GHANA COLLEGE OF PHYSICIANS AND SURGEONS

FACULTY OF NEUROSURGERY

ACCURACY OF FREEHAND VENTRICULAR CANNULATION USING KOCHER'S AND KEEN'S POINTS IN HYDROCEPHALUS PATIENTS AT A TERTIARY INSTITUTION IN GHANA

SUBMITTED TO THE FACULTY OF NEUROSURGERY, IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE CONFERMENT OF A FELLOW OF THE GHANA COLLEGE OF SURGEONS (FGCS)

DR RICHMOND HAGAN
RESIDENT NUMBER: GS/12/19/015/F

SEPTEMBER, 2023

DECLARATION

I declare that this dissertation is my own work which is a research undertaken under supervision. This research work has not been submitted in any form to any other institution. Authors whose works have been useful in putting this study together have been duly acknowledged in the text and list of references.

Signature: ……………………………………….

Dr. Richmond Hagan

Date: 15/10/2023

CERTIFICATION BY SUPERVISORS

DEPARTMENT OF SURGERY

In case of reply the number
And the date of this
Letter should be quoted

My Ref. No.............................
Your Ref. No...........................

KORLE BU TEACHING HOSPITAL
P. O. BOX KB 77,
KORLE BU, ACCRA.

Tel: +233 302 667759/673034-6
Fax: +233 302 667759
Email: Info@kbth.gov.gh
pr@kbth.gov.gh
Website: www.kbth.gov.gh

30th October, 2023.

CERTIFICATION BY SUPERVISORS

We certify that this work titled **"ACCURACY OF FREEHAND VENTRICULAR CANNULATION USING KOCHER'S AND KEEN'S POINTS IN HYDROCEPHALUS PATIENTS AT A TERTIARY INSTITUTION IN GHANA"** was undertaken by Dr. Richmond Hagan at the Neurosurgery unit of Korle Bu Teaching Hospital, Accra under our supervision. We have also supervised the writing of the dissertation.

SUPERVISORS:

Dr. Thomas Dakurah
Department of Surgery, UGSMS, Accra, Ghana
Email: tomdakura@gmail.com
Signature: ....
Date: ....06/11/2023..........

Dr. Mawuli Ametefe
Consultant Neurosurgeon, KBTH
Email: ametmk@yahoo.co.uk
Signature: ....
Date: .....07-11-2023.....

DEDICATION

This book is dedicated to God for the strength and the ability to undertake this endeavor and to my beautiful family for the unflinching support.

ACKNOWLEDGEMENT

I wish to express my sincere appreciation to my supervisors Dr. Thomas Dakurah and Dr. Mawuli Ametefe for the support. I also want to thank Dr. George Wepeba and all the consultants in the Neurosurgery unit for the support and advice. Finally, I want to appreciate all the other members of the Neurosurgery unit for the understanding and support in making sure this research was successful.

ABSTRACT

BACKGROUND

Cerebrospinal fluid diversionary procedures are life-saving procedures in neurosurgical practice. It is also one of the most common procedures performed. Accuracy of ventricular cannulation as part of the diversionary procedure is of utmost importance as it reduces complications significantly, more so when some of the procedures like the ventriculoperitoneal shunting is lifelong. There have been various methods applied including freehand and image guided ventricular cannulation.

AIM

This study aims to determine how accurate the freehand cannulation of lateral ventricle is in patients with hydrocephalus using at Kocher's and Keen's points.

METHODOLOGY

This is a cross-sectional study of patients with hydrocephalus undergoing CSF diversion (external ventricular drain or ventriculoperitoneal shunt placement) in the Neuroscience unit of Korle Bu Teaching Hospital. A consecutive sampling method was used to select patients who presented to the emergency unit and outpatient department with hydrocephalus requiring CSF diversion. A total of 54 participants were recruited for this study. CT scan of the head was taken after CSF diversion using Kocher's point of Keen's point and catheter tip position was graded. The data collection was done using questionnaires and analysed with the Excel spread sheet and the IBM SPSS version 21 and 24. Patient's demographic characteristics, the size of the dilated ventricles were obtained and Evan's ratio calculated using the radiological imaging available, aetiology and type of hydrocephalus were also obtained and analyzed using descriptive statistics. The primary outcome which is accuracy grade was categorized as accurate and coded 1 or inaccurate and coded 0. Multivariable logistic regression was used to identify correlation of factors that may influence accuracy.

RESULTS

Out of the 54 participants, 61.1% were males and 38.9% were female with a mean age of 22.6 with a standard deviation of 26.01. Tumour was the commonest cause of hydrocephalus (38.9%) followed by congenital causes (27.8%). Post infectious causes accounted for the least (9.3%). Accuracy of the ventricle cannulation using Kocher's point was 78.3% while that of Keen's point was 25.8%. There was no statistically significant relationship between the Evans index ($p=0.836$) and accuracy and level of experience of surgeon and accuracy of ventricular catheter placement ($p=0.437$).

CONCLUSION

Freehand ventricular cannulation was more accurate using Kocher's point than using Keen's point. There was no significant correlation between the Evans ratio and level of experience of surgeon with the accuracy rate of ventricular cannulation using the Kocher's and Keen's point. Ventricular catheter placement can be significantly improved using a modification of technique (especially for Keen's point access) in order to optimize outcome.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABREVIATIONS

CSF ---------------------------Cerebrospinal Fluid

AG-----------------------------Arachnoid Granulations

IVH----------------------------Intraventricular Haemorrhage

TB-----------------------------Tubercuosis

PCA---------------------------Posterior Cerebral Artery

TH -----------------------------Temporal Horn

FH------------------------------Frontal Horn

ID-------------------------------Internal Diameter

BPD----------------------------Biparietal Diameter

MRI----------------------------Magnetic Resonance Imaging

CT -----------------------------Computerized Tomograpy

VP------------------------------Ventriculoperitoneal

EVD----------------------------External Ventricular Drain

GCS----------------------------Glasgow Coma Score

SAH----------------------------Subarachnoid Haemorrhage

CHAPTER ONE

INTRODUCTION

BACKGROUND

Hydrocephalus is a major neurosurgical problem worldwide. This is especially so in Subsaharan Africa due to high level of illiteracy, late presentation to the hospital and low socioeconomic status. In Ghana, it constitutes a high burden of cases.

It is defined as excessive accumulation of Cerebrospinal fluid (CSF) within the ventricles resulting from excessive production of CSF or reduced absorption.[1] It can either be congenital or acquired. CSF diversion is one of the most common life-saving neurosurgical procedures performed in patients with hydrocephalus worldwide. Korle Bu Teaching Hospital, Ghana is not an exception. CSF diversional procedures using external ventricular drain (EVD) and ventriculoperitoneal (VP) shunt placement are well established, in which ventricular cannulation is required in both cases. [2] Several landmarks have been used for ventricular cannulation including Kocher's and Keen's point.

Accuracy of ventricular cannulation is varied. Studies have shown that using Kocher's point which have gained so much popularity especially for external ventricular drain placement is relatively inaccurate.[3] Also even though accuracy rates using Keen's point has not been recorded, complications of VP shunting done using this point has been revealing.[4]

Dakurah et al found out that amongst the 109 patients who underwent VP shunting in Korle Bu Teaching Hospital, 33.9% had shunt related complications. Out of these, 53.2% had infections, 16.2% had tracts leak, 13.5% had migrations, 13.5% had blockages and 13.5% had disconnections.[2]

How accurate the ventricular cannulation is goes a long way to determine the functionality of the diversion and also reduces the risk of complications and the need for revision surgery. In an article "Relationship of the location of the ventricular catheter tip and function of the ventriculoperitoneal shunt", Shoko et al noted that VP shunt function or failure is directly influenced by the location of the tip of catheter within the ventricle.[5]

Freehand ventricular catherterization is based on anatomical landmarks without any technological guidance.[6] However, there have been many advancements in the placement of ventricular catheters which have also proven to improve outcomes, including image guided ventricular cannulation.

This study will use Kocher's and Keen's points in CSF diversionary procedures (mainly EVD and VP shunt placement) to assess the accuracy of freehand ventricular catheterization.

PROBLEM STATEMENT

The burden of infant hydrocephalus in Africa is very significant, with over 6000 recorded new cases annually in East Africa.[7] New infant hydrocephalus cases in sub-Saharan Africa is found to be between 100,000-200,000 annually.[8]

Hydrocephalus is one of the most common cranial neurosurgical emergencies requiring surgical intervention in Korle Bu Teaching Hospital, especially in patients with fused cranium.
Shunting used to treat hydrocephalus has had variable outcome over the years, especially depending on the setting in which it is performed. In Subsaharan Africa, outcome of Ventriculoperitoneal shunt placement is poor in some series (constituting about 59.8%) with a mortality rate of 7.1%.[9,10] Another series records a high morbidity of between 34-47%.[11]

EVD placement has its fair share of complications. Huyette et al in their assessment of freehand pass technique for ventriculostomy found the catheter tip in the ipsilateral lateral ventricles in 56.1% of the cases. 7.1% of the catheter tips were in the contralateral lateral ventricles, 8.2% were in the third ventricles, 6.1% were within the interhemispheric fissure, and 22.4% were within extraventricular spaces. The author then concluded that there is much room for improvement even though many neurosurgeons believe that the practice of ventriculostomy presently is good enough.[12]

In a review of trajectories for external cranial ventricular access, it was reported that the number of catheter passages using Kocher's point ranged from 1-4 with 62% first passage, and accuracy of puncture between 56-84%.[13] Another article quotes a relatively inaccurate Kocher's point despite its popularity with a miss rate of up to 40%.[3,8]

Currently, there is no completed study to determine the accuracy of ventricular cannulation using Keen's point in a human subject.[14]

In some Centre's, image guided ventricular cannulation is used to improve accuracy. This is not readily available in the centre of study. Recent data shows there is a favourable effect of image guided ventricular cannulation on drain accuracy and drain failure rates. As drain failure rate may be reduced, drain accuracy may be enhanced. This was evident in a recent study to compare accuracy of ventricular catheter placement using freehand versus using neuronavigation or XperCT laser. Accuracy was found to be 69.2% using freehand and 83.2% using image guidance.[15]

JUSTIFICATION OF STUDY

Hydrocephalus is a major problem in neurosurgical practice in Subsaharan Africa including Ghana. With its high prevalence, 1-1.5% worldwide and 3.8% in Ghana, it presents a high burden of cases.

Various surgical procedures including External Ventricular drain and ventriculoperitoneal shunt placement which are used to surgically divert CSF in patients with hydrocephalus are very useful procedures in reducing the high morbidity posed by this condition and in some cases serve as complete treatment.

With a high incidence of miss rates, and other complications, it is important to properly study ventricular accuracy in our subregion to improve ways of doing these procedures. This is especially so in our environment where CSF diversion poses a lot of economic burden on the patient and relatives, the hospital and the country as a whole. This will also go a long way to reduce revision surgeries in an already overburdened neurosurgical service in the subregion.

Also, the morbidity that can result from complications of these procedures, especially related to proximal catheters can be reduced to the barest minimum if accurate placement of catheter is ensured.

In ventriculoperitoneal shunt placement, the implant is considered to be lifelong and therefore, care must be taken for accurate placement of the catheter. Improvement in the technique of ventricular cannulation like the use of image guidance can be considered if freehand is found to be less accurate in this study.

Freehand ventricular cannulation is acceptable worldwide and more commonly practiced. In the Korle Bu Teaching hospital where this study was carried out, it is the standard for CSF diversionary procedures. There is therefore the need to establish the accuracy here and by extension, the subregion.

NULL HYPOTHESIS

Freehand Ventricular cannulation of ventricles is accurate for CSF diversion using EVD or VP shunt placement

ALTERNATE HYPOTHESIS

CSF diversion using freehand ventricular cannulation is not accurate and may require assisted cannulation.

AIM

To determine how accurate the freehand cannulation of lateral ventricle is in patients with hydrocephalus using at Kocher’s and Keen’s points.

SPECIFIC OBJECTIVES

1. To assess the position of the tip of ventricular catheter after cannulation.
2. To determine factors that influence accuracy of ventricular cannulation
3. To identify the number of times ventricular cannulation is attempted in each patient.

CHAPTER TWO

LITERATURE REVIEW

Hydrocephalus is an abnormal accumulation of CSF within the ventricles of the brain.[16] It is also defined as excessive accumulation of CSF within the ventricles resulting from excessive production of CSF or reduced absorption.[1] Hydrocephalus can either be congenital or acquired. Congenital or developmental hydrocephalus is usually present at birth and is often part of a genetic syndrome or spinal dysraphism.[17]

In 1913, Dandy was the first to classify hydrocephalus as communicating and non-communicating. More classifications have been proposed over the past years. In adults for example, hydrocephalus can be classified as obstructive, communicating, hypersecretory and normal pressure hydrocephalus.[17]

Global prevalence of hydrocephalus is approximately 85 per 100,000 individuals. Different age groups have varying prevalence. It is 88 per 100,000 for the pediatric population and 11 per 100,000 in adults. As a result of high incidence of Normal Pressure Hydrocephalus(NPH) in the elderly, the prevalence is much higher in the older age group – 175 per 100,000 and 400 per 100,000 for those greater than 80 years old.[17]

In Africa, prevalence of hydrocephalus is higher. In infants, it ranges between 1 and 32 per 10,000 births. There is no male or female predilection.[18,19]

Some of the congenital causes includes Chiari Malformation (type 1 and 2), Primary aqueductal stenosis, Dandy Walker malformation. Acquired causes includes infectious cause (eg post-meningitis), post haemorrhagic (Subarachnoid and Intraventricular haemorrhage), intracranial masses, post-operative (post posterior fossa tumour excision).[16]

Since the Neolithic period, surgeons have been operating on the human skull. Early civilizations of the East left writings that described the surgeries of the head and spine as early as 3000-2500BC. However, progress in the neurological surgery stagnated until recently in this century. One of the pathologic states that modern neurosurgical world has conquered is Hydrocephalus. Hydrocephalus had a tragic consequence until second and third decade of the twentieth century.[20]

Hydrocephalus in Ancient History

Returning to the ancient pioneers in neurosurgery, we find that by 400 BC trepanning was already widely practiced. Hippocrates recommended it for the treatment of epilepsy, blindness, headache, and possibly hydrocephalus. Although physicians clearly recognized hydrocephalus as a clinical entity at this time, it was not until around the 17th century that definitive evidence of surgical therapy for this condition first appeared. But one should not take this lack of treatment as an indication of lack of interest in the problem. Galen spoke of it in the 2nd century AD, and Vesalius gave the first description of the ventricles as the location of excess fluid collection in the 16th century.[20]

Types of Hydrocephalus

Broadly, hydrocephalus can be classified generally due to subnormal CSF reabsorption or, rarely, CSF overproduction. The subnormal CSF reabsorption has two main functional subdivisions:

1. Obstructive hydrocephalus (AKA non-communicating): This is as a result of a block proximal to the arachnoid granulations.

2. Non-obstructive hydrocephalus (AKA communicating): In this case, there is defect in CSF reabsorption by the AG.

CSF overproduction is rare but does occur where there is production of excess CSF more than can be absorbed by the arachnoid granulations.[16]

Specific aetiology of Hydrocephalus

As stated above, hydrocephalus can be congenital or acquired. Some of the congenital causes include:

a) Chiari Type 2 malformation and/or myelomeningocele

b) Chiari Type 1 malformation

c) Primary aqueductal stenosis

d) Secondary aqueductal gliosis

e) Dandy Walker malformation

f) X-linked inherited disorder- This is rare.[16]

Some of the acquired causes include:

a) Infectious causes which includes post-meningitis, especially purulent and basal, including TB, cryptococcus , cysticercosis

b) Post-hemorrhagic which includes post subarachnoid haemorrhage (SAH), post-intraventricular hemorrhage (IVH).

c) Secondary to masses which could be non neoplastic (e.g. vascular malformation) or neoplastic (e.g. posterior fossa tumour, colloid cyst, pineal region tumours, etc)

d) Post-operative: It is known that about 20% of pediatric patients develop permanent hydrocephalus (requiring shunt) following posterior fossa tumor removal.

e) Neurosarcoidosis

f) "Constitutional ventriculomegaly": In this case, they are usually asymptomatic. It requires no treatment

g) Associated with spinal tumors: This may be due to increased protein within the CSF space, increased venous pressure or may be due to previous hemorrhage in some cases.

Signs and symptoms of Hydrocephalus

Hydrocephalus can present in various ways. In older children and adults where the cranial vault is fused and rigid, they can present with symptoms of increased ICP including visual disturbance, headache, nausea and vomiting, gait changes, upgaze and/or abducens palsy. Slowly enlarging ventricles may initially be asymptomatic.

In young children cranium enlarges at a rate that is greater than facial growth resulting in a craniofacial disproportion. Other symptoms they may present with may include irritability, poor head control, nausea and vomiting, regression in milestones. Some of the signs may include abnormalities in head circumference (OFC), full fontanelle and bulging, frontal bossing, enlargement and engorgement of scalp veins due to reversal of flow from intracerebral sinuses, due to increased intracranial pressure.

Other signs may include Macewen's sign/Cracked pot sign. 6th nerve (abducens) palsy can also occur is thought to be due to the long intracranial course which makes this nerve very sensitive to pressure. "Setting sun sign" (upward gaze palsy) is also common, which is also a component of Parinaud's syndrome. Patients with hydrocephalus can also present with hyperactive reflexes and irregular respirations with apneic spells.

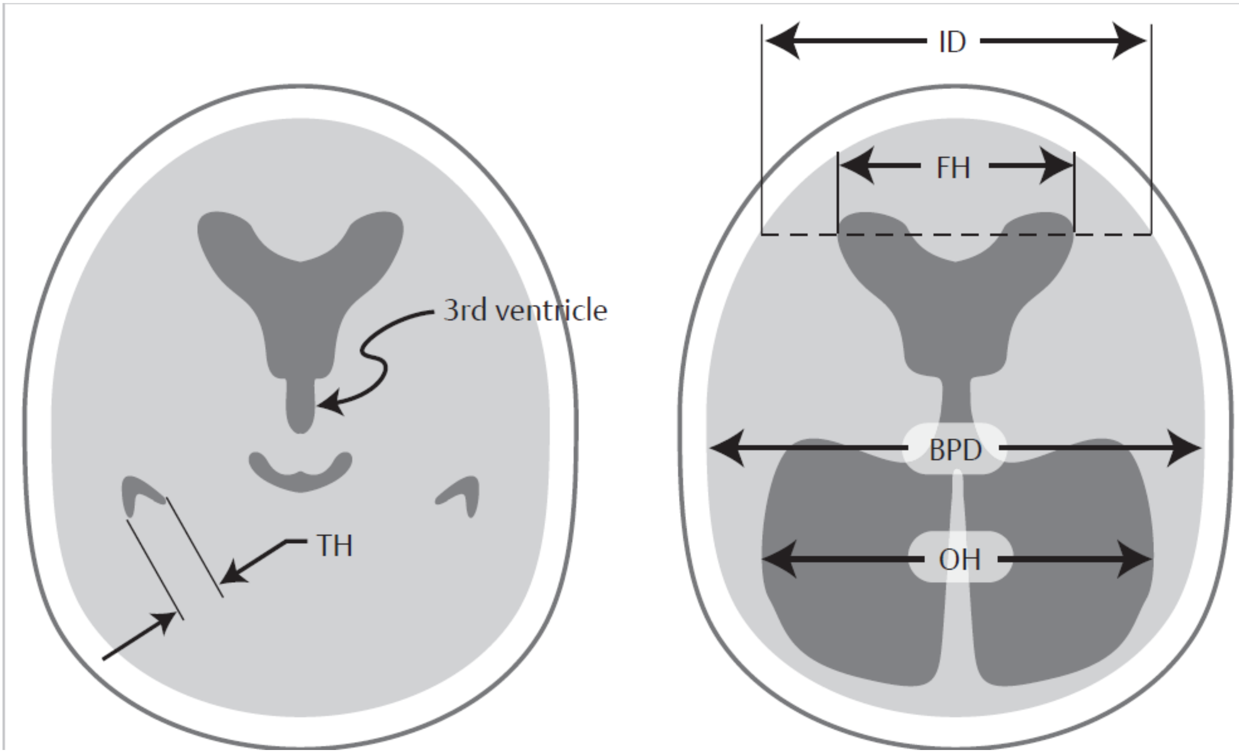
Blindness from hydrocephalus

Hydrocephalus can lead to blindness. Some of the possible causes include:

- Occlusion of posterior cerebral arteries (PCA caused by downward transtentorial herniation)
- Chronic papilledema causing injury to optic nerve at the level of the optic disc
- Dilatation of the 3rd ventricle which exerts a compressive effect on the optic chiasm

Imaging is the mainstay of diagnosis of Hydrocephalus. Computerized Tomography Scan (CT scan) will show the dilated ventricles and the other radiological signs as discussed below. Magnetic resonance imaging is another imaging modality that can be done. In addition to making a diagnosis, it gives further information as to the cause of the hydrocephalus.[16]

Specific imaging criteria for hydrocephalus



The following are some of the imaging signs that reveal the presesnce of hydrocephalus:

1. The size of both temporal horns (TH) is ≥ 2mm in width and the Sylvian & interhemispheric fissures and cerebral sulci are not visible

2. Both TH are ≥ 2 mm, and the ratio FH:ID > 0:5

3. Ballooning of frontal horns of lateral ventricles ("Mickey Mouse" ventricles) and/or 3rd ventricle

4. Periventricular low density on CT, or periventricular high intensity signal on T2 Weighted Image on MRI

5. Evans ratio or index: ratio of FH to BPD.

   > 0.3 suggests hydrocephalus

6. Sagittal MRI may show thinning of the corpus callosum (generally present with chronic HCP) and/or upward bowing of the corpus callosum.[16]

Normal Pressure Hydrocephalus (NPH)

This was first described in 1965, also known as Hakim Adams syndrome. It occurs in the older age group. It is characterized by a triad of dementia, gait disturbance and urinary incontinence. These symptoms are however not pathognomonic of Normal pressure Hydrocephalus. This type of hydrocephalus was initially described to be idiopathic. However, a predisposing factor may be identified suggestive of a raised intracranial pressure at a point. This may be termed secondary NPH whose aetiology may include:

- Post subaracnoid haemorrhage
- Following posterior fossa surgery
- Post infectious eg meningitis,
- Post traumatic
- Following radiationtherapy to the brain
- Tumours, including carcinomatous meningitis.

Some patients who have normal pressure hydrocephalus are said to have periods of raised intracranial pressure.[16]

There are other conditions that may mimic hydrocephalus but are not in its true sense. These includes "hydrocephalus ex vacuo", and developmental anomalies where the ventricles or portions of the ventricles appear enlarged such as corpus callosum agenesis, septo-optic dysplasia and hydranencephaly.[16]

Treatment of hydrocephalus is CSF diversion. There are various diversionary procedures that can be used. Common amongst which are External ventricular drain (EVD) and Ventriculoperitoneal shunt placement (VP shunting).[16]

Various emergent and elective neurosurgical procedures require that the ventricular system is accessed routinely. Different locations within the ventricles may need to be accessed depending on the indication. Therefore, various access points have been developed over the years. Each entry point requires different surface landmarks for burrhole placement as well as trajectories for catheterization and ending locations within the ventricles.[14] The various access points incude:

Anterior access sites - Kocher's, Kaufman's, Paine's, Menovksy's, and Tubbs' points; posterior access sites - Keen's, Frazier's, Dandy's, and Sanchez's points. In this review, we will discuss in details Kocher's and Keen's points.[14]

KOCHER'S POINT

This is said to be the most common point of access to the ventricles. This point was named after the first Swiss neurosurgeon Emil Theodor Kocher (1841-1917) who received a Nobel Prize for Physiology or Medicine in 1909.[13] The first ventriculostomy using this point is however credited to Cushing and Tillmanns. In 1908, Tillman described this point in the British Medical Journal, and also cited Neisser and Pollack.[13,21,22] Kocher's point is the most commonly used location to access the ventricles for external ventricular drain placement. It has also been used for ventriculoperitoneal shunt placement, as access point for endoscopic third ventriculostomy,[23,24] endoscopic removal of colloid cyst and intraventricular clots.[25,26]

The dimension (Craniometrics) for Kocher's point is 11cm superior and posterior from the nasion and 3cm lateral to the midline which corresponds to a point along the mid-pupillary line. This point is also anterior to the coronal suture (about 1-2cm), lateral to the superior sagittal sinus (SSS) and anterior to the primary motor cortex. This is important as avoiding the SSS and the primary motor cortex is critical. Generally, placing the catheter on the nondominant side is preferred, however it can be placed on the left side depending on the pathology and the surgical outcome required.[3,7,13,27]

The skin incision can be linear or curvilinear with a small flap to make the burrhole.[13] The ventricular catheter is directed perpendicular to the meeting point of a line drawn from the ipsilateral medial cantus and ipsilateral external auditory meatus. The catheter is advanced until "a give" is felt, corresponding to a depth of approximately 6cm from skin surface to enter the ipsilateral frontal horn of the lateral ventricle.[7,27]

Although Kocher's point is very popular, it has some limitations. The number of catheter passages ranges from 1-4 with 62% first passage, an accuracy of puncture between 56-84%.[13]

Another article quotes a relatively inaccurate Kocher's point despite its popularity with a miss rate of 4-40%.[3,8]

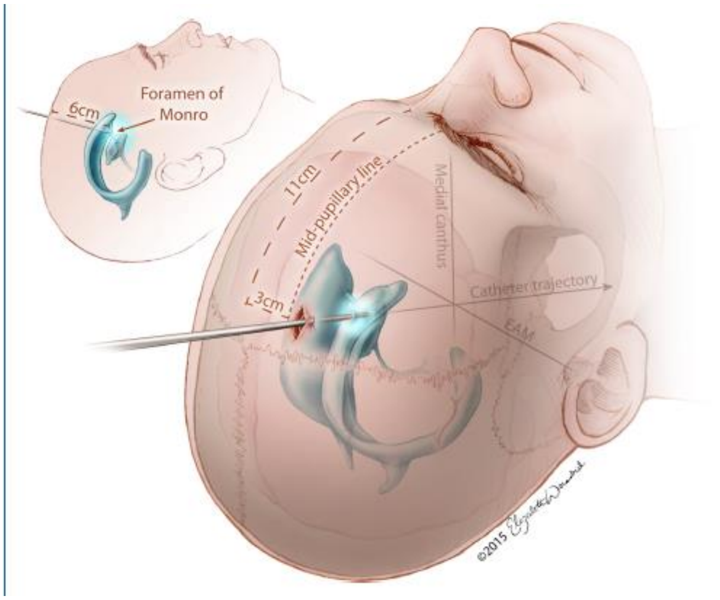


Figure 1: Ventricular access through Kocher's point.

Grading System

A grading system using Computerized Tomography scan has been developed to assess the accuracy of the placement of ventricular catheters.[28] The grading is as follows:

1. Grade 1 - the tip within the ipsilateral lateral ventricle nearing foramen of Monro.
2. Grade 2 - the medial deviation into a contralateral frontal horn or a lateral ventricle.
3. Grade 3 - the lateral deviation through the caudate nucleus along the lateral corner and wall of the frontal horn.
4. Grade 4 - extraventricular catheterization.

Ghajar advocated a perpendicular trajectory of ventricular catheter relative to the skull surface as a guide to optimize trajectory during ventriculostomy.[29] However, the slope of the calvarium does not allow this trajectory to hold, especially in the coronal plane.[13,28]

KEEN'S POINT

Keen's point was first described by Keen in 1888. He described it for a child presumed to have cerebellar tumour with hydrocephalus. In his description, the entry point was 1.25 inch behind the ipsilateral auditory meatus with the catheter directed to a point 2.5 inches above the opposite meatus to enter the ventricle at about 3-4cm. [14,30]. Historically, Keen's point was referred to as Posterior parietal point.[31] In a more recent description, the burrhole is placed approximately 2.5 to 3cm superior and posterior to the pinna of the ear. It can be placed on either the right or left side depending on the pathology and the surgical goal or outcome required. The ventricular catheter is positioned perpendicular to the temporal lobe cortex and aimed slightly cephalad. It is then passed to a depth of 4-5cm until the trigone of the lateral ventricle is entered.

Use of Keen's point is indicated for emergent diversion of CSF during posterior fossa surgery. Most times, it is included in the operative field. However, it is more commonly used in ventriculoperitoneal shunt placement. [13,32] Several successful ventricular cannulation using Keen's point have been described, however, no clinical series to determine its accuracy have been completed.[14]

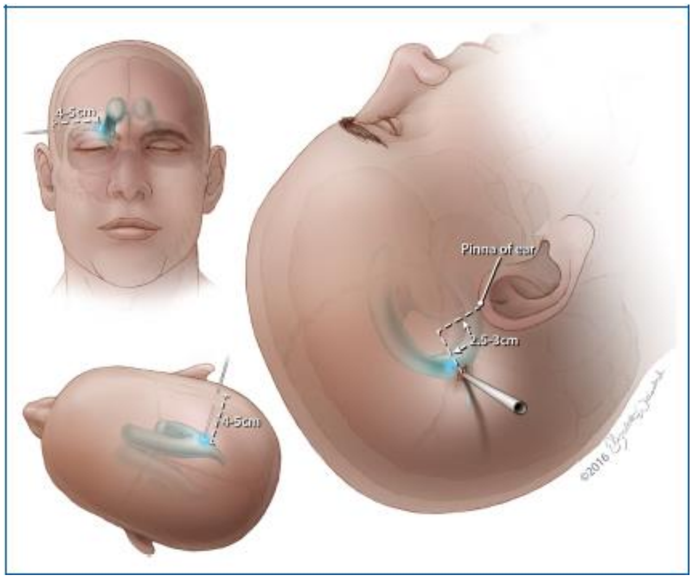


Figure 2: Ventricular access through Keen's point

Other grading systems have been described in the literature as to the accuracy of ventricular cannulation. These include the following:

A. In this grading system, the catheter position is rated in a centralized manner in regard to the 2 cm tip of the catheter (perforated part):[6]

– grade I: Ideal catheter position without contact to the ventricular wall of more than 0.5 cm

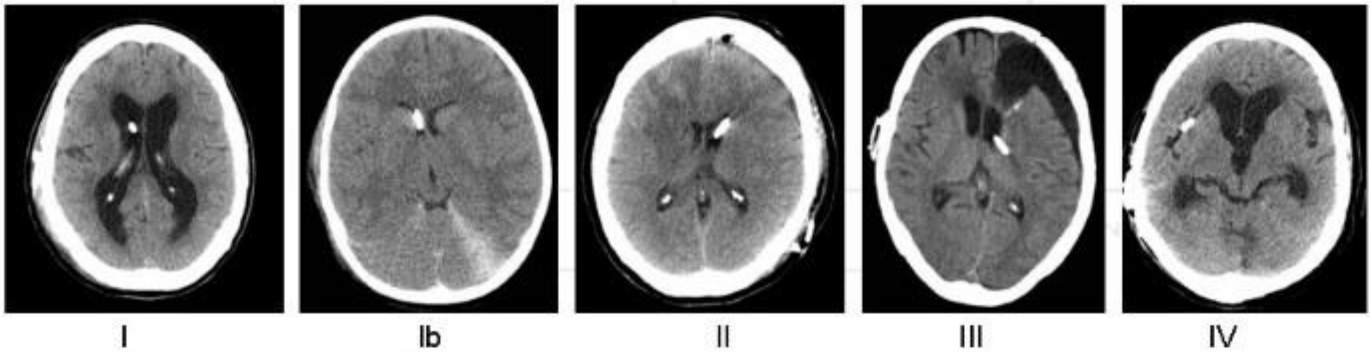
– grade Ib: Contact to the medial and lateral ventricular wall in the case the ventricular width equals the catheter diameter

– grade II: Contact to the ventricular wall or the choroid plexus of more than 0.5 cm

– grade III: Partly intraventricular position of the catheter (less than 1.5 cm intraventricular)

– grade IV: extraventricular position of the catheter (less than 0.5 cm intraventricular)

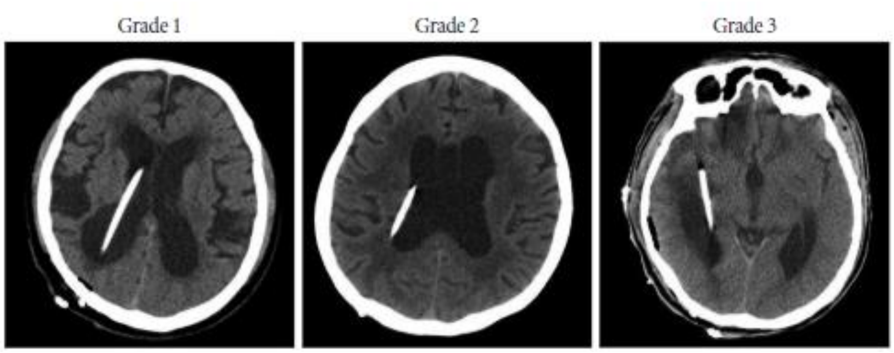
Figure



B. The grading system proposed by Kakarla et al:[33]

Grade 1: Optimal placement with the tip either in the ipsilateral frontal horn or in the third ventricle through the foramen of Monro.
Grade 2: Functional placement into the contralateral lateral ventricle.
Grade 3: Suboptimal placement into eloquent structures or non-target cerebrospinal fluid space, with or without functional drainage.

C. Jung et al also proposed and used a grading system for VP shunts following 3-point scale:[34]
Grade I: Catheter tip position free-floating in CSF, away from ventricular wall or choroid plexus,
Grade II: Catheter tip touching choroid plexus or ventricular wall
Grade III: Tip within parenchyma or failure to reach the intraventricular space



To ensure increased accuracy of ventricular cannulation, several methods have been developed. With advancement in the neurosurgical image guidance, different types of images have been used to enhance the accuracy of ventricular cannulation. In 1981, the use ultrasonography was first described. Other image guidance such as the use of neuronavigation, endoscopy and augmented reality using phone applications have been applied.[15] Other assisted techniques like the use of Adjustable Ghajar guide and electromagnetically navigated assisted ventricular catheter placement have been described.[28,34]

CHAPTER THREE

METHODOLOGY

STUDY DESIGN

This is a Cross-sectional study of patients with hydrocephalus undergoing CSF diversion (external ventricular drain or ventriculoperitoneal shunt placement) in the Neuroscience unit of Korle Bu Teaching Hospital.

STUDY AREA

This study was conducted in the Neuroscience unit of Korle Bu Teaching Hospital (KBTH). KBTH is situated in the capital city of Ghana, Accra, specifically in the Ablekuma Central municipality. It is the foremost and the leading tertiary hospital in Ghana. It is also the teaching hospital for the School of Medicine and Dentistry (SMD) of the University of Ghana. Its total bed capacity is 2000. The Neuroscience unit serves as a referral centre for neurosurgical cases for most hospitals all over Ghana and also some countries in the West African subregion such as Cote D'Ivoire, Liberia, Sierra Leone, Burkina Fasso, Togo and others. The Neuroscience unit has 32 beds, two operating theatres, 4 bed capacity intensive care unit and 4-bed High Dependency unit. There are currently 9 active neurosurgeons, 4 residents in the neuroscience unit. On an average, about 8-10 cases of hydrocephalus are seen every month in the neuroscience unit.

STUDY POPULATION

All patients who present to KBTH with hydrocephalus who require either emergent or elective CSF diversion using external ventricular drain or ventriculoperitoneal shunt placement.

INCLUSION CRITERION

All patients who present or are referred to KBTH with hydrocephalus (CT scan or MRI proven) of various causes in a fused cranium who undergo either external ventricular drain or ventriculoperitoneal shunt placement.

EXCLUSION CRITERIA

- Patients who are unable to do CT scan post operatively due to generally unstable state and prolonged ICU stay

- Unknown patients who are unable to consent to participate in the study due to decreased level of consciousness.

SAMPLING METHOD

A consecutive sampling method was used to select patients who presented to the emergency unit and outpatient department with acute hydrocephalus requiring CSF diversion.

DETERMINATION OF SAMPLE SIZE

Using the Cochran formula, the sample size was calculated

$$n_0 = \frac{Z^2pq}{e^2}$$

Where

n = Sample size

Z = Confidence level (95%. – 1.96)

p = Estimated proportion of attribute in population – 0.5

q = 1-p

e = Level of precision – 0.05

N = 384

Correction of finite population formula used to correct sample size using the formula

$$n = \frac{n_0}{1 + \frac{(n_0 - 1)}{N}}$$

Where

n = Adjusted sample size

N = Population size

Using an estimated average of 10 patients per month, with a cumulative of about 60 patients within the study period,

Adjusted Sample size = 52

In adding a buffer to adjusted sample size obtained, dropout rate of 10% was used

$$N1 = n/1\text{-}d$$

Where

N1 = New adjusted sample = 58

D = Dropout rate – 10%

PROCEDURE USED

Selection of patients for the study commenced after ethical and college clearance. Patients who presented to KBTH neuroscience unit who met the inclusion criteria were selected to participate in this study.

Consent was obtained from patient and/or relatives, identification number was then given, and an admission proforma administered which included details of the patient's demographic characteristics, cormorbid conditions. Data on the size of the dilated ventricles was obtained and Evan's ratio calculated using the radiological imaging available. The aetiology and type of hydrocephalus was recorded. Also, the level of consciousness of patient using Glasgow coma scale was obtained. This was done by the researcher. WHO standard preoperative measures were observed.

The surgical procedure followed the standard of the neurosurgical unit of Korle Bu Teaching Hospital which is also the standard worldwide. Consultants, Senior specialists and Senior residents with at least 2 years of experience carried out the surgical procedure. Accuracy of placement of ventricular catheter was compared with the level of experience of surgeon.

Since the primary aim is to determine the accuracy of ventricular catheterization, 24 -72hours after the procedure, a new CT scan of the brain was done, and then the trajectory and location of catheter tip identified to determine how accurate the cannulation was. This was done by the neuroradiologist and sometimes the researcher. With Kocher's point cannulation, the Ghajar's grading system of accuracy used. With the Keen's point, the three point scale grading system was used to assess the accuracy.

Procedure for external ventricular drain placement.

Under General anaesthesia or local anaesthesia, patient is positioned supine with head in neutral position. Hair shaved and incision site marked and infiltrated with 1% lidocaine in 1: 200,000 adrenaline. Incision made and deepened onto the skull and scalp retracted. Burrhole at Kocher's point made and dura cauterized with bipolar diathermy. Cruciate durotomy done. Ventricular catheterization done and number of attempts recorded. Subgaleal tunneling done and catheter secured, and then connected to the external system which is set up at a desired pressure.

Procedure for ventriculoperitoneal shunt placement

Under General anaesthesia, patient is positioned supine with head tilted to the left (or right as the case may be). Hair shaved and incision site marked and infiltrated with 1% lidocaine in 1: 200,000 adrenaline. Scalp Incision made and deepened onto the skull and scalp retracted. Burrhole at Keen's point made and dura identified. Abdominal incision made and carefully deepened to enter the peritoneum. Subcutaneous tunneling done to connect the two wounds using the shunt passer. Catheter is then introduced into the subcutaneous space and passer removed. Dura cauterized with bipolar diathermy. Cruciate durotomy done. Ventricular catheterization done and number of attempts recorded. The ventricular catheter is connected to the valve and the distal catheter and then secured. The distal catheter is inspected for CSF flow and then peritonealized. Wounds are then closed in layers.

DATA COLLECTION AND TOOLS

The data collection was done using questionnaires, and included the demographic characteristics of the patient, brief clinical state of the patient, mainly the symptoms, GCS, type and aetiology of hydrocephalus in the patient. Using the preoperative imaging, the size of the dilated ventricles was determined and recorded, and the Evans ratio calculated. Post-operative CT scan was used to determine how accurate the ventricular cannulation was using the Ghajar's grading system for Kocher's point and the three-point scale for the Keen's point. The tools are attached.

DATA ANALYSIS

Data was captured and analysed with the Excel spread sheet and the IBM SPSS version 24. All continuous variables normally distributed were summarized as the means with standard deviation or as median with their interquartile ranges for those not normally distributed. Summary of categorical variables such as sex and accuracy grade, type of imaging, type of hydrocephalus, treatment outcome were presented as frequencies, proportions or percentages. Comparison of means was done using T-test or ANOVA where appropriate. Accuracy was measured in percentages. Accuracy grades 1 for Kocher's point and grade 1 for Keen's point were considered accurate and assigned a code of 1 and all other grades were considered inaccurate with a code 0. A multivariable logistic regression analysis was done to determine the factors that influence the accuracy. Accuracy was considered the dependent variable and size of ventricle, experience of the surgeon and demographic characteristics as independent variables. To test the hypothesis, alpha level was set at 0.05 and statistical significance when p value is <0.05. Results of analysis were presented as charts and tables.

DATA SECURITY AND CONFIDENTIALITY

Data collected was coded. Names of patients were not used and did not appear in the article to ascertain confidentiality of information provided. Data collected was kept in a safe place accessible to only the researcher

DISSEMINATION OF RESULTS

This dissertation is a partial fulfilment for an award of Fellowship with the Ghana College of Physicians and Surgeons in the faculty of Neurosurgery. The results will therefore be submitted to the college. Also, after the fellowship award, the outcome of the study will be published in a reputable journal.

ETHICAL CONSIDERATION

Ethical approval was obtained from Ethical Review Board at the Korle Bu Teaching Hospital before the commencement of the study.

CSF diversion (VP shunt or EVD placement) was done following standard protocol. The type of CSF diversionary procedure was determined by the specific indication for it. CT scan of the brain was done within 72 hours post operatively as part of standard protocol worldwide. Because this is not routinely done in the study centre, the cost of the post-operative CT scan was borne by a collaboration between the investigator and the radiology unit of KBTH.

In patients who could not consent by themselves due to altered level of consciousness, consent was sought from close relatives available. In patients who would have presented as unknown, and procedure was able to restore level of consciousness, consent would have been taken from the patient. Otherwise, such an unknown patient would be excluded from the study. For children less than 18 years, consent was taken from close relatives or caregivers. For children who were old enough to provide their views and concerns, child assented to participate in the study.

Consenting process began soon after decision to do surgery and which CSF diversionary procedure to be used was made. The consenting period spanned through hours to days depending on how emergent the condition was and the availability of theatre space. This period formed the preoperative preparatory phase, and afforded the patient and/or relatives enough time to make a decision. The decision to participate in the study or not therefore, did not influence the professional care patients received.

Patient and/or patient relatives was/were talked to by the primary investigator or research assistant who was thoroughly educated on the manner of administering the consent. Interpreters were used for patients and/or relatives who were unable to read and/or write or who did not understand English or the native language of the investigator or research assistant, so that consent could be fully explained in a language that can be well understood by them. It was fully explained to patient and/or relatives that their decision to participate or not to participate would not influence the care of the patient in any way, and they were also at liberty to opt out of the study at any point should they decide to do so. Data collection only began when consent was duly sought.

Information obtained from patient was treated as highly confidential. Data collected was secured in a cabinet and kept under lock and key and only the investigator had access to this. A digital copy of the data was also be kept accessible only to the investigator. The data was de-identified (names and numbers removed) and codes assigned.

CHAPTER FOUR

RESULTS AND ANALYSIS

Demographic characteristics

Age Distribution

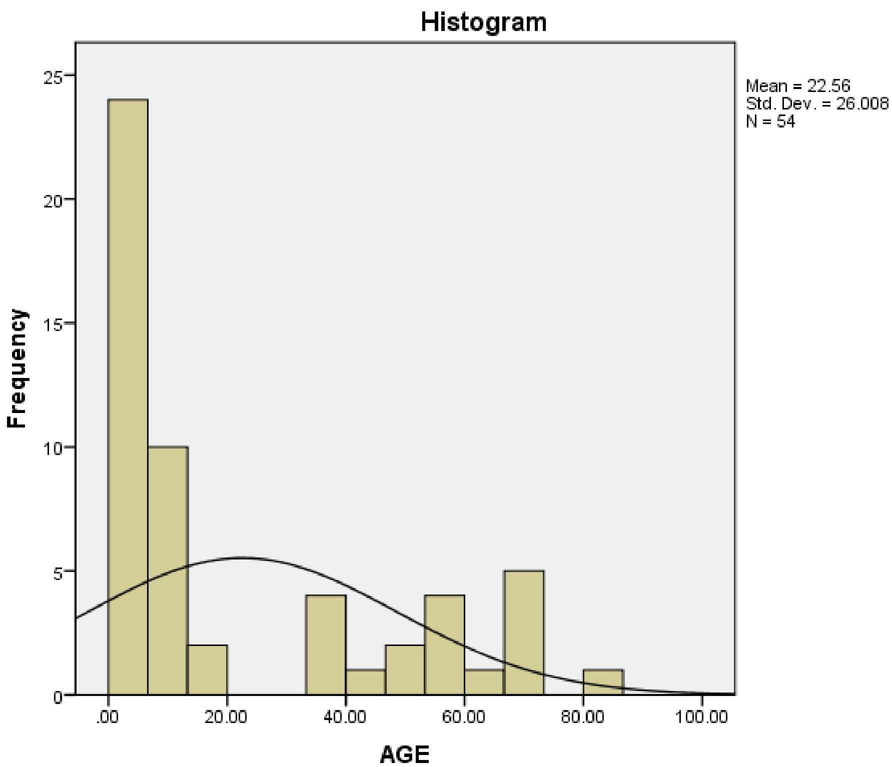


Figure 1:0 Age distribution of participants

The age of the participants is significantly skewed. Out of the 54 participants that were recruited for this study, the age ranged from 1 month old to 84 years with a mean age of 22.56 years and Standard deviation of 26.01. The descriptive summary of the age distribution is as shown in Table 1.0 below.

Descriptive summary of Age

Table 1.0: Descriptive summary of age

Mean		22.56
Median		8.50
Std. Deviation		26.01
Minimum		0.08
Maximum		84.00
Percentiles	25	3.00
	50	8.50
	75	46.00

Sex Distribution

Table 1.1: Distribution by sex

	Frequency	Percent
MALE	33	61.1
FEMALE	21	38.9
Total	54	100.0

Out of the 54 participants, 33 were male constituting 61.1% while 21 were female (38.9%). There was a male preponderance with a ratio of 1.6:1. Table 1.1 above shows the sex distribution as obtained in this study.

Level of Education of participants

Table 1.2: Educational level of participants

Level of education	Frequency	Percent
PRIMARY	13	24.1
SECONDARY	12	22.2
TERTIARY	7	13.0
PRESCHOOL	12	22.2
NONE	10	18.5
Total	54	100.0

Most of the participants were either in primary (elementary) school or were preschool children constituting 24.1% and 22.2% respectively. Secondary (High) school leavers were 22.2% with those who had tertiary education being the least (13%). 10 out of 54 participants (18.5%) had no formal education as most were infants or toddlers.

Presenting symptoms of patients with hydrocephalus

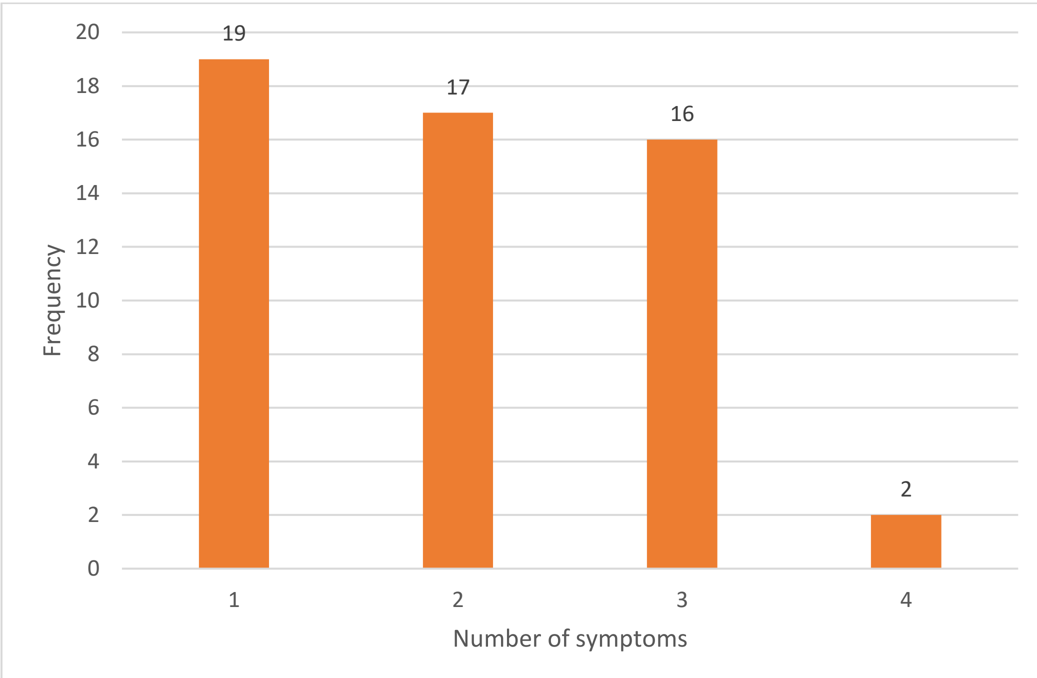


Figure 1:1 Number of symptoms at presentation

Most of the patients (19) under this study presented with one main symptom. 17 out of the 54 patients presented with two main symptoms, 16 presented with 3 symptoms and 2 with four symptoms.

Presenting symptoms of patients with hydrocephalus

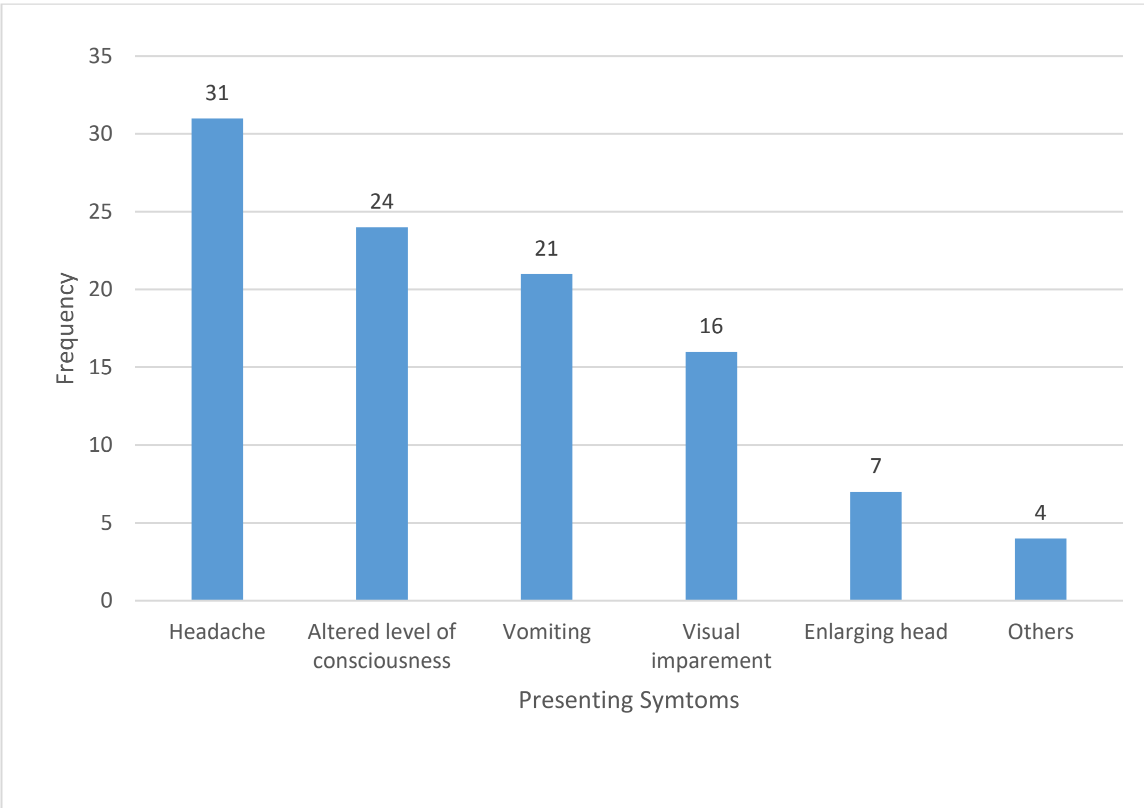


Figure 1:2 Type of presenting symptoms

Headache was the commonest symptom of presentation, constituting 31, followed by altered level of consciousness and then vomiting. Other symptoms were visual impairment which constituted 16 out of 54 patients and 7 presented with enlarging head size. “Others” included fever and myelomeningocele as part of the presentation of hydrocephalus.

Glasgow Coma Score (GCS) of patient at presentation

Table 2.0 Presenting GCS

GCS	Frequency	Percent
4	5	9.3
8	1	1.9
9	2	3.7
10	7	13.0
12	1	1.9
13	2	3.7
14	8	14.8
15	28	51.9
Total	54	100.0

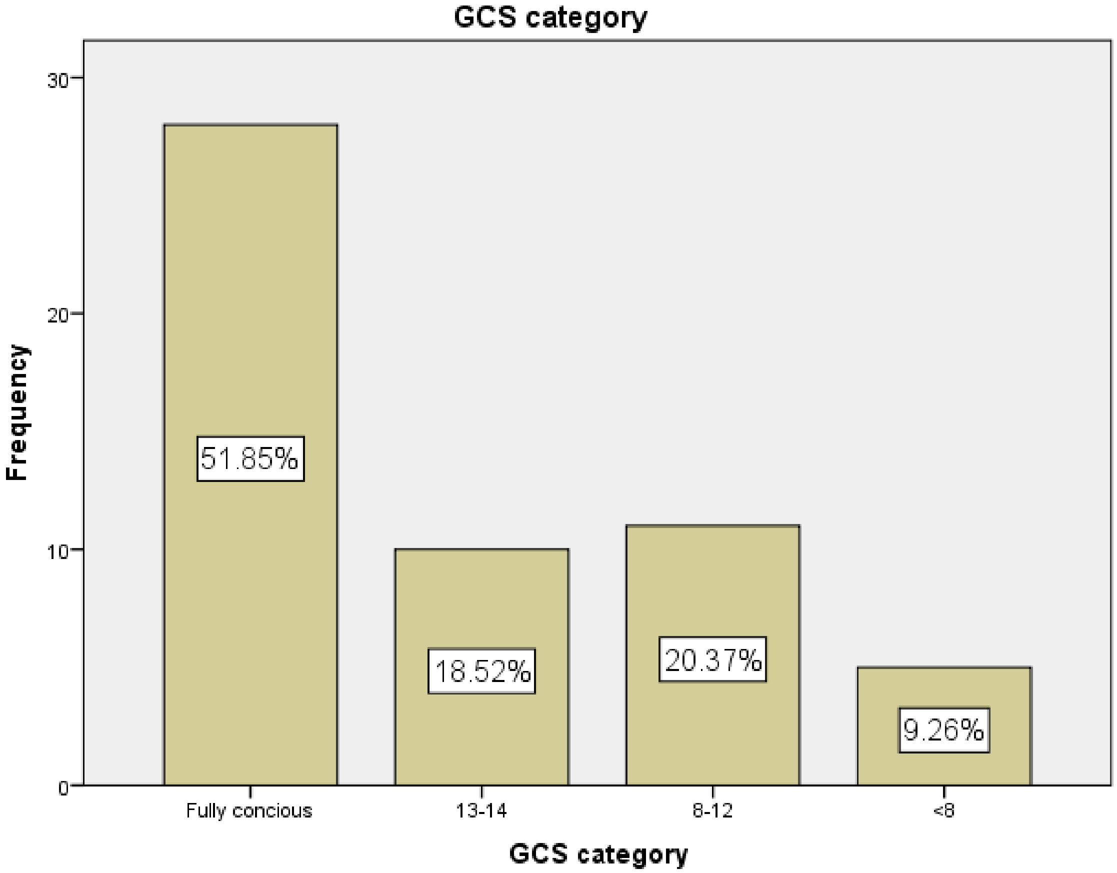


Figure 2.0 Categories of Presenting GCS

Most of the patients presented with GCS of 15/15 (51.85%). Those with GCS less than 8/15 constituted 9.26% of the patients, while those with GCS 8-12/15 and 13-14/15 constituted 20.37% and 18.52% respectively. Although the GCS of those with GCS of <8/15 had high accuracy rate of ventricular cannulation, this was not statistically significant.

Presenting GCS and Accuracy of Ventricular Cannulation

Table 3.0: Presenting GCS and Accuracy of Ventricular Cannulation

GCS category	ACCURACY		Total
	INACCURATE	ACCURATE	
Fully conscious	18 64.3%	10 35.7%	28 100.0%
13-14	5 50.0%	5 50.0%	10 100.0%
8-12	4 36.4%	7 63.6%	11 100.0%
<8	1 20.0%	4 80.0%	5 100.0%
Total	28 51.9%	26 48.1%	54 100.0%

P=0.192

The level of consciousness of patient had no statistically significant relationship with the accuracy rate.

Evans index/ratio of participants using preoperative imaging

Table 4.0: Descriptive summary of Evans index/ratio

Mean		.4313
Median		.4000
Std. Deviation		.12771
Minimum		.25
Maximum		.72
	25	.3450
Percentiles	50	.4000
	75	.4750

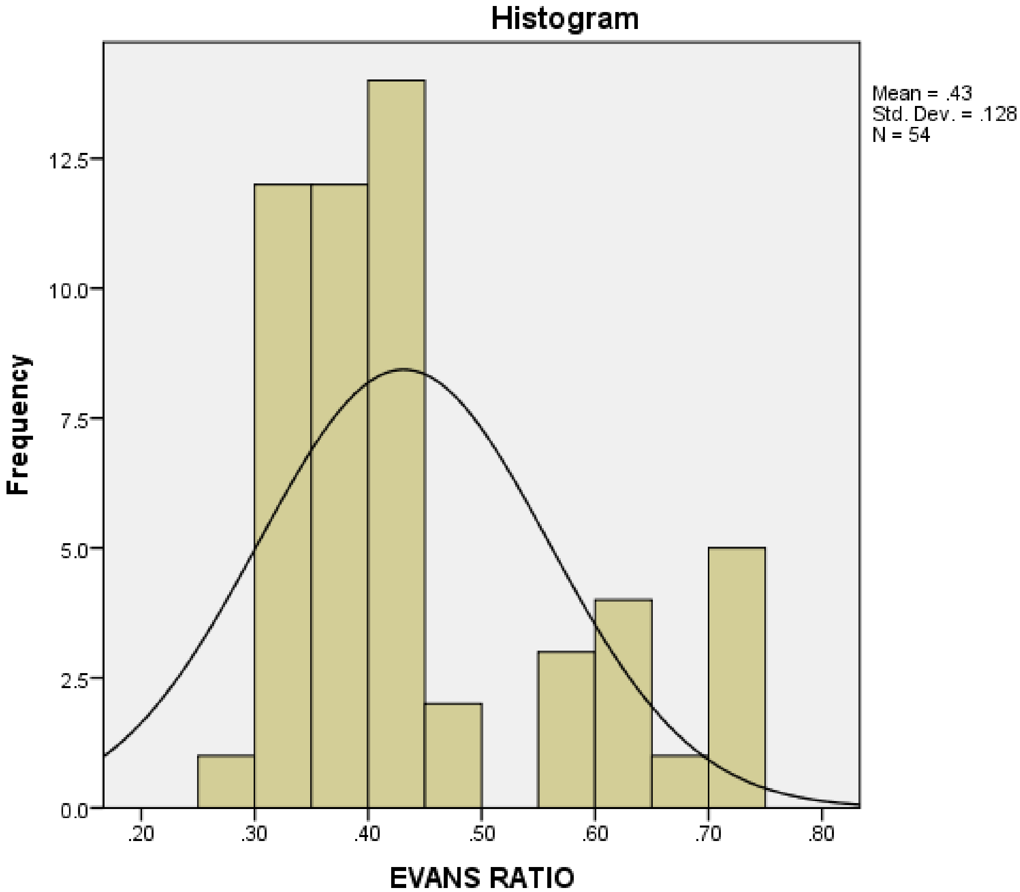


Figure 3.0 Evans ratio/index

The Evans index appears to be skewed, the Evans ratio ranged from 0.25 to 0.72 with an average of 0.43 and a standard deviation of 1.28.

Imaging modality done for the purpose of diagnosis

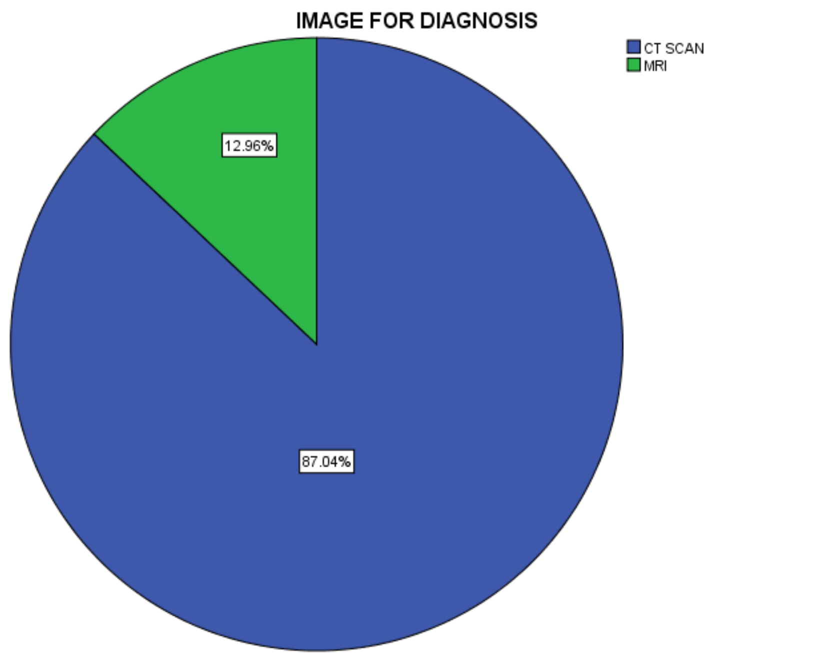


Figure 4.0: Type of Imaging used for diagnosis

Most of the preoperative diagnostic imaging study done were Computerized Tomography (CT) scan of the head constituting 87.04 %. The rest was Magnetic Resonance Imaging (MRI).

Type of hydrocephalus amongst the patients recruited for the study

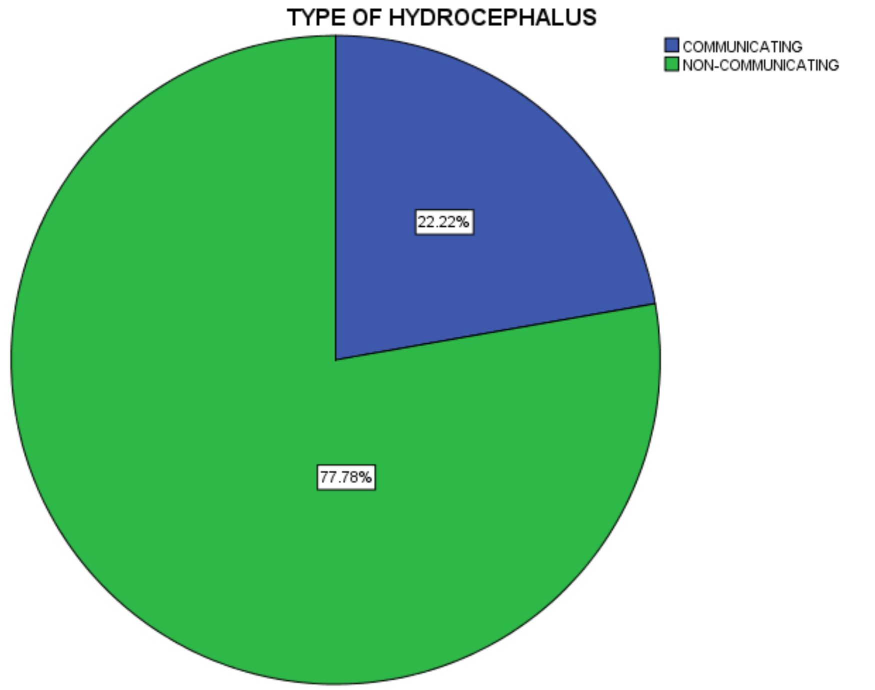


Figure 5:0 Type of Hydrocephalus

Out of the 54 patients recruited for the study, 42(77.8%) had non-communicating hydrocephalus which was significantly higher, while 12(22.2%) had communicating type.

Aetiology of hydrocephalus among the participants

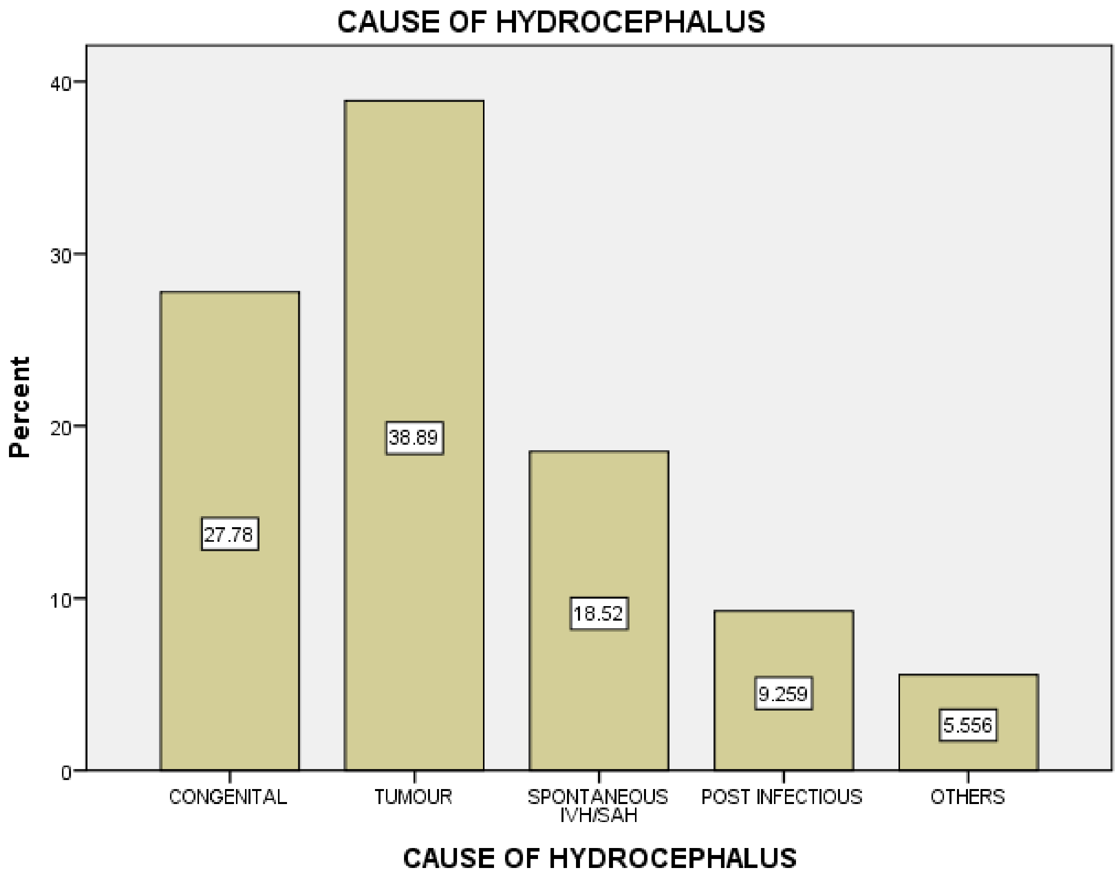


Figure 5.1 Causes of Hydrocephalus

Tumour was the commonest cause of hydrocephalus during the period of study accounting for 38.9% of the cases. This was followed by congenital causes (27.8%). Spontaneous IVH/SAH constituted 18.5% and post infectious causes accounted for the least (9.3%). Others included post-operative hydrocephalus.

The access point that was used for ventricular cannulation

Table 5:0 Access Point used for ventricular cannulation

	Frequency	Percent
KOCHER'S	23	42.6
KEEN'S	31	57.4
Total	54	100.0

During the period of study, Kocher's and Keen's points were used to access the ventricles. 23(42.6%) of the ventricular cannulations were through Kocher's point while 31(57.4%) were through Keen's point.

Accuracy of Ventricular catheter placement

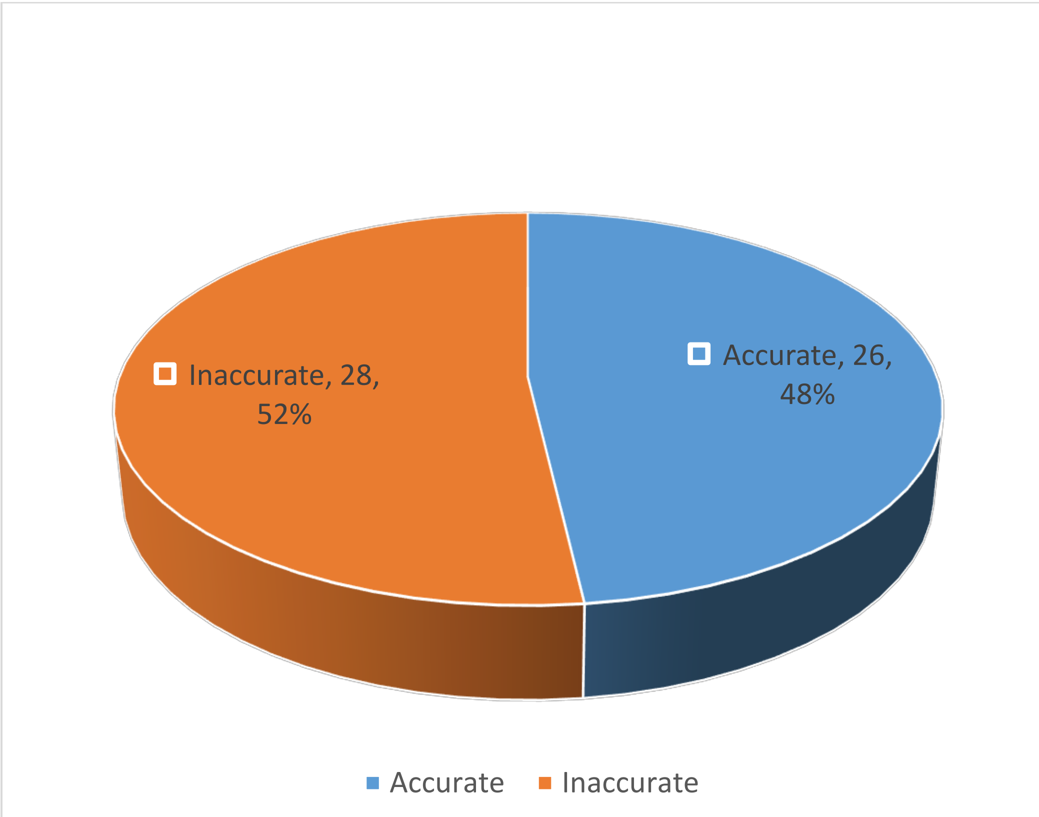


Figure 6:0 Accuracy of Ventricular cannulation

Overall, out of the 54 ventricles which were cannulated using both Kocher's and Keen's point, 26(48%) were found to be accurate while 28(52%) were inaccurate.

Grades of catheter placement by access point – Kocher's and Keen's point

Table 5:1 Grading of Ventricular cannulation by access point.

ACCESS POINT	GRADE OF CATHETER PLACEMENT				Total
	GRADE 1	GRADE 2	GRADE 3	GRADE 4	
KOCHER'S	18 78.3%	3 13.0%	0 0.0%	2 8.7%	23 100.0%
KEEN'S	8 25.8%	18 58.1%	5 16.1%	0 0.0%	31 100.0%
Total	26 48.1%	21 38.9%	5 9.3%	2 3.7%	54 100.0%

Fisher Exact test, $p<0.001$

Using the Kocher's point, 18 out of 23 had grade 1 of the catheter placement while 2 out of 23 had grade 4. On the other hand, using the Keen's point, 8 out of 31 had grade 1 of catheter placement. 18 out of 31 had grade 2 and 5 had grade 3. Therefore, 78.3% of ventricular cannulation using Kocher's point had grade 1 and 25.8% using Keen's point also had grade 1.

Accuracy rate of freehand ventricular cannulation using Kocher's and Keen's point

Table 6:0 Level of accuracy by the access point

ACCESS POINT	ACCURACY		Total	
	INACCURATE	ACCURATE		P-value
KOCHER'S	5 21.7%	18 78.3%	23 100.0%	<0.001
KEEN'S	23 74.2%	8 25.8%	31 100.0%	
Total	28 51.9%	26 48.1%	54 100.0%	

The accuracy of ventricular cannulation using Kocher's point was found to be 78.3% and 25.8% using Keen's point.

The level of experience of surgeon and grades of ventricular catheter placement

Table 6:1 Grading by level of expertise

LEVEL OF EXPERIENCE OF SURGEON	GRADE OF CATHETER PLACEMENT				Total
	GRADE 1	GRADE 2	GRADE 3	GRADE 4	
RESIDENT >2 YEARS EXPERIENCE	18 52.9%	12 35.3%	3 8.8%	1 2.9%	34 100.0%
SENIOR SPECIALIST	4 57.1%	2 28.6%	0 0.0%	1 14.3%	7 100.0%
CONSULTANT	4 30.8%	7 53.8%	2 15.4%	0 0.0%	13 100.0%
Total	26 48.1%	21 38.9%	5 9.3%	2 3.7%	54 100.0%

Fisher exact test, P= 0.437

There was no statistically significant difference in the grade of ventricular cannulation with the different level of experience of the surgeon. P - value = 0.437. Consequently also, the level of experience of the surgeon did not make any statistically significant difference in the accuracy if ventricular cannulation (p=0.35).

Level of experience of the surgeon and accuracy of ventricular cannulation

Table 7.0 Accuracy by level of experience of surgeon

LEVEL OF EXPERIENCE OF SURGEON	ACCURACY		Total
	INACCURATE	ACCURATE	
RESIDENT >2 YEARS EXPERIENCE	16 47.1%	18 52.9%	34 100.0%
SENIOR SPECIALIST	3 42.9%	4 57.1%	7 100.0%
CONSULTANT	9 69.2%	4 30.8%	13 100.0%
Total	28 51.9%	26 48.1%	54 100.0%

Fisher exact test, P=0.35

The number of times each ventricular cannulation was attempted

Table 7.1: Number or cannulation attempts

Number of attempts	Frequency	Percent
1	40	74.1
2	8	14.8
3	4	7.4
4	1	1.9
5	1	1.9
Total	54	100.0

Most of the ventricular cannulations done using Kocher's and Keen's points were attempted once (74.1%). 14.8% had two and 7.4% had three passes. Isolated 4 and 5 passes occurred in one patient each. Average number of cannulation attempt was 1.43 with a standard deviation of 0.86. This is shown in Table 7.1 in the previous page.

Correlation matrix between Evans ratio and grading of ventricular catheter placement

Table 8:0: Evans ratio and grading of ventricular catheter placement

	Spearman's rho	GRADE OF CATHETER PLACEMENT
EVANS RATIO	Correlation Coefficient	.029
	Sig. (2-tailed)	.836
	N	54

There is not significant correlation between the Evans Ratio and the grading of the ventricular catheter placement, p=0.836.

Association between Evans ratio and Accuracy

Table 8.1: Independent-Samples Mann-Whitney U Test Summary

Total N	54
Mann-Whitney U	322.500
Wilcoxon W	673.500
Test Statistic	322.500
Standard Error	57.520
Standardized Test Statistic	-.721
Asymptotic Sig.(2-sided test)	.471

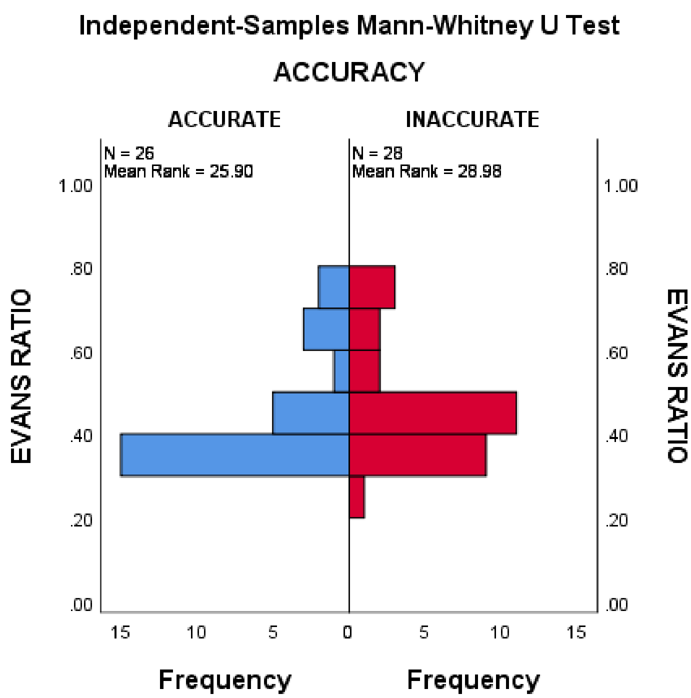


Figure 7.0: Evans ratio/index and accuracy of ventricular catheter placement

CHAPTER FIVE

DISCUSSION

A total of 54 patients were recruited for this study. The age distribution was significantly skewed, ranging from months to 84 years of age. This may be due to the varying aetiology of hydrocephalic patients which were included in this study ranging from congenital to causes which are more prevalent in the older age groups like spontaneous intracranial bleeds. Mean age was 22.56 with a standard deviation of 26.01. **Dakurah et al, in their review of Hydrocephalus management using ventriculoperitoneal shunt found t**he mean age of patients with hydrocephalus to be 5.35 years with standard deviation of 1.26 which differs from that obtained in this study.[2] This likely due to the fact that most of the recruited patients were children.

There was a male preponderance in the patients recruited for this study with proportion of 61.1% males as against 38.9% for females. **EK Ofori et al in their work titled "Hydrocephalus cases in Ghana: A 6 year review (2007-2012) of computed tomography radiological report"** reported a male to female distribution of 39.9% and 60.1% respectively. This is almost a direct contrast with this study.[35]

Obstructive hydrocephalus was the commoner type of hydrocephalus in this study constituting 77.8%. **EK Ofori et al in their 6 year review of Hydrocephalus cases found out that there was a slight preponderance** of communicating hydrocephalus (49.0%) over non-communicating (47.8%).[35] This may be as a result of the large sample size with a better representation of the distribution of the types of hydrocephalus.

Dakurah et al, stated in their review of 109 patients at Korle Bu Teaching Hospital that the commonest cause of hydrocephalus was aqueductal stenosis (24.2%) followed by Meningitis and Posterior fossa tumour (16.4% each). Other tumours were also mentioned including pineal region tumours and brain stem tumours.[2] In this study, tumours constituted the most common cause of hydrocephalus (38.9%) followed by the congenital causes (27.8%). This is in agreement with the previous study.

Anatomical landmarks are used to guide the insertion of ventricular catheters so as to aim for an optimum target of placement. In the 1880s, Theodore Kocher who was a neurosurgeon set out some points which were identified in surgical craniometry.[36],[37] This led to the definition of Kocher's point which is the most common entry point for ventricular cannulation.

Keen's point was also described by WW Keen which is also wildly used for ventricular cannulation especially in ventriculoperitoneal shunt placement.[32]

Out of the 54 patients recruited for this study, 23 had freehand ventricular cannulation, using Kocher's point and 31 using Keen's point. The accuracy using Kocher's point was found to be 78.3%. A review by Yam Bahadur Roka found accuracy of puncture using Kocher's point to be 56-84%.[13] This is consistent with the findings of this study. Another review article by Peter J.M et al quoted a miss rate of Kocher's point access between 4 to 40%.[38] This also consistent with this study with a miss rate of 22%.

In the work of Huyette et al titled "Accuracy of the freehand pass technique for ventriculostomy catheter placement: retrospective assessment using computed tomography scans", 56.1% of the catheter tips were in the ipsilateral lateral ventricle, 7.1% were in the contralateral lateral ventricle, 8.2% were in the third ventricle, 6.1% were within the interhemispheric fissure, and 22.4% were within extraventricular spaces. Using the Ghajar's grading, the accuracy of ventricular cannulation would be 64.3%.[12] This is below the accuracy rate found in this study using the Kocher's point. The accuracy for the ideal placement of ventricular catheter tip using Kocher's point was found to be 86%.[39]. This is higher than that gotten from this study which was 78.3%. However, of note is accuracy rate (78.3%) of this study which is in strong agreement with Karkala's investigation (77%) and C. Brenke et al (79%) using Kocher's point.[33],[40]

Although this accuracy is significantly high, it leaves a significant number of misplacements. This is likely to lead to high number of complications. Some of the complications that may arise from inaccurate placement include track or intraventricular bleeding and injury to surrounding structures. Direct injury may occur when catheters pass into the basal ganglia, internal capsule, fornix, thalamus, choroid plexus and vessels such as the superior thalamostriate vein or the posterior medial choroidal arteries. There are also reports of misplacement into the brainstem,[33] sylvian fissure, interpeduncular, or suprasellar cistern[41] as well as into the basal cisterns (carotid-ophthalmic, chiasmatic, prepontine).[42]

Ghajar proposed a method to improve accuracy of ventricular cannulation to 96%. In this method, a plastic frame is placed after proper calculation to enter the ventricle. Also the use of modern day neuronavigation has accuracy rate of 95%. Other image guided ventricular cannulation including ultrasonography, endoscopy, etc have been shown to improve accuracy.[13,28,43,44]

Most literature have reported successful ventricular cannulation using the Keen's point. For example, in an article by Woo et al, Keen's point was the most correctly sited burrhole with 63% of the catheters optimally placed.[45] Also, Mohammed J. et al noted in his article that ventriculoperitoneal shunting using Keen's point was very successful in their practice.[4] However, clinical series determining the accuracy of ventricular catheter placement have not been completed.[38]

The accuracy rate of ventricular cannulation using Keen's point was found to be low (26%) in this study. Using the three point scale grading, 25.8% had grade 1, 58.1% had grade 2 and 16.1% had grade 3. It was noticed that most of the catheters crossed to the contralateral side, and the tip of the catheter may be in brain tissue. Although, the function of the catheter may not be immediately of concern, may eventually cause proximal malfunction of the shunt.

Nayoung Jung et al in his submission, noted that patients who had a higher grade of catheter tip placement had a higher rate of proximal shunt malfunction and higher revision rate. He stated that "proximal obstruction took place 7% in grade I, 15% in grade II and 100% in grade III. Compared in terms of proximal catheter position, there was growing trend of revision rate according to increase of grade on each group".[34]

In the literature, a suitable position of ventricular catheterization is usually obtained after an average of 1.4 to 2.4 passes. In the work by Huyette et al, it was noted that freehand ventricular catheterization at the study institution typically required 2 passes per successful placement.[41] Also, a review of trajectories for external cranial ventricular access by Yam Bahadur Roka et al stated the number of catheter passages ranging from one to 4 with a first passage of 62%.[13] In the present study, the average number of catheter passages was 1.43 with a first passage of 74.1%.

Multiple passages of the ventricular catheter increases the risk of complications such as haemorrhage and direct injury to the brain tissue as enumerated above. It is therefore prudent to improve the technique of ventricular cannulation to increase the accuracy. Currently, many techniques have been employed to improve success rate and accuracy of ventricular catheterization. Percutaneous CT controlled ventriculostomy is one of these techniques which has improved the accuracy of external ventricular drain placement and reduced the number of passes. HS Min and JH Song reported in their study that of the 20 patients who had ventriculoperitoneal shunt placement using this technique none of them had poor location of the proximal ventricular catheter. However, in the non-CT guided group, 9 out of 20 patients had a poor location. This was found to be statistically significant.[46–48]

The Ghajar Guide is a device that sits on the calvarial surface and guides the ventriculostomy perpendicular to the plane tangent to the calvarium at the burr hole. To be able to use this, the brain anatomy should not be distorted by any lass lesion. In a prospective trial assessing the accuracy of ventricular catheter placement using the Ghajar guide, the success rate was 96%. This is far better than previously documented accuracy rates and that of this present study.[48,49]

In another a study of image-guided robotic placement of 16 ventricular catheters, successful placement with a single pass was reported with no intraparenchymal catheter tip placement. Other methods of improving accuracy of ventricular cannulation include the use of neuronavigation, a localizer device or endoscope, and stylet guidance usingultrasonography.[48,50–52]

Just as image guided ventricular cannulation is advantageous in helping improving accuracy, it also helps reduce procedural time and complications that arise from multiple passes, especially in patients with distorted anatomy where the surface landmarks and craniometrics are rendered inaccurate. On the other hand, ventricular cannulation with image guidance presents considerable disadvantages which includes the fact that it is very expensive and some of them require equipments that are bulky and difficult to manipulate.[48]

In low- and middle-income countries like Ghana with low socio-economic profile, image guided ventricular cannulation may be difficult to come by in most centres. In such places, freehand ventricular catheterization may suffice. However, the skills should be developed and appropriate craniometric dimensions applied. In addition, training simulation has been used in neurosurgery education and can be applied to ventriculostomy training to improve the performance of the procedure.[53]

Also, in this present study, where the accuracy rate of ventricular cannulation using Keen's point is low, it calls for an adjustment of technique or the use of other cranial access points like the posterior parietal access which has been shown to have better accuracy rate. In a review article by Shibu V Pillai titled Techniques and Nuances in Ventriculoperitoneal Shunt Surgery, it was stated that Parieto-occipital entry site is preferred and has the advantage of accommodating all head sizes unlike Frazier's point, Dandy's point or Keen's point. It is centered on a point that is 4 cm lateral to the midline, in a plane that is midway between the orbito-meatal plane (OMP) and the parallel vertex plane. The ventricular catheter can be placed from this entry site in the frontal horn or occipital horn. In these positions, the choroid plexuses are avoided, and risk of proximal catheter blockage is reduced. The catheter is directed toward the ipsilateral medial canthus in a plane midway between the supraorbital plane (parallel to OMP through supraorbital ridges) and the parallel vertex plane.

Pillae also stated in his article that the length of the ventricular catheter can be measured on the brain scan with the required position in mind and then translated to the patient from the burrhole to the Kocher's point if frontal horn cannulation is required.[54]

Using the parieto-occipital access point will reduce the risk of catheter crossing to the contralateral ventricle as the direction of the catheter suggests a different course within the ventricle. Also, on using the Keen's point, there will be a need to accurately measure the length of ventricular catheter required to keep the catheter within the same side of the lateral ventricle.

A proposed grading of Ventricular catheter placement using Keen's point is as follows:
Grade I – Catheter tip within the ipsilateral lateral ventricle
Grade II – Catheter tip touching the wall of the ventricles
Grade III – Catheter tip across the midline in the contralateral ventricle or brain tissue
Grade IV – Extraventricular catheter placement.

Surgeons are very confident performing freehand ventricular cannulation despite the high level of inaccuracy. The level of experience of the surgeon could play a part in determining how accurate the catheter placement is. However, in this study where the groups of surgeons included Residents with > 2 years experience, Senior specialists and Consultants, there was no statistically significant difference in level of accuracy amongst these groups of surgeons (p=0.35). This agrees with a study on the surgical management of EVD placement using a virtual reality simulator which showed no statistically significant correlation between the number of neurosurgical training years of the surgeon and the performance.[53] **Also, in another work by Ji-Hoon Lee et al, on Accuracy of the Free Hand Placement of an External Ventricular Drain,** it was noticed that the level of experience of the surgeon did not make a statistically significant difference in the level of accuracy of ventricular catheter placement.[48]

Evans ratio is an index used to measure the size of the ventricles. The ratio/index is significant for hydrocephalus when 0.3. The higher the ratio, the bigger the size of the ventricle. In this study, we tried to determine whether the size of the ventricle determines the level of accuracy of the ventricular placement. It was noted that there was no statistically significant correlation between the Evans ratio and the accuracy rate (p=0.836). **Ji-Hoon Lee et al in their work on assessing freehand placement of ventricular catheter categorized the Evans index into <0.4 and >0.4.** It was noted that using the preoperative CT scans, when the Evans index was <0.4, 22.1% of the ventricular catheter tips were in the ipsilateral frontal horns while 37.1% were not. On the other hand, when the Evans index was >0.4, 20.4% of the ventricular catheter tips were in the ipsilateral frontal horns while 20.4% were not. Though numerically had some difference, this was not statistically significant.[48] There is therefore agreement with this study in which we could not demonstrate a correlation between the level of accuracy of ventricular cannulation and the size of the ventricle.

CONCLUSION

Overall, Freehand ventricular cannulation had a significantly low accuracy. Accuracy of cannulation was far better using Kocher's point than using Keen's point. Most of the cannulation had a successful first pass while a few had multiple cannulation attempts. There was no significant correlation between the Evans index and level of experience of surgeon with the accuracy rate of ventricular cannulation using the Kocher's and Keen's point. Ventricular catheter placement can be significantly improved using a modification of technique (especially for Keen's point access) to optimize outcome and prevent long term proximal catheter related complications.

RECOMMENDATIONS

- While using Keen's point as the access point for the ventricular cannulation, strict measurement of the ventricular catheter should be done using the preoperative brain imaging to know exact intracranial length required to prevent it from crossing to the contralateral side. This is also applicable to ventricular cannulation using Kocher's point.

- Parieto-occipital access for ventriculoperitoneal shunting has been shown to have advantages over keen's point as stated and is recommended for its use.

- Training by simulation and other mentorship programs should be undertaken to enhance the understanding of anatomy and improve the skills of trainees in ventricular catheterization.

REFERENCES

1. Bauman N, Poenaru D. Hydrocephalus in Africa: A surgical perspective. Ann African Surg. 2008;2(June):30–7.
2. Dakurah TK, Adams F, Iddrissu M, Wepeba GK, Akoto H, Bankah P, et al. Management of Hydrocephalus with Ventriculoperitoneal Shunts: Review of 109 Cases of Children. World Neurosurg [Internet]. 2016;96:129–35. Available from: http://dx.doi.org/10.1016/j.wneu.2016.06.111
3. Abdoh MG, Bekaert O, Hodel J, Diarra SM, Le Guerinel C, Nseir R, et al. Accuracy of external ventricular drainage catheter placement. Vol. 154, Acta Neurochirurgica. 2012. p. 153–9.
4. Junaid M, Ahmed M, Ur Rashid M. An experience with ventriculoperitoneal shunting at keen's point for hydrocephalus. Pakistan J Med Sci. 2018;34(3):691–5.
5. Yamada SM, Kitagawa R, Teramoto A. Relationship of the location of the ventricular catheter tip and function of the ventriculoperitoneal shunt. Vol. 20, Journal of Clinical Neuroscience. 2013. p. 99–101.
6. Schaumann A, Thomale UW. Guided Application of Ventricular Catheters (GAVCA) - multicentre study to compare the ventricular catheter position after use of a catheter guide versus freehand application: Study protocol for a randomised trail. Vol. 14, Trials. 2013.
7. Rehman T, Rehman AU, Ali R, Rehman A, Bashir H, Ahmed Bhimani S, et al. A radiographic analysis of ventricular trajectories. Vol. 80, World Neurosurgery. 2013. p. 173–8.
8. Toma AK, Camp S, Watkins LD, Grieve J, Kitchen ND. External ventricular drain insertion accuracy: Is there a need for change in practice? Vol. 65, Neurosurgery. 2009. p. 1197–200.
9. Outcomes of ventriculoperitoneal shunt insertion in Sub-Saharan Africa in_ Journal of Neurosurgery_ Pediatrics Volume 6 Issue 4 (2010) Journals.
10. Mwachaka PM, Obonyo NG, Mutiso BK, Ranketi S, Mwang'Ombe N. Ventriculoperitoneal shunt complications: A three-year retrospective study in a Kenyan national teaching and referral hospital. Vol. 46, Pediatric Neurosurgery. 2010. p. 1–5.
11. Drake JM, Kestle JRW, Tuli S. CSF shunts 50 years on - Past, present and future. Vol. 16, Child's Nervous System. 2000. p. 800–4.

12. Accuracy of the freehand pass technique for ventriculostomy catheter placement_ retrospective assessment using computed tomography scans in_ Journal of Neurosurgery Volume 108 Issue 1 (2008) Journals.
13. Article R, Roka YB, Cardio N, Hospital M. A review of trajectories for external cranial ventricular access. 2021;18(2):2–8.
14. Burke JF, Magill ST. Letter: Craniometrics and ventricular access: A review of Kocher's, Kaufman's, Paine's, Menovksy's, Tubbs', Keen's, Frazier's, Dandy's, and Sanchez's points. Oper Neurosurg. 2020;19(5):E550–1.
15. Aljoghaiman M, Bergen B, Takroni R, Wang B, Eangles P, Farrokhyar F, et al. Image-Guided versus Freehand Ventricular Drain Insertion: Systematic Review and Meta-analysis. Vol. 160, World Neurosurgery. 2022. p. 85-93.e5.
16. Greenberg MS. Handbook of neurosurgery. 2020. 408 p.
17. Koleva M, Jesus O De. Hydrocephalus - StatPearls - NCBI Bookshelf [Internet]. 2021. Available from: https://www.ncbi.nlm.nih.gov/books/NBK560875/
18. Isaacs AM, Riva-Cambrin J, Yavin D, Hockley A, Pringsheim TM, Jette N, et al. Age-specific global epidemiology of hydrocephalus: Systematic review, metanalysis and global birth surveillance. Vol. 13, PLoS ONE. 2018.
19. Munch TN, Rostgaard K, Rasmussen MLH, Wohlfahrt J, Juhler M, Melbye M. Familial aggregation of congenital hydrocephalus in a nationwide cohort. Brain. 2012;135(8):2409–15.
20. Rachel RA. Surgical treatment of hydrocephalus: A historical perspective. Pediatr Neurosurg. 1999;30(6):296–304.
21. Hildebrandt G, Surbeck W, Stienen MN. Emil Theodor Kocher: The first Swiss neurosurgeon. Vol. 154, Acta Neurochirurgica. 2012. p. 1105–15.
22. Cushing H. surgery of the head. Keen WW, ed Surg Its Princ Pract. 1908;Vol 3(Philadelphia: WB Sauners):17–276.
23. Woo H, Kang DH PJ. Preoperative determination of ventriculostomy trajectory in ventriculoperitoneal shunt surgery using a simple modification of the standard coronal MRI. J Clin Neurosci. 2013;20(12):1754-1758.
24. Jones RF, Stening WA BM. Endoscopic third ventriculostomy. Neurosurgery. 1990;26(1):86–92; discussion 91-82.

25. Zohdi A EKS. Endoscopic approach to colloid cysts. Minim Invasive Neurosurg. 2006;49(5):263–8.
26. Wang WH, Hung YC, Hsu SP et al. Endoscopic hematoma evacuation in patients with spontaneous supratentorial intracerebral hemorrhage. J Chin Med Assoc. 2015;78(2):101–7.
27. Park YG, Woo HJ, Kim E PJ. Accuracy and safety of bedside external ventricular drain placement at two different cranial sites: Kocher's point versus forehead. J Korean Neurosurg Soc. 2011;50(4):317–21.
28. S.-Y. Y, Y. K, J. P. Adjustable Ghajar guide technique for accurate placement of ventricular catheters: A pilot study [Internet]. Vol. 60, Journal of Korean Neurosurgical Society. 2017. p. 604–9. Available from: http://www.embase.com/search/results?subaction=viewrecord&from=export&id=L618270406%0Ahttp://dx.doi.org/10.3340/jkns.2016.1011.004
29. JB G. A guide for ventricular catheter placement. Technical note. J Neurosurg. 1985;63(6):985–6.
30. Keen W. Surgery of the lateral ventricles of the brain. Med Rec. 1890;38(12):317.
31. Aitken A. A ventricular catheter guide for rapid and accurate ventricular access. J Clin Neurosci. 1996;3(3):257–60.
32. Keen W. Surgery of the lateral ventricles of the brain. Med News. 1890;58:275–8.
33. Kakarla UK, Kim LJ, Chang SW, Theodore N SR. Safety and accuracy of bedside external ventricular drain placement. Neurosurg 63. 2008;ONS164-ONS(discussion ONS166-ONS167).
34. Jung N, Kim D. Effect of electromagnetic navigated ventriculoperitoneal shunt placement on failure rates. J Korean Neurosurg Soc. 2013;53(3):150–4.
35. Ofori EK, Gyamfua AOB, Tettey KD, Brakohiapa EK, Angmorterh SK, Oblitey JN. Hydrocephalus cases in Ghana: a six-year (2007-2012) review of computed tomography (CT) radiological reports. South African Radiogr. 2017;56(1):15–9.
36. Aschoff A, Kremer P, Hashemi B KS ;22:67-93. The scientific history of hydrocephalus and its treatment. Nuerosurgical Rev. 1999;22:67–93.
37. Srinivasan VM, O'Neill BR, Jho D, Whiting DM OM. The history of externalventricular drainage. J Neurosurg. 2014;120:228–36.

38. Singer RJ. Craniometrics and Ventricular Access : A Review of. 2020;18(5):461–9.
39. Hsieh CT, Chen GJ, Ma HI, Chang CF, Cheng CM, Su YH, Ju DT, Hsia CC, Chen YH, Wu HY LM. The misplacement of external ventricular drain by freehand method in emergent neurosurgery. Acta Neurol Belg. 111(1):22-8.
40. Brenke C, Fürst J, Katsigiannis S, Carolus AE. High accuracy of external ventricular drainage placement using anatomical landmarks. 2020;66:435–41.
41. Huyette DR, Turnbow BJ, Kaufman C, Vaslow DF W, BB OM. Accuracy of the freehand pass technique for ventriculostomy catheter placement: retrospective assessment using computed tomography scans. J Neurosurg. 2008;108:88–91.
42. Saladino A, White JB, Wijdicks EFM LG. Malplacement of ventricular catheters by neurosurgeons: a single institution experience. Neurocrit Care. 2009;10:248–252.
43. Manfield JH YK. Real-time ultrasound-guided external ventricular drain placement: technical note. Neurosurg Focus. 43(E5):5.
44. Thomale UW, Schaumann A, Stockhammer F, Giese H, Schuster D, Kästner S, Ahmadi AS, Polemikos M, Bock HC, Gölz L, Lemcke J, Hermann E, Schuhmann MU, Beez T, Fritsch M, Orakcioglu B, Vajkoczy P, Rohde V BGGS. Randomized, Multicenter Trial to Evaluate the Quality of Ventricular Catheter Placement with a Mobile Health Assisted Guidance Technique. Neurosurgery. 2018;2(83):252–62.
45. Woo PY, Wong DK, Yuan Y, Guo X, See MK, Tam M, Wong AK CKA. morphometric analysis of commonly used craniometric approaches for freehand ventriculoperitoneal shunting. Oper Neurosurg. 22(2):51–60.
46. Krotz M, Linsenmaier U, Kanz KG, Pfeifer KJ MW, M. R. Evaluation of minimally invasive percutaneous CT controlled ventriculostomy in patients with severe head trauma. Eur Radiol. 2004;(14):227–33.
47. Ruchholtz S, Waydhas C, Muller A, Lewan UM, Nast-Kolb D, Euler E, Pfeiffer KJ SL. Percutaneous computed tomographic-controlled ventriculostomy in severe traumatic brain injury. J Trauma Acute Care Surg. 45(3):505–11.
48. Lee JH, Park CW, Lee U, Kim YB, Yoo CJ, Kim EY, et al. Accuracy of the free hand placement of an external ventricular drain (EVD). Korean J Cerebrovasc Surg [Internet]. 2010;12(2):82–6.
49. O'Leary ST, Kole MK, Hoover DA, Hysell SE, Thomas A SC. Efficacy of the Ghajar

Guide revisited: a prospective study. J Neurosurg. 92(5):801–3.

50. Arginteanu M, Abbott R FA. ISG viewing wand-guided endoscopic catheter placement for treatment of posterior fossa CSF collections. Pediatr Neurosurg. 27(6):319–24.

51. CR G. Ultrasonic ventriculostomy stylet. Neurosurgery. 37(5):1020–1.

52. Garell PC, Mirsky R, Noh MD, Loftus CM, Hitchon PW, Grady MS, Dacey RG HM. Posterior ventricular catheter burr-hole localizer. J Neurosurg. 89(1):157–60.

53. Banerjee PP, Luciano CJ, Lemole GM, Charbel FT OM. Accuracy of ventriculostomy catheter placement using a head-and hand-tracked high-resolution virtual reality simulator with haptic feedback. J Neurosurg. 107(3):515–21.

54. Techniques and Nuances in Ventriculoperitoneal Shunt Surgery Pillai SV Neurol India.

APPENDICES

INFORMED CONSENT

My name is Dr Richmond Hagan. I am a senior resident in the Neurosurgery unit of Korle Bu Teaching Hospital undergoing a fellowship program with the Ghana College Of Physicians and Surgeons.

Title of Study: Accuracy of freehand ventricular cannulation using kocher's and keen's point in hydrocephalus patients at a tertiary institution
Principal investigator: Dr. Richmond Hagan
Supervisors: Dr. Thomas Dakurah, Consultant Neurosurgeon, KBTH
Dr Mawuli Ametefe, Consultant Neurosurgeon, KBTH

Please kindly take some time to read the following document carefully. Ask questions if there are areas you do not understand.
(For patients and/or relatives who are unable to read and/or write or does not understand the native language of investigator or research assistant, an interpreter sholud be used, and consent should be fully explained in a language that he/she fully understands).

Purpose of Study:
Every patient who has acute hydrocephalus (a condition where there is accumulation of water in the brain) undergoes a diversion of the CSF. This involves inserting a catheter (tube) in the brain where the CSF (water in the head) is and drained outside or to another part of the body. This study is to assess how accurate inserting the catheter into the ventricle (the central part of the brain where the water is) is using freehand. This will enable us to improve our methods if the need be and reduce complications and revision surgeries.
Procedures:
Once you accept to be part of the surgery, you will go through the normal process of treatment as is required by standard practice here in KBTH without any alteration which includes CSF diversion under general or local anaesthesia after thorough clinical evaluation. It will be required of you to

do a CT scan of the head within 48-72 hours after the surgery. The images of the CT scan will be assessed and accuracy of placement of the catheter(s) will be determined.

Risks: There is no anticipated risk in participating in this research.

Benefits: How accurate the catheter in the ventricle is will be known and this might necessitate the revision of the procedure to reposition the ventricular catheter if found to be inaccurately positioned. . Also from this study, we will be able to tell whether the procedure is very accurate or we need to modify it for the benefit of the society at large.

Compensation: Patients/relatives will not be compensated for participating in this study.

Confidentiality: All information provided by the participants will be treated as strictly confidential. Identity of the participants will be replaced with study ID

Rights of participants: Participation in this study is solely voluntary and participants can opt out at any given time during the study. There will be no health care consequence or any other when you withdraw from the study.

Contact of IRB : In case of any challenge during the course of the study, or if you have concerns on your rights of participation as well as questions regarding the research, you can contact:

IRB Vice Chairperson: Dr. Daniel Ankrah, IRB, Korle Bu Teaching Hospital.

Supervisor: Dr Mawuli Ametefe, Consultant Neurosurgeon, KBTH

PARTICIPANT STATEMENT

I …………………………………………..attest that I have read the informed consent and/or the above study has been fully explained to me in a language that I understand. I therefore agree to participate in this study.

Name of patient/relative/caregiver:……………………….................
Signature/Thumb Print:………………………………………………..
Relationship with patient:
Date: ……………………………………………………………….

WITNESS:
Name:………………………………………………………….
Signature/Thumb print:……………………………………..
Relationship with patient:.…………………………………….
Date:.………………………………………………………..

CHILD ASSENT: (For children old enough to provide their views)
Name of child:……………………………………………………..
Signature of child/Thumb print:………………………………………
Date:…………………………………………………………………..

RESEARCHER'S STATEMENT

This study will help the researcher obtain information from you in order to assess the accuracy of freehand ventricular cannulation using Kocher's and Keen's points in CSF diversionary procedures. The information gathered from you will be kept highly confidential. Your privacy therefore will be a top priority and protected at all times.

KORLE BU TEACHING HOSPITAL INSTITUTIONAL REVIEW BOARD APPROVAL LETTER

In case of reply the number
And the date of this
Letter should be quoted

My Ref. No. KBTH/MD/G3/23

Your Ref. No...........................

KORLE BU TEACHING HOSPITAL
P. O. BOX KB 77,
KORLE BU, ACCRA.

Tel: +233 302 667759/673034-6
Fax: +233 302 667759
Email: Info@kbth.gov.gh
pr@kbth.gov.gh
Website: www.kbth.gov.gh

26th July, 2023

DR. RICHMOND HAGAN
SENIOR RESIDENT, NEUROSURGERY,
KORLE BU

INSTITUTIONAL APPROVAL: KORLE BU TEACHING HOSPITAL-SCIENTIFIC AND TECHNICAL COMMITTEE/INSTITUTIONAL REVIEW BOARD (KBTH-STC/IRB/000201/2023

Following approval of your study entitled "Accuracy of Freehand Ventricular Cannulation Using Kocher's and Keen's Points in Hydrocephalus Patients at a Tertiary Institution" by the Korle Bu Teaching Hospital-Scientific and Technical Committee/Institutional Review Board.

I am pleased to inform you that institutional approval has been granted for the conduct of your study in Korle Bu Teaching Hospital.

Please contact the Heads of Departments to discuss the commencement date of the study.

Please note that, this institutional approval is rendered invalid if the terms of the Institutional Reviewed Board/Scientific and Technical Committee approval are violated.

Sincere regards,

Dr. Harry Akoto
Ag. Director of Medical Affairs
For: Chief Executive

KORLE BU TEACHING HOSPITAL INSTITUTIONAL APPROVAL LETTER

In case of reply the number
And the date of this
Letter should be quoted

My Ref. No. KBTH/MS/G5/23

Your Ref. No...........................

KBTH
1923
KORLE BU TEACHING HOSPITAL
Excellence in Healthcare

KORLE BU TEACHING HOSPITAL
P. O. BOX KB 77,
KORLE BU, ACCRA.

Tel: +233 302 667759/673034-6
Fax: +233 302 667759
Email: Info@kbth.gov.gh
pr@kbth.gov.gh
Website: www.kbth.gov.gh

25th July, 2023

DR. RICHMOND HAGAN
SENIOR RESIDENT, NEUROSURGERY,
KORLE BU TEACHING HOSPITAL

ACCURACY OF FREEHAND VENTRICULAR CANNULATION USING KOCHER'S AND KEEN'S POINTS IN HYDROCEPHALUS PATIENTS AT A TERTIARY INSTITUTION

KBTH-IRB 000201/2022

Investigator: DR. RICHMOND HAGAN

The Korle Bu Teaching Hospital Institutional Review Board (KBTH IRB) reviewed and granted approval to the study entitled: "Accuracy of Freehand Ventricular Cannulation Using Kocher's and Keen's Points in Hydrocephalus Patients at a Tertiary Institution"

Please note that the Board requires you to submit a final review report on completion of this study to the KBTH-IRB.

Kindly, note that, any modification/amendment to the approved study protocol without approval from KBTH-IRB renders this certificate invalid.

Please report all serious adverse events related to this study to KBTH-IRB within seven days verbally and fourteen days in writing.

This IRB approval is valid till 30th June, 2024. You are to submit annual report for continuing review.

Sincere regards,

DR. DANIEL ANKRAH
VICE CHAIR (KBTH-IRB)
FOR: CHAIR (KBTH-IRB)

Cc: The Chief Executive Officer, KBTH
The Director of Medical Affairs, KBTH

QUESTIONNAIRE

ACCURACY OF FREEHAND VENTRICULAR CANNULATION USING KOCHER'S AND KEEN'S POINT IN HYDROCEPHALUS PATIENTS AT A TERTIARY INSTITUTION IN GHANA

Please kindly take some few minutes to fill this questionnaire.

Q1. Study ID: [ ] [ ]
Q2. Please how old were you on your last birthday: [ ] [ ] years
Q3. What is your sex? (*Please circle one)* Male…………………..1 Female………………...2
Q4. What is your highest level of education? Primary……………….1 Secondary…………….2 Tertiary……………….3 None…………………4 Others………………..5
Q5. What symptom did you present with? *(Circle as appropriate – You can choose more than one answer)* Headache……………………………….1 Vomiting………………........................2 Altered level of consciousness…………3 Seizures…………………………………4 Fever…………………………………….5 Blurred vision/inability to see…………..6 Others…………………………………...7 Q6. What level of consciousness did the patient present with using GCS? [ ] [ ]/ [1] [5]
Q7. What type of imaging was used to make diagnosis?

CT scan………………..1 MRI……………………2 Others…………………3
Q8. What is the type of Hydrocephalus patient presented with? Communicating……………..1 Non-communicating………...2
Q9. What is the cause of the Hydrocephalus? Congenital……………………………………………..1 Tumour…………………………………………………..2 Trauma…………………………………………...............3 Spontaneous intraventricular haemorrhage/SAH…………...4 Post infectious……………………………………………5
Q10. What is the Evans ratio? [ ]
Q11. What access point was used for ventricular cannulation? Kocher's point…………………..1 Keen's point……………………..2
Q12. How many times was ventricular cannulation attempted? [____] times
Q13. Which side was procedure done? Right…………………..1 Left……………………2
Q14. What is the level of experience of the surgeon? Resident > 2 years experience ………………..1 Senior specialist……………………………2 Consultant…………………………………3
Q15. Using the Post-operative CT scan, what is the grade of position of the ventricular catheter? Grade 1…………………1 Grade 2………………...2 Grade 3…………………3

Grade 4…………………4
Q16. What was the duration of hospitalization? [_____] days
Q17. What was the immediate outcome of the surgery? Discharge…………………1 Dead………………………2
Q18. If patient was discharged, on what post-operative day was the discharge? POD [____]
Q19. What are the intra/post-operative complications that occurred within the first month of surgery? Infection…………………………………1 Ventricular Catheter blockage…………..2 Ventricular catheter pull out…………….3 Other shunt malfunction…………………4 CSF leakage……………………………...5 Intracranial bleed…………………………6 Others, specify……………………………7