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Study of Hydrocephalus in Children using MRI and CT.

دراسة استسقاء الراس للأطفال باستخدام الاشعة المقطعية والرنين المغنطيسى

A thesis Submitted for Partial Fulfillment Of the Requirements of

The M.Sc. Degree in Diagnostic Radiologic Technology

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الآية الكريمه

قال تعالى:

(قُلْ إِنَّ صَلاَتِي وَنُسُكِي وَمَحْيَايَ وَمَمَاتِي للَّهِ رَبِّ ٱلْعَالَمِينَ)

سورة الانعام الآية (١٦٢)

Dedication

To my father .

To my mother .

To my brothers .

To my teachers .

To my husband .

To my colleagues .

Acknowledgment

Grateful thanks and grace to Allah, the Almighty for guiding and helping me to finish this research

I would like to express my deep gratitude to Dr.Hussien ahamed Hassan for this encouraging , supervision and guidance of this research.

My thanks go to the staff technologist in central modern medical and Ibrahim malik hospital , alzaytona specialized hospital.

Finally , special thanks to my family and friends who were of great help during the whole study period.

Abstract

Hydrocephalus is common disease which effects pediatric and elderly people . this research aimed to study the hydrocephalus using the computed tomography(CT) and magnetic resonance (MR) modality. The study was carried out at central modern medical and alzaytona hospital and Ibrahim malik hospital in khartoum during the period from September 2017 to December 2017.

Arandom sample of 50 patient (21 male and 29 female) with different age was included in the study the patient selection was based on the diagnostic reports at the MR and CT department of hospital . the study revealed the significant of CT in the diagnosis of hydrocephalus ,in term of the causes determination of the site of obstruction and determine type of hydrocephalus, and also the study revaled the significant of MR in the diagnosis of hydrocephalus aid in therapy planning and post surgery follow up of patient .

congenital genetic factor is considered the main cause of this disease were 62% .

The result showed the non-communicating hydrocephalus constituted68% and the communicating type constituted 32% of the study sample.

Finally, the study recommended conducting future study on greater sample on other places.

مستخلص الدراسة

يعتبر مرض استسقاء الراس من الامراض التي تصيب الصغار بصفه اساسية وأحيانا يصيب كبار السن والهدف من هذا البحث هو دراسة قدرة الاشعة المقطعية والرنين المغنطيسى فى تشخيص المرض وتحديد اسبابة .

اجريت الدراسة فى المركز الطبى الحديث و مستشفى الزيتونة ومستشفى ابراهيم مالك بالخرطوم خلال الفترة من سبتمبر ٢٠١٧م حتى ديسمبر ٢٠١٧م وتم اخذ عينه من(٥٠)مريضا(٢١ ذكور، ٢٩ اناث) من مختلف الاعمار وكان اختيار المرضى مبنيا علي التقارير الطبية لصور الاشعه المقطعيه والرنين المغناطيسي الخاصة بالمرضى في المستشفي.

اوضحت الدراسة ان الاشعة المقطعية لها دور هام فى تشخيص مرض استسقاء الراس وتحديد مكان الانسداد والرنين المغناطيسي له دور في توضيح خطه العلاج والمتابعة بعد العمليه الجراحيه.

اوضحت الدراسة ان السبب الاساسى لهذا المرض هو جينى ولادى بنسبة ٦٢ %

اوضحت الدراسة ايضا ان استسقاء الراس غير التوصيلي قد شكل(٦٨%) من العينه والتوصيلي (٣٢%).

اوصت الدراسة بإجراء دراسة مستقبليه علي عينات اكبر وفي اماكن اخرى

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Abbreviations

3V- SF	Third ventricle – sylvian fissure
CMV	Cytomegalovirus
CNS	Central nervous system
CSF	Cerebro spinal fluid
CT	Computed tomography
ETV	Endoscopic third ventriculo stomy
ICP	Intracranial pressure
INPH	Idiopathic normal pressure hydrocephalus
LP	Lumbo peritoneal
MRI	Magnetic Resonance Imaging
NPH	Normal pressure of carbon Dioxide
RBCS	Red Blood Cells
US	Ultra sound
VA	Ventriculo –atrial
VJ	Ventriculo – jugular
VP	Ventriculo – peritoneal
WBCS	White blood cells

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Chapter One

1.1 Introduction:

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 kinds 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, 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 "noncommunicating." 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 'not be as dramatic. Both types of elevated-pressure hydrocephalus 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 noncommunicating hydrocephalus. In cases of suspected normal pressure hydrocephalus, a spinal tap may help determine CSF pressure. A cisternagram evaluates the dynamics of CSF flow in the brain and spinal cord. In this procedure, a diagnostic 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 reveal 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 infections (e.g., cytomegalovirus [CMV], toxoplasmosis, rurjella) and internal bleeding in the brain. (Alfred Aschoff, et al, 1999).

The congenital malformations are commonly associated with CSF obstruction, which are Aqueductalstenosis-narrowing of the pathway to the fourth ventricle, Arnold-Chiari malformations-small part of the cerebellum protrudes into the spinal canal, Dandy-Walker syndrome-enlarged fourth ventricle due to obstruction in pathway and Spina 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.

Hemorrhaging, traumatic brain injury, and infection are seen in some premature births; premature births may be a risk factor for hydrocephalus.

Symptoms of 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 Problem of the study :

Hydrocephalus now day common disease children the Hydrocephalus is determine by size of ventricle this study try to identify the abnormal size of ventricle when can regarded of Hydrocephalus disease

1.3 Objectives of study:

The general objective: Study of hydrocephalus in children using MRI and CT .

The specific objective:

- To correlate hydrocephalus with age.
- To classificate type of Hydrocephalus.
- To assess causes of Hydrocephalus.
- To assess nature of hydrocephalus.

1.4 Overview of study :

- Chapter one : introduction and objectives of the study .
- Chapter tow : literature Review and background study .
- Chapter Three : Material and Methods .
- Chapter Four : Results .
- Chapter Five : Discussion , conclusion and Recommendations .

References and Appendixes

Chapter Two

Literature Review

and background studies

Chapter Two

Literature Review

2.1 Theoretical Background

2.1.1 **Anatomy of CSF 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 trigone or atrium, the posterior or occipital horn and the inferior or temporal horn. Each lateral ventricle communicates with the thin single midline 3rd ventricle by their interventricular foramen of Monro. The 3rd ventricle is connected to the 4th ventricle by the cerebral aqueduct of Sylvius. The 4^{m} ventricle communicates with the subarachnoid space by a medial aperture, the foramen of Magendie and two lateral apertures, the foramen of Luschka. (Alfred Aschoff et al, 1999)

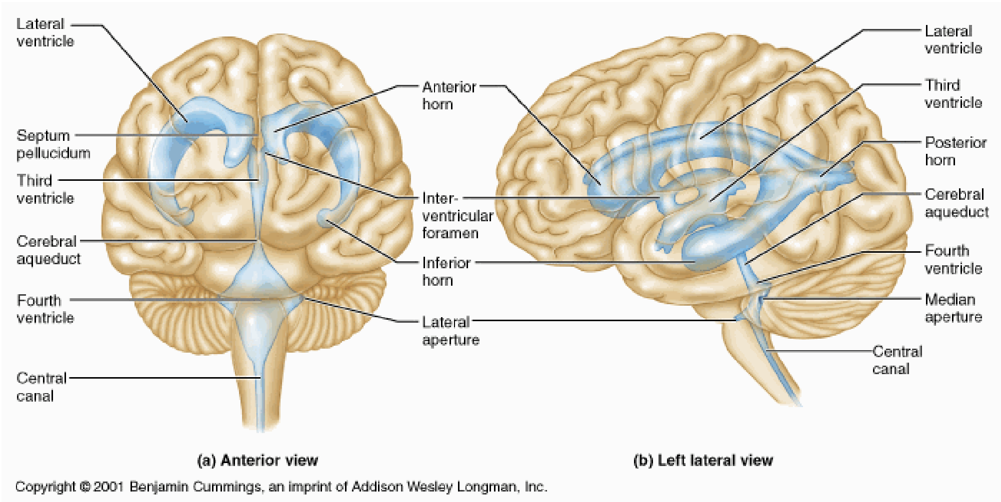


Fig (2 -1) anterior and lateral views of brain ventricles

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 trigone and the superior medial aspect of the temporal horns. The choroid plexus of the lateral ventricles travels through the foramen of Monro and is continuous with the choroid plexus found in the roof of the 3rd ventricle. There is also choroid plexus in the roof of the 4th ventricle. (Alfred Aschoff et al, 1999)

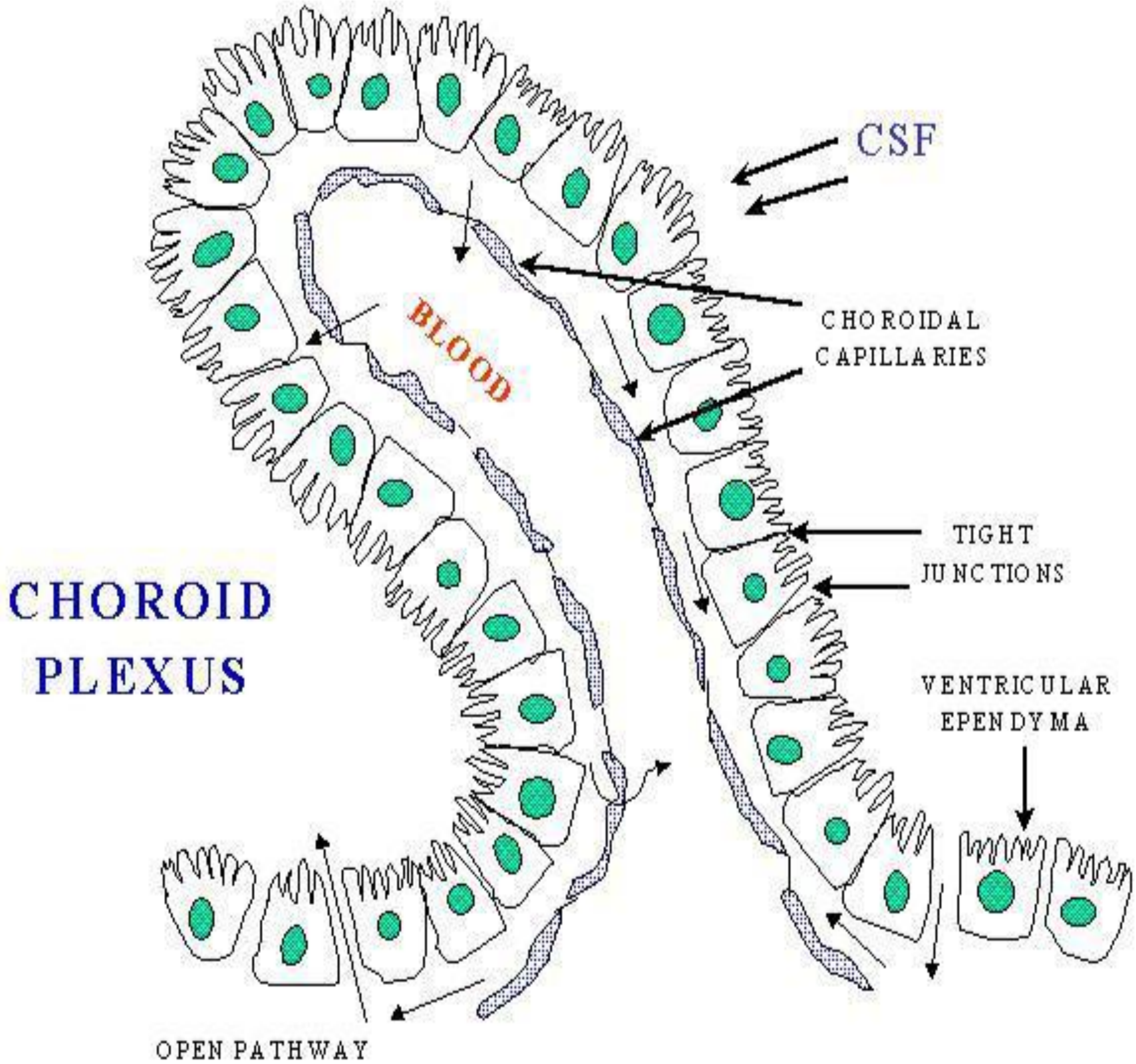


Fig (2 -2) shows choroid plexus

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 arachnoidvilli that empty into the radicular veins. The conusmedullaris of the spinal cord is usually located at the inferior aspect of the Li vertebral body and the lumbar and sacral spinal nerve roots form the caudaequina below this level. The CSF space around the caudaequina is 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)

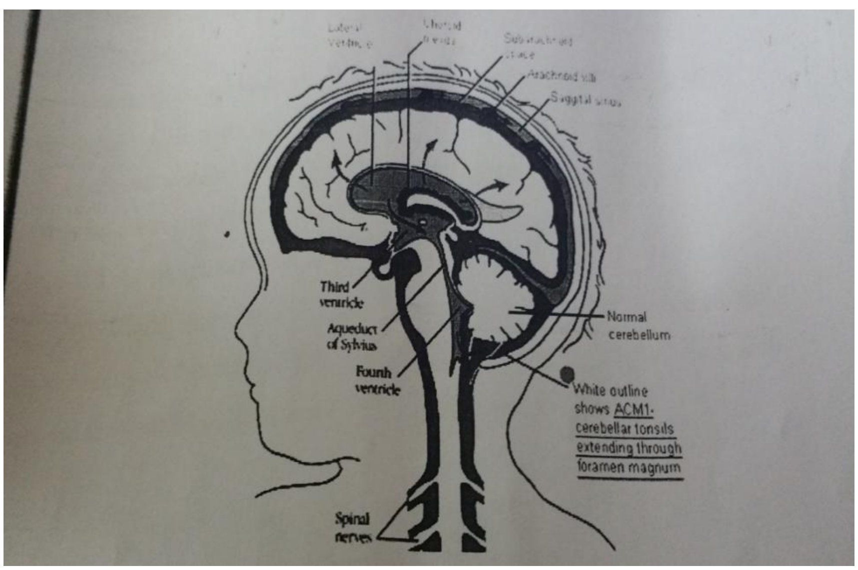


Fig. (2-3) Diagram showing the positions of the three principal sub arachnoidcisternal

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 Aschoffetal, 1999)

The ventricles are filled with cerebrospinal fluid (CSF), which provides the following functions: 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 of the CSF is produced) to the third and then fourth ventricles. From the fourth ventricle, 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 returns to the blood through the arachnoidvilli located in the dural sinuses of the meninges. (Alberto J Espay, 2010)

There are four cerebral ventricles: the paired lateral ventricles, and the midline third and fourth ventricles. The two lateral ventricles, located within the cerebrum, are relatively large and C-shaped, roughly wrapping around the 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. (Alberto J Espay, 2010)

Hydrocephalus (known colloquially as "water on the brain"), is an extremely serious condition due to both the damage caused by the pressure as well as nature of whatever caused the block (e.g. a tumour or inflammatory swelling).the cavity of cerebral hemisphere are called lateral ventricles orl&2 ventricles, these two ventricles open commonly into 3 ventricles by a common opening called foramen of monroe. (Alberto 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 ventricle, 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 arachnoidvilli in the subarachnoid space into the cerebral venous system to maintain a constant volume and intracranial pressure within the brain. CSF functions 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 cc in ventricles); 450 cc is produced per day.

Arachnoid granulations absorb if pressure is 3-6 cmH20 above venous pressure. Normal pressure is 10-15 cmH20; 3-6 cmH20 in children; 20-30 cmH20 when sitting. Secretion increased by C02 and volatile anesthetics; secretion decreased by NE and carbonic anhydrase inhibitors. (Relkin et al., 2005)

Cerebrospinal fluid (CSF) is considered a part of the transcellular fluids. It is contained in the ventricles and the subarachnoid space 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 this '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 mis. The daily production is 550 mis/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 ventricules (50%). CSF flows through the foramens of Magendie& Luschka into the subarachnoid space of the brain and spinal cord. It is absorbed by thearachnoidvilli (90%) and directly into cerebral venules (10%).(Relkin et al., 2005)

The normal intracerebral pressure (ICP) is 5 to 15 mmHg. The rate of formation of CSF is constant and is not affected by ICP. Absorption of CSF increases linearly as pressure rises above about

7 cmsH20 pressure. At a pressure of about 1 lcmsH20, the rate of secretion & absorption are equal.

The CSF has a composition identical to that of the brain Extra Cellular Fluid (ECF) but mis is different from plasma. The major differences from plasma are; the Partial Pressure of Carbon Dioxide (pCO2), reflects the the amount of carbon dioxide gas dissolved in the blood, is higher (50 mmHg) resulting in a lower CSF pH (7.33), the protein content is normally very low (0.2g/l) resulting in a low buffering capacity, the glucose concentration is lower, the chloride concentration is higher and the cholesterol content is very low.

There are no lymphatic channels in the brain and CSF fulfils the role of returning interstitial fluid and protein to the circulation.

The CSF is separated from blood by the blood-brain barrier. Only lipid soluble substances can easily cross this barrier and this is important in maintaining the compositional differences. (Relkin et al., 2005)

Fluid (CSF), Liquor cerebrospinalis, is a clear bodily fluid that occupies the subarachnoid space and the ventricular system around and inside the brain and spinal cord. In essence, the brain "floats" in it. The CSF occupies the space between the arachnoid mater (the middle layer of the brain cover, meninges), and the pia mater, (the layer of the meninges closest to the brain).

It constitutes the content of all intra-cerebral (inside the brain, cerebrum) ventricles, cisterns, and sulci (singular sulcus), as well as the central canal of the spinal cord. It acts as a "cushion" or buffer for the cortex, providing a basic mechanical andimmunological 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 ab^ut 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 sections without CSF. (Kenneth Saladin, 2007). CSF protects the brain tissue from injury when jolted or hit. In certain situations such as auto accidents or sports injuries, the CSF cannot protect the brain from forced contact with the skull case, causing hemorrhaging, brain damage, and sometimes death. (Kenneth Saladin, 2007). CSF flows throughout the inner ventricular system in the brain and is absorbed back into the bloodstream, rinsing 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 decreases total intracranial pressure and facilitates blood perfusion. (Kenneth Saladin, 2007). When CSF pressure is elevated, cerebral blood flow may be constricted. When disorders of CSF flow occur, they may therefore affect not only CSF movement but 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 pressuredynamics. This may have significant treatment implications, but the underlying path physiology needs to be further explored. (Johnston M, 2003)

CSF connections with the lymphatic system have been demonstrated in several mammalian systems. Preliminary data suggest that these CSF-lymph connections form around the time that the CSF secretory capacity of the choroid plexus is developing (in utero).

There may be some relationship between CSF disorders, including hydrocephalus and impaired CSF lymphatic transport. CSF can be tested for the diagnosis of a variety of neurological diseases. It is usually obtained by a procedure called lumbar puncture. Removal of CSF during lumbar puncture can cause a severe headache after the fluid is removed, because the brain hangs on the vessels and nerve roots, and traction on them stimulates pain fibers. The pain can be relieved by intrathecal injection of sterile isotonic saline. Lumbar puncture is performed in an attempt to count the cells in the fluid and to detect the levels of protein and glucose. These parameters alone may be extremely beneficial in the diagnosis of subarachnoid hemorrhage and central nervous system infections (such as meningitis). Moreover, a CSF culture examination may yield the microorganism that has caused the infection. By using more sophisticated methods, such as the detection of the oligoclonal bands, an ongoing inflammatory condition (for example, multiple sclerosis) can be recognized. A beta-2 transferrin assay is highly specific and sensitive for the detection for, e.g., CSF leakage. (Johnston M, 2003)

Lumbar puncture can also be performed to measure the intracranial pressure, which might be increased in certain types of hydrocephalus. However a lumbar puncture should never be

performed if increased intracranial pressure is suspected because it could lead to brain herniation and ultimately death. This fluid has an importance in anesthesiology. Baricity. refers to the density of a substance compared to the density of human cerebral spinal fluid. Baricity is 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 cerebrospinal fluid (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 flmtotor from complications of head injuries or infections. (Cabot, Richard C, 1919)

Compression of the brain by the accumulating fluid eventually may cause convulsions and mental retardation. These signs 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 C, 1919) The elevated intracranial pressure may cause compression of the brain, leading to brain damage and other complications. Conditions among affected individuals vary widely. Children who have had hydrocephalus may have very small ventricles, and presented as the "normal case".If the foramina of the fourth ventricle or the cerebral aqueduct are blocked, cereobrospinal fluid (CSF) can accumulate within the ventricles. This condition is called internal hydrocephalus and it results in increased CSF pressure. The production of CSF continues, even when the passages that normally allow it to exit the brain are blocked. Consequently, fluid builds inside the brain causing pressure that compresses the nervous tissue and dilates the ventricles. Compression of the nervous tissue usually results in irreversible brain damage. If the skull bones are not completely ossified when the hydrocephalus occurs, the pressure may also severely enlarge the head. The cerebral aqueduct may be blocked at the time of birth or may become blocked later in life because of a tumor growing in the brainstem.Internal hydrocephalus can be successfully treated by placing a drainage tube (shunt) betweenn the brain ventricles and abdominal cavity to eliminate the high internal pressures. There is some risk of infection being introduced into the brain through these shunts, however, and the shunts must be replaced as the person grows. A subarachnoid hemorrhage may block the return of CSF to the circulation. If CSF accumulates in the subarachnoid space, the condition is called external hydrocephalus. In this condition, pressure is applied to the brain externally, compressing neural tissues and causing brain damage. Thus resulting in further damage of the brain tissue and leading to necrotization. (YadavYR, et al 2007).j In spite of the fact that CSF pathways are blocked CSF is formed at a normal rate so the ventricles have to dilate at the expense of the white matter particularly but also the grey matter since the CSF has no place to be resorbed.Hydrocephalus exvacuo is enlargement of the ventricles due to atrophy of brain substance, not increased intracranial pressure. (Yadav YR, et al 2007)

Hydrocephalus is often an accompaniment of a meningomyelocoele or Arnold- Chiari malformation. It can also be caused by isolated stenosis of the Aqueduct of Sylvius due to in utero viral infection.Meningitis can cause communicating hydrocephalus.

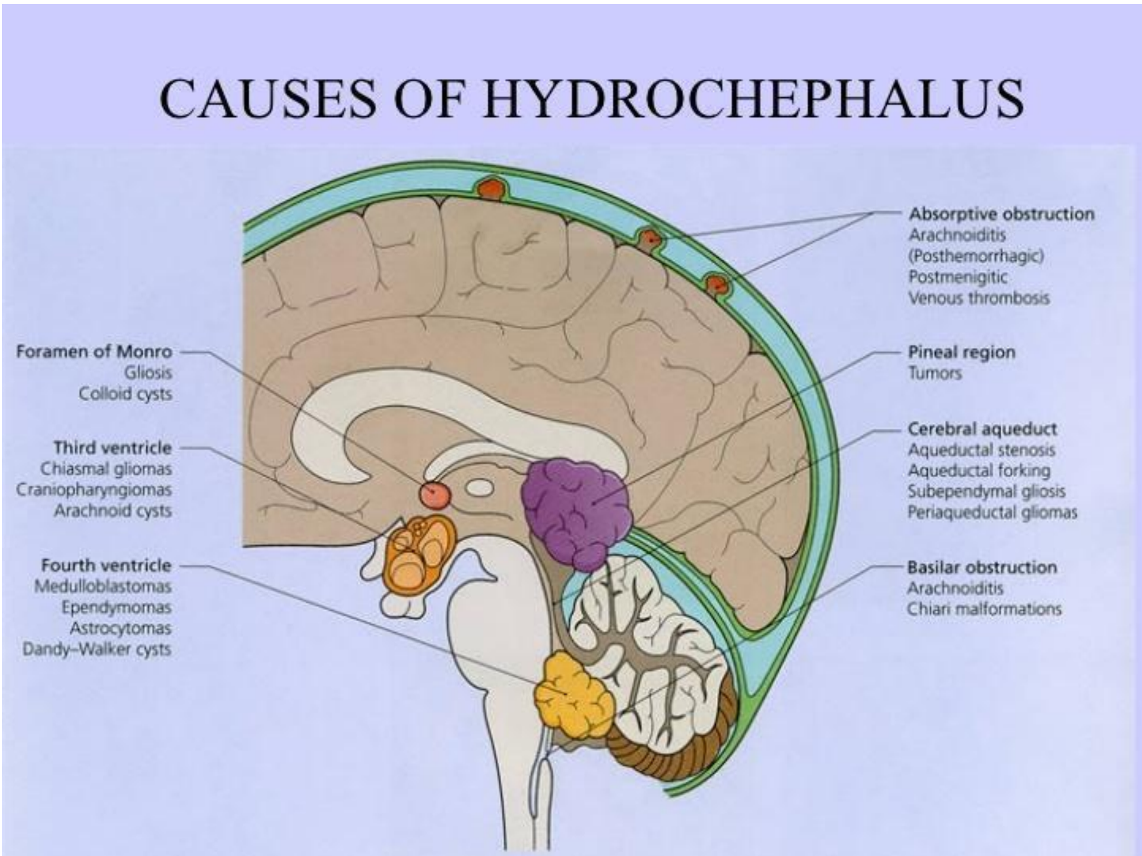
Infants have large heads as well ventricles because of their flexible skull. Older children and adults develop headache and

signs of increased intracranial pressure such as lethargy or a dilated pupil. Treatment involves shunting the extra fluid from the ventricles to the peritoneal cavity. (Yadav YR, et al 2007).

2.1.3.1 Etiology:

Congenital aqueductalstenosis, Dandy-Walker syndrome (small malformed cerebellum with large posterior fossa cyst in communication with 4th ventricle obstructing flow of CSF to subarachnoid cisterns). Intracranial mass (especially posterior fossa, third ventricular and pineal region lesions). Subarachnoidinflammation - meningitis, hemorrhage. Loss of brain parenchyma - infarcts, perinetal insults.

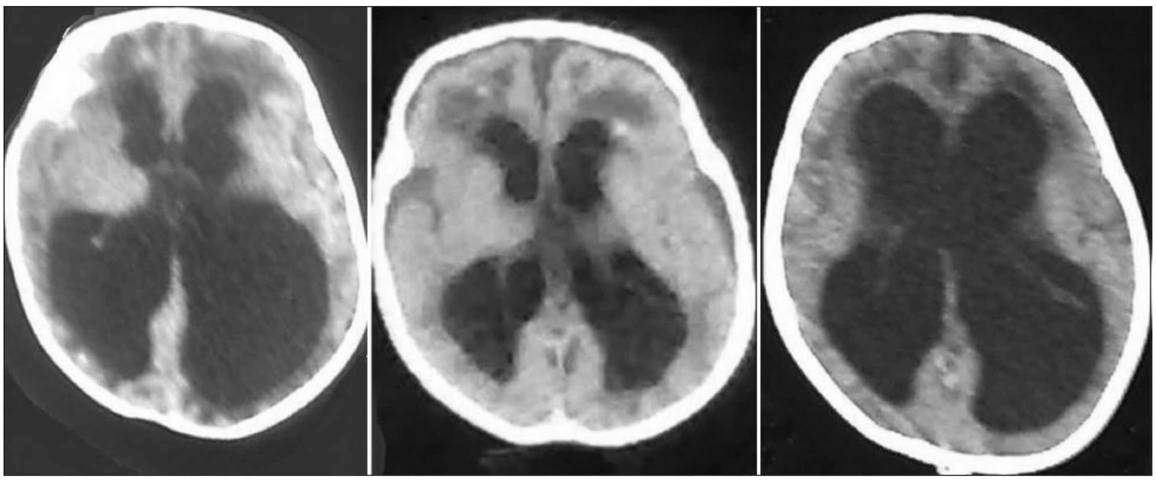
Intraventricular Hemorrhage (IVH) is most common cause of congenital hydrocephalus. Hemorrhage in the periventricular germinal matrix ruptures into the ventricular system. Frequently seen in premature infants. May proceed to cause non-obsto£ti|e hydrocephalus .



Fig(2.4) shows the causes of hydrocephalus.

2.1.4 Appearance of hydrocephalus:

CT would snow an abnormally large cranial 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(2.5) axial CT scan shows large ventricles with soft tissue damage

2.1.4.1 Grade of hydrocephalus:

Grade I - Isolated hemorrhage confined to the germinal matrices

Grade II - Intraventricular extension of germinal -matrix hemorrhage withouthydrocephalus.

Grade III - Intraventricular extension of germinal matrix hemorrhage with accompanying ventricular enlargement

Grade IV - Intraparenchymal extension of hemorrhage in addition to intraventricular hemorrhage with hydrocephalus

2.1.4.2 Diagnosis:

Diagnosis is needed by U/S or follow patient's daily head circumference plotted on appropriate head growth chart. The most common initial diagnostic test to determine hydrocephalus at any age is an image of the brain (CT Scan or MRI) to identify the enlarged ventricles (spaces) within the brain that are typical of hydrocephalus. More tests are often performed in adults.

2.1.4.3 Treatment: Ventriculoperitoneal (VP) shunt:

Infants 1500 g generally are too small for shunting, so serial Lumboperitoneal (LP) are done until patient is large enough for shunting. If Lumboperitoneal (LP) unsuccessful, serial ventricular taps through the fontanelle can be performed or a temporary blind-ended ventricular catheter can be placed and serially tapped.

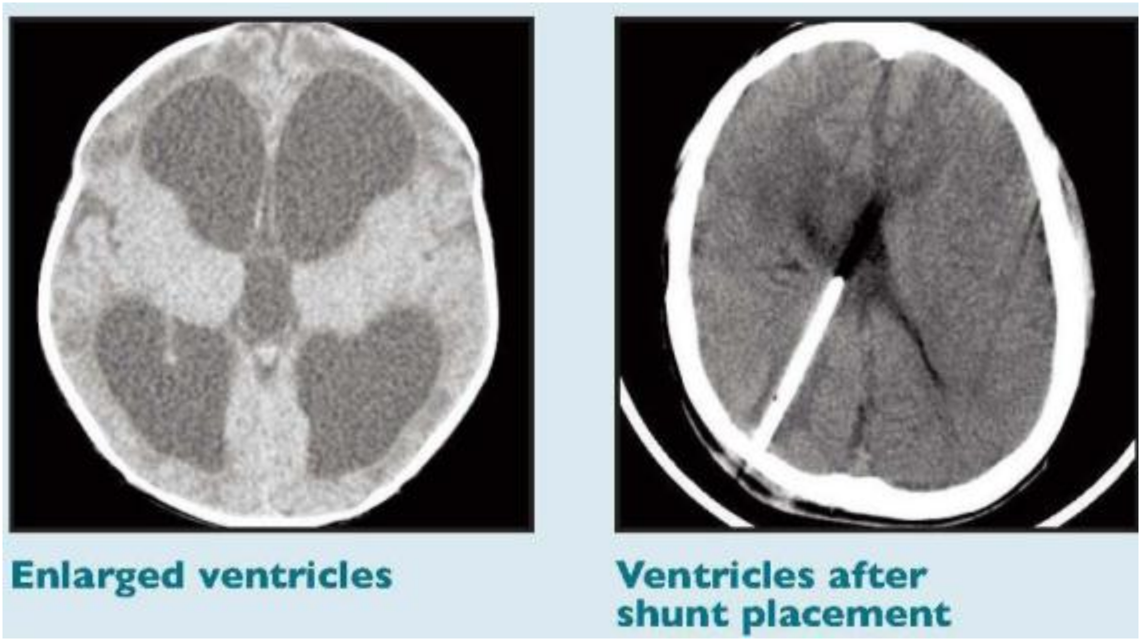


Fig 2.6 :CT scans showing the ventricles as viewed from the top of the head

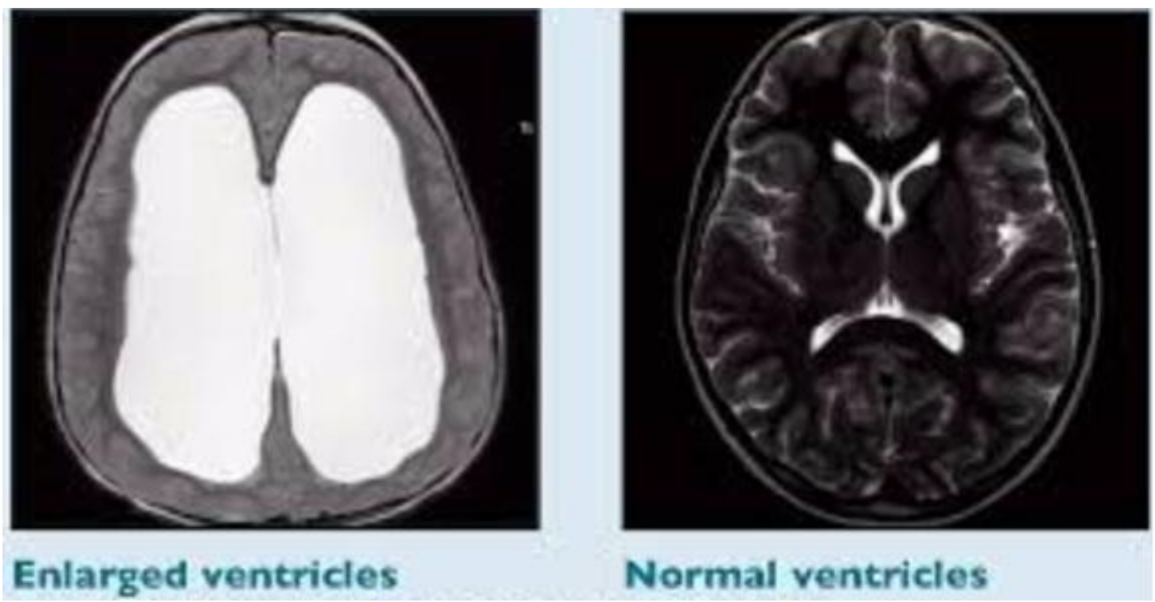


Fig 2.7 :MRI scans showing the ventricles from the top view

2.1.4.4 CSF Shunting:

Ventriculo-peritoneal (VP) - Most common shunt used today. Drains fluid from ventricles to peritoneum. Ventriculo-atrial (VA) /Ventriculo-jugular (VJ) : Drains fluid from ventricles into venous system through the facial, jugular or subclavian vein. Distal tubing on CSR should be between T4 and T8. Lumboperitoneal (LP): Drains fluid from lumbar theca to peritoneum. Only used in communicating hydrocephalus (NPH). Subdural-peritoneal Drains fluid from subdural space to peritoneum. Used in chronic subdural hygroma/hematoma which recur after external drainage.

2.1.4.5 Shunt hardware:

Rickham Reservoir - Hard non-compressible plastic dome placed where ventricular catheter exits skull. Site of shunt tap with a Huber needle. Some older shunts do not have this reservoir.

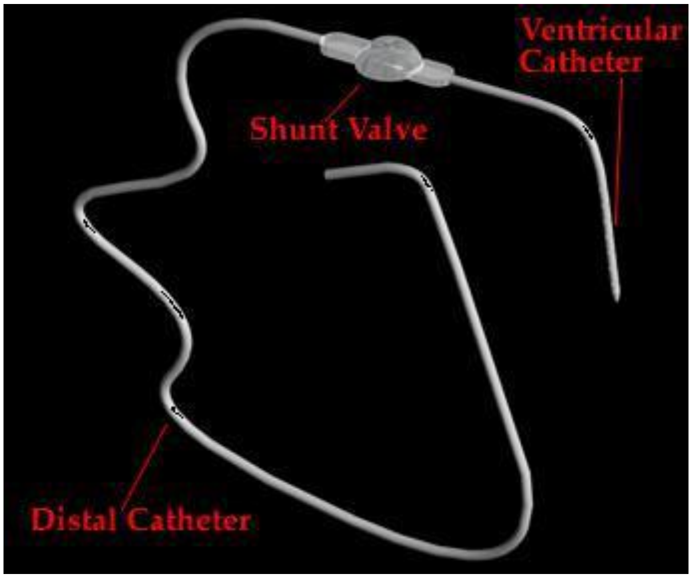
Valve Regulates intracranial run-off pressure; Are uni-directional allowing flow only distally; Many different types: Holier - shaped like cylinder, PS Medical single compressible dome, available in low, medium and high pressure, Delta combined anti-syphon device and compressible dome, must be placed at ear level, available in 2 pressure levels designated I and II, Can be "pumped" to assess shunt function - Should empty without resistance and refill rapidly, Most are impregnated with radio-opaque arrow so that appropriate direction of flow and pressure setting can be confirmed on plain x-ray, Single dot: PS Medical low pressure, Delta I, Double dot: PS Medical medium pressure, Delta II, Triple dot: PS Medical high pressure,

Distal "A" tubing Travels subcutaneously to peritoneal cavity, Needs to be lengthened when patient hits adolescent growth spurt and Should be randomly coiled within abdomen.

Straight Metal Connectors - Used to connect above pieces and Potential site of shunt disconnection.

On-Off Valve additional valve with on-off switch to allow control of shunt patency and when central ball is depressed (dimpled), shunt is occluded. "Y" Connector Y-shaped metal connector used to connect biventricular catheters to a single distal tubing.

Anti-Syphon Device Additional valve to prevent drainage of CSF during change in posture and Used in patients who over-drain CSF and have slit ventricles. Can also place catheter into ventricle leading to blind reservoir for CSF access for intrathecal chemotherapy (Ommaya), or into lumbar cistern for intrathecal morphine (leads to lumbar flushing reservoir on chest wall). (Owler B.,2009)



Fig(2.8) shows the hardware component of shunt

2.1.4.6 Shunt Dysfunction:

Multiple etiologies can cause dysfunction of the shunt Proximal. Most common source of dysfunction, Plugged ventricular/lumbar catheter and Disconnection from Rickhamreservoir. Distal disconnection of tubing, Broken valve Distal tubing no longer inside abdomen. Classic presentation: Headache, lethargy, nausea/vomiting. (OwlerB , 2009)

2.1.4.7 Evaluating shunt function:

Shunt series Plain x-rays of the entire system searching for disconnection, breaks, and tubing placement. Skull films (AP, lat), CXR, KUB (and LS spine films for LP). All shunt components are radio-opaque except parts of some valves.

Uncontrasted head CT Most useful when used in comparison

to prior films when shunt was working, Evaluate ventricular size for enlargement. Abdominal ultrasound/CT. Used to evaluate patients with significant abdominal pain or distention.

Shunt tap Placing Huber needle into Rickham reservoir and checking for spontaneous CSF flow and distal run-off. Only to be done under the supervision of a neurosurgery resident. Never go to sleep without fixing a broken shunt. (Owler B., 2009)

2.1.4.8 Shunt Infection:

Rarely occurs more than a few months after the last manipulation. In patient with a fever, evaluate for other sources first unless there are clear meningeal signs: Ask about recent viral illness in family, Check urine, lungs, ears, throat and Send appropriate cultures. (Owler B., 2009)

If shunt is infected, it must be removed since it is a foreign body which serves as a continued nidus for infection. Shunt dependent patients with infections are maintained with externalized ventricular catheters until infection clears and new shunt can be placed. Intraventricular injection of antibiotics (either gent or vanco) is frequently used in addition to systemic antibiotics. (Owler B., 2009)

2.1.4.9Normal Pressure Hydrocephalus (NPH):

Symptomatic hydrocephalus without elevated ICP. Symptoms: Classic triad - progressive dementia, urinary incontinence, and gait apraxia.

Etiology, fibrosingarachnoiditis of unknown etiology, prior SAH, trauma, prior surgery, meningitis, idiopathic Idiopathic form typically presents in the 6th decade with no sex predominance Diagnosis, uncostrasted head CT shows ventriculomegaly. Nuclear cisternogram shows delayed reabsorption of CSF.

Treatment: VP/LP shunt: Dementia responds least to treatment. (Owler B., 2009).

2.1.4.10PseudotumorCerebri(Benign Intracranial Hypertension):

Elevated ICP without hydrocephalus. Symptoms, Headaches, papilledema, and increased intracranial pressure in the absence of CNS inflammatory disease, venous occlusion, or a space occupying mass. Associated with obesity, pregnancy, and menstrual irregularities. Presents typically in women during adolescence or early adulthood. Diagnosis: Normal head CT (except decreased ventricular size). Increased ICP (measured by opening pressure on LP). (Owler B., 2009).

2.2 **Previous Studies :**

In a study by (burwer et al , 2003) entitled can predict the level of CSF block in tuberculosis 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-commencating hydrocephalus had arounded third ventricle than those with commincating hydrocephalus .

In study done by (kouzo moritahea et al , 2007), ct was used in more than half of the cases . for diagnosis of fetal hydrocephalus . either U/S or MRI had become dominantly utilized and CT had gone out of use in (1996-2000).

In other study done by (relkin et al 2005), showed that idiopathic normal

pressure hydrocephalus (INPH) typically occurs in a dults

more than 60years old

and is a progressive , chronic disoreder without specific

identifiablecause . the classic traid of symptoms-gaitdisturbance ,

cognitive dysfunction , and urinary incontinence_ genarelly responds to treatment if present for less than 2 years duration . gait and balance distribution are often the first most common symptoms of INPH and may develop over the course of mounth or years. INPH is a disorder of CSF circulation , probably related to decreased absorption at the arachnoid villi leading to venriculomegaly (kernich,2006) . in INPH,CSF accumulation occurs in ventricles , resulting in temporarily elevated ICP . the increase in

ICP causes ventricular dilation , which allow the ICP to reset at higher

pressure . this new sustained intracranial pressure , altrough within the

normal range of 60_240mm H2O, is higher than pressure prior to the onset of INPH IN INPH , as CSF gradually increase in volume , dilating the cerebral ventricles , brain tissue is

compressed , acting as a temporizing mechanism to maintain ICP within the normal range . however , ventricular dilatation exert pressure on brain tissue deforming the white matter motor tract and fibers directly adjacent to the lateral ventricles . gait abnormalities result from compression of these white matter motor tract and fibers ; it is described as a' glue footed' or 'shiffting' type of gait . cognitive disorders and urinary incontinence result from compression and deformation of adjacent motor tracts and fibers and white matter limbic structures .

Chapter three

Material and method

3.1 Materials

3.1.1study design:

Descriptive study.

3.1.2 Study Area :

Sudanese population.

3.1. 3 Study place :

Center modern medical , Alzaytona hospital, Ebrahim Malik hospital.

3.1.4 Study Duration:

From1/9/2017 -1/12/2017

3.1.5 Inclusion criteria:

Disease patient

3 .1.6 Exclusion criteria

Normal patient

3.1.7 Equipment

Figure 3.1 :TOSHIBA MRI (1.5 tesla) scanner spine array coil used in alzaytona specialized hospital

Figure 3.2 GE Dual slice CT scan in Modern Medical center

3.2 Methods:

3.2.1 Technique:

All axial scan obtain with slice thickness 3-5mm at base of skull 7-10mm above 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 10 mm with similar spacing and scan time 5 seconds .

-technique for MRI brain:

Patient under go to MR department for MRI brain.

Head first supine and position the head in the head coil. Centre the laser Beam localiser over the glabellas.

Most of children under went CT scan and MRI after sedation

3.2.2 Image interperation:

All axial images were studied by senior radiologist , to dignose the stages of hydrocephalus , types communicated and non communicated and underline causes

3.2.3 Methods of data collection:

References, websites, textbooks

3.2.4 Method of data analysis:

The all data analyzed through statistical method that includes frequency table percentage.

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Chapter Four

Result:

The following tables and figures presented the data obtained from 50 patient who were Examined for axial CT brain and MRI brain .

The data were analysis using excel program and SPSS version .Frequency table, means and standard deviation were presented

Table (4.1) frequency distribution of age

Age	Frequency	Percent	Valid Percent	Cumulative Percent
1 day to 6month	31	62.0	62.0	62.0
6month 1d to 12month	7	14.0	14.0	76.0
more than 1 years	12	24.0	24.0	100.0
Total	50	100.0	100.0	

Figure (4.1)

frequency distribution of age

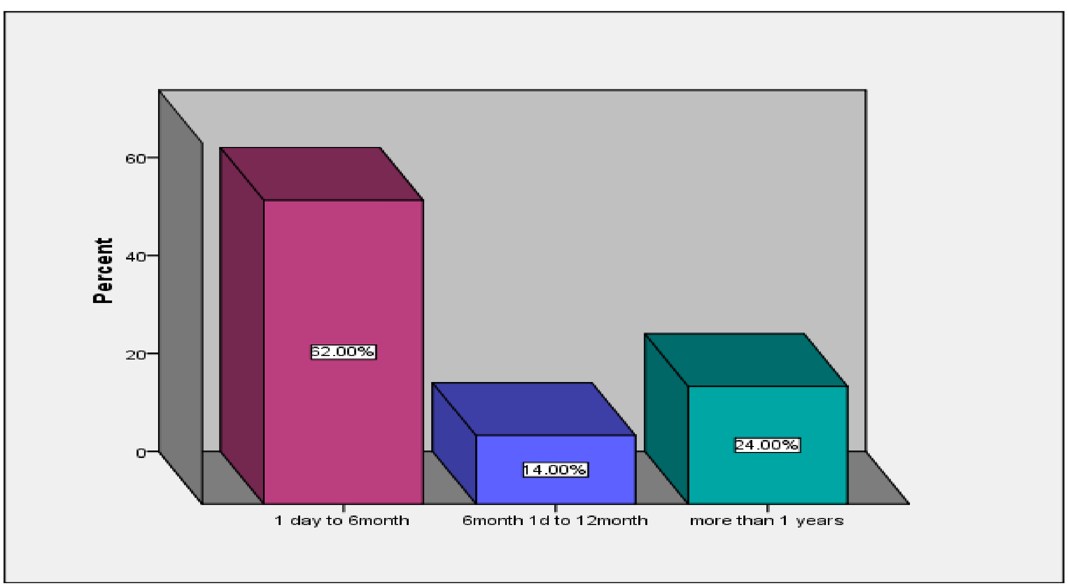

Table (4.2) frequency distribution of gender

Gender	Frequency	Percent	Valid Percent	Cumulative Percent
Female	29	58.0	58.0	58.0
Male	21	42.0	42.0	100.0
Total	50	100.0	100.0	

Figure (4.2) frequency distribution of gender

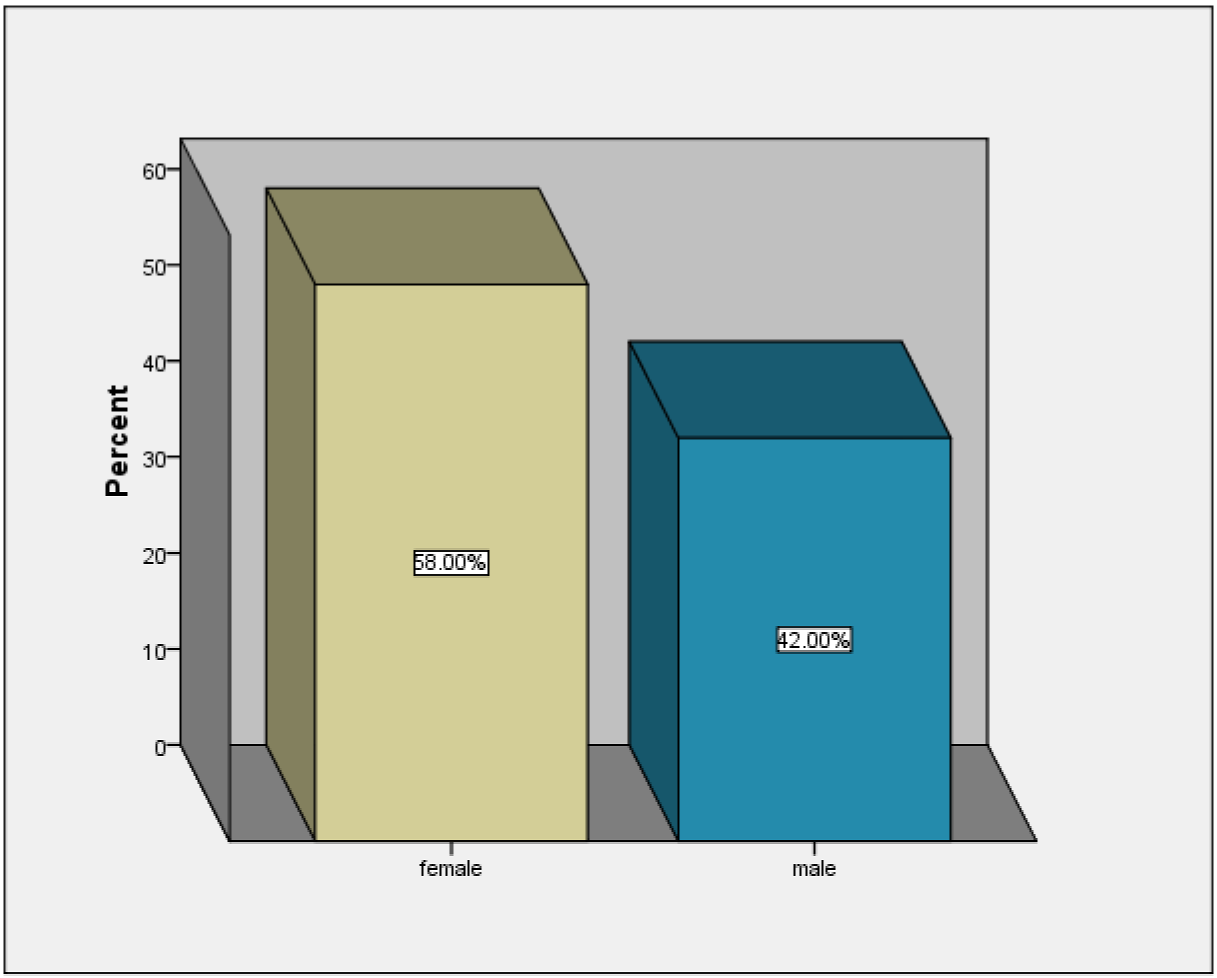

Table (4.3) frequency distribution of type of hydrocephalus

Type	Frequency	Percent	Valid Percent	Cumulative Percent
communicating	16	32.0	32.0	32.0
Obstructive	34	68.0	68.0	100.0
Total	50	100.0	100.0	

Figure (4.3) frequency distribution of type of hydrocephalus

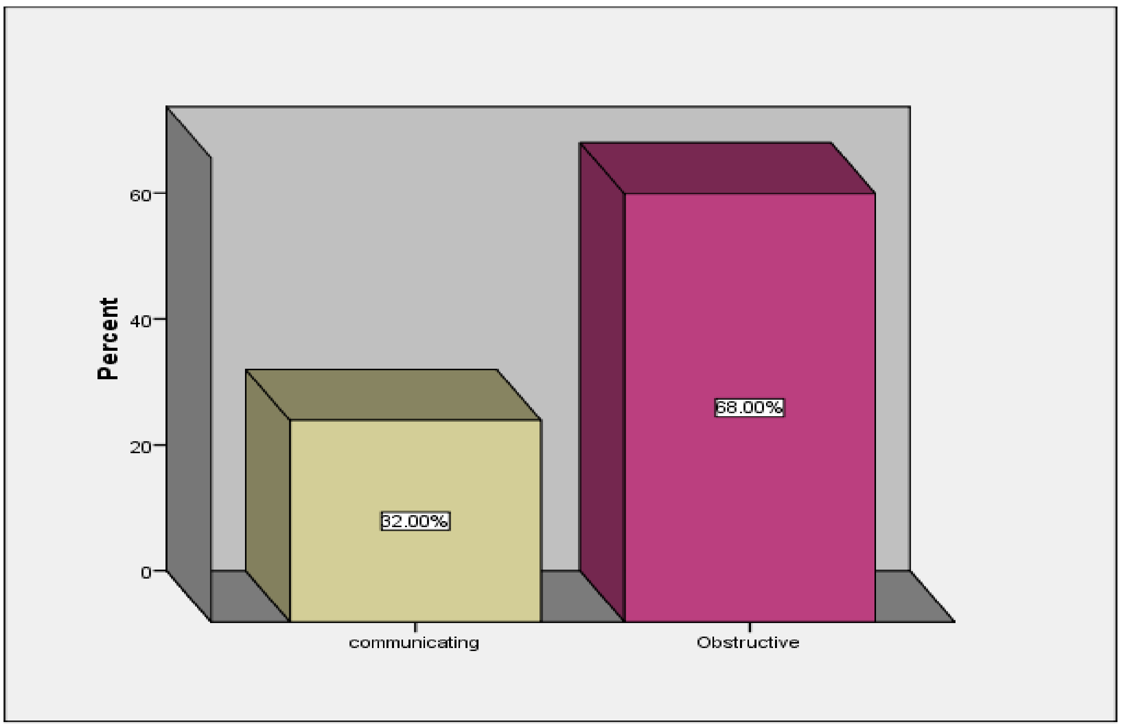

Table (4.4) frequency distribution of nature of hydrocephalus

Nature	Frequency	Percent	Valid Percent	Cumulative Percent
Acquired	19	38.0	38.0	38.0
Congenital	31	62.0	62.0	100.0
Total	50	100.0	100.0	

Figure (4.4) frequency distribution of nature of hydrocephalus

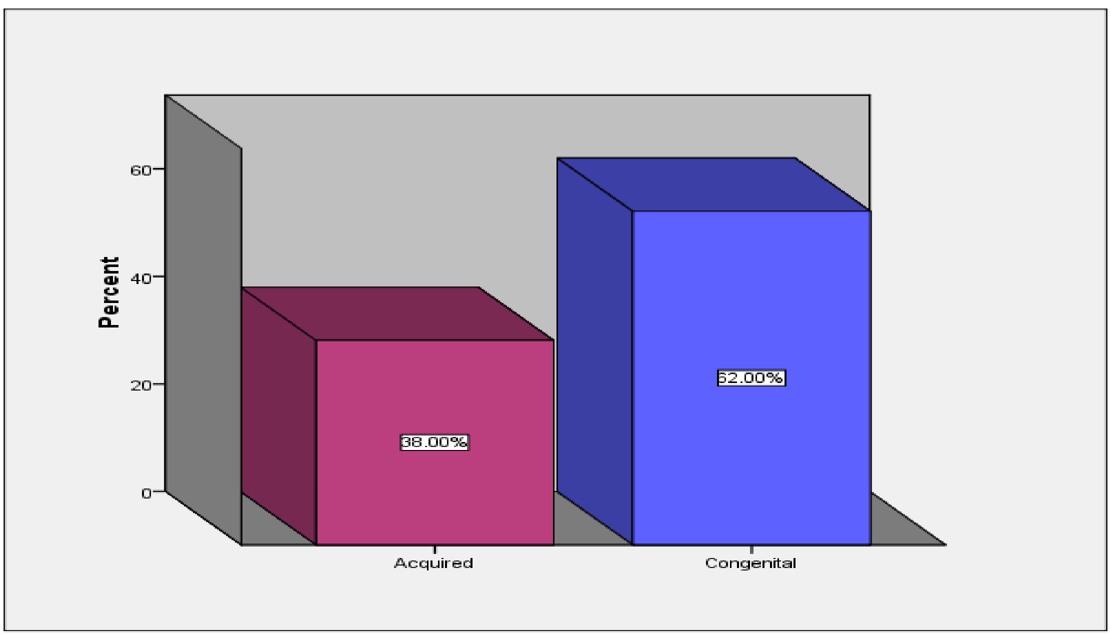

Table (4.5) frequency distribution of location of hydrocephalus

Location	Frequency	Percent	Valid Percent	Cumulative Percent
Left	3	6.0	6.0	6.0
right ,left and third	15	30.0	30.0	36.0
third and fourth	5	10.0	10.0	46.0
all of them	24	48.0	48.0	94.0
right and left	3	6.0	6.0	100.0
Total	50	100.0	100.0	

Figure (4.5) frequency distribution of location of hydrocephalus

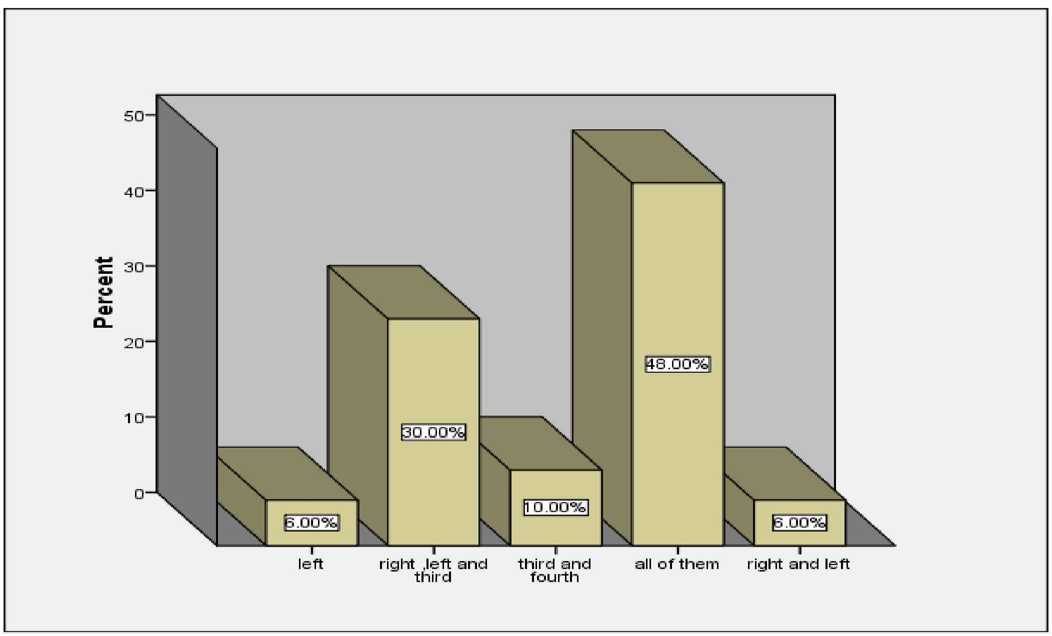

Table (4.6) cross tabulation age and type of hydrocephalus

Age	Type		Total
	Obstructive	Communicatin g	
1 day to 6month	21	10	31
6month 1d to 12month	5	2	7
more than 1 years	8	4	12
Total	34	16	50
P value = 0.976			

Table (4.7) cross tabulation Gender and type of hydrocephalus

Gender	Type		Total
	Obstructive	communicating	
Female	18	11	29
Male	16	5	21
Total	34	16	50
P value= 0.228			

Table (4.8) cross tabulation location and type of hydrocephalus

Location	Type		Total
	Obstructive	Communicating	
Left	1	2	3
right , left and third	12	3	15
third and fourth	4	1	5
all of them	15	9	24
right and left	2	1	3
Total	34	16	50
P value =0.506			

Table (4.9) cross tabulation location and nature of hydrocephalus

Location	Nature		Total
	Acquired	Congenital	
Left	2	1	3
right , left and third	8	7	15
third and fourth	1	4	5
all of them	7	17	24
right and left	1	2	3
Total	19	31	50
P value = 0.399			

Chapter Five

Discussion , Conclusion and Recommendation

5.1 Discussion:

Table and figure(4.1) showed that the age of 31 patient(62%) out of50 patient ranged between one –day to 6 monnth,7 patient (14%)Thir ages ranged between 6 month to 12 month, 12 patient(24%) their age more than one year. This study finding the hydro cephalus in infantmost commonly.

Table and figure(4.2) show that 29of patient out of 50(58%) are female while21(42%) are male.

Table and figure(4.3) showed there were16 patient(32%) out of 50 patient with communicating hydrocephalus. The other34% patient(68%) were with non communating hydrocephalus.This finding showed that the CT is informative in demonstrating the type of hydrocephalus.

Table and figure(4.4)show the nature of hydrocephalus .The hydrocephalic patient there are 19(38%)those cause aquired ,31 patient (62%)their cause was congenital anomalies.

This finding reflected that the congenital anomalies were the most common causes of hydrocephalus ,and acquired was the least cause.

Table and figure(4.5) show location of hydrocephalus. the hydrocephalic patient there are 3(6%) in left ventricle,15 patient(30%)in right.left.third ventricle,5 patient(10%) in third and fourth ventricle, 24patient(48%)in right,left,third,fourth,3patient (6%) in right, lift.This finding reflected that the location in right, lift,third ,fourth venricle most commonly.

Table (4.6) show the age one day to sex month 21 obstructive and 10 communicating . the age 6 month to 12 month obstructive 5 and communicating 2 and more than one year obstructive 8 and communicating 4 .

Table(4.7) show gender and type of hydrocephalus. The hydrocephalic patient there are18 female obstructive and 11communicating. There are 16 male obstructive and 5 communcating .this finding reflected that the obstructive and communicating in female more than male.

Table(4.8) show location and type of hydrocephalus. The hydrocephalic patient there are obstructive in lift ventricle 1 and communicating 2.obstructive in right,lift.third 12 and communicating 3. Obstructive in third ,fourth 4 and communicatimg1, all of them ventricle 15 obstructive and 9 communicating. Obstructive in right, left ventricle 2 and communicating 1.These finding reflected more children with obstructive had round right ,left,third,fourth.

Table(4.9) show location and nature of hydrocephalus. The hydro cephalic patient there are acquired in left 2 and congenital 1.aquerd in right,left,third ventricle8 and congenital7,aquerd in third,fourth ventricle1 and 4 congenital, acquired in all of them ventricle 7 and17 congenital .acquired in right ,lift ventricle 1 and congenetal2. This finding reflected more children congenital had round right, lift,third.fourth.

5.2 Conclusion :

The main objective of this study was to study the role of CT and MRI in the diagnosis of hydrocephalus ,its most commonly found in children who are below6 years .CT important imaging technology for demonstrating hydro cephalus and its causes,but it has its own advantage delimitation ,The CT is very informative in demonstrating the cause and the site of obstruction.

MRI important image for diagnose hydro cephalous and MRI is not only beneficial in the diagnosis of CSF- related disease but also aid in therapy planning and post – surgery follow – up of the patients .such as cinc pc , TSE , and GRE T_2^* sequences.

5.3 Recommendations:

-patient infant with hydro cephalus associated with myelomingocele need care to prevent meningitis.

- All government hospital should have CT, MRI department .
- The training department in ministry of health should offer considerable chance for staff training CT, MRI.

-More research should be done using a large sample of patient for further assessment،

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Appendex (1)

Fig 1: sagittal MRI image for female (10 month) show hydrocephalus of ventricle

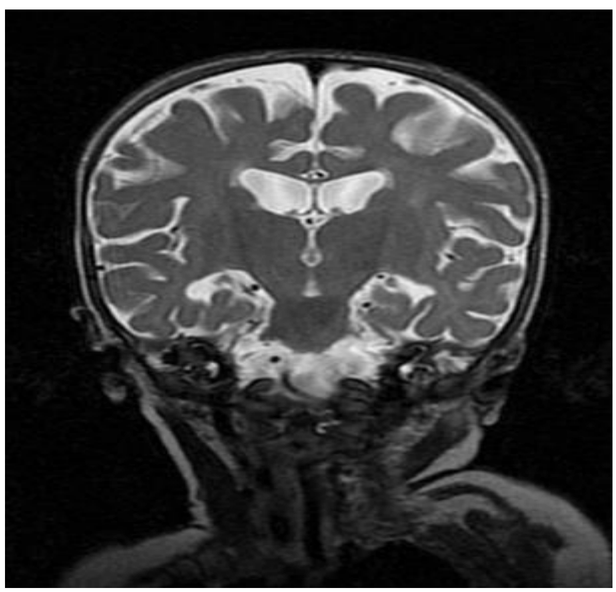
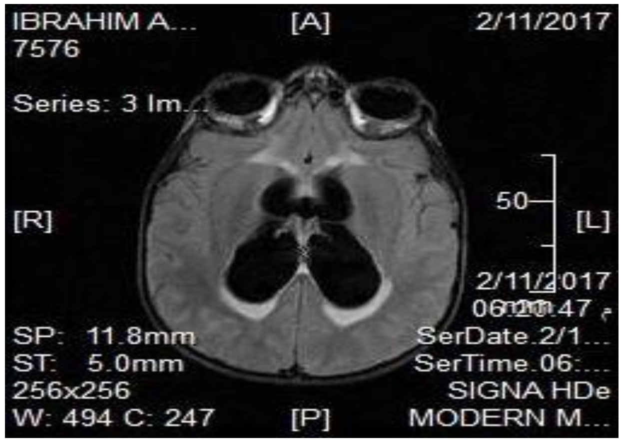


Fig 2 : coronal MRI image female (3 month)



Feg 3 :Axial MRI image for male (one day) show obstructive hydrocephalus

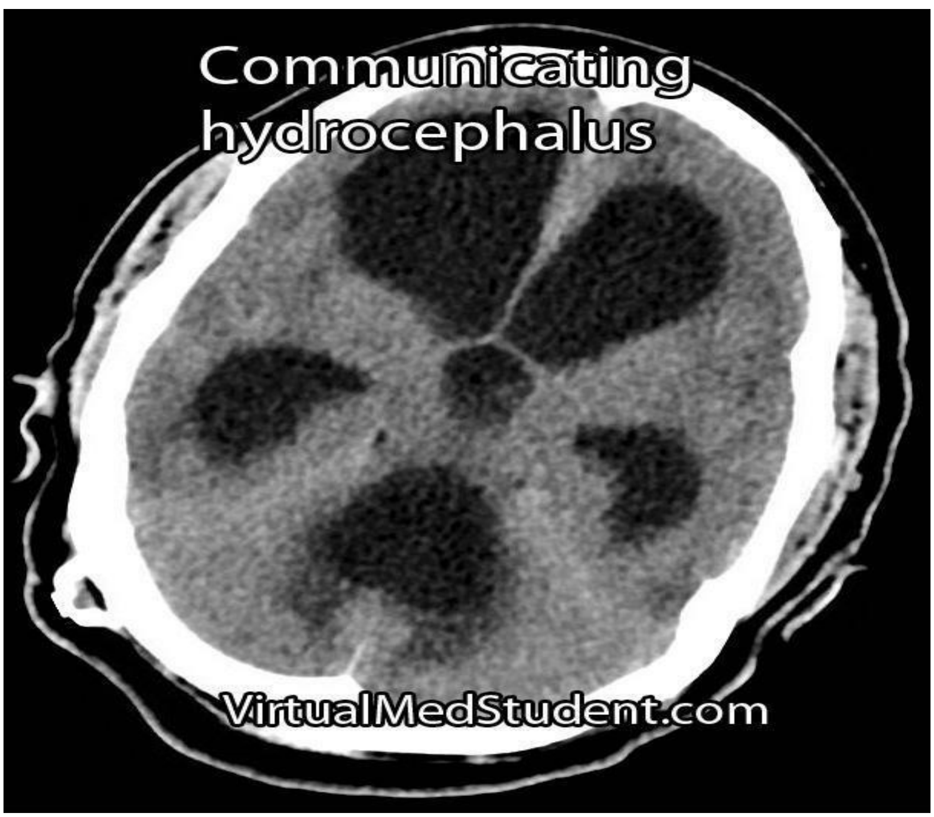


Fig 4 : Axial CT scan how communicating hydrocephalus

Appendex (2)

Child with hydrocephalus , before and after treatment

Appendex (3)

Sudan university of Science and technology

Collage of Graduate study

Study of hydrocephalus in child using Computed tomography and magnetic resonance

Data collection sheet

No	Age	Sex	Type	Description	Right	Left	3rd	4th