

# CHAPTER ONE

## **1.1 Introduction:**

The human cerebral ventricular system contains a series of interconnecting spaces and channels which originates from the central lumen of embryonic neural tube. Cerebrospinal fluid filled ventricular system is an essential part of brain. The ventricular system in the cerebral hemispheres consists of two lateral ventricles; midline third and fourth ventricles connected by inter ventricular foramen and aqueduct of Sylvius respectively (Standring et al., 1995). Understanding the normal and abnormal anatomy of the ventricular system of brain is helpful for clinicians, neurosurgeons, and radiologists in day-to-day clinical practice (Srijit and Shipra, 2007).

Pneumoencephalography 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). Computerized Tomography is a revolutionary method of utilizing x-rays in the diagnosis. It is developed by Hounsfield GN, which provides images of transverse slices of brain without the use of contrast media in plain study (Gawler et al., 1976; Sabattini, 1982; Gomori et al., 1984).

## **1.2 Problem Statement:**

There is lacking evidence to date from available literature and in radiology practice of the ranges of the sizes of cerebral ventricles for the adult Sudanese since currently used reference values were drawn from other populations and races that have different epidemiological, Demographic and anatomical distribution. Radiologists are frequently faced with problems of deciding whether ventricles are within normal limits or enlarged for a patient's age.

## **1.3 Objectives:**

### **1.3.1 General Objective:**

To establish baseline reference values for the lateral, third and fourth ventricular dimensions on normal brain Computed Tomography for adult Sudanese patients, standardized for sex and age.

### **1.3.2 Specific Objectives:**

- To determine the lateral, third and fourth cerebral ventricular linear dimensions on brain computed tomography scan.
- 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)

## CHAPTER TWO

### Literature Review

#### 2.1 Theoretical back ground:

##### 2.1.1 Anatomy:

The brain consist of three main parts the cerebrum, the cerebellum, and the brain stem. The cerebrum consists of two cerebral hemispheres connected by a bundle of nerve fibers, the corpus callosum. The largest and most visible part of the brain, the cerebrum, appears as folded ridges and grooves, called convolutions. The following terms are used to describe the convolutions a gyrus is an elevated ridge, a sulcus is a shallow groove, and a fissure is a deep groove. The deeper fissures divided the cerebrum into five lobes (Figure 2.1) most lobes are named after bordering skull bones: the frontal lobe, the parietal lobe, the temporal lobe, the occipital lobe, and the insula. All but the insula are visible from the outside surface of the brain. The cerebral cortex is a thin outer layer of gray matter.

The cerebral white matter underlies the cerebral cortex. It contains mostly myelinated axons that connect cerebral hemispheres (association fibers), connect gyri within hemispheres (commissural fibers), or connect the cerebrum to the spinal cord (projection fibers). The corpus callosum is a major assemblage of association fibers that forms a nerve tract that connects the two cerebral hemispheres. (M.R.E Dean, 1990)

Basal ganglia are several pockets of gray matter located deep inside the cerebral white matter. The major regions in the basal ganglia—the caudate nuclei, the putamen, and the globuspallidus—are involved in relaying and modifying nerveimpulses passing from the cerebral cortex to the spinal cord. The brainstem connects the diencephalon to the spinal

cord. The brainstem resembles the spinal cord in that both consist of white matter fiber tracts surrounding a core of gray matter. The brainstem consists of the following four regions, all of which provide connections between various parts of the brain and between the brain and the spinal cord structures of the brainstem are Midbrain, uppermost part of the brainstem Pons, bulging region in the middle of the brainstem, medulla oblongata, reticular formation, within the white matter of the various regions of the brainstem and certain regions of the spinal cord, diencephalon, and cerebellum. Cerebellum is located dorsal to the pons and medulla and occupies the space between the brain stem and the occipital lobes of the cerebral cortex. It is connected to the brainstem by three peduncles (Vishram Singh. 2004).

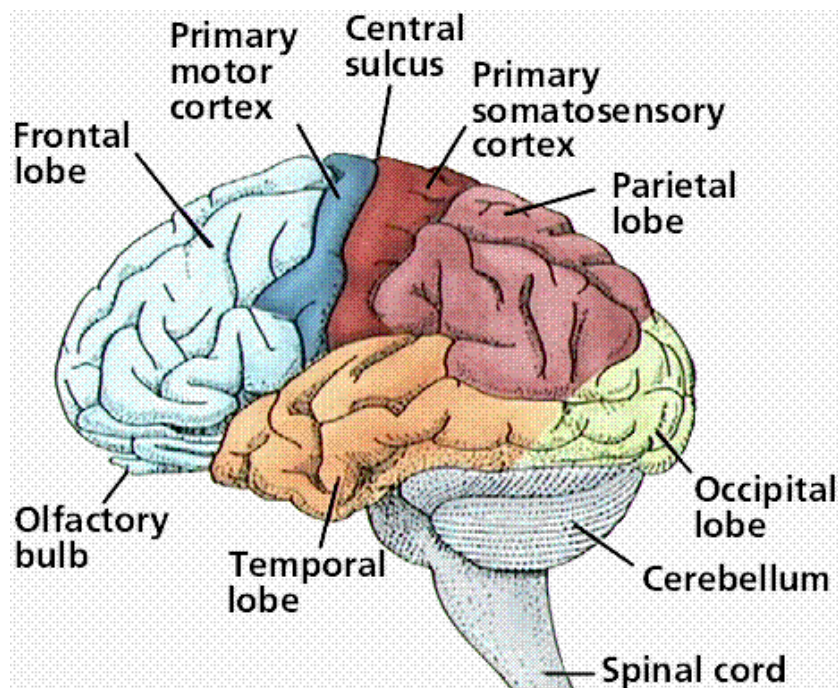


Fig 2.1 lobes of the brain ([www.brain-tumoursurgery.co.uk/brain-anatomy](http://www.brain-tumoursurgery.co.uk/brain-anatomy))

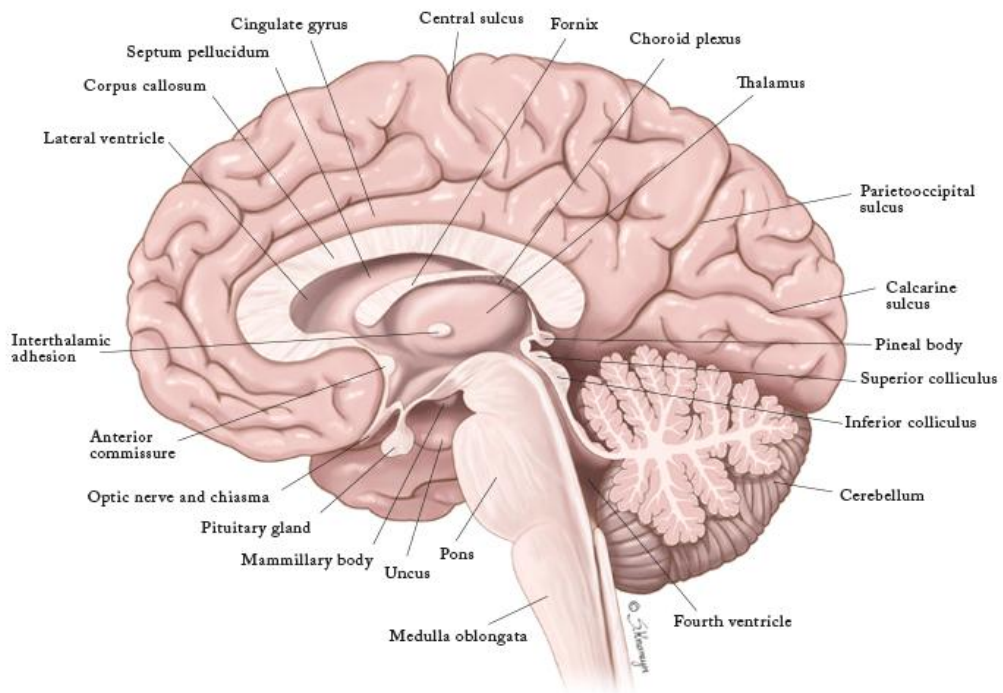


Fig 2.2 Sagittal section of the brain ([www.sigrid.knemeyer.com/portfolio/mid-section-of-the-brain/](http://www.sigrid.knemeyer.com/portfolio/mid-section-of-the-brain/))

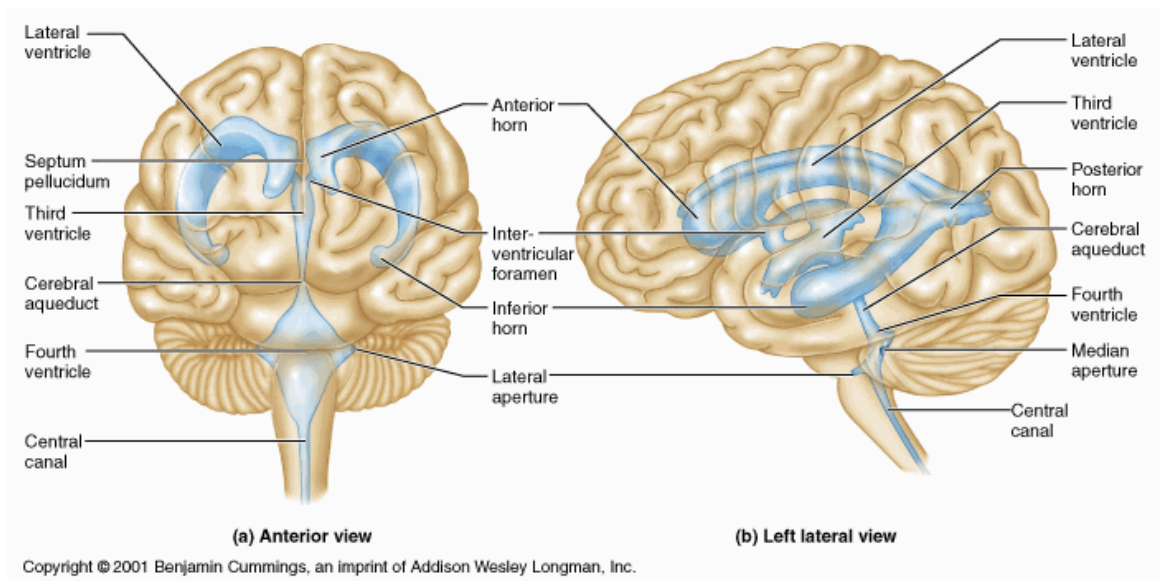


Fig 2.3 Ventricles of the brain

([www.medicallook.com/human\\_anatomy/organs/ventricles\\_and\\_cerebrospinal\\_fluid.html](http://www.medicallook.com/human_anatomy/organs/ventricles_and_cerebrospinal_fluid.html))

### **2.1.1.1 Blood supply of brain:-**

#### **A. Major Blood Vessels:-**

Normal function of the brain's control centers is dependent upon adequate supply of oxygen and nutrients through a dense network of blood vessels. Blood is supplied to the brain, face, and scalp via two major sets of vessels: the right and left common carotid arteries and the right and left vertebral arteries.

The common carotid arteries have two divisions. The external carotid arteries supply the face and scalp with blood. The internal carotid arteries supply blood to the anterior three-fifths of cerebrum, except for parts of the temporal and occipital lobes. The vertebral arteries supply the posterior two-fifths of the cerebrum, part of the cerebellum, and the brain stem (Vishram Singh, 1999).

#### **B. circle of Willis:-**

At the base of the brain, the carotid and vertebral arteries form a circle of communicating arteries known as the Circle of Willis. From this circle, other arteries—the anterior cerebral artery, the middle cerebral artery, the posterior cerebral artery—arise and travel to all parts of the brain. Posterior Inferior Cerebellar Arteries, which branch from the vertebral arteries (Vishram Singh, 1999).

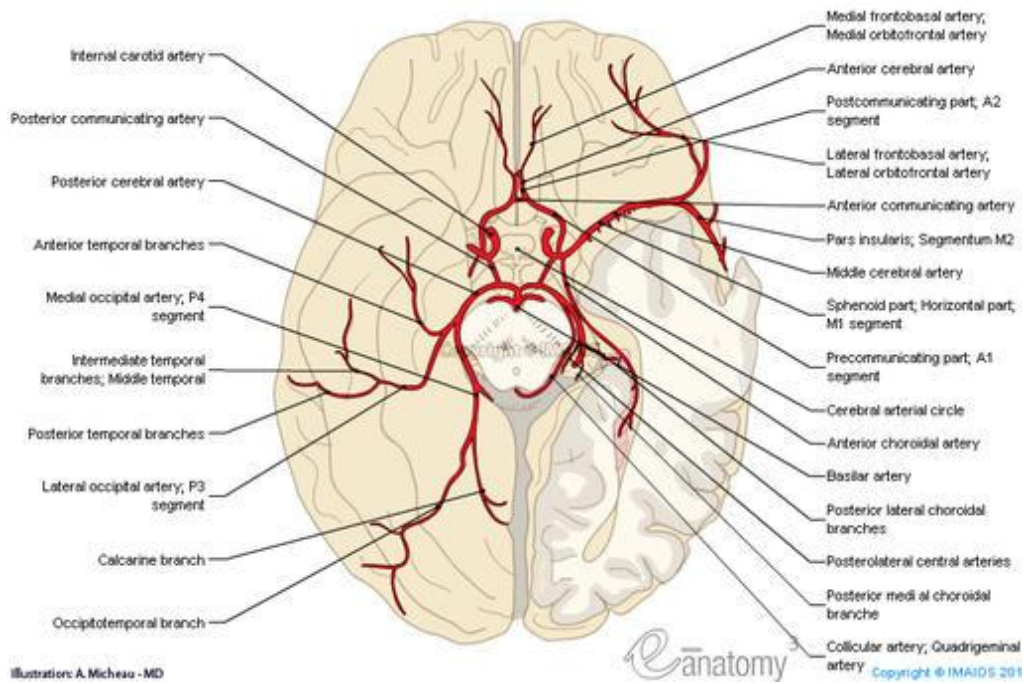


Fig 2.4 showing blood supply of the brain.

([www.csuchico.edu/~pmcaffrey//syllabi/cmsd%20320/362unit11.html](http://www.csuchico.edu/~pmcaffrey//syllabi/cmsd%20320/362unit11.html))

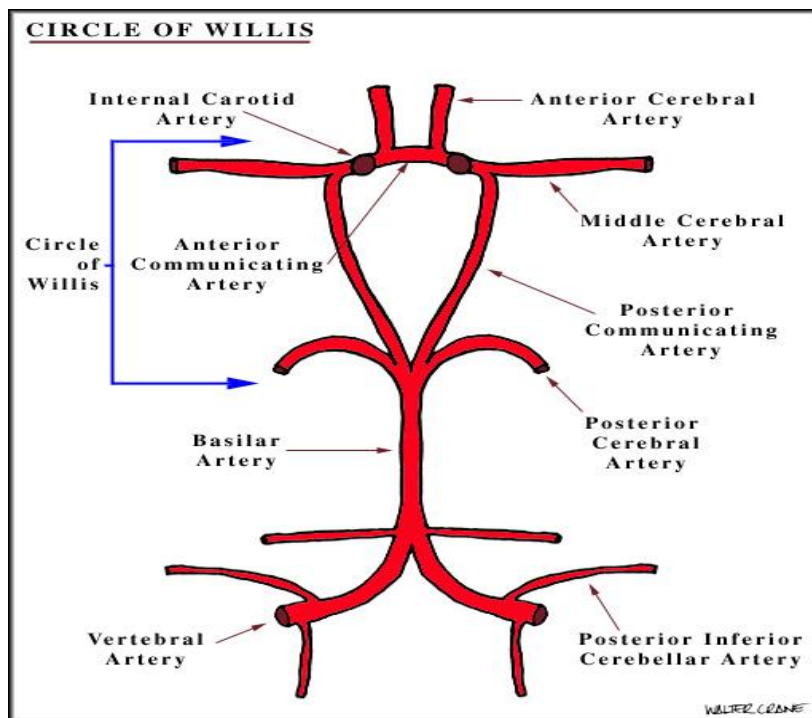


Fig 2.5 Showing circle of wills.



## 2.2 THE ANATOMY OF CEREBRAL VENTRICLES

In the adult human brain, there are four connected ventricles: two lateral ventricles within the cerebrum, a third ventricle within the diencephalon and a fourth ventricle lying between the cerebellum and the pons, shown in Fig. 2.1 below (Webber *et al.*, 1995; Lowery and Sive, 2009).

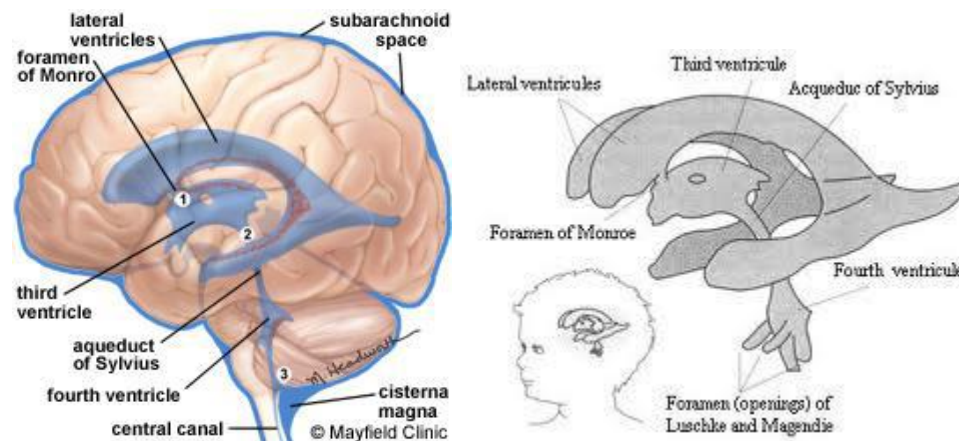


Fig. 2.6 Cerebral ventricles including relative position in the brain (source: Lowery and Sive, 2009).

The lateral ventricles, which lie within each cerebrum, are connected to the third ventricle (via interventricular foramina of Monro (labeled 1 in Figure 2.1) whilst the latter is linked to the fourth ventricle via the cerebral aqueduct of Sylvius (labeled 2 in Figure 2.1). In turn, the fourth ventricle joins to the spinal cord canal and the subarachnoid space that envelops the brain and spinal cord through foramina of central canal, Luschka and Magendie (Segev *et al.*, 2001; Pople, 2002; Lowery and Sive, 2009).

### 2.1.1 THE LATERAL VENTRICLE

The lateral ventricles, the first and second ventricles (Figure 2.1), are the largest cavities of the ventricular system and occupy large areas of the cerebral hemispheres. Each ventricle is a roughly C-shaped cavity lined with ependymal and filled with CSF. It may be divided into a body,



which occupies the parietal lobe, and from which anterior, posterior and inferior horns extend into the frontal, occipital and temporal lobes respectively. Each lateral ventricle opens through an interventricular foramen into the third ventricle (Lowery and Sive, 2009). The tips of the frontal (anterior) horn are a region of interest in the measurement of bifrontal distance.

### **2.1.2 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),

### **2.1.3 THE FOURTH 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.

## **2.2 THE CEREBRAL VENTRICULAR SYSTEM AT WORK**

The adult human brain contains about 140 ml of CSF, of which approximately 20 ml is within the ventricles and the remainder is surrounding the brain and spinal cord in the subarachnoid space (Lowery and Sive, 2009). Adult CSF is produced mainly by the choroid plexuses, highly vascular structures located within the ventricles (relative position shown by a red hue line in fig 2.1) and some CSF may be produced by the cells lining the ventricles (Segevet *al.*, 2001; Pople, 2002; Lowery and Sive, 2009).

It is now believed that CSF flows from the lateral ventricles to the third and fourth, and then out into the subarachnoid space where it is absorbed into the hematopoietic circulatory and lymphatic systems via the arachnoid granulations. Control of CSF flow is thought to originate in pressure gradient produced by secretion, arterial systolic pulsations, and changes in central nervous pressure during respiration and by beating cilia with uniform orientation located on the ependymal epithelium that lines the ventricles (Segevet *al.*, 2001; Pople, 2002; Greitz, 2004; Igbaseimokumo, 2009; Lowery and Sive, 2009). The notion of a circulatory system deep within the brain suggests functions analogous to the hematopoietic circulatory system, including the transport of nutrients and wastes, and the functions have been attributed to the adult CSF. In addition, CSF protects the adult brain from physical trauma, and recent data suggests that in both the embryo and adult brain, CSF may additionally carry signaling molecules that regulate neurogenesis and survival (Lowery and Sive, 2009).

## **2.1.1 Physiology:**

### **2.1.1.2 Physiology of brain:**

The three main components of the brain—the **cerebrum**, the **cerebellum**, and the **brainstem**—have distinct functions. The cerebrum is the largest and most developmentally advanced part of the human brain. It is responsible for several higher functions, including higher intellectual function, speech, emotion, integration of sensory stimuli of all types, initiation of the final common pathways for movement, and fine control of movement. The left hemisphere controls the majority of functions on the right side of the body; while the right hemisphere controls most of functions on the left side of the body the crossing of nerve fibers takes place in the brain stem. Thus, injury to the left cerebral hemisphere produces sensory and motor deficits on the right side, and vice versa. One hemisphere has a slightly more developed, or dominant, area in which written and spoken language is organized. (Johan .E 2006)

The cerebral cortex or gray matter contains the centers of cognition and personality and the coordination of complicated movements. The gray matter is also organized for different functions. The white matter is a network of fibers that enables regions of the brain to communicate with each other. Such activities as speech, evaluation of stimuli, conscious thinking, and control of skeletal muscles occur here. These activities are grouped into motor areas, sensory areas, and association areas. The cerebellum, the second largest area, is responsible for maintaining balance and fine control of movement and coordination. A stroke involving the cerebellum may result in a lack of coordination, clumsiness, shaking, or other muscular difficulties. The brain stem is the final pathway between cerebral structures and the spinal cord. It is responsible for a variety of automatic functions, such as control of respiration, heart

rate, and blood pressure, wakefulness, arousal and attention. (Johan .E 2006)

## **2.1.2 Pathology:**

### **2.1.2.1 Pathology of Brain**

Primary CNS neoplasms are the sixth most common tumors in adults, and lesion location, intra axial or extra axial, supratentorial or infratentorial, tumor characterization regular or irregular or calcification, homogeneous or inhomogeneous contrast enhancement and may cause mass effect, edema, and brain herniation. Neoplasms divide in primary neoplasms as Glioma, Meningiomas, schwannoma, pituitary adenoma, lymphoma and secondary as metastases, cyst and tumor like lesions. (Howard lee et al 1992)

## 2.2 Previous Studies:

**ZILUNDU PRINCE L. M.** (2012) This study found an average (Mean±SE) frontal horn diameter, third ventricle width, fourth ventricle width, fourth ventricle height, Frontal Horn ratio (A/B), and the third ventricle ratio (C/D) for the sample being  $31.8\pm0.2\text{mm}$ ,  $3.25\pm0.09\text{mm}$ ,  $10.6\pm0.1\text{mm}$ ,  $10.5\pm0.1$ ,  $0.313\pm0.002$ , and  $0.030\pm0.002$ , respectively. Except for the fourth height which was not significantly affected by age ( $p=0.515$ ), the present study showed that there was a significant difference between different age groups on all of the above measurements and ratios ( $p<0.01$ )

Ahmed, Amina Abdelbagi () .This study was carried out using CT machines in Khartoum teaching hospital and some clinical private centers, from June 2009 to December 2009The analysis shows that the mean of width of right and left lateral ventricles (at maximum posterior horn), Level of the body of right and left lateral ventricles, CT- No. of cerebrospinal fluid were  $1.0 \pm 0.2$  ,  $1.0 \pm 0.2$  ,  $1.1 \pm 0.3$  ,  $1.1 \pm 0.3$  ,  $9.4 \pm 2.8$  respectively . The correlation between the age and all parameters (the width of right and left lateral ventricles (at maximum posterior horn), the level of the body of right and left lateral ventricles and CT- No. of CSF were insignificant giving the values of 0.8 , 0.8 , 0.8 , 0.5 and 0.2 respectively. The correlation between weight and all parameters (the width of right and left lateral ventricles (at maximum posterior horn), the level of the body of right and left lateral ventricles and CT- No. of CSF were insignificant giving the values of 0.3 , 0.6 , 0.5 , 0.08 and 0.5 respectively. The correlation between the height and the width of right and left lateral ventricles (at maximum posterior horn) were significant giving the values of 0.033, 0.022 respectively, but the correlation between the height versus the level of the body of right and left lateral ventricles and CT- No. of CSF were so insignificant giving the values of 0.9, 0.9 and 0.1 respectively. The correlation between the gender and the width of right and left lateral ventricles (at maximum posterior horn), level of the body of right and left lateral ventricles, CT- No. of CSF were insignificant giving the values of 0.6 ,0.6 ,0.9 , 0.5 and 0.1 respectively. The correlation between the tribe and the width of right and left lateral ventricles (at maximum posterior horn), level of the body of right and left lateral ventricles, CT- No. of CSF were insignificant giving the values of 0.2 ,0.4 ,0.4 ,0.3 and 0.7 respectively . The correlation between the width of right lateral ventricles (at maximum posterior horn), and left lateral ventricles (at maximum posterior horn) was significant giving the values of 0.0, 0.0 respectively. The correlation between the level of the body of

right lateral ventricles and the level of the body of left lateral ventricles was significant giving the values of 0.0, 0.0 respectively. The correlation between the ratio VR/HR and (age, weight, height, gender) were insignificant giving the values of 0.6, 0.5, 0.1 and 0.8 respectively. The correlation between the ratio VL/HL and (age, weight, height, gender) were insignificant giving the values of 0.9, 0.9, 0.1 and 0.8 respectively.

## **CHAPTER THREE**

### **METHODOLOGY**

#### **1.4 Materials and Methods :**

##### **1.4.1 Materials:**

This study was carried out using CT scan of 16 slice (GE) in the period from August 2016– November 2016

##### **1.4.3 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.

##### **1.4.4 Sample size and type:**

A convenient sample type will be adapted, where a total of 80 patient (40 male, 40 female) present for Brain CT scan will be included in the study.



## **1.4.5 Method of data collection:**

### **3.1.1 Techniques:**

Patient undergo to CT department for CT brain, use the head rest with a sheet on the table, remove dentures, hair clips, hair combs, earrings, nose rings, necklaces, position the patient so their head and neck are relaxed, but without rotation in either plane, centre the field of view on the nasion in the midline, making minor adjustments for baseline tilt.

### **3.1.2 Measurement:**

Data collection sheet will be used to collect data about demographic characteristics (gender and age).

In this study various parameters of corpus callosum were measured in people at the mid-sagittal plane of magnetic resonance imaging as follows:

- High and width of **Fourth Ventricle**
- High and width of **third Ventricle**
- High and width of **lateral ventricle (anterior and posterior horn)**

#### **1.4.6 Method of data analysis:**

The data will be analyzed using Excel (scatter plots depict the relationship of the Ventricular System measurement with the age and gender) and SPSS (histogram plots with the mean, standard deviation, and normal curve superimposed as well as significant differences between the different age groups and the international measurement) under window

## Chapter Four

### Results

The following tables and figures presented the data obtained from 80 patients who were examined for axial CT Brain. The Ventricles length and width were measured. The data were analyzed using Excel program and SPSS version 22 for significance of tests. Frequency tables, means and standard deviations were presented.

**Table 4.1:** Characteristics of subjects enrolled in computed tomography imaging studies of the Ventricles:

Variables	Mean	Minimum	Maximum
Age	39.78 +/- 18.30	10	86
Fourth Ventricle Height	9.25 +/- 2.65	3.30	18.90
Fourth Ventricle Width	10.15 +/- 1.78	5.80	14.10
Third Ventricle Height	17.35 +/- 3.28	9.2	25.7
Third Ventricle Width	10.20 +/- 2.81	5.4	21.9
Anterior Horn Height	27.04 +/- 3.28	17.90	36.60
Anterior Horn Width	5.67 +/- 2.56	2	19
Posterior Horn Height	29.45 +/- 6.66	15.40	49.60
Posterior Horn Width	9.27 +/- 2.57	4.90	16.10

Values are means  $\pm$  standard deviation

**Table 4.2:** Characteristics of subjects enrolled in Magnetic Resonance Imaging studies of the Corpus Callosum according to age group:

Age Group	Fourth Ventricle Height	Fourth Ventricle Width	Third Ventricle Height	Third Ventricle Width	Anterior Horn Height	Anterior Horn Width	Posterior Horn Height	Posterior Horn Width
<b>10-30</b>	9.76 +/- 1.79	10.04 +/- 1.50	17.02 +/- 2.76	10.77 +/- 3.02	25.34 +/- 1.87	4.78 +/- 1.20	29.80 +/- 6.28	8.86 +/- 2.69
<b>31-50</b>	9.24 +/- 2.99	10.25 +/- 2.05	16.83 +/- 2.64	9.31 +/- 1.76	27.47 +/- 3.14	5.14 +/- 2.14	28.74 +/- 7.27	8.79 +/- 2.04
<b>51-70</b>	8.94 +/- 3.19	10.12 +/- 1.82	18.18 +/- 4.35	11 +/- 3.41	27.86 +/- 3.57	7.39 +/- 3.55	30.74 +/- 6.61	10.18 +/- 2.70
<b>71-90</b>	7.33 +/- 1.49	10.23 +/- 1.89	19.58 +/- 4.74	9.18 +/- 3.58	31.43 +/- 4.91	7.43 +/- 2.58	26.35 +/- 4.94	11.38 +/- 3.43

Values are means  $\pm$  standard deviation

**Table 4.3** comparison between males and females:

Variables	Age	Fourth Ventricle Height	Fourth Ventricle Width	Third Ventricle Height	Third Ventricle Width	Anterior Horn Height	Anterior Horn Width	Posterior Horn Height	Posterior Horn Width
<b>Males</b>	40.51 +/- 19.71	9.44 +/- 2.49	10.58 +/- 1.69	17.66 +/- 3.68	10.25 +/- 3.35	28.19 +/- 3.05	5.98 +/- 2.10	29.44 +/- 7.08	9.48 +/- 2.84
<b>Females</b>	39.13 +/- 17.20	9.08 +/- 2.81	9.77 +/- 1.80	17.08 +/- 2.91	10.14 +/- 2.28	26.06 +/- 3.18	5.40 +/- 2.89	29.47 +/- 6.36	9.09 +/- 2.32

Values are means  $\pm$  standard deviation

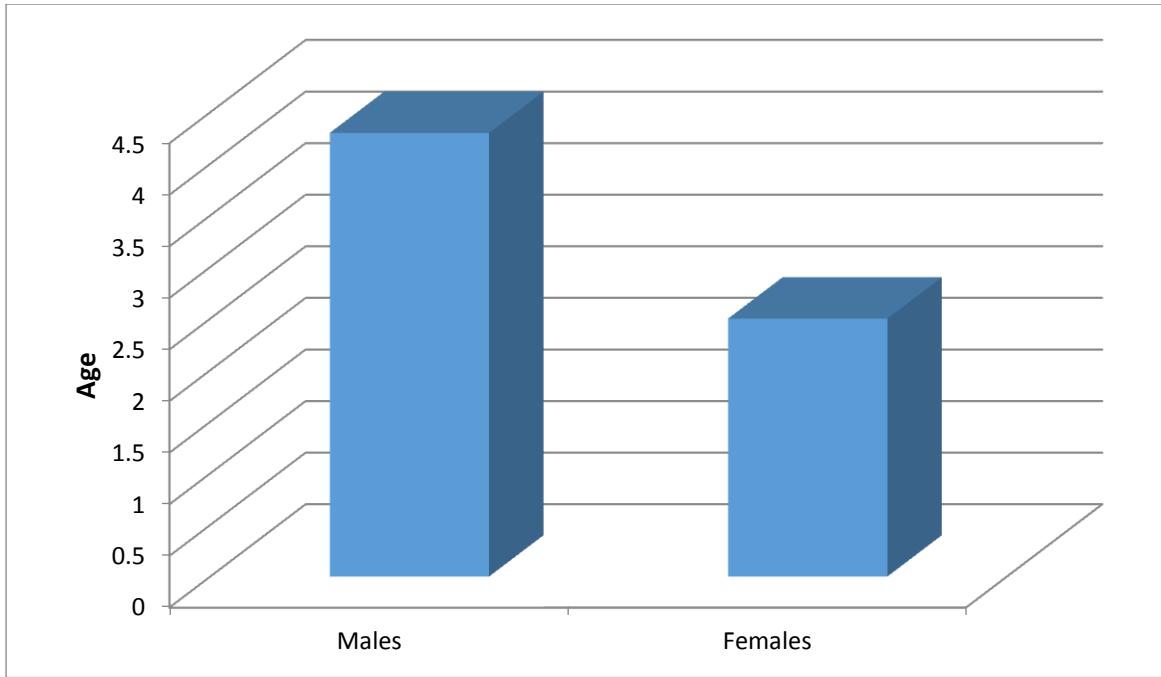


Fig 4.1: Comparison between males and females in Age.

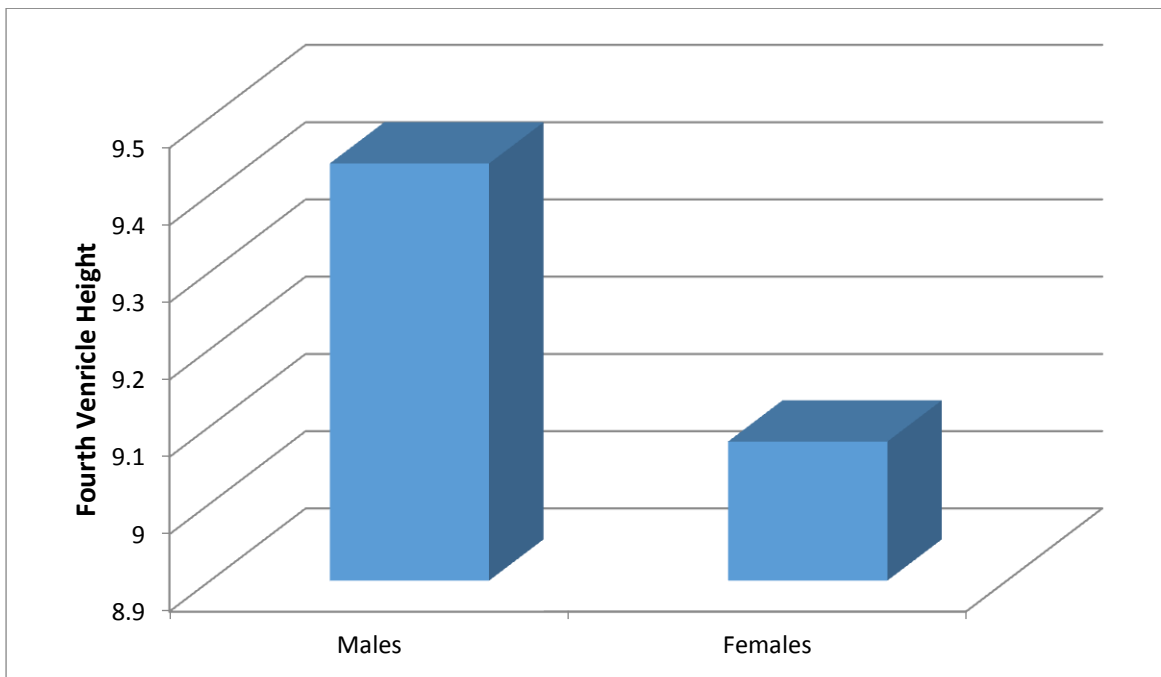


Fig 4.2: Comparison between males and females in **Fourth Ventricle Height**

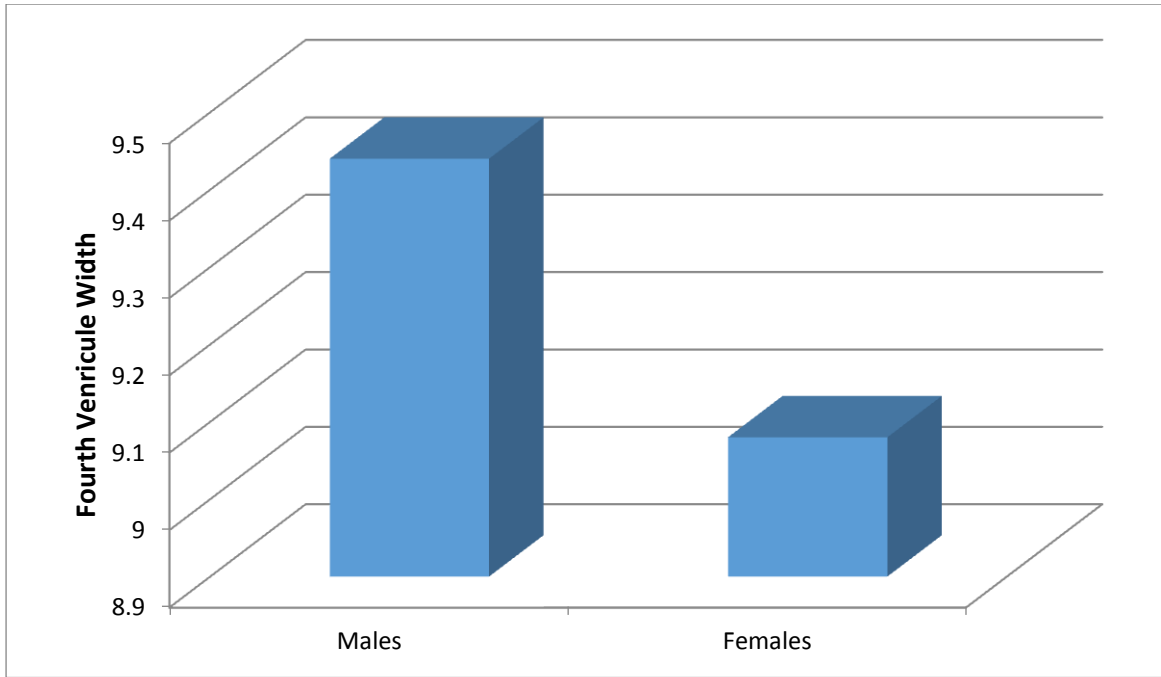


Fig 4.3: Comparison between males and females in **Fourth Ventricle Width**.

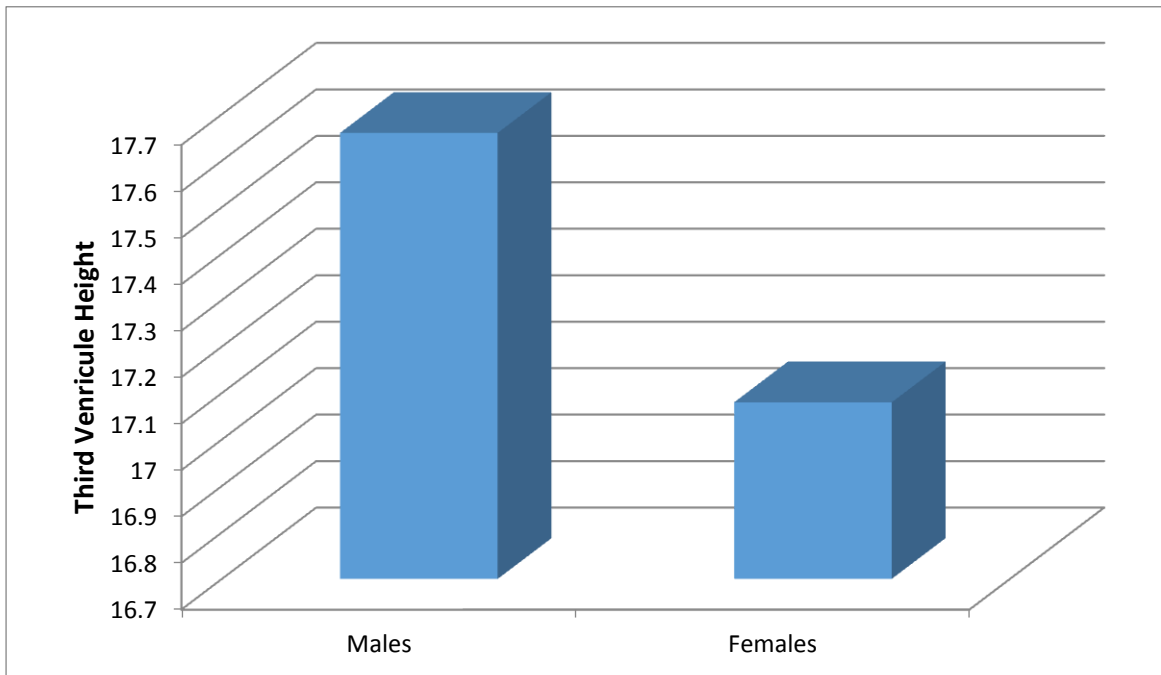


Fig 4.4: Comparison between males and females in **Third Ventricle Height**.

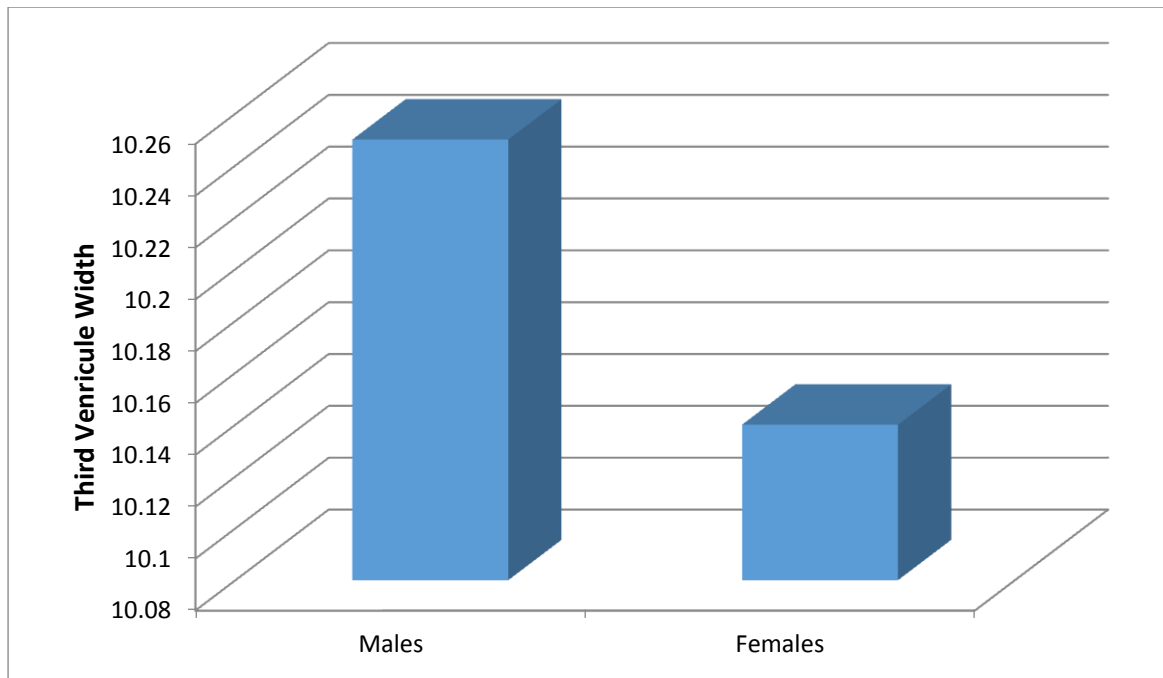


Fig 4.5: Comparison between males and females in **Third Ventricle Width**.

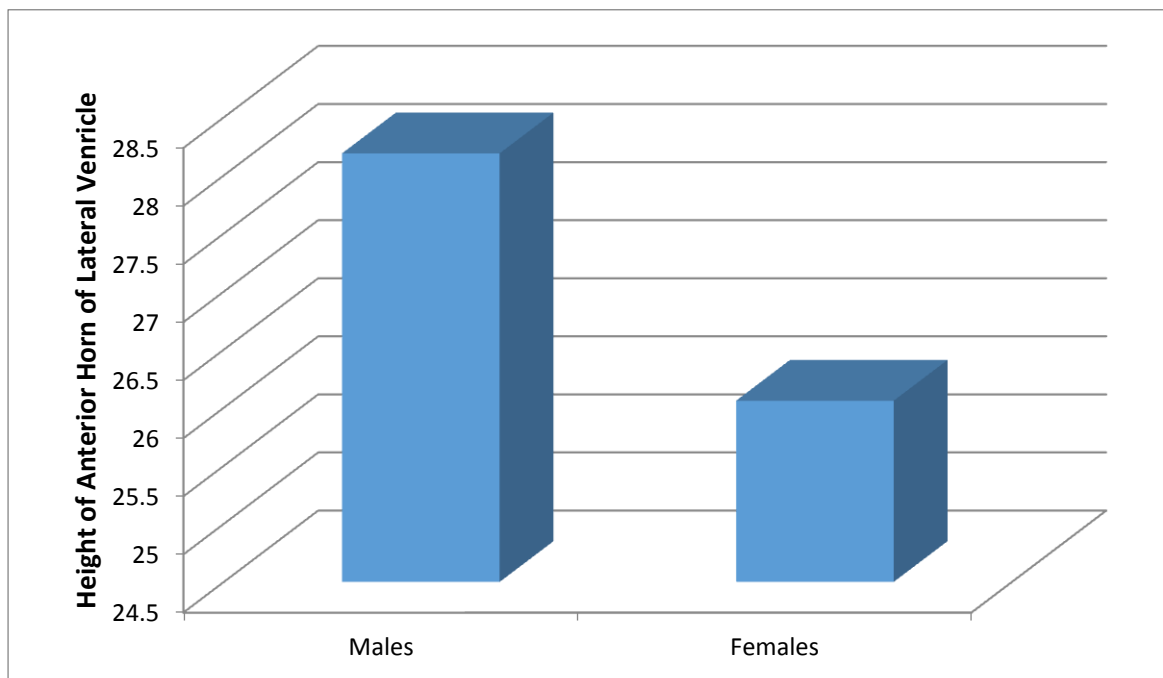


Fig 4.6: Comparison between males and females in **Height of Anterior Horn of Lateral Ventricle**



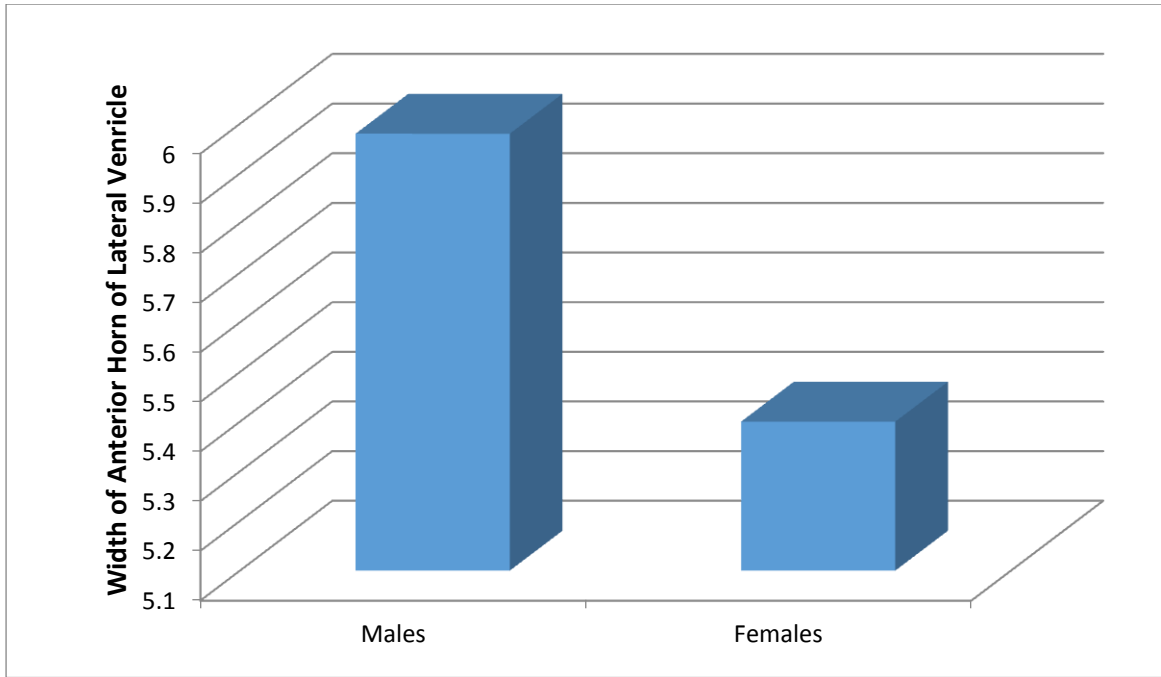


Fig 4.7: Comparison between males and females in **Width of Anterior Horn of Lateral Ventricle.**

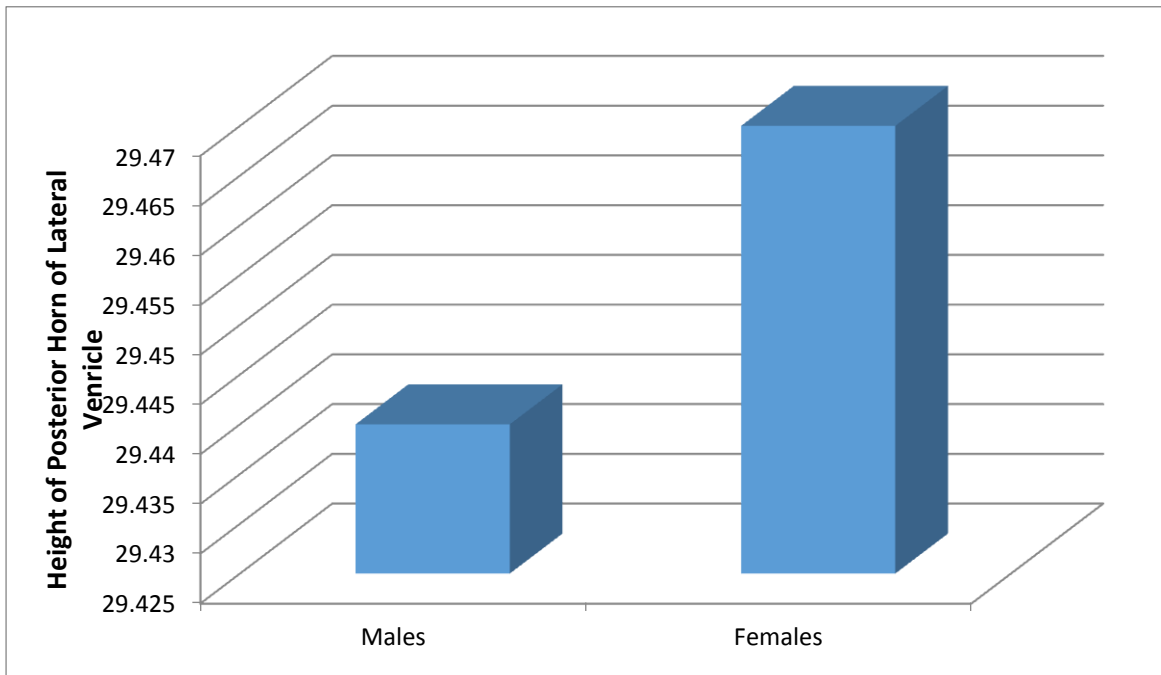


Fig 4.8: Comparison between males and females in **Height of Posterior Horn of Lateral Ventricle.**

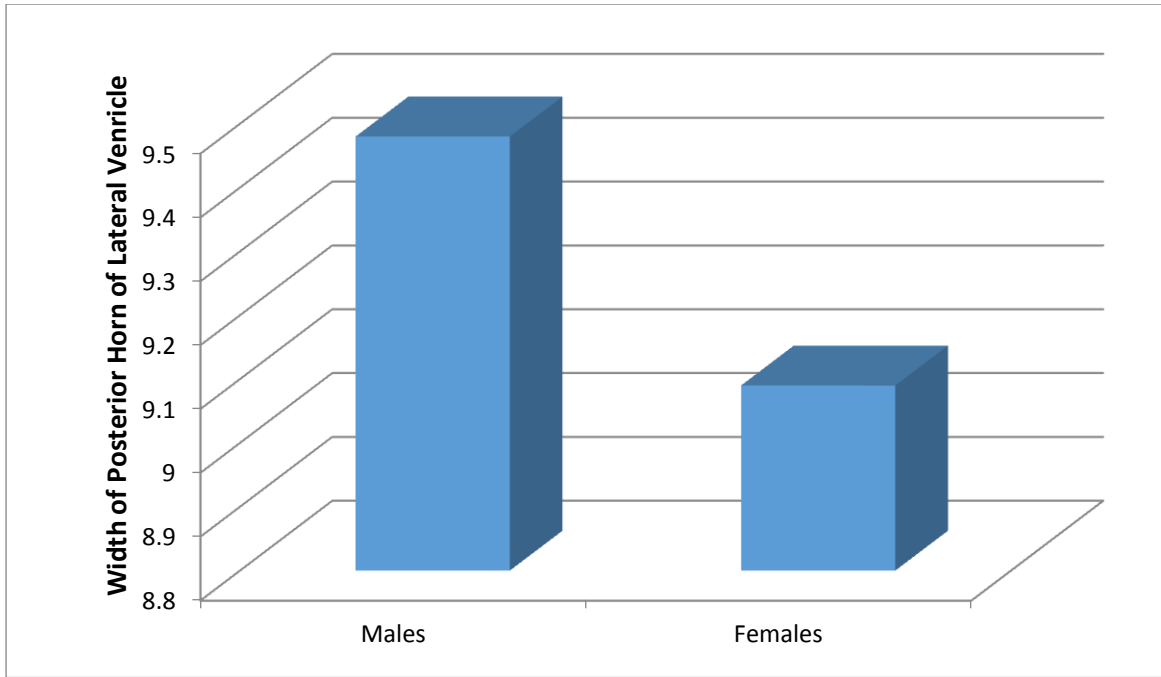
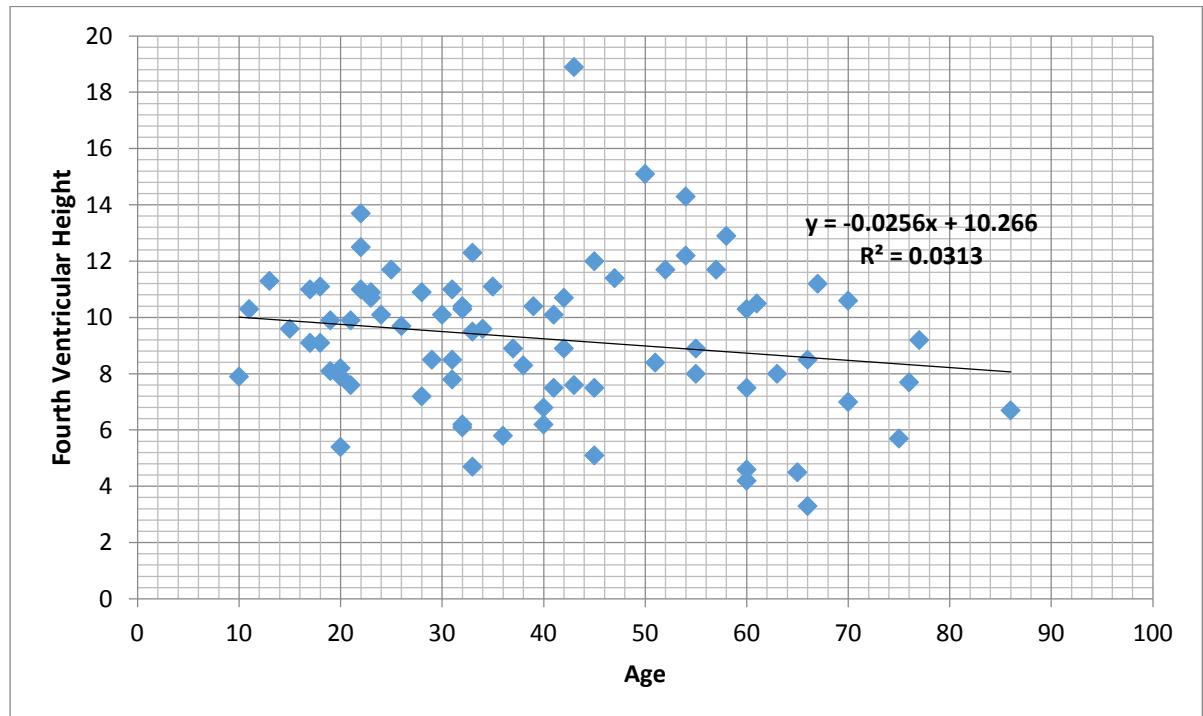
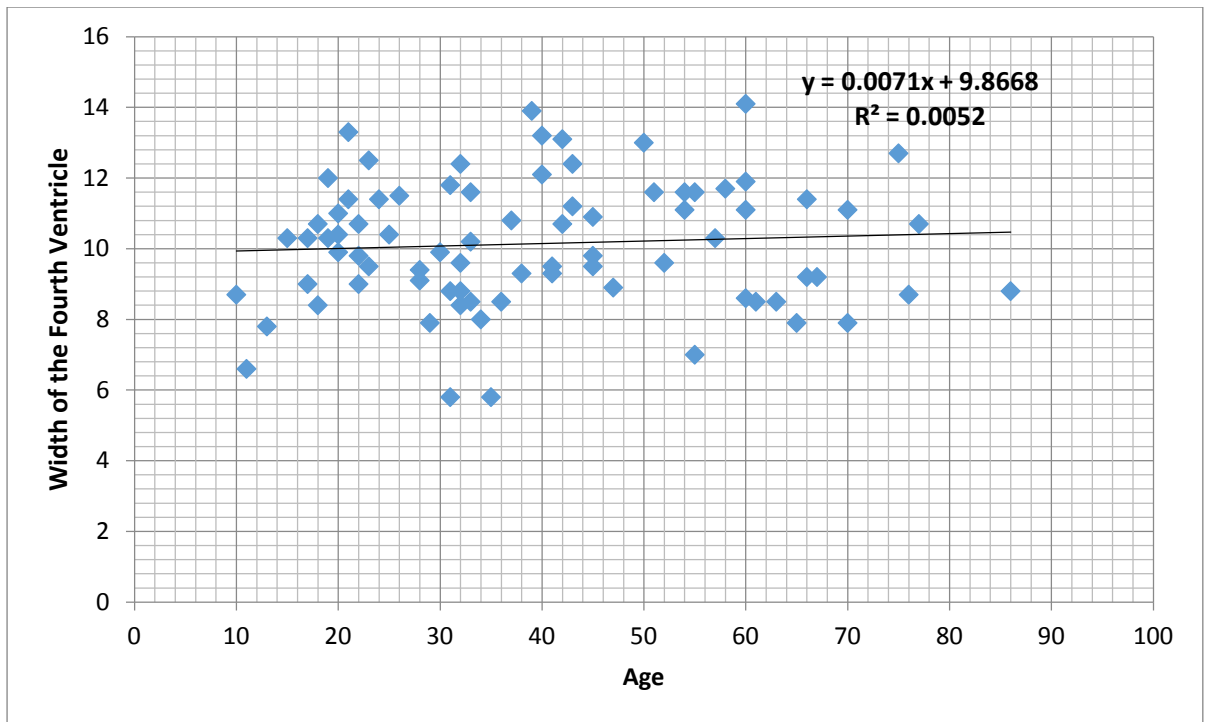


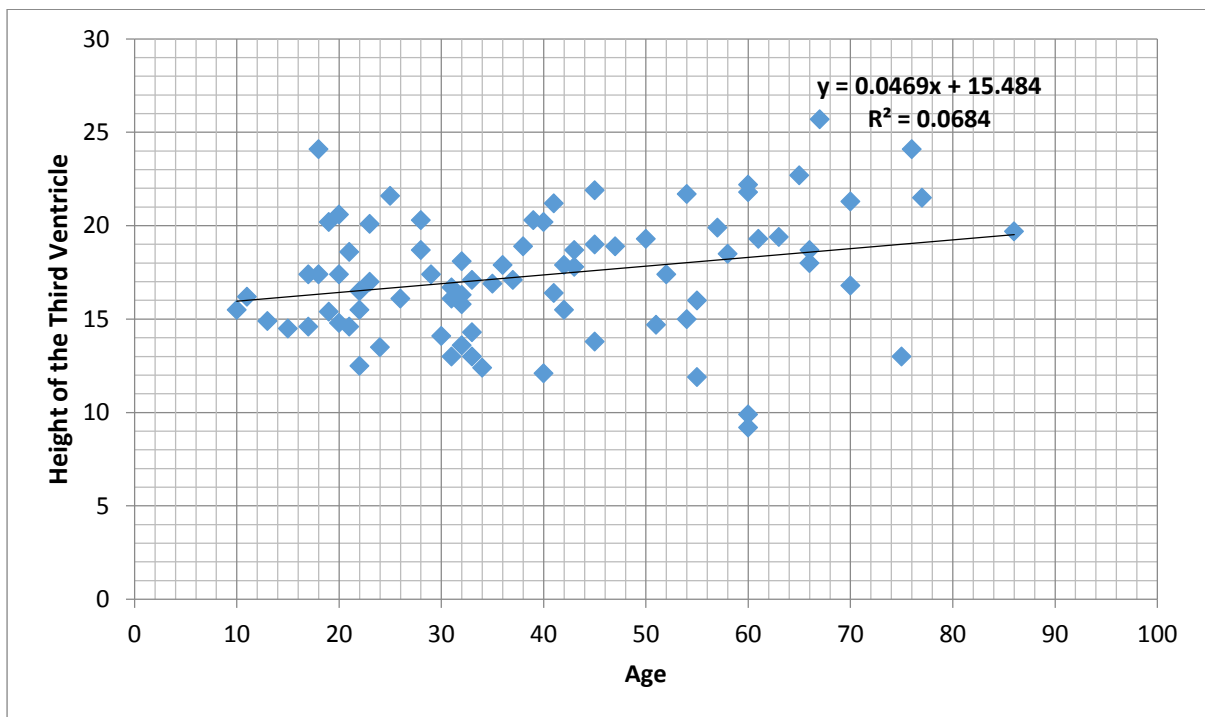
Fig 4.9: Comparison between males and females in **Width of Posterior Horn of Lateral Ventricle**.



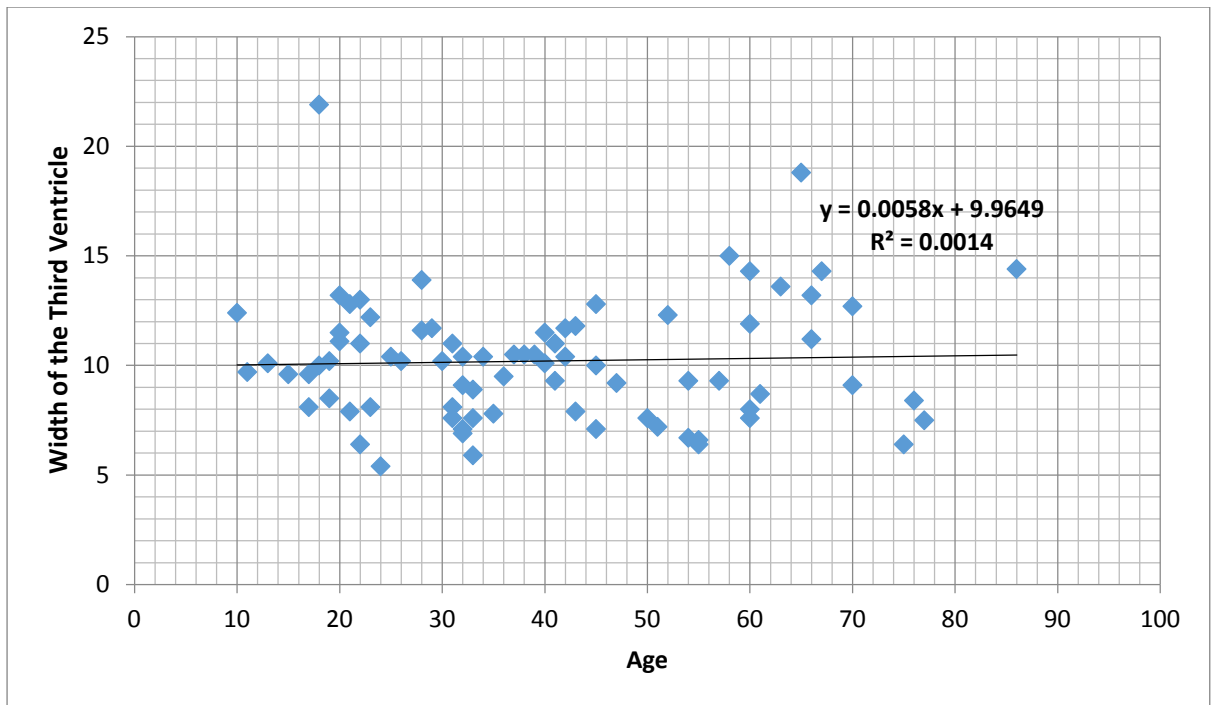
**Figure 4.10** A scatter plot diagram shows a linear relationship between the **Age** and the **Fourth Ventricular Height** of the subjects,  $R^2 = -0.031$ .



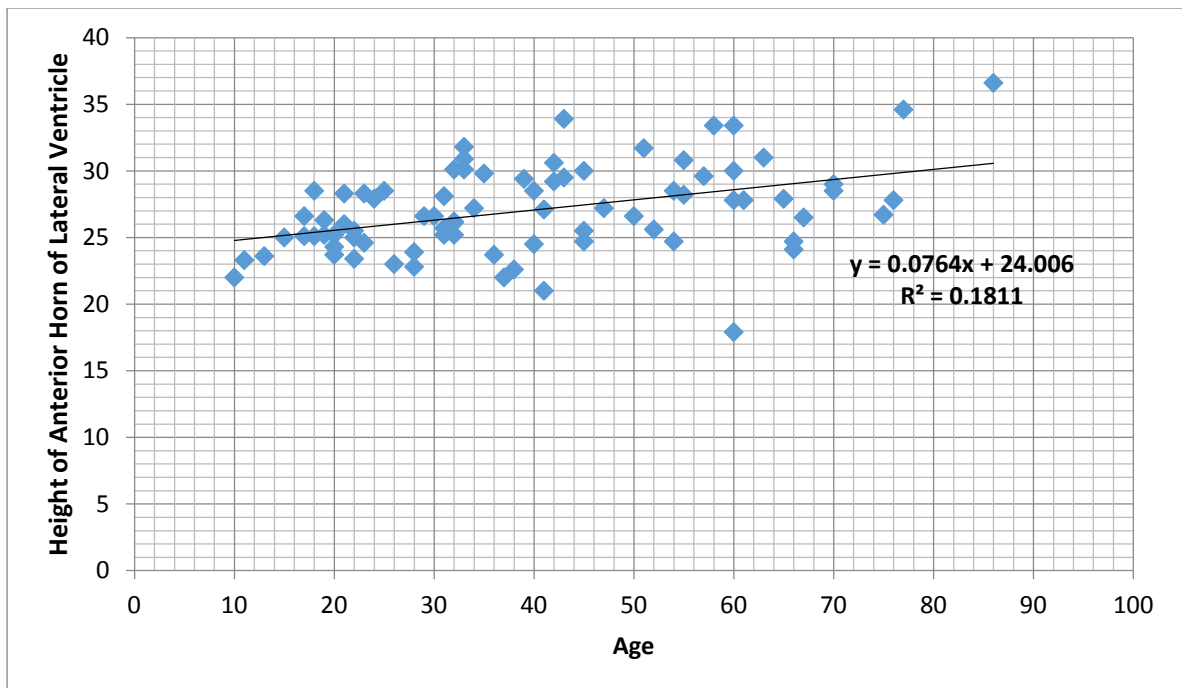
**Figure 4.11** A scatter plot diagram shows a linear relationship between the **Age** and the **Width of the Fourth Ventricle** of the subjects,  $R^2 = 0.005$ .



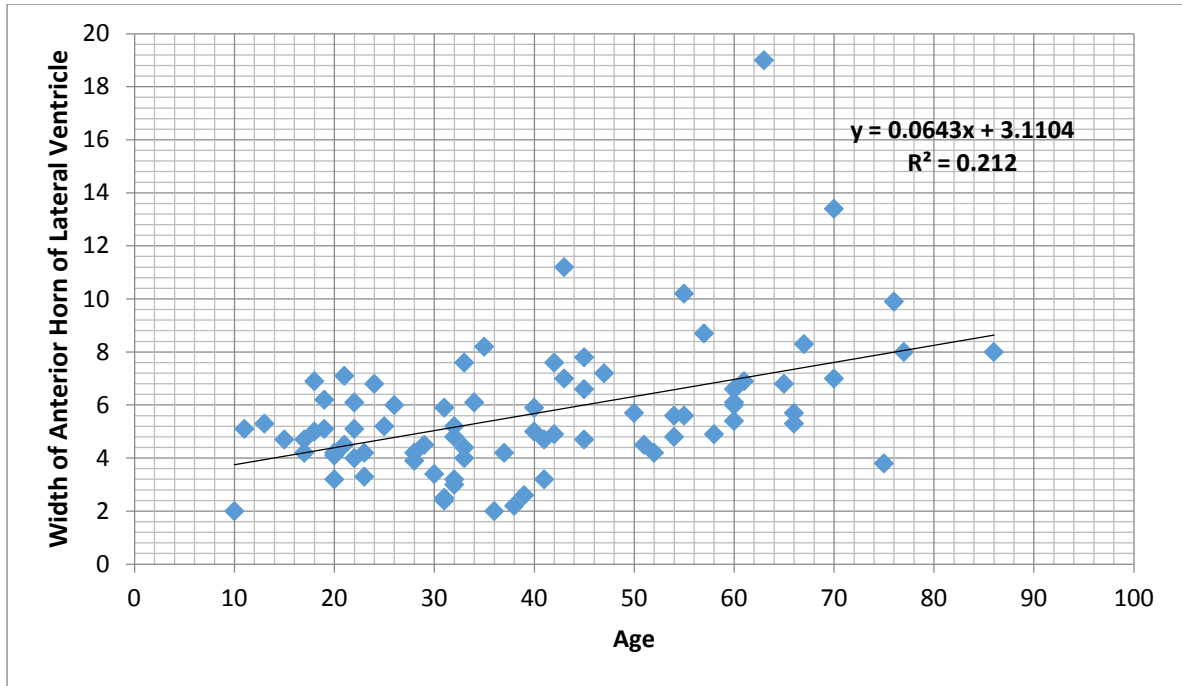
**Figure 4.12** A scatter plot diagram shows a linear relationship between the **Age** and the **Height of the Third Ventricle** of the subjects,  $R^2 = 0.068$ .



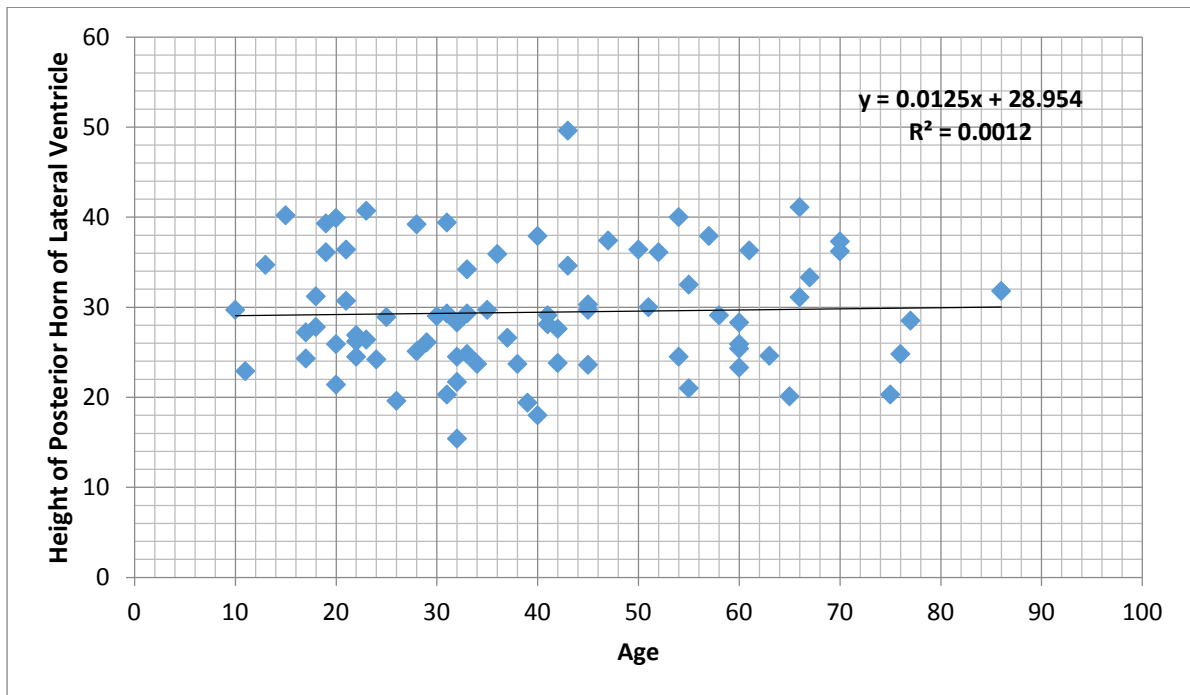
**Figure 4.13** A scatter plot diagram shows a linear relationship between the **Age** and the **Width of the Third Ventricle** of the subjects,  $R^2 = 0.001$ .



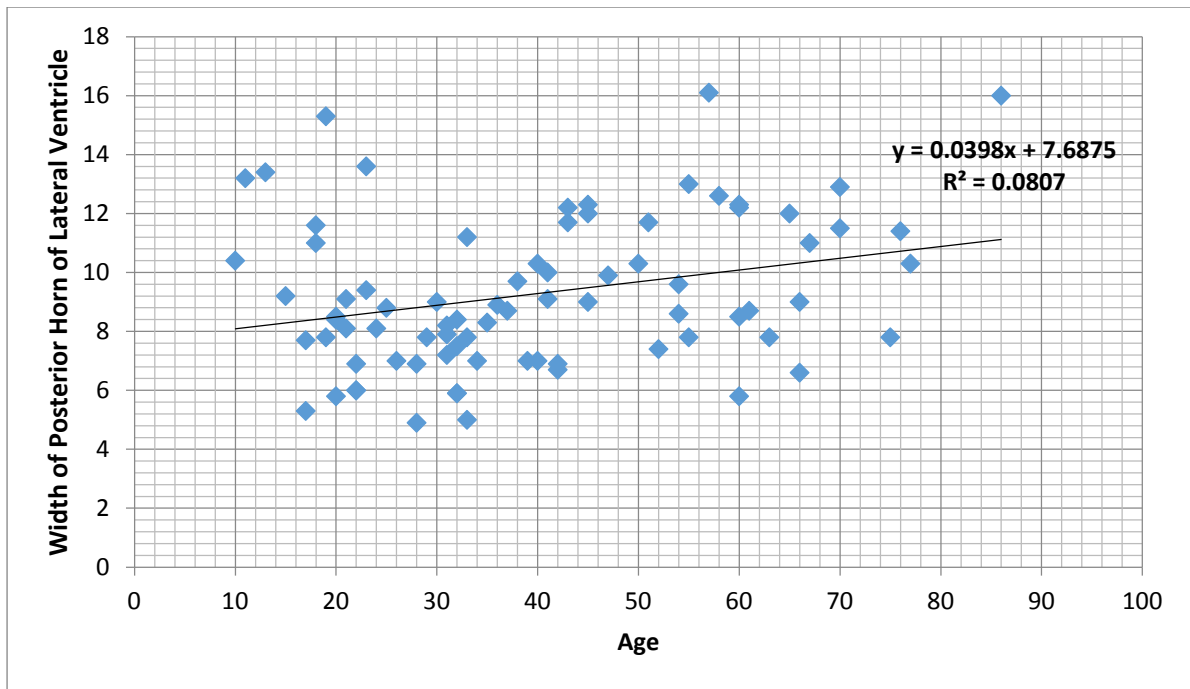
**Figure 4.14** A scatter plot diagram shows a linear relationship between the **Age** and the **Height of Anterior Horn of Lateral Ventricle** of the subjects,  $R^2 = 0.181$ .



**Figure 4.15** A scatter plot diagram shows a linear relationship between the **Age** and the **Width of Anterior Horn of Lateral Ventricle** of the subjects,  $R^2 = 0.181$ .



**Figure 4.16** A scatter plot diagram shows a linear relationship between the **Age** and the **Height of Posterior Horn of Lateral Ventricle** of the subjects,  $R^2 = 0.001$ .



**Figure 4.17** A scatter plot diagram shows a linear relationship between the **Age** and the **Width of Posterior Horn of Lateral Ventricle** of the subjects,  $R^2 = 0.080$ .

## Chapter Five

### Discussion, Conclusion and Recommendations

#### 5.1 Discussion:

The objective of this study was to characterize ventricles in normal Sudanese population using computed tomography CT .This study was performed on 80 patients. The data collected from patients of ages ranged between 10-90years old.

We found that the mean age was  $39.78 \pm 18.30$  and fourth ventricles height and width were  $9.25 \pm 2.065$ mm,  $10.15 \pm 1.78$ mm respectively ,third ventricles height and width were  $17.35 \pm 3.28$ mm,  $10.20 \pm 2.81$ mm respectively ,Height and width of Anterior Horn of Lateral Ventricle were  $27.04 \pm 3.28$  , $5.67 \pm 2.56$ mm respectively . And the Height and width of Posterior Horn of Lateral Ventricle were  $29.45 \pm 6.66$ mm,  $9.27 \pm 2.57$ mm respectively (**Table 4.1**).

According to the age group we found that 4<sup>th</sup> ventricle height is decreasing through life time and it is width start to increase from 10Y to 50Y then start decrease till 70Y then start increase again ,3th ventricle height decreasing 10Y to 50Y then start increase till 90Y and it is width start to decrease 10Y to 50Y then start increase 50Y to 70Y then start decrease again, anterior horn of lateral ventricle height and width is increasing through life time ,posterior horn of lateral ventricle height start to decrease 10Y to 50Y then start increase 50Y to 70Y then decrease again and it is width start to decrease 10Y to 50Y then start increase 50Y to 90Y . Table 4.2

A significant negative correlation was observed between Age and the **Fourth Ventricular Height** of the subjects,  $R^2 = - 0.031$ . (**Fig 4.10**)



, A significant positive correlation was observed between Age and the Width of the Fourth Ventricle of the subjects,  $R^2= 0.005$ . (Fig 4.11), A positive correlation was observed Age and the Height of the Third Ventricle of the subjects,  $R^2= 0.068$  (Fig 4.12) A significant Positive correlation was observed between the Age and the Width of the Third Ventricle of the subjects,  $R^2= 0.001$ .(Fig 4.13), A significant Positive correlation was observed between the Age and the Height of Anterior Horn of Lateral Ventricle of the subjects,  $R^2= 0.181$ .(Fig 4.14). A significant Positive correlation was observed between the Age and the Width of Anterior Horn of Lateral Ventricle of the subjects,  $R^2= 0.181$ .(Fig 4.15). A significant Positive correlation was observed between the Age and the Height of Posterior Horn of Lateral Ventricle of the subjects,  $R^2= 0.001$  (Fig 4.16). A significant Positive correlation was observed between the Age and the Width of Posterior Horn of Lateral Ventricle of the subjects,  $R^2= 0.080$  (Fig 4.17).

#### **Males in comparison to females:**

The mean age for males was 1.38 years higher than the mean age for females. The mean in Fourth Ventricle Height and width in male higher than female by .4mm(Fig 4.2)( Fig 4.3) The mean in Height of the Third Ventricle in male higher than female by .6mm(Fig 4.4) The mean in width of the Third Ventricle in male higher than female by .12mm(Fig 4.5) The mean in Height of Anterior Horn of Lateral Ventricle in male higher than female by 2.5mm(Fig 4.6) The mean in Width of Anterior Horn of Lateral Ventricle Ventricle in male higher than female by .6mm (Fig 4.7) The mean in Height of Posterior Horn of Lateral Ventricle in female higher than male by .03mm (Fig4.8) The mean in Width of Posterior Horn of Lateral Ventricle in male higher than female by .4mm (Fig4.9)

**These** measurements were compared to study done by **ZILUNDU PRINCE L. M.** that found the average mean of third ventricle width, fourth ventricle width, fourth ventricle height  $3.25\pm 0.09\text{mm}$ ,  $10.6\pm 0.1\text{mm}$ ,  $10.5\pm 0.1$  which was lower than this study by 6.95mm in third ventricle width and 0.45 mm fourth ventricle width and 1.25mm fourth ventricle height

This difference may be due to smaller sample size in this study, racial differences and patient habits.

## **5.2 Conclusion:**

We concluded that According to the normal cells adaptation the age have direct effect on the ventricular size and noted that increase age lead to decrease ventricular size, also the size of the Ventricles is higher in male than female.

## **5.3 Recommendations:**

Further study in evaluation of ventricular system with larger sample of Sudanese population for more accurate results is needed.

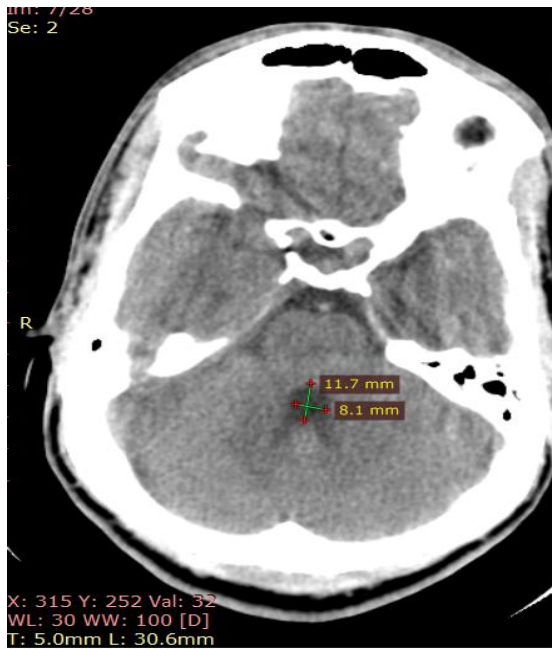
Future studies should calculate the Ventricles volume to give full demographic information.

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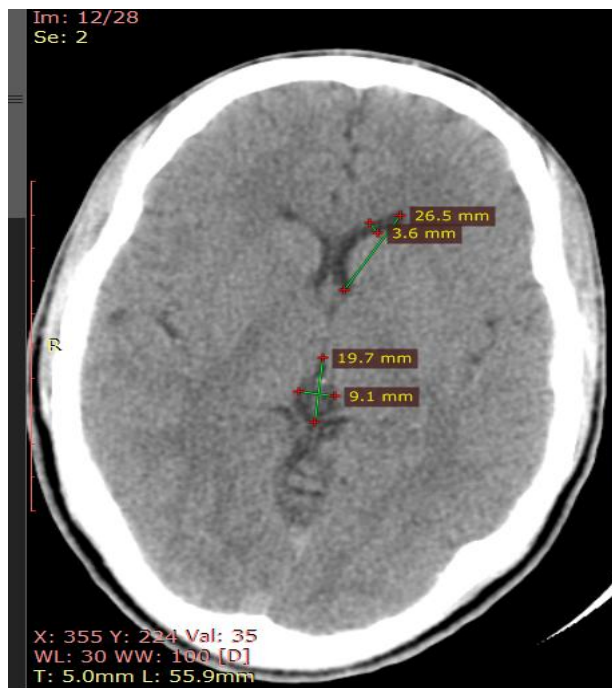
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# Appendices

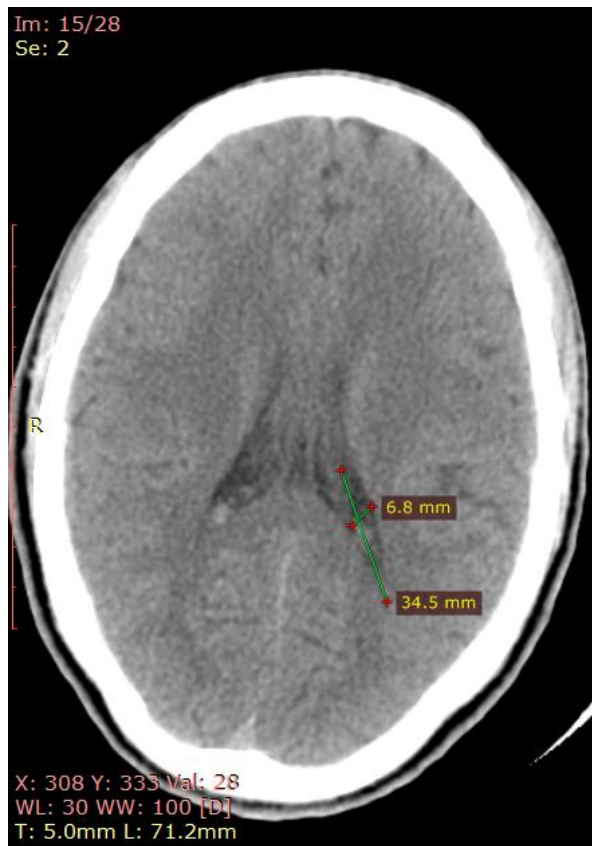




**Figure 5.1** axial CT brain (slice thickness: 5/7.5mm) of male patient (17 Y) showing measurement high and width of 4<sup>th</sup> ventricle



**Figure 5.2**axial CT brain (slice thickness: 5/7.5mm) of male patient (17 Y) showing measurement high and width of lateral ventricle anterior horn and 3th ventricle.



**Figure 5.3** axial CT brain (slice thickness: 5/7.5mm) of male patient (17 Y) showing measurement high and width of lateral ventricle posterior horn.