

## الآية الكريمة

قال تعالى:

(فتعالى الله الملك الحق ولا تعجل بالقرآن من قبل إن يقضي

إليك وحيه وقل رب زدني علما)

صدق الله العظيم

سورة طه الايه1(114)

# **Dedication**

- To My Mother.
- To My Father.
- To My Brothers.
- To My Sister.
- To My Husband.
- To My Friends.

# ***Acknowledgement***

***Grateful Thanks And Grace To Allah For Guiding And  
Helping Me Finishing This Research.***

***I Would Like Also To Express Sincere Thanks And  
Gratitude To My Supervisor Dr :Duha Abdu Mohmmed  
For His Keen Supervision, Guidance And Valuable  
Comment And Support From The Idea Of This  
Research Until Finishing.***

***. Special Thanks to my Best Friend Sara Sorag***

**Abstract**

This study was carried out in Sudanese to determine the role of magnetic resonance imaging (MRI) in diagnosing and classification of meningiomas, using 1.5 Tesla scanner closed permanent magnet unit.

The main objective of this study to classified the gender, age, size, common site and diagnosis of meningiomas, ,and to characterize different grade feature of meningiomas by magnetic resonance imaging (MRI)

The study was carried on seventy two (72) patients with clinically diagnosed for meningiomas , and were grouped to gender male 29 patient about (40.3%) and female 43 patient about (59.7%),according to age study finding the meningiomas are common in elder patient with range (61-80) years found 25 patients about (34%) ,according to diagnosis the convexity meningiomas are common diagnosis found in 23 patients about (32%) and are very rare diagnosis as intraventricular there one patient about (1.4%), according to his site flax cerbri is common site of meningiomas found in 16 patient about (22%),according to size most meningiomas are small size(less than 2cm) there appear in 41 patient begnin about (57%), and according to classification of meningioma grade(I) meningiomas are most common were 67patients about (93%).

It was concluded the MRI has very big role in diagnosis of meningiomas.

خلاصة

أجريت هذه الدراسة في السودانين لتحديد دور الرنين المغناطيسي في تشخيص وتصنيف أورام السحايا باستخدام وحده مغناطيسي مغلقة 1.5 تسلا .

الهدف الرئيسي لهذه الدراسة تصنيف الجنس والعمر والحجم والموقع الأكثر عرضة للإصابة بأورام السحايا. وكذلك لوصف الي اي درجة وصل الورم باستخدام التصوير بالرنين المغناطيسي.

هذه الدراسة أجريت في 72 مريضا يعانون من تشخيصا سريريا من أورام السحايا , وتم تجميعها للجنسين وجد 29 من الذكور حوالي (40.3 %) و 43 من الإناث حوالي (59.7), وفقا للعمر وجد أن السحايا أكثر انتشارا في المرضى الأكبر سنا وجد 25 مريضا بين الفئة العمرية (61-80) , وفقا للتشخيص ان السحايا المحدبه هي الأكثر انتشارا وجد 23 مريضا حوالي (32%) ووجود الحائندر جدا داخل البطني وجد مريض واحد فقط حوالي (1.4 %) تطابق هذه النتائج دراسة تشنغ مينغ (2013), وفقا للموقع صنفنا الياف المخ هي الأكثر عرضة للسحايا وجد 16 مريضا حوالي (22%) ليس هنالك دراسة سابقة وجدت فيما يتعلق بموقع السحايا, وفقا للحجم معظم السحايا هي صغيرة الحجم اقل من 2 سنتيمتر وجد 41 مريضا حوالي (57%) طبقت هذه النتيجة دراسة كريستوفر (2001), اما التصنيف علي حسب النوع السحايا الحميده هي الأكثر شيوعا هذه النتيجة تتوافق مع دراسة أجراها ناجار (2013) وكريستوفر (2001).

واستنتج ان التصوير بالرنين المغناطيسي يتميز بدقه عالية جدا في تشخيص وتصنيف أورام السحايا.

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### **List of the Abbreviations**

MRI	Magnetic Resonance Imaging
NMR	Nuclear Magnetic Resonance
FMRI	Functional Magnetic Resonance Imaging
MRA	Magnetic Resonance Angiography
CT	Computed Tomography
CSF	Cerebrospinal Fluid
ACA	Anterior Cerebral Artery
MCA	Middle Cerebral Artery
PCA	posterior Cerebral Artery
PICA	Posterior Inferior Cerebral Artery
CBF	Cerebral Blood Flow
CBV	Cerebral Blood Volume
EEG	<u>Electroencephalogram</u>
TE	Time of echo
TR	Time of Repletion
RF	Radio Frequency
FLAIR	Fluid Attenuation Inverse Recovery
IV	Intra Venous
MHZ	Mega Hertz
T	Tesla
CSE	Conventional Spin Echo
SNR	Signal to Noise Ratio
FOV	Field Of View
WI	Weighted Image
ADC	Apparent Diffusion Coefficient
NADC	Normalized Apparent Diffusion Coefficient

ROC	Receiver Operating Characteristic
DW	Diffusion Weighted
CVA	Cerebrovascular Accident
CVI	Cerebrovascular Insult
kW	Kilo watt
WHO	World Health Organization



# CHAPTER ONE

## 1.1 Introduction

Meningiomas are a diverse set of tumors arising from the meninges, the membranous layers surrounding the central nervous system. They arise from the arachnoid "cap" cells of the arachnoid villi in the meninges. These tumors usually are benign in nature; however, a small percentage are malignant. Many meningiomas are asymptomatic, producing no symptoms throughout a person's life, and if discovered, require no treatment other than periodic observation. (herman2009)

Approximately 90% of all meningiomas fall into the benign category, these tumors exhibit slow growth and very little multiplication of cells and very rarely invade the brain tissue, Benign meningiomas are less likely to recur than the atypical malignant, grades, atypical meningiomas represent approximately 5% of meningiomas and exhibit increased tissue and cell abnormalities. (Donnell and etal 2004)

Atypical meningiomas have higher likelihood of recurrence than benign, malignant meningiomas account for approximately 3-5% of all meningiomas. These tumors show increased cellular abnormalities as well as a faster growth rate compared to benign and atypical meningiomas. Malignant meningiomas are the most likely to invade the brain and spread (metastasize) to other organs in the body. (Niedermaier2015)

In general, a meningioma is classified into one of three grades:

- A grade (I) tumor grows slowly and is noncancerous.
- A grade (II) tumor is atypical and is between noncancerous and cancerous.

- A grade (III) tumor is cancerous and can grow and spread very quickly.  
(Donnell and etal 2004)

Magnetic resonance imaging (MRI) is a medical imaging technique used in radiology to visualize detailed internal structures. MRI makes use of the property of nuclear magnetic resonance to image nuclei of atoms inside the body.  
(Victoria2013)

An MRI machine uses a powerful magnetic field to align the magnetization of some atoms in the body, and radio frequency fields to systematically alter the alignment of this magnetization. This causes the nuclei to produce a rotating magnetic field detectable by the scanner and this information is recorded to construct an image of the scanned area of the body. (Victoria2013)

## **1.2 Problem f Study**

Other radiological modalities are failed to detect the classification of Meningiomas

## **1.3 Objectives of Study**

### **1.3.1 General Objectives**

To determine role of magnetic resonance imaging (MRI) in diagnosing and classification of meningiomas in Sudan.

### **1.3.1 Specific Objectives**

- 1-To classified the gender, age, size, and common site of meningiomas.
- 2-To determine common diagnosis of meningiomas .
- 3- To characterize different classifications of meningiomas by MRI.

## **1.4 Overview of the Study**

This study is contains the following chapters:

Chapter one is the introduction .

Chapter two is the theoretical background and previous study.

Chapter three is the materials and a method.

Chapter four is the results.

Chapter five is the discussion, conclusion and recommendations.

Reference.

Appendixes .

## **CHAPTER TWO**

### **2.1 Theoretical Background**

#### **2.1.1 Brain Components**

##### **2.1.1.1 Brainstem**

The brainstem is the lower extension of the brain, located in front of the cerebellum and connected to the spinal cord (Fig 2:1). It consists of three structures: the midbrain, pons and medulla oblongata. It serves as a relay station, passing messages back and forth between various parts of the body and the cerebral cortex. (Dorland's 2012)

##### **2.1.1.2 Cerebellum**

The cerebellum is located at the back of the brain beneath the occipital lobes (Fig2:1). It is separated from the cerebrum by the tentorium , cerebellum consists of a tightly folded and crumpled layer of cortex, with white matter underneath, several deep nuclei embedded in the white matter, and a fluid-filled ventricle in the middle.(Rosdahl and etal 2015)

##### **2.1.1.3 Cerebrum**

The cerebrum is the largest part of the brain ,is divided into two major parts: the right and left cerebral hemispheres, fissure or groove that separates the two hemispheres is called the great longitudinal fissure, the two sides of the brain are joined at the bottom by the corpus callosum. The corpus callosum connects the two halves of the brain and delivers messages from one half of the brain to the other. The surface of the cerebrum contains billions of neurons and glia that together from the cerebral cortex, the cerebral cortex appears grayish brown in color and is called the "gray matter." The surface of the brain appears wrinkled. The cerebral cortex has sulci (small grooves), fissures (larger grooves) and bulges between the grooves called gyri.(Edwards and etal 2008)

#### **2.1.1.4 Meninges**

The brain is housed inside the bony covering called the cranium. The cranium protects the brain from injury. Together, the cranium and bones that protect the face are called the skull, between the skull and brain is the meninges. Which consist of three layers of tissue that cover and protect the brain and spinal cord, From the outermost layer inward they are the dura mater, arachnoids and pia mater.(Fig2.2) (Herman 2009)

In the brain, the dura mater is made up of two layers of whitish, non-elastic film or membrane. The outer layer is called the periosteum. An inner layer, the dura, and lines the inside of the entire skull and creates little folds or compartments in which parts of the brain are protected and secured. The two special folds of the dura in the brain are called the falx and the tentorium. The falx separates the right and left half of the brain and the tentorium separate the upper and lower parts of the brain . (Shepherd 2004)

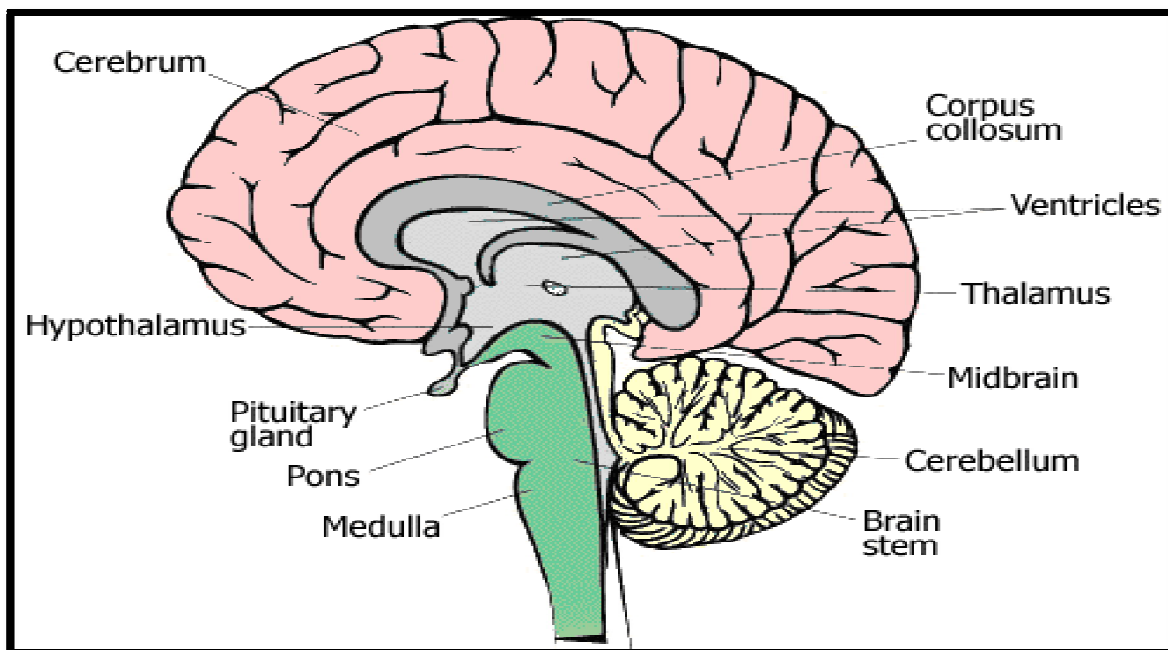
The second layer of the meninges is the arachnoid. This membrane is thin and delicate and covers the entire brain. There is a space between the dura and the arachnoid membranes that is called the sub-dural space. The arachnoid is made up of delicate, elastic tissue and blood vessels of varying sizes. (Niedermaier 2015)

The layer of meninges closest to the surface of the brain is called the pia mater. The pia mater has many blood vessels that reach deep into the surface of the brain. The pia, which covers the entire surface of the brain, follows the folds of the brain. The major arteries supplying the brain provide the pia with its blood vessels. The space that separates the arachnoid and the pia is called the subarachnoid space. It is within this area that cerebrospinal fluid flows. (Herman 2009)

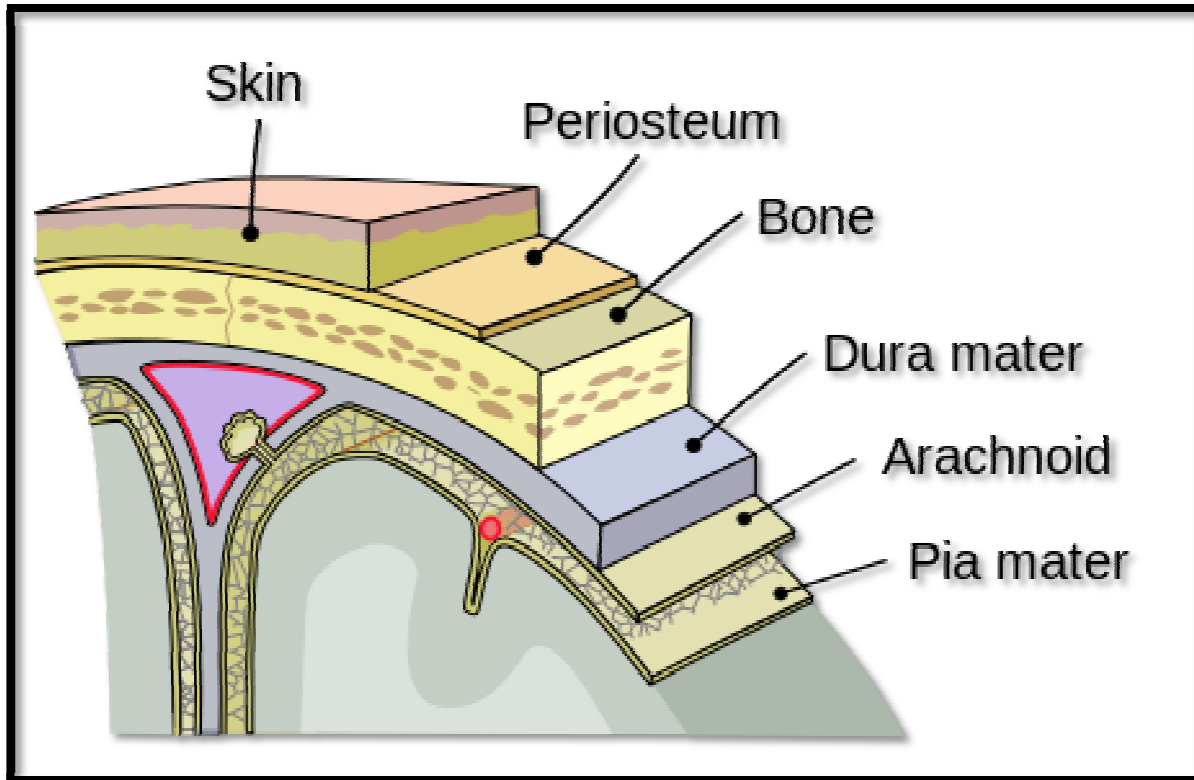
### 2.1.1.5 The Nervous System

The nervous system is commonly divided into the central nervous system and the peripheral nervous system. The central nervous system is made up of the brain, its cranial nerves and the spinal cord. The peripheral nervous system is composed of the spinal nerves that branch from the spinal cord and the autonomous nervous system divided into the sympathetic and parasympathetic nervous system (Finger 2001).

The brain is made up of two types of cells: neurons and glial cells, also known as neuroglia or glia. The neuron is responsible for sending and receiving nerve impulses or signals. Glial cells are non-neuronal cells that provide support and nutrition, maintain homeostasis, form myelin, and facilitate signal transmission in the nervous system. In the human brain, glial cells outnumber neurons by about 50 to one. Glial cells are the most common cells found in primary brain tumors. (Finger 2001).



**Fig 2.1 Brain Components.** (www.bennywills.org)



**Fig 2.2The Meninges.** ([www.en.wikipedia.org//Meninges](http://www.en.wikipedia.org//Meninges))

### 2.1.1.6 The Ventricular System

The ventricular system is divided into four cavities called ventricles, which are connected by a series of holes called foramen, and tubes.

Two ventricles enclosed in the cerebral hemispheres are called the lateral ventricles (first and second). They each communicate with the third ventricle through a separate opening called the interventricular Foramen (Fig 2.3). The third ventricle is in the center of the brain, and its swells are made up of the thalamus and hypothalamus, the third ventricle connects with the fourth ventricle through a long tube called the Aqueduct of Sylvius.,SF flowing through the fourth ventricle flows around the brain and spinal cord by passing through another series of openings. (Adrian Raine and etal 2010)

### **2.1.1.7 Cranial Nerves**

There are 12 pairs of nerves that originate from the brain itself. These nerves are responsible for very specific activities and are named as follows:

Olfactory:smell , Optic , oculometer: , Trochlear , Trigeminal , Abducens, Facial, vestibulocochlear, Glossopharyngeal, Vagus, Accessory and Hypoglossal. (Fig2.4)(Adrian Raine and etal 2010)

### **2.1.1.8 The Lobes**

#### **2.1.1.8.1 Frontal Lobes**

located at the front of the brain, is one of the four major lobes of the cerebral cortex in the mammalian brain. The frontal lobe is located at the front of each cerebral hemisphere and positioned in front of the parietal lobe and above and in front of the temporal lobe (Fig2.5). It is separated from the parietal lobe by a space between tissues called the central sulcus, and from the temporal lobe by a deep fold called the lateral sulcus also called the Sylvian fissure. The precentral gyrus, forming the posterior border of the frontal lobe, contains the primary motor cortex (Badre and etal 2010)

#### **2.1.1.8.2 Parietal Lobes**

These lobes are located above the occipital lobe and behind the frontal lobe and central sulcus. (Fig 2:4) (Yang2009).

#### **2.1.1.8.3 Temporal Lobes**

These lobes are located on each side of the brain at about ear level (Fig 2.5), and can be divided into two parts. One part is on the bottom (ventral) of each hemisphere, and the other part is on the side (lateral) of each hemisphere. (Badre and etal 2010)



#### **2.1.1.8.4 Occipital Lobe**

The occipital lobe is one of the four major lobes of the cerebral cortex in the brain of mammals. Is located in the posterior, or back, region of the cerebrum, superior to the cerebellum (Fig2.5), It's protected by cranial bones, with the primary protective bone being the occipital bone. The occipital lobe is also divided into right and left halves, as is the entire cerebrum. (Badre and etal 2010)

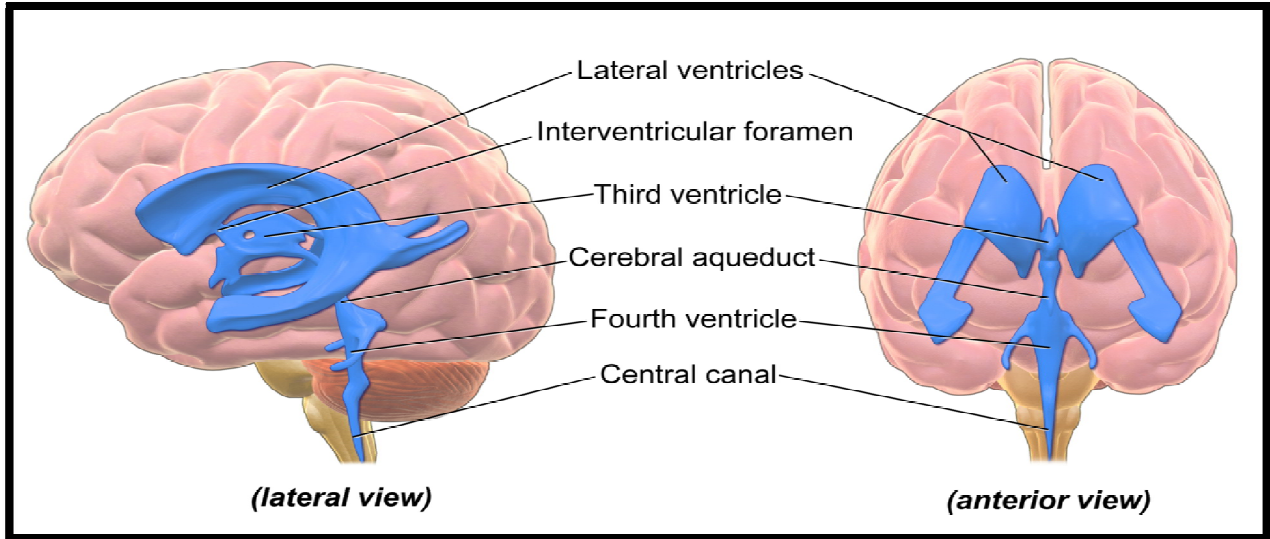
#### **2.1.1.9 Blood Flow to the Brain**

Blood is supplied to the brain, face, and scale via two major sets of vessels: the right and left common carotid arteries and the right and left vertebral arteries (Fig 2.6).

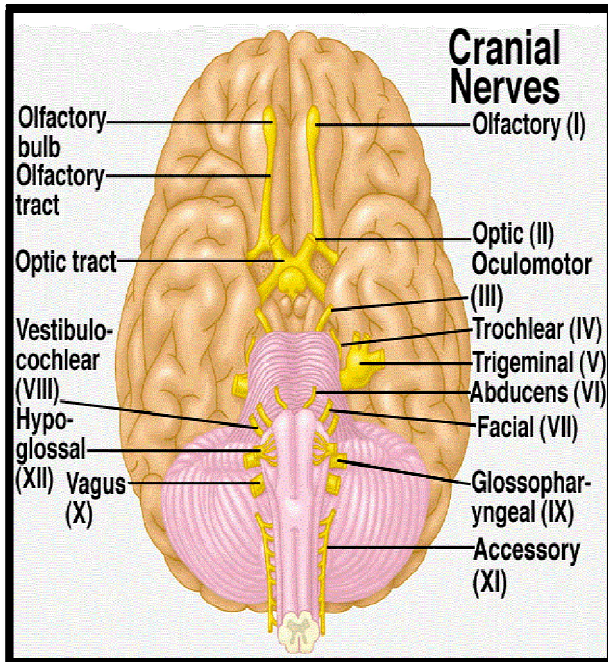
The common carotid arteries have two divisions. The external carotid arteries supply the face and scalp with blood. The internal carotid arteries supply blood to the anterior three-fifths of cerebrum, except for parts of the temporal and occipital lobes. The vertebrobasilar arteries supply the posterior two-fifths of the cerebrum, part of the cerebellum, and the brain stem.(Uston, Cagatay 2004)

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. 2.7). Posterior Inferior Cerebellar Arteries (PICA), which branch from the vertebral arteries. .(Uston, Cagatay 2004)

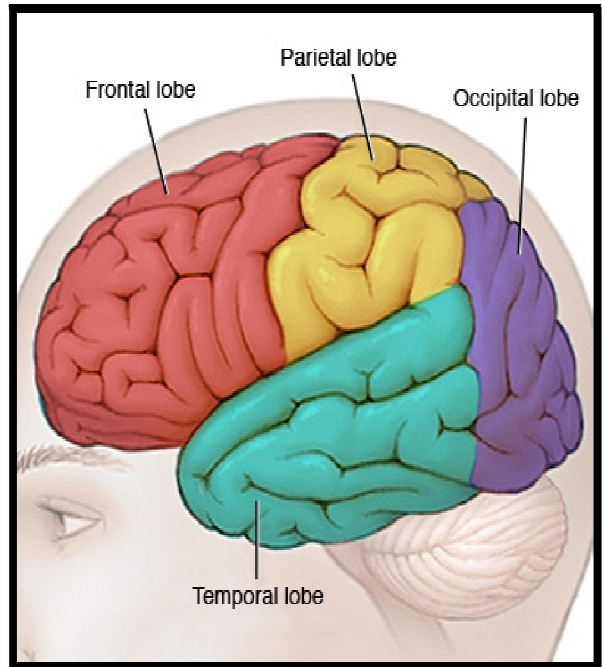
Because the carotid and vertebrobasilar arteries form a circle, if one of the main arteries is occluded, the distal smaller arteries that it supplies can receive blood from the other arteries (collateral circulation). (Van Rijk. 2006)



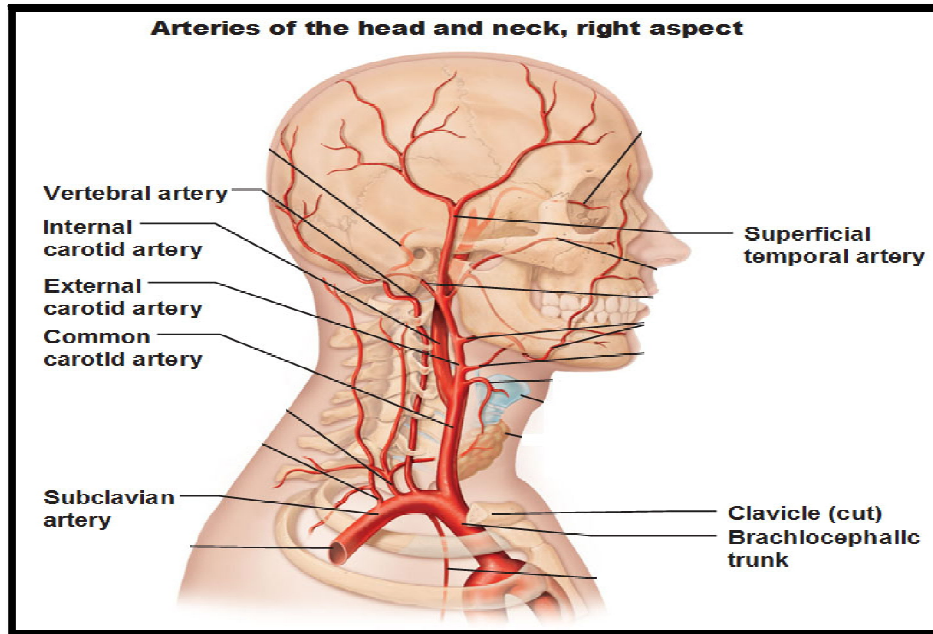
**Fig 2:3 The Ventricular System.** ([www.en.wikipedia.org](http://www.en.wikipedia.org))



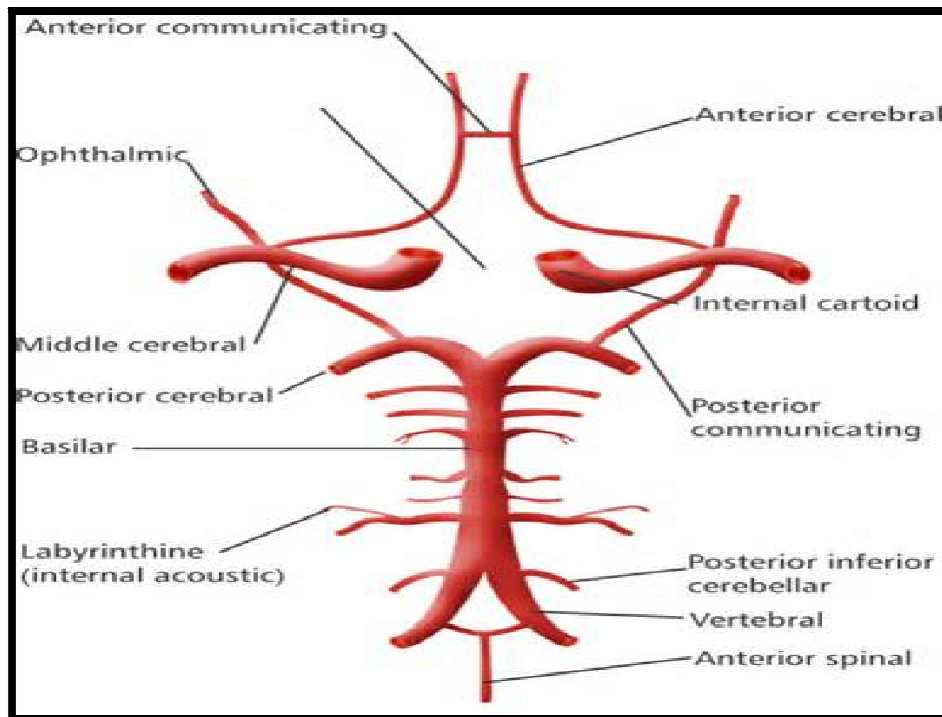
**Fig 2:4 Cranial Nerves.** ([www.bing.com](http://www.bing.com))



**Fig2.5 Brain Lobes.**([www.mayoclinic.org](http://www.mayoclinic.org))



**Fig 2:6 Arteries of brain.** ( [www.nlm.nih.gov](http://www.nlm.nih.gov) )



**Fig 2.7 Circle of Willis.** ( [www.nlm.nih.gov](http://www.nlm.nih.gov) )

## **2.1.2 Physiology of The Brain**

### **2.1.2.1 Brain Stem**

Breathing, Heart Rate, Swallowing, Reflexes to seeing and hearing (Startle Response), Controls sweating, blood pressure, digestion, temperature (Autonomic Nervous System), Affects level of alertness, Ability to sleep, Sense of balance (Vestibular Function). (peckmann2004)

### **2.1.2.2 Cerebellum**

Coordination of voluntary movement, Balance and equilibrium, some memory for reflex motor acts. (Nieuwenhuys and etal 2008)

### **2.1.2.3 Cerebrum**

Consists of four different lobes that control senses, thoughts, and movement, the left cerebrum controls the right side of the body.(Nieuwenhuys and etal 2008)

Four Lobes of the Cerebrum and Their Functions:

#### **2.1.2.3.1 Frontal Lobes**

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. (peckmann2004)

#### **2.1.2.3.2 Parietal Lobes**

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. (Nieuwenhuys and etal 2008)

#### **2.1.2.3.3 Temporal Lobes**

Hearing ability, Memory acquisition, some visual perceptions, Categorization of objects. (Nieuwenhuys and etal 2008)

#### **2.1.2.3.4 Occipital Lobes**

associated with visual processing. (peckmann2004)

#### **2.1.2.4 The Meninges**

The main functions of the meninges include:

- Protecting the brain and spinal cord from mechanical injury
- Providing blood supply to the skull and to the hemispheres
- Providing a space for the flow of cerebrospinal fluid. (peckmann2004)

#### **2.1.2.5 The Cranial Nerves**

provide motor and sensory innervations mainly to the structures within the head and neck. The sensory innervations includes both "general" sensation such as temperature and touch, and "special" innervations such as taste, vision, smell, balance and hearing.

The olfactory nerve (I) conveys the sense of smell, The optic nerve (II) transmits visual information, The oculomotor nerve (III), trochlear nerve (IV) and abducens nerve (VI) coordinate eye movement, The trigeminal nerve (V) provide sensation to the skin of the face and also controls the muscles, Lesions of the facial nerve (VII) may manifest as facial palsy, The vestibulocochlear nerve (VIII) splits into the vestibular and cochlear nerve, Oral sensation, taste, and salivation (IX), Loss of function of the vagus nerve (X) will lead to a loss of parasympathetic innervation Shoulder elevation and head-turning (XI),and Tongue movement (XII). (peckmann2004.)

## **2.1.3 Pathology of The Brain**

### **2.1.3.1 Genetic Brain Disorders**

A genetic brain disorder is caused by a variation or a mutation in a gene. A variation is a different form of a gene. A mutation is a change in a gene. Genetic brain disorders affect the development and function of the brain, some genetic brain disorders are due to random gene mutations or mutations caused by environmental exposure, such as cigarette smoke. Other disorders are inherited, which means that a mutated gene or group of genes is passed down through a family. they can also be due to a combination of both genetic changes and other outside factors, some examples of genetic brain disorders include leukodystrophies. Penylketonutria, Tay-Sachs disease, and Wilson disease.( Laan and etal 2005)

### **2.1.3.2 Hydrocephalus**

is a medical condition in which there is an abnormal accumulation of cerebrospinal fluid (CSF) in the brain, this causes increased intracranial pressure inside the skull and may cause progressive enlargement of the head if it occurs in childhood, potentially causing convulsion, tunnel vision, and mental disability. (Cabot Richard 2004)

### **2.1.3.4 Stroke**

also known as cerebrovascular accident (CVA), cerebrovascular insult (CVI), or brain attack, is when poor blood flow to the brain results in cell death. there are two main types of stroke ischemic, due to lack of blood flow, and hemorrhagic due to bleeding, Signs and symptoms of a stroke may include an move or feel on one side of the body, problems understanding or speaking, or side among others. (Halkes and etal 2007)

### **2.1.3.5 Hematoma**

A hematoma is an abnormal collection of blood outside of a blood vessel. It occurs because the wall of a blood vessel wall, artery, vein, or capillary, has been damaged and blood has leaked into tissues. (Halkes and etal 2007)

### **2.1.3.6 Encephalitis**

Encephalitis is defined as inflammation of the brain. this means encephalitis is different from meningitis, which is defined as inflammation of the layers of tissue, or membranes, covering the brain, encephalitis may cause fever, headache, poor appetite, loss of energy, or just a general sick feeling, the signs and symptoms of that illness usually come before symptoms of inflammation in the brain. (Halkes and etal 2007)

### **2.1.3.7 Alzheimer's disease**

It is a chronic neurodegenerative disease that usually starts slowly and gets worse over time. The most common early symptom is difficulty in remembering recent events (short-term memory loss). As the disease advances, symptoms can include problems, disorientation (including easily getting lost), mood swings, loss of motivation, not managing self care. Gradually, bodily functions are lost, ultimately leading to death. Although the speed of progression can vary, the average life expectancy following diagnosis is three to nine years. ( Laan and etal 2005)

### **2.1.3.8 Meningitis**

Meningitis is inflammation of the thin tissue that surrounds the brain and spinal cord, called the meninges., which a virus enters the body through the nose or mouth and travels to the brain. Bacterial meningitis is rare, but can be deadly. It usually starts with bacteria that cause a cold-like infection. It can block blood

vessels in the brain and lead to stroke and brain damage. It can also harm other organs. .( Laan and etal 2005)

### **2.1.3.9 Meningiomas**

Meningiomas are a diverse set of tumors arising from the meninges, the membranous layers surrounding the central nervous system. they arise from the arachnoid "cap" cells of the arachnoid villi in the meninges. These tumors usually are benign in nature; however, a small percentage are cancerous. (Victoria 2013)

#### **2.1.3.9.1 Diagnosis of Meninguomas**

##### **2.1.3.9.1.1 Convexity Meningioma**

Grows on the surface of the brain directly under the skull . Accounting for approximately 20% of meningiomas, convexity meningiomas may not present symptoms until the tumor has become large enough to push on the brain. (Halkes and etal 2007)

##### **2.1.3.9.1.2 Sphenoid Wing Meningioma**

Also called sphenoid ridge Sphenoid wing meningiomas form on the sphenoid ridge behind the eyes. These types of meningiomas can cause visual impairment and facial numbness. In severe cases, they can cause blindness. (Victoria 2013)

##### **2.1.3.9.1.3 Olfactory Groove Meningioma**

Olfactory meningiomas grow near the olfactory nerve, located between the brain and the nose. An olfactory meningioma can cause a loss of smell, and if the tumor becomes very large, it can affect the optic nerves, resulting in visual impairment. (Halkes and etal 2007)



#### **2.1.3.9.1.4 Suprasellar Meningioma**

Suprasellar meningiomas develop in an area near the pituitary gland and optic nerve at the base of the skull. These types of meningiomas are slow growing and can cause severe visual impairment in one or both of the eyes. (Halkes and etal 2007)

#### **2.1.3.9.1.5 Posterior Fossa Meningioma**

Posterior fossa petrous meningiomas are located on the underside of the brain. These types of meningiomas can cause facial pain, such as trigeminal neuralgia, and can produce spasms in the face. (Victoria 2013)

#### **2.1.3.9.1.6 Intraventricular Meningioma**

Intraventricular meningiomas are associated with the connected chambers of fluid that circulate throughout the central nervous system. This fluid is known as cerebro-spinal fluid (CSF). (Victoria 2013)

#### **2.1.3.9.1.7 Intraorbital Meningioma**

Intraorbital meningiomas grow around the eye sockets of the skull.(Victoria 2013)

#### **2.1.3.9.1.8 Flax and parasagittal Meningioma**

The flax is a groove that runs between the two sides (hemispheres) of the brain (front to back). Running along the top of this groove is a large blood vessel, known as the superior sagittal sinus. Flax tumors arise from the meninges folded down in the groove, whereas parasagittal tumors arise from the meninges that are near or close to the superior sagittal sinus at the top of the groove . (Cabot Richard 2004)

### **2.1.3.9.1.8 Tentorial Meningioma**

Tentorial meningiomas are rare tumors that are located under the surface of the tentorium cerebella in the brain. These types can cause headaches, seizures and make it difficult to walk. (Cabot Richard 2004)

### **2.1.3.9.1.9 Foramen Magnum Meningioma**

Foramen magnum meningiomas originate primarily within the foramen magnum, which is the opening through which the spinal cord passes from the brain. (Cabot Richard 2004)

### **2.1.3.9.1.10 Spinal Meningioma**

Spinal meningiomas are less common and typically occur in middle-aged women. The tumors press against the spinal cord in the thoracic region of the chest and can cause back pain, numbness and tingling due to the pressure surrounding the mass. (Victoria 2013)

### **2.1.3.9.2 Causes of Meningiomas**

Most cases are sporadic while some are familial. Persons who have undergone radiation to the scalp are more at risk for developing meningiomas.

The most frequent genetic mutations involved in meningiomas are inactivation mutations in the neurofibromatosis gene (merlin) on chromosome 22q. (Cabot Richard 2004)

### **2.1.3.9.3 Signs and symptoms of Meningioma**

Symptoms may be specific to the location of the tumor include:

- Single or multiple muscle spasms.
- Loss of control of body functions.
- Change in sensation, vision, smell, and/or hearing without losing consciousness.
- Nausea or vomiting.

- Headaches, which may be severe.
- Blurred vision
- Loss of consciousness and body tone, followed by twitching and relaxing muscle contractions.
- Focal neurological deficits .(Al-Kadi 2015)

#### **2.1.3.9.4 Mechanism of Meningioma**

Meningiomas arise from arachnoidal cells, most of which are near the vicinity of the venous sinuses, and this is the site of greatest prevalence for meningioma formation. They are most frequently attached to the dura over the superior parasagittal surface of frontal and parietal lobes, along the sphenoid ridge, in the olfactory grooves, the sylvian region, superior cerebellum along the flax cerebri, cerebellopontine angle, and the cord, the tumor is usually gray, well-circumscribed, and takes on the form of space it occupies. They are usually dome-shaped, with the base lying on the dura. (Cabot Richard 2004)

Histologically, the cells are relatively uniform, with a tendency to encircle one another, forming whorls and psammoma bodies (laminated calcific concretions). They have a tendency to calcify and are highly vascularized. (Al-Kadi 2015)

Meningiomas are often considered benign tumors curable by surgery, but most recurrent meningiomas correspond to histologic benign tumors. The metabolic phenotype of these benign recurrent meningiomas indicated an aggressive metabolism resembling that observed for atypical meningioma . (Al-Kadi 2015)

#### **2.1.3.9.5 Diagnosis Meningioma By**

Meningiomas are readily visualized with contrast CT, MRI with gadolinium and arteriography, all attributed to the fact that meningiomas are extra-axial and

vascularized. CSF protein is usually elevated if lumbar puncture is attempted.,hough the majority of meningiomas are benign, they can have malignant presentations. (Victoria 2013)

### **2.1.3.9.6 Classification of Meningioma**

Are based upon the WHO (world health organization) classification system

#### **2.1.3.9.6.1 Benign (Grade I)**

(90%) include Meningothelial (syncytial) meningioma ,Transitional (mixed) meningioma,Fibroblastic (fibrous) meningioma ,Psammomatous meningioma ,Angiomatous (vascular) meningioma ,Microcystic meningioma ,Secretory meningioma ,Lymphoplasmacyte-rich meningioma and Metaplastic meningioma. (Al-Kadi 2015)

#### **2.1.3.9.6.2 Atypical (Grade II)**

(7%) include chordoid, clear cell and atypical meningiomas (includes brain invasion). (Al-Kadi 2015)

#### **2.1.3.9.6.3 Anaplastic Malignant (Grade III)**

(2%) include papillary, rhabdoid and anaplastic meningiomas . (Al-Kadi 2015)

### **2.1.3.9.7 Treatment of Meningioma**

#### **2.1.3.9.7.1 Surgical Resection**

Meningiomas can usually be surgically resected with permanent cure if the tumor is superficial on the dural surface and easily accessible. transarterial embolization has become a standard preoperative procedure in the preoperative management, If invasion of the adjacent bone occurs, total removal is nearly impossible. Malignant transformation is rare. (Victoria 2013)

### **2.1.3.9.7.2 Radiation therapy**

Radiation therapy may include photon beam or proton beam treatment, or fractionated external beam radiation. Radiosurgery can be used in lieu of surgery in small tumors located away from critical structures. (Al-Kadi 2015)

A gamma knife is another form of radiation therapy that concentrates highly focused beams of gamma radiation on the tumor. A gamma knife can only be used for meningioma in the brain, not meningioma on the spin. (Al-Kadi 2015)

## **2.1.4 Magnetic Resonance Imaging (MRI)**

### **2.1.4.1 Background**

Magnetic resonance imaging (MRI), nuclear magnetic resonance imaging (NMRI), or magnetic resonance tomography (MRT) is a medical imaging technique used in radiology to image the anatomy and the physiological processes of the body in both health and disease. MRI scanners use strong magnetic fields, radio waves, and field gradients to form images of the body. (Fig 2.8 and Fig 2.9) .( Hollingworth 2000)

### **2.1.4.2 History of MRI**

**1882** - Nikola Tesla discovered the Rotating Magnetic Field in Budapest, Hungary. This was a fundamental discovery in physics.

**1937** - Columbia University Professor Isidor I. Rabi working in the Pupin Physic Laboratory in New York City, observed the quantum phenomenon dubbed nuclear magnetic resonance (NMR). He recognized that the atomic nuclei show their presence by absorbing or emitting radio waves when exposed to a sufficiently strong magnetic field .

**1973**- Paul Lauterbur, a chemist and an NMR pioneer at the State University of New York, Stony Brook, produced the first NMR image. It was of a test tube.

1993 - Functional MR imaging of the brain is introduced .

**2000's** - Cardiac MRI, Body MRI, fetal imaging, functional MR imaging are further developed and become routine in many imaging centers. Research centers make significant strides forward in imaging cartilage on high field scanners. The number of free standing MRI centers, most of which utilize low or moderate field MR scanners significantly increases. (Sandrone2014)

### **2.1.4.3 Principle of MRI**

The basis of MRI is the directional magnetic field, or moment, associated with charged particles in motion. Nuclei containing an odd number of protons and/or neutrons have a characteristic motion or precession. Because nuclei are charged particles, this precession produces a small magnetic moment.(Nolen and etal 2014)

When a human body is placed in a large magnetic field, many of the free hydrogen nuclei align themselves with the direction of the magnetic field. The nuclei precess about the magnetic field direction like gyroscopes. This behavior is termed Larmor precession. (Sandrone2014)

In a 1.5 T magnetic field at room temperature this difference refers to only about one in a million nuclei since the thermal energy far exceeds the energy difference between the parallel and ant parallel states. Yet the vast quantity of nuclei in a small volume sum to produce a detectable change in field. Most basic explanations of MRI will say that the nuclei align parallel or anti-parallel with the static magnetic field; however, because of quantum mechanics quantum mechanical reasons, the individual nuclei are actually set off at an angle from the direction of the static magnetic field. The bulk collection of nuclei can be partitioned into a set whose sum spin are aligned parallel whose sum spin are anti-parallel. (Sandrone2014)

## **2.1.4.4 Scanner Construction and Operation**

### **2.1.4.4.1 Magnet**

The magnet is the largest and most expensive component of the scanner (Fig 2.8), and the remainder of the scanner is built around it, the strength of the magnet is measured in Teslas (T). Clinical magnets generally have a field strength in the range (0.1 – 3.0 T).

Three types of magnet have been used:

- Permanent magnet: Conventional magnets made from ferromagnetic materials.
- Resistive electromagnet: A solenoid wound from copper wire is an alternative to a permanent magnet.
- Superconducting electromagnet: most common type found in MRI scanners today. (Nolen and etal 2014)

### **2.1.4.4.2 Radio Frequency (RF) System**

The RF transmission system consists of a RF synthesizer, power amplifier and transmitting coil. This is usually built into the body of the scanner (Fig 2.10), the power of the transmitter is variable, but high-end scanners may have a peak output power of up to 35 kW, and be capable of sustaining average power of 1 kW. The receiver consists of the coil, pre-amplifier and signal processing system. (Nolen and etal 2014)

A recent development in MRI technology has been the development of sophisticated multi-element phased array coils which are capable of acquiring multiple channels of data in parallel. This 'parallel imaging' technique uses unique acquisition schemes that allow for accelerated imaging, by replacing some of the spatial coding originating from the magnetic gradients with the spatial sensitivity of the different coil elements. However the increased acceleration also reduces

SNR and can create residual artifacts in the image reconstruction. Two frequently used parallel acquisition and reconstruction schemes are sense. (Sandrone2014)

### **2.1.4.4.3 Coils**

A Coils are part of the hardware of MRI machines and are used to create a magnetic field by voltage induced in the wire, coil consists of one or more loops of conductive wire, looped around the core of the coil. (Nieuwenhuys and etal 2008)

Different types of MRI coils are used in MR systems:

#### **2.1.4.4.3.1 Surface Coil**

is essentially a loop of conducting material, this type of receiver coil is placed directly on or over the region of interest for increased magnetic sensitivity. (Nieuwenhuys and etal 2008)

#### **2.1.4.4.3.2 Volume Coil**

that surrounds either the whole body, or one specific region, such as the head or a knee, Volume coils have a better RF homogeneity than surface coils, which extends over a large area. . (Nieuwenhuys and etal 2008)

#### **2.1.4.4.3.3 Gradient Coil**

Current carrying coils designed to produce a desired magnetic field gradient, Gradient coils in general vary the main magnetic field, so that each signal can be related to an exact location. The gradient coil configuration for the z-axis (Fig 2.10) . (Nieuwenhuys and etal 2008)

### **2.1.4.5 Tissue Signal Characteristics**

Signal in MR images are high or low (bright or dark), depending on the pulse sequence used, and the type of tissue in the image region of interest. The following is a general guide to how tissue appears on T1- or T2- weighted images. (Buckley2013)



#### **2.1.4.5.1 Dark on T1 weighted image**

In edema, tumor, infarction, inflammation, infection, hemorrhage - (hyperacute or chronic). (Buckley2013)

#### **2.1.4.5.2 Bright on T1 Weighted Image**

Fat, Subacute hemorrhage, Melanin, Protein-rich fluid, Slowly flowing blood, Paramagnetic substances: gadolinium, manganese, copper, Calcification (rarely), Laminar necrosis of cerebral infarction. (Buckley2013)

#### **2.1.4.5.3 Bright on T2 Weighted Image**

Increased water, as in edema, tumor, infarction, inflammation, infection, subdural collection, Methemoglobin (extracellular) in subacute hemorrhage. (Buckley2013)

#### **2.1.4.5.4 Dark on T2 Weighted Image**

Paramagnetic substances: deoxyhemoglobin, methemoglobin (intracellular), iron, ferritin, hemosiderin, melanin. Protein-rich fluid, Flow void. (Nolen and et al 2014)

#### **2.1.4.6 Dynamic Contrast Enhancement**

Is an imaging method where T1-weighted MRI scans are acquired dynamically after injection of an agent. that is gives information about physiological tissue characteristics. For example, it enables analysis of blood vessels generated by a brain tumor. The contrast agent is blocked by the regular blood–brain barrier but not in the blood vessels generated by the tumor.. The contrast agents used are often gadolinium. Gadolinium injection causes the relaxation time to decrease, and therefore images done after gadolinium injection have higher signal, first a regular T1-weighted MRI scan is done (with no gadolinium), then gadolinium is injected (usually at a dose of 0.05-0.1 mmol/kg) and another T1-weighted scan is done. (Sandrone2014)

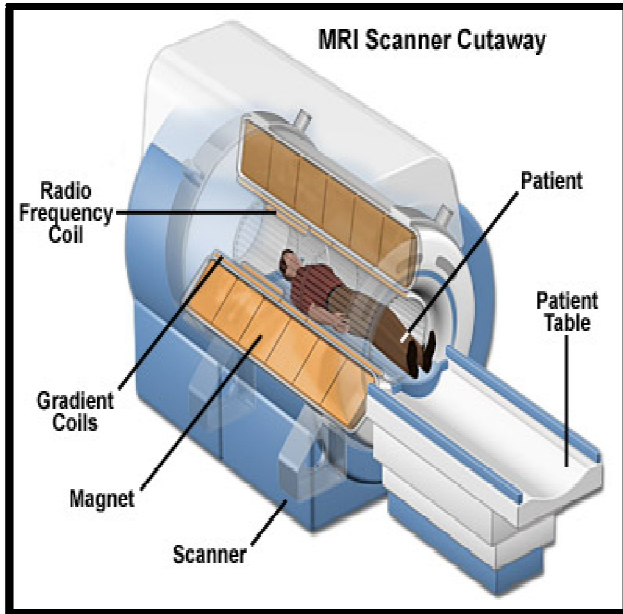


Fig 2.8 Permanent magnet MRI scanner .

(www.hopkinsmedicine.org)



Fig 2.9 Electromagnet MRI Scanner:

(www.nlm.nih.gov/medlineplus)

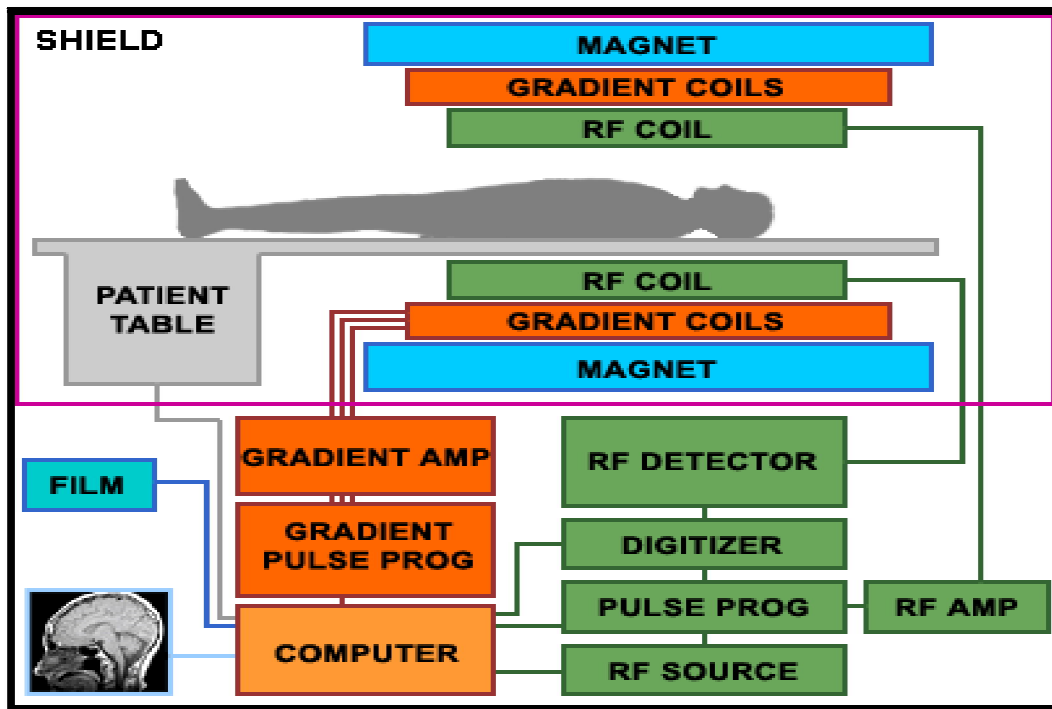


Fig 2.10 Diagram of MRI Unit (MRI Hardware). (www.hopkinsmedicine.org)

## 2.2 Pervious Study

Nagara et al(2013) studied Diffusion-Weighted MR Imaging Diagnosing Atypical or Malignant Meningiomas and Detecting Tumor Dedifferentiation, Atypical and malignant meningiomas are uncommon tumors with aggressive behavior and higher mortality, morbidity, and recurrence compared with benign tumors. We investigated the utility of diffusion-weighted (DW) MR imaging to differentiate atypical/malignant from benign meningiomas and to detect histologic dedifferentiation to higher tumor grade.they retrospectively compared conventional and DW (diffusion - wieghted) MR images acquired on a 1.5T clinical scanner between 23 atypical/malignant and 25 benign meningiomas. The optimal cutoff for the absolute apparent diffusion coefficient (ADC) and normalized ADC (NADC) ratio to differentiate between the groups was determined by using receiver operating characteristic (ROC) analysis. Irregular tumor margins, peritumoral edema, and adjacent bone destruction occurred significantly more often in atypical/malignant than in benign meningiomas.

Ming- Zheng et al(2013) studied papillary meningioma found Eight female and nine male patients (female/male ratio: 0.89) were observed in the study ,The mean age was 60 (male: 38.0; female: 42.3; range: 6 to 70) years. For comparison, we listed the female/male ratios and mean ages of WHO grade I and II meningiomas also operated on in our department during the same period of time , The tumor locations for the 17 cases were cerebral convexity (n=14), parasagittal (n=1), peritorcular (n=1) and sellar (n=1). The cerebral convexity was the most common site for papillary meningioma to be found. Interestingly, with three tumors showing midline growth, nine of the 17 cases were located on the left side, and the other five cases were on the right side , Using MR and/or CT scans, the preoperative diagnosis was confirmed as meningioma in 13 of the 17 cases, all

presented with irregular tumor margin ,heterogeneous enhancement with gadolinium ,and severe peritumoral brain edema.

Takahiro Nakano et al (2012), in their study Meningiomas with brain edema: Radiological characteristics on MRI and review of the literature, Despite their benign characteristics, meningiomas are often accompanied by perifocal brain edema. The aims of this study are to determine what kind of characteristics on magnetic resonance (MR) image are indicative of a meningioma that produces brain edema and to investigate the mechanism responsible for brain edema accompanying meningiomas, Fifty-one patients with meningioma were examined by magnetic resonance imaging (MRI), and tumor size, tumor location, shape of tumor margin, peritumoral rim, and signal intensity of tumor on T2-weighted image (T2WI) were compared and correlated with the presence versus absence of brain edema. Surgical histopathology was also examined and correlated with the MRI findings and brain edema, Shape of tumor margin, peritumoral rim, and signal intensity of tumor on T2WI correlated with brain edema on multivariate analyses, Invasive pattern of brain–tumor interface and hyperintensity on T2WI were indicative factors of meningiomas producing brain edema.

Another study by Go KG et al(2010), A study on peritumoural brain oedema around meningiomas by CT and MRI scanning, There is a great variability in the amount of peritumoural brain oedema accompanying meningiomas. In a previous study it was found that the degree of brain oedema in the white matter around meningiomas correlated with disruption of the layers (especially the cerebral cortex), which separate the tumour from the white matter, as well as with the size and histological subtype of the tumour. In the present study comprising 9 meningiomas, the volume of oedema was calculated by integration of the cross-sectional oedematous areas on serial MRI slices. The volume of oedema was zero in 3 cases and ranged from 11 to 176.4 ml in the other 6 cases. The MRI-scans also

showed disruption of the cortex in all cases, ranging from slight to severe. T1 and T2 measurements were made at the level of maximum extension, using a mixed sequence at a field strength of 1.5.

Faruk İldan,et al (2009), Predicting the Probability of Meningioma Recurrence in the Preoperative and Early Postoperative Period: A Multivariate Analysis in the Midterm Follow-Up,they reviewed the clinical, radiological, surgical, and histopathological features of patients with meningiomas to identify factors that can predict tumor recurrence after “microscopic total removal,” to improve preoperative surgical planning, and to help determine the need for close radiological observation at shorter intervals or the need for radiotherapy as an adjuvant treatment in the early postoperative period. Clinical data, magnetic resonance imaging studies, angiographic data, operative reports, and histopathological findings were examined retrospectively in 137 patients with a meningioma treated microsurgically and with no evidence of residual tumor on postoperative MR images.

Another study was done by Nishizaki et al (2006), Meningiomas are most common in people between the ages of 40 and 70. They are more common in women than in men , were admitted to departments of neurosurgery in Yamaguchi prefecture with meningioma. The clinical features and prognostic implications of meningioma in the elderly were assessed retrospectively. Seventy-eight (88%) of the 89 patients underwent surgery, which was a higher rate than has been previously reported. The length of clinical history was also shorter than in previous studies, and was partly due to the recent introduction of magnetic resonance imaging (MRI). The incidence of poor prognosis (severe disability, vegetative or dead) in the elderly and a younger group aged less than 70 years was 13% and 7%, respectively, but the difference was not statistically significant. In the surgically treated elderly group, age did not influence the patient's outcome. The factors

affecting the outcome were pre-operative neurological deficit ( $< 0.05$ ), histological malignancy ( $< 0.05$ ), and multiple operations ( $< 0.05$ ). Twenty-seven of the elderly meningioma patients were in good physical condition with minimal neurological involvement. They underwent total removal of the tumour at the first operation, and the histological diagnosis was benign. Twenty-five of these 27 patients fell into the best outcome category. Therefore, age alone was not a factor preventing proper surgical treatment of meningioma in the elderly.

Christopher et al (2001) study for Appearance of Meningiomas on Diffusion-weighted Images: Correlating Diffusion Constants with Histopathologic Findings Seventeen patients (13 women and four men; average age, 55 years) with meningiomas were prospectively studied using routine MR imaging and diffusion-weighted imaging with a single-shot gradient-echo echo-planar pulse sequence (6000/100 [TR/TE]), calculated within the tumor mass from ADC maps before resection, Four meningiomas were malignant or atypical (World Health Organization grades II and III), hyperintense on diffusion-weighted images and hypointense on ADC maps. Thirteen meningiomas were benign.  $D_{av}$  values were higher than normal brain values On diffusion-weighted images and ADC maps, most were isointense. Five benign meningiomas had very high  $D_{av}$  values, bright signal on ADC maps, The difference in  $D_{av}$  values between malignant and benign meningiomas was statistically significant, Albeit a small sample size, meningiomas with low  $D_{av}$  tended to be malignant or highly atypical whereas meningiomas with the highest  $D_{av}$  had increased water content due to either a specific histologic subtype of meningioma or the presence of associated pathologic abnormality.

## CHAPTER THREE

### MATERIAL AND METHODS

#### 3.1 Material

##### 3.1.1 Patient

The entire populations of this study were 72 patients males and females with ages range between 1-80 years .they referred to MRI center for MRI examination of brain. All patients suspected to have meningiomas according to the clinical signs and symptoms.

##### 3.1.2 Machine used

For MRI was used 1.5 Tesla scanner closed permanent magnet unit,use Quadrate head coil.

##### 3:1:3 Study area

Khartoum state hospitals .

##### 3.1.4 patient preparation

- Written consent from the pt before entering the scanner room.
- Ask the pt to Remove all metal object
- pt with electrically, magnetically or mechanically activated implants including cardiac pacemaker ,insulin pups should be identified before undergoing MRI.
- Note the weight of the pt.
- gadolinium (DTPA) that is usually required for tumor assessment , given intravenously (IV) ,the recommended dose is 0.1mmol/kg

### **3.1.6 Patient position**

- Patient Supine with his head within the head coil.
- The longitudinal alignment light lies in the midline and horizontal alignment light passes through the nasion.
- Straps and foam pads are used for immobilization .

### **3:1:7 Protocol used**

- Sagittal , axial and coronal SE T1
- Axial and coronal SE T2
- FLAIR this sequence provides arspid acquisition with suppression of CSF signal it useful for lesions.
- When contrast is indicated:
- Sagittal,coronal and axial T1.

## **3.2 Method**

### **3.2.1 Data Collection**

Data is collected from image reports and from data collection sheet that demonstrate age size, site, diagnosis, classifications, and enhanced tumors.

The images were interpreted and confirmed by the radiologists who were unaware of all clinical information to determined pathological finding seen.

### **3.2.1 Data Analyzed**

Data analyzed by using statistcal package and then using simple Excel for data presentation(Appendex).



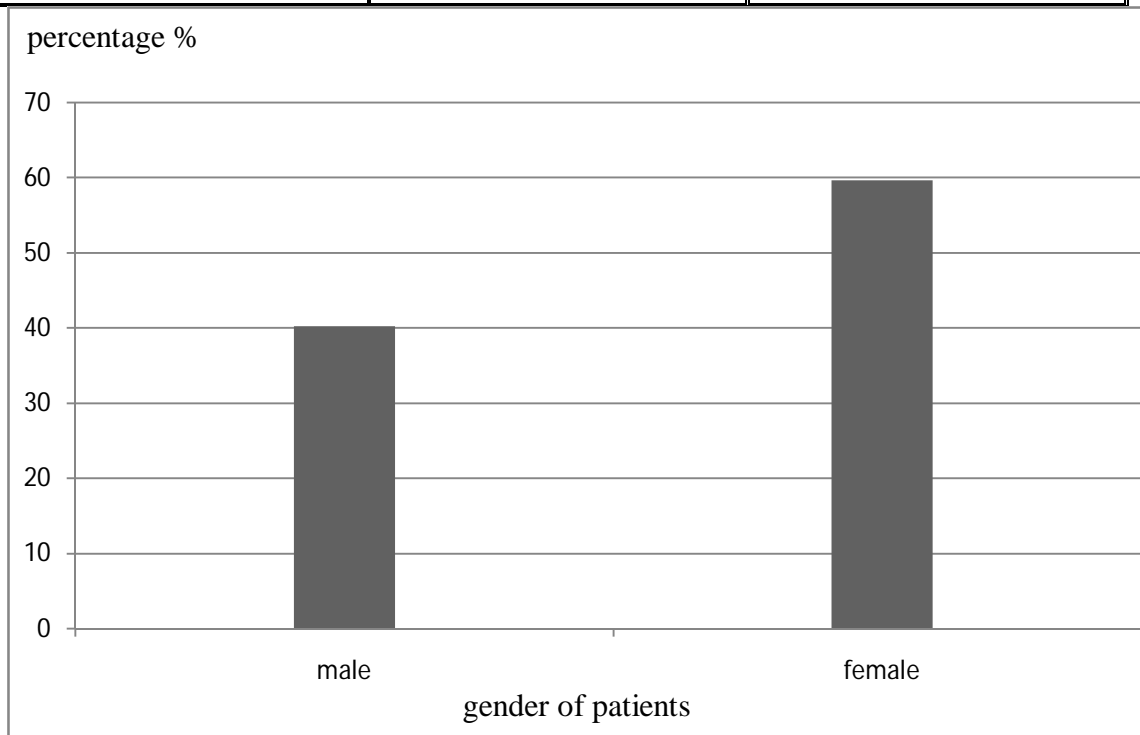
## CHAPTER FOUR

### Results

The MRI images of 72 patients were evaluated. For pathological finding, the site, age, gender size ,locations , and grading of meningiomas , All this information were shown in the following tables and graphs.

**Table 4.1 Show Study Group According to Gender**

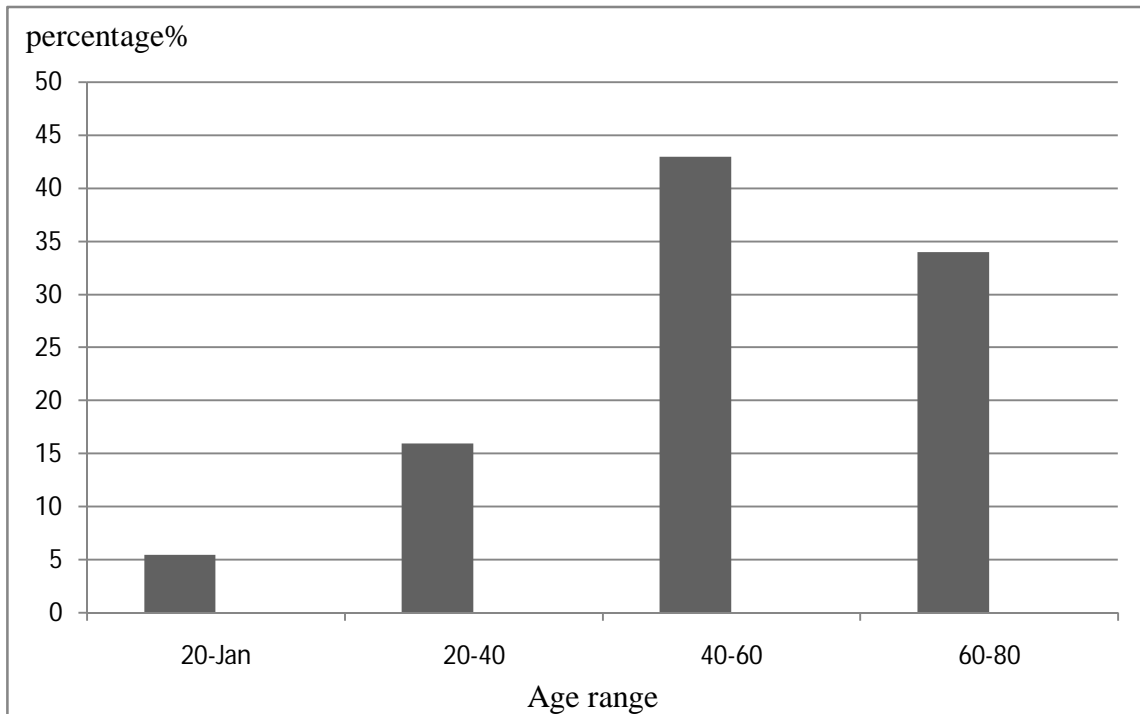
Gender	Frequency	Percentage
Male	29	40.3%
Female	43	59.7%
Total	72	100%



**Fig 4.1 Illustrated The Relation Between Percentage and Gender.**

**Table 4.2 Show Division of Subject Group According to the Age**

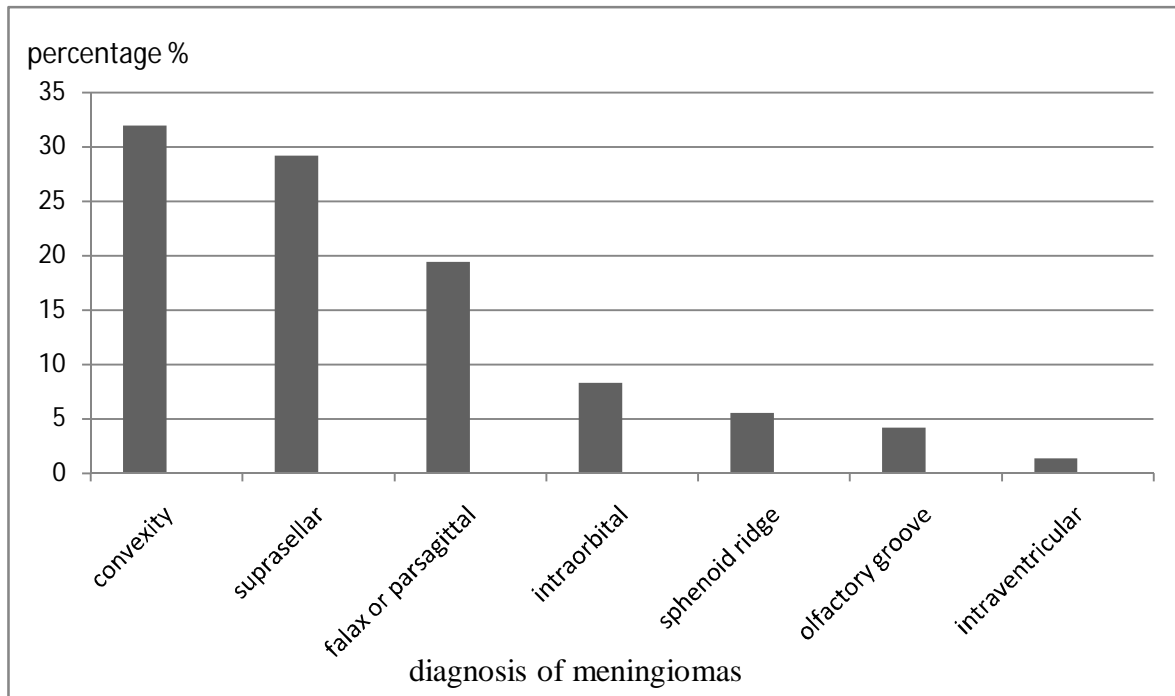
<b>Patient age group</b>	<b>Frequency</b>	<b>Percentage</b>
1-20	4	5.5%
21-40	12	16.5%
41-60	25	35%
61-80	31	43%
Total	72	100%



**Fig 4.2 Illustrated The Relation Between Percentage and Population Ages.**

**Table 4.3 Show Study Group According to Diagnosis of Meningiomas**

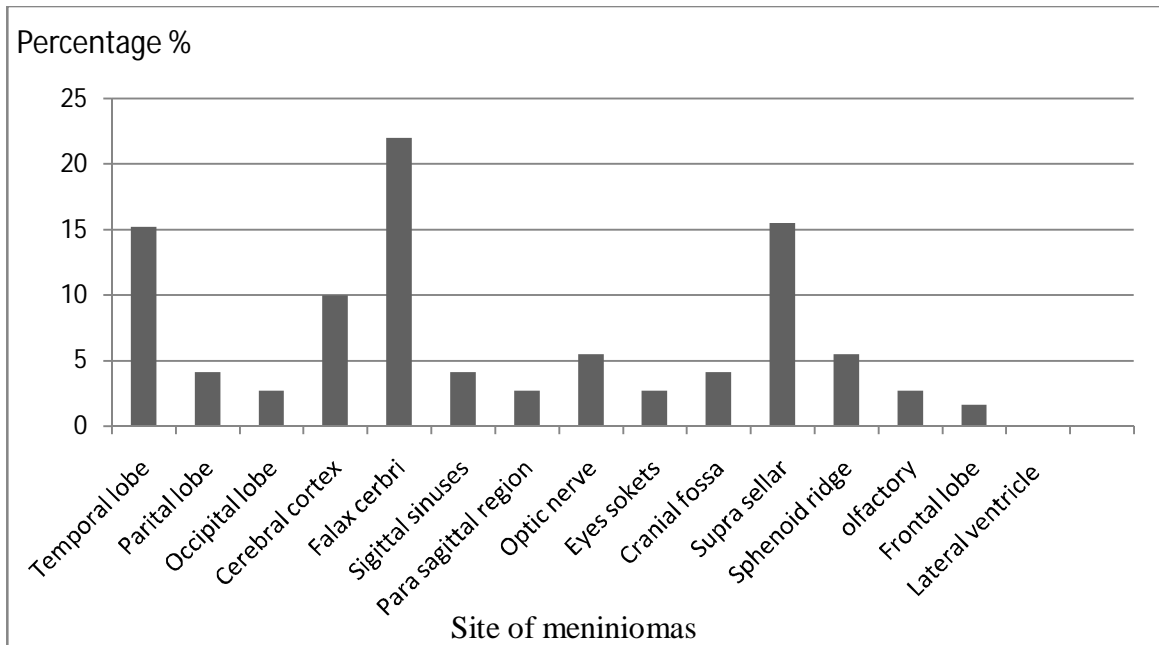
<b>Diagnosis</b>	<b>Frequency</b>	<b>Percentage</b>
Convexity	23	32%
Falax orParasagittal	21	29.2%
Suprasellar	14	19.4%
intraorbital	6	8.3%
Sphenoid ridge	4	5.5%
Olfactory groove	3	4.2%
Intraventricular	1	1.4%
Total	72	100%



**Fig 4.3 Illustrated The Relation Between Percentage and Diagnosis of Meningioma.**

**Table4.4 Show Study Group According To Site and Diagnosis of meningioma**

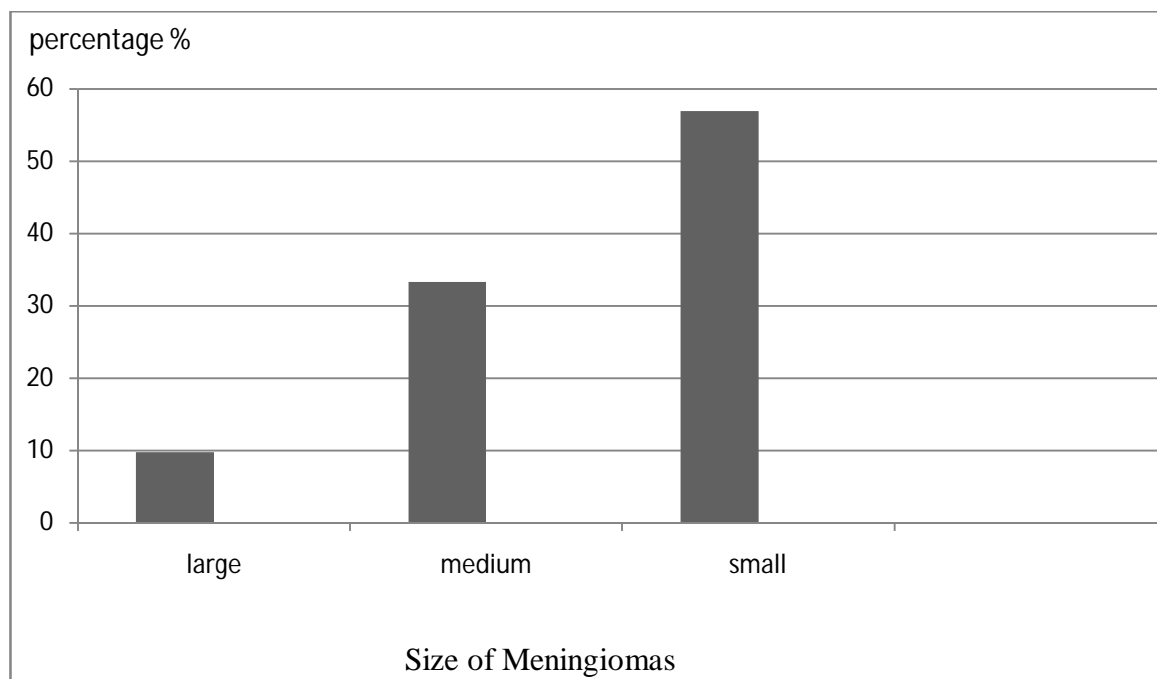
Diagnosis	Site	frequency	Percentage
Convexity	Temporal lobe	11	15.2%
	Parital lobe	3	4.1%
	Occipital lobe	2	2.7%
	Cerebral cortex	7	10%
Falax or parsagittal	Falax cerbri	16	22%
	Sigittal sinuses	3	4.1%
	Para sagittal region	2	2.7%
Intraorbital	Optic nerve	4	5.5%
	Eyes sokets	2	2.7%
Suprasellar	Cranial fossa	3	4.1%
	Supra sellar	11	15.5%
Sphenoid ridge	Sphenoid ridge	4	5.5%
Olfactory groove	olfactory	2	2.7%
	Frontal lobe	1	1.6%
Intraventricular	Lateral ventricle	1	1.6%
Total		72	100%



**Fig4.4 Illustrated The Relation Between Percentage and Site of Meningiomas.**

**Table 4.5 show study group according to size**

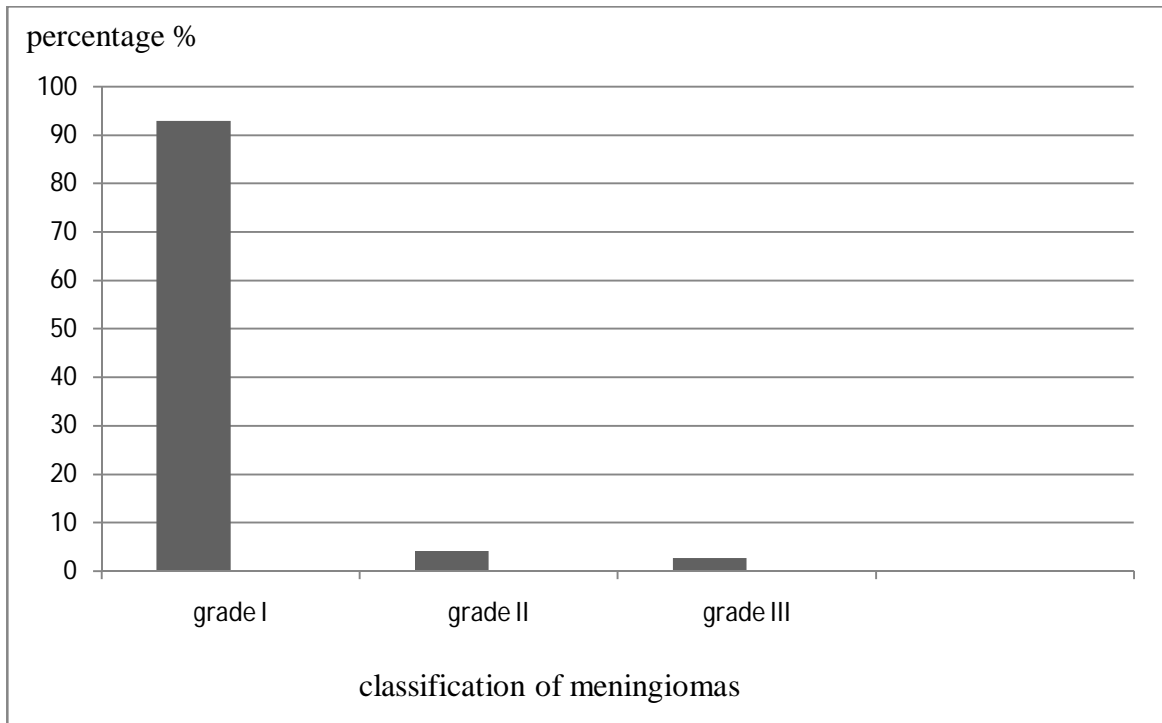
<b>Size</b>	<b>Frequency</b>	<b>Percentage</b>
Large(>5cm)	7	9.7%
Medium(2-5cm)	24	33.3%
Small(<2cm)	41	57%
Total	72	100%



**Fig 4.5 Illustrated The Relation Between Percentage and Size of Meningiomas.**

**Table 4.6 Show Study Group According to Classification of Meningiomas**

<b>Grade</b>	<b>Frequency</b>	<b>Percentage</b>
Grade (I)	67	93%
Grade (II)	3	4.3%
Grade (III)	2	2.7%
Total	72	100%



**Fig 4.6 Illustrated The Relation Between Percentage and Classification of Menongiomas.**

## Chapter FIVE

### Discussion, Conclusion and Recommendation

#### 5.1 Discussion

This study carried out to evaluate the role of MRI in diagnosis and classification of meningiomas.

The and fig table {4.1} show meningiomas according to gender 29 patient (40.3%) are male and 43 patient (59.7%)are female ,Subsequently meningiomas are more common in women than in men , this result match the study by Nishizaki (2006) Ming- Zheng(2013found eight female and nine male patients (female\male ratio 0.8:0. ), and Christopher (2001) found 13 women about (76.5%)and four men about (23.5%).

The table and fig {4.2} show meningiomas according to age 4 patients (5.5%) with age range (1-20) years,12 patients (17%) with age range (21-40) years ,31 patients (43%) with range (41-60) years, and 25 patients (34%) with range (61-80) years, according to this result meningiomas is rare in young patients (1-20) years and is more common in elder patients (61-80) years. This result match study by Christopher (2001) the average age 70 years, Nishizaki (2006) found meningiomas most common in people between age of 40-80 years and Ming- Zheng (2013) more common in range (60-70) years.

The table fig {4.3} show The meningiomas according to diagnosis , There were 23 patients form study group meningiomas were convexity meningiomas (32%), the second common diagnosis was falax or parassgittal meningiomas found in 21 patients (29.2%), the third diagnosis in study is suprasellar found in 14 patients (19.4%) ,the fourth common diagnosis is intraorbital found in 6 patients (8.3%),fifth common dignosis is sphenoid ridge found in 4 patients (5.5%),the sixth common diagnosis is olfactory groove found in 3 patients (4.2%)and meningiomas are very rare diagnosis as intraventricular there one patient about

(1.4%), this findings was confirm by a study Ming- Zheng (2013)found convexity meningiomas is more common diagnosis 14 patients about (82.3%).

The table fig {4.4} show meningiomas according to his size Large meningiomas (more than 5 cm) appear in 7 patients about( 9.7%) , Medium meningiomas(between 2-5 cm) appear in 24 patients about (33.3%),and the Small size (less than 2 cm) more than large and medium appear in 41 patient (57%) from study group. concerning the study by Christopher(2001).

Table and fig {4.5} shows meningiomas in different site the convexity meningiomas found in temporal lobe 11 patients about (15%), in parietal lobe 3 patients about (4.1%), in occipital lobe 2 patients about (2.7%),and in cerebral cortex 7 patients about (10%), the falax or parsagittal meningioma found in Falax cerbri 16 patients about (22%) that is more common site, and in para sagittal region 2 patients about (2.7%), the Intraorbital meningima found in optic nerve 4 patients about (5.5%) and in eyes sockets 2 patients about( 2.7%), the sphenoid ridge meningiomas in sphenoid ridge 4 patients about (5.5%),the olfactory groove meningiomas in olfactory 2 patents about (2.7%) and one patient in frontal lobe about (1.6%), and the interventriclar meningimas found one patient in lateral ventricle about (1.6%). there no pervious study found concerning the site of meningiomas.. there no pervious study found concerning the site of meningiomas.

Table and fig {4.6} shows the distribution of the classification of meningioma grade(I) meningiomas is most common were 67patients about (93%) , grade (II) found in three patients about (4.3%), and meningiomas are very rare to be malignant in grade (III) there two patients about (2.7%). that correspond study by Nagara (2013) found 25 patient grade(I) about(52%) and Christopher(2001)four meningiomas were malignant or typical about 23.5% grade (II) and grade (III) and thirteen patients were benign about (76.4%) .



All meningiomas have homogenous enhanced after contrast, indicating there is high blood supply ,most meningiomas has appear bright (high signal) in T2 and FLAIR, dark (low signal) in T1, meningiomas has homogenous enhanced after contrast.

## **5.2 Conclusion**

In conclusion , this study has showed that MRI is the best modality to identifying and localizing meningiomas, standard MRI sequence failed to detect meningiomas without contrast , there for use Gadolinium (DTPA) about 10 ml.

All meningiomas enhanced.

The meningiomas are more common in female than male about (59.7%).

The incident of meningiomas are common in elder patients with range (61-80) years about (34%).

convexity is common diagnosis of meningiomas about (32%).

flax cerbri is common site of meningiomas about (22%).

Most meningiomas are small in size(57%).

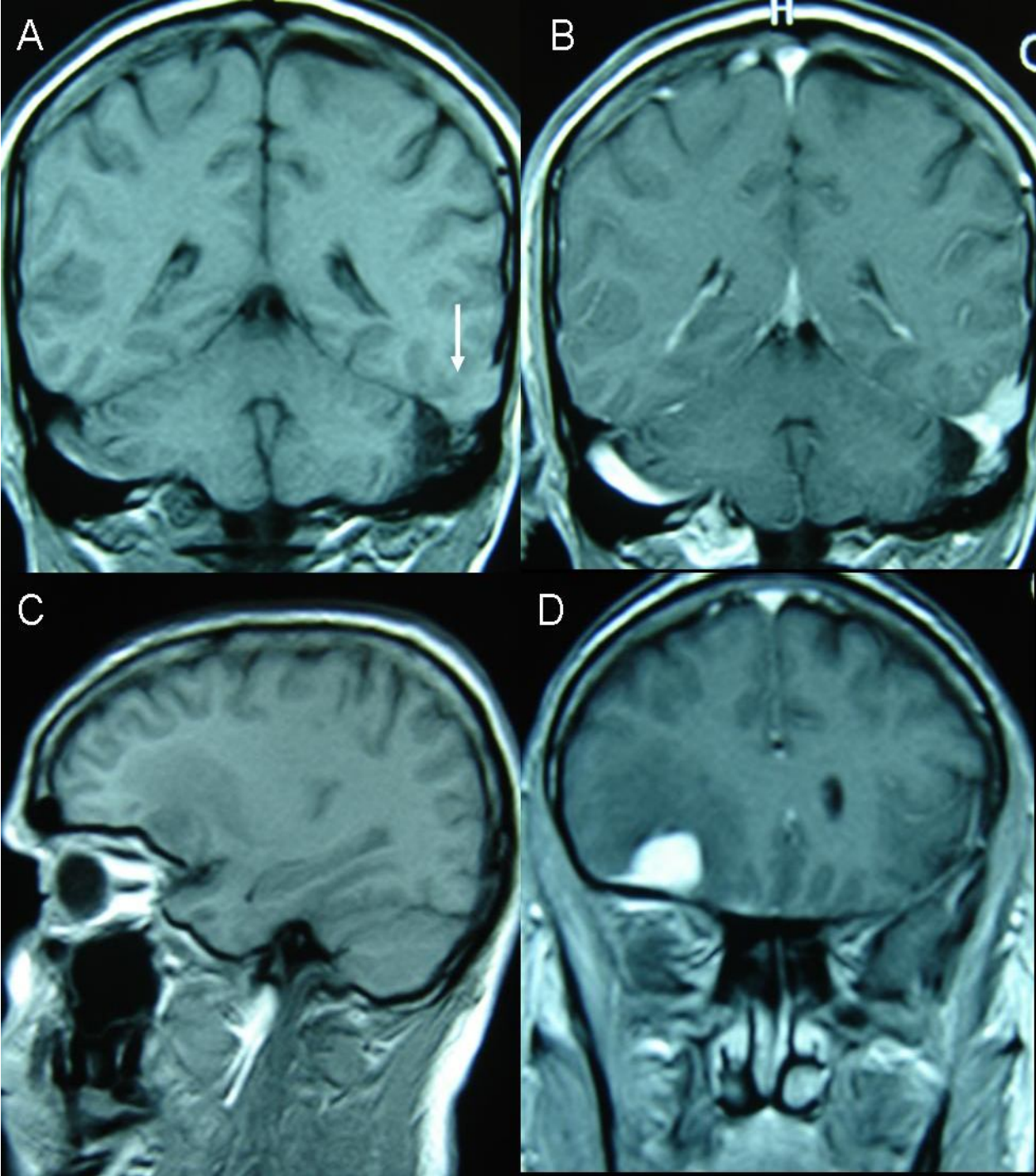
The majority of meningiomas are Grade (I) accounts for (93%)

## **5.3 Recommendation**

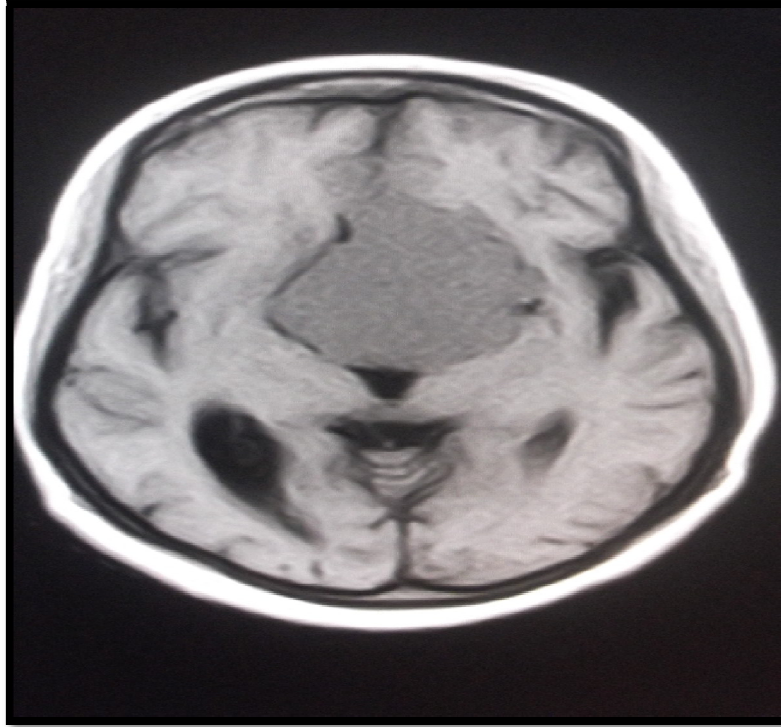
- This study showed that MRI is better for detection of classification of meningiomas ,there for it should be the preferred test for accurate diagnosis of patients with suspected meningiomas
- This study showed that , the sensitivity of MRI depends ,on the experience of operator so ,the radiologist and technologist should be continuously trained
- Future studies must used large sample to support the findings
- Biopsy must be done after MRI exam to support the accuracy of MRI versus biopsy

- Technologist must be interpreted how to read MRI images if needed for other sequence or protocols to help the radiologist in diagnosis of classification of meningiomas
- Requests for MRI Brain must be written by experienced physician with clinical data to aid technologist in selecting proper MRI protocol.

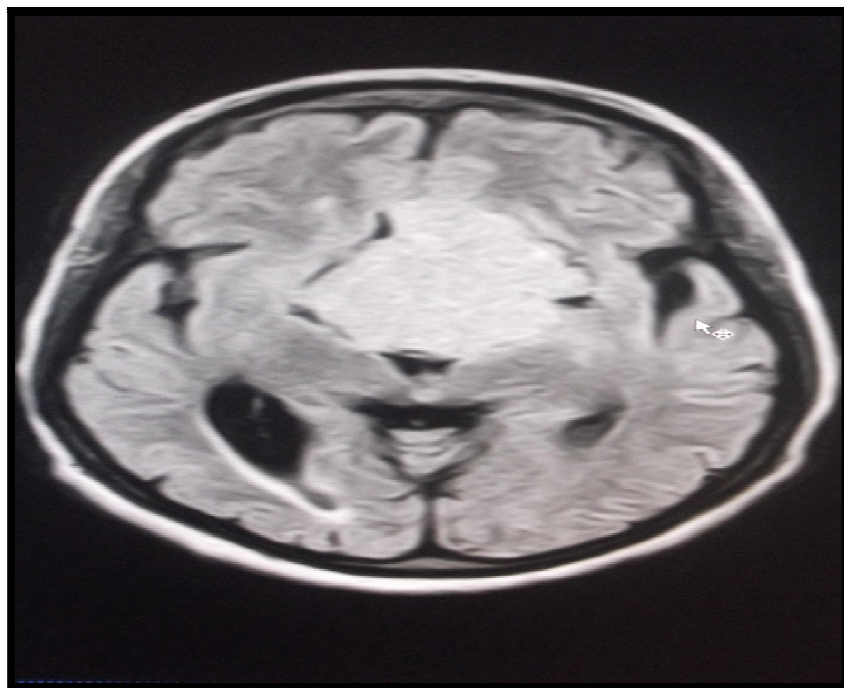
**5.4 MRI Images of Patients**



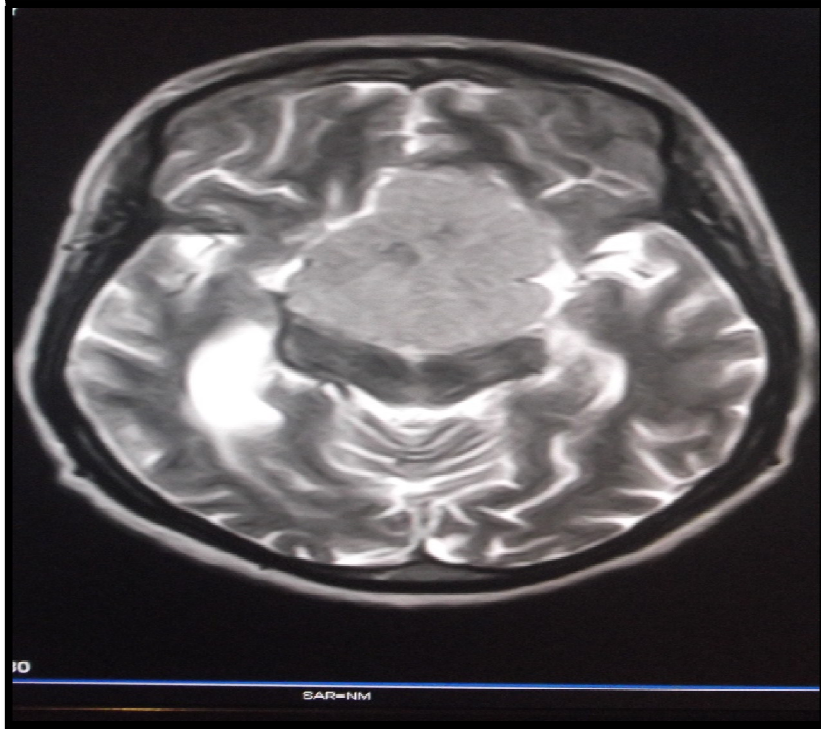
**Fig 5.1 MRI For Convexity Meningiomas.**



**Fig 5.2 MRI Supra Seller Meningioma Axial With Out Contrast.**



**Fig 5.3 Axial MRI Supra Seller Meningioma With Contrast.**



**Fig 5.4 Axial MRI T2 Supra Seller Meningioma.**



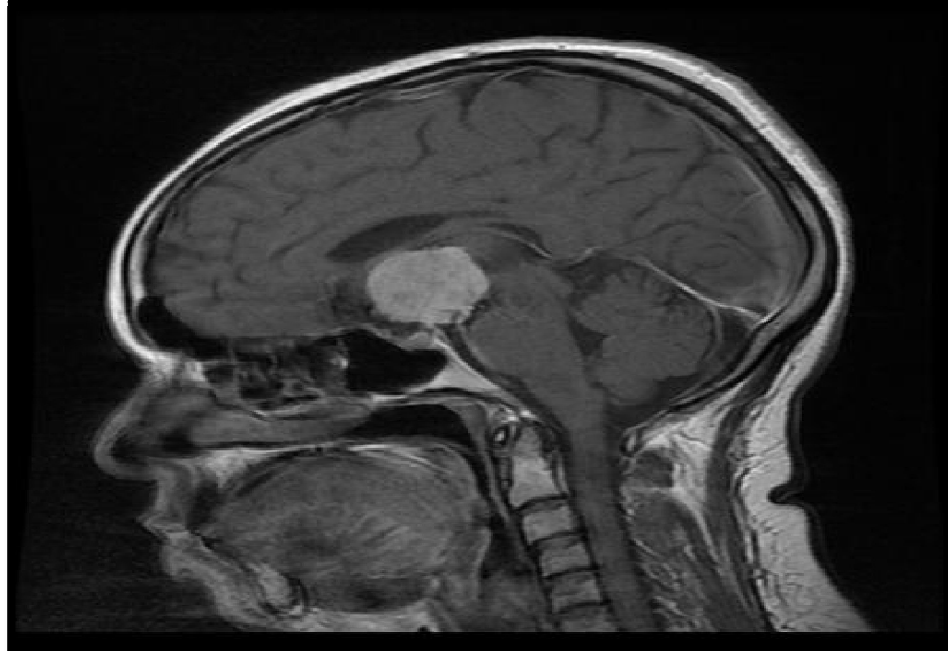
**Fig 5.5 MRI Sagittal T1 With Contrast Supra Seller Meningioma.**



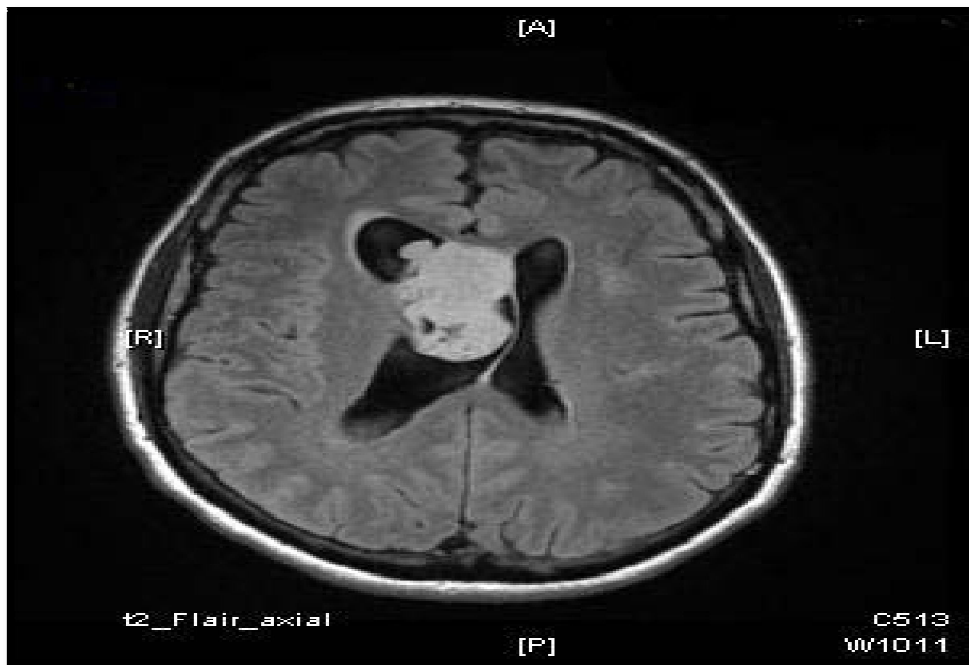
**Fig 5.6 Axial MRI Sphenoid Wing Meningioma.**



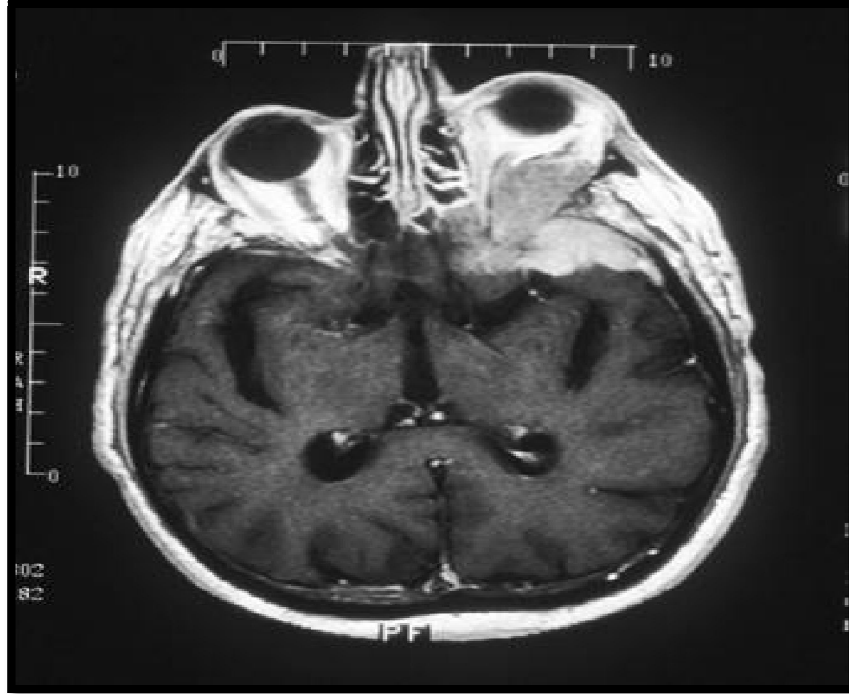
**Fig 5.7 Axial MRI Olfactory Groove Meningioma.**



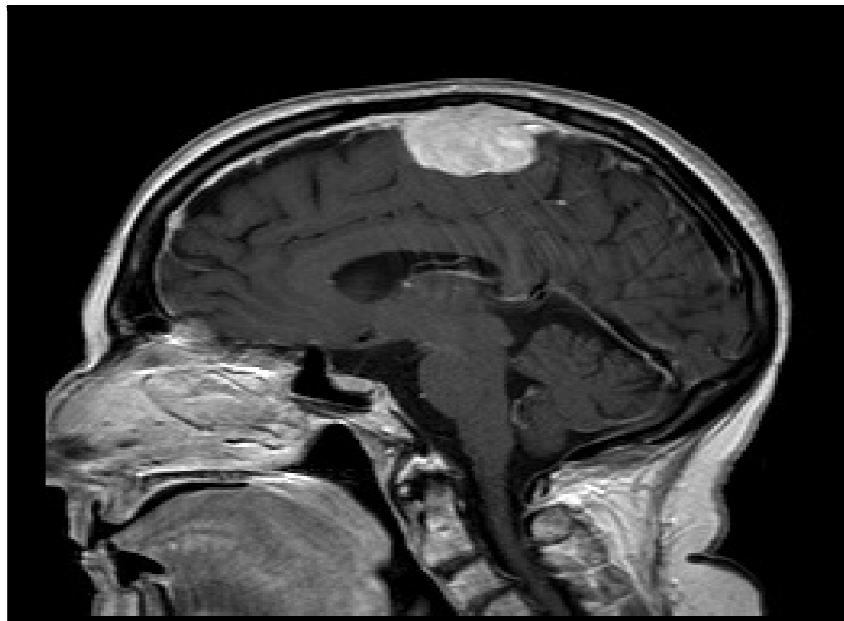
**Fig 5.8 Sagittal MRI Suprasellar Meningioma.**



**Fig 5.9 Axial MRI Intraventricular Meningioma.**



**Fig 5.10 Axial MRI of Intraorbital Meningioma**



**Fig 5.11 Sagittal MRI Falx or Parasagittal Meningioma.**



## Reference

- Adrian Raine, Lydia Lee, Yaling Yang, Patrick Colletti (2010) Neurodevelopmental marker for limbic maldevelopment in antisocial personality disorder and psychopathy, *the British Journal of Psychiatry* 197
- Al-Kadi, (April 2015) a multiresolution clinical decision support system based on fractal model design for classification of histological brain tumours". *Computerized medical imaging and graphics : the official journal of the Computerized Medical Imaging Society* 41: 67–79.
- Badre , Kayser , D'Esposito (April 2010) Frontal cortex and the discovery of abstract action rules *Neuron* 66 (2) 315.
- Buckley, Sourbron, (2013) Classic models for dynamic contrast enhanced MRI". *NMR in Biomedicine* (8) 1004–1027.
- Cabot, Richard (2004) *Physical diagnosis* , William Wood and company, New York, 7th edition, 527 pages, page 5.
- Christopher et al (2001) Department of Neurological Surgery, Feinberg School of Medicine, Northwestern University, Chicago; and Evanston Northwestern Healthcare, Evanston, Illinois.
- Donnel Gray and forbes, et al (Aug 2004) Radiosurgery for benign meningiomas *Neurosurg* 107(2) 325–36.
- Dorland's (2012) *Dorland's Illustrated Medical Dictionary* (32nd ed) Elsevier Saunders page 30.
- Edwards, Newman, Bismark, et al. (2008). Cerebellum volume and eyeblink conditioning in schizophrenia *Psychiatry Res* 185–194.
- Faruk İldan, et al (2009), Fasting improves discrimination of grade 1 and atypical or malignant meningioma in FDG-PET. *J Nucl Med* 2009; 38:26–30.
- Finger (2001) *The brain in antiquity*". *Origins of neuroscience: a history of explorations into brain function*. pp. 43–50 Oxford Univ Press. 19-51.

Halkes , van Gijn , Kappelle , Koudstaal , Algra A (2007) Medium intensity oral anticoagulants versus aspirin after cerebral ischaemia of arterial origin a randomised controlled trial *Lancet Neurol* 6 –24.

Herman (2009) The meningiomas (dural endotheliomas): their source, and favoured seats of origin *Brain* 45.

Hollingworth Todd Bell MI Arafat , Girling , Karia ,Dixon (2000). The diagnostic and therapeutic impact of MRI an observational multi-centre study *Clin Radiol* 55 (11).

Laan, Laura Vein, Alla (2005).Angelman syndrome: is there a characteristic Brain and Development 27 .

Ming- Zheng et al(2013) studied papillary meningioma Statistical Report: primary brain and central nervous system tumors diagnosed in eighteen states in Central Brain Tumor Registry of the United States.

Nagara et al(2013) studied Diffusion-Weighted MR Imaging Diagnosing Atypical or Malignant Meningiomas ,Department of Biostatistics, Yong Loo Lin School of Medicine, National University of Singapore, Singapore .

Niedermaier, Behrens, Schmid, Schlecht, Fischer, Leitzmann, (16 September 2015). Body mass index, physical activity, and risk of adult meningioma and glioma A meta-analysis *Neurology* 85.

Nieuwenhuys, Rudolf; Voogd, Jan; van Huijzen, Chris (2008), The human central nervous system Springer 177.

Nishizaki et al (2006), World Health Organization classification of tumours of the central nervous system. 4th ed.Lyon, France.

Nolen-Hoeksema, Susan (2014). Abnormal Psychology (Sixth ).New York, McGraw-Hill Education 67.

peckmann, Elger, (2004) Introduction to the neurophysiological basis of the EEG and DC potentials In Niedermeyer, Lopes da Silva, Electroencephalography: Basic

Principles, Clinical Applications, and Related Fields. Lippincott Williams & Wilkins. pp. 17

Rosdahl, Caroline; Kowalski, Mary (2008). Textbook of Basic Nursing (9th ). Lippincott Williams & Wilkins. 189. Retrieved 28 January 2015.

Saladin, Kenneth (2012). Anatomy & Physiology: The Unity of Form and Function, Sixth Edition. New York mcgraw-Hill.

Sandrone et al. (2014) Weighing brain activity with the balance: Angelo Mosso's original manuscripts come to light. Brain 137: 621-633.

Takahashi et al (2010), A study on peritumoural brain oedema around meningiomas by CT and MRI scanning The combination of mitotic as a useful method for predicting short-term recurrence of meningiomas. 149–155. discussion 155–146.

Takahiro Nakano et al (2012), in their study Meningiomas with brain edema , usual location, atypical radiological findings and favourable treatment outcome. Childs Nerv Syst. 2001.

Van Rijk, Hendrikse, (2006) Spect measurements of regional cerebral perfusion and carbon dioxide reactivity: Correlation with cerebral collaterals in internal carotid artery occlusive disease Neurol 253.

Victoria, Clark, Zyenep Erson-Omay, Akdes Serin; et al. (March 2013) Genomic analysis of non- meningiomas reveals mutations Science 339 1077–80 Retrieved 30 January 2016.

Yang, Raine (November 2009). "Prefrontal structural and functional brain imaging findings in antisocial, violent, and psychopathic individuals: a meta-analysis". Psychiatry Research 174 .

<http://www.bennywills.org/education.aspx>.

<http://www.bing.com/search.FORM.UP97DF&PC=UP97&q=lCranial+Nerves>.

<https://www.en.wikipedia.org//Meninges>.

[https://en.wikipedia.org/wiki/Ventricular\\_system](https://en.wikipedia.org/wiki/Ventricular_system).

<http://www.hopkinsmedicine.org/employment/>.

<http://www.mayoclinic.org/brain-lobes>.

<https://www.nlm.nih.gov/medlineplus>.

## Appendices

gender	age	site	size	Signal characteristics			Diagnosis
				T1	T2	FLAIR	
M	53	Sphenoid ridge	Small	Low	Isointense	High	Sphenoid
M	53	Lt Temporal	Small	low	Isointense	High	Convexity
M	30	Falx Cerebri	Small	Low	High	High	parasigittal
F	46	Falx cerebri	small	Low	High	High	parasigittal
F	45	Falx cerebri	Small	Low	High	High	parasigittal
F	59	Supra sellar	Small	Low	High	High	SupraSella
F	62	Suprasellar	Small	Low	High	High	Suprasellar
M	55	Rt temporal lobe	Small	Low	High	High	convexity
F	27	Rt temporal lobe	Small	Low	High	High	convexity
M	70	Lt temporal lobe	large	Low	High	High	convexity
F	55	Supra seller	small	Low	Isointense	Isointense	Supra sellar
F	75	Supra seller	Medium	Isointense	Isointense	Isointense	SupraSellar
F	80	Suprasellar	Medium	Low	High	High	Suprasellar
M	56	Rt temporal lobe	small	Low	high	high	convexity
M	3	Rt temporal lobe	Small	Low	High	High	Convexity
F	65	Falx cerbri	Medium	Isointense	Isointense	Isointense	parasigittal
F	45	Rt temporal Lobe	Small	Low	High	High	convexity
F	70	Falx cerbri	Medium	Isointense	Isointense	Isointense	parasigittal
M	12	Falx cerbri	Medium	Low	High	High	parasigittal
F	34	Lt Para-Sagittal Region	Large	Low	Isointense	Isointense	ParaSagittal
F	55	Falx cerbri	Small	Isointense	Isointense	Isointense	parasagittal
M	70	Spenoid Ridge	Medium	Intermedia te	Isointense	Isointense	Sphenoid Ridge
M	6	Cortex Of Parital Lobe	Small	Low	High	High	Convexity
M	76	Cerbebral cortex	Large	Low	High	High	convexity
F	71	Falx cerbri	Medium	Low	High	High	parasigittal
M	55	Falx cerbri	Medium	low	high	isointense	Parasigittal
F	32	parietal lobe	small	Isointense	high	high	convexity
F	74	optic nerve	Medium	low	high	isointense	intraorbital
F	80	occipital lobe	small	low	high	high	convexity
M	66	Lt temporal lobe	large	low	high	high	convexity
F	75	around eye sockets	Medium	low	high	high	intraorbital
M	54	Rt parasagittal	Medium	low	high	isointense	parsigittal
F	57	suprasellar	small	low	high	high	suprasellar
F	38	olfactory nerve	small	low	high	isointense	olfactory
F	75	cortex of parital Llobe	Medium	low	high	high	convexity

gender	age	site	size	Signal characteristics			Diagnosis
				T1	T2	FLAIR	
F	47	suprasellar	small	low	high	high	suprasellar
F	71	sphenoid ridge	medium	isointense	high	high	sphenoid
M	35	Cerebral cortex	small	isointense	high	high	convexity
F	52	suprasellar	small	isointense	high	high	suprasellar
F	63	sphenoid ridge	medium	isointense	high	high	sphenoid
F	75	suprasellar	small	isointense	high	high	convexity
M	70	Cerebral cortex	large	low	high	high	convexity
M	60	Cerebral cortex	large	low	high	high	convexity
M	68	Cerebral cortex	large	low	high	high	convexity
F	70	lateral ventricular	small	isointense	high	high	intraventricular
M	52	olfactory nerve	small	low	high	isointense	olfactory
F	57	Rt temporal lobe	small	low	high	isointense	convexity
F	62	falx cerebri	medium	low	high	isointense	parasagittal
F	47	around eye sockets	small	low	high	high	intra orbital
F	64	Cerebral cortex	small	isointense	high	high	convexity
F	78	falx cerebri	medium	low	high	isointense	parasagittal
F	62	optic nerve	medium	low	high	isointense	intra orbital
F	53	Suprasellar	small	low	high	isointense	suprasellar
F	45	falx cerebri	small	low	high	isointense	parasagittal
F	73	superior sagittal sinuses	small	low	high	isointense	parasagittal
F	57	frontal lobe	small	low	high	isointense	olfactory nerve
M	80	occipital lobe	large	low	high	high	convexity
F	43	suprasellar	small	low	high	high	suprasellar
F	55	suprasellar	small	low	high	high	Suprasellar
F	38	falx cerebri	Small	isointense	high	high	parasagittal
F	40	sphenoid ridge	Small	isointense	high	high	sphenoid
F	41	suprasellar	small	low	high	isointense	suprasellar
F	64	inferior sagittal sinuses	Medium	low	high	isointense	parasagittal
F	69	optic nerve	medium	low	high	isointense	intraorbital
F	70	falx cerebri	medium	low	high	high	parasagittal
M	73	Cerebral cortex	small	low	high	isointense	convexity
M	50	falx cerebri	medium	low	high	isointense	parasagittal
M	56	superior sagittal sinuses	medium	low	high	isointense	parasagittal
F	46	suprasellar	small	Isointense	high	high	suprasellar
F	42	cranial fossa	small	low	high	high	Suprasellar

gender	age	site	size	Signal characteristics			Diagnosis
				T1	T2	FLAIR	
F	44	falx cerbri	Medium	low	high	isointense	Parasigittal
F	63	optic nerve	Medium	low	high	high	Intraorbital
F	55	Lt temporal lobe	small	Isointense	high	high	convexity

## Data Collection Sheet

**A-gender**.....

**B-age**.....

**C-size**.....

**D-site**.....

1- Temporal lobe ( )

2- Parital lobe ( )

3- Occipital lobe ( )

4- Falax cerbri ( )

5- Optic nerve ( )

6- Supra sellar ( )

7- Olfactory ( )

8- Others.....

### **E-Tissue signal characteristics**

1-T1.....

2-T2.....

3-T1 With contrast.....

4- FLAIR.....

### **F-Diagnosis**

1- Convexity ( )

2- Suprasellar ( )

3- Falax orParasagittal ( )

4- Sphenoid ridge ( )

5- Olfactory groove ( )

6- Others.....

### **G- Classification**

1- Grade (I) ( )

2- Grade (II) ( )

3- Grade (III) ( )