Sudan University of Science and Technology

College of Graduate Studies

Evaluation of Diffusion Magnetic Resonance Imaging with Clinical Findings for Brain Stroke Patients in Khartoum State

تقويم تصوير الرنين المغناطيسي الانتشاري مع النتائج السريرية لمرضى الجلطة الدماغية في ولاية الخرطوم

A thesis Submitted for Partial Fulfillment for the requirement of M.Sc Degree in Diagnostic Radiological Technology

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الاية

بسم الله الرحمن الرحيم

((وَأَنْزَلَ اللَّهُ عَلَيْكَ الْكِتَابَ وَالْحِكْمَةَ وَعَلَّمَكَ مَا لَمْ تَكُنْ تَعْلَمُ وَكَانَ فَضْلُ اللَّهِ عَلَيْكَ عَظِيمًا))

صدق الله العظيم

جزء من الايه 113 سورة النساء

Dedication

To my father who never stop believing me

To my mother who always support me

To my brother and my sisters

To all people who assisted me

To my university Alzaiem Alazhari University

Acknowledgement

First of all, a deeply thank to my supervisor **Dr/ Duha Abdu Mohammed Abdu** who provided me professional help and support me in this study.

Secondly a big thank to my family for all their hard work to stand beside me and give me the hope.

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Abstract

The aim of this study is to evaluate of the diffusion magnetic resonance imaging with clinical findings for brain stroke patients in Khartoum state, to evaluate the doctor's experience about the diffusion weighted imaging for brain stroke, measure the accuracy of diffusion weighted imaging in detection brain stroke, compare the DWI findings and the conventional MRI protocols findings for brain stroke, determine the most clinical findings for brain stroke and to determine the MRI departments in Khartoum state that using diffusion-weighted imaging.The data of 50 patients undergone MRI brain with DWI was collected from doctors clinic hospital by clinical data sheet and the data were analyzed by Microsoft office Excel and visited ten MRI departments to shows the DWI was apply or not. The results of this study shows 9 (18%) only of patients suspected brain stroke requested for MRI brain with DWI that obtain the deficiency of doctors experience about DWI for stroke, 40 (80%) of strokes diagnosis by DWI that prove the highly accuracy of DWI in detection brain stroke, the conventional MRI protocols show 50 (100%) the same findings in both positive and negative DWI findings, so the conventional MRI protocols can not detect the brain stroke and the most clinical findings for brain stroke are the right/left side weakness 16 (32%) and the right/left side hemiplegia 14 (28%). All the ten MRI departments apply the diffusion weighted imaging and five (50%) of the MRI departments use the DWI as an essential protocol and five (50%) uses DWI only when requested by the doctors.

ملخص الدراسة

الهدف من هذه الدراسة هو تقييم تصوير الرنين المغناطيسي الانتشاري مع النتائج السريرية لمرضى الجلطة الدماغية في ولاية الخرطوم ،تقييم خبرة الاطباء عن التصوير الانتشاري للجلطة الدماغية،قياس دقة التصوير الانتشاري في كشف الجلطة الدماغية،مقارنة نتائج التصوير الانتشاري ونتائج تقنيات الرنين المغناطيسي التقليدية للجلطة الدماغية،تحديد اكثر النتائج السريرية للجلطة الدماغية ولتحديد اقسام الاشعة في الخرطوم التي تستخدم التصوير الانتشاري.جمعت بيانات 50مريضا خضعو للرنين المغناطيسي مع التصوير الانتشاري من مستشفى الاطباء وذلك بواسطة ورقة بيانات سريرية و حللت البيانات بواسطة برنامج الاكسيل و زيارة 10اقسام رنين مغناطيسي لمعرفة اذا كان الرنين المغناطيسي الانتشاري مطبق ام غير مطبق.نتائج هذه الدراسة توضح9(18%) فقط من المرضى المشتبه بهم الجلطة الدماغية طلب منهم الرنين المغناطيسي للدماغ بالاضافة للتصوير الانتشاري وذلك يوضح نقص في خبرة الاطباء عن التصوير الانتشاري للجلطة الدماغية،40 (80%) من الجلطات تم تشخيصها بواسطة التصوير الانتشاري وذلك يثبت الدقة العالية للتصوير الانتشاري في كشف الجلطة الدماغية، نتائج تقنيات الرنين المغناطيسي التقليدية50(100%) اظهرت نفس النتائج مقارنة بنتائج التصوير الانتشاري الايجابية والسلبية وذلك يدل على ان تقنيات الرنين المغناطيسي التقليدية لا تستطيع كشف الجلطة الدماغية،اكثر الاعراض السريرية للجلطة الدماغية هي16(32%) ضعف في الجانب الايمن/الايسر و14(28%) شلل نصفي في الجانب الايمن/الايسر.كل اقسام الرنين المغناطيسي العشرة تطبق التصوير الانتشاري خمسة (50%) منها تطبقه كتقنية اساسية وخمسة (50%) تطبق التصوير الانتشاري فقط عند طلب الطبيب.

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List of abbreviations

MRI	Magnetic Resonance Imaging
CT	Computerized Tomography
DWI	Diffusion Weighted Image
CNS	Central Nervous System
PNS	Peripheral Nervous System
CSF	Cerebro Spinal Fluid
ACA	Anterior Cerebral Artery
PCA	Posterior Cerebral Artery
MCA	Middle Cerebral Artery
TIA	Transient Ischemic Attack
CVA	Cerebral Vascular Attack
AIDS	Acquired Immune Deficiency Syndrome
EPI	Echo Planner Imaging
ADC	Apparent Diffusion Coefficient
FLAIR	Fluid Attenuation Inversion Recovery
PACS	Picture Archiving and Communication System
DVD	Digital Versatile Disc
SE	Spin echo
FSE	Fast Spin Echo
SS	Single Shot
GRE	Gradient Echo
IR	Inversion Recovery
MT	Magnetization Transfer
SNR	Signal to Noise Ratio
PD	Proton Density

Chapter one

Introduction

1.1Introduction:

A stroke is a serious medical condition that requires emergency care. It can cause lasting brain damage, long-term disability, or even death. A stroke occurs when blood flow to a part of the brain is interrupted as a result of a broken or blocked blood vessel. Stroke may be hemorrhagic or ischemic. A hemorrhagic stroke occurs when a blood vessel in the brain ruptures or breaks, allowing blood to leak into the brain. An ischemic stroke occurs when a blood vessel carrying blood to the brain is blocked or restricted by severely narrowed arteries or a blood clot. In the United States, strokes are a major health problem. Every year, around 110,000 people have a stroke in England and it is the third largest cause of death, after heart disease and cancer. The brain injuries caused by strokes are a major cause of adult disability in the United States. Someone has a stroke every 53 seconds. Someone dies of a stroke every 3 minutes. Older people are most at risk of having strokes, although they can happen at any age including in children and stroke is more common in men than in women. (Miniño et al, 2010)

The first step in assessing a stroke patient is to determine whether the patient is experiencing an ischemic or hemorrhagic stroke so that the correct treatment can begin, Immediate stroke treatment can help save lives and reduce disability by restoring blood flow for an ischemic stroke or controlling bleeding and reducing pressure on the brain in the case of a hemorrhagic stroke. A CT scan or MRI of the head is typically the first test performed. MRI (Magnetic resonance imaging) is a test that uses a magnetic field and pulses of radio wave energy to make pictures of organs and structures inside the body. In many cases, MRI gives different information about structures in the body than can be seen with an X-ray, ultrasound, or computed tomography scan. MRI also may show problems that cannot be seen with other imaging methods. Magnetic resonance imaging device offers stunning images of the brain, spine, and soft tissues located around joints. (Chalela JA et al, 2007)

Diffusion-weighted magnetic resonance imaging provides potentially unique information on the viability of brain tissue. It provides image contrast that is dependent on the molecular motion of water, which may be substantially altered by disease. The method was introduced into clinical practice in the middle 1990s. The primary application of diffusion-weighted magnetic resonance imaging has been in brain imaging, mainly because of its exquisite sensitivity to ischemic stroke—a common condition that appears in the differential diagnosis in virtually all patients who present with a neurologic complaint. Because diffusion-weighted magnetic resonance imaging uses fast (echo-planar) imaging technology, it is highly resistant to patient motion, and imaging time ranges from a few seconds to 2 minutes. Diffusion-weighted magnetic resonance imaging provides image contrast that is different from that provided by conventional magnetic resonance 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. Because stroke is common and in the differential diagnosis of most acute neurologic events, diffusion-weighted magnetic resonance imaging should be considered an essential sequence, and its use in most brain magnetic resonance studies is recommended. (Keir S et al, 2004) .

1.2Problem of the study:

Stroke is the one of most leading cause of death and the leading cause of sever disability and conventional magnetic resonance imaging may not show positive findings in cases of acute stroke when the diffusion weighted imaging can diagnosis the stroke early. Importance of this study lies in avoiding misdiagnosis or incomplete diagnosis and also to find out the best modality to detect the expected disease and to develop the perfect plan to treat the disease without delay on the other hand we can assess the accuracy of diffusion weighted imaging.

1.3 Objectives:

1.3.1General objective:

To evaluate the diffusion magnetic resonance imaging with the clinical findings for brain stroke patients in Khartoum state.

1.3.2Specific objectives:

1. To evaluate the doctor's experience about diffusion weighted imaging in patients with brain stroke.
2. To measure the accuracy of diffusion weighted imaging in detection brain stroke.
3. To compare between the DWI findings and the conventional MRI findings for brain stroke.
4. To determine the most clinical findings for brain stroke.
5. To determine the MRI departments in Khartoum state that using diffusion-weighted imaging.

1.4Significance of the study:

This study will provide rich information about diffusion weighted imaging for brain stroke. Diffusion weighted imaging helps in early detect of brain stroke so that it helps in early treatment and prevent complications.

1.5Overview 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

2.1 Theoretical background

2.1.1 Anatomy of the Brain

2.1.1.1 Skull

The purpose of the bony skull is to protect the brain from injury. The skull is formed from 8 bones that fuse together along suture lines. These bones include the frontal, parietal (2), temporal (2), sphenoid, occipital and ethmoid (Fig2.1). The face is formed from 14 paired bones including the maxilla , zygoma, nasal, palatine, lacrimal, inferior nasal conchae, mandible, and vomer (Martini, Frederic H, 2007)

2.1.1.2 Meninges

The brain and spinal cord are covered and protected by three layers of tissue called meninges. From the outermost layer inward they are: the dura mater, arachnoid mater, and pia mater (Figure 2.2). The dura mater is a strong, thick membrane that closely lines the inside of the skull; its two layers, the periosteal and meningeal dura, are fused and separate only to form venous sinuses. The dura creates little folds or compartments. There are two special dural folds, the falx and the tentorium. The falx separates the right and left hemispheres of the brain and the tentorium separates the cerebrum from the cerebellum. The arachnoid mater is a thin, web-like membrane that covers the entire brain. The arachnoid is made of elastic tissue. The space between the dura and arachnoid membranes is called the subdural space. The pia mater hugs the surface of the brain following its folds and grooves. The pia mater has many blood vessels that reach deep into the brain. The space between the arachnoid and pia is called the subarachnoid space. It is here where the cerebrospinal fluid bathes and cushions the brain. (Martini, Frederic F, 2007)

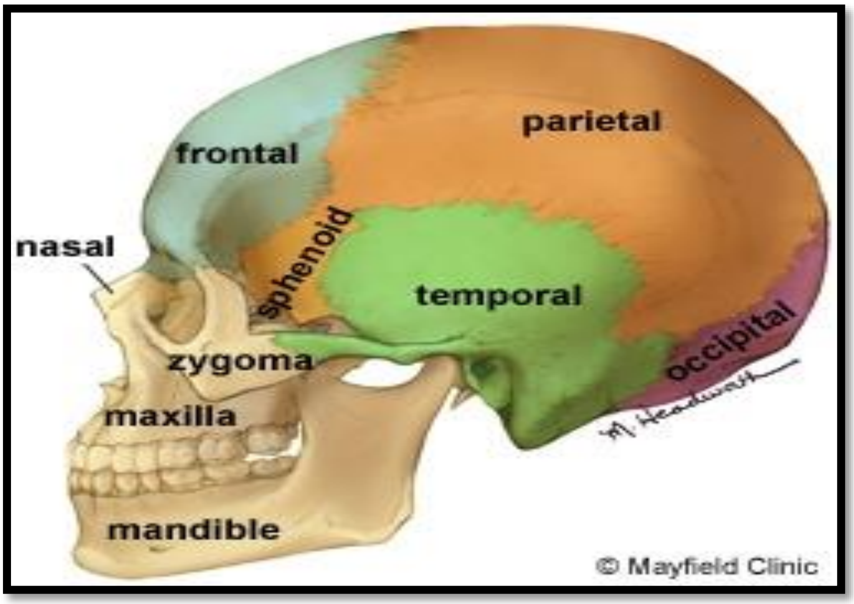


Figure2.1 The skull. (http://Mayfieldclinic.com)

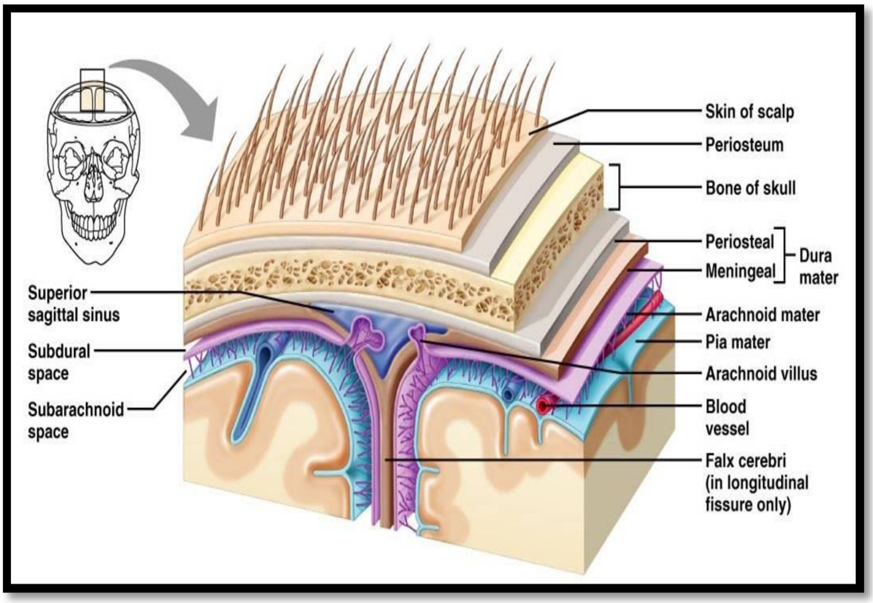


Figure 2.2 Meninges (http://faculty.irsc.edu.com**)**

2.1.1.3 Ventricles and cerebrospinal fluid

The brain has hollow fluid-filled cavities called ventricles (Fig2.3). Inside the ventricles is a ribbon-like structure called the choroid plexus that makes clear colorless cerebrospinal fluid. CSF flows within and around the brain and spinal cord to help cushion it from injury. This circulating fluid is constantly being absorbed and replenished. There are two ventricles deep within the cerebral hemispheres called the lateral ventricles. They both connect with the third ventricle through a separate opening called the foramen of Monro. The third ventricle connects with the fourth ventricle through a long narrow tube called the aqueduct of Sylvius. From the fourth ventricle, CSF flows into the subarachnoid space where it bathes and cushions the brain. CSF is recycled or absorbed by special structures in the superior sagittal sinus called arachnoid villi. (Martini, Frederic H, 2007)

2.1.1.4 Cerebrum:

The cerebral hemispheres are narrower posteriorly, at the occipital pole, than anteriorly, at the frontal pole .The midline longitudinal cerebral fissure, occupied in life by the falx cerebri, incompletely separates the two cerebral hemispheres from one another. The floor of the cerebral fissure is formed by the corpus callosum, a large myelinated fiber tract that forms an anatomical and functional connection between the right and left hemispheres. The surface few millimeters of the cerebral hemisphere are composed of a highly folded collection of gray matter, known as the cerebral cortex. This folding increases the surface area and presents elevations, gyri, and depressions, sulci. Deep to the cortex is a central core of white matter that forms the bulk of the cerebrum and represents fiber tracts, supported by neuroglia, ferrying information destined for the cortex and cortical responses to other regions of the central nervous system .(Maria et al, 2006)

2.1.1.5 Lobes of the cerebral hemispheres

Each cerebral hemisphere is subdivided into five lobes: the frontal, parietal, temporal, and occipital lobes, and the insula(fig2.4). Additionally, the cortical constituents of the limbic system are also considered to be a region of the cerebral hemisphere and some consider it to be the sixth lobe, the limbic lobe. Viewed from the side, each cerebral hemisphere resembles the shape of a boxing glove, where the thumb is the temporal lobe and is separated from the parietal lobe by the lateral fissure. Although the geographic distributions of many of the sulci and gyri are relatively inconsistent, some regularly occupy specific locations, are recognizable in most brains, and are named. The sulci are generally smaller and shallower than the fissures, and one of these, the central sulcus, separates the frontal lobe from the parietal lobe. The division between the parietal and occipital lobes is not readily evident when viewed from the lateral aspect because it is defined as the imaginary line between the preoccipital notch and the parieto-occipital notch. (Maria et al, 2006)

2.1.1.5.1 Frontal lobe

The frontal lobe extends from the frontal pole to the central sulcus, constituting the anterior one-third of the cerebral cortex. Its posterior most gyrus, the precentral gyrus, consists of the primary motor area and is bordered anteriorly by the precentral sulcus and posteriorly by the central sulcus. The region of the frontal lobe located anterior to the precentral sulcus is subdivided into the superior, middle, and inferior frontal gyri. This subdivision is due to the presence, though inconsistent, of two longitudinally disposed sulci, the superior and inferior frontal sulci. The inferior frontal gyrus is demarcated by extensions of the lateral fissure into three subregions: the pars triangularis, pars opercularis, and pars orbitalis. In the dominant hemisphere, a region of the inferior frontal gyrus is known as Broca's area, which functions in the production of speech. On its inferior aspect, the frontal lobe presents the longitudinally disposed olfactory sulcus. Medial to this sulcus is the gyrus rectus, and lateral to it are the orbital gyri. The olfactory sulcus is partly occupied by the olfactory bulb and olfactory tract. At its posterior extent, the olfactory tract bifurcates to form the lateral and medial olfactory striae. The intervening area between the two striae is triangular in shape and is known as the olfactory trigone and it abuts the anterior perforated substance. On its medial aspect, the frontal lobe is bordered by the arched cingulate sulcus, which forms the boundary of the superior aspect of the cingulate gyrus. The quadrangular-shaped cortical tissue anterior to the central sulcus is a continuation of the precentral gyrus and is known as the anterior paracentral lobule. (Maria et al, 2006) .

2.1.1.5.2 Parietal lobe

The parietal lobe is interposed between the frontal and occipital lobes and is situated above the temporal lobe. On its lateral aspect, its anteriormost gyrus, the postcentral gyrus, is the primary somesthetic area to which primary somatosensory information is channeled from the contralateral half of the body. The remainder of the parietal lobe, separated from the postcentral gyrus by the postcentral sulcus, is subdivided by the inconsistent intraparietal sulcus, into the superior and inferior parietal lobules. The former is an association area involved in somatosensory function, whereas the latter is separated into the supramarginal gyrus, which integrates auditory, visual, and somatosensory information, and the angular gyrus, which receives visual input. On its medial aspect, the parietal lobe is separated from the occipital lobe by the parieto occipital sulcus and its inferior continuation, the calcarine fissure. This region of the parietal lobe is subdivided into two major structures, the anteriorly positioned posterior paracentral lobule a continuation of the postcentral gyrus and the posteriorly situated precuneus. (Maria et al, 2006)

2.1.1.5.3 Temporal lobe

The temporal lobe, the "thumb of the boxing glove," is situated inferiorly to the lateral fissure and anterior to the parieto-occipital sulcus The temporal lobe is separated from the frontal and parietal lobes by the lateral fissure and from the occipital lobe by an imaginary plane that passes through the parieto-occipital sulcus. The anteriormost aspect of the temporal lobe is known as the temporal pole. On its lateral aspect, the temporal lobe exhibits three parallel gyri, the superior, middle, and inferior temporal gyri, separated from each other by the inconsistently present superior and middle temporal sulci. The superior temporal gyrus of the dominant hemisphere contains Wernicke's area, which is responsible for the individual's ability to speak and understand the spoken and written word. Hidden within the lateral fissure is the superior aspect of the temporal lobe whose surface is marked by the obliquely running transverse temporal gyri , the primary auditory cortex. The inferior aspect of the temporal lobe is grooved by the inferior temporal sulcus that is interposed between the inferior temporal gyrus and the lateral occipitotemporal gyrus. The collateral sulcus separates the fusiform gyrus from the parahippocampal gyrus of the limbic lobe. (Maria et al, 2006)

2.1.1.5.4 Occipital lobe

The occipital lobe extends from the occipital pole to the parieto-occipital sulcus. On its lateral aspect, the occipital lobe presents the superior and inferior occipital gyri, separated from each other by the horizontally running lateral occipital sulcus On its medial aspect, the occipital lobe is subdivided into the superiorly located cuneate gyrus and the inferiorly positioned lingual gyrus, separated from each other by the calcarine fissure. The cortical tissue on each bank of this fissure is known collectively as the striate cortex, and forms the primary visual cortex. (Maria et al, 2006)

2.1.1.6 Cerebellum

The cerebellum is located in the posterior aspect of the brain, just below the occipital lobes of the cerebrum (Figs 2.5). It is separated from the cerebrum via a horizontal dural reflection, the tentorium cerebelli. The cerebellum is connected to the midbrain, pons, and medulla of the brainstem via three pairs of fiber bundles, the superior, middle, and inferior cerebellar peduncles, respectively. Viewing the cerebellum, it can be seen that it is composed of the right and left cerebellar hemispheres and the narrow, intervening vermis. The vermis is also subdivided into a superior and an inferior portion, where the superior portion is visible between the two hemispheres, while its inferior portion is buried between the two hemispheres. The surface of the cerebellum has horizontal elevations, known as folia, and indentations between the folia, known as sulci. Some of these sulci are deeper than others and they are said to subdivide each hemisphere into three lobes, the small anterior lobe, the much larger posterior lobe, and the inferiorly positioned flocculonodular lobe formed from the nodule of the vermis and the flocculus of each cerebellar hemisphere. The anterior lobe is separated from the posterior lobe by the primary fissure, and the posterolateral fissure separates the flocculonodular lobe from the posterior lobe . Similar to the cerebrum, the cerebellum has an outer rim of gray matter, the cortex, an inner core of nerve fibers, the medullary white matter, and the deep cerebellar nuclei, located within the white matter. The cortex and white matter are easily distinguished from each other in a midsagittal section of the cerebellum, where the white matter arborizes, forming the core of what appears to be a tree-like architecture, known as the arbor vitae. (Maria et al, 2006).

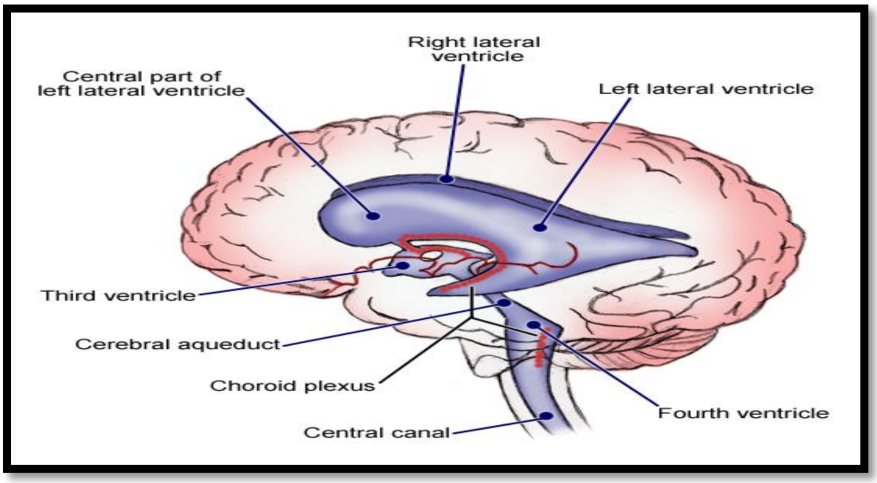


Figure 2.3 Ventricles of the brain (http://withealth.net)

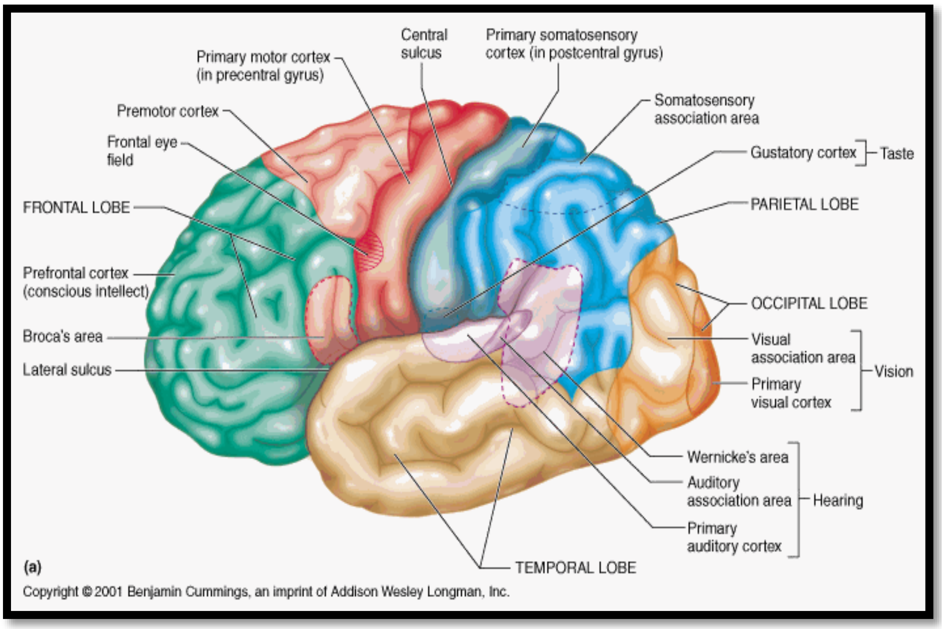


Figure 2.4 lobes of cerebral hemisphers (http://legacy.owensboro.kctcs.edu)

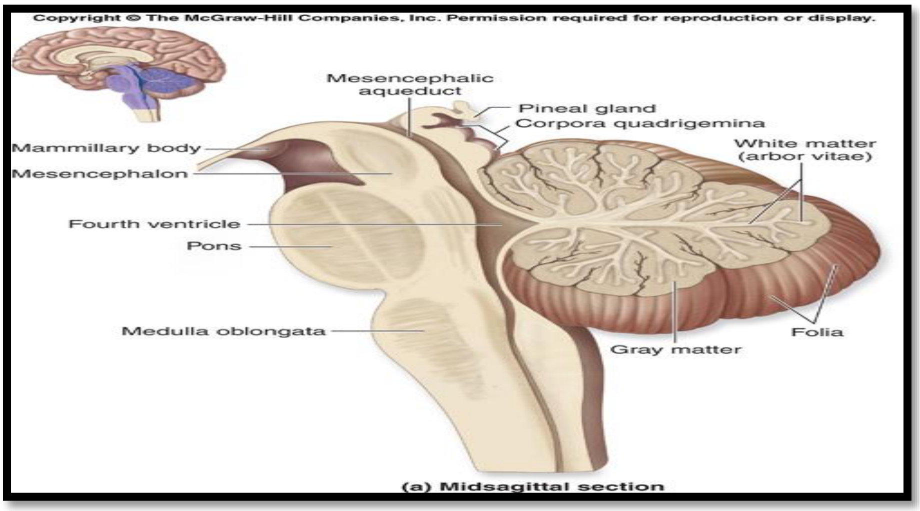


Figure 2.5 midsaggital section of the cerebellum (http://academic.kellogg.edu/)

2.1.1.7 Brainstem

The brainstem, the oldest part of the CNS, is composed of the mesencephalon, metencephalon, and myelencephalon. (Maria et al, 2006)

2.1.1.7.1 Mesencephalon

The mesencephalon (midbrain) is a relatively narrow band of the brainstem surrounding the cerebral aqueduct, extending from the diencephalon to the pons. The dorsal aspect of the midbrain is known as the tectum and incorporates the paired superior and inferior colliculi. These structures are associated with the lateral and medial geniculate bodies, respectively, and they are all associated with visual and auditory functions. The trochlear nerve (CN IV) exits the dorsal aspect of the mesencephalon just below the inferior colliculus. All other cranial nerves exit the ventral aspect of the brainstem. The region of the mesencephalon below the cerebral aqueduct is known as the midbrain. The cerebral hemispheres are connected to the brainstem by two large fiber tracts, the cerebral peduncles, and the depression between the peduncles is known as the interpeduncular fossa, the site of origin of the oculomotor nerve (CN III). (Maria etal, 2006).

2.1.1.7.2 Metencephalon

The cerebellum overlies and hides the dorsal aspect of the brainstem, but its ventral aspect, the pons, is clearly evident. Rostrally, the superior pontine sulcus acts as the boundary between the metencephalon and the midbrain and the inferior pontine sulcus as the boundary between the metencephalon and the myelencephalon. Part of the floor of the fourth ventricle is formed by the dorsal aspect of the pons, and is known as the pontine tegmentum, the structure that houses the nuclei of the trigeminal, abducent, facial, and vestibulocochlear nerves. Cranial nerves VI, VII, and VIII leave the brainstem at the inferior pontine sulcus, whereas the trigeminal nerve exits the brainstem through the middle cerebellar peduncle. (Maria et al, 2006).

2.1.1.7.3 Myelencephalon

The caudal-most portion of the brainstem, the myelencephalon, also known as the medulla oblongata, extends from the inferior pontine sulcus to the spinal cord. The boundary between them is the region where the lateral walls of the fourth ventricle converge in a V shape at the midline obex at the level of the foramen magnum. The ventral surface of the myelencephalon displays the anterior midline fissure, bordered on each side by the pyramids and crossed by the pyramidal decussations, connecting the right and left pyramids to each other. The olives are olivepit-shaped swellings lateral to each pyramid. (Maria et al, 2006).

2.1.1.8 Blood supply of the Brain

Blood is supplied to the brain, face, and scalp via two major sets of vessels: the right and left common carotid arteries and the right and left vertebral arteries. The common carotid arteries have two divisions. The external carotid arteries supply the face and scalp with blood. The internal carotid arteries supply blood to the anterior three-fifths of cerebrum, except for parts of the temporal and occipital lobes. The vertebrobasilar arteries supply the posterior two-fifths of the cerebrum, part of the cerebellum, and the brain stem. Any decrease in the flow of blood through one of the internal carotid arteries brings about some impairment in the function of the frontal lobes. This impairment may result in numbness, weakness, or paralysis on the side of the body opposite to the obstruction of the artery. (Charles R.N et al, 2005)

2.1.1.8.1 Circle of Willis

At the base of the brain, the carotid and vertebrobasilar arteries form a circle of communicating arteries known as the circle of Willis. From this circle other arteries – the anterior cerebral artery (ACA), the middle cerebral artery (MCA), the posterior cerebral artery (PCA) – arise and travel to all parts of the brain (Fig. 2.6). (Charles R.N et al,2005)

2.1.1.9 Cranial nerves

The brain communicates with the body through the spinal cord and twelve pairs of cranial nerves (Fig. 2.7). Ten of the twelve pairs of cranial nerves that control hearing, eye movement, facial sensations, taste, swallowing and movement of the face, neck, shoulder and tongue muscles originate in the brainstem. The cranial nerves for smell and vision originate in the cerebrum. (Charles R.N et al, 2005)

Table 2.1 The Roman numeral, name, and main function of the twelve cranial nerves. (Charles R.N et al, 2005)

Number	Name	Function
I	Olfactory	Smell
II	Optic	Sight
III	Oculomotor	moves eye, pupil
IV	Trochlear	moves eye
V	Trigeminal	face sensation
VI	Abducens	moves eye
VII	Facial	moves face, salivate
VIII	Vestibulocochlear	hearing, balance
IX	Glossopharyngeal	taste, swallow
X	Vagus	heart rate, digestion
XI	Accessory	moves head
XII	Hypoglossal	moves tongue

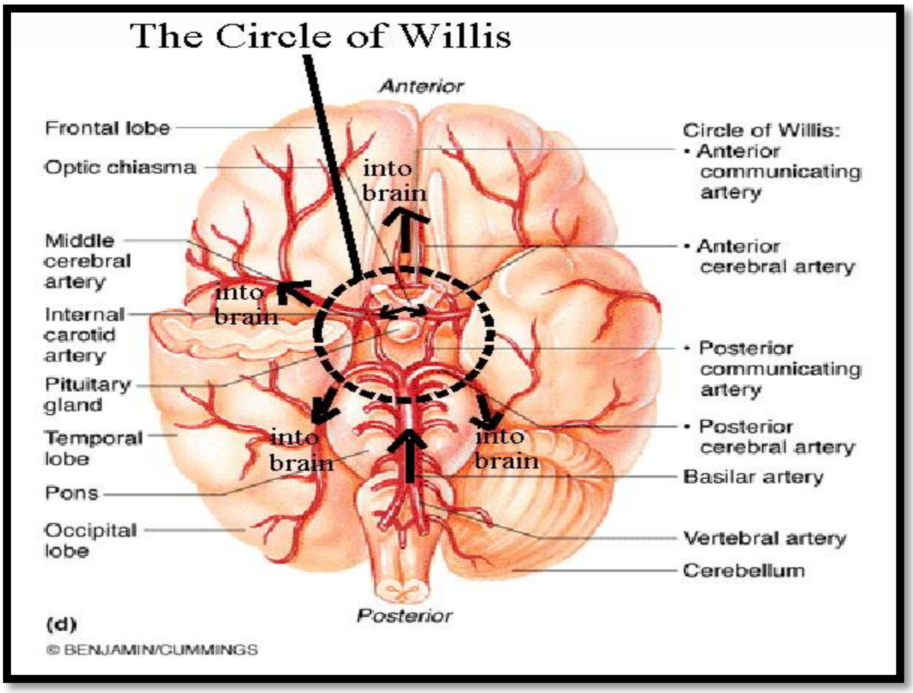


Fig 2.6 Circle of Willis (http://yazoqem.hostoi.com/blood-flow-to-the-brain.php)

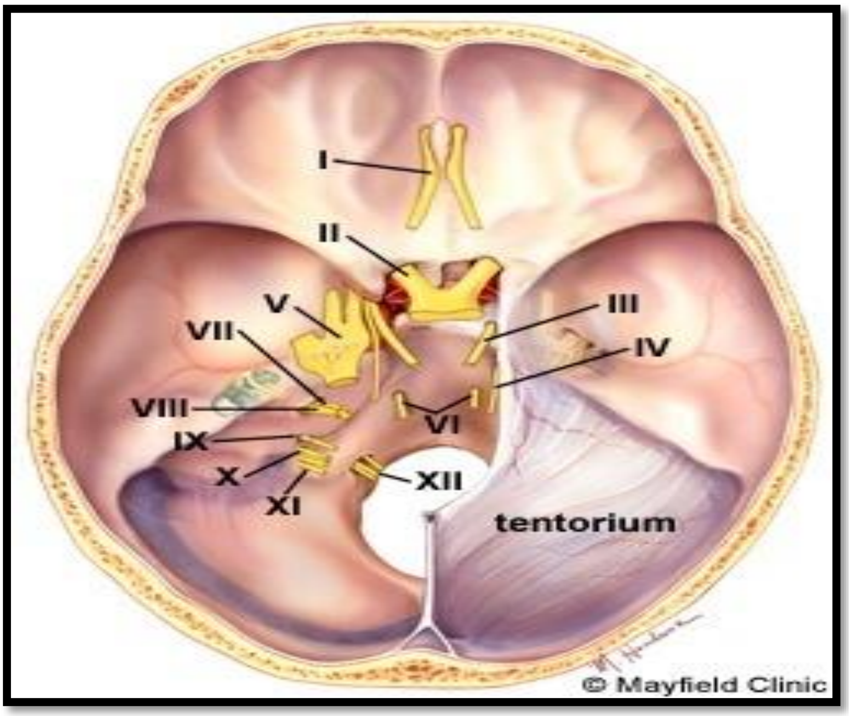


Figure 2.7 The Roman numeral, name, and main function of the twelve cranial nerves.

(Charles R.N et al, 2005)

2.1.2 Physiology of the brain

2.1.2.1Frontal Lobes

The frontal lobes are considered the emotional control center and home personality. The frontal lobes are involved in motor function, problem solving, spontaneity, memory, language initiation, judgment, impulse control, and social and sexual behavior and consciousness, initiation of activity in response to our environment, judgments what occurs in activities, controls emotional response, controls expressive language, assigns meaning to the words we choose, involves word association, memory for habits and motor activities. (Richards.S, 2001)

2.1.2.2Parietal Lobes

The parietal lobes can be divided into two functional regions, one involves sensation and perception and the other is concerned with integrating sensory input, primarily with the visual system. The first function integrates sensory information to form single perception cognition. The second function constructs a spatial coordinate system to represent the world around us. The main functions are location for visual attention, location for touch perception, goal directed voluntary movements, manipulation of objects, integration of different senses that allows for understanding a single. (Charles R.N et al, 2005).

2.1.2.3 Temporal Lobes

The main functions are hearing ability, memory acquisition, some visual perceptions, categorization of objects. (Charles R.N et al, 2005)

2.1.2.4 Occipital Lobes

The occipital lobes are the center of visual perception system. The main function is the vision. (Charles R.N et al,2005)

2.1.2.5 Cerebellum

The cerebellum is involved in the coordination of voluntary motor movement, balance and equilibrium and muscle tone. It is located just above the brain stem and toward the back of the brain. It is relatively well protected from trauma compared to the frontal and temporal lobes and brain stem. The main functions are coordination of voluntary movement, balance and equilibrium, some memory for reflex motor acts. (Martini, Frederic H, 2007) .

2.1.2.6 Brain steam

The brain stem plays a vital role in basic attention, arousal, and consciousness. All information to the from our body passes through the brain stem on the way to or from the brain. Like the frontal and temporal lobes, the brain stem is located in an area near bony protrusions making it vulnerable to damage during trauma. The main functions are breathing, heart Rate, swallowing, reflexes to seeing and hearing, controls sweating, blood pressure, digestion, temperature, affects level of alertness, ability to sleep, sense of balance. (Martini, Frederic H, 2007)

2.1.3 Pathology of the brain

There are several diseases and disorders that may affect the brain. Some of these include:

2.1.3.1 Headache: There are many types of headaches; some can be serious but most are not and are generally treated with analgesics/painkillers. (Sudhir, 2008)

2.1.3.2 Brain aneurysm: An artery in the brain develops a weak area that swells, balloon-like. A brain aneurysm rupture can cause a stroke. (Sudhir, 2008)

2.1.3.3 Subdural hematoma: Bleeding within or under the dura, the lining inside of the skull. A subdural hematoma may exert pressure on the brain, causing neurological problems. (Sudhir, 2008)

2.1.3.4 Epidural hematoma: Bleeding between the tough tissue (dura) lining the inside of the skull and the skull itself, usually shortly after a head injury. Initial mild symptoms can progress rapidly to unconsciousness and death, if untreated. (Sudhir, 2008)

2.1.3.5 Intracerebral hemorrhage: Any bleeding inside the brain. (Sudhir, 2008)

2.1.3.6 Concussion: A brain injury that causes a temporary disturbance in brain function. Traumatic head injuries cause most concussions. (Sudhir, 2008)

2.1.3.7 Cerebral edema: Swelling of the brain tissue in response to injury or electrolyte imbalances. (Sudhir, 2008)

2.1.3.8 Brain tumor: Any abnormal tissue growth inside the brain. Whether malignant or benign, brain tumors usually cause problems by the pressure they exert on the normal brain. (Sudhir, 2008)

2.1.3.9 Glioblastoma: An aggressive, malignant brain tumor (cancer). Brain glioblastomas progress rapidly and are very difficult to cure. (Sudhir, 2008)

2.1.3.10 Hydrocephalus: An abnormally increased amount of cerebrospinal fluid inside the skull. Usually this is because the fluid is not circulating properly. (Sudhir, 2008)

2.1.3.11 Meningitis: Inflammation of the lining around the brain or spinal cord, usually from infection. Stiff neck, neck pain, headache, fever, and sleepiness are common symptoms. (Sudhir, 2008)

2.1.3.12 Encephalitis: Inflammation of the brain tissue, usually from infection with a virus. Fever, headache, and confusion are common symptoms. (Sudhir, 2008)

2.1.3.13 Parkinson's disease: Nerves in a central area of the brain degenerate slowly, causing problems with movement and coordination. A tremor of the hands is a common early sign. (Sudhir, 2008)

2.1.3.14 Huntington's disease: An inherited nerve disorder that affects the brain. Dementia and difficulty controlling movements are its symptoms. (Sudhir, 2008)

2.1.3.15 Epilepsy: The tendency to have seizures. Head injuries and strokes may cause epilepsy, but usually no cause is identified. (Sudhir, 2008)

2.1.3.16 Dementia: A decline in cognitive function resulting from death or malfunction of nerve cells in the brain. Conditions in which nerves in the brain degenerate, as well as alcohol abuse and strokes, can cause dementia. (Sudhir, 2008)

2.1.3.17 Alzheimer's disease: For unclear reasons, nerves in certain brain areas degenerate, causing progressive dementia. Alzheimer's disease is the most common form of dementia. (Sudhir, 2008)

2.1.3.18 Brain abscess: A pocket of infection in the brain, usually by bacteria. Antibiotics and surgical drainage of the area are often necessary. (Sudhir, 2008)

2.1.3.19 Multiple sclerosis: Multiple sclerosis describes a condition where the protective myelin coating surrounding nerve fibres is damaged in the brain and spine causing problems with muscle movement, vision and balance. (Sudhir, 2008)

2.1.3.20 Stroke

Stroke (brain infarction): Blood flow and oxygen are suddenly interrupted to an area of brain tissue which then dies. A blood clot, or bleeding in the brain, is the cause of most strokes. Stroke can be caused either by an ischemic stroke where a clot blocks the flow of blood to the brain or by a hemorrhagic stroke where a blood vessel ruptures, preventing blood flow to the brain. A transient ischemic attack, or "mini stroke", is caused by a temporary clot. (Sudhir, 2008)

2.1.3.20.1 Types of stroke:

80% of strokes are caused by a blockage, called ischemic strokes and 20% of strokes are caused by bleeding in or around the brain, called hemorrhagic strokes. There is also a related condition known as a transient ischemic attack (TIA), where the supply of blood to the brain is temporarily interrupted, causing a "mini-stroke" often lasting between 30 minutes and several hours. (Miniño et al, 2010)

2.1.3.20.2 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. (Miniño et al, 2010)

Some signs of stroke include:
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(Sudhir,2008)

2.1.3.20.3 Effects of Stroke

If a stroke occurs and blood flow can't reach the area that controls a particular body function, that part of the body stops working as it should. If the stroke occurs toward the back of the brain, for example, it's likely that some level of vision will be impaired. The effects of a stroke depend on several factors, including the location of the blockage and how much brain tissue is affected. Because one side of the brain controls the opposite side of the body, a stroke affecting one side will result in neurological complications on the side of the body it affects. For example, if the stroke occurs in the brain's right side, the left side of the body and the left side of the face will be affected, which could produce any or all of the following: Paralysis on the left side of the body, Vision problems, inquisitive behavioral style, Memory loss. If the stroke occurs in the left side of the brain, the right side of the body will be affected, producing some or all of the following: Paralysis on the right side of the body, Speech/language problems, Slow, cautious behavioral style, Memory loss.When stroke occurs in the brain stem, depending on the severity of the injury, it can affect both sides of the body and may leave someone in a 'locked-in' state. When a locked-in state occurs, the patient is generally unable to speak or achieve any movement below the neck. (Sudhir, 2008)

2.1.3.20.4Diagnosis 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 et al, 2004)

2.1.3.20.5Treating a stroke

Strokes are a medical emergency and early treatment is essential. The sooner a person receives treatment for a stroke, the less damage is likely to happen. The treatment depends on the type of stroke , including which part of the brain was affected and what caused it. Most often, strokes are treated with medicines. This generally includes drugs to prevent and remove blood clots, reduce blood pressure and reduce cholesterol levels. In some cases, surgery may be required. This could be to clear fatty deposits in your arteries or to repair a blood vessel that has burst, causing bleeding in the brain. (Sudhir, 2008)

2.1.4 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)

2.1.4.1 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. (Bushong, 2005)

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)

2.1.4.1.1 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. 2.8) 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. 2-9). 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. (Bushong, 2005)

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. 2-12, 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)

2.1.4.1.2 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.2.10) (Bushong, 2005)

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. 2-11). 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)

2.1.4.1.3Relaxation

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. (Bushong, 2005)

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. 2-12).

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

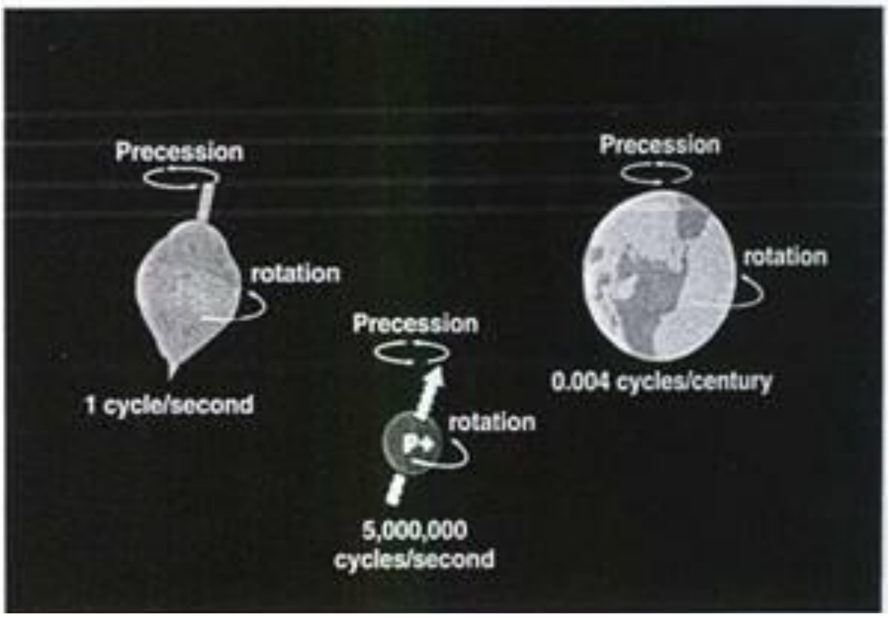


Fig.2.8 Example of precession (Bushong, 2005)

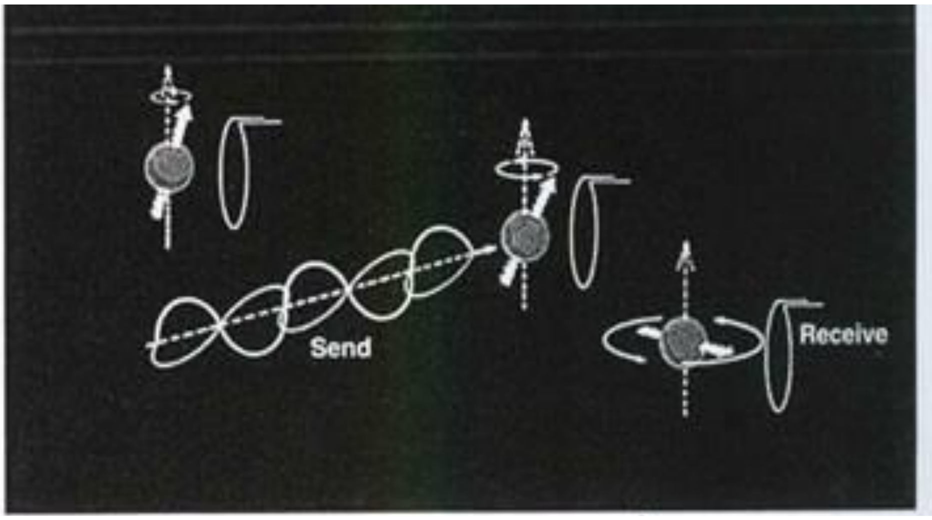
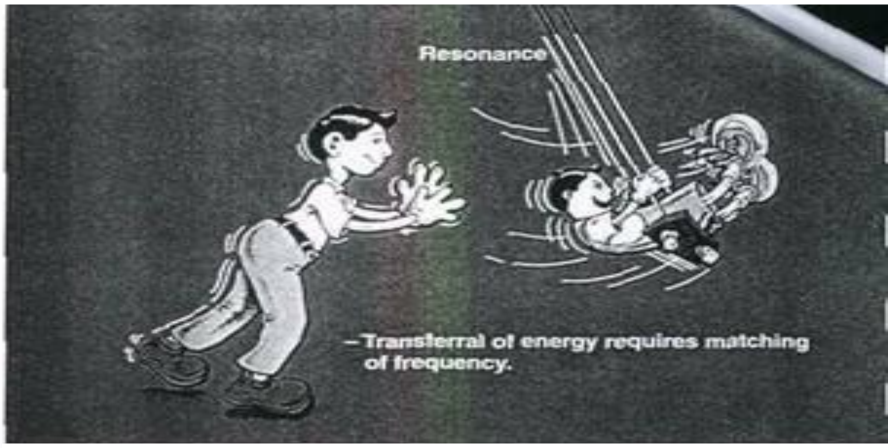


Fig.2.9 radio waves increase angle of precession (Bushong, 2005)



2.10 Example of resonance (Bushong, 2005)

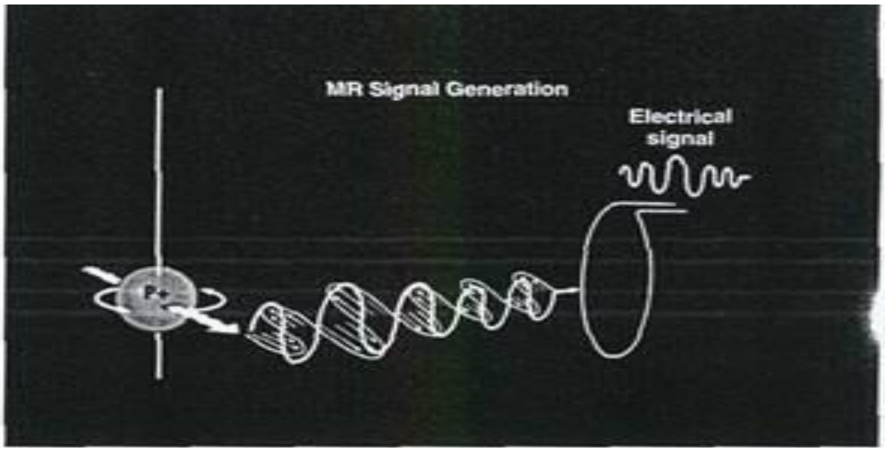


Fig.2.11 MRI signal generation and receiver coil sending electrical signal to computer. (Bushong, 2005)

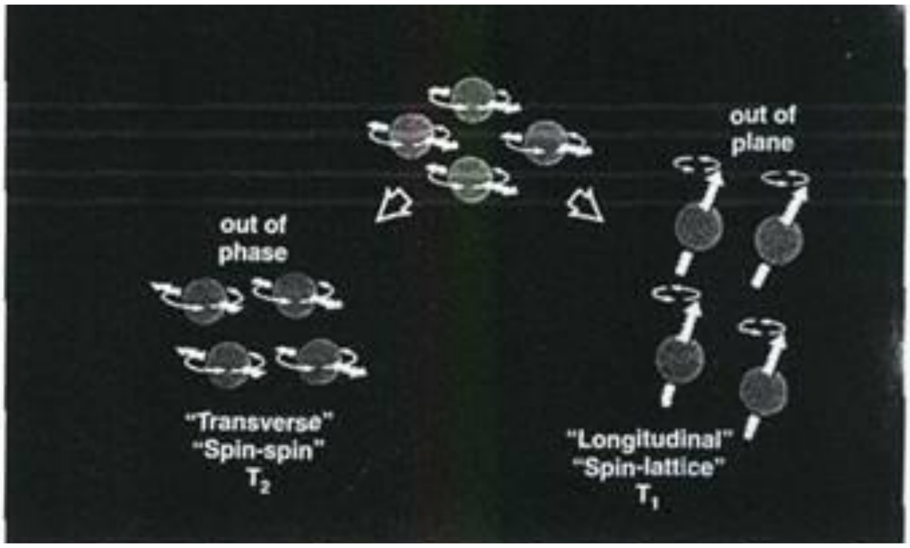


Fig2.12 Two categories of relaxation. (Bushong, 2005)

2.1.4.2 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)

2.1.4.2.1Magnets

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)

2.1.4.2.1.1 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)

2.1.4.2.1.2Permanent 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)

2.1.4.2.1.3 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)

2.1.4.2.2 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. (Catherine, 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 interpupillary 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. (Catherine, 2008)

2.1.5.3 Suggested protocol for brain

Sagittal SE/FSE/incoherent (spoiled) GRE T1

Axial/oblique SE/FSE PD/T2

Coronal SE/FSE PD/T2. (Catherine, 2008)

2.1.5.3.1 Additional sequences:

Axial/oblique IR T1

Axial/oblique FLAIR/EPI

Axial/oblique SE/FSE/incoherent (spoiled) GRE T1

SS-FSE T2

Axial 3D incoherent (spoiled) GRE T1

Axial/oblique GRE/EPI T1/T2

Axial/oblique SE MT

Axial perfusion imaging (Catherine, 2008)

Axial DWI

This sequence is important in the investigation of early stroke.

A DWI sequence is most often acquired using a T2 weighted EPI sequence. In a standard T2 weighted EPI sequence, there is not enough motion (diffusion) of the extra-cellular water during the imaging cycle to result in dephasing of the water protons. Diffusion gradients are therefore utilized to increase the sensitivity to the motion of the extra-cellular water molecules. The more restricted the diffusion, the less dephasing of the water protons and higher signal will be seen on the diffusion image. (fig.2.13) it is important to remember that high signal seen on a diffusion weighted image may actually be high signal from spins with a long T2-relaxation time shining through. These so-called 'T2 shine-through' effects are eliminated by the calculation and production of an ADC map or image. The apparent diffusion coefficient (ADC) expresses the amount of motion of extra-cellular water. (Catherine, 2008)

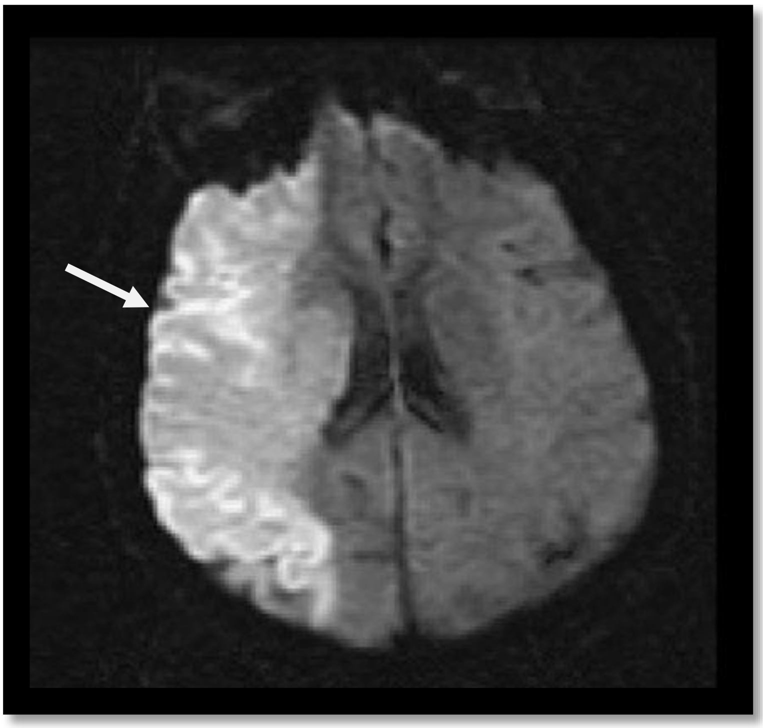


Figure 2.13 DWI showing large area of high signal on right. High signal on a DWI can be the result of restricted diffusion or ‘T2 shine-through (Catherine, 2008)

2.2 Previous studies

Alejandro M. Brunser, (2012), Performed study to 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.

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

3 Materials and Methods

3.1Materials:

3.1.1 The population and the study area

A total of 50 adult patients (20-80 years) males and females, from MRI department referred to Doctors clinic Hospital with neurological symptoms suspected stroke and requested for brain MRI include diffusion weighted image. Data of the patients undergone MRI brain with diffusion weighted image and collected during April 2016.

3.1.2 The inclusion criteria:

The patients who suspected stroke and requested for MRI brain with diffusion weighted image or MRI brain only. .

3.1.3 The exclusion criteria:

The patients who requested for MRI brain only.

3.1.4 Equipment of study:

MRI machines Philips 1.5Tesla, made in Holland in 2011

The coil that used for the study:

Head coil.

3.2Methods:

3.2.1 Data collection:

The data collected by clinical data sheet for all patients undergone MRI brain with DWI sequences. The data including patient age, gender, clinical findings, DWI findings, conventional MRI protocols findings and requested exam were collect in data collection sheet and visit ten MRI departments to see the MRI departments that apply the diffusion weighted image or not. .

3.2.2 Data analysis:

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

3.2.3 Interpretation of MR images:

Images, reports and requests collected from PACS in DVD and compare the requests which suspected stroke with reports which show restricted or non restricted findings in diffusion weighted images. .

3.2.4 The techniques used in the study:

3.2.4.1Patient 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.

3.2.4.2Patient 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 nasion, Straps and foam pads are used for immobilization.

3.2.4.3Protocols that used for study:

Axial T1, T2 and FLAIR weighted images

Axial Diffusion weighted image

Coronal T2 weighted image

Sagittal T1 weighted image

Chapter four

Results

4 Results

This chapter shows the results of the data was collected by data sheet from Doctors clinic Hospital and the result of the ten MRI departments was visited by the researcher to show the diffusion weighted image protocol apply or not.

4.1 Results of data sheet:

Table 4.1.1 shows the frequency and the percentage of gender.

Gender	Frequency	Percentage
Male	29	58%
Female	21	42%
Total	50	100%

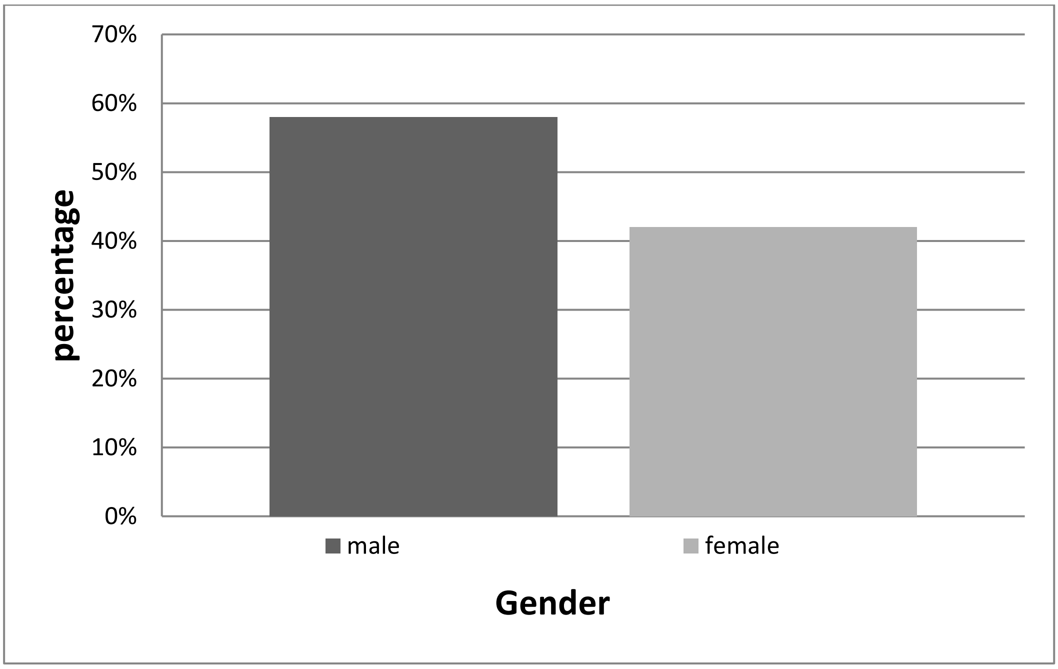


Figure 4.1.1 shows the relation between gender and the percentage.

Table 4.1.2 shows the frequency and the percentage of age group.

Age group	**Frequency**	**Percentage**
20-39	3	6%
40-59	7	14%
60-80	40	80%
Total	50	100%

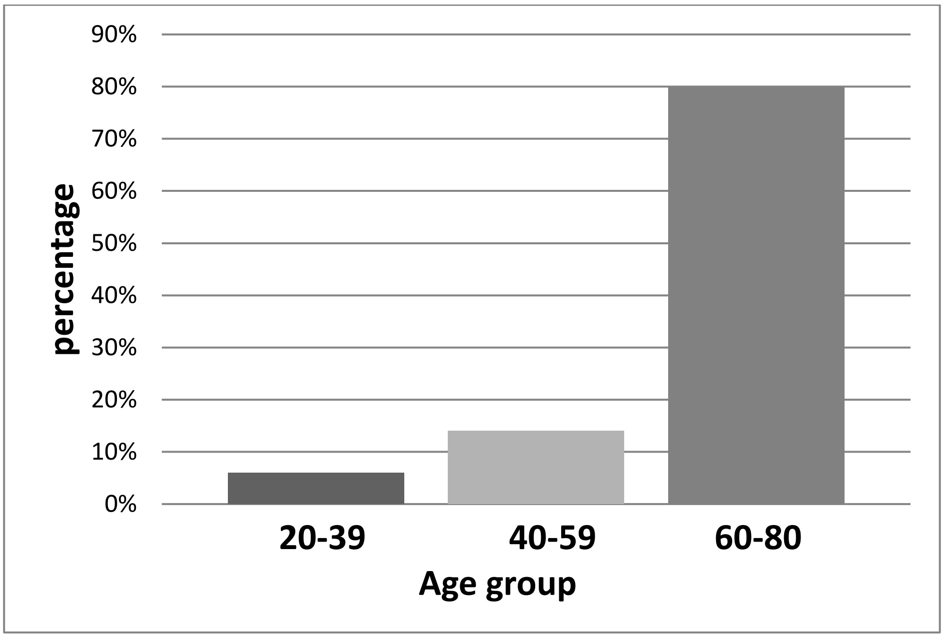


Figure 4.1.2 shows the relation between age group and the percentage.

Table 4.1.3 shows the frequency and the percentage of DWI findings.

DWI findings	Frequency	Percentage
Restricted DWI	40	80%
Non restricted DWI	10	20%
Total	50	100%

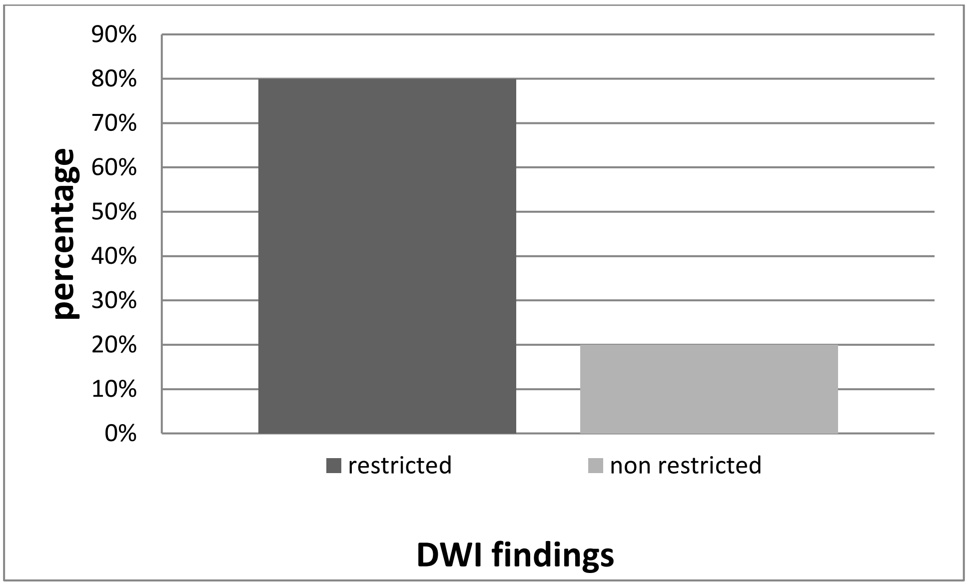


Figure4.1.3 shows the relation between restricted and non restricted DWI and the percentage.

Table4.1.4 shows the frequency and the percentage of requested exam for brain stroke.

Requested exam	**Frequency**	**Percentage**
MRI brain+ DWI	9	18%
MRI brain	41	82%
Total	50	100%

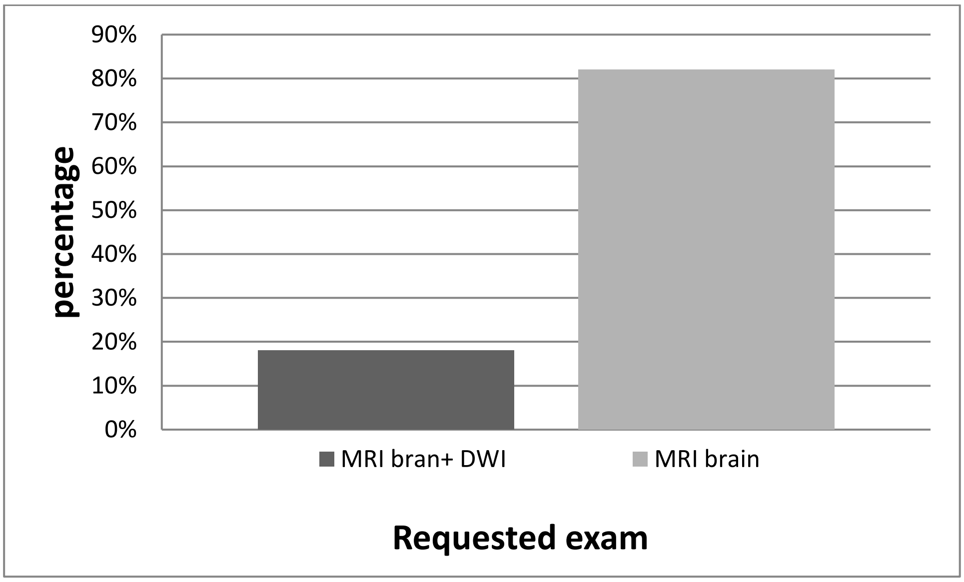


Figure 4.1.4 shows the relation between requested exam for brain stroke and the percentage.

Table4.1.5 shows the frequency and the percentage of conventional MRI findings for stroke.

conventional MRI protocol	**T1**		**T2**		**FLAIR**	
Signal intensity	low	high	low	high	Low	High
Frequency	50	0	0	50	0	50
Percentage	100%	0%	0%	100%	0%	100%

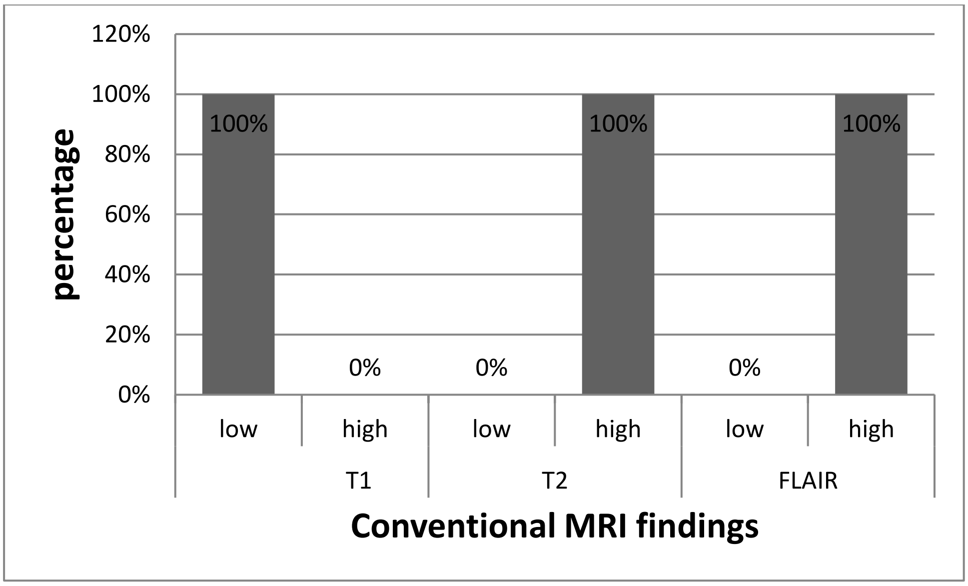


Figure4.1.5 shows the relation between conventional MRI findings for stroke and the percentage.

Table 4.1.6 shows the frequency and the percentage of clinical findings for brain stroke.

Clinical findings	Frequency	Percentage
TIA	4	8%
Right/left side weakness	16	32%
Right/left side hemiplegia	14	28%
Aphasia	3	6%
Dysarthria	3	6%
Dysphagia	1	2%
Convulsion	5	10%
CVA	4	8%
Total	50	100%

*TIA Transient Ischemic Attack.

*CVA Cerebral Vascular Attack.

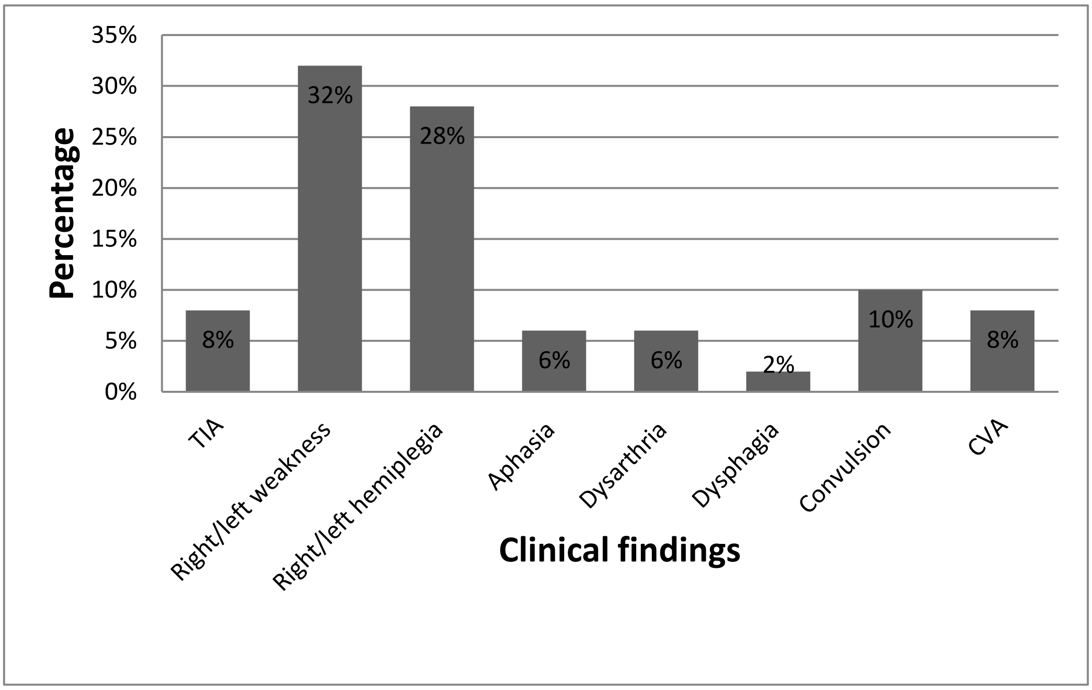


Figure4.1.6 shows the relation between clinical findings for brain stroke and the percentage.

4.2. Results of the ten MRI departments which were visited by the researcher:

Ten from 10 MRI departments apply the diffusion weighted image protocol and five (**50 %**) of MRI departments use the DWI as an essential protocol and five (**50%**) use the DWI only when requested by the doctors. .

Chapter five

Discussion, Conclusion, Recommendations

5.1Discussion

Table and figure (4.1.1) show the frequency and the percentage of gender and the relation of gender and the percentage, the result showed 58%male and 42%female, the results demonstrate the stroke is more in male than in female and that agree with (Minino,2010) results. .

Table and figure (4.1.2) show the frequency and the percentage of age groups and the relation of different age group 20-39, 40-59, 60-80 years and the percentage of values of this relation with age groups its 6%, 14% and 80% respectively, the results demonstrate the older people are most at risk of having stroke that also agree with (Minion, 2010) results.

Table and figure (4.1.3) show the frequency and the percentage of DWI findings and the relation between the restricted and non restricted DWI and the percentage, the result showed 80% restricted DWI and 20% non restricted DWI, the results demonstrate 80% of suspected stroke was restricted DWI, so the DWI is highly accurate for diagnosis brain stroke and that agree with (Gilberto, 2000) results.

Table and figure (4.1.4) show the frequency and the percentage of requested exam for brain stroke and the relation between the requested exam (MRI brain only/MRI brain+ DWI) and the percentage, the result showed 82%requested MRI brain only and18% requested MRI brain+ DWI.

Table and figure (4.1.5) show the frequency and the percentage of conventional MRI finding for stroke and the relation between the signal intensity of T1, T2 and FLAIR and the percentage, the result show T1 100% low and 0% high, T2 0% low and 100% high, FLAIR 0% low and 100% high, the results showed the conventional MRI protocols gives the same findings in both restricted and non restricted DWI, so the DWI is a better imaging method than conventional MRI in detecting stroke and that agree with (K.J Van Everdingen,2000) results.

Table and figure(4.1.6) show the frequency and the percentage of clinical findings for brain stroke and the relation of clinical findings TIA, right/left side weakness, right/left side hemiplegia, aphasia, dysarthria, dysphagia, convulsion , CVA and the percentage of values of this relation with clinical findings its 8%, 32%, 28%, 6%, 6%, 2%, 10% and 8% respectively. .

Result 4.2 shows the ten MRI departments which were visited by the researcher:

Ten from 10 MRI departments apply the diffusion weighted image protocol and five (**50 %**) of MRI departments use the DWI as an essential protocol and five (**50%**) use the DWI only when requested by the doctors.

5.2 Conclusion

All the patients referred to Doctors clinic hospital with neurological symptoms suspected stroke and requested for MRI brain (58%)male and (42%)female,(80)% older people (60-80years) and (18%) only of patients requested MRI brain with DWI that obtain the deficiency of doctors experience about DWI for stroke, (80%) of strokes detected by DWI that prove the highly accuracy of DWI in detection brain stroke, the conventional MRI protocols give (100%) same findings in restricted and non restricted DWI, so the conventional MRI protocols can not detection brain stroke and the most clinical findings for brain stroke found are right/left side weakness (32%) and right/left side hemiplegia (28%). All the ten MRI departments in Khartoum state which were visited by the researcher apply the diffusion weighted imaging and five (**50 %**) of MRI departments use the DWI as an essential protocol and five (**50%**) use the DWI only when requested by the doctors.

5.3 Recommendations

The researcher recommends the following:

-The MRI departments should use the diffusion weighted imaging as an essential protocol for brain stroke.

-Apply PACS system in hospitals .

-For future studies, increase the number of sample and apply more advance MRI techniques.

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Appendices

Appendix 1:

Clinical data collection sheet

Evaluation of Diffusion Magnetic Resonance Imaging with Clinical Findings for Brain Stroke Patients in Khartoum State

Case No	Age	Gender	Clinical findings	DWI findings	Conventional MRI findings	Requested exam

Appendix 2:

MRI images from the sample of the study

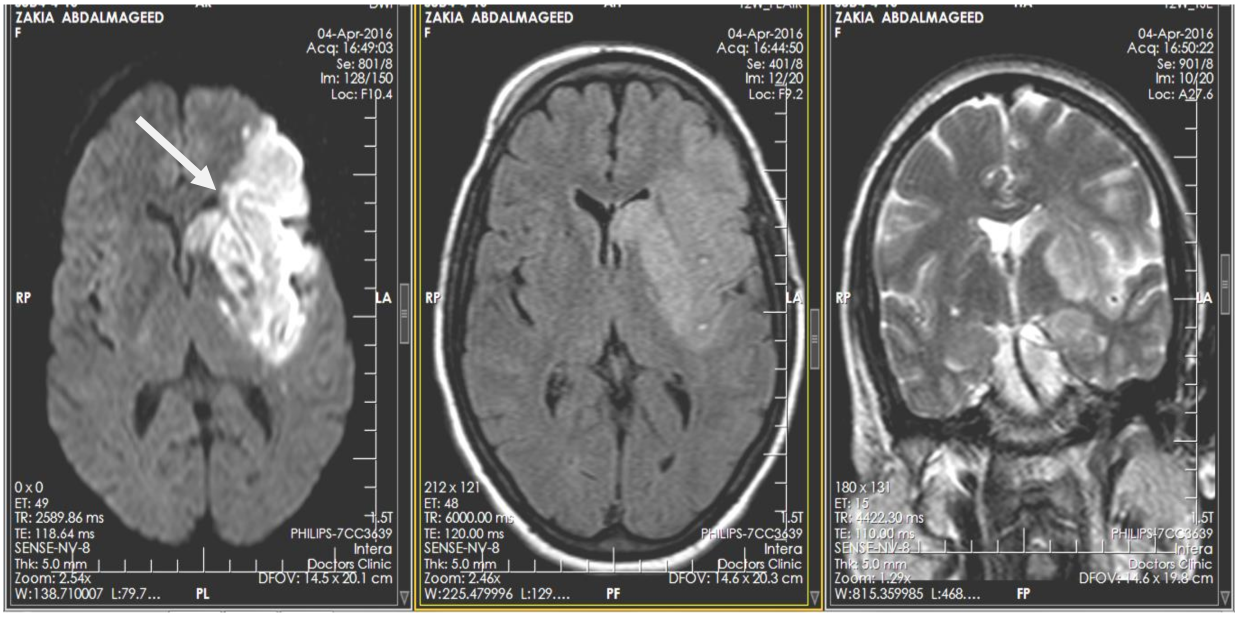

Figure (1) Axial MRI of the brain. Diffusion weighted imaging sequence showing left cerebral recent infarction for female patient 65 years old.

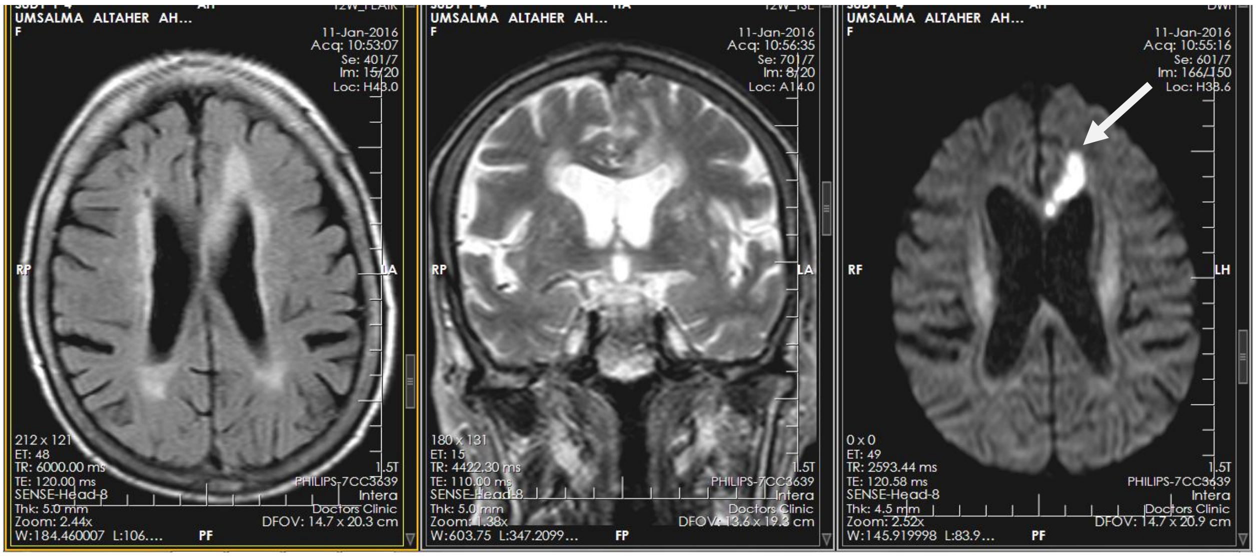

Figure (2) Axial FLAIR, coronal T2 and axial DWI showing Left corpus callosum acute cerebral ischemic infarct for female patient 60 years old.

Figure (3) Axial MRI of the brain. Diffusion weighted imaging sequence showing Left basal ganglia recent area of infarction for male patient 65 years old.

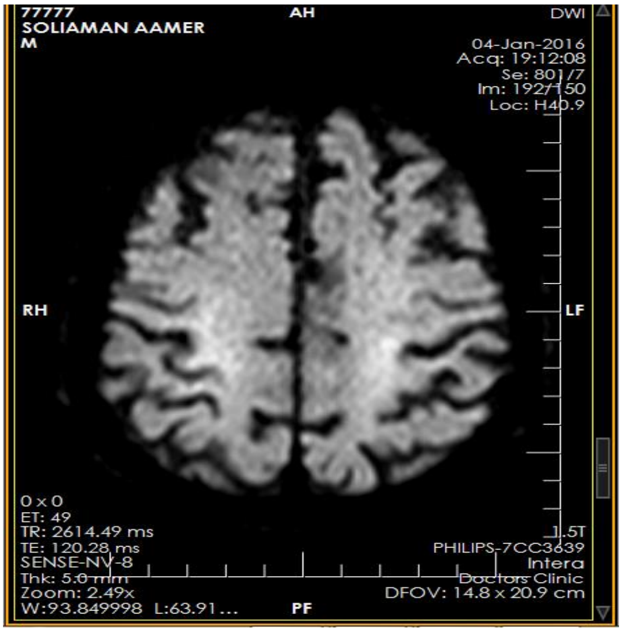

Figure (4) Axial MRI of the brain. Diffusion weighted imaging sequence showing non restricted signal at DWI for male patient 50 years old.

Figure (5) Axial diffusion weighted imaging sequence showing small recent right anterior pontine infarction for male patient 75 years old.

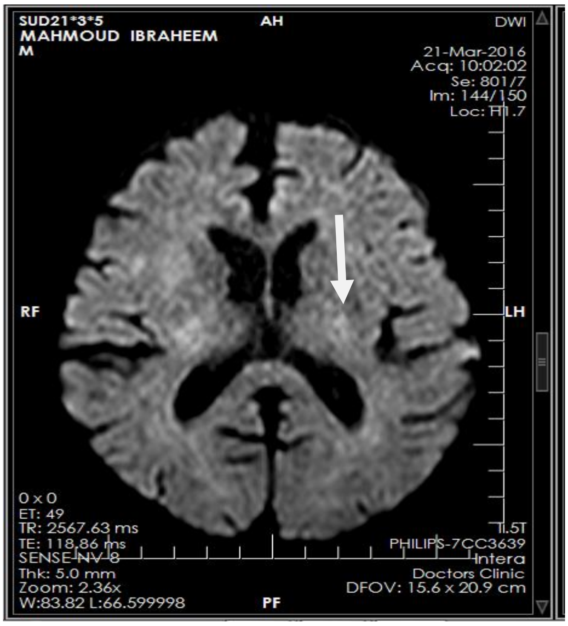

Figure (6) Axial diffusion weighted imaging sequence showing Small residual left fronto-parietal subdural hematoma for male patient 80 years old.

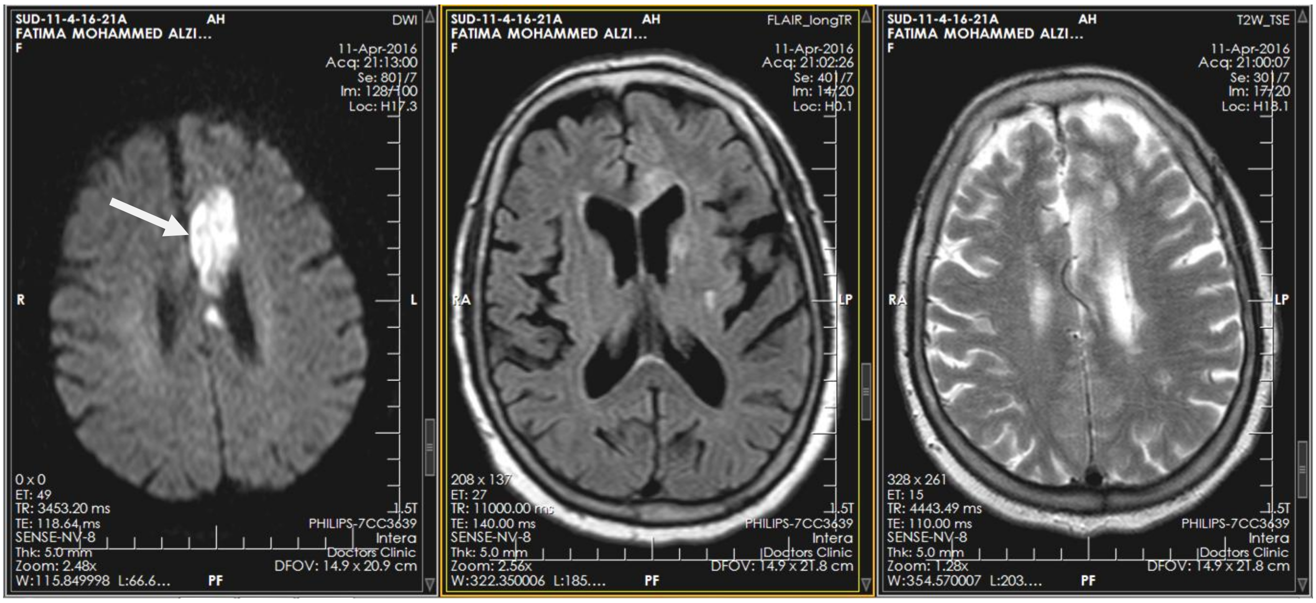

Figure (7) Axial diffusion weighted imaging sequence showing Left paramedian cerebral and corpus callosum recent infarction for female patient 72 years old.

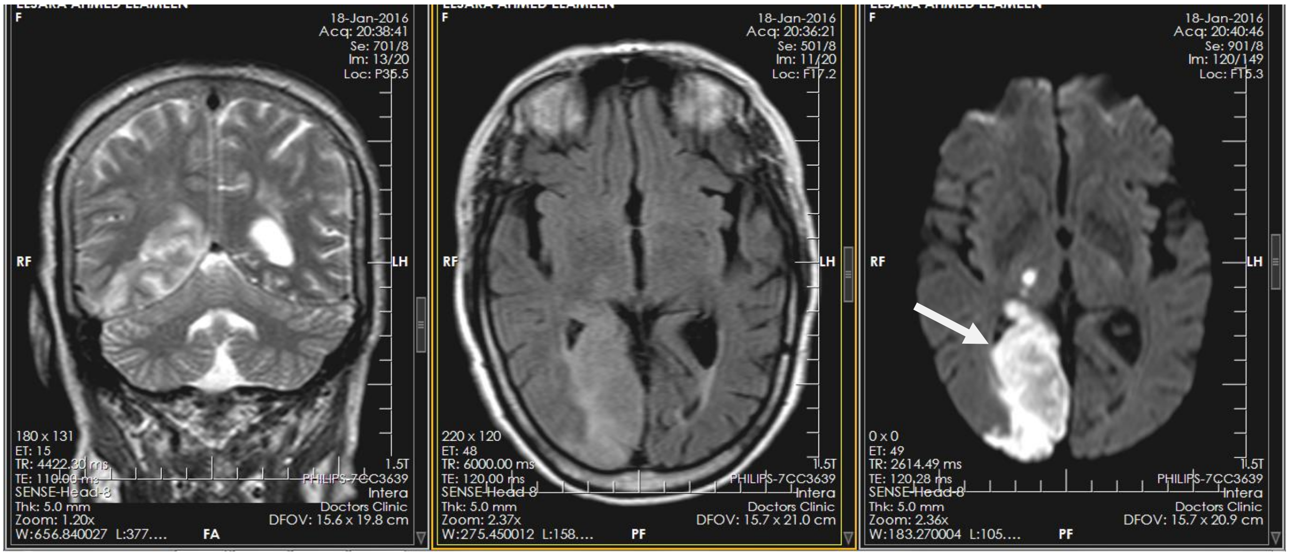

Figure (8) Coronal T2, axial FLAIR and DWI showing right occipital and thalamis recent acute infarctions for male patient 60years old.

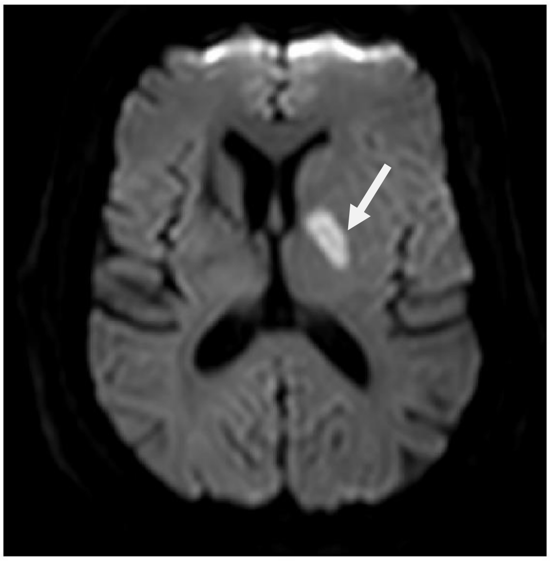

Fig (9) Axial MRI of the brain. Diffusion weighted imaging sequence showing acute globus pallidus left infarct for male patient 66 years old.

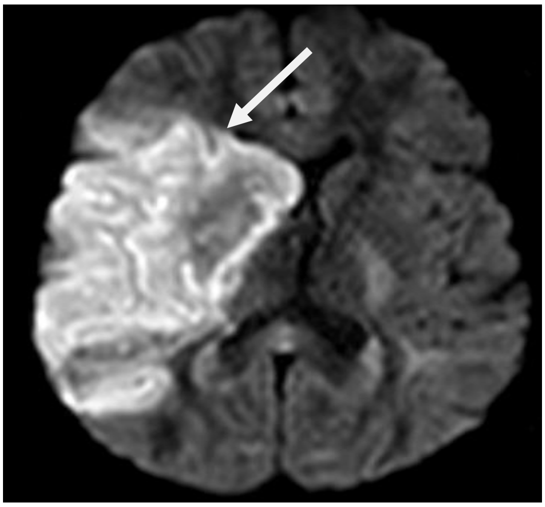

Figure (10) Axial diffusion weighted image showing right cerebral large patchy area of recent infarction for male patient 77years old.