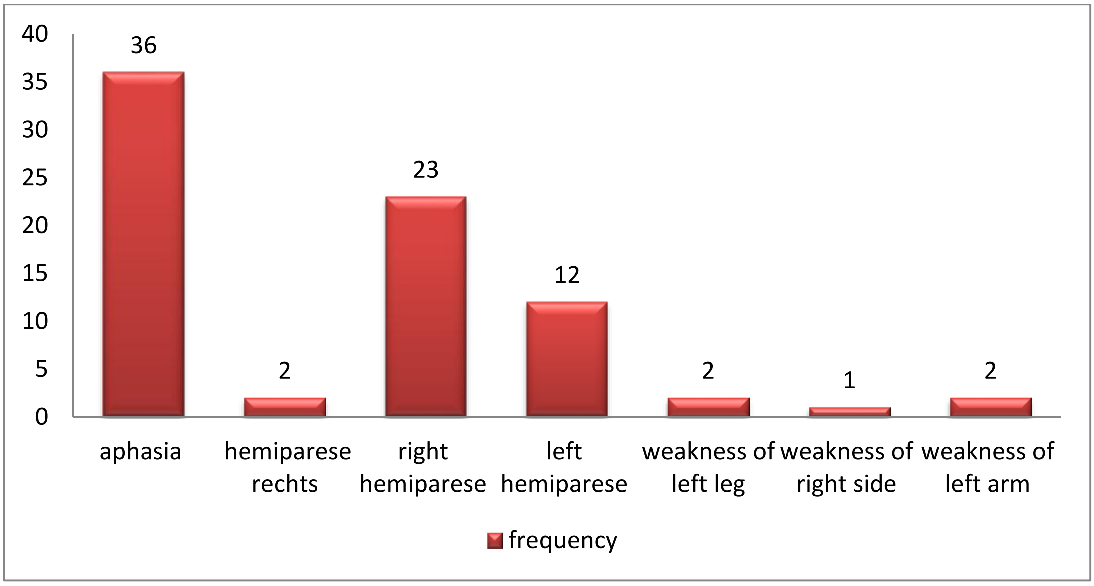


Figure 4.3: Presenting Complaints of the patients

Table 4.4: Presenting the frequency and the percentage of Scan time per hour.

Scan time (h)	Frequency	Percentage
0.9-10.9	29	58.00%
10.9-20.9	12	24.00%
20.9-30.9	3	6.00%
40.9-50.9	4	8.00%
60.9-70.9	1	2.00%
70.9-80.9	1	2.00%
Grand Total	**50**	**100.00%**

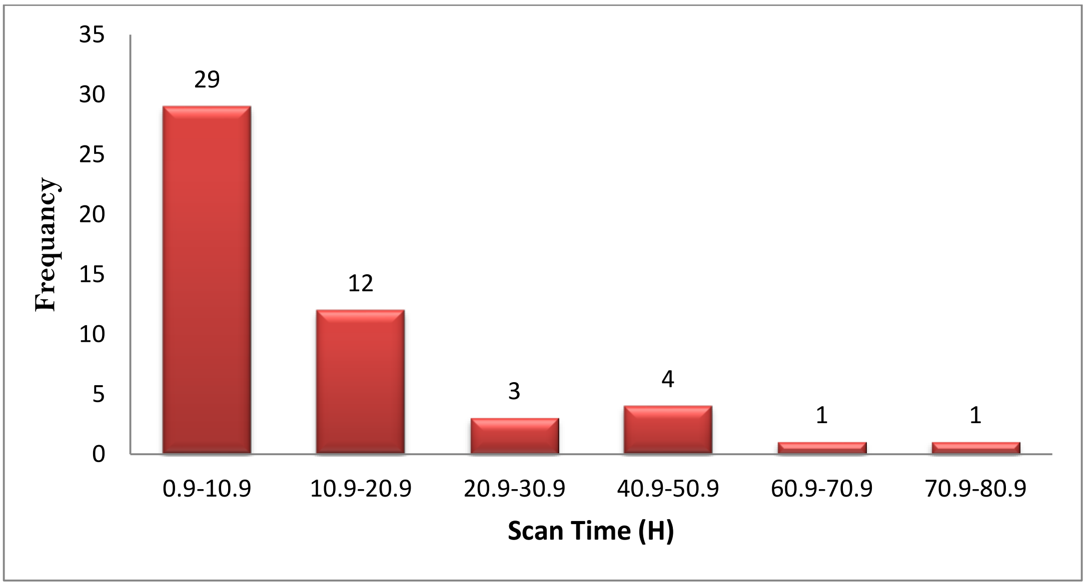


Figure 4.4: Presenting the relation between Scan time and the frequency.

Table 4.5: Presenting the frequency and the percentage of Site of infarct.

Site of infarct	Frequency	Percentage
Anterior cerebral circulation	4	8.00%
Middle cerebral circulation	30	60.00%
Posterior cerebral circulation	9	18.00%
Lacunar	7	14.00%
Grand Total	**50**	**100.00%**

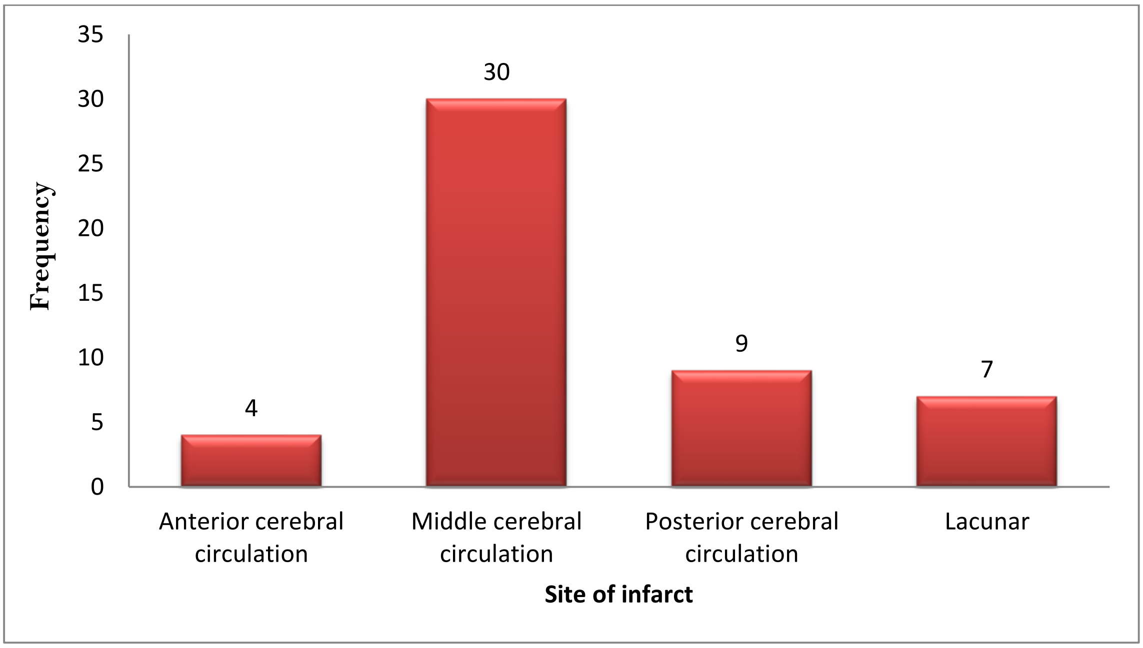


Figure 4.5: Presenting the relation between Site of infarct and the frequency.

Table 4.6: Presenting the relation between Site of infarct and the Gender.

Site of infarct	Male	Female
Anterior cerebral circulation	3	1
Middle cerebral circulation	15	15
Posterior cerebral circulation	4	5
Lacunar	6	1

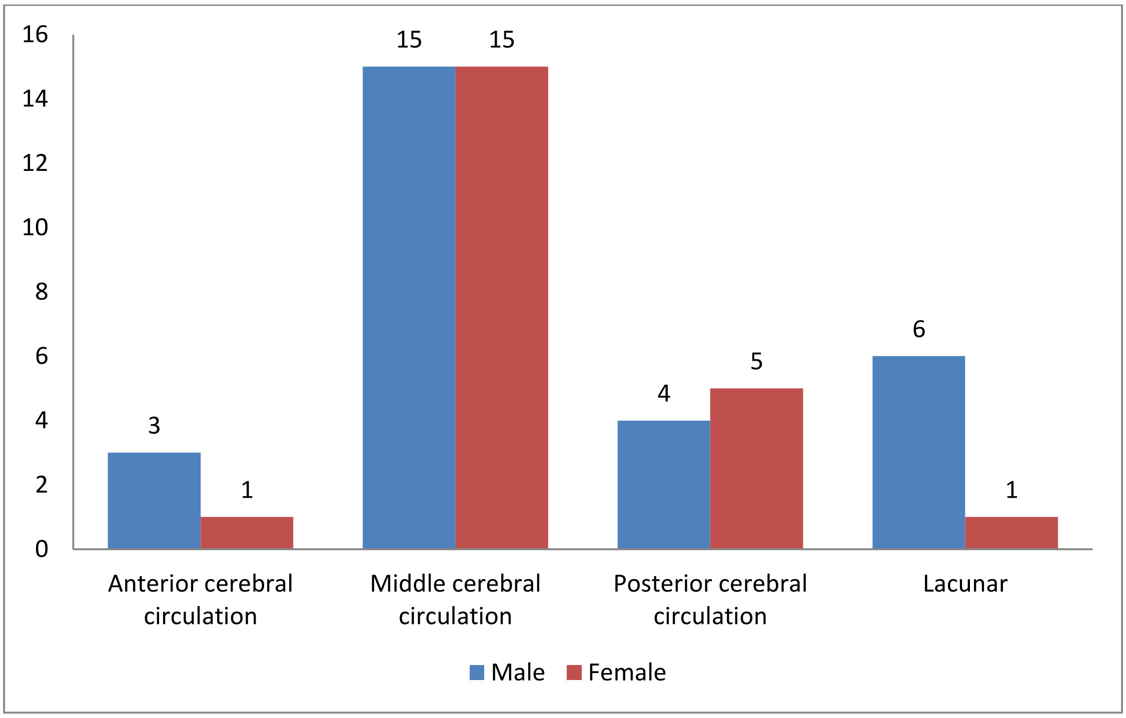


Figure 4.6: Presenting the relation between Site of infarct and the Gender.

Table 4.7: The characteristic appearance of ischemic infarction on ADC map, diffusion-weighted imaging and T2WI

	Acute stage (minutes)	Subacute stage (hours– days)	9-10 days	Complete infarction
ADC	Decrease, hypointense	Decrease, hypointense	Isointense	Increase, hyperintense
DWI	Hyperintense	Hyperintense	Hyperintense	Hyperintense or isointense
T2WI	Isointense (not detectable)	Hyperintense from 24 hrs.	Hyperintense	Hyperintense

Chapter Five

Discussion, Conclusion and Recommendations

5.1 Discussion

The fundamental examinations acquired from this study uncovered that the ischemic stroke patient's partaken in this study, men's with being more influenced than women’s in respects with ischemic stroke disease, as our study including 28 males and 22 females, which is 56% males to 44% females and that concur with (Miniño, 2010,) results.

The fundamental examinations acquired from this study uncovered that the ischemic stroke patient's partaken in this study, patients with old ages more influenced than more youthful patient's, we found the most influenced age group is (56-65)yrs. were that 12 patient 24% and (66-75) were that 15 patient 30% and that concur with (Noman, 2016) results.

The fundamental examinations acquired from this study uncovered that the ischemic stroke patient's partaken in this study, we found the most patients symptoms are aphasia by 36 frequency 47% percentage, right hemiparesis 23 frequency 31.65% percentage and left hemiparesis 12 frequency 13.57% percentage, and that concur with (Noman, 2016) results

The fundamental examinations acquired from this study uncovered that the ischemic stroke patient's partaken in this study, patients came at the first 10 hour of stroke symptoms onset, which is (0.9-10.9) scan time per hour 29 frequency 58% percentage and (10.9-20.9) scan time per hour 12 frequency 24% percentage. and that concur with (Jun Ma, 2004)

One of the most interesting observations obtained from this study is to identify the common site of ischemic stroke, the outcome demonstrates that the level of stroke most happen in Middle cerebral circulation was 60% 30 from aggregate number of study test, and Less incidence in Anterior cerebral circulation 8% with 4 frequencies. and that concur with (Jun Ma, 2004)

In the present study, data showed the relation between gender and site of infarction are similar in Middle cerebral circulation for both gender, but increase for male in other site except in Posterior cerebral circulation that occur in female more than male. and that concur with (Jun Ma, 2004)

The characteristic appearance of ischemic infarction in acute stage it decrease hypointense in ADC, Hyperintense in DWI, Isointense (not detectable) T2WI. Subacute stage (hours – days) Keep as it is in ADC and DWI but in T2WI appear Hyperintense from 24 hrs. 9-10 days appear isointense in ADC, and hyperintense in both DWI and T2WI. the Complete infarction it appear hyperintense in all image or isointense in DWI and that concur with (Jun Ma, 2004)

5.2 Conclusions

Every one of the patients alluded to Doctors facility clinic with neurological side effects speculated ischemic stroke and asked for brain MRI (56%) male and (44%) female, (54%) more established individuals (56-75years) and most clinical findings for ischemic stroke found are aphasia (47%) and right hemiparesis (31.65%), (58%) of patients came at the first 10 hour of stroke symptoms onset, we found Middle cerebral circulation is most site of infarction by (60%). And we found Diffusion-weighted imaging (DWI) is best image for detection of ischemic stroke for all stages.

5.3 Recommendations

1. We recommend in next studies to study using Perfusion weighted imaging (PWI) in ischemic stroke imagine ass main protocol.

2. We recommend studying the effectiveness of functional MR in diagnosing ischemic stroke

3. Apply picture archiving and communication system (PACS) system in hospitals.

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Appendices

Data sheet

Hospital:

1. Age ______________________

2. Sex ☐ male ☐ female

3. Symptoms

☐ Aphasia ☐ Right hemiparesis ☐ Left hemiparesis

☐ Weakness of right arm ☐ Weakness of left arm ☐ Weakness of right leg

☐ Weakness of left leg ☐ Weakness of right side ☐ Weakness of right side

4. Time of scan from Symptoms onset ☐

5. Site of infarct :

☐ Anterior cerebral circulation

☐ Middle cerebral circulation

☐ Posterior cerebral circulation

☐ Lacunar

6. Intensity

Sequence	Intensity
T2W	
DWI	
ADC	

Final Diagnosis

Differential diagnosis