Sudan University of Sciences and Technology

College of Graduate Studies

Estimation of Normal Brain Lateral Ventricles by Using Computed Tomography

تقدير بطينات المخ الجانبية الطبيعية باستخدام الاشعة المقطعية

A Thesis Submitted, The Requirement for Partial Fulfillment of award of Master Degree in Diagnostic Radiological Technology

By

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الآيـة

بِسۡمِ ٱللَّهِ ٱلرَّحۡمَٰنِ ٱلرَّحِيمِ

قال تعالى:

(و اصبر لحكم ربك فأنك بأعيننـا)

صدق الله العظيم

سورة الطور الآية 48

Dedication

To my father how learned me that only man can defeat odds and arrive to the goals

To my mother how learned me that only love and compassion are the secret of the happy life

Acknowledgment

First all thanks and praise are due to ALLAH .

I would like to express my grateful thanks to my supervisor,Dr: Asma Ibrahim for her valuable and continuous help and guidance.

My thanks extended to the staff of the Radiology Department in Sharq Alneel hosiptal who my helped me in collecting data.

Abstract

This study was conducted with the aim of naturally measuring the lateral ventricles in Sudanese patients using CT scans in the Sharq Alneel Hospital and National Rabat Hospital in the period of time from September 2019 to December 2019, conducted on 56 patients including 33 men and 23 women, ages of 20_70 years old. The results were generally as follows:

The average length of the right anterior horn was 30.521mm, the average length of the left anterior horn was 31.588mm, the average length of right posterior horn was 36.2mm, the average length of the left posterior horn was 36.62mm, the average length of the right ventricular body was 75.086mm, and the average length of the left ventricular body was 76.47mm.

In men, the average length of the right anterior horn was 30.882mm, the average length of the left anterior horn was 31.955mm, the average length of right posterior horn was 37.376mm, the average length of the left posterior horn was 37.364mm, the average length of the right ventricular body was 76.158mm, and the average length of the left ventricular body was 77.515mm.

In women, the average length of the right anterior horn was 30.004mm, the average length of the left anterior horn was 31.061mm, the average length of right posterior horn was 34.513mm, the average length of the left posterior horn was 35.561mm, the average length of the right ventricular body was 73.548mm, and the average length of the left ventricular body was 74.970mm.

The study showed there is no difference in the average lengths of the anterior horns and bodies of the lateral ventricles with age, but there is marked difference in the lengths of the posterior horns with age.

Also study showed 0.005%difference in the right lateral ventricle with weight, and 0.0003% in the left lateral ventricle with weight.

المستخلص

أجريت هذه الدراسة بهدف قياس البطينات الجانبية بصورتها الطبيعية لدى المرضى السودانيين باستخدام الاشعة المقطعية في مستشفى شرق النيل النموذجي و مستشفى الرباط الوطني في الفترة من سبتمبر 2019 الى ديسمبر 2019، أجريت على 56 مريض منهم 33 من الرجال و 23 من النساء، تتراوح اعمارهم بين 20–70 عاما و كانوا لا يعانون من اى مرض من شأنه التأثير على البطينات الجانبية.

و كانت النتائج بشكل عام كالأتي:

متوسط طول الرأس الامامي الأيمن 30.521مم، و متوسط طول الرأس الامامي ألأيسر 31.588مم، متوسط طول الرأس الخلفي الأيمن 36.2مم، و متوسط طول الرأس الخلفي الأيسر 36.62مم، و كان متوسط طول جسم البطين الايمن 75.086مم، و متوسط طول جسم البطين الأيسر 76.47مم.

و في الرجال متوسط طول الرأس الامامي الأيمن 30.882مم، و متوسط طول الرأس الامامي ألأيسر 31.955مم، متوسط طول الرأس الخلفي الأيمن 37.376مم، و متوسط طول الرأس الخلفي الأيسر 37.364مم، و كان متوسط طول جسم البطين الأيمن76.158مم، و متوسط طول جسم البطين الأيسر 77.515مم.

و في النساء كان متوسط طول الرأس الامامي الأيمن 30.004مم، و متوسط طول الرأس الامامي ألأيسر 31.061مم، متوسط طول الرأس الخلفي الأيمن 34.513مم، و متوسط طول الرأس الخلفي الأيسر 35.561مم، و كان متوسط طول جسم البطين الايمن 73.548مم، و متوسط طول جسم البطين الأيسر 74.970مم.

و أظهرت الدراسة انه لا يوجد اختلاف في متوسط اطوال الرأس الامامي و جسم البطينات الجانبية مع التقدم في العمر، ولكن يوجد اختلاف ملحوظ في اطوال الرأس الخلفي مع العمر.

و أيضا اظهرت الدراسة وجود اختلاف بنسبة 0.005%في البطين الجانبي الايمن مع الوزن، و بنسبة 0.0003% في البطين الجانبي الايسرمع الوزن.

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List of Abbreviations

CNS	Central Nervous System
CSF	Cerebrospinal Fluid
EAM	External Auditory Meatus
CT	Computed Tomography
3D	Three Dimensions
MRI	Magnetic Resonance Imaging
SPSS	statistical Package for Social Sciences

Chapter One

Interdiction

1.1 Introduction

The brain is most fascinating and least under stood organ in human body. For centuries, scientists and philosophers have pondered the relationship between behavior, emotion, memory, thought, consciousness and physical body. In the middle age there was much controversy as to whether the soul was located in the brain or in the heart .As ideas developed however, it was suggested that mental processes were located in ventricles of the brain. According to this theory, common sense was located in the lateral ventricles, with imagination in its posterior part (Last, 1977).

The ventricles, which became known as "cellulae" until the

Renaissance, were counted from three to five in number, and many medical illustrations attempted to demonstrate their appearance in the brain. One of these was by Albertus Magnus in1506, which represented three cavities surrounded by thin brain tissue. He believed that the functions of these cavities were, from anterior to posterior, imagination, reasoning, and memory. Around (1504), Leonardo da Vinci was the first to make an accurate depiction of the ventricles by performing the first known ventriculography by injecting molten wax into the ventricles of an ox.

However, he also followed the same older belief regarding the functions of the ventricles with only slight modifications. Following Da Vinci's illustrations of the ventricles, anatomists of the Renaissance started to give more attention on studying these cavities, but even in Vesalius's Fabrica, the ventricles were described as air containing spaces that fill during inspiration, and contain the animal spirit. In the same period of time, some anatomists, including Nicolo Massa in 1569, opposed the widely held belief of the content of the ventricles. It took almost a century until Constanzo Varolio and Francis Glisson described humor content instead of the classical spirit.

This did not end the debate, however. In 1764, Domenico Felice Antonio Cotugno was the first to discover cerebrospinal fluid and to describe the continuity between the ventricles and subarachnoid space. His findings were later confirmed by François Jean Magendie, whose contribution to the discovery of the foramen of Magendie will be described below in addition to the history of ventricular communications (Schiller, 1997).

As ageing advances, the brain undergoes many gross and histopathological changes with regression of the brain tissueleading to the enlargement of the ventricles.(Schiller, 1997)Both imaging and autopsy studies revealed that there is correlationwith increase in cerebrospinal fluid spaces and reduction in cerebral volume accompanying normal human ageing (Standring,2008), (Rhoton, 2002).

Due to these changes that occurs normally with ageing, the diagnosis of diseases in elderly patients is often complicated. So, the two major changes that may occur in elderly individual without neurologic deficits is enlargement of ventricles and cortical atrophy. However surprisingly, there is lack of clinical, radiologic and pathologic information regarding these changes in humans. The normal ventricular size during life was previously unknown (Schiller, 1997).

neumoencephalography and ventriculography are the older techniques of visualizing the ventricular system by injecting air through lumbar puncture under local anaesthesia (Evans, 1942; Hahn and Rim, 1976; Meese et al., 1980). Ventricular system can also be studied by two dimensional ultrasonic studies especially in children (Davies et al., 2000). In recent years, Computed Tomography (CT) scan and Magnetic Resonance Imaging (MRI) have replaced the older methods of studying ventricular system (Sabattini, 1982).

1.2 Problem of study:

This study was provided a reference measurement of lateral ventricles in Sudanese groups depending on the CT imaging which can help in diagnosing of related disease.

1.3 Objectives of the study:

1.3.1 General objectives:

To estimate and assess the lateral ventricles length in order to have a Sudanese index value.

1.3.2 Specific objectives:

- To determine the relationship of ventricular dimensions from CT scans across age groups.
- To compare the mean values of ventricles dimension between males and females of comparative age groups.
- To compute Linear Ventricular Brain ratios (Frontal horn ratio and third ventricular index)
- To help the physician to differentiate between the normal and abnormal lateral ventricles size.

1.4 Significance of the study:

This study will profiled an index of brain lateral ventricles length in Sudanese population.

1.5 Overview of the study

The study composed of five chapters:

Chapter one introduction which consisting of an introduction, problem of study, objectives, and significance of study and overview of the study.

Chapter two which contains anatomy, physiology and pathology of brain lateral ventricles, computed tomography (CT) and previous studies.

Chapter three material and methods.

Chapter four including result presentation.

Chapter five discussion, conclusion and recommendation

Chapter Two

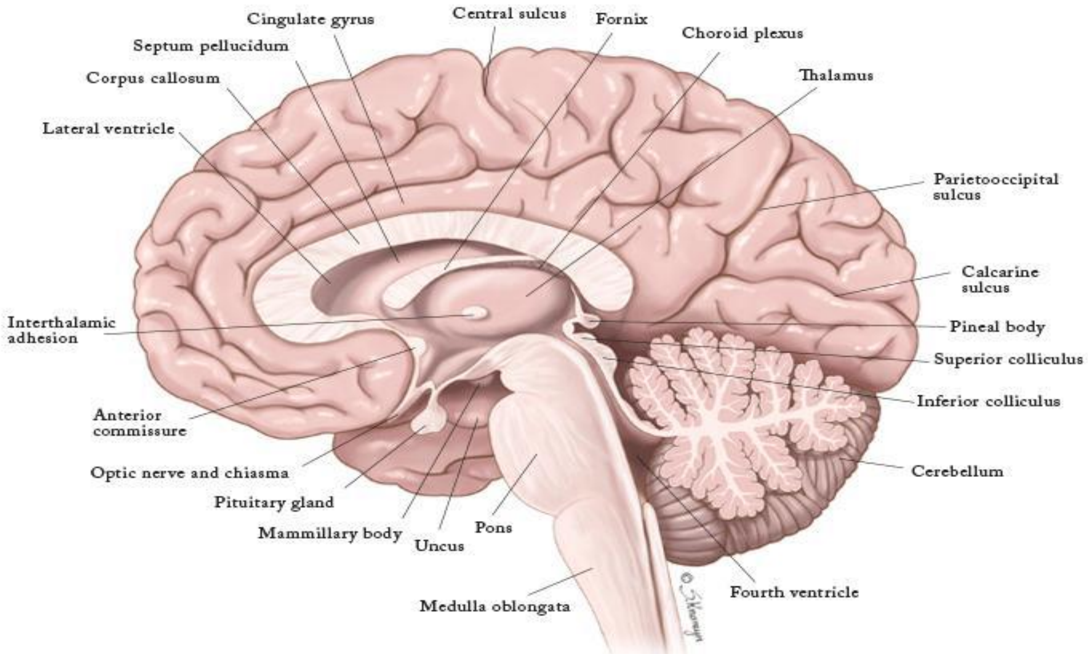
Background

Literature Review

2.1 Anatomy:

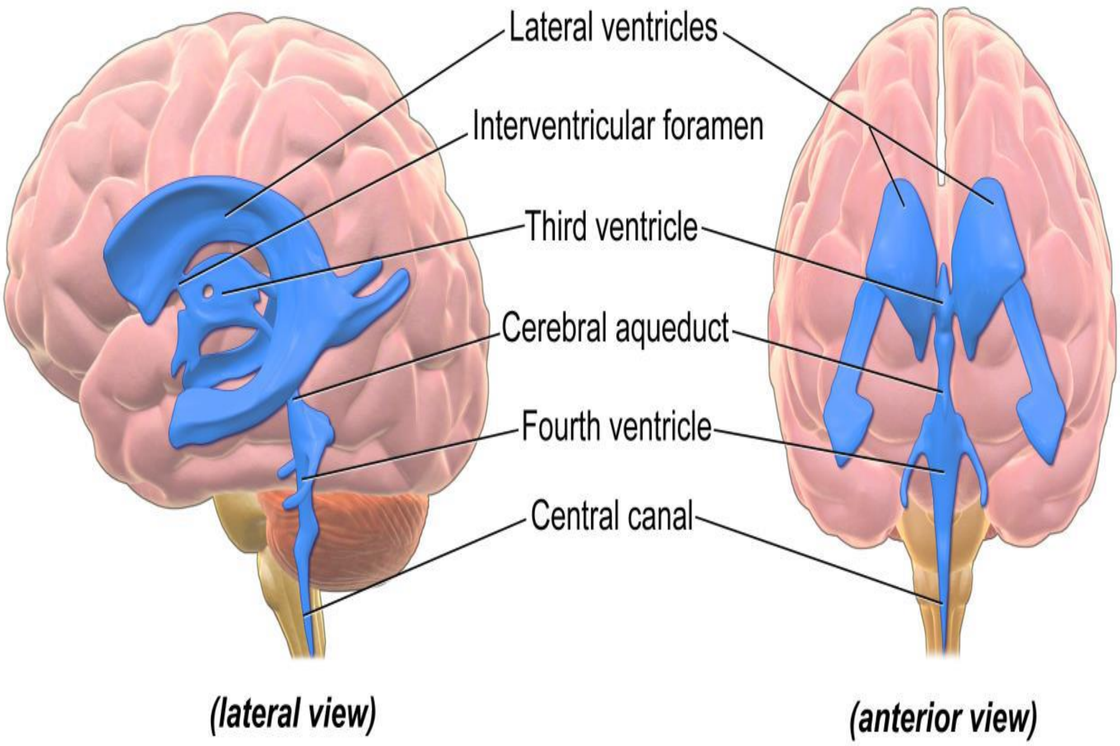
The brain is large mass of soft nervous tissue made up of both neurons and supporting glial cells lying within the cranium of the skull. Brain is composed of: midbrain, pons, medulla oblongata. The diencephalon is consists of thalamus and hypothalamus. The cerebellum consists of two lateral hemispheres. The cerebrum includes cerebral hemispheres, separated by the cerebral falx, and it divided into four lobes for descriptive purposes: frontal, parietal , occipital and temporal lobe. There are four cavities in the cerebral hemisphere called the ventricular system, including the two lateral ventricles, the third ventricle and the fourth ventricle (Fix, 2002).

2.1.1Ventricular System:



Fig(2. 1) Sagittal section of the brain

(www.sigrid.knemeyer.com/portfolio/mid-section-of-the-brain/)



Fig(2. 2) Shows the anatomy of ventricular system

Ventricular system is an internal cavity of the brain. It is divided into four cavities called ventricles, which connected by a series of holes called foramen and tubes(Vasan2010). The two largest ventricles (first and second)are the lateral ventricles in the cerebral hemispheres. They ach communicate with the third ventricles through the foramen of Munro. The third ventricle in the diencephalon of the forebrain between right and left thalamus, and the fourth ventricle is located at the back of the pons and upper half of the medulla oblongata of the hind brain. The third connects with the fourth through aqueduct of Sylvius(www.aanas.org.co). This ventricular system with normal brain, which provides a pathway for the circulation of cerebrospinal fluid (CSF) (Singh, 2010).

2.1.1.1 Lateral ventricles:

The lateral ventricles are a cavities within the cerebral hemispheres, one on each side of the median plane just below the corpus callosum. They are separated from each other by a thin membrane (septum pellucidum) and not communicating directly. They communicate with third ventricle by interventricular foramina (Anne, 2006).

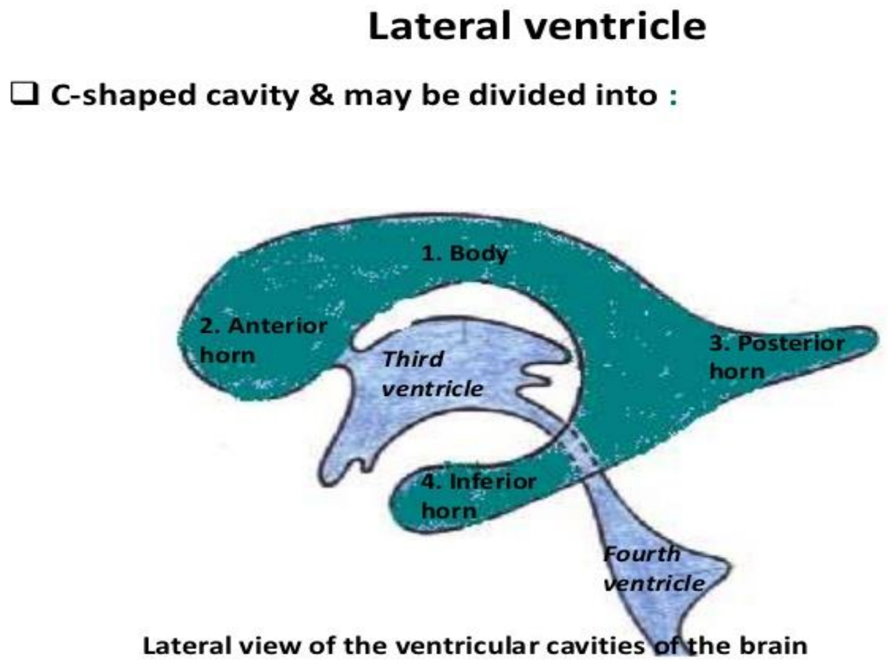
The lateral ventricle is composed of:

(1) The anterior or frontal horn extend into the frontal lobe

(2) The posterior or occipital horn extend into occipital lobe

(3) The inferior or temporal horn extend into temporal lobe

(4) Body of lateral ventricle.



Fig(2. 3) show Parts of lateral ventricles

The body is the central portion just posterior to frontal horn. The junction of the body anteriorly and temporal horn inferiorly and occipital horn posteriorly form the triangular area termed the trigone(atria). The cella media is a central part of lateral ventricle. Ependyma cover the inside of lateral ventricle and are epithelial cell. The lateral ventricles open downward into the third ventricle through the paired interventriclar foramen (foramen of monro) (Lorrie, 1997).

The lateral ventricles, similar to other part of ventricular system of the brain, developed from central canal of neural. Specifically the lateral ventricles originate from portion of the tube that is present in the developing prosencephalon ,and subsequently in the developing telencephalon (Vasan, 2010). During the first trimester of pregnancy the central canal expanded into lateral , third and fourth ventricles connected by thinner channel. In lateral ventricle specialized area (choroid pluxes) appear, which produce cerebrospinal fluid (CSF) (Calrson, 1999).

2.1.1.1.1 Parts of lateral ventricle:

2.1.1.1.1.1 Anterior (frontal) horn:

The anterior horn lies anterior to the interventricular foramen and extends forward laterally and ventrally. It is triangular in coronal section. The posterior aspect of the genu of the corpus callosum and the rostrum borders the horn antriorly. The roof of the each ventricle is formed by the anterior part of callosal body while the rounded head of caudate nucleus forms most of the lateral wall and floor.

Medically the upper aspect of the rostrum forms part of the floor. The medical boundary of each lateral ventricle is spetumpellucidum , which contains the columns of forricesin it's posterior edge. The head of the caudate produces a characteristic bulge, which can be identified in ventriculogram and CT cuts. The posterior parts of anterior horn are separated by the septum pellucidum only, as where their tips diverge from each other (Ali,1993). This is how they appear in sections of brain specimen or in transverse cuts of computed tomography (CT).There is no choroid plexus in the anterior horn(Chan,1995).

2.1.1.1.1.2 Central part (Body):

The central part extends backwards from the interventricular foramen to the atrium. The body of the corpus callosum roofs the central part of the ventricle. The medial wall which decrease in height as it is followed posteriorly, is formed by fornix and septum pellucidum anteriorly and by the fornix posteriorly (Corbett,1997).

The floor consists from lateral to medial by the following structures:-

- The caudate uncles ,which lies in the angle between the floor and the roof and narrows rapidly as it is traced posteriorly.
- The thalamostriate vein runs anteriorlly in the groove between thalamus and caudate nucleus and passes beneath the ependyma to join the internal cerebral vein just posterior to the interventricular foramen. A number of tributaries enterit from the center of the hemisphere by running across the caudate nucleus outside the ependyma of the ventricle.
- The striaterminalis runs with the thalamostriate vein and is aslender bundle of fibers which passes with the fibers of fornix to grey matter around the anterior commissure. It arise in theamygdaloid body deep to the uncus.
- Anarrowstrip of the dorsal surface of the thalamus.
- The choroid plexus.
- The fornix anteriorly this around bundle, but posteriorly it becomes progressively flattened and extends laterally into the floor of lateral ventricle (Williams, 1995).

(The choroid plexus is attached to the lateral margin of the fornix, and the torn ependyma (taeniafornices)).

In the higher transverse gross CT (MRI) slices of the brain the bodies appear symmetrical by the side of midline, but the atria diverge laterally (Chan, 1995).

2.1.1.1.1.3 Posterior (occipital) Horns:

The posterior horn curved posteromedialy into the occipital lobe. It extends from the atrium to a variable distance in the occipital lobe, tapering to a point. The left is slightly longer than the right. The roof lateral wall, and floor formed by a sheet of fibers(tapetum) from splenium of the corpus callosum , which arches over it and passes inferiorly to the lower parts of occipital lobe. The medial wall is invaginated by two edges; The upper (bulb of posterior horn) is the formed by commissural fibers of the forceps major . The lower edge (calcaravis) is produced by calcarniesulcus , which extends deeply into the medial surface of the occipital lobe .There is no choroid plexus in the posterior horn (Corbett,1997).

There is often symmetry between the two posterior horns, and they are usually diamond shaped or square in outline(Williams,1995).

Varibility and asymmetry of posterior horn make it difficult to compare the radiological image of two sides. However ,familiarity with the configuration of each side helps in detecting abnormalities(Ali1993,Chan1995).

2.1.1.1.1.4 Inferior (Temporal) horn:

The inferior horn is the direct continuation of the ventricular cavity into the temporal lobe. It is inclined downwards and forwards from the atrium . Like the posterior horn, it varies in width and length. It curves around the posterior aspect of the thalamus(pulvinar)and at first passes downwards and posterolaterally before curving anteriorly to end with 25 mm of the temporal pole near uncus. It position on the surface of the hemisphere usually corresponds to the superior temporal sulcus. The roof of the temporal horn is formed mainly by the tapetum of the corpus callosum but the tail of the caudate nucleus and striaterminalies also extend forward in the roof to terminate in the mygdala at the anterior end of the ventricle . The roof of ventricle consist of collateral the eminence laterally and the hippocampus medially. The fimbria of hippocampus extends back on the superior medial surface of the hippocampus to become the alveus and then the crus of the fornix. Between the striaterminalis in the roof of the temporal horn and the fimmria, is inferior part of the choroid fissure and temporal extenuation of the choroid plexus filling the fissure and covering the outer surface of the hippocampus(Williams,1995).

In coronal sections, the temporal horns of lateral ventricle is flattened and when opened superiorly it can be seen that the collateral eminence form along swelling lateral and parallel to hippocampus and over lying the collateral sulcus. The eminence continues posteriorly into the flattened triangular collateral trigone forming the floor of the ventricle between its temporal and posterior horns (Corbett,1997).

2.1.1.1.2 Size of the lateral ventricles:

Most studies have demonstrated that brain weight is decreased among the elderly. Brain weight is probable maximal during the second and third decades of life at which time the brain from a normal man weighs about 1350 to 1400 grams.

The brain from a normal woman of comparable age weighs about 100 grams less. With the passage of time there is progressive loss of weight averaging 7% to 8% of peak adult weight. The weight loss occurs predominantly after the age 55(Riggs,1998)

The volume of the lateral ventricles was determined by weighing the hemispheres with and without water in the lateral ventricles. The recorded variables were age, sex, body length and body weight. In normal brains there was a significant correlation between the size of the lateral ventricles and the weight of the cerebral hemispheres. Women had smaller brains than the men even when the difference in body length was taken into account. The difference was approximately 110- 115g for the whole brain after correction for other variables. Women had also smaller lateral ventricles than men, but this difference was in proportion with the smaller size of their hemispheres(Skullerud,1995).

The ventricular size changes with aging normally, there was considerable variation in size up to the seventh decade (Knudson,1958).Most studies of the aging brain have showing a slight increase in average size of the lateral ventricles up to seventh decadeand then a more rapid increase in size (Buhrenne1963,Engeset1958). The measurement of the cella media (the smallest transverse diameter of the body of lateral ventricles) gives best correlation with overall size of the lateral ventricles(Engeset,1958).

There was physiologic decline in brain weight and a widening of the lateral ventricles with increasing with age. The shrinkage properly started after the age of 55. There was a clear correlation between body lengthand brain weight. The estimated increase in brain weight was approximately 3g per cm body length(Skullerud,1995).

Sexual dimorphism of human brain an anatomy has not been well studied between 4 and 18 years of age, a time of emerging sex differences in behavior and sexually specific hormonal changes of adrenarche (the predominately androgenic augmentation of adrenal cortex function occurring at approximately age 8) and puberty. The lateral ventricles demonstrated a prominent sex difference in brain maturation with robust increase in size in males only. There was a significant change in the linear regression slope of the lateral ventricle volume in males after age 11years (Giedd, 1997).

In spite of the apparent congruity, in size and proportion, of the right and left hemisphere, they are not (mirror images) .

There is some evidence of anatomical asymmetry. The posterior part of the superior temporal gyrus is larger on the left in the majority of brains, and posterior horn of the lateral ventricle is said to be more prominent on the left than on the right side. The symmetry of the temporal lobe has been traced back to infancy suggesting a hereditary or genetic factor in the development of cerebral asymmetry. Agreement is not unanimous over the elements of morphological symmetry, but the search continues in order to establish a structural basis for well founded functional differences between the hemispheres(Wadaa,1975).

The left lateral ventricles were found to be larger than the right in both sexes, and both lateral ventricle were larger in male.There was a statistical significant increase of all cerebral parameters with age and the linear measurements at the lateral ventricles demonstrated positive correlation to cranial size (Gyldensted,1977). In object older than 60 years relative lateral ventricular area was larger in men than women, which showed marked relation to age . The age relation was more marked for the left hemisphereic structures (Agatz,1992).

2.1.1.2 The third ventricle:

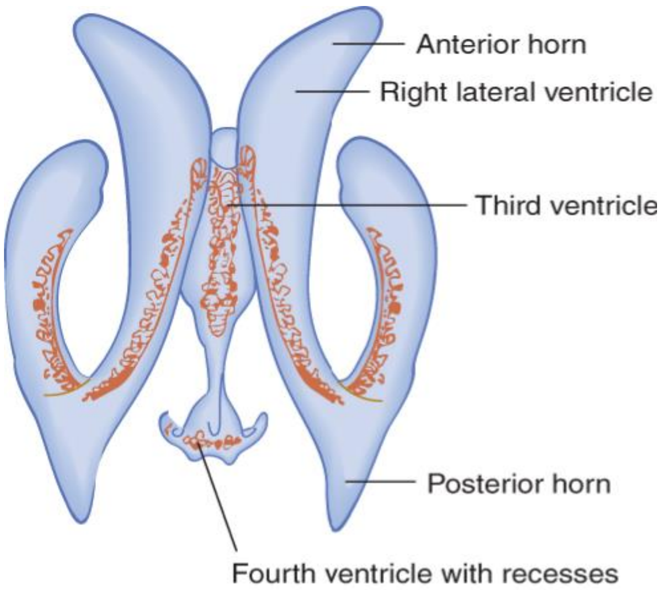
This is a slit-like cavity between the right and the left halves of the diencephalon (between two halves of the thalami). It communicates with the lateral and fourth ventricles as described above. The choroid plexus, which produces cerebrospinal fluid (CSF).

2.1.1.3 The forth ventricle:

The pyramid-shaped cavity filled with CSF is situated in the posterior part of the pons and the cranial part of the medulla and anterior to the cerebellum. Inferiorly, it tapers to a narrow channel that continues into the cervical region of the spinal cord as the central canal. It is lined with ependymal and is continuous superiorly with the cerebral aqueduct of the midbrain and inferiorly with the central canal of the medulla oblongata.

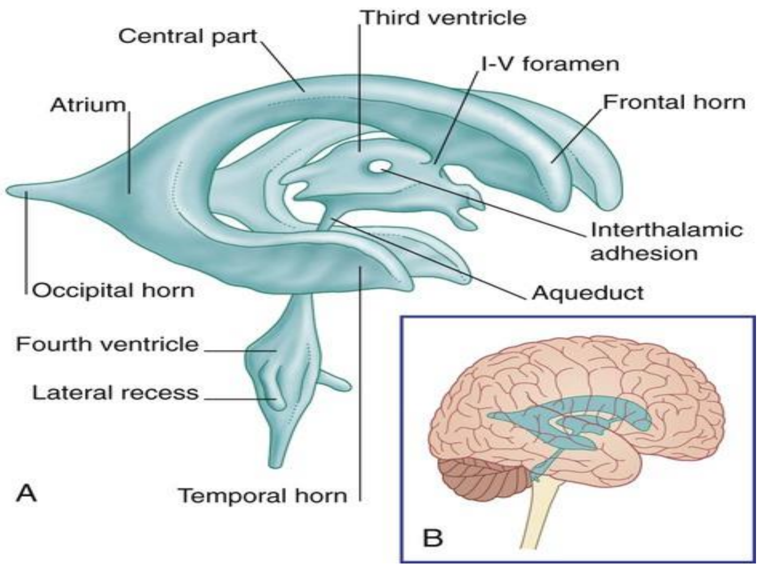
CSF drains into the subarachnoid space from the fourth ventricle through a single median aperture of Magendie and paired lateral apertures of Luschka.

These apertures are the only means by which CSF enters the subarachnoid space (Lowery and Sive, 2009). If they are blocked, CSF accumulates and the ventricles distend, producing compression of the substance of the cerebral hemispheres in conditions such as hydrocephalus.



Fig(2. 4) show 3D view of ventricles of the brain

www.sudyblue.com



Fig(2. 5) lateral view of brain ventricles

www.ScienceDirect.com

2.2 Physiology (Cerebrospinal fluid CSF):

2.2.1 Physical characteristics and composition:

CSF is a clear, colorless fluid. It posses in solution , inorganic salts to those in the blood plasma. The glucose content is about half that of blood and there is only a trace of protein. Only afew cells are present and these are lymphocytes . The normal lymphocyte count is 0-3 cells/m13. In the lateral recumbent position the cerebrospinal fluid pressure, as measured by lumber puncturing is about 60-150mm of water. Straining , coughing or compressing of the internal jugular veins in the neck may easily raise this pressure. The total volume of CSF in the subarachnoid space and within the ventricles is about 130 ml (Snell, 1997).

2.2.2 Formation and Secretion:

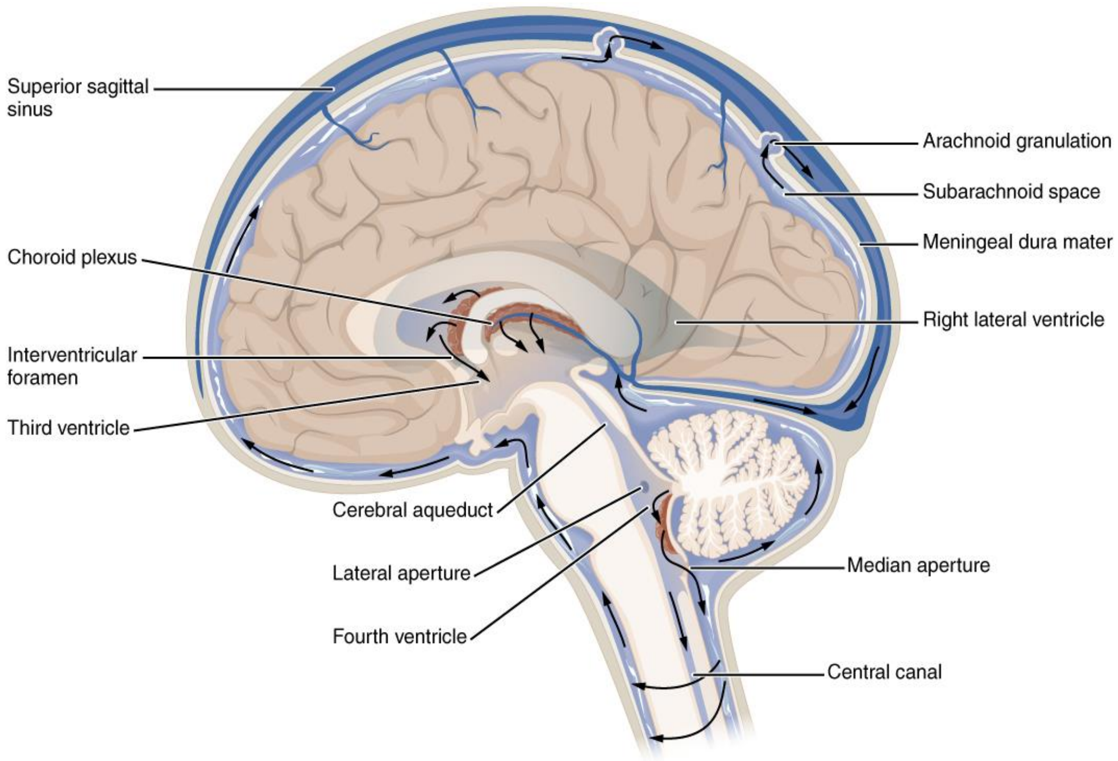
The rate of production of CSF is about 0.35 ml per minute and its volume is completely renewed 3-4 times per day. Two third or more of this fluid originates as a secretion from the choroid plexus in four ventricles. Additional amounts of fluid are secreted by all the ependymal surfaces of the ventricles and the arachniodal membranes. The secretion of fluid by choroid plexus depends mainly on active transport of sodium ions through the epithelial cells that line outsides of the plexus (Guxton,1991).

2.2.3 Circulation and Absorption:

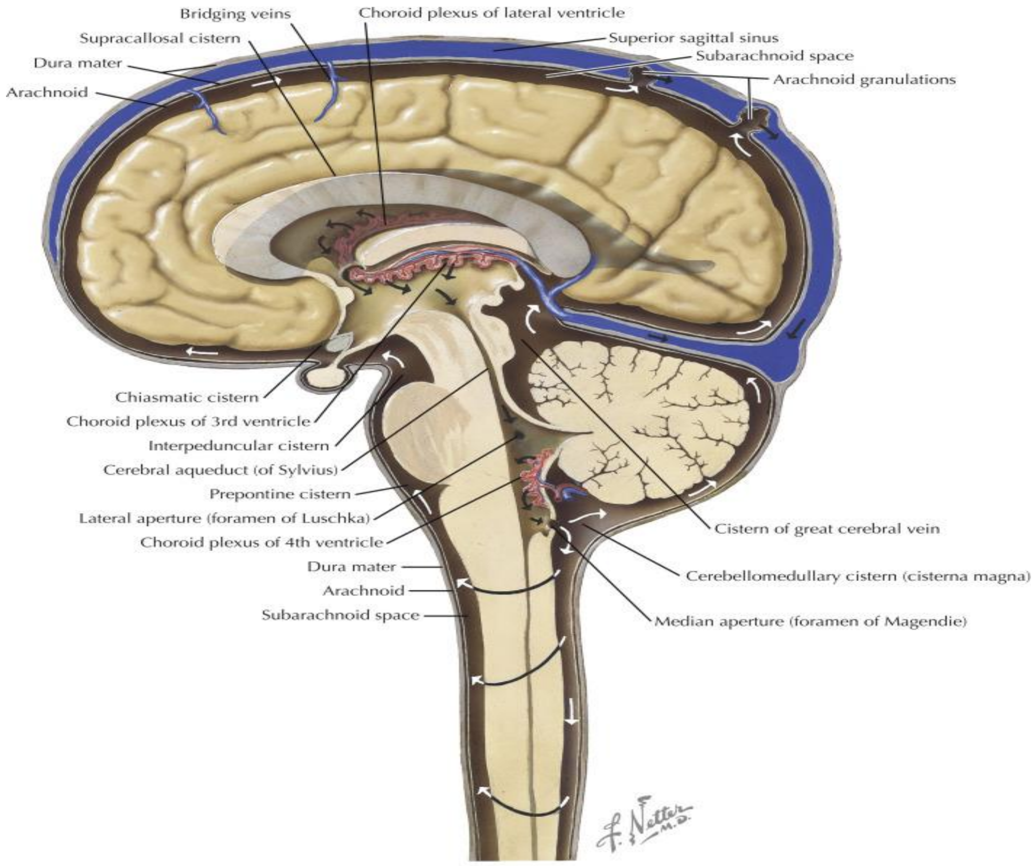
CSF leaves the lateral ventricles through interventricular foramina and enters the third ventricle, CSF passes from the 3rd ventricle to the 4th ventricle through its median and lateral apertures and enters the subarachnoid space, which is continuous around the spinal cord and posterosuperior over the cerebellum , however , part of the CSF flow into the interpeduncular and quadrigeminal cisterns, CSF from the various subarachnoid cisterns flows superiorly through the sulci and fissure on the medial and superolateral surface of the cerebral hemispheres, and also passes into extensions of the subarachnoid space system is through the arachnoid granulation specially the superior sagittal sinus and its lateral lacuae (Moore,1999).

2.2.4 Functions of Cerebrospinal fluid:

- The CNS (brain and spinal cord) is rendered buoyant by the CSF medium in which they are suspended. This provides the nervous system with support and protection against rapid movements and trauma.
- The CSF is believed to be nutritive for both neurons and glial cells.
- The CSF provides a vehicle for removing waste products for cellular metabolism from nervous system. In this capacity , it functions like a lymphatic system.
- The CSF plays a role in maintaining the constancy of the ionic composition of the local microenvironment of the cells of the nervous system. The extracellular space of the brain freely communicates with the CSF compartments and therefore the composition of the two fluid compartment is similar.
- The presence of a number of biologically active principles (releasing factors, hormones, neutrons, smatters and metabolites) within the CSF suggests that it may function as a transport system.
- The H+ and Co2 concentrations in the CSF (PH) may affect both pulmonary ventilation and cerebral blood flow.
- Since the CSF and brain extracellular space in continuity, analysis of the composition of the CSF provides diagnostic information about the normal and pathological state of the nervous system functions (www.umanitoba.ca).



Fig(2. 6) Shows CSF within the choroid plexus.



Fig(2. 7) Circulation and Absorption of the CSF

2.3 Pathology of Lateral ventricles:

Most pathology studies have shown progressive increase in ventricular size especially after 70 years of age. As the ventricular system enlarge ,the angles of the lateral ventricles become rounded the third and fourth ventricles become ballooned, and hippocampi don’t pill the temporal horn as fully as normal. More recently thesechange have been re investigated by CT and MRI scanning.

Some of these radiologic studies have identified may elderly individuals who did not exhibit the expected degree of cortical atrophy or ventriclular enlargement. It was concluded from these findings that ventricular enlargement and cortical atrophy are not inevitable consequences of advancing age alone but may indicate abnormal aging (Riggs,1998).

When pneumoenphalogramorventriculogram is analyzed , the following are assessed:

Enlargement:(generalized, as in communication hydrocephalus or global as in cerebral atrophy, localized, due to local cerebral atrophy and involving one ventricle only due to focal atrophy or obstruction at the interventricular foramen and probably also hernition , as caused by a tumor),dislocation of the midline structures or of various portions of the system, filling defect and deformity(Grainger,1986).

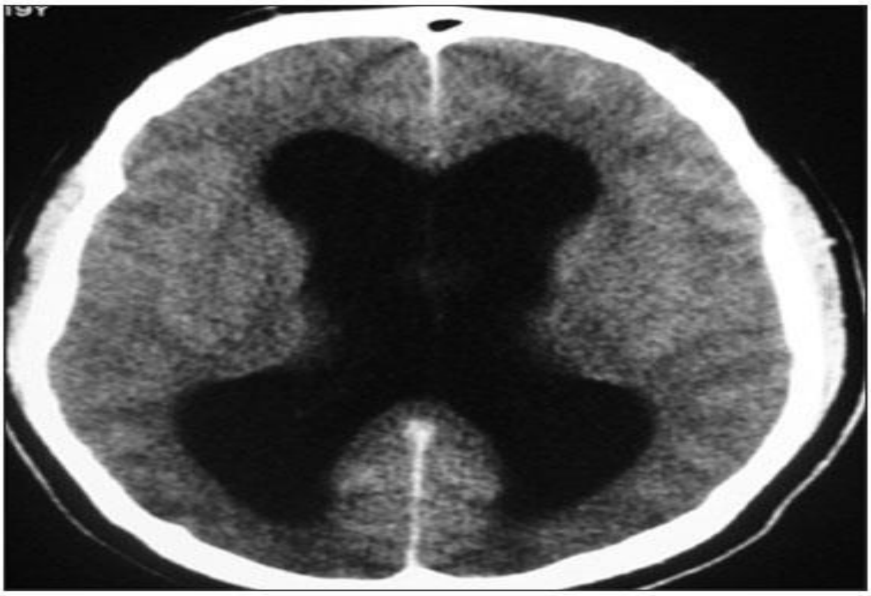
2.3.1 Hydrocephalus:

Congenital hydrocephalus in infants and young children may be classified, like adult hydrocephalusas communicating and non-communicating. In the former there is free communication betweenthe ventricles and the basal cisterns, with obstruction to the flow of the CSF in the subarachnoid space or basal cistrens. This is due to meningeal irritation by hemorrhage, infection or trauma. All the ventricles are enlarged and basal cisterns may be prominent (Sutton,1998).

Fig(2. 8) CT scan Shows hydrocephalus

2.3.2Cerebral atrophy:

Generalized atrophy of the brain is a routine concomitant of the aging process and is a normal finding in the elderly, increasing with age. The loss of natural tissue in the senile brain occurs in a cranium of unchanged size and is therefore compensated by an increase in the volume of CSF, which occupies the resulting enlarged ventricles, sulic and subarachnoid space (Rewcastle,1999.



Fig(2. 9) CT scan shows cerebral atrophy.

2.3.3Vascular disease:

Under normal circumstances, the brain receives 15% of the cardiac output and utilizes roughly 20% of the oxygen consumed by the body . Interruption of normal blood flow to the brain and spinal cord may produce irreversible parenchymal injury within a very brief time. Hence, the brain is exquisitely sensitive to changes in cerebral blood flow and is capable of regulating the flow of blood over a wide range of perfusion pressure, a process termed auto regulation.

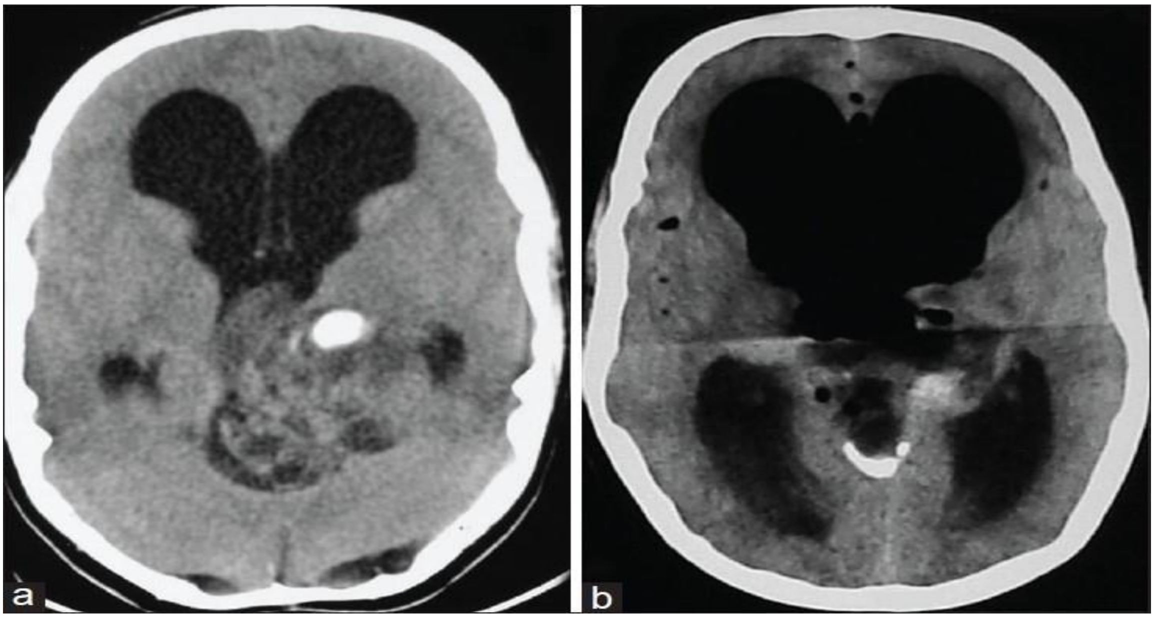
Although the incidence of cerebrovascular disease has decreased in recent decades, vascular insults remain the third most common cause of death in United State, exceeded only by heart disease and cancer (Sutton,1998).

2.3.4 Trauma:

Cranial trauma is a major problem in accident and emergency departments and in one series study provided 10% of patients seen. It is not necessary for every patient who suffers a head injury undergo a CT scan. In the acute phase, the indications are deterioration of the patient's conscious level, with or without focal neurological sings (Graham,1999)

2.3.5 Neoplasm:

Cerebral tumors account for 2% of death at all ages. The majority are metastasis tumors from malignancies outside the nervous system. Benign or malignant neoplasm of the central nervous tissue account for the remainder of cerebral tumors. Intracranial tumors are often associated with hydrocephalus and evidence of increased intracranial pressure, resulting with enlarged ventricles, sulci and subarachnoid space (Chlivers, 1991).



Fig(2. 10) CT scan shows the neoplasm of brain

2.3.6 Schizophrenia:

In vivo, brain have demonstrated ventricular enlargement in brain of schizophrenia patients. Enlargement was shown in the studies of (lllowskyet;1998, Nasraallah, 1986). While others did not see any enlargement (Kemali,1989, Wood,1990). They related this discrepancy in finding to methodology differences between various studies. In lateral ventricular subdivision of male patients, the most substantial volume increase was in the left temporal horn, and volume increas were observed in the bilateral anterior horns and the right body. The females patients showed similar patterns with less statistical significant (Dequardo,2003).

2.4 Computed tomography (CT) investigation

2.4.1 Definition:

Computed tomograghy (CT) is a medical imaging method employing tomography and digital geometry processing, it use constant three – dimensional image of the inside of an object from a large series of two-dimensional x-ray images taken a round a single axis of rotation (Serum).

Physical Principle of CT scanning:

The primary purpose of CT is to produce a tow-dimensional representation of the linear x-ray attenuation coefficient distribution through a narrow planner cross section of the human body. The resultant image delineates various structures within the body , showing the relative anatomic relationship (Gasmo,1992).

2.4.2 Physical Principle of CT scanning:

The physical principle of the CT includes the three processes referred to as :
Data acquisition.
Data processing.
Image display (Gasmo, 1992).

2.4.2.1 Data acquisition:

Refer to systemic collection of information from the patient to produce the CT image.
The two method of data acquisition are slice-by-slice data acquisition and volume data acquisition (Gasmo,1992).
In conventional slice-by-slice data acquisition , data are collected through different beam geometries to scan the patient. Essentially , the x-ray tube rotates round the patient and collects data from the first slice. The tube stops and the patient moves into position to scan next slice. This process continues until all slices have been individually scanned(Gasmo,1992).
In volume data acquisition , special beam geometry referred to as spiral or helical geometry is used to scan a volume of tissue rather than one slice at a time. In spiral or helical CT , the x-ray tube rotates around the patient and traces a spiral/ helical path scan an entire volume tissue while the patient holds a single breath. This method generates a single slice per one revolution of the x-ray tube . More recently , multi-slice spiral / helical CT has become available for faster imaging patients. It generates multiple slices per one revolution of the x-ray tube (Gasmo, 1992).

2.4.2.2 Data processing:

Essentially constitutes the mathematical principles involved in CT. Data processing is a three-step process. First , the raw data undergo some form of pre-processing, in which corrections are made and some reformatting of data occurs (Gasmo,1992).

This is necessary to facilitate the next step in data processing, image reconstruction. In this step , the scan data , which represent attenuation readings converted into a digital image characterized by CT number. The final step is image storage of the reconstructed digital image. This image is held in a disk memory is a short-term storage(Gasmo,1992).

Image display:

It is final process . After the CT image has been reconstructed, it exits the computer in digital form. The must be converted to a form that is suitable for viewing and meaningful to the observer. In CT the digital reconstructed image is converted into a gray scale image for interpretation by the radiologist. Because a diagnosis is made from this image, it is important to present this image in a way that facilitates diagnosis (Gasmo1992).

2.4.2.3 Display devise:

The gray scale image is display on a cathode ray tube (CRT), or television monitor, which is an essential component of the control or viewing console.

In some scanner there are two monitors, one for text information and one for images(Gasmo,1992).

The instrumentation: a modern CT facility consists of :

A scanning gantry that includes the collimated x-ray source, the detectors, the computer for data acquisition, the image reconstruction system, Motorized patient – handling table and the CT viewing console.

The major technical difference between various commercial scanner lies in the gantry design and the number and type of x-ray detectors used (Gasmo, 1992).

The Advantages of CT:

- CT has capacity to image material ranging from air to metal.
- CT is used as a guide in taking biopsy of the lesion demonstrated by other imaging technique.
- CT images has high contrast resolution which can easily demonstrate the brain tissue and the ventricular system and any other brain lesion (Gasmo1992).

The disadvantages of CT:

Long exposure time.

The x-ray has serious effects in early pregnancy

It is less available(Gasmo1992).

2.5 Measurement of lateral ventricles (Previous studies):

There are many studies have been dose in this case:

Gyldensted G.(1977) studied the measurements of the normal brain ventricular system and hemispheric sulci of 100 adults with CT. The left lateral ventricle was found larger than the right in both sexes and both lateral ventricles are larger in male. There are statistically significant increases of all cerebral parameters with age, and the cella media index showed a correspondingly small decrease with age. The linear measurements of lateral ventricles demonstrated positive correlation to cranial size, while the width of the third ventricle and hemispheric sulci were independent of the size of the skull(Gyldensted,1977).

Stephen A et al : (2005), were studies the changes in the size of the normal lateral ventricles during aging determined by computerized tomography , one hundred thirty – five normal volunteers were examined and their ventricular size was measured by planimetry. A pattern of change in ventricular size from the first through the ninth decades was discerned and quantified. A gradually progressive increase in ventricular size from the first through sixth decades was followed by a dramatic increase in eighth and ninth . The range of normal ventricular size wasrelatively wider in the eighth and ninth decades than in the first seven; thus , abnormalities of ventricular size may be more easily identified in younger than older subjects. These data are more valuable than those from pneumocephalography or autopsy studies because CT is not subject to the artifact inherent in the procedures(Stephen2005).

Amani A. in (2003) reported that measurement of different part of the lateral ventricles in Sudanese were 26mm for anterior horn and 44mm in body in both (CT and MRI) the posterior horn was 44mm in CT imaging while it was 25mm in MRI imaging. Inferior horn was 31 mm in (MRI), also she found that the different parts of the lateral ventricles were found to be larger in males than females, the size of anterior horn and bodies of lateral ventricles significant correlation with age, body weight, and length, the size of posterior and inferior horns of lateral ventricles has so no significant variation in relation to age, body weight and length, horizontal CT scan such show cuts the full extensions of posterior horn in the occipital to better than horizontal MRI scan(Amani,2003).

D,Souza E et al (2007), studies on the ventricular system of brain by computerized tomography. 1000 pts were examined for the various morphmetric measurement of the ventricles of brain and it was observed that the anterioposterior extent of the lateral ventricles (inclusive of their frontal horns) on the right side was 6.96 +0.76cms males and 6.57 + 0,75 cms in females and on the left side was 7.09 +0 .78 cm in males and 6.73 + 0.77 cms in females; the anteroposterior extent of the frontal horns on the right side was 2.74 + 0.36 cms in males and 2.55 + 0.33 cms in females and on the left side 2.78 + 0.37 cms in males and 2.58 + 0.35 in females (Souza,2007).

M.Gameraddin et al (2014), Studies on the morphometric analysis of the brain ventricles in normal subjects , 152 pts were examined of fourth , third and lateral ventricles. It was observed that The anteroposterior extent of the body of the lateral ventricles on the right side was (74.89 + 9.86 mm) and (70.06 + 8.83 mm) in males and females , and on the left side (74.89 + 9.89 mm) and (69.56 +11.42 mm) in males and females respectively . It was also observed that mean length of the right frontal horns (28.53+ 3.88 mm) and (26.16 + 4.21mm) in males and females and on the left side (28.53 + 3.88 mm) and (26.17 + 4.237 mm)in males and females respectively (Gameraddin,2014).

Chapter Three

Materials and Methods

Methodology

3.1 Materials:

This study was carried out using CT scan of126 slice in the period from September 2019 – November 2019.). Done in Sudanese males and females patients who presented to the clinical department of the Computed Tomography (CT) in two hospital in Khartoum city of Sudan in AL-Ribat Teaching Hospital and Sharq Alneel hospital.

Data was collected through Questionnaire and patients interviewing system prior to imaging; where personal demographic notes; age, sex, and weight and collected randomly according to our inclusion criteria, and statistical analysis was performed using Statistical Package for Social Sciences (SPSS).

3.1.1 Population:

This study will include male and female with normal Ventricular size their age ranged between 10-90 years. Patients were excluded only when the pathologic process affected, or theoretically could affect, the Ventricular System (e.g., hydrocephalus or tumor) and when the entire Ventricular System was not on a single slice as a consequence of an oblique imaging plane.

3.1.2 Sample size and type:

A convenient sample type will be adapted, where a total 50 patient (25 male, 25 female) present for Brain CT scan will be included in the study.

3.1.3 Machine:

TOSHIPA CT scanner in Sharq Alneel Hospital and

NEOSFT CT scanner in Ribat University Hospital.

3.2 Method of data collection:

Fig (3.1) CT machine scanner

3.2.1 Techniques:

3.2.1.1 Patient preparation:

The technician explained procedure to the patient briefly before examination .All metallic objects were removed from the area under examination, including such items as earrings, hair pins and necklaces.

If the patient was comfortable on the table, the result was less motion and therefore less degradation of image quality.

3.2.1.2 Patient Position:

- Patient should be supine, head first into the gantry, with the head in the head-holder whenever possible.
- Center the table height such that the external auditory meatus (EAM) is at the center of the gantry.

3.2.1.3 Scan Range:

Top of C1 lamina through top of calvarium.

3.2.1.4 Scanning protocol:

Scanning protocol was established to include information such as pt position, pre-scan localization (scout view), scan range, slice thickness, spacing and MA values. This was intended to assist the technologist performed the CT examination and generally helped increase the efficiency of the examination.

The axial plane used for brain imaging . The plane of the scans was based on the anthropologic baseline, which joins the infraorbital point anteriorly to the posterior border of the external auditory meatus (EAM), better cross-sectional images of the orbits, cellaturica temporal lobes, ventricular system and brain stem were obtained than a more steeply angled plane. Slice thickness of 10 mm was used , although often many site used 2-1 mm slice to improve spatial resolution.

3.3 Method of measurement on CT image:

Standard CT examination of the head consists of a series of tomographic sections 10mm in thickness, at 10mm intervals from skull base to vertex. The orbitomeatal line is commonly used as the base line ,but sections may angled in either direction, views with increased extension may be preferred for examination of the posterior fossa since if the chin is extended, the beam will not pass through the orbit , thereby reducing radiation does to the eyes. The techniques used for measuring the head was the adopted by Grainger and Allison (Rewcaste199).Most adult's heads can be covered in 10 to 20 sections. The patient was placed on the CT table and the head was centralized and supported for correct alignment and to reduce blurring of images.

A lateral image was taken to confirm correct position of patient. The lateral ventricles on CT are seen three or four contiguous slices; the highest tomogram to pass clearly through them contains the superior segments of the cellaemediae, with the corpus callosum in between; the superior segments of trigones and occipital horns may be also seen; the next descending contiguous tomogram incorporates the frontal horns anteriorly and occipital horns posteriorly whereas the temporal horns cannot be identified with certainty and their clear delineation implies that they are dilated

Chapter Four
Results

The Results

Statistical Methods:comparative analytical method was used, using SPSS statistical program based on descriptive statistics and comparative associational hypothesis tests (0.05 sig. level), to evaluate the mean lateral ventricles of the brain in Sudanese adults and to demonstrate the differences in mean size (head and body) with respect to (gender, weight and age).

The student-t test and F test were usedto study the hypothesis.

Table (4. 1) Participants distribution with respect gender:

Gender	Frequency	Percent
Male	33	58.9
Female	23	41.1
Total	**56**	**100.0**

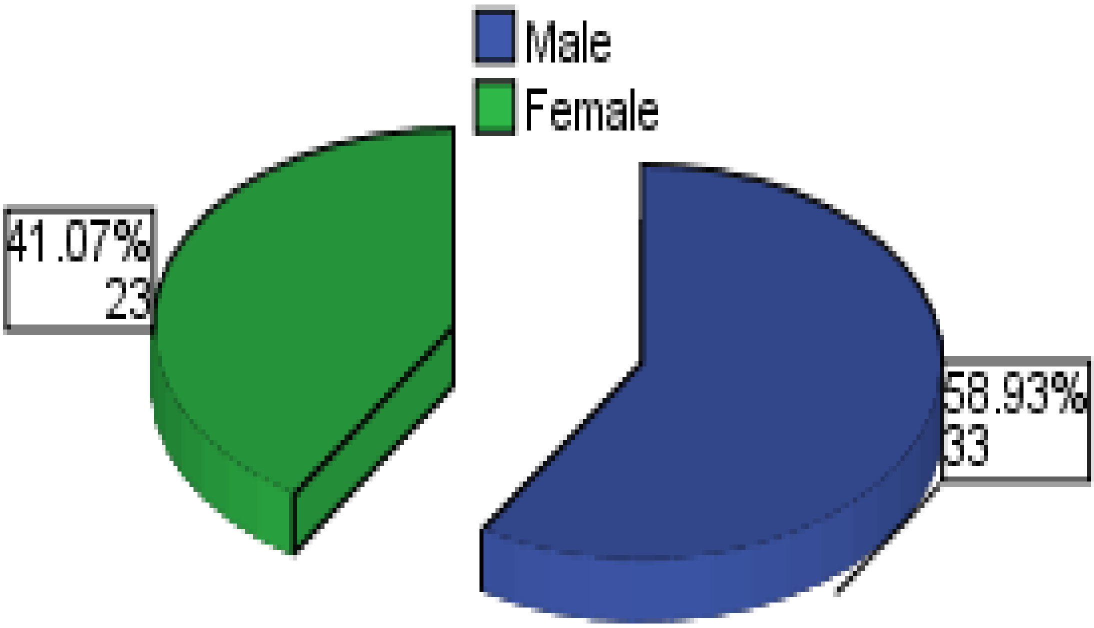


Fig (4. 1) distribution of participants according to gender

Table (4.1) and figure (4.1) show that most (58.9%) of participants are males, while (41.1%) of them are females.

Table (4. 2) Participants distribution with respect to age:

Age	**Frequency**	**Percent**
20-30 years	28	50.0
31-40 years	2	3.6
41-50 years	9	16.1
51-60 years	7	12.5
More than 60 years	10	17.9
Total	**56**	**100.0**

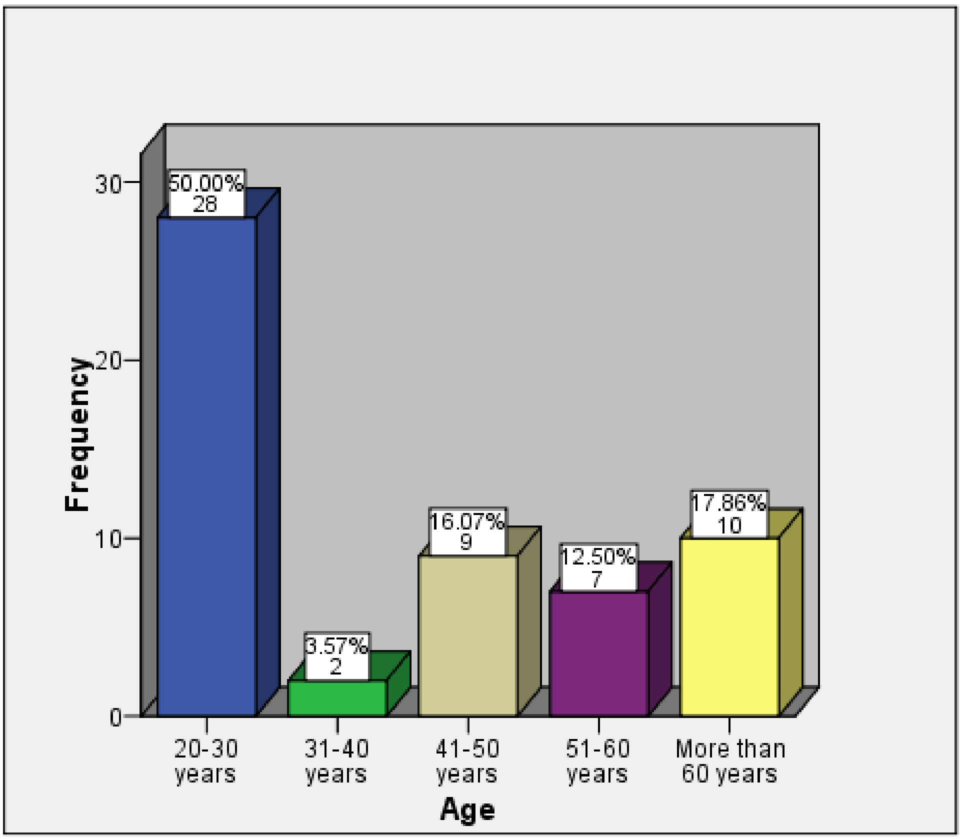


Fig (4. 2) Participants distribution with respect to age

Table (4.2) and figure (4.2) show that most (50%) of participants were (20-30) years old,since (3.6%) of them were 31-40 years, (16.1%) of them 41-50 years and (12,5%) of them were 51-60 years old, whereasonly (17.9%) were more than 60 years old.

Table (4. 3) Descriptive statistics for lateral ventricles of the brain**:**

	Minimum	Maximum	Mean	Std. Deviation
Right anterior head	22.8	35.2	30.521	3.0509
Left anterior head	20.1	38.4	31.588	3.6223
Right posterior head	26.8	53.1	36.200	5.3188
Left posterior head	10.3	55.0	36.623	7.0786
Right body of lateral ventricles	59.7	96.9	75.086	7.3683
Left body of lateral ventricles	60.4	97.8	76.470	8.0919

Table (4.3) shows that a total of (56) adult Sudanese were selected, whom present (22.8-35.2 mm with 30.521±3.051 mm mean of right anterior head), (21.1-38.4 mm with 31.588±3.622 mm mean of left anterior head), (26.8-53.1 mm with 36.2±5.319 mm mean of right posterior head), (10.3-55 mm with 36.623±7.079 mm mean of left posterior head), (59.7-96.9 mm with 75.086±7.368 mm mean right body of lateral ventricles).and (60.4-97.8 mm with 76.47±8.092 mm mean left body of lateral ventricles).

Table (4. 4) Mean lateral ventricles of the brain with respect to gender**:**

	Gender	N	Mean	Std. Deviation	Std. Error Mean
Right anterior head	Male	33	30.882	2.8320	0.4930
	Female	23	30.004	3.3362	0.6957
Left anterior head	Male	33	31.955	3.4318	0.5974
	Female	23	31.061	3.8962	0.8124
Right posterior head	Male	33	37.376	5.2864	0.9202
	Female	23	34.513	5.0028	1.0431
Left posterior head	Male	33	37.364	7.8791	1.3716
	Female	23	35.561	5.7417	1.1972
Right body of lateral ventricles	Male	33	76.158	7.3275	1.2756
	Female	23	73.548	7.3100	1.5242
Left body of lateral ventricles	Male	33	77.515	7.8657	1.3692
	Female	23	74.970	8.3493	1.7410

Table (4.4) provides useful descriptive statistics for the two groups that we compared, including the mean and standard deviation.

Table (4. 5) t-test for equality of mean lateral ventricles of the brain for males and females:

	t-test for Equality of Means				
	T	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
Right anterior head	1.060	54	0.294	0.8775	0.8278
Left anterior head	0.907	54	0.369	0.8937	0.9855
Right posterior head	2.058	49	0.054	2.8627	1.3910
Left posterior head	0.937	54	0.353	1.8028	1.9249
Right body of lateral ventricles	1.313	48	0.195	2.6097	1.9876
Left body of lateral ventricles	1.149	46	0.256	2.5456	2.2149

T-test results will tell us if the meanlateral ventricles of the brain (head, and body) for the two groups were statistically different (significantly different) or they were relatively the same.

We can see that the male and female means for (lateral ventricles of the brain), are statistically, non-significantly different because the all values of P-values in "Sig. (2-tailed) are more than 0.05. Looking at the Distributions of two groups table (4.4) above, we can conclude that there is no statistically significant difference between the lateral ventricles of the brain(head, and body) mean for males and females

Table (4. 6) Mean lateral ventricles of the brain with respect to age**:**

		N	Mean	Std. Deviation	Std. Error
Right anterior head	20-30 years	28	30.175	3.4451	.6511
	31-40 years	2	31.600	.2828	.2000
	41-50 years	9	30.600	3.2585	1.0862
	51-60 years	7	30.729	2.7115	1.0249
	More than 60 years	10	31.060	2.4364	.7705
	Total	56	30.521	3.0509	.4077
Left anterior head	20-30 years	28	31.389	3.1857	.6020
	31-40 years	2	31.300	.4243	.3000
	41-50 years	9	30.756	5.2238	1.7413
	51-60 years	7	31.814	3.6265	1.3707
	More than 60 years	10	32.790	3.7705	1.1923
Right posterior head	20-30 years	28	34.396	3.9669	.7497
	31-40 years	2	33.800	4.1012	2.9000
	41-50 years	9	34.622	3.4633	1.1544
	51-60 years	7	40.786	6.4510	2.4382
	More than 60 years	10	39.940	6.2939	1.9903
Left posterior head	20-30 years	28	34.679	6.2692	1.1848
	31-40 years	2	35.000	5.0912	3.6000
	41-50 years	9	33.878	4.3654	1.4551

	51-60 years	7	41.314	6.5999	2.4945
	More than 60 years	10	41.580	8.6682	2.7411
Right body of lateral ventricles	20-30 years	28	72.750	5.9377	1.1221
	31-40 years	2	74.850	12.9401	9.1500
	41-50 years	9	74.800	6.4971	2.1657
	51-60 years	7	81.771	8.7890	3.3219
	More than 60 years	10	77.250	7.8329	2.4770
Left body of lateral ventricles	20-30 years	28	75.079	6.7631	1.2781
	31-40 years	2	76.200	13.8593	9.8000
	41-50 years	9	73.456	8.6542	2.8847
	51-60 years	7	82.057	8.8769	3.3552
	More than 60 years	10	79.220	8.6411	2.7326

Table (4.6) provides useful descriptive statistics for the age groups that we compared, including the mean and standard deviation.

Table (4. 7) ANOVA table for difference between age groups in mean of lateral ventricles of the brain:

ANOVA						
		Sum of Squares	df	Mean Square	F	Sig.
Right anterior head	Between Groups	8.944	4	2.236	.227	.922
	Within Groups	503.011	51	9.863		
	Total	511.954	55			
Left anterior head	Between Groups	22.315	4	5.579	.407	.803
	Within Groups	699.347	51	13.713		
	Total	721.661	55			
Right posterior head	Between Groups	412.082	4	103.021	4.593	.003
	Within Groups	1143.858	51	22.429		
	Total	1555.940	55			
Left posterior head	Between Groups	578.733	4	144.683	3.389	.016
	Within Groups	2177.147	51	42.689		
	Total	2755.880	55			
Right body of lateral ventricles	Between Groups	513.334	4	128.334	2.647	.054
	Within Groups	2472.734	51	48.485		
	Total	2986.069	55			
Left body of lateral ventricles	Between Groups	430.276	4	107.569	1.730	.158
	Within Groups	3171.023	51	62.177		
	Total	3601.298	55			

Table (4.7) shows the results of (1-WayANOVA) test for differences between subjects (age groups) in mean lateral ventricles of the brainas in table (4.6). We take a look at the (Sig. value) in the last column; which determine if the different age groups were relatively have the same lateral ventricles of the brain or if they were significantly different from one another.

The Sig. value for anterior head and body of lateral ventricles (right and left) are more than 0.05, and we can conclude that the differences in for anterior heads and body of lateral ventricles with respect to age are likely due to chance and they are relatively the same for different age groups, while the differences in for posterior heads(right and left) depend on age, since the Sig. values are less than 0.05, therefore, for posterior headsare different for different age groups.

Table (4. 8) Measure of weighteffect to body of lateral ventricles of the brain:

R	R Square
0.067	0.005
0.018	0.0003

Table (4.8) provides the *R* and R^2 values. The *R* value represents the simple correlations are (0.067 and 0.018) (the "R" Column), which indicates a very weak degree of correlation between body of lateral ventricles of the brain (right and left) and weight. The R^2 value (the "R Square" column) indicates how much of the total variation in the body of lateral ventricles of the brain, can be explained by weight. In this case, only (0.005%) of variations in right body of lateral ventricles of the brain participated by weight and only (0.0003%) of variations in left body of lateral ventricles of the brain participated by weight and.

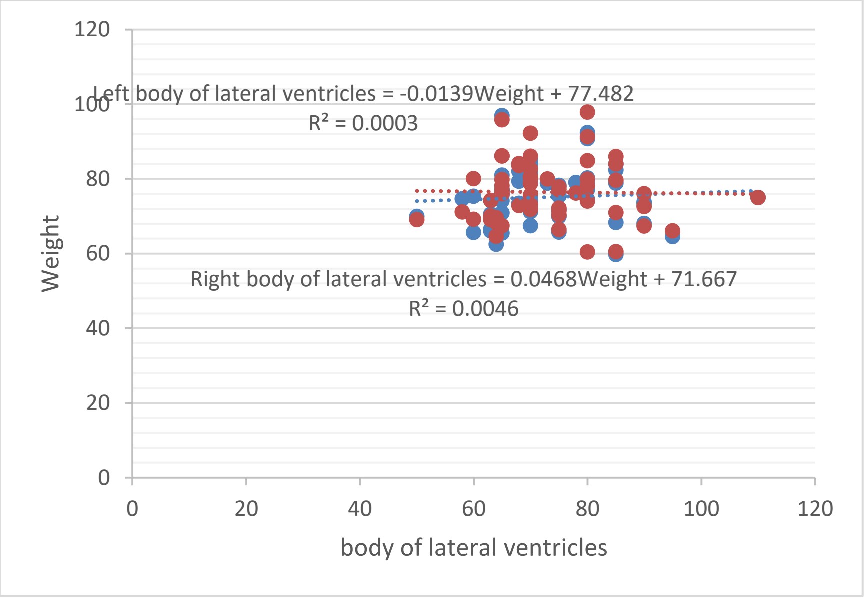


Fig (4. 3) the linear relationship between body of lateral ventricles of the brain and weight

Table (4. 9) regression model of body of lateral ventricles of the brain (right and left) on weight:

		Unstandardized Coefficients		t	Sig.
		B	Std. Error		
Right body of lateral ventricles	(Constant)	71.667	6.952	10.309	0.000
	Weight	0.047	0.094	0.497	0.621
Left body of lateral ventricles	(Constant)	77.482	7.651	10.128	0.000
	Weight	-0.014	0.104	-0.134	0.894

The Coefficients in table (4.9) provide us with the necessary information to predict body of lateral ventricles of the brainfrom weight and determine whether weight contributes significantly to the rbody of lateral ventricles of the brain("Sig." are 0.621 and 0.894 >0.05) which indicates that statistically an insignificant correlation between body of lateral ventricles of the brain and weight.

Chapter Five

The Discussion, Conclusion and Recommendations

5.1Discussion:

This study is attempting to know the measure and assess the lateral ventricles length in Sudanese population and to study the effect of the age and gender and weight on the length, and to differentiate between the normal and abnormal lateral ventricles size. This study was performed on 56 patients. The data collected for age (20-70) years old.

Table (4.3) shows that a total of (56) adult Sudanese were selected, whom present (22.8-35.2 mm with 30.521±3.051 mm mean of right anterior head), (21.1-38.4 mm with 31.588±3.622 mm mean of left anterior head), (26.8-53.1 mm with 36.2±5.319 mm mean of right posterior head), (10.3-55 mm with 36.623±7.079 mm mean of left posterior head), (59.7-96.9 mm with 75.086±7.368 mm mean right body of lateral ventricles).and (60.4-97.8 mm with 76.47±8.092 mm mean left body of lateral ventricles).

Table (4.4) provides useful descriptive statistics for the two groups that we compared, including the mean and standard deviation.

Table(4.5) T-test results will tell us if the meanlateral ventricles of the brain (head, and body) for the two groups were statistically different (significantly different) or they were relatively the same.

We can see that the male and female means for (lateral ventricles of the brain), are statistically, non-significantly different because the all values of P-values in "Sig. (2-tailed) are more than 0.05. Looking at the Distributions of two groups table (4.4) above, we can conclude that there is no statistically significant difference between the lateral ventricles of the
brain(head, and body) mean for males and females.

Table (4.6) provides useful descriptive statistics for the age groups that we compared, including the mean and standard deviation

Table (4.7) shows the results of (1-WayANOVA) test for differences between subjects (age groups) in mean lateral ventricles of the brainas in table (4.6). We take a look at the (Sig. value) in the last column; which determine if the different age groups were relatively have the same lateral ventricles of the brainor if they were significantly different from one another. The Sig. valuefor anterior head and body of lateral ventricles (right and left) are more than 0.05, and we can conclude that the differences in for anterior heads and body of lateral ventricles with respect to age are likely due to chance and they are relatively the same for different age groups, while the differences in for posterior heads(right and left) depend on age, since the Sig. values are less than 0.05, therefore, for posterior headsare different for different age groups.

Table (4.8) provides the R and R^2 values. The R value represents the simple correlations are (0.067 and 0.018) (the "R" Column), which indicates a very weak degree of correlation between body of lateral ventricles of the brain (right and left) and weight. The R^2 value (the "R Square" column) indicates how much of the total variation in the body of lateral ventricles of the brain, can be explained by weight. In this case, only (0.005%) of variations in right body of lateral ventricles of the brain participated by weight and only (0.0003%) of variations in left body of lateral ventricles of the brain participated by weight and.

Table (4.8) provides the R and R^2 values. The R value represents the simple correlations are (0.067 and 0.018) (the "R" Column), which indicates a very weak degree of correlation between body of lateral ventricles of the brain (right and left) and weight. The R^2 value (the "R Square" column) indicates how much of the total variation in the body of lateral ventricles of the brain, can be explained by weight. In this case, only (0.005%) of variations in right body of lateral ventricles of the brain participated by weight and only (0.0003%) of variations in left body of lateral ventricles of the brain participated by weight.

When compared between this study in Sudanese patients with other studies in the other community , was found the bodies of ventricles Rt&Lt in

Sudanese (7.5 , 7.7) (7.2 , 7.3) cms in males and females respectively, and in Saudis Arabia(7.4, 7.4cms) (7.0 , 6.9) cmsin males and females respectively , that is means the Sudanese have larger brain lateral ventricles than the Saudis Arabian.

And also compared with other study in India by Souza 2007 was found the right and Left bodies of lateral ventricles (6.9 , 7.1) (6.5 , 6.7) cms in males and females respectively. Comparing with study the Sudanese have lager body of lateral ventricles than Hindus.

From this results of study observe that the CT has specific ability to measurement of brain lateral ventricles

5.2 Conclusion:

The study calculated the mean of lateral ventricles of the brain in Sudanese adults is (30.521 mm mean of right anterior head), (31.588 mm mean of left anterior head), (36.2 mm mean of right posterior head), (36.62 mm mean of left posterior head), (75.086mm mean right body of lateral ventricles).and (76.47 mm mean left body of lateral ventricles).

The mean diameter of the lateral ventricles in male is (30.882 mm mean of right anterior head), (31.955 mm mean of left anterior head), (37.376 mm mean of right posterior head), (37.364 mm mean of left posterior head), (76.158mm mean right body of lateral ventricles).and (77.515 mm mean left body of lateral ventricles).

In female (30.004 mm mean of right anterior head), (31.061 mm mean of left anterior head), (34.513 mm mean of right posterior head), (35.561 mm mean of left posterior head), (73.548mm mean right body of lateral ventricles).and (74.970 mm mean left body of lateral ventricles), we can conclude that there is no statistically significant difference between the lateral ventricles of the brain (head, and body) mean for males and females. We concluded that the differences in for anterior heads and body of lateral ventricles with respect to age are likely due to chance and they are relatively the same for different age groups, while the differences in for posterior heads(right and left) depend on age, since the Sig. values are less than 0.05, therefore, for posterior heads are different for different age groups.

This study shows only (0.005%) of variations in right body of lateral ventricles of the brain participated by weight and only (0.0003%) of variations in left body of lateral ventricles of the brain participated by weight.

5.3 Recommendations:

CT device must be available in all hospital.

Reduce the cost of investigation.

Increase the efficiency of technologist by making course in CT investigation to increase the assurance.

For future research the researcher suggest doing the same study in normal lateral ventricles by using the MRI due to the fact that MRI is safe and more accurate.

Another research using large sample of patients is recommended for further assessment.

CT investigation should not be asked for routine investigation and should only be reserved the needed cases.

Follow up measurement of change of the lateral ventricles size with age from child hood could also be conducted, also can apply this study in assessment of lateral ventricles in hydrocephalus patients.

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Appendix

Data Collection Sheet

Date………………….

Patient name …………………..

Sex…............... Age…………………

Height………….. Weight…………….

Measurement of parts of brain lateral ventricles:

Part of lateral ventricle	**Rt**	**Lt**
Anterior horn		
Body of lateral ventricles		
Posterior horn		