Sudan University of Science and Technology

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A Study of Hydrocephalus Using CT scan

دراسة إستسقاء الرأس باستخدام مسوحات الأشعة المقطعية المحوسبة

A thesis Submitted for Partial Fulfillments for the Requirements of M.Sc. Degree in Diagnostic Radiological Technology

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الآيـــة

قال تعالى:

(إِنَّ الَّذِينَ آمَنُوا وَالَّذِينَ هَادُوا وَالنَّصَارَى وَالصَّابِئِينَ مَنْ آمَنَ بِاللَّهِ وَالْيَوْمِ الْآخِرِ وَعَمِلَ صَالِحًا فَلَهُمْ أَجْرُهُمْ عِندَ رَبِّهِمْ وَلَا خَوْفٌ عَلَيْهِمْ وَلَا هُمْ يحزنون)

سورة البقرة (62)

صدق الله العظيم

Abstract

Hydrocephalus is the common disease occurs in pediatrics and it may occur in the elderly. The main objective of this study is to evaluate the role of CT in diagnosis of this disease and Find out its causes.

The study has been carried out in Soba university hospital and EL-Almal national hospital during the period from October 2017 up to march 2018 , selecting a random sample of 35 patients , 16 of them were males and 19 were females with different age who were transferred to CT department to make investigations . Brain ventricles were measured to determine the site of obstruction and then determine the type of hydrocephalus. There are three different types of hydrocephalus, none communicating, communicating, and a third type called normal pressure hydrocephalus.

Hydrocephalus is the buildup of too much cerebrospinal fluid (CSF) in the brain. Normally, this fluid cushions the brain. When there is too much, it puts harmful pressure on the brain. There are two kind of hydrocephalus. Congenital hydrocephalus is present at birth. Causes include genetic problems and problems with how the fetus develops. An unusually large head is the main sign of congenital hydrocephalus. Acquired hydrocephalus can occur at any age. Causes can include head injuries, stroke, infections, tumors and bleeding in the brain. Hydrocephalus can permanently damage the brain, causing problems with physical and mental development. If untreated, it is usually fatal. With treatment, many people lead normal lives with few limitations. Treatment usually involves surgery to insert a shunt.

The problem of the study is increase the number of cases with hydrocephalus. The main objective has been to study hydrocephalus using computer tomography, while specific objectives have been done to correlate causes of hydrocephalus with age, to measure size of lateral ventricle, to correlate clinical sign and symptoms with cause, to classify types of hydrocephalus.

The technique used in cases of my research, all axial images studied by senior radiologist to diagnose the stage of hydrocephalus , types and causes, the data analyzed through statistical package for social science . My result found that the females affected with hydrocephalus are more common than males 54.7%_ 54.3% the none communicating type is 57.1% while the communicating is 57.1% , congenital anomalies are the most common cause of hydrocephalus 28.6% , enlargement of head is the most common sign 54.3% , the maximum size of the lateral ventricle is 22 , the minimum is 10 , the most common site of restriction in hydrocephalus is the lateral ventricle the dilated lateral ventricle equal 97% while the normal third ventricle is 2.9% .

Finally hydrocephalus is a disease occurs in neonate and children below 10 years, the most common type was none communicating and the main cause is congenital.

المستخلص

مرض استسقاء الرأس يتلخص في تراكم الكثير من السائل النخاعي داخل المخ، عاده السوائل تقوم بعمل وساده للمخ لكن عدما يكون هناك الكثير منها فانها تقوم باحداث ضغط على المخ.

هناك تصنيفات لمرض الاستسقاء الرأسي : الاستسقاء الرأسي الناتج عن عيب خلقي دائما يحدث ويظهر بعد الولاده لأسباب كثيره منها العامل الوراثي والمشاكل اثناء نمو الجنين فتره الحمل، الرأس المتضخم عاده يعتبر اول علامه من علامات المرض.

النوع الثاني : الاستسقاء الرأسي المكتسب ويمكن ان يحدث في اي عمر ومن اسبابه اصابات الرأس، الجلطه الدماغيه، الالتهابات ، الاورام الدماغيه والنزيف الداخلي للمخ، الاستسقاء لرأسي بامكانه احداث ضرر دائم للدماغ مما يؤدي لمشاكل حركيه وعقليه للمريض واذا لم تتم معالجته يؤدي للوفاه الحاليه. خيارات العلاج تشمل الجراحه لعمل انبوب من الدماغ الى البطن.

هناك ثلاثه انواع من مرض استسقاء الرأسي : الاتصالي، غير الاتصالي، والنوع الثالث يسمى بالاستسقاء الرأسي ذو الضغط الطبيعي، هذه الدراسه اجريت في الفتره من اكتوبر 2017 الى مارس 2018 في مستشفى سوبا الجامعي ومستشفى الامل الوطني.

موضوع هذه الدراسه يتعلق بزياده عدد المصابين بمرض الاستسقاء الرأسي والهدف الاساسي يرتكز على دراسه حالات الاستسقاء الرأسي باستخدام الاشعه المقعيه بينما الاهداف العامه تكمن في ربط مرض الاستسقاء الرأسي باعمار المرضى، قياس حجم التجاويف البطنيه في الدماغ، ربط العلامات السريره والاعراض بالمسبب لمرض، وايضا تصنيف انواع مرض استسقاء الرأس .

كل الصور المحوريه تمت دراستها من قبل اخصائي علم الاشعه من اجل تشخيص مرحله مرض الاستسقاء الرأسي ومعرفه انواعه واسبابه.

المعلومات المتوفره تم تحليلها وفق طرق احصائيه من خلال العلوم الاجتماعية .

اوضحت النتائج ان نسبه اصابه الاناث بالمرض اكثر من الذكور بحوالي 54.3%:45% ، النوع غير الاتصالي من المرض يمثل 57.1%. العيوب الخلقيه هي من اكثر الاسباب شيوعا للمرض بنسبه 28.6% اما تضخم الرأس للمريض يعتبر اكثر الاعراض شيوعا بنسبه 54.3% . وجدت الدراسه ان اكبر حجم للتجويف البطني الجانبي يساوي 22 ملم واصغر حجم يساوي 10 ملم واكثر منطقه لوجود الانسداد في مرض استسقاء الرأس هي منطقه التجويف البطني الثالث.

اخيرا مرض الاستسقاء الرأسي يحدث في الاطفال حديثي الولاده والرضع والاطفال دون سن العاشره، النوع الاكثر شيوعا هو النوع غير الاتصالي، من اكثر الاسباب للمرض هي العيوب الخلقيه.

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Dedication

To..

My father who truthfully presented me the chance of being knowledgeable and the tribute of being a graduate;

My mother, who maintained with compassion and ambition;

My relatives with the warmth and deepest regards and accompaniment;

And to all friends, colleagues and other people who assisted in this study.

My professors and colleagues in Department of Diagnostic, College of Medical Radiological Science, Sudan University of Science and Technology,

I dedicate this thesis

Acknowledgment

“Give thanks for a little and you will find a lot”

My special heartfelt thanks an appreciation to my supervisor Dr.Ekhlas Abdelaziz Hassan for his great and sincere support and guidance through the work from inception to the end.

I would like to give my sincere thanks to the Administrator of Police Central Hospital and National Elamal Hospital for their full cooperative and assistance in order to achieve this research and also not forgotten the college Medical Radiological Science, Sudan University of Science and Technology..

My gratitude to all people exerted efforts to achieve the goal.

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Abbreviation

CMV	Cytomegalovirus
CSF	Cerebrospinal Fluid
CT	Computed Tomography
MRI	Magnetic Resonance Imaging
NPH	Normal Pressure Hydrocephalus
pCO^2	Partial Pressure of Carbon Dioxide

CHAPTER ONE
INTRODUCTION

Chapter One

Introductions

1.1 introductions:

Hydrocephalus is the buildup of too much cerebrospinal fluid (CSF) in the brain. Normally, this fluid cushions the brain. When there is too much, it puts harmful pressure on the brain. There are two kind of hydrocephalus .congenital hydrocephalus is present at birth. Causes include genetic problems and problems with how the fetus develops. An unusually large head is the main sing of congenital hydrocephalus. Acquired hydrocephalus can occur at any age. Causes can include head injuries, strokes, infections, tumors and bleeding in the brain. Hydrocephalus can permanently damage the brain, causing problems with physical and mental development. If untreated, it is usually fatal. With treatment, many people lead normal lives with few limitations. Treatment usually involves surgery to insert a shunt. Medicine and rehabilitation therapy can also help. (Figaji et al, 2005)

Hydrocephalus is the result of an imbalance between the formation and drainage of cerebrospinal fluid (CSF). Approximately 500 milliliters (about a pint) of CSF is formed within the brain each day, by epidermal cells in structures collectively called the choroid plexus. These cells line the ventricles which are located within the brain. There are four ventricles in a human brain. Once formed, CSF usually circulates among all the ventricles before it is absorbed and returned to the circulatory system. The normal adult volume of circulating CSF is 150 ml. the CSF turn-over rate is more than three times per day. Because production is independent of absorption, reduced absorption causes CSF to accumulate within the ventricles. (Golden, et al. 2007)

There are three different types of hydrocephalus. In the most common variety, reduced absorption occurs when one or more passages connecting the ventricles become blocked. This prevents the movement of CSF to its drainage sites in the subarachnoid space just inside the skull. This type of hydrocephalus is called “non-communicating” in a second type; a reduction in the absorption rate is caused by damage to the absorptive tissue. This variety is called “communicating hydrocephalus” Both of these types lead to an elevation of the CSF pressure within the brain. This increased pressure pushes aside the soft tissues of the brain. This squeezes and distorts them. This process also results in damage to these tissues. In infants whose skull bones have not yet fused, the intracranial pressure is partly relieved by expansion of the skull, so that symptoms may occur from infancy to adulthood. A third type of hydrocephalus, called “normal pressure hydrocephalus,” is marked by ventricle enlargement without an apparent increase in CSF pressure. This type affects mainly the elderly. (Figaji et al, 2005)

Hydrocephalus may be suggested by symptoms; however, imaging studies of the brain are the mainstay of diagnosis. Computed tomography (CT scan) and magnetic resonance imaging (MRI) typically reveal enlarged ventricles and may indicate a specific cause. Abnormalities such as tumors and hemorrhages can also be detected. Small abnormalities that may not be detected using CT scan, such as cysts and abscesses, are often seen with MRI. CT and MRI can also help the neurosurgeon differentiate between communicating and non-communicating hydrocephalus. In case of suspected normal pressure hydrocephalus, a spinal tap may help determine CSF pressure. A cistern gram evaluates the dynamics of CSF flow in the brain and spinal cord. In this procedure the dynamic dye is injected into the subarachnoid space around the brain. A series of pictures is taken once the dye has circulated through the entire CSF path. Cisternography can travel CSF concentration, obstruction, leakage, and pressure. In older people, pressure in the head can cause papilledema, swelling of the optic nerve. Papilledema can often be seen while examining the eyes. Unfortunately, it typically indicates hydrocephalus that is well developed. In rare cases, long standing hydrocephalus causes blindness. (Alfred Aschoff, et al, 1999).

Obstruction causes CSF to build up in the brain. If the cause is congenital, symptoms such as an enlarged head may be present at birth. Acquired hydrocephalus can develop at any age as a result of head trauma or illness. Congenital hydrocephalus occurs during fetal development and is present at birth. Causes include infection (e.g. cytomegalovirus [CMV], toxoplasmosis, rubella) and internal bleeding in the brain. (Alfred Aschoff, et al, 1999).

The congential malformations are commonly associated with CSF obstruction, which are Aqueductal stenosis-narrowing of the pathway to the fourth ventricle, Arnold – Chiare malformations-small part of the cerebellum protrudes into the spinal canal, Dandy-Walker syndrome-enlarged fourth ventricle due to obstruction in pathway and Spine bifida-portion of the spinal cord is pushed through an abnormal opening between two vertebrae.

Acquired hydrocephalus can occur at any age. The conditions may cause CSF obstruction and subsequently acquired hydrocephalus can be represented in hemorrhage, brain trauma, brain tumor, cyst and infection.

Hydrocephalus, traumatic brain injury, and infection are seen in some premature births; premature births may be a risk factor for hydrocephalus are determined by factors such as age, degree of ventricular enlargement, rate of hydrocephalus development, type and underlying condition. (Alfred Aschoff, et al, 1999).

1.2 Objectives of the study:

1.2.1 The general objective:

The aim of this study is to study hydrocephalus Using Computed Tomography .

1.2.2 The specific objective:

- To show the role of CT in investigation of hydrocephalus.
- To correlate hydrocephalus with age.
- To measure size of ventricle of the brain.
- To detect the clinical signs and symptoms of hydrocephalus.
- To classificate type of hydrocephalus.

1.3 Importance of the study:

Computed Tomography scan (CT) creates an image of the brain by using x-rays and a special scanner. It is safe, reliable, painless, and relatively quick (about 5 minutes). An x-ray beam passes through the head, allowing a computer to make an image of the brain. A CT will show if the ventricles are enlarged or if there is obvious blockage.

1.4 Organization of the study:

- Chapter One: Introduction.
- Chapter Two: Literature Review.
- Chapter Three: Material and Methods.
- Chapter Four: Results.
- Chapter Five: Discussion, Conclusion and recommendation.

Chapter Tow
LITERATURE REVIEW

Chapter two

Literature review

2.1 background:

2.1.1 anatomy of nervous system:

nervous system is the part of an animal that coordinates its actions by transmitting signals to and from different parts of its body. The nervous system detects environmental changes that impact the body, then works in tandem with the endocrine system to respond to such events.[1] Nervous tissue first arose in wormlike organisms about 550 to 600 million years ago. In vertebrates it consists of two main parts, the central nervous system (CNS) and the peripheral nervous system (PNS). The CNS consists of the brain and spinal cord. The PNS consists mainly of nerves, which are enclosed bundles of the long fibers or axons, that connect the CNS to every other part of the body. Nerves that transmit signals from the brain are called *motor* or *efferent* nerves, while those nerves that transmit information from the body to the CNS are called *sensory* or *afferent*. Spinal nerves serve both functions and are called *mixed* nerves. The PNS is divided into three separate subsystems, the somatic, autonomic, and enteric nervous systems. Somatic nerves mediate voluntary movement. The autonomic nervous system is further subdivided into the sympathetic and the parasympathetic nervous systems. The sympathetic nervous system is activated in cases of emergencies to mobilize energy, while the parasympathetic nervous system is activated when organisms are in a relaxed state. The enteric nervous system functions to control the gastrointestinal system. Both autonomic and enteric nervous systems function involuntarily. Nerves that exit from the cranium are called cranial nerves while those exiting from the spinal cord are called spinal nerves. (Alfred Aschoff, et al, 1999).

At the cellular level, the nervous system is defined by the presence of a special type of cell, called the neuron, also known as a "nerve cell". Neurons have special structures that allow them to send signals rapidly and precisely to other cells. They send these signals in the form of electrochemical waves traveling along thin fibers called axons, which cause chemicals called neurotransmitters to be released at junctions called synapses. A cell that receives a synaptic signal from a neuron may be excited, inhibited, or otherwise modulated. The connections between neurons can form neural circuits and also neural networks that generate an organism's perception of the world and determine its behavior. Along with neurons, the nervous system contains other specialized cells called glial cells (or simply glia), which provide structural and metabolic support. (Alfred Aschoff, et al, 1999).

2.1.1.2The brain :

The brain is composed of 3 main structural divisions: the cerebrum, the brainstem, and the cerebellum (see the images below). At the base of the brain is the brainstem, which extends from the upper cervical spinal cord to the diencephalon of the cerebrum. The brainstem is divided into the medulla, pons, and midbrain. Posterior to the brainstem lies the cerebellum.

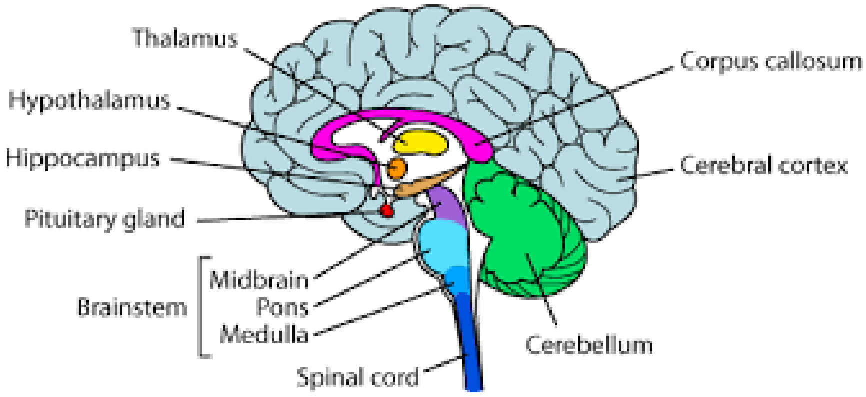
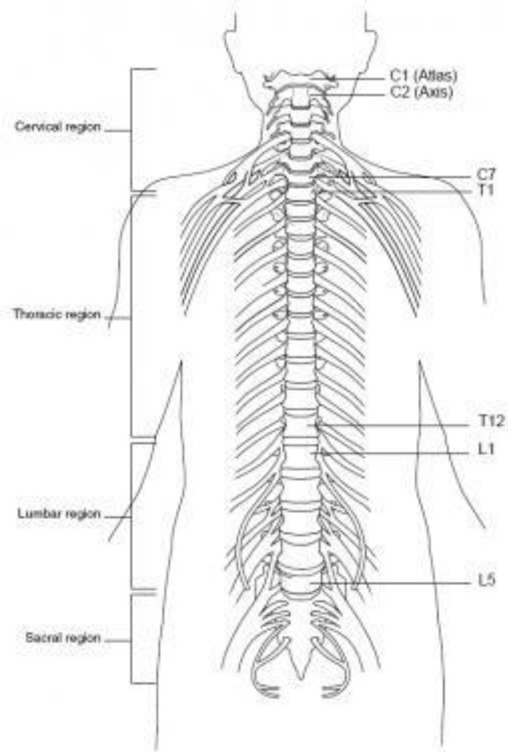


Fig.(2.1) lateral view of brain ventricle

2.1.1.3 The spinal cord :

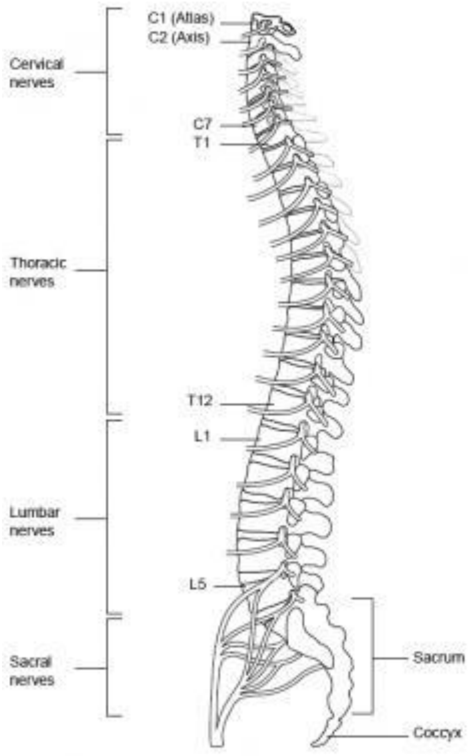


Spine, anterior view.

The spinal cord is composed of the following 31 segments:

- 8 cervical (C) segments
- 12 thoracic (T) segments
- 5 lumbar (L) segments
- 5 sacral (S) segments
- 1 coccygeal (Co) segment - mainly vestigial

The spinal nerves consist of the sensory nerve roots, which enter the spinal cord at each level, and the motor roots, which emerge from the cord at each level. The spinal nerves are named and numbered according to the site of their emergence from the vertebral canal. C1-7 nerves emerge above their respective vertebrae. C8 emerges between the seventh cervical and first thoracic vertebrae. The remaining nerves emerge below their respective vertebrae. See the image below.



Fig(2.2) Spine, lateral view.

The dorsal rami of C1-4 are located in the suboccipital region. C1 participates in the innervation of neck muscles, including the semispinalis capitis muscle. C2 carries sensation from the back of the head and scalp, along with motor innervation to several muscles in the neck. C3-C5 contribute to the formation of the phrenic nerve and innervate the diaphragm. C5-T1 provide motor control for the upper extremities and related muscles.
The thoracic cord has 12 segments and provides motor control to the thoracoabdominal musculature. The lumbar and sacral portions of the cord have 5 segments each. L2-S2 provide motor control to lower extremities and related muscles.

2.1.1.4CSF and ventricles:

There are two lateral ventricles. The lateral ventricles are C shaped structures (with a tail) that are deep in the cerebral hemispheres. The parts of the lateral ventricle include the anterior or frontal horn, the body, the trigon or atrium, the posterior or occipital horn and the inferior or temporal horn. Each lateral ventricle communicates with the thin single midline 3^{rd} ventricle by their interventricular foramen of Monroe. The 3^{rd} ventricle is connected to the 4^{th} ventricle by the cerebral of Sylvius. The 4^{th} ventricle communicates with the subarachnoid space by a medial aperture, the foramen of Magendie and two lateral apertures, the foramen of Luschka. (Alfred

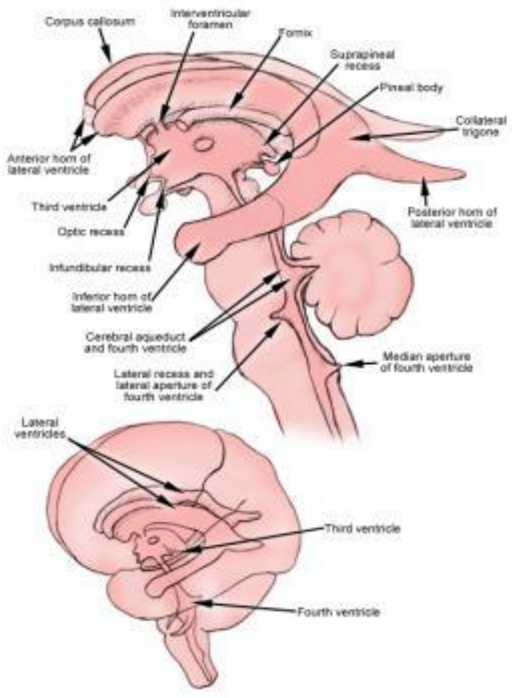


Fig (2.3) The ventricle

Most of the CSF is formed by the choroid plexus. In the lateral ventricles, the choroid plexus is a continuous structure that is found on the floor of the body and anterior trigon and the superior medial aspect of the temporal horns. The choroid plexus of the lateral ventricles travels through the foramen of Monro and is continues with the choroid plxus found in the roof of the 3rd ventricles. There is also choroid plexus in the roof of the 4th ventricle. (Alfred Aschoff, et al, 1999).

Some of the CSF flows down around the spinal cord in the subarachnoid space. The spinal nerve roots traverse the CSF space and CSF surrounds the nerve roots as they exit through the Dura. Some of the CSF is absorbed through arachnoid villi that empty into the radicular veins. The conusmedullars of the spinal cord is usually located at the inferior aspect of the L_1 vertebral body and the lumbar and sacral spinal nerve roots from the lumbar cistern. Approximately 30 ml of CSF surrounds the spinal cord with most of that volume located in the lumbar cistern. (Alfred Aschoff, et al, 1999).

Cisternal spaces are enlargements of the subarachnoid space and they contain “pools” of CSF. Total CSF volume for the adult brain is approximately 150 ml with 25 ml of that total in the ventricles and 75 ml in the cisterns. (Alfred Aschoff, et al, 1999)

The ventricles are filled with cerebrospinal fluid (CSF), which provides the following function: absorbs physical shocks to the brain, distributes nutritive materials to and removes wastes from nervous tissue
and provides a chemically stable environment. (Alfred Aschoff, et al, 1999).

The CSF circulates from the lateral ventricles (where most the CSF is produced) to the third and then fourth ventricles. From the fourth ventricles, most of the CSF passes into the subarachnoid space, a space within the linings (meninges) of the brain, although some CSF also passes into the central canal of the spinal cord. The CSF returnes to the blood through the arachnoid villi located in the dural sinuses of the meninges. (Aberto J Espay, 2010)

There are four cerebral ventricles the paired lateral ventricles, and the midline third and fourth ventricles. Two lateral ventricles, located within the cerebrum, are relative large and C-shaped, roughly wrapping around dorsal aspects of the basal ganglia. It is in the lateral ventricles of the embryo that the successive generation of neurons gives rise to the 6-layered structure of the neocortex, constructed from the inside out during development. (Aberto J Espay, 2010)

Hydrocephalus (known colloquially as “water on the brain”), is an extremely serious condition due to both the damage cause by the pressure as well as nature of whatever caused the block (e.g. a tumor or inflammatory swelling). The cavities of cerebral hemisphere are called lateral ventricles or 1&2 ventricles. These two ventricles open commonly into 3 ventricles by a common opening called foramen of Monroe. (Aberto J Espay, 2010)

2.1.2 Physiology of CSF and ventricles:

Cerebral Spinal Fluid (CSF) produced at a rate of 20 ml per hour by the choroid plexus, CSF is located in all four ventricles. Fluid flows from the two lateral ventricles via the foramen of Monro into the third ventricles, then through the aqueduct of Sylvius into the fourth ventricle. It then exits via three small openings into the subarachnoid space where it circulates around the surface of the spinal cord and brain. CSF is reabsorbed by the arachnoid villi in the subarachnoid space into the cerebral venous system to maintain a constant volume and intracranial pressure within the brain. CSF function to cushion and support the brain, and it plays an important role in brain metabolism. Approximately 140 ml of CSF is contained within the ventricles. (Relkin et al. 2005)

CSF volume is 150 cc (25 in ventricles): 450 cc produced per day.

Arachnoid granulations absorb if pressure is 3-6 cmH2O above venous pressure. Normal pressure is 10-15 cmH2O; 3-6 cmH2O in children; 20-30 cmH2O when sitting. Secretion increased by CO2and volatile anesthetics; secretion decreased by NE and carbonic anhydrase inhibitors. (Relkin et al. 2005)

Cerebrospinal fluid (CSF) is considered a part of the Trans cellular fluids. It is contained in the ventricles and subarachnoidspace and bathes the brain and spinal cord. The CSF is contained within the meninges and acts as a cushion to protect the brain from injury with position or movement. It has been estimated that his “water bath” effect gives the 1400g brain an effective net weight of only 50g. (Relkin et al. 2005)

The total volume of CSF is 150 mls. The daily production is 550 mls/ day so the CSF turns over about 3 to 4 times per day. The CSF is formed by the choroid plexus (50%) and directly from the walls of the ventricles (50%). CSF flows through the foramen of Magendie&Luschkainto the subarachnoid space of the brain and spinal cord. It is absorbed by the immunological protection to the brain inside the skull. It is produced in the choroid plexus. (Kenneth Saladin, 2007)

2.1.2.1 CSF Function:

The actual mass of the human brain is about 1400 grams; however, the net weight of the brain suspended in the CSF is equivalent to a mass of 25 grams. The brain therefore exists in neutral buoyancy, which allows the brain to maintain its density without being impaired by its own weight, which would cut off blood supply and kill neurons in the lower section without CSF. (Kenneth Saladin, 2007).

CSF protects the brain tissue from injury when jolted or hit. In certain situation such as auto accidents or sports injury, the CSF cannot protect the brain from forced contact with skull case, causing hemorrhaging, brain damage, and sometime death. (Kenneth Saladin, 2007).

CSF flows throughout the inner ventricular system in the brain and is absorbed back into the bloodstream, raising the metabolic waste from the central nervous system through the blood-brain barrier. This allows for homeostatic regulation of the distribution of neuroendocrine factors, to which slight changes can cause problems or damage to the nervous system. For example, high glycine concentration disrupts temperature and blood pressure control, and high CSF pH causes dizziness and syncope.(Kenneth Saladin, 2007).

The prevention of brain ischemia is made by decreasing the amount of CSF in the limited space inside the skull. This decrease total intracranial pressure and facilitates blood perfusion.(Kenneth Saladin, 2007).

When disorders of CSF flow occur, they may therefore affect not only CSF movement also craniospinal compliance and the intracranial blood flow, with subsequent neuronal and glial vulnerabilities. The venous system is also important in this equation. Infants and patients shunted as small children may have particularly unexpected relationships between pressure and ventricular size, possibly due in part to venous pressure used in anesthesia to determine the manner in which a particular drug will spread in the intrathecal space. (Johnston M, 2003)

2.1.3 Pathology of CSF and ventricles:

Hydrocephalus is usually due to blockage of cerebrospinalfluid (CSF) outflow in the ventricles or in the subarachnoid space over the brain. In a person without hydrocephalus, CSF continuously circulates through the brain. Its ventricles and the spinal cord and is continuously drained away into the circulatory system. Alternatively, the condition may result from an overproduction of the CSF fluid from a congenital malformation blocking normal drainage of the fluid, or from complication of head injuries or infections. (Cabot, Richard, 1919)

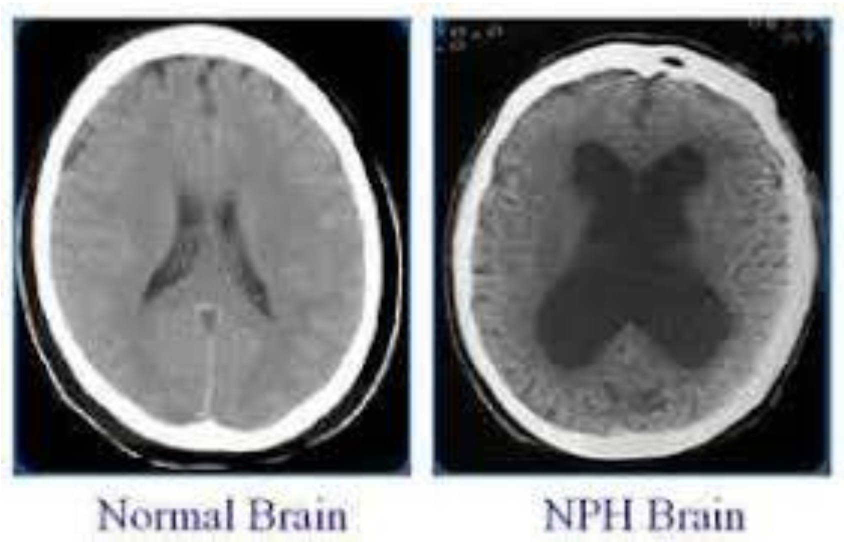
Compression of the brain by the accumulating fluid eventually may cause convulsions and mental retardation. These sings occur sooner in adults, whose skulls no longer are able to expand to accommodate the increasing fluid volume within. Fetuses, infants, and young children with hydrocephalus typically have an abnormally large head, excluding the face, because the pressure of the fluid causes the individual skull bones-which have yet to fuse-to bulge outward at their juncture points. Another medical sign, in infants, is a characteristic fixed downward gaze with whites of the eyes showing above the iris, as though the infant were trying to examine its own lower eyelids. (Cabot, Richard, 1919)

Inflammation – meningitis, hemorrhage. Loss of brain parenchymainfarcts, perinatal insults.

Intraventricular Hemorrhage (IVH) is most common cause of congenital hydrocephalus. Hemorrhage in the periventricular germinal matrix ruptures into the ventricular system. Frequently seen in premature infants.May proceed to cause non-obstructive hydrocephalus.

2.1.4 CT Appearance of hydrocephalus:

CT would show an abnormally large criminal vault with increased soft tissue opacity within the cranial vault. An MRI would be able to distinguish between the pathologic fluid and the neural tissue remaining.



Fig(2.4) Normal brain and NPH

2.1.4Grade of hydrocephalus:

Grade I – Isolated hemorrhage confined to the germinal matrices
Grade II –Intraventricular extension of germinal matrix hemorrhage without hydrocephalus.
Grade III – Intraventricular extension of germinal matrix hemorrhage with accompanying ventricular enlargement.
Grade II – Intraventricular extension of germinal matrix hemorrhage in addition to intraventricular hemorrhage with hydrocephalus.

2.2 Previous Studies:

In a study by (Bruwer, et al, 2003) entitled “Can CT predict the level of CSF block in tuberculous hydrocephalus?” showed that the only CT finding that correlated with the type of hydrocephalus was the shape of the third ventricle. Significantly more children with non-communication hydrocephalus had a rounded third ventricle than those with communication hydrocephalus.

In study done by (KouzoMoritakea et al, 2007), CT was used in more than half of the cases. For diagnosis of fetal hydrocephalus, either US or MRI had become dominantly utilized and CT had gone out of use in 1996 – 2000.

In another study done by Davis A, et al,2010 showed that hydrocephalus occurs in fetal more than adult with different causes and symptoms.

Perdaens et al,2008 studied the causes of hydrocephalus in different group of people and the study showed that the hydrocephalus or water on the brain is condition associated with build of CSF in or around the brain.

There are many causes of hydrocephalus and is often congenital , meaning babies and born with it and there is no specific causes of congenital hydrocephalus. However,it may be genetic defect , or be the result of another disorder such spina bifida or encephalocele .

CHAPTER THREE
MATERIALS AND METHODS

Chapter Three

Material And Methods

3.1 Material:

3.1.1 Sample of the study:

A total sample of 35 patients with signs and symptoms of hydrocephalus, we included in the study. All of the patients investigated by CT scan and had ct reports. The average age ranging between (1day -75 years)of patents were female and were males.

3.1.2 Area and duration of the study:

The study has been carried out during the period from October 2017 up to march 2018 in soba university hospital and EL_AMAL hospital.

3.1.3 Machine used:

Siemensens smoatoms , sensation 16 with KVP/120 , mA with medium (63 mA) , low (45 mA) , in police hospital .

Siemens smoatoms , sensation 16 with 16 eith kvp/120 , mA with medium (64mA), low (250 mA) , in soba university hospital

3.2 Methods:

3.2.1 Technique used:

All axial scan obtain with slice thickness 3-5 mm at base of skull 7-10mm above the sella. Axial images, without contrast obtain with 10-15 degree angle with radiographic base line. Most of children underwent ct scan after sedation and slice thickness 10mm with similar spacing and scan time 5 seconds.

3.2.2 Image interpretation:

All axial images were studied by senior radiologist, to diagnose the stage of hydrocephalus, types communicating or none communicating and underline causes.

3.2.3 Data analysis:

The data analyzed through statistical package for social science.

CHAPTER FOUR
RESULTS

Chapter Four
Results

Table (4.1) frequency distribution of gender

Gender	Frequency	Percent	Valid Percent	Cumulative Percent
Female	19	54.3	54.3	54.3
Male	16	45.7	45.7	100.0
Total	35	100.0	100.0	

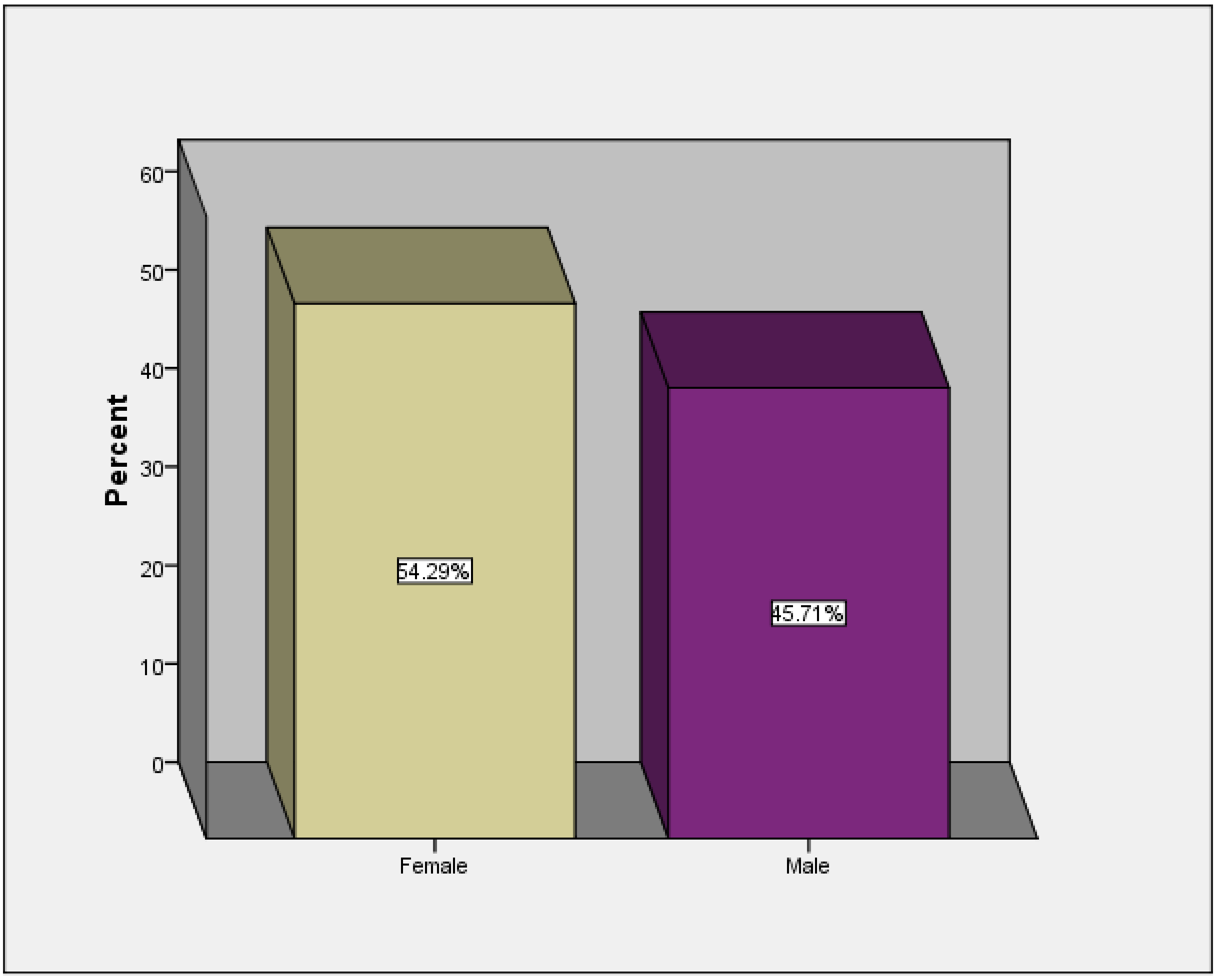


Figure (4.1) frequency distribution of gender

Table (4.2) frequency distribution of age

	Frequency	Percent	Valid Percent	Cumulative Percent
10y	4	11.4	11.4	11.4
12y	1	2.9	2.9	14.3
13d	1	2.9	2.9	17.1
14m	1	2.9	2.9	20.0
15y	1	2.9	2.9	22.9
18y	1	2.9	2.9	25.7
1m	1	2.9	2.9	28.6
1y	1	2.9	2.9	31.4
20d	1	2.9	2.9	34.3
20y	1	2.9	2.9	37.1
22y	1	2.9	2.9	40.0
25m	2	5.7	5.7	45.7
2y	4	11.4	11.4	57.1
33y	1	2.9	2.9	60.0
3m	4	11.4	11.4	71.4
3y	1	2.9	2.9	74.3
5m	1	2.9	2.9	77.1
5y	1	2.9	2.9	80.0
6m	2	5.7	5.7	85.7
7y	3	8.6	8.6	94.3
9y	2	5.7	5.7	100.0
Total	35	100.0	100.0	

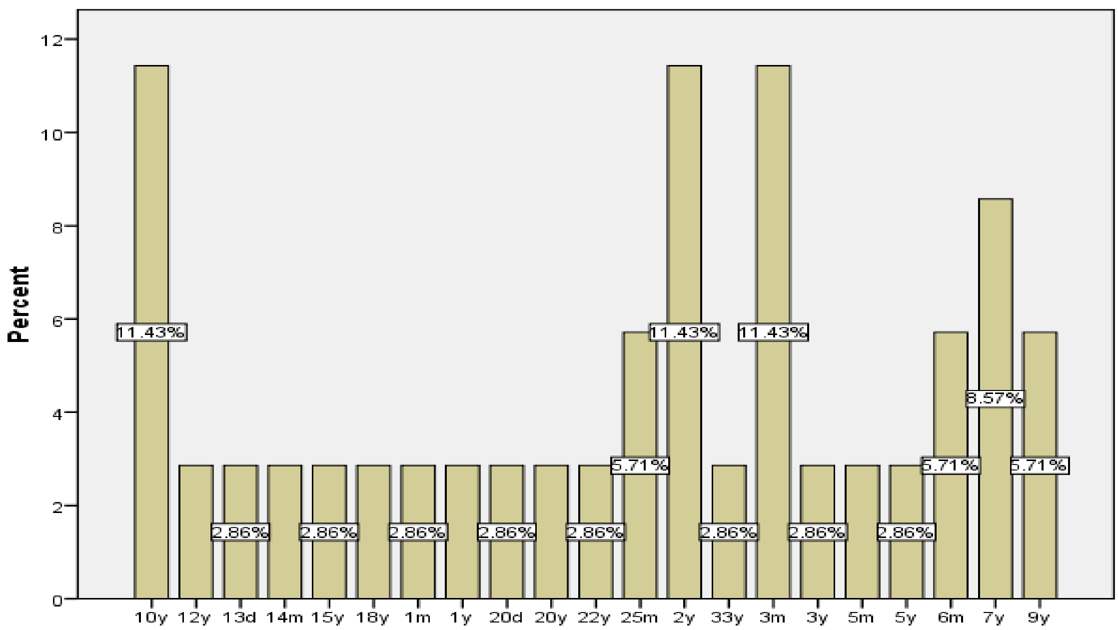


Figure (4.2) frequency distribution of age

Table (4.2) frequency distribution of age

	Frequency	Percent	Valid Percent	Cumulative Percent
day to month	3	8.6	8.6	8.6
one month to year	10	28.6	28.6	37.1
years one month to 10 years	16	45.7	45.7	82.9
11 year to 20 years	4	11.4	11.4	94.3
more than 20 years	2	5.7	5.7	100.0
Total	35	100.0	100.0	

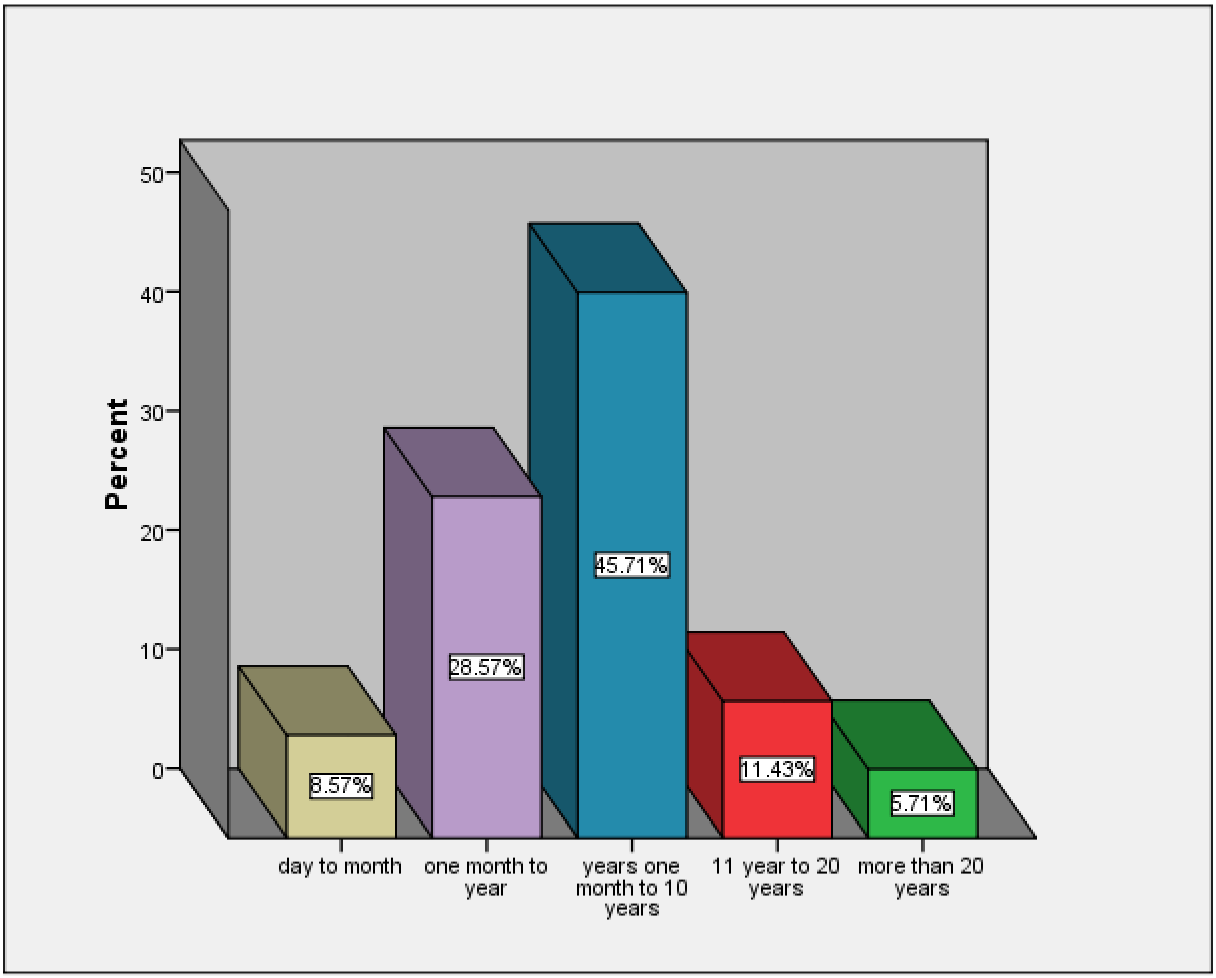


Figure (4.2) frequency distribution of age

Table (4.3) frequency distribution of type of hydrocephalus

	Frequency	Percent	Valid Percent	Cumulative Percent
Communicating	15	42.9	42.9	42.9
Non-Communicating	20	57.1	57.1	100.0
Total	35	100.0	100.0	

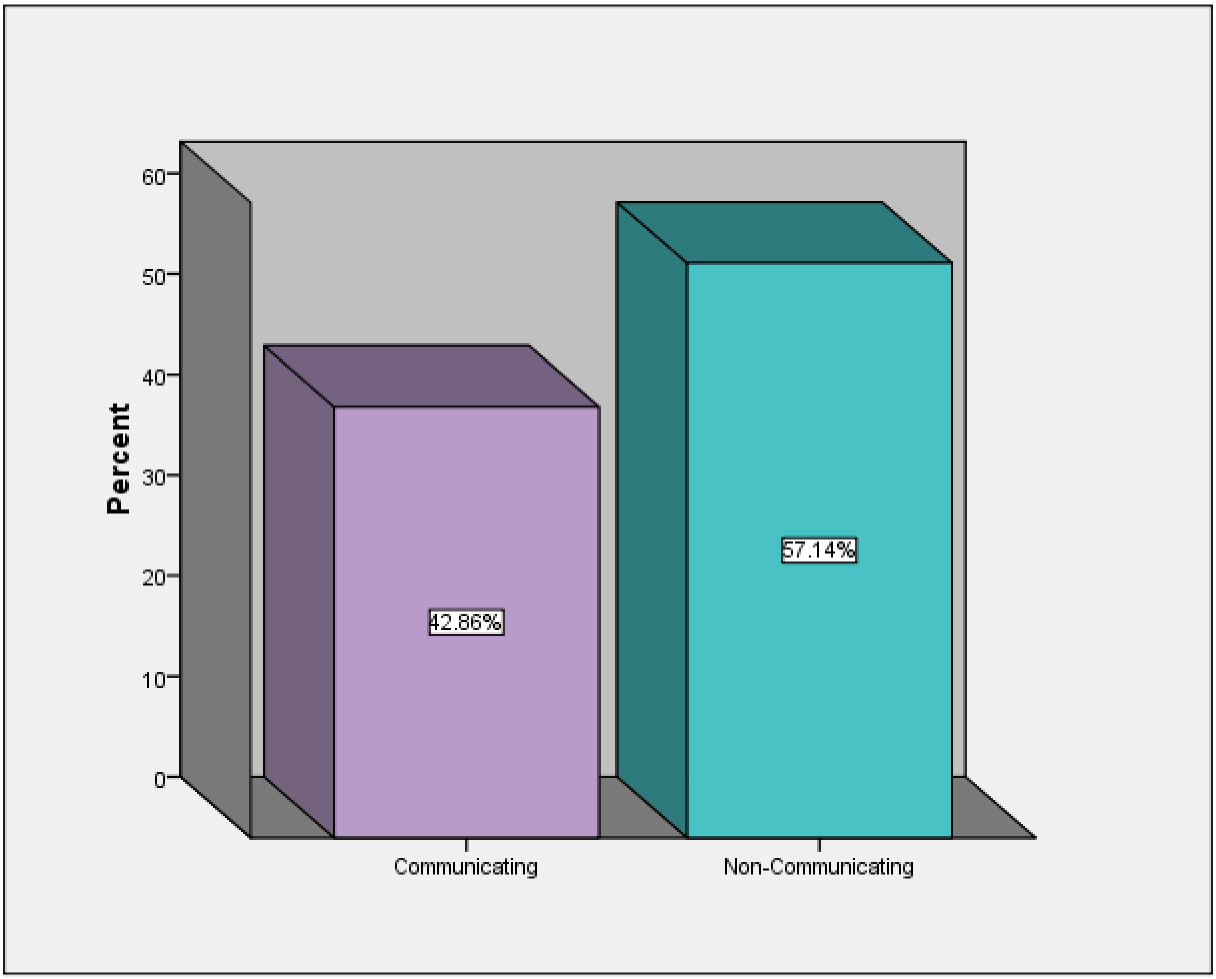


Figure (4.3) frequency distribution of type of hydrocephalus

Table (4.4) frequency distribution of causes of hydrocephalus

	Frequency	Percent	Valid Percent	Cumulative Percent
Mass	4	11.4	11.4	54.3
Congenital syvian duct obstruction	1	2.9	2.9	31.4
Aqueductal stenosis	1	2.9	2.9	34.3
Choroid plexus papilloma	1	2.9	2.9	37.1
Congenitalanamolies	10	28.6	28.6	28.6
Congenital aqueductal stenosis	4	11.4	11.4	54.3
Congenital cerebroplasia	1	2.9	2.9	57.1
Congenital mass	1	2.9	2.9	60.0
Cyst	1	2.9	2.9	62.9
Dandy walker malformation	4	11.4	11.4	74.3
Infection	1	2.9	2.9	77.1
Un known	5	14.3	14.3	91.4
Post meningitis	2	5.7	5.7	97.1
Posterior fossa	1	2.9	2.9	100.0
Total	35	100.0	100.0	

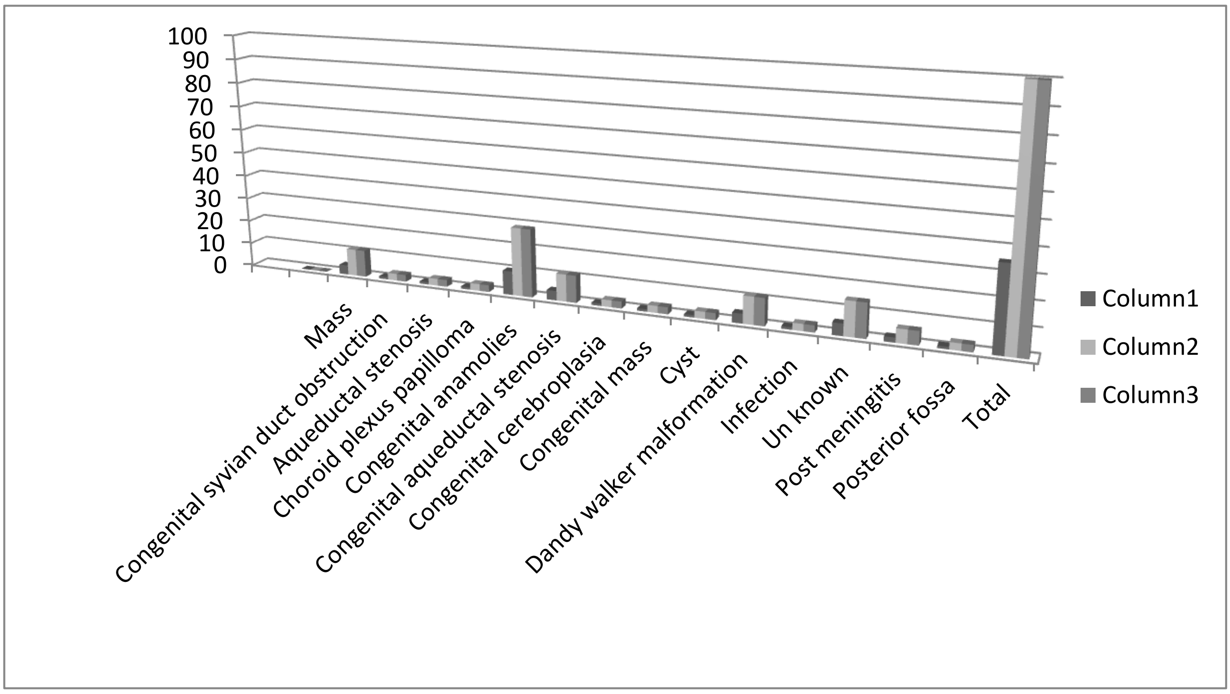


Figure (4.4) frequency distribution of causes of hydrocephalus

Table (4.5) frequency distribution of symptom and sign

	Frequency	Percent	Valid Percent	Cumulative Percent
Enlargement of head	19	54.3	54.3	54.3
Headache	8	22.9	22.9	77.1
Loss of balance	1	2.9	2.9	80.0
Visual disturbance	7	20.0	20.0	100.0
Total	35	100.0	100.0	

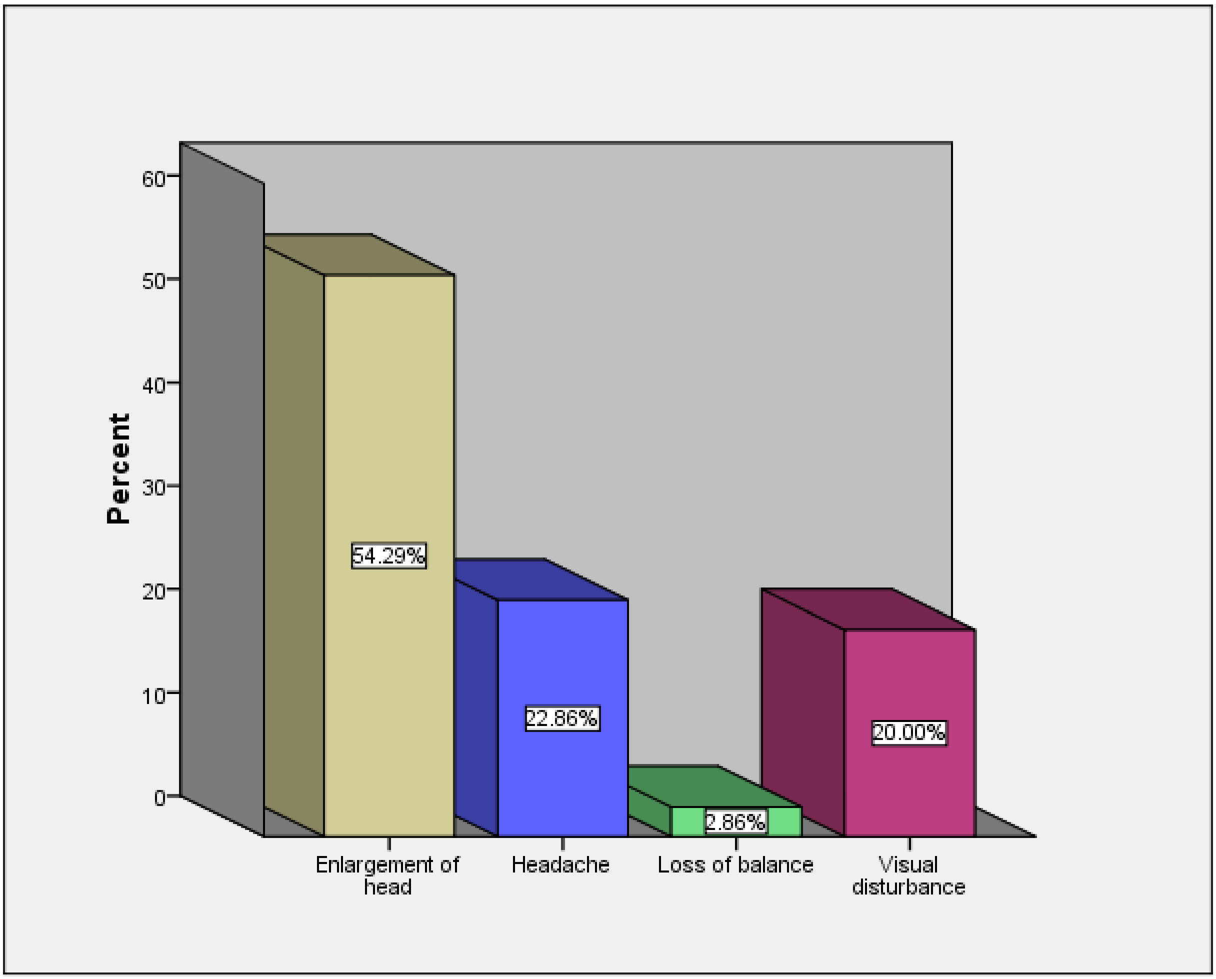
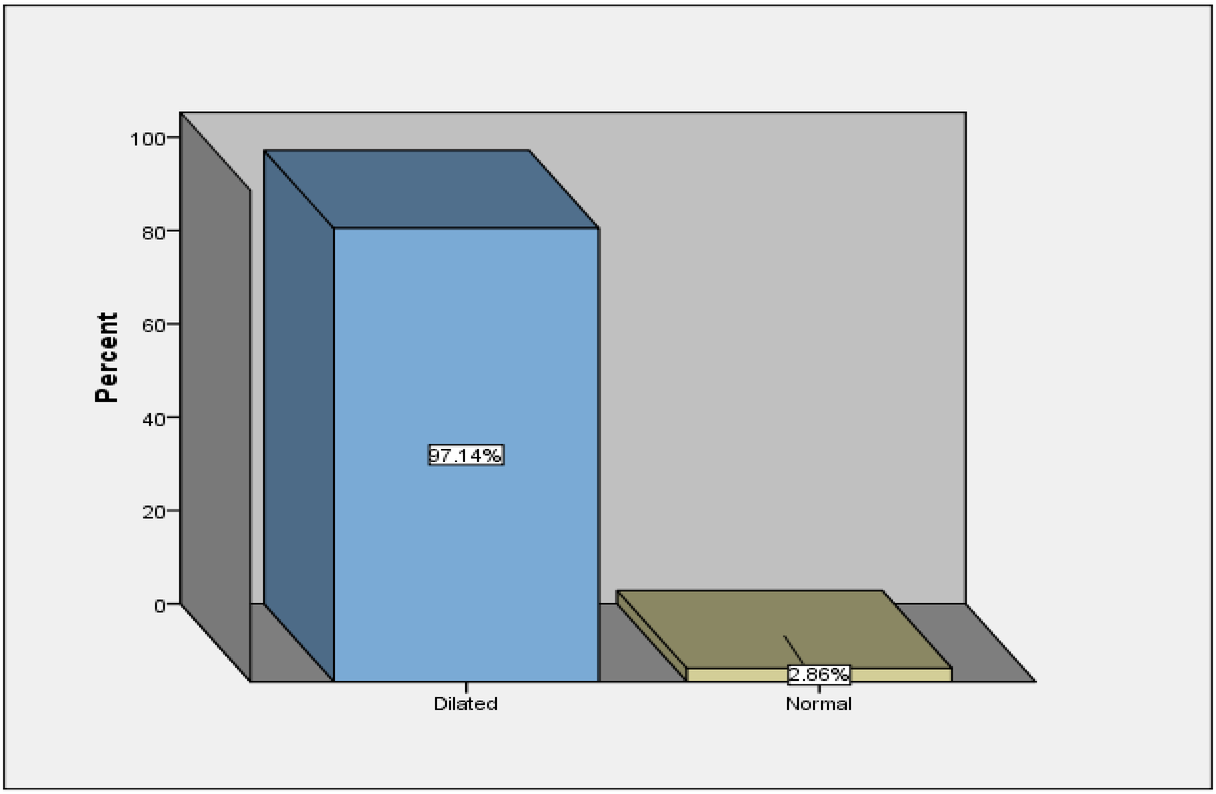


Figure (4.5) frequency distribution of symptom and sign

Table (4.6) measurement of two lateral ventricles

	N	Minimum	Maximum	Mean	Std. Deviation
Lat ventricle	35	10.00	22.00	15.7429	3.61649
Lat ventricle	35	10.00	22.00	15.8714	3.56318
Valid N (listwise)	35				



Figure(4.6) measurement of third ventricle

Table (4.7) measurement of third ventricle

	Frequency	Percent	Valid Percent	Cumulative Percent
Dilated	34	97.1	97.1	97.1
Normal	1	2.9	2.9	100.0
Total	35	100.0	100.0	

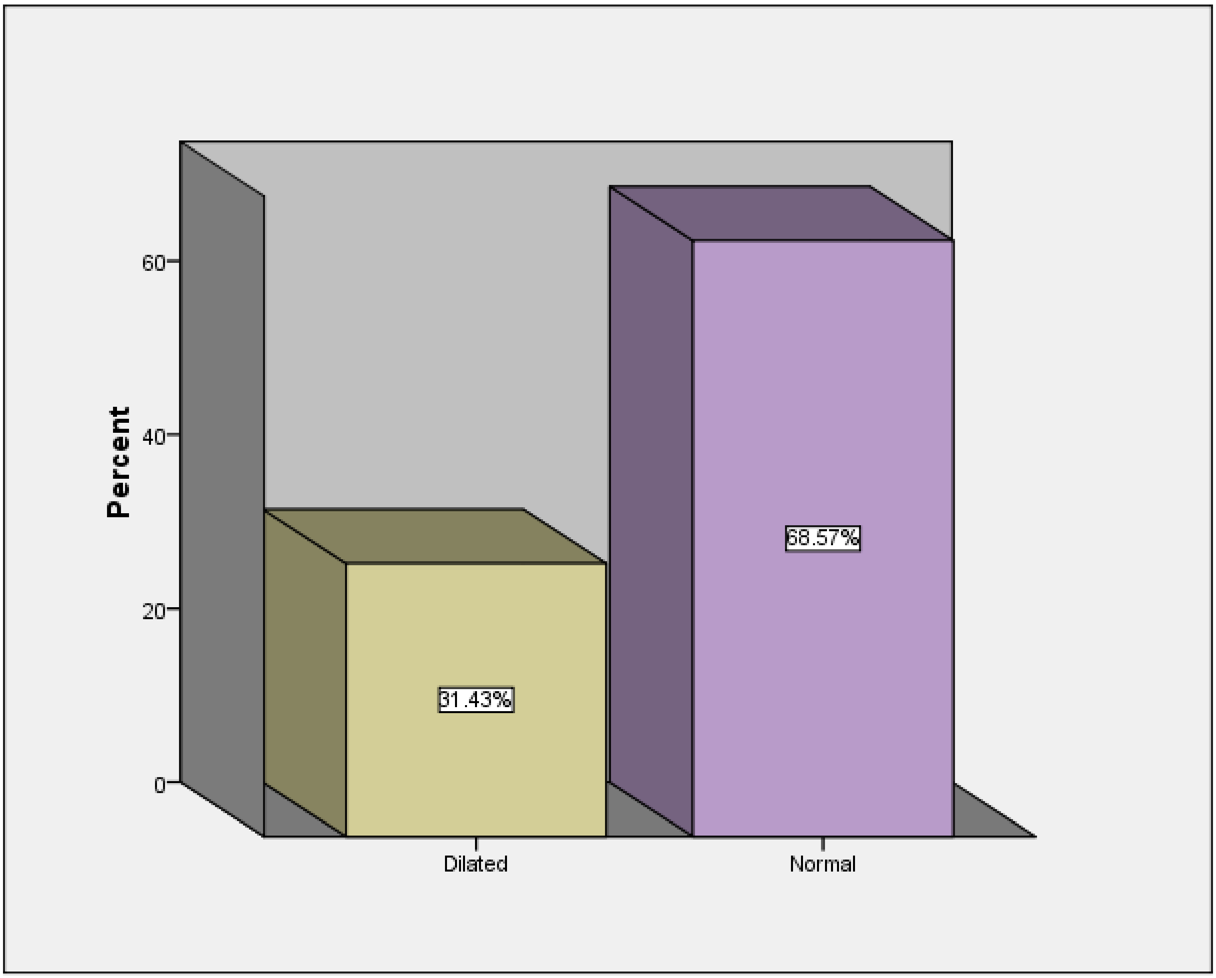


Figure (4.7) measurement of fourth ventricle

Table (4.8) measurement of fourth ventricle

	Frequency	Percent	Valid Percent	Cumulative Percent
Dilated	11	31.4	31.4	31.4
Normal	24	68.6	68.6	100.0
Total	35	100.0	100.0	

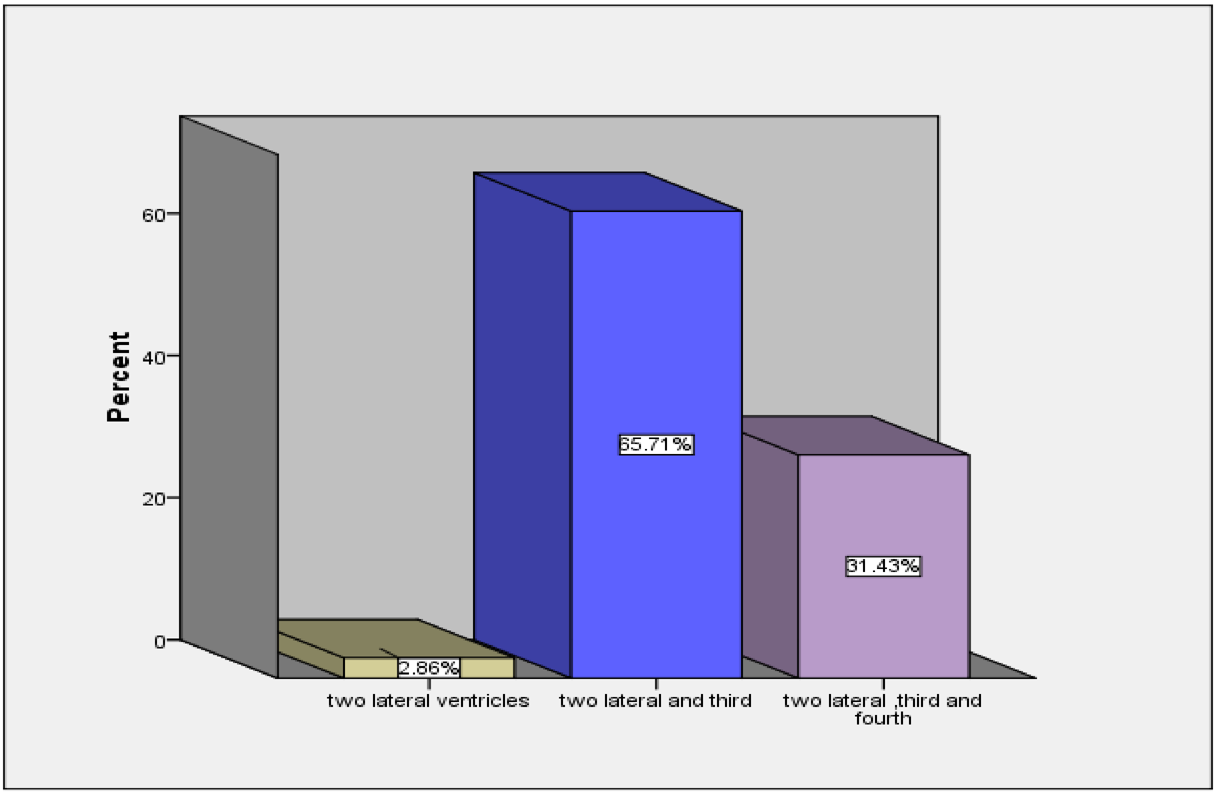


Figure (4.8) frequency of dilated ventricles

Table (4.9) frequency of dilated ventricle

	Frequency	Percent	Valid Percent	Cumulative Percent
two lateral ventricles	1	2.9	2.9	2.9
two lateral and third	23	65.7	65.7	68.6
two lateral ,third and fourth	11	31.4	31.4	100.0
Total	35	100.0	100.0	

Table (4.10) cross tabulation causes with age

Cause	Age					Total
	day to month	one month to year	years one month to 10 years	11 year to 20 years	more than 20 years	
	1	3	6	0	0	10
Congenital syvian ductobstruction	0	0	1	0	0	1
Aqueductal stenosis	0	0	1	0	0	1
Choroid plexus papiloma	1	0	0	0	0	1
Congenital	0	1	0	1	0	2
Congenital aqueductal stenosis	0	1	1	0	2	4
Congenital cerebroplasia	0	0	0	1	0	1
Congenital mass	0	0	1	0	0	1
Cyst	0	0	0	1	0	1
Dandy walker malformation	0	1	3	0	0	4
Infection	0	1	0	0	0	1
Mass	1	3	1	0	0	5
Post meningitis	0	0	1	1	0	2
Posterior fossa	0	0	1	0	0	1
Total	3	10	16	4	2	35
P value =0.123						

Table (4.11) cross tabulation causes with type of hydrocephalus

Causes	type		Total
	Communicating	Non-Communicating	
Not mention	4	6	10
Congenital syvian ductobstruction	0	1	1
Aqueductal stenosis	0	1	1
Choroid plexus papilloma	1	0	1
Congenital	0	2	2
Congenital aqueductal stenosis	4	0	4
Congenital cerebroplasia	1	0	1
Congenital mass	1	0	1
Cyst	0	1	1
Dandy walker malformation	1	3	4
Infection	1	0	1
Mass	1	4	5
Post meningitis	1	1	2
Posterior fossa	0	1	1
Total	15	20	35
P value =0.207			

Table (4.12) cross tabulation causes with dilated ventricles

Causes	Dilated ventricles			Total
	two lateral ventricles	two lateral and third	two lateral ,third and fourth	
	0	7	3	10
Congenital syvian ductobstruction	0	1	0	1
Aqueductal stenosis	0	1	0	1
Choroid plexus papilloma	0	0	1	1
Congenital	0	2	0	2
Congenital aqueductal stenosis	0	1	3	4
Congenital cerebroplasia	0	0	1	1
Congenital mass	0	1	0	1
Cyst	0	1	0	1
Dandy walker malformation	1	2	1	4
Infection	0	1	0	1
Mass	0	4	1	5
Post meningitis	0	1	1	2
Posterior fossa	0	1	0	1
Total	1	23	11	35
P value =0.776				

Chapter Five
Discussion, conclusion and recommendation

Chapter Five

Discussion, Conclusion And Recommendation

5.1 Discussion

My study show that (54,3%) are male while (45,7%) are females as in table and fig(4.1).
(8,6%) their ages between one day to one month. (28,6%) their ages between one month to one year. 16 patients (45,7%) their ages between years one month to 10 years. ,(11,4%) their ages between 11 years to 20 years .While (5,7%)their ages more than 20 years These findings reflects that the clinical suspicion of hydrocephalus is high in children more than adult because most of hydrocephalus were fetal .from this study , the research found that there is same result with Davis A, et al,2010(.

(42,9%) out of patients with communicating hydrocephalus, others (57%) with non-hydrocephalus.

(11,4) their cause are mass, (28,6%) their cause are congenital anomalies . ((2,9) with acquiductal stenosis, (2,9%) congenital syvian duct,(2,9%) choroid plexus papilloma, (28,6%) congenital anomalies,(28,6%) unknown cause, (2,9%) infection and (11,4%) acquiductal stenosis , ,my result similar to Perdaens et al,2008

(54,3%) of the patients with head enlargement, (22,9%) headache, (2,9%)loss of balance and (20%) visual disturbance as in table and fig(4.5)

(10)% with dilated right and left lateral ventricle by different size in mm because if there is no dilatation in lateral ventricle there is no hydrocephalus as in show in table and fig(4.6)

the CT is informative in demonstrating the site of obstruction and these reflected that the third ventricle is the most common site of obstruction as in table and fig (4.7) , The research found that there are same results with Bruwer et al, 2003.

(31,4%) with dilated 4^{th}ventricle while (68,6%) is with normal 4^{th}ventricle as in tab and fig(4.8).

According to these findings , ct is important in assessment hydrocephalus. Ct can deal with all age group , and usually identify the level and cause of obstruction

5.2 Conclusion:

Hydrocephalus is a disease occurs in pediatric and it may occur in the elderly. The main objective of this study is to study the role of CT in diagnosis of the disease.

Hydrocephalus involves neonates and children who are below 10 years most commonly.

CT is important imaging technology for demonstrating hydrocephalus and its causes, but it has its own advantages delimitations. The main cause of hydrocephalus is congenital. CT is very informative in demonstrating the cause and the site of obstruction. Some cases of congenital hydrocephalus the cause remains unknown in this study.

5.3 Recommendations:

- For unknown cause of hydrocephalus there should be further imaging investigations such as MRI.
- All governmental hospitals should have a CT department especially Gafar Ibn Auf Hospital.
- The goverrnent should encourage establishing of CT clinics by giving more financial facilities, which should decrease the price of CT investigation.
- The training department in Ministry of Health should offer considerable chances for staff training in CT.
- Upcoming studies should only be done on pediatric field.

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Appendixes

Appendix

Appendix (B)

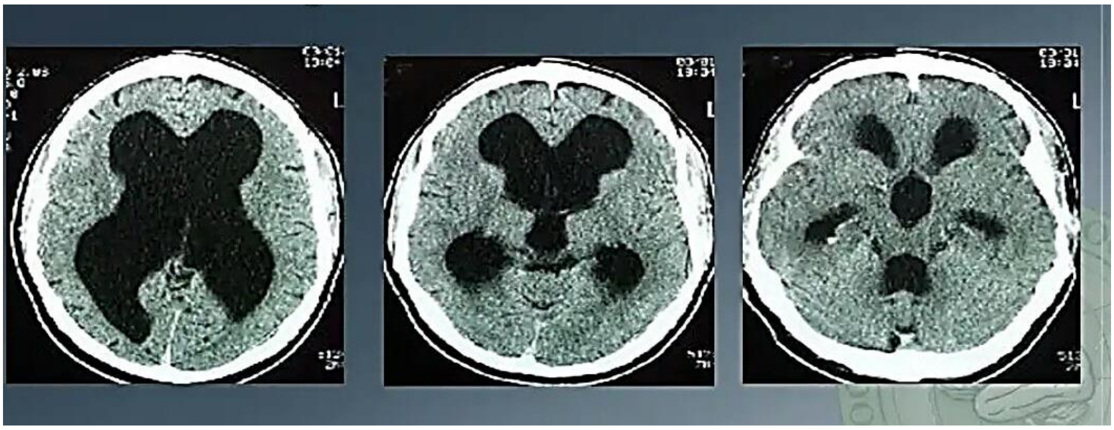

Image (B.1)

Communicating Hydrocephalus

- Enlargement of lateral, 3rd, and 4th ventricles

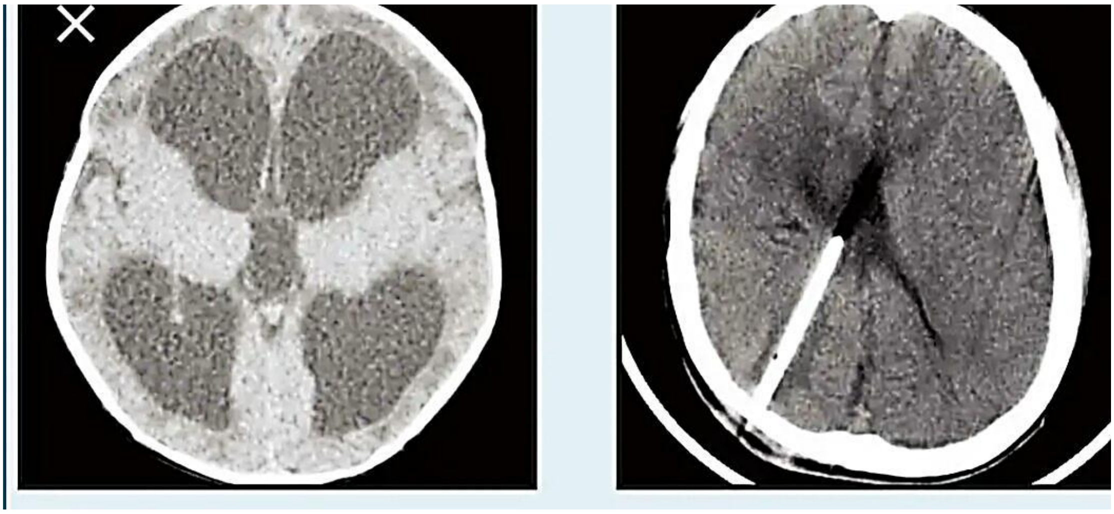

Image (B.2)
Enlarged ventricles

Ventricles after shunt placement

Image (B.3)
Shows a 5- year – old child’s head affected by hydrocephalus.

Image (B.4)
Preoperative V-P Shunt done

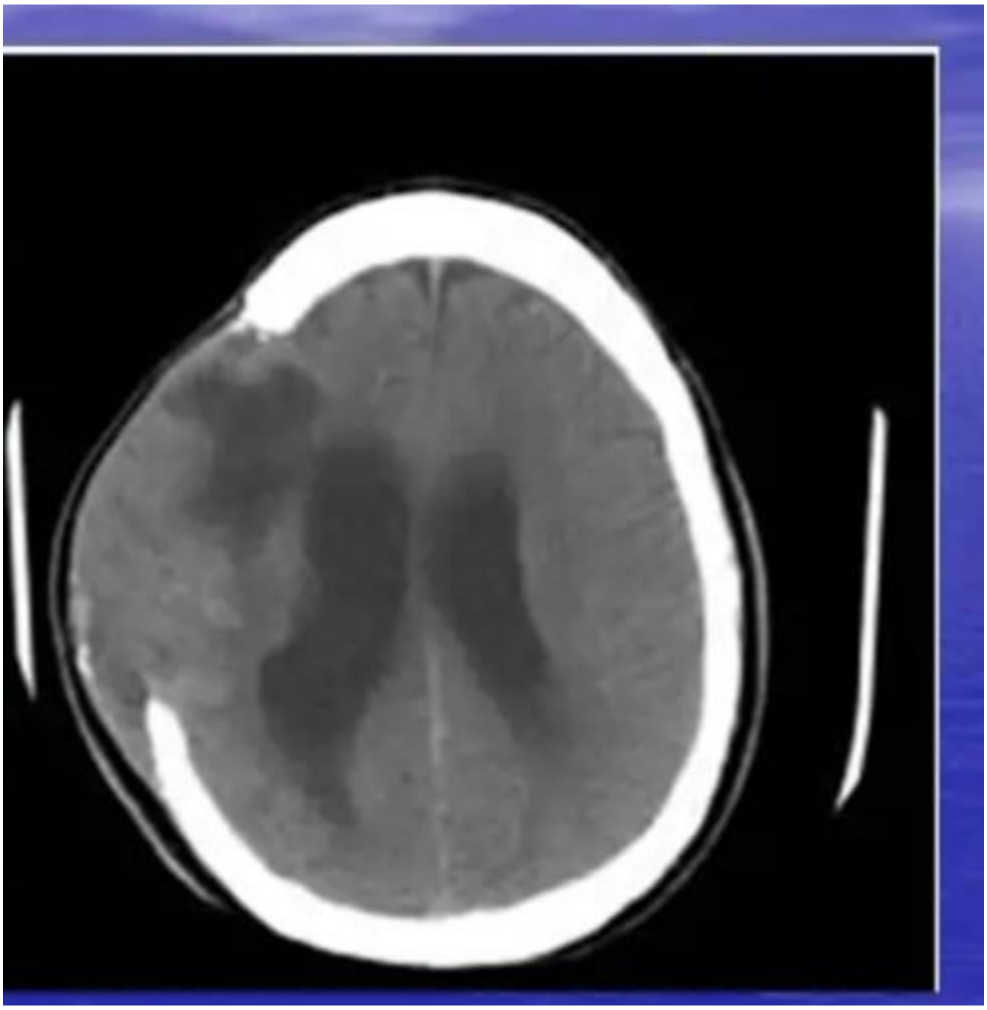

Image (B.5)
Nonenhanced computer tomography (CT) scan of the brain at the level of the body lateral ventricles was obtained in a 37-year-old man who underwent a right frontotemporal decompression craniectomy for a large right frontal hematoma after skiing accident. A focal hypoattenuating infract is seen in the right frontal lobe, with an adjacent edematous brain parenchyma herniating through the right frontotemporalcraniectomy defect. The patient had communicating hydrocephalus with dilatation of the lateral ventricles.

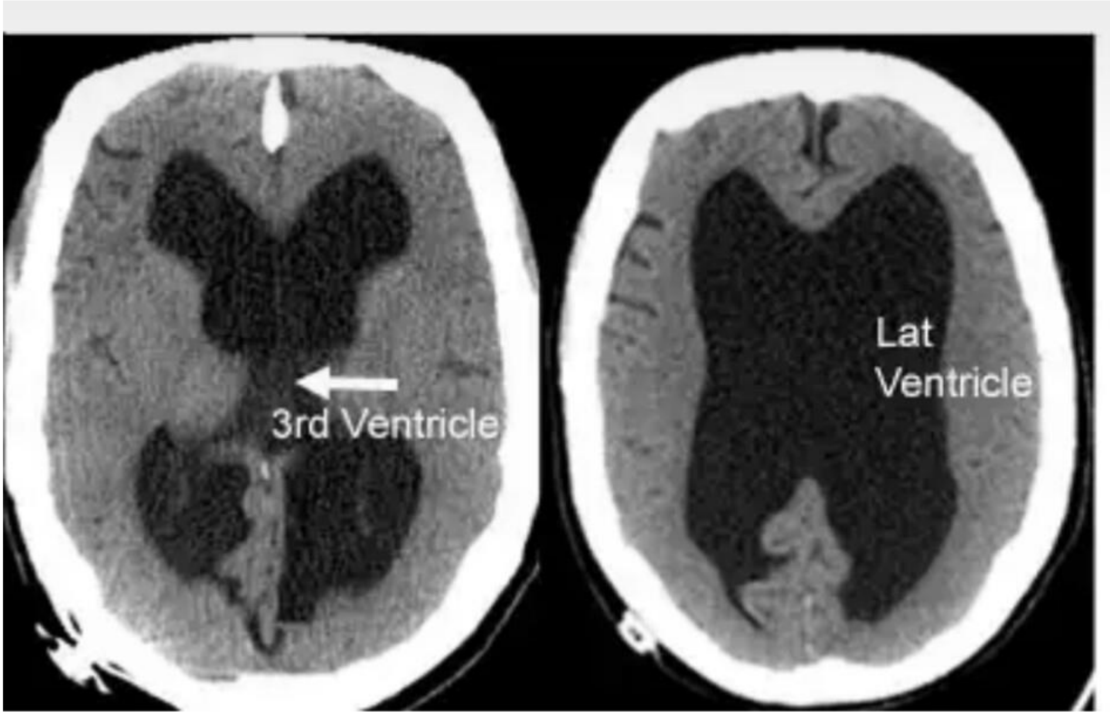

Image (B.6)

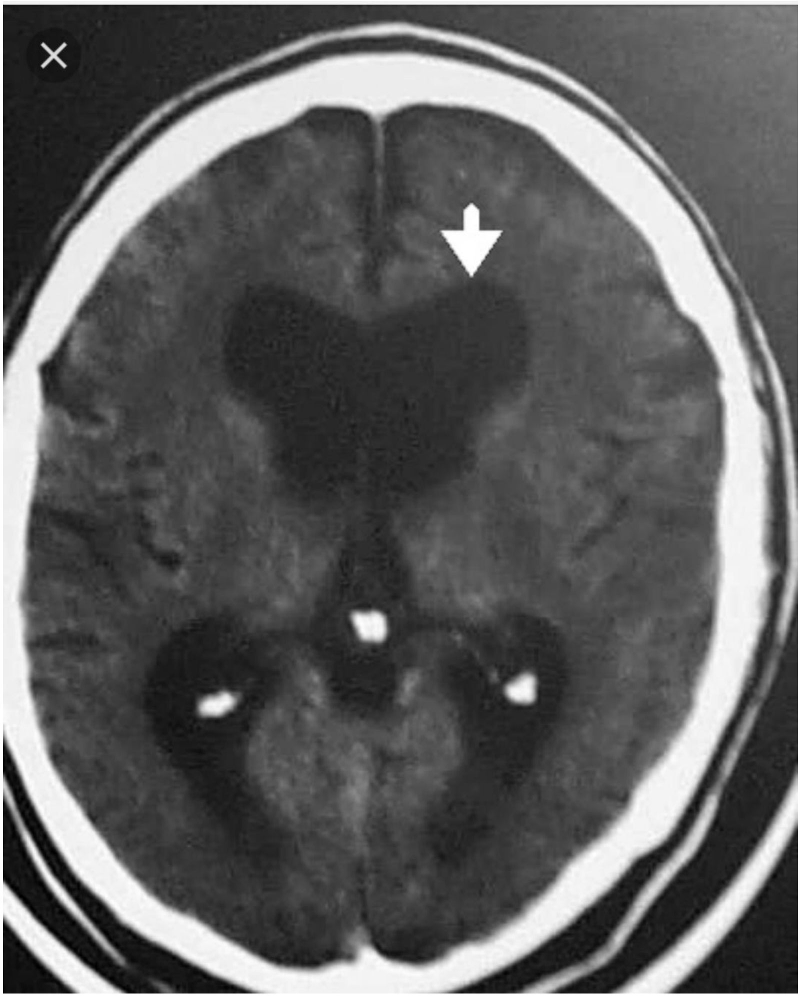

Image (B.8)
What is normal pressure hydrocephalus?