بسم الله الرحمن الرحيم

Sudan University of Science and Technology

Collage of Graduate studies

Measurement of Normal Third and Forth Ventricles inAdults Using Magnetic Resonance Imaging

قياسات البطينين الثالث والرابع للدماغ عند البالغيين بواسطة الرنيين المغنطيسي

A thesis submitted for partial fulfillment for the requirements of MSc degree. in Diagnostic Radiologic Technology

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DeDication

To my father

To my mother

To my brothers and sisters

To my teachers, friends and colleagues

Acknowledgment

Praise and thanks are due to Allah, the Lord and creator.

Special thanks to my supervisor, D/Asma Ibrahim, for her valuable and continuous help and guidance.

My thanks extended to t staff of the radiology departments in different hospitals and centers for their help me in collection of information.

Abstract

This retrospective study aimed to measure normal size of third and fourth ventricles in adults.

This study was done to general electric and new soft MRI machines 1.5T.

The study period from September to December 2016.

The important Study carried out in sample of 205patient (121male and 84female) how underwent brain MRI examination the male 121(59%)and femal84 (41%)patient not complained for any disease affected to the measurements.

The study found that normal third ventricle measurement were length in axial T2 diameter for male (26.33 mean±4.356 SD) and female (25.3 mean±3.32 SD).

The third ventricle width diameter for male (5.01 mean± 2.496SD) and female (4.39 mean±2.223SD).

The normal fourth ventricle measurements were length diameter for male (15.99mean±3.404SD). And female (15.66mean±4.006SD). The fourth ventricle width for male (11.26mean±2.632SD).and female (10.27mean± 2.79SD).

The study recommended that doing more measurements of third and fourth ventricles.

مستخلص البحث

هذه دراسة وصفية لقياس البطينيين الثالث والرابع عند البالغيين بواسطة الرنيين المغنظطيسي تمت في عدد من المراكز والمستشفيات في الفترة من سبتمبر الي ديسمبر 2016.

تكمل مشكلة البحث بان البطيينين الثالث والرابع يتاثران ببعض الامراض التي توثر علي حجمهما.

برزت اهمية الدراسة في ايجاد قياسات للطول والعرض للبطينيين الثالث والرابع للدماغ وهدفت لجعل هذه القياسات لتساعد الاطباء للكشف المبكر للامراض التي تصيبهما شملت الدراسة مائتان وخمسة مريضا (121) من الرجال(59%)و(84) من النساء(41%).

وجدت الدراسة إن متوسط الطول والعرض للبطين الثالث للرجال
والنساء(4.35±26.33)(3.32±25.3)والبطين الرابع للرجال
والنساء(3.404±15.99)(4.0006±15.66) .

خلصت الدراسة ان نتائج التحليل إن الطول والعرض للبطينين الثالث تزداد مع تقدم العمر حيث تم ملاحظة ذلك انه في الرجال الطول والعرض يزيد مقارنة مع النساء.

اوصت الدراسة بإجراء مزيد من القياسات لبطينين الثالث والرابع وعمل قياسات مرجعية تساعد في التشخيص ومعرفة الطول والعرض بصورة دقيقة .

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Abbreviations

CSFF=crebro-spinal fluid

CT=computed tomography

MRI=magnetic resonance image

3v=third ventricle

4v=fourth ventricle

RF=radiofrequency

Chapter one

Introduction

Chapter One

1.1 Introduction

The ventricles of the brain are communicating network of cavities filled with cerebrospinal fluid (CSF) and located within the brain parenchyma. The ventricular system is composed of 2lateral ventricles, third ventricle, the cerebral aqueduct and forth ventricle. .(Hamidu 2016)

The cerebrospinal fluid within the ventricles could be excess or markedly recued and these could be only singing of an intracranial or intraventricular disease. The linear dimension of third and fourth cerebral ventricles is key to some finding observing a change in the shape and size of the ventricles can be very subjective, hence the need normal values. .(Hamidu 2016)

Medical imaging is employed to describe the anatomy of deep structure within the body cavities for descriptive or diagnosis purposes. To subject normal individuals to (MRI) just to measure the size of the third (3v) and fourth (4v) cerebral ventricles. However, it is important to know the normal values of the size of the ventricles. This will enable early detection of change due to intrinsic and extrinsic pathology. It also important to monitor and evaluate response to therapy in patient being treated for hydrocephalus. The use of ultrasound is most applicable to children and post craniotomy, which serves a window for ultrasound. However in recent time, CT and MRI produce cross-sectional image with direct view of the ventricular system, and make possible direct linear measurement.(Hamidu 2016)

1.2 Research Problem:

The third and fourth ventricles affected by of some neurological disorders this lead to increase or decrees size of ventricles. We have present establish linear dimensions of third and fourth cerebral to provide available and safe means of aiding the diagnosis of some neurological disorders such as early detection of hydrocephalus, cerebral atrophy…..act, and provide important follow up information in affected patients it should be noted that there is a continuous debate in the literature of neuro- anatomy, psychiatry, neuroradiology and neurology over the best method of assessing the various parts of the cerebral ventricular system.

1.3 Objective

1.3.1 General objective

To measure the normal size of the third and fourth ventricles in adult Sudanese population using magmatic resonance imaging.

1.3.2 Specific objective

To measure linear dimensions of third and fourth cerebral ventricles

To correlate between ventricular measurement and age

To correlate between ventricular measurement and gender

.

1.5 Research Overview:

To make the aims of the project stated above true, the thesis falls into five chapters: chapter one, which is an introduction, deals with theoretical frame work of the study. it present the statement of the study problem objective of the study and research overview chapter two, deals with theoretical background of brain(anatomy ,physiology, pathology) ,review of the instrumentations and techniques which include assessment by magnetic resonance image and literature review(previous studies). While chapter three discusses the material and method and chapter four include presentation of the result and finally chapter five deals with discussion of the study.

Chapter Two

Literature Review

Chapter Tow

Literature Review

2-1AnatomyofVentricular System of the Brain

The ventricles of the brain are a communicating network of cavities filled with cerebrospinal fluid (CSF) and located within the brain parenchyma. The ventricular system is composed of 2 lateral ventricles, the third ventricle, the cerebral aqueduct, and the fourth ventricle. The choroid plexuses are located in the ventricles produce CSF, which fills the ventricles and subarachnoid space, following a cycle of constant production and reabsorption. (Elena, 2016)

The ventricular system is embryologically derived from the neural canal, forming early in the development of the neural tube. The 3 brain vesicles (prosencephalon or forebrain, mesencephalon or midbrain, and rhombencephalon or hindbrain) form around the end of the first gestational month. The neural canal dilates within the prosencephalon, leading to the formation of the lateral ventricles and third ventricle. The cavity of the mesencephalon forms the cerebral aqueduct. The dilation of the neural canal within the rhombencephalon forms the fourth ventricle.

The lateral ventricles communicate with the third ventricle through interventricular foramens, and the third ventricle communicates with the fourth ventricle through the cerebral aqueduct (see the image below). During early development, the septum pellucidum is formed by the thinned walls of the 2 cerebral hemispheres and contains a fluid-filled cavity, named the cavum, which may persist. (Elena, 2016)

the roofs of prosencephalon and rhombencephalon, forming the choroid plexuses of the ventricles. Cerebrospinal fluid (CSF) is secreted by the choroid plexuses, filling the ventricular system. CSF flows out of the fourth ventricle through the 3 apertures formed at the roof of the fourth ventricle by 12 weeks' gestation. (Elena, 2016)

2-1-1Lateral ventricles

The largest cavities of the ventricular system are the lateral ventricles. Each lateral ventricle is divided into a central portion, formed by the body and atrium (or trigone), and 3 lateral extensions or horns of the ventricles. The central portion or the body of the ventricle is located within the parietal lobe. The roof is formed by the corpus callosum, and the posterior portion of the septum pellucidum lies medially. The anterior part of the body of the fornix, the choroid plexus, lateral dorsal surface of the thalamus, stria terminalis, and caudate nucleus, form the floor of the lateral ventricle.

The interventricular foramen is located between the thalamus and anterior pillar of the fornix, at the anterior margin of the body. The 2 interventricular foramens (or foramina of Monro) connect the lateral ventricles with the third ventricle. The body of the lateral ventricle is connected with the occipital and temporal horns by a wide area named the atrium. (Elena, 2016)

The anterior or frontal horn is located anterior to the interventricular foramen. The floor and the lateral wall are formed by the head of the caudate nucleus, the corpus callosum constitutes the roof and anterior border, and the septum pellucidum delineates the medial wall. The posterior or occipital horn is located within the occipital lobe. The fibers of the corpus callosum and the splenium form the roof. The forceps major is located on the medial side and forms the bulb of the occipital horn.

The inferior or temporal horn is located within the temporal lobe. The roof is formed by the fibers of the temporal lobe; the medial border contains the stria terminalis and tail of the caudate. The medial wall and the floor are formed by the hippocampus and its associated structures. The amygdaloid complex is located at the anterior end of the inferior horn. (Elena, 2016)

Capillaries of the choroid arteries from the pia mater project into the ventricular cavity, forming the choroid plexus of the lateral ventricle. The choroid plexus is attached to the adjacent brain structures by a double layer of pia mater called the tela choroidea. The choroid plexus extends from the lateral ventricle into the inferior horn. The anterior and posterior horn have no choroid plexus. (Elena, 2016)

The choroid plexus of the lateral ventricle is connected with the choroid plexus of the contralateral ventricle and the third ventricle through the interventricular foramen. The anterior choroidal arteries (branch of internal carotid artery) and lateral posterior choroidal arteries (branch of the posterior cerebral artery) form the choroid plexus. Venous supply from the choroidal veins drains into the cerebral veins. (Elena, 2016)

2-1-2Third ventricle

The third ventricle is the narrow vertical cavity of the diencephalon. A thin tela choroidea supplied by the medial posterior choroidal arteries (branch of posterior cerebral artery) is formed in the roof of the third ventricle. The fornix and the corpus callosum are located superiorly. The lateral walls are formed by the medial thalamus and hypothalamus. The anterior commissure, the lamina terminalis, and the optic chiasm delineate the anterior wall. The floor of the third ventricle is formed by the infundibulum, which attaches the hypophysis, the tuber cinereum, the mammillary bodies, and the upper end of the midbrain. The posterior wall is formed by the pineal gland and habenular commissure. The interthalamic adhesions are bands of gray matter with unknown functional significance, which cross the cavity of the ventricle and attach to the external walls. .(Abdel monem, 2016)

Sitethe thired ventricle It lies in the median (sagittal) plane in-between the 2 thalami (below the fornix and corpus callosum). and shape it is a slit-like cavity.The boundaries:Lateral wall: is formed by the following:- Thalamus, hypothalamus, hypothalamic groove, between thalamus and hypothalamus. It extends from the interventricular foramen anteriorly to the cerebral aqueduct postero-inferiorly. interventricular foramen (of *Monro*) lies at the most anterior part of the lateral wall. It is the connection between ventricles; third and lateral ventricle on each side.and Floor it is formed by Hypothalamus, anteriorly. *hypothalamus of the lateral wall slopes down to form the floor,*Subthalamus, posteriorly. .(Abdel monem, 2016)

theRoofIt is formed by athin layer of ependyma, stretched between the upper surfaces of the 2 thalami. It is covered by pia mater and is invaginated by the choroid plexus of the third ventricle. (Elena, 2016)

The Anterior wallof thired ventricle it is formed from anterior to posterior by lamina terminalis, it extends from the rostrum of corpus callosum to the optic chiasma. It represents the cephalic end of the developing neural tube, anterior commissure: it connects the 2 cerebral hemispheresand anterior columns of fornix. They extend from the body of fornix to reach the mamillary bodies.andposterior wallit is formed from above downwards by habenular commissure- above, Pineal body- in the middle and Posterior commissure- below.The Communications of the third ventricle with the lateral ventricle on each side through the interventricular foramen, with the fourtn ventricle through the cerebral aqueduct. .(Abdel monem, 2016)

N.B.: Interventricular foramen is bounded by the anterior columns of fornix anteriorly and the anterior end of thalamus posteriorly.(Abdel monem, 2016)

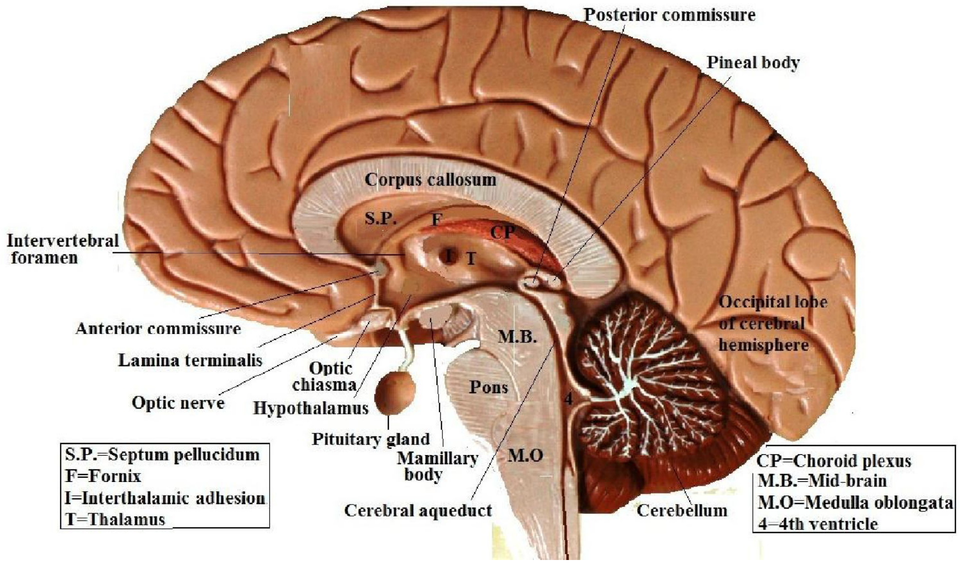


Figure 2-1: Show *Medial surface of cerebral hemisphere and sagittal section in brain stem and cerebellum. . (*Abdel monem, 2016)

2-1-3 Fourth ventricle

The fourth ventricle is connected to the third ventricle by a narrow cerebral aqueduct. The fourth ventricle is a diamond-shaped cavity located posterior to the pons and upper medulla oblongata and anterior-inferior to the cerebellum. The superior cerebellar peduncles and the anterior and posterior medullary vela form the roof of the fourth ventricle. The floor of the fourth ventricle is named the rhomboid fossa. The lateral recess is an extension of the ventricle on the dorsal inferior cerebellar peduncle. .(Abdel monem, 2016)

Inferiorly, it extends into the central canal of medulla. The fourth ventricle communicates with the subarachnoid space through the lateral foramen of Luschka, located near the flocculus of the cerebellum, and through the median foramen of Magendie, located in the roof of the ventricle. Most of the CSF outflow passes through the medial foramen. The cerebral aqueduct contains no choroid plexus. The tela choroidea of the fourth ventricle,which is supplied by branches of the posterior inferior cerebellar arteries, is located in the posterior medullary velum. it is the cavity of hindbrain (rhombencephalon). .(Abdel monem, 2016)

The Site of fourth ventricle it lies between pons and upper part of medulla oblongata, anteriorly and cerebellum posteriorly. Shape it takes the following shapes, according to the side of view: Tent-shaped in lateral view, Rhomboidal (diamond) in shape in posterior view. It has Floor, Lateral boundaries, Angles and Roof and sites of Escape of CSF to subarachnoid space (F L A R E). .(Abdel monem, 2016)

The Floor is directed anteriorly, it shows a median longitudinal sulcus, dividing it into two identical halves; right and left. The floor is formed of two portions separated by transverse fibers called *medullary stria*and upper "pontine" portion, formed by the posterior surface of pons. lower "medullary" portion, formed by the posterior surface of upper part of medulla oblongata "open medulla" andLateral boundaries composed upper lateral boundaries: Formed by *superior cerebellar peduncle* on each side and lower lateral boundaries Formed from medial to lateral by *gracile tubercle*, *cuneate tubercle* and *inferior cerebellar peduncle*, on each side.

The Angles formed by superior angle where the ventricle communicates with the cerebral aqueduct (of Sylvius), inferior angle: where the ventricle communicates with the central canal of closed medulla and lateral angles are pulled laterally to form 2 lateral recesses. The recesses are situated one on each side of the medulla oblongata. They open into the subarachnoid space, through *foramina of Luschka*, one on each side.(Abdel monem, 2016)

The Roof composed of upper part is formed by the superior medullary velum (a thin sheet of white matter), stretching between the two superior cerebellar peduncles and Middle part is formed by the inferior vermis of cerebellum. And lower part formed by the inferior medullary velum, stretching between the two inferior cerebellar peduncles. This part is formed only by ependyma, covered by pia mater. It is invaginated by the *choroid plexus*, secreting cerebrospinal fluid (CSF). Also, this part is perforated in its middle part to form *foramen of Magendie*. This foramen represents the main route for communication of ventricles with subarachnoid space. .(Abdel monem, 2016)

N.B.: Choroid plexus of the 4th ventricle is T-shaped. It receives a arterial blood from a branch of posterior inferior cerebellar artery on each side. The branch passes through the lateral aperture to meet its fellow and then they descend forming the vertical limbs of the plexus. .(Abdel monem, 2016)

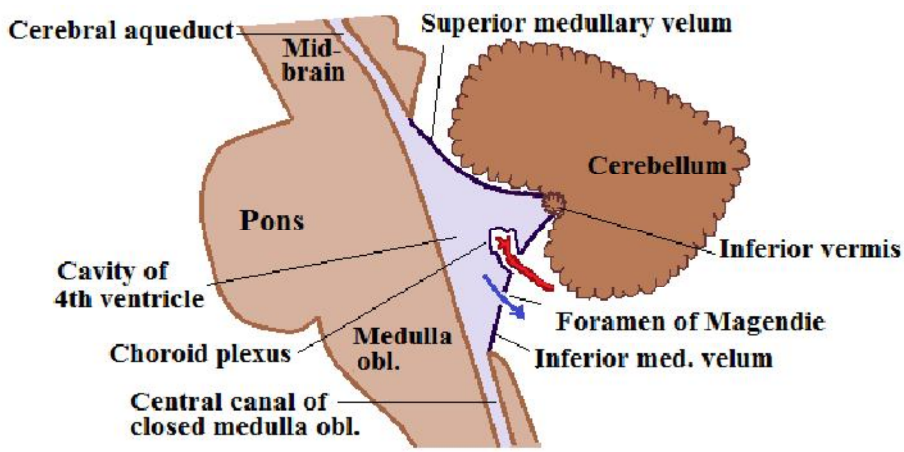


Figure 2-2: diagram Show *Fourth ventricle (lateral view)*. *(*Abdel monem, 2016)

2-2 physiology (Cerebro-Spinal Fluid (CSF))

CSF is a clear, watery fluid that fills the ventricles of the brain and the subarachnoid space around the brain and spinal cord. CSF is primarily produced by the choroid plexus of the ventricles (≤70% of the volume); most of it is formed by the choroid plexus of the lateral ventricles. The rest of the CSF production is the result of transependymal flow from the brain to the ventricles.(Saunders,2005)

CSF flows from the lateral ventricles, through the interventricular foramens, and into the third ventricle, cerebral aqueduct, and the fourth ventricle. Only a very small amount enters the central canal of the spinal cord. CSF flow is the result of a combination of factors, which include the hydrostatic pressure generated during CSF production (known as bulk flow), arterial pulsations of the large arteries, and directional beating of the ependymal cilia. Hydrostatic pressure has a predominant role in the CSF flow within the larger ventricles, whereas cilia favor the movement of the CSF in the narrow regions of the ventricular system, such as the cerebral aqueduct. Immotile cilia syndrome is a rare cause of hydrocephalus in children. (Saunders, 2009)

The ventricles constitute the internal part of a communicating system containing CSF. The external part of the system is formed by the subarachnoid space and cisterns. The communication between the 2 parts occurs at the level of fourth ventricle through the median foramen of Magendie (into the cistern magna) and the 2 lateral foramina of Luschka (into the spaces around the brainstem cerebellopontine angles and prepontine cisterns). The CSF is absorbed from the subarachnoid space into the venous blood (of the sinuses or veins) by the small arachnoid villi, which are clusters of cells projecting from subarachnoid space into a venous sinus, and the larger arachnoid granulations. (Saunders, 2009)

The total CSF volume contained within the communicating system in adults is approximately 150 mL, with approximately 25% filling the ventricular system. CSF is produced at a rate of approximately 20 mL/h, and an estimated 400-500 mL of CSF is produced and absorbed daily.

CSF absorption capacity is normally approximately 2-4 times the rate of production. The normal CSF pressure is between 5-15 mm Hg (65-195 mm H_2O) in adults. In children younger than 6 years, normal CSF pressure ranges between 10-100 mm H_2O. (Saunders, 2009)

CSF plays an important role in supporting the brain growth during evolution, protecting against external trauma, removal of metabolites produced by neuronal and glial cell activity, and transport of biologically active substances (like hormones and neuropeptides) throughout the brain.(FA Davis, 2003)

2-3Pathology

An increase in CSF pressure happens as a result of an increase in the intracranial volume (eg, tumors), blood volume (with hemorrhages), or CSF volume (eg, hydrocephalus). Blocking the circulation of the CSF leads to dilatation of the ventricular system upstream to the level of obstruction have many type:

2-3-1Hydrocephalus

Theold classification divides hydrocephalus into two types:

noncommunicating and communicating. In noncommunicating or obstructive hydrocephalus, the CSF accumulates within the ventricles as a result of an obstruction within the ventricular system (most commonly at the level of cerebral aqueduct). In communicating hydrocephalus, the CSF flows freely through the outflow foramens of the fourth ventricles into the arachnoid space. (Ransohoff J, Shulman, 1960)

The etiologies and pathogenesis of hydrocephalus include overproduction, blockage, or diminished absorption. The only known etiology of excess production is choroid plexus papilloma, which accounts for less than 2% of childhood tumors. (Ransohoff J, Shulman, 1960)

Etiologies of hydrocephalus secondary to blockage or diminished absorption include developmental abnormalities, trauma, tumors, infectious, inflammatory, and idiopathic. Solid tumors produce hydrocephalus by obstruction of the ventricles, whereas nonsolid tumors (eg, leukemia, carcinomatous infiltration) impair CSF absorption within the subarachnoid space. (Ransohoff J, Shulman, 1960)

The following are some causes of obstruction at specific locations in the ventricular system:

Foramen of Monro obstruction may be caused by a suprasellar mass (eg, glioma, arachnoid cyst, craniopharyngioma), septum pellucidum tumor, colloid cyst, or tuberous sclerosis Third ventricle obstruction may result from a colloid cyst, large hypothalamic-optic or thalamic glioma, or suprasellar mass Cerebral aqueduct obstruction may be the result of aqueductal stenosis, vascular malformations (eg, arteriovenous malformations or vein of Galen aneurysm), ventriculitis, ependymitis, or tumors (eg, pineal, brainstem, cerebellar, or mesencephalic)

Obstruction at the level of fourth ventricle may be caused by posterior fossa tumors, hemorrhage, or ventriculitis. (Ransohoff J, Shulman, 1960)

Obstruction of the fourth ventricle foramina of Luschka and Magendie may be due to a Dandy-Walker malformation, arachnoid cyst, infection (eg, ventriculitis, meningitis), or cerebellar tumors. (Ransohoff J, Shulman, 1960)

Obstruction at the level of subarachnoid space is usually caused by hemorrhage (subarachnoid or subdural), meningitis, and, rarely, by Chiari malformation. (Ransohoff J, Shulman, 1960)

2-3-2Congenital hydrocephalus

Congenital hydrocephalus has an incidence of 0.4-0.8 per 1000 live births and stillbirths; noncommunicating hydrocephalus is the most common form of hydrocephalus in fetuses. Aqueductal stenosis is the most common cause of congenital hydrocephalus, whereas mass lesions are the most common cause of aqueductal obstruction during childhood. Other causes of congenital noncommunicating hydrocephalus include the following:

Dandy-Walker malformation, which consists of a markedly dilatated fourth ventricle associated with failure of the foramen of Magendie to open, aplasia of the posterior cerebellar vermis, heterotopias of the inferior olivary nuclei, pachygyria, agenesis of the corpus callosum, and other abnormalities. (Ransohoff J, Shulman, 1960)

Klippel-Feil syndrome, defined by obstructive hydrocephalus at the level of fourth ventricle associated with malformation of the craniocervical skeleton (This condition may be associated with Chiari malformation and basilar impression.) (Ransohoff J, Shulman, 1960)

Chiari malformation Congenital brain tumors, most common being astrocytoma, medulloblastoma, teratoma, and choroid plexus papilloma (These tumors are more often supratentorial and midline, usually compressing the cerebral aqueduct. (Ransohoff J, Shulman, 1960)

Vein of Galen malformation. (Ransohoff J, Shulman, 1960)

Walker-Warburg syndrome, a congenital syndrome characterized by hydrocephalus, agyria, and retinal dysplasia, with or without encephalocele, associated with congenital muscular dystrophies. (Ransohoff J, Shulman, 1960)

2-3-3Craniopharyngioma

Craniopharyngiomas represent the most common nonglial neoplasms in children, accounting for 1 to 2% of all intracranial neoplasms and nearly 50% of all suprasellar masses in children. The peak incidence of craniopharyngiomas occurs when the patient is between 5 and 10 years of age. There is a second, smaller peak incidence noted between the fifth and sixth decades.Lesions that involve the third ventricle primarily arise extraventricularly along the infundibular stalk or in the floor of the anterior portion of the third ventricle with ventricular extension. Purely intraventricular craniopharyngiomas are rare, however, with fewer than 30 pediatric cases reported in a recent review. The clinical presentation typically involves a combination of symptoms of raised ICP or manifestations of visual, hypothalamic, or endocrinological dysfunction. . (Rekate HL, 2009)

2-3-4 Colloid Cyst.

These histologically benign lesions are typically found in the roof of the third ventricle at the level of the foramen of Monro. Colloid cysts account for 15 to 20% of all intraventricular masses and represent the most common mass lesion found in the anterior portion of the third ventricle. The histogenesis of colloid cysts remains unclear. They are rare in children, with only 1 to 2% occurring in patients younger than 10 years of age. Colloid cysts rarely become symptomatic before the patient reaches 20 years of age and are usually found in adults in the second to fourth decades of life. Colloid cysts are relatively rare intracranial lesions located in the rostral aspect of the third ventricle. They may produce acute hydrocephalus, brain herniation, and lead to death. Although the clinical and imaging features of colloid cysts are well known, their etiology and the factors responsible for their imaging features continue to be a subject of debate. We present the imaging-pathologic correlation of a patient with a colloid cyst as well as data supporting the fact that the presence of cholesterol is probably responsible for the MR imaging features exhibited by some colloid cysts. (Rekate HL, 2009)

2-3-5Ependymoma

Ependymoma is a tumor that arises from the ependyma, a tissue of the central nervous system. Usually, in pediatric cases the location is intracranial, while in adults it is spinal. The common location of intracranial ependymoma is the fourth ventricle. (Rekate HL, 2009)

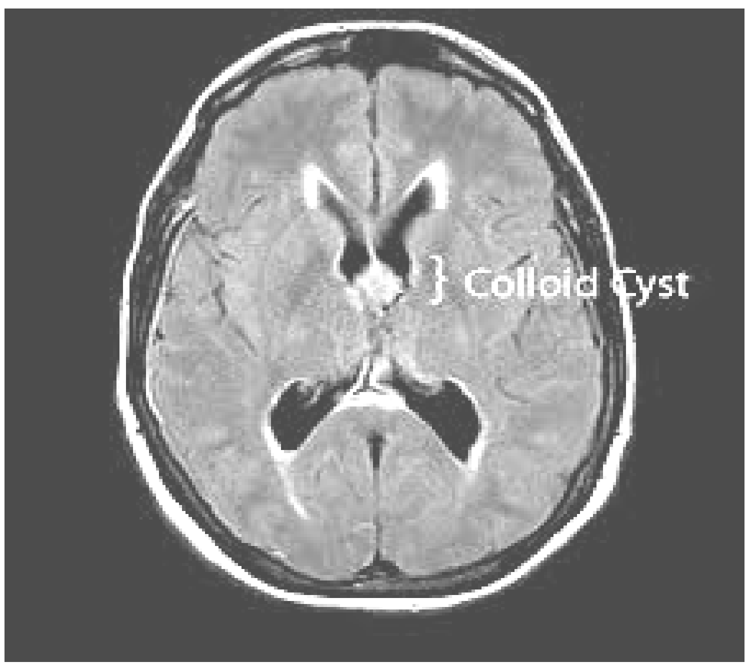


Figure 2-3: axial MRI image show Colloid Cyst

http://www.phsoregon.org/newsletters/eneuro/removing-colloid-cysts-endoscopically

Figure 2-4: sagittal T1-weighted MRI imaging show the dandy walker syndrome

http://emedicine.medscape.com/article/408059-overview

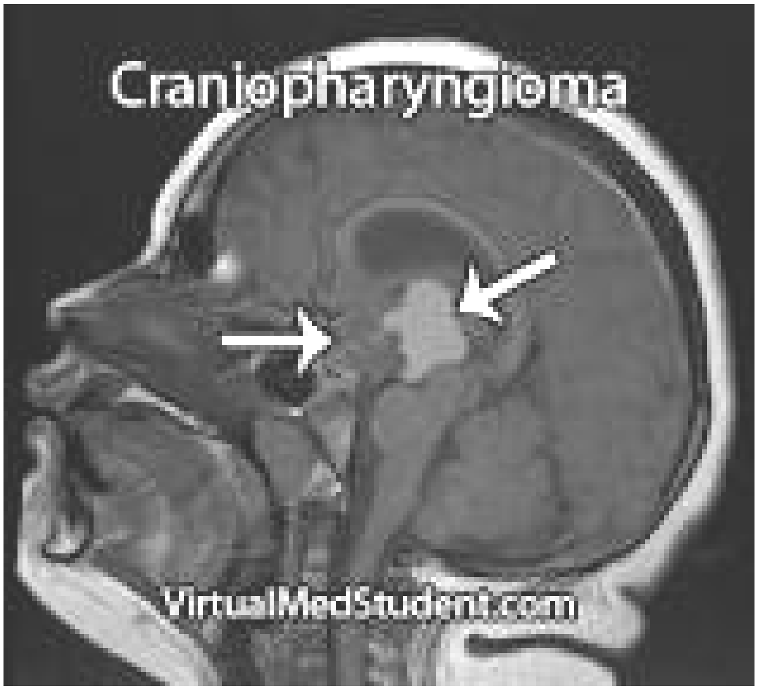


Figure 2-5: sagittal T1-weighted show craniopharynioma.

http://www.virtualmedstudent.com/links/neurological/craniopharyngioma.html

2-4 Magnetic Resonance Imagings (MRI):

Medical magnetic resonance (MR) imaging uses the signal from the nuclei of hydrogen atoms (1H) for image generation. A hydrogen atom consists of a nucleus containing a single *proton* and of a single electron orbiting the nucleus. The proton having a positive charge and the electron a negative charge, the hydrogen atom as a whole is electrically neutral. The proton is of interest here. Apart from its positive charge, the proton possesses *spin*, an intrinsic property of nearly all elementary particles. This means that the proton rotates about its axis like a spinning top. Such a proton has two important properties:As a rotating mass (m), the proton has *angular momentum* and acts like aspinning top that strives to retain the spatial orientation of its rotation axis as a rotating mass with an electrical charge, the proton additionally has *magnetic moment (B)* and behaves like a small magnet. Therefore, the proton is affected by external magnetic fields and electromagnetic waves and, when it moves, induces a voltage in a receiver coil A hydrogen nucleus differs from a spinning top, however, in that we cannot look into it and thus cannot see its intrinsic angular momentum, or spin, from the outside. In this respect, the nucleus is a black box for us. Nevertheless, we can identify the *orientation of its rotation axis* from the magnetization vector B. Thus, when we describe the rotation of a proton, we are not referring to its (invisible) angular momentum but to the "visible" motion of its magnetic axis, B. This motion is visible, so to speak, because it generates a signal in a receiver coil just like a magnet does in an electrical generator (e.g. a bicycle dynamo). (Dominik Weishaupt, MD ,2006)

There is another, very important difference: while a spinning top can be slowed down and thus finally comes to a standstill, a proton's spin always has the same magnitude and can neither be accelerated nor decelerated,precisely because it is a fundamental property of elementary particles. Spin is simply there all the time! How will a spin behave when brought into a strong magnetic field? To answer this question, let us again consider the spinning top. (Dominik Weishaupt, MD ,2006)

When an external force (typically the earth's gravitational field *G*) acts on a spinning top and tries to alter the orientation of its rotational axis, the top begins to wobble, a process called *precession*. At the same time, friction at the point of contact withdraws energy from the spinning top and slows down its rotation. As a result, its axis becomes more and more inclined and the top finally falls over. Once again, back to our hydrogen nuclei: when these are exposed to an external magnetic field, B0, the magnetic moments, or spins, align with the direction of the field like compass needles. The magnetic moments do not only align with the field but, like spinning tops, undergo Precession of the nuclei occurs at a characteristic speed that is proportional to the strength of the applied magnetic field and is called *Larmor frequency*. Alignment of the spins parallel to the magnetic field is a gradual process and, as with spinning tops, is associated with the dissipationof energy. (Dominik Weishaupt, MD ,2006)

The Larmor frequency is a very important concept that is at the core of MR imaging.

The Larmor or precession frequency is the rate at which spins wobble when placed in a magnetic field. The Larmor frequency is directly proportional to the strength (B0) of themagnetic field and is given by the Larmor equation:

$\omega 0=\gamma 0 \cdot B0$

Where:

$\omega 0$ is the Larmor frequency in megahertz [MHz],

$\gamma 0$ the gyromagnetic ratio, a constant specific to a particular nucleus,

B0 the strength of the magnetic field in tesla [T].

Protons have a gyromagnetic ratio of γ=42.58 MHz/T, resulting in a Larmor frequency of 63.9 MHz at 1.5 T as opposed to only about 1 kHz in the magnetic field of the earth by comparison, FM radio transmitters operate at (88–108 MHz). What happens to the spins precessing and slowly aligning inside the magnetic field? Let us see … While the spin system relaxes and settles into a stable state, *longitudinalmagnetization M*z is building up in the z-direction because the magnetic vectors representing the individual magnetic moments add together. This also happens in the earth's magnetic field but the resulting longitudinal magnetization is only weak. The magnetic field B0 of an MR imager is 60,000 times stronger and the resulting longitudinal magnetization is correspondingly larger. Because the MR signal is very weak, magnetization must be large enough to obtain a signal at all. Actually, things are even a bit more complicated: the spins tend to align parallel or anti-parallel to the magnetic field with parallel alignment being slightly preferred because it is equivalent to spins residing in a more favorable energy state. Hence, under steady-state conditions, a slightly larger fraction aligns parallel to the main magnetic field. It is this small difference that actually produces the measurable net magnetization Mz and is represented by the *net magnetization vector (NMV)*. Since the energy difference between the two orientations dependson the strength of the external magnetic field, Mz increases with thefield strength. (Dominik Weishaupt, MD ,2006)

Energy can be introduced into such a stable spin system by applying an electromagnetic wave of the same frequency as the Larmor frequency. This is called the *resonance condition*. The required electromagnetic wave is generated in a powerful radio transmitter and applied to the object to be imaged by means of an antenna coil. The process of energy absorption is known as excitation of the spin system and results in the longitudinal magnetization being more and more tipped away from the z-axis toward the transverse (xy-)plane perpendicular to the direction of the main magnetic field. (Dominik Weishaupt, MD ,2006)

All of the longitudinal magnetization is rotated into the transverse plane by aradiofrequency (RF) pulse that is strong enough and applied long enough to tip the magnetization by exactly 90° (*90° RF pulse*). The resulting magnetization is now denoted by Mxy rather than Mz because it now lies in the xy-plane. Whenever transverse magnetization is present, it rotates or precesses about the z-axis, which has the effect of an electrical generator and induces an alternating voltage of the same frequency as the Larmor frequency in a receiver coil: the *MR signal*. This signal is collected and processed with sensitive receivers and computers to generate the MR image. (Dominik Weishaupt, MD ,2006)

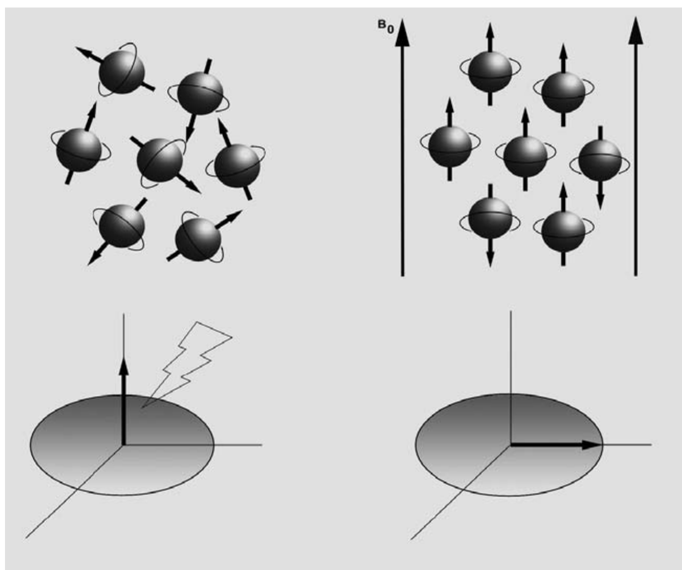


Fig2-6: With no external magnetic field present, spins rotate about their axes in random direction **(a).** In the presence of a magnetic field, slightly more spins align parallel to the main magnetic field, B0, and thus produce longitudinal magnetization, Mz **(b).** An RF pulse **(c)** tips the magnetization vector by exactly 90°, causing the entire longitudinal magnetization to flip over and rotate into transverse magnetization, Mxy **(d)**.(Dominik Weishaupt, MD ,2006)

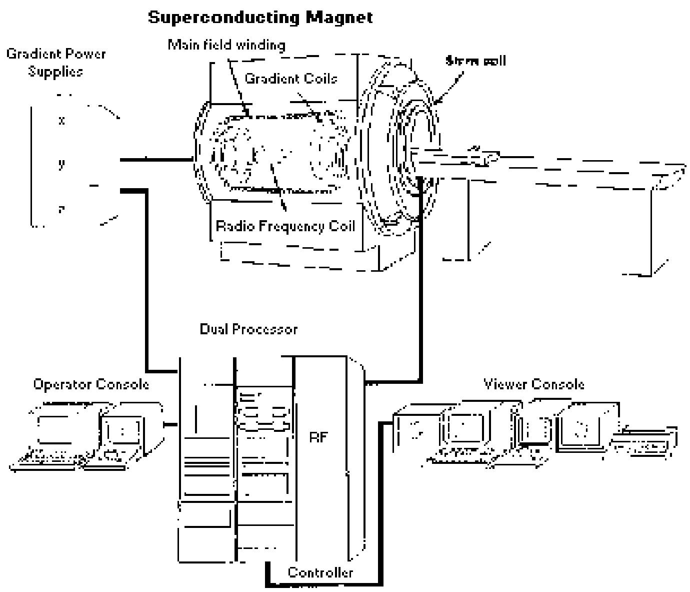


Figure 2-7: diagram Show the MRI instrument

http://wtlab.iis.u-tokyo.ac.jp/~wataru/lecture/rst/Intro/Part2_26c.html

Figure2-8 image Show MRI Machine

http://wtlab.iis.u-tokyo.ac.jp/~wataru/lecture/rst/Intro/Part2_26c.html

2-4-1Computer requirements:

Computers are used to control the gradient fields and RF pulses with precise timing and accurate amplitude, whose patterns is known as the sequence. .(www.wikapidia.com)

Computers must also be able to be reprogrammed for different imaging protocols like that for transaxial and saggital images. Computer Storage is also crucial as well as processor powers since many images are needed to be stored in a short time (e.g. 40 images in 6.5 minutes for a head scan)An array processor (a computer performing many identical arithmetic calculations in parallel) is needed for data reconstruction. .(www.wikapidia.com)

As the reconstruction algorithm (Fourier transformation) is two-dimensional, no special-purpose hard-wired back projector is required as in CT. Changing acquisition parameters affects contrasts, and colour is useful in MRI due to its wide latitude in contrast. Images of calculated parameters like T1and T2 could be produced to supplement the acquired images. These fundamental images allow calculation of TE and TR values not actually acquired. It is critical for data analysis computing not to interfere with the data acquisition for the next patient to be diagnosed; hence it is sensible for separate consoles with different functions- physician display console, data acquisition and image reconstruction. .(www.wikapidia.com)

2-4-2Advantages

Superb contrast between different soft tissues

Higher resolution than CT

No ionizing radiation

3D data acquisition

May be fused with CT scans

2-4-3Disadvantages

Machines are more expensive than CT imagers

Small magnet bore prevents scanning in treatment position (especially breast treatments)

More artifacts than CT

Some patients are unable to have CT due to presence of sensitive equipment (eg. pacemakers, cerebral aneurysm clips).

Other implantable devices (hip replacements, dental fillings etc) are not damaged by the magnetic field but may cause localised artifact.

Magnetic field in homogeneity leads to inaccuracy in determining the position of volumes.(www.wikapidia.com)

2-5 previous studies

The study was done by(Ahmed Umdagas Hamidu[1], Solomon Ekott David[2], Sefiya Adebanke Olarinoye-Akorede[1], Barnabas Danborno[2], Abdullahi Jimoh[3], Olaniyan Fatai[4]) .

obtained the widest linear dimensions of the 3rd and 4th cerebral ventricles using the inbuilt linear calipers of the computer tomography (CT) scan machine for each patient. Statistical analysis was performed using Sigmastat 2.0 for Windows (Statsoft, San Rafael, CA). The following statistical tests employed: students *t*-test and analysis of variance, and a probability level of <0.001 taken as statistically significant The 488 brain CT scans analyzed for this study comprised of 319 (65.36%) males and 169 (34.63%) females. The ages ranged from 18 to 84 years with a mean age of 37.26 years. The age difference between males and females were statistically significant. The mean 3rd ventricular widths were 4.23 ± 1.25 and 3.81 ± 0.87 in males and females respectively, whereas the mean 4th ventricular widths were, 7.87 ± 1.30 and 7.54 ± 1.33, in males and females, respectively. In this study, we have established normal linear values for the 3rd and 4th cerebral ventricles in Zaria using computed tomography. These values could serve as a quick reference for radiologists and neurosurgeons, obviating the need for advanced software packages, which may not be readily available. When compared with the study by different authors who are mainly Caucasians, there is no significant racial difference in the sizes of the ventricles. The present author in a study of CT changes in childhood seizures found out that cerebral atrophy and enlarged ventricles to be the most common findings. It is thought that this could persist in adulthood and perhaps such children would have larger ventricular sizes in adulthood. As collaborated by Abidoye, and Scrimshaw, children who suffered from malnutrition are more likely to show growth retardation, difficulty in school and may remain malnourished up to adulthood. This could however not be ascertained by the present study, but would be a basis for a future study.

In conclusion, normal 3V and 4V sizes have been obtained in order to serve as a normogram in our environment as there is no study of such to the best knowledge of the authors.

Chapter Three

Materials and methods

Chapter Three

Materials and methods

3-1Materials

3-1-1Patient

This study I include the age between 12-82 because in this range third and fourth ventricles was complete the process of development, I exclude the patient with hydrocephalus, colloid cyst, and any diseases affect to the third and fourth ventricles. 205sudanees adult patient (121 males, 84females), underwent magnetic resonance imaging.

This is community based descriptive study. It was took place in Khartoum state in different hospital and centers.

3-2Method

3-2-1Technique

The following MRI technique was used:

Filed Strength: 1.5T

Sequence: 2DSagittalT1, AxialT2, Axial T2 Flair, cronalT1,T2

Patient position:

Patient supine head first

The sagittal laser beam localizer parallel to the midline of the body and the axial laser beam perpendicular to midline of the body.

Patient preparation:

No need fasting.

Remove any metallic object before inter magnetic field.

Ask the patient have any device in the body.

3-2-2Image interpretation

The data result collected from the result of MRI scan finding and supported the result by radiologist report. Determine by the wall thickened,increase or decrease CSF and tissue enhancement.

3-2-3Data analysis

All data entered and analyzed using statistical package for social sciences (SPSS) version 20.

3-2-4Measurement of third and fourth ventricles

The widest diameters of third and fourth ventricles on axial image use the linear approach were measured (figure3-1) and (figure3-2).the average of the two measurements was recorded for each patient.

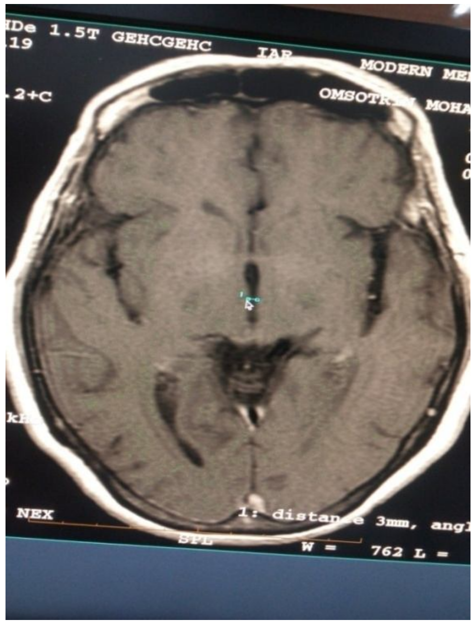


Figure 3-1: 1axial magnetic resonance image at level of third ventricle, showing how the measurement of the width was taken

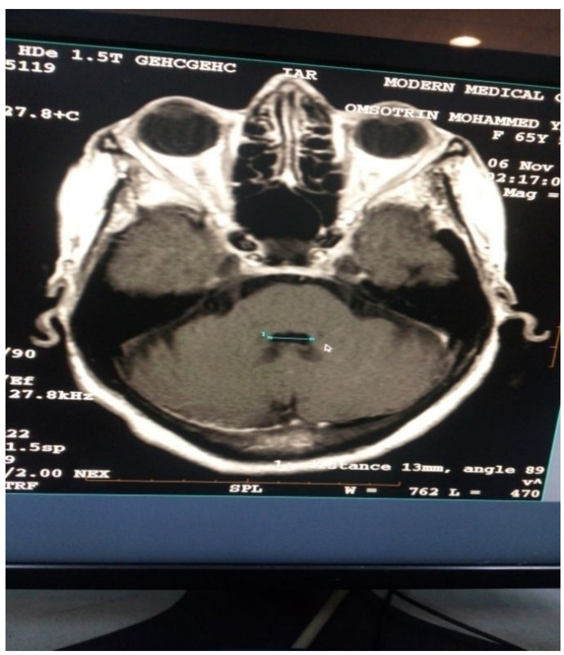


Figure 3-2:axial magnetic resonance image at level of fourth ventricle, showing how the measurement of the width was taken.

Chapter four

Results

Chapter four

Results

Table 4:1Show study group gender distribution.

GENDER	Frequency	Percentage%
MALE	121	59%
FEMALE	84	41%
Total	205	100%

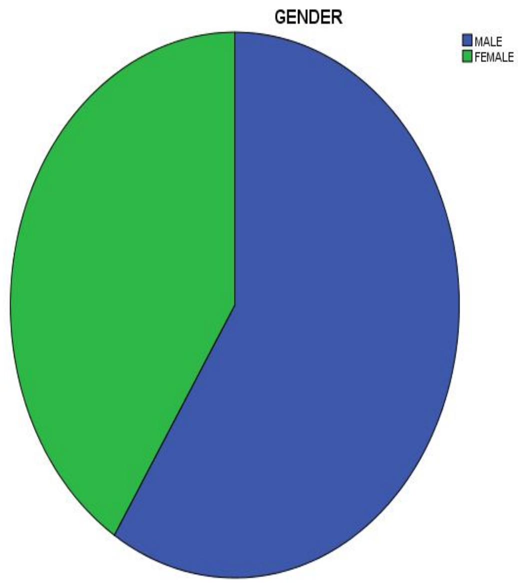


Figure 4:1 Diagram Show study group gender distribution

Table 4-2: Show the descriptive statistic between age and gender

Gender	Mean	Median	Std.Deviation	Minimum	Maximum	Range
Male	48.68	51	18.858	12	82	70
Female	42.04	41	17.220	14	82	68

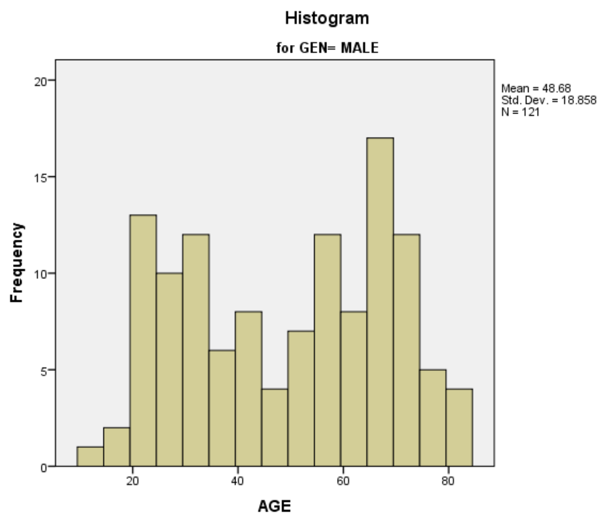


Figure 4-2: Show the descriptive histogram of the male

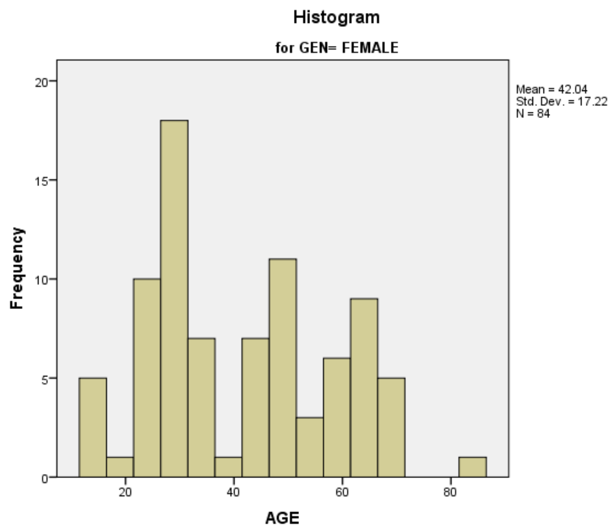


Figure 4-3: Show the descriptive histogram of the female

Table 4-3: Show the descriptive statistic of the third ventricle length

Gender	Mean	Median	Std.Deviation	Minimum	Maximum	Range
Male	26.33	27	4.356	11	40	29
Female	25.3	25	3.32	17	34	17

Table 4-4: Show the descriptive statistic of the third ventricle width

Gender	Mean	Median	Std.Deviation	Minimum	Maximum	Range
Male	5.01	6.231	2.496	1	19	18
Female	4.39	3.15	2.223	1	13	12

Table 4-5: Show the the descriptive statistic of the forth ventricle length inSigT1

Gender	Mean	Median	Std.Deviation	Minimum	Maximum	Range
Male	15.99	11.585	3.404	7	28	21
Female	15.66	15	4.006	9	32	23

Table 4-6: Show the descriptive statistic of the forth ventricle width inSigT1

Gender	Mean	Median	Std.Deviation	Minimum	Maximum	Range
Male	11.26	11	2.632	6	19	13
Female	10.27	9.75	2.79	6	17	11

Table 4-7: Show the descriptive statistic of the forth ventricle length inAxialT2F

Gender	Mean	Median	Std.Deviation	Minimum	Maximum	Range
Male	11.43	12	2.367	4	17	13
Female	10.48	11	2.329	4	19	15

Table 4-8: Show the descriptive statistic of the forth ventricle width inAxialT2F

Gender	Mean	Median	Std.Deviation	Minimum	Maximum	Range
Male	13.39	12	9.735	6	116	110
Female	12.25	12	2.638	5	25	20

Table 4-11Show correlation between age and3ED ventricle length

		AGE	3ED VENTRICAL LENGTH
AGE	Pearson Correlation	1	.285**
	Sig. (2-tailed)		.000
	N	205	205
3ED VENTRICAL LENGTH	Pearson Correlation	.285**	1
	Sig. (2-tailed)	.000	
	N	205	205

**. Correlation is significant at the 0.01 level (2-tailed).

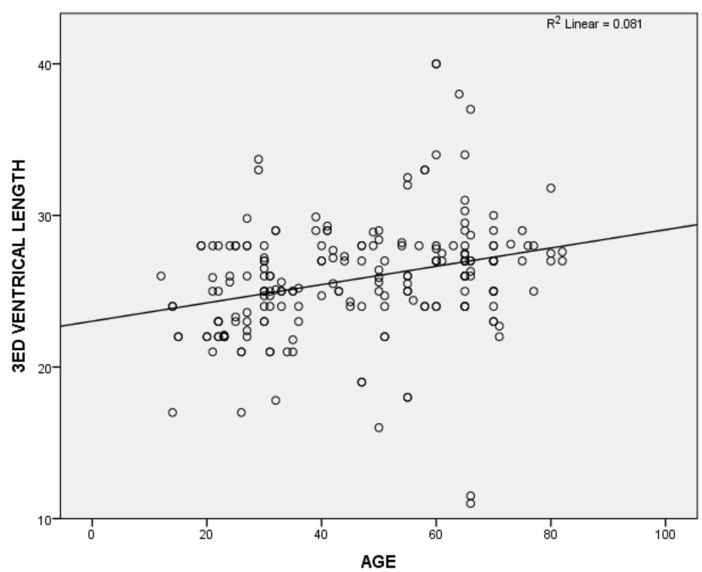


Figure 4-5:Scatter plot diagram show the correlation between the age and3ED ventricle length.

Table 4-12: Show correlation between age and3ED ventricle widths

		AGE	3ED VENTRICAL WIDTH
AGE	Pearson Correlation	1	.497**
	Sig. (2-tailed)		.000
	N	205	205
3ED VENTRICAL WIDTH	Pearson Correlation	.497**	1
	Sig. (2-tailed)	.000	
	N	205	205

**. Correlation is significant at the 0.01 level (2-tailed).

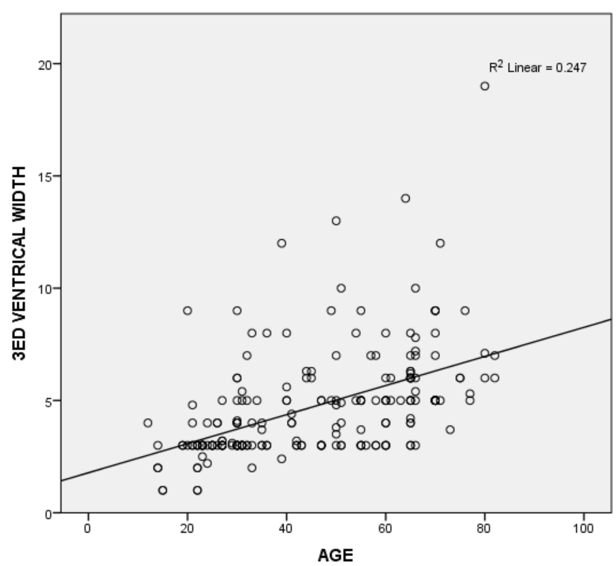
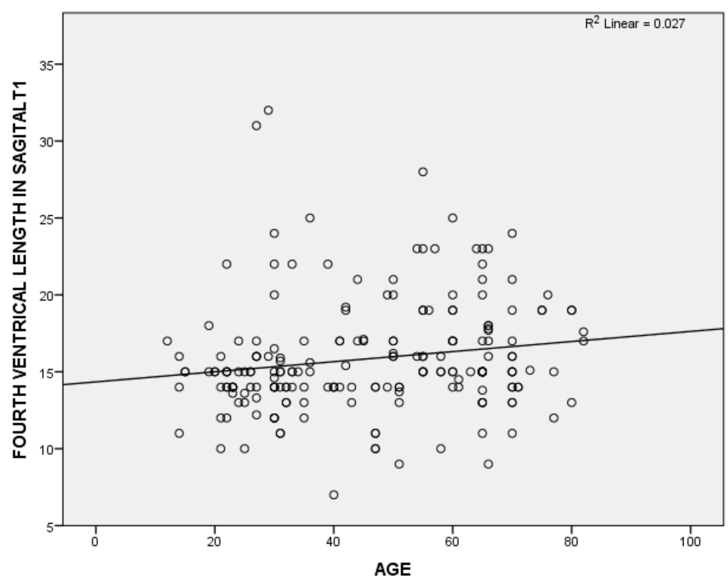


Figure 4-6:Scatter plot diagram show the correlation between the age and3ED ventricle widths

Table 4-13: Show correlation between age and fourth ventricle length in SigT1

			AGE	FOURTH VENTRICAL LENGTH IN SAGITALT1
Kendall's tau_b	AGE	Correlation Coefficient	1.000	.152**
		Sig. (2-tailed)	.	.002
		N	205	205
	FOURTH VENTRICAL LENGTH IN SAGITALT1	Correlation Coefficient	.152**	1.000
		Sig. (2-tailed)	.002	.
		N	205	205

**. Correlation is significant at the 0.01 level (2-tailed).



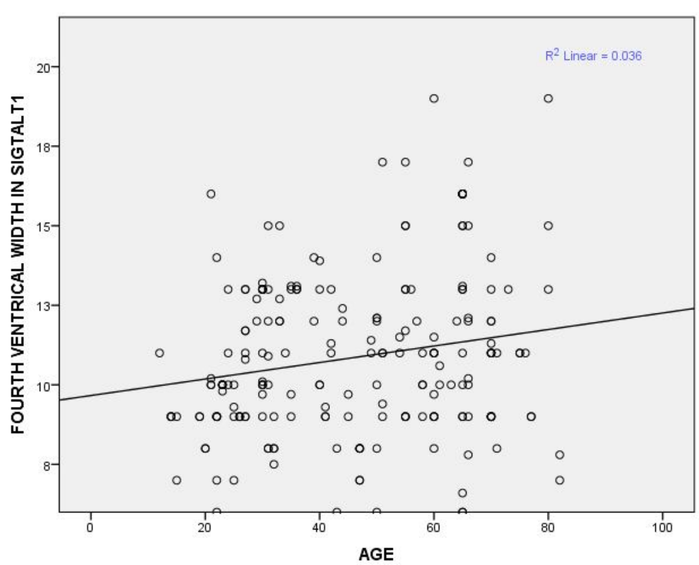
[redacted]

Figure 4-7: Scatter plot diagram show the correlation between the age andfourth ventricle length in SigT1.

Table 4-14: Show correlation between age and fourth ventricle width in SigT1

		AGE	FOURTH VENTRICAL WIDTH IN SIGTALT1
AGE	Pearson Correlation	1	.189**
	Sig. (2-tailed)		.007
	N	205	205
FOURTH VENTRICAL WIDTH IN SIGTALT1	Pearson Correlation	.189**	1
	Sig. (2-tailed)	.007	
	N	205	205

**. Correlation is significant at the 0.01 level (2-tailed).

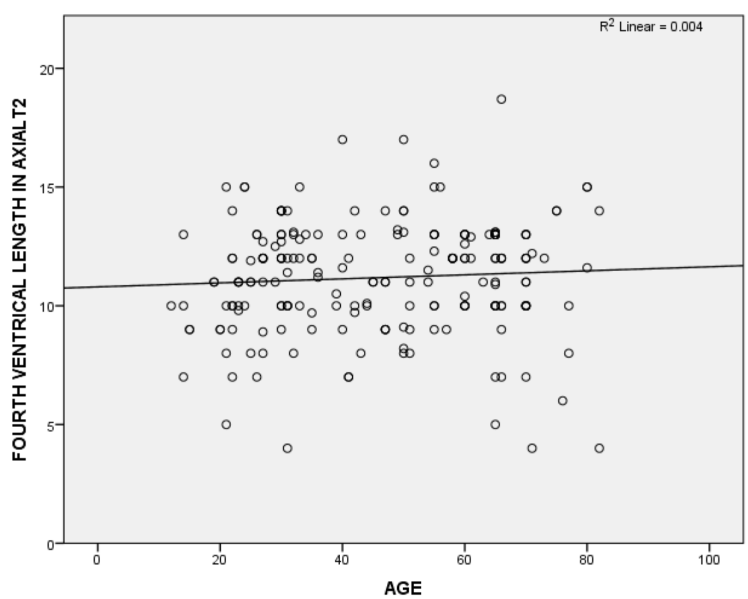


[redacted]

Figure 4-8: Scatter plot diagram show the correlation between the age andfourth ventricle width in SigT1

Table 4-15: Show correlation between age and fourth ventricle lengthin axial T2F

		AGE	FOURTH VENTRICAL LENGTH IN AXIALT2
AGE	Pearson Correlation	1	.066
	Sig. (2-tailed)		.346
	N	205	205
FOURTH VENTRICAL LENGTH IN AXIALT2	Pearson Correlation	.066	1
	Sig. (2-tailed)	.346	
	N	205	205

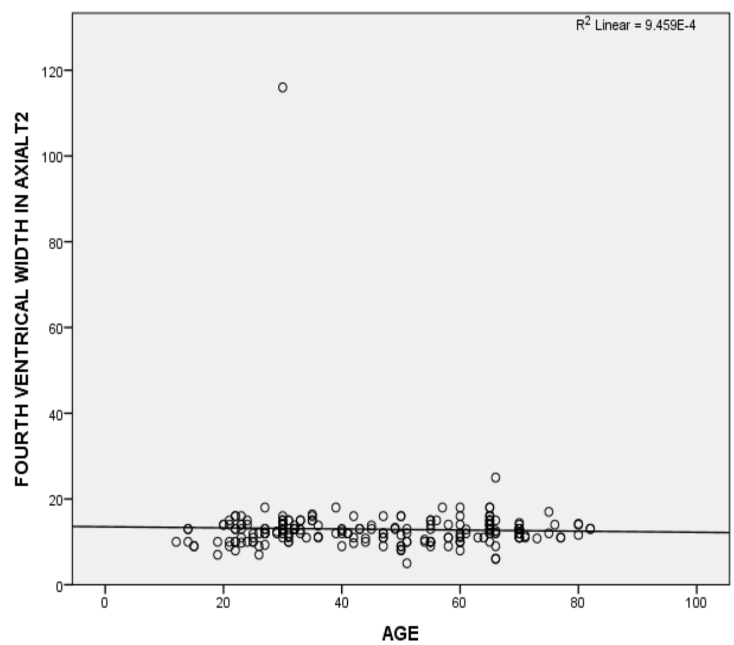


[redacted]

Figure 4-9: Scatter plot diagram show the correlation between the age andfourth ventricle length in axialT2F

Table 4-16: Show correlation between age and fourth ventricle width in axial T2

		AGE	FOURTH VENTRICAL WIDTH INAXIALT2
AGE	Pearson Correlation	1	-.031-
	Sig. (2-tailed)		.662
	N	205	205
FOURTH VENTRICAL WIDTH IN AXIALT2	Pearson Correlation	-.031-	1
	Sig. (2-tailed)	.662	
	N	205	205



[redacted]

Figure 4-10: Scatter plot diagram show the correlation between the age andfourth ventricle width in axialT2

Table 4-17: Show correlation between gender and3EDventricle length andwidth in axial T2F

		GENDER	3ED VENTRICAL LENGTH	3ED VENTRICAL WIDTH
GENDER	Pearson Correlation	1	-.164-*	-.127-
	Sig. (2-tailed)		.019	.069
	N	205	205	205
3ED VENTRICAL LENGTH	Pearson Correlation	-.164-*	1	.246**
	Sig. (2-tailed)	.019		.000
	N	205	205	205
3ED VENTRICAL WIDTH	Pearson Correlation	-.127-	.246**	1
	Sig. (2-tailed)	.069	.000	
	N	205	205	205

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

\Table 4-18: Show correlation between gender and fourth ventricle length andwidth in SigT1.

		GENDER	FOURTH VENTRICAL LENGTH IN SAGITALT1	FOURTH VENTRICAL WIDTH IN SIGTALT1
GENDER	Pearson Correlation	1	-.046-	-.193-**
	Sig. (2-tailed)		.517	.006
	N	205	205	205
FOURTH VENTRICAL LENGTH IN SAGITALT1	Pearson Correlation	-.046-	1	.207**
	Sig. (2-tailed)	.517		.003
	N	205	205	205
FOURTH VENTRICAL WIDTH IN SIGTALT1	Pearson Correlation	-.193-**	.207**	1
	Sig. (2-tailed)	.006	.003	
	N	205	205	205

**. Correlation is significant at the 0.01 level (2-tailed).

Table 4-19: Show correlation between gender and fourth ventricle length and width in axialT2F.

		GENDER	FOURTH VENTRICAL LENGTH IN AXIALT2	FOURTH VENTRICAL WIDTH IN AXIALT2
GENDER	Pearson Correlation	1	-.123-	-.073-
	Sig. (2-tailed)		.080	.298
	N	205	205	205
FOURTH VENTRICAL LENGTH IN AXIALT2	Pearson Correlation	-.123-	1	.139*
	Sig. (2-tailed)	.080		.046
	N	205	205	205
FOURTH VENTRICAL WIDTH IN AXIALT2	Pearson Correlation	-.073-	.139*	1
	Sig. (2-tailed)	.298	.046	
	N	205	205	205

*. Correlation is significant at the 0.05 level (2-tailed).

Chapter five

Discussion, Conclusion and Recommendations

Chapter five

5-1Discussion

The aim of this study was measurement of the third and fourth ventricles of the brain in adult Sudanese population with magnetic resonance image. The study took into consideration of the normal third and fourth ventricles measurements and correlates that with age and gender.

The normal third ventricle measurement were length in axial T2 diameter for male (26.33 mean±4.356 SD) And female (25.3 mean±3.32 SD).

The third ventricle width diameter for male (5.01 mean± 2.496SD) and female (4.39 mean±2.223SD).

The normal fourth ventricle measurements were length in SigT1diameter for male (15.99mean±3.404SD). And female (15.66mean±4.006SD).

The fourth ventricle width for male (11.26mean±2.632SD).and female (10.27mean± 2.79SD).

The normal fourth ventricle measurements were length in axialT2 diameter for male (11.43mean±2.367SD). Andfemale (10.48mean±2.329SD).

The fourth ventricle width for male (13.39mean±9.735SD).

Andthe mean of age in male was48 years and female was 42years from the total number of cases205 The male121 and female 84.

From this study show mean of the third ventricle length and width higher (larger) in mal than female and forth ventricle length and width is higher in male accepted the width of female is higher than mal in SigT1.

The normal size of ventricles in MRI shows the width in third to be3mm and length 23mm increase or decrease on age. The study accepted with the previous study

The age above the 55 year show the third ventricles become wider.

After applying the correlation between the age and third ventricle length and width the study showed that there was significant correlation at the 0.01 level. Ana the third ventricle length increased by factor of 0.285 as the age increased and the third ventricle width increased by factor of 0.497 as age increased.

The correlation between age and fourth ventricles length and width in SigT1 the study showed that there was significant correlation at the 0.01 level. And the fourth ventricle length increased by factor 0.046 and width increased by factor 0.193as age increased.

The correlation between age and fourth ventricles in axial T2 the study showed that there was no significant correlation seen

The correlation between the gender and third ventricle length and width the study showed that there was significant correlation at the 0.01and 0.05 level. And the third ventricle length increased by factor of 0.164as the age increased and the third ventricle width increased by factor of 0.246 as age increased.

The correlation between gender and fourth ventricles length and width in AxialT2F the study show there are no significant correlation between third ventricle length and the fourth ventricle width showed that there was significant correlation at the 0.05.And fourth ventricle width increased by factor 0.139as age increased.

The correlation between gender and fourth ventricles length and width in SigT1 the study showed that there was significant correlation at the 0.01 level. And the fourth ventricle length increased by factor 0.193 and width increased by factor 0.207as age increased.

5-2Conclusion

The research concluded that incident of variations of third and fourth ventricle of the brain in the size in age and gender.

The normal size of ventricles in MRI shows the width in third to be3mm and length 23mm increase or decrease on age. The study accepted with the previous study .

The MRI best modality to demonstrate the tissue of the brain that allows to show outline of the third and fourth ventricle clearly and easily to be measured.

5.3 Recommendation

1-For further assessment another study should done using large sample of patient.

2-Some of study measured the ventricle of children by ultrasound I wish to do by the MRI.

3-Another researches should be done with MRI and compare it with CT to evaluate which best modality to measure the normal third and fourth ventricle.

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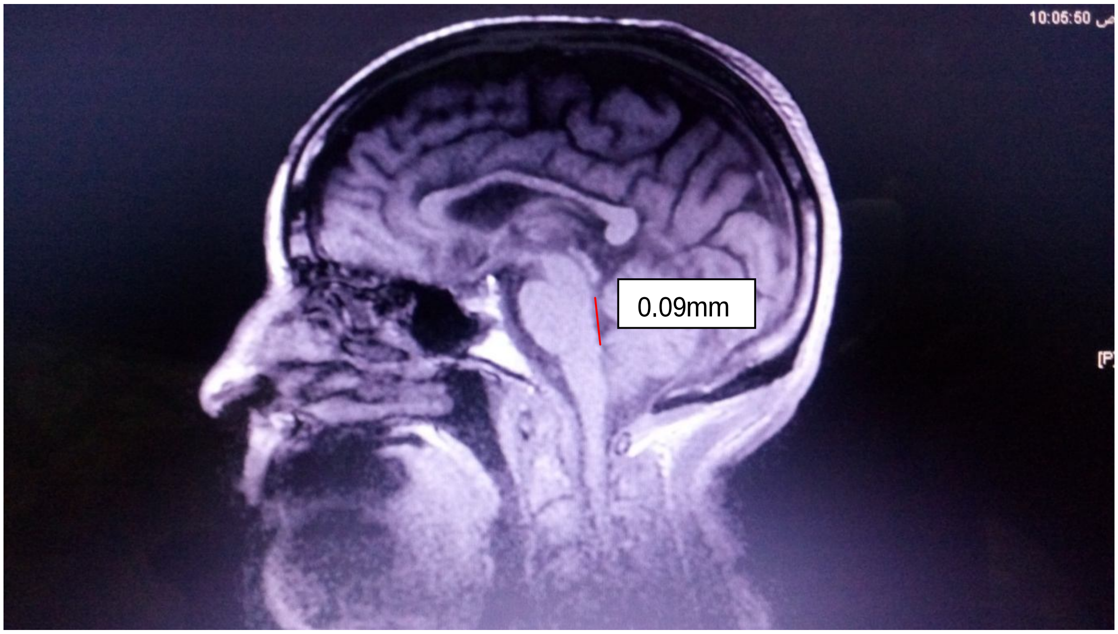
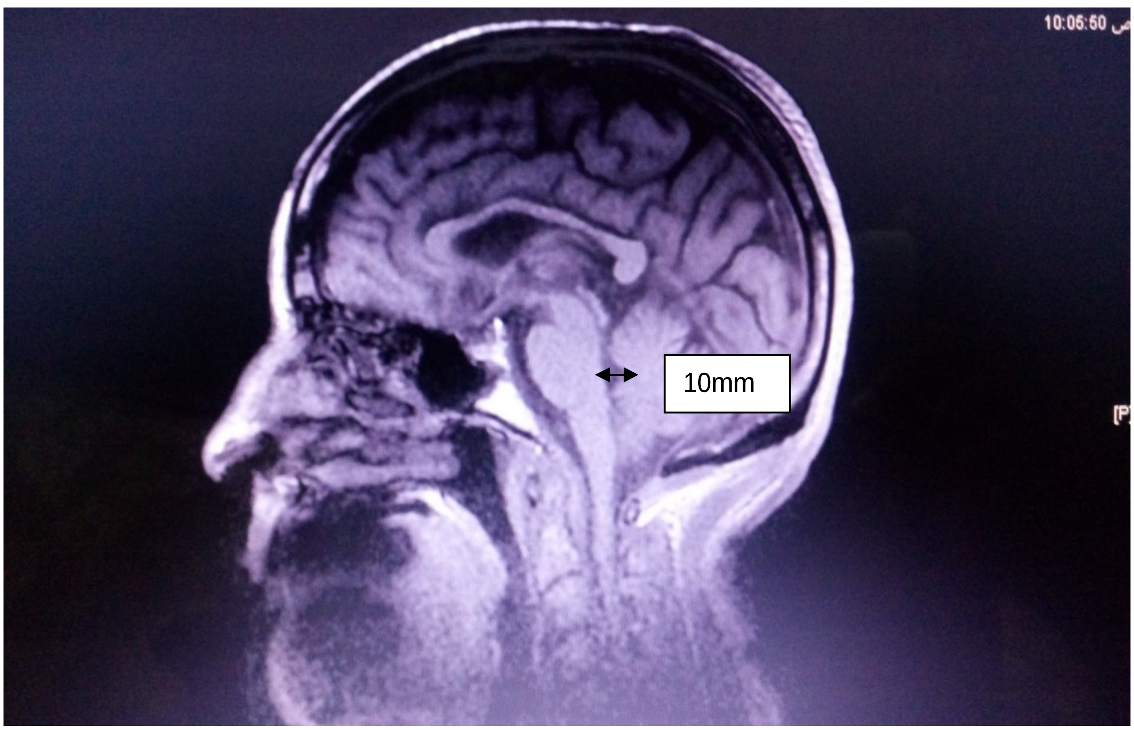
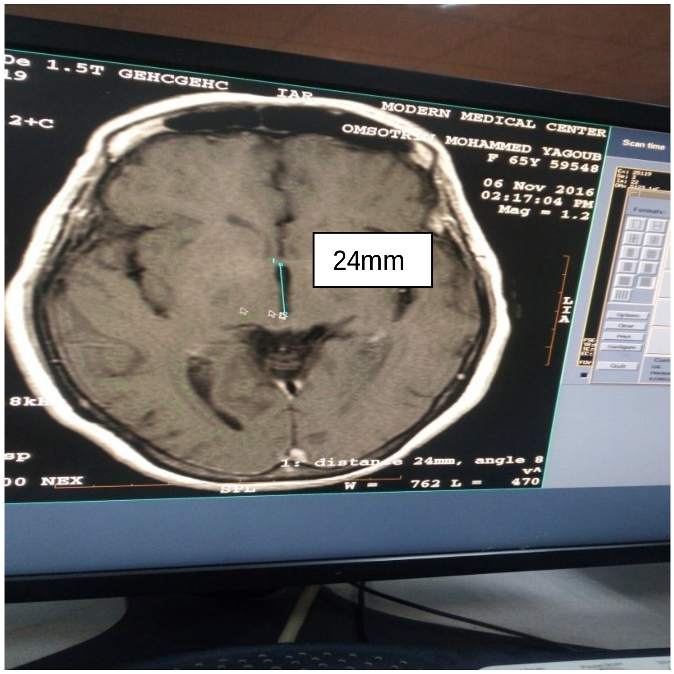
Appendices



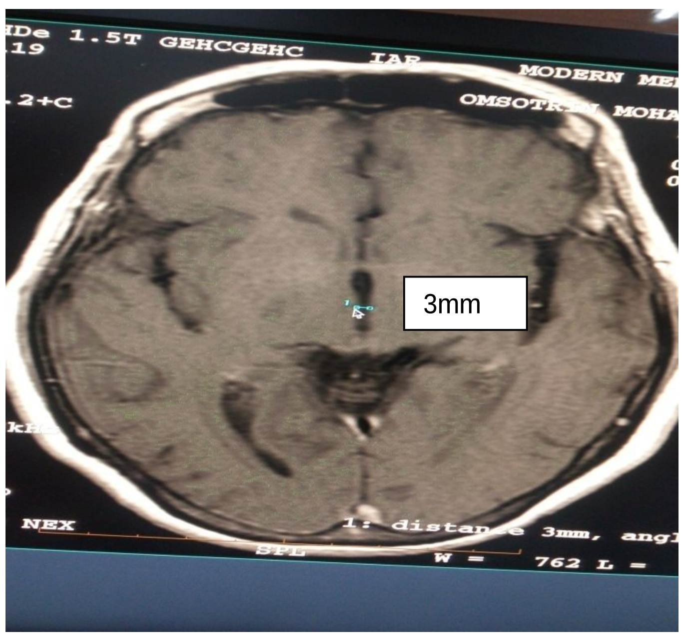
Appendices A: Sagittal MRI image for female (30years) show the measurements of fourth ventricle length diameter



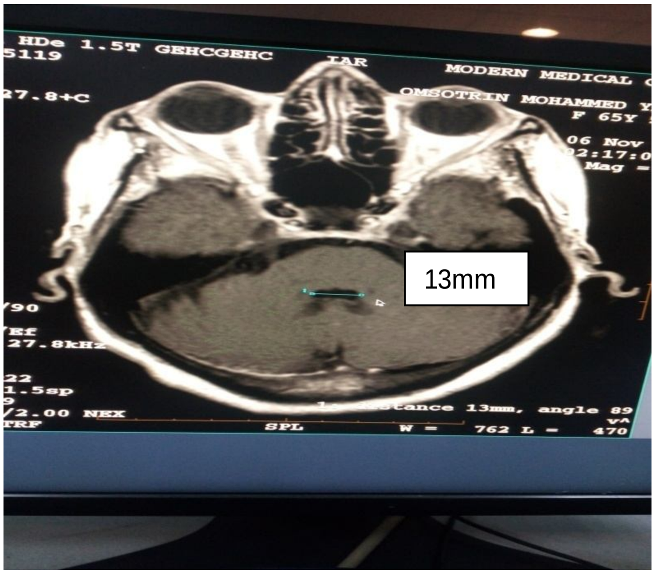
Appendices A: Sagittal MRI image for female (30years) show the measurements of fourth ventricle width diameter



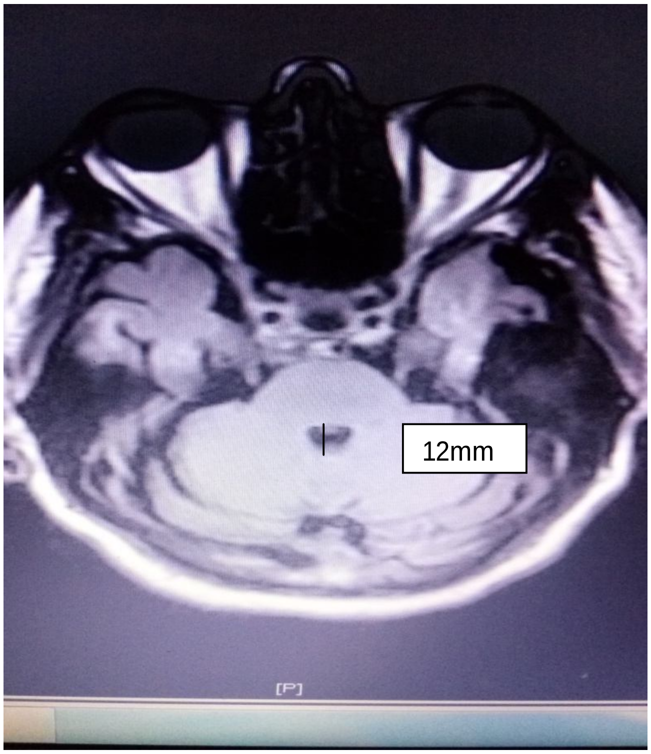
Appendices A: Axial MRI image for male (65years) show the measurement of third ventricle length diameter



Appendices A: Axial MRI image for male (65years) show the measurement of third ventricle width diameter



Appendices A: Axial MRI image for male (65years) show the measurement of fourth ventricle width diameter



Appendices A: Axial MRI image for male (65years) show the measurement of fourth ventricle length diameter

Sudan University of Sciences and Technology

Collage of Graduate Study

Measurement of Normal Third and Forth Ventricles

In adult Sudanese Patients Using Magnetic Resonance Imaging

Appendices B:Data Collection Sheet

AGE	GEN	WT	HIGT	THVLAXT2	THVWAXT2	FRLSAJT1	FRWSAJT1	FRLAXT2	FRWAXT2

THVLAXT2=third ventricle length in axialT2 MRI image

THVWAXT2= third ventricle width in axialT2 MRI image

FRLSAJT1=fourth ventricle length in sagittal T1 MRI image

FRWSAJT1=fourth ventricle width in sagittal T1MRI image

FRLAXT2=fourth ventricle length in axialT2 MRI image

FRWAXT2=fourth ventricle width in axialT2 MRI image

GEN=gender

WT=weight