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# A Comparative Study Of High-Resolution Ultrasonography And Ct Scan In Hydrocephalus In A Tertiary Care Hospital

Dr. Abhishek
*Junior Resident Department of Radiodiagnosis Narayan Medical College Sasaram Bihar.*
Dr. Md. Shamim Ahmad
*Professor Department of Radiodiagnosis Narayan Medical College Sasaram Bihar.*
Dr. Gaurav Prakash
*Junior Resident Department of Radiodiagnosis Narayan Medical College Sasaram Bihar.*
Dr. Prabhat Kumar
*Senior Resident Department of Radiodiagnosis Narayan Medical College Sasaram Bihar.*
Dr. Nishant
*Junior Resident Department of Radiodiagnosis Narayan Medical College Sasaram Bihar.*

***Abstract***
***Introduction:***
*Ultrasound is a safe, quick, non-invasive & repeatable modality, has a definite role in the diagnosis of hydrocephalus. However, the ultrasound waves cannot penetrate the bony skull. It is still used in neonatal brain imaging where the open anterior fontanelle is the acoustic window. Hence, its use is limited between the age group 6 months-2 years. Ultrasonography is a safe, inexpensive, portable, readily available, and radiation-free method for evaluating suspected hydrocephalus. CT and MRI modalities are regarded the gold standard for hydrocephalus diagnosis.*
***Objective:***
*To assess the accuracy of cranial ultrasonography in the diagnosis of hydrocephalus, with a CT scan serving as the gold standard.*
***Method:***
*A total of 50 infants witha clinical diagnosis of hydrocephalus were selected and subjected to ultrasound of the head. Subsequently, a CT scan of the head was done when possible.*
***Result:***
*The majority of cases were 4-6 months old, with male new-borns predominating (35 (70%) of patients in our study). Ultrasonography of the head detected hydrocephalus in 45 (90%) patients while CT scan detected 49 (98%). CT detected hydrocephalus with other associated pathology more accurately.*
***Conclusions:***
*Transcranial sonography is a valuable screening tool for the diagnosis of hydrocephalus.*
***Keywords:*** *Ultrasonography; Hydrocephalus; Computed Tomography.*

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## I. INTRODUCTION

Hydrocephalus is described broadly as a disruption of cerebrospinal fluid (CSF) production, flow, or absorption. As a result, the volume of CSF in the central nervous system (CNS) increases. One of the most prevalent disorders in neonates is hydrocephalus, which affects 4.65 out of every 10,000 live births. [(1)] Garne E et al. The most prevalent acquired cause is cerebral haemorrhage from early delivery. When the disorder is congenital, males are more impacted. A build-up of fluid in the skull can cause brain compression and mental impairment. Estey, C.M., and colleagues [(2)]. Hydrocephalus is diagnosed clinically, and radiological investigations can help confirm the diagnosis and determine the cause.

Ultrasonography (USG) is regarded as a fundamental screening tool for macrocephalic new-borns. PR Tabrizi and colleagues [(3)]. Furthermore, sensitivity and specificity are greater than 75%. Serial imaging can be used to track the disease's prognosis. Ultrasonography of the macrocephaly skull is an important imaging technique for detecting hydrocephalus without the risk of radiation. [(4)] Radadiya K et al. A CT scan is a cost-effective method for evaluating hydrocephalus among modern neuro imaging. Where facilities are restricted, a CT scan combined with myelography is a viable alternative to magnetic resonance imaging (MRI). CT scanning is more sensitive and specific for studying the etiological and pathological characteristics of hydrocephalus, and it is more than 90% sensitive and specific for this disease. USG for the examination of suspected hydrocephalus is a safe, affordable, portable, readily available, and radiation-free approach, according to Joriczyk Potoczria K et al [(5)].

## II. AIMS & OBJECTIVES

The study's goal is to assess the diagnosis accuracy of USG for hydrocephalus in babies using CT scans as the gold standard. Because of the restricted availability of this entity in our nation, the results may assist us to consider USG as a good substitute for CT scan.

## III. MATERIALS & METHODS

This prospective observational study was conducted at Narayan Medical College & Hospital Jamuhar, Sasaram, Bihar from April 2022 to March 2023. An informed consent was taken from all the parents of the participants, after explaining the main objectives of the study and the procedure. 50 infants with clinical features of hydrocephalus (increasing head size, dysmorphic features, myelomeningocele, etc.) were evaluated sonographically and by CT scan, who come from the Department of Paediatrics and Neuro surgery. The study was entirely observational in nature.

**Criteria for patient selection:**
The age limit was maintained at 6 months, and both male and female infants were accepted. All guardians provided informed written consent.

**Technical consideration:**
All patients underwent cranial USG with a 5-7MHzprobe. Transcranial USG assessment of anterior, middle, and posterior cranial fossa structures, as well as CSF circulating in the ventricular chain, was performed utilizing open fontanelles in approved standard perspectives. When the mean transverse diameter of the lateral ventricle at the level of the atria on cranial USG was greater than 10 mm, the patients were diagnosed with hydrocephalus. The same diagnostic criteria were used to CT scan pictures, namely a width of more than 10 mm at the atria level.

**Technique of screening:**
The patient was forced to sit on the laps of her mother or an older relative. After that, the coupling gel was administered to the anterior fontanelles. The baby's brain was then scanned in the sagittal, parasagittal, and coronal planes. The images were then appropriately recorded. Any related lesions, such as encephaloceles, Chiarry II malformation, Dandi Walker variations, and so on, were then inspected to see and diagnose their contents.
With a sensitivity of 82.7%, specificity of 95.6%, PPV of 82.7%, and NPV of 95.6 (p value 0.001 and kappa value 0.678), USG demonstrated to be a useful screening method.

**Inclusion Criteria:**
Cases of hydrocephalus detected by ultrasonography during the studyperiod up to 6 months of age.

**Exclusion criteria**:
Infants more than 6 months.

**Statistical Analysis**:
All the records will be recorded by using structural schedule (Case Report Forms) and entered in Microsoft Excel Sheet. All the records will be rechecked for their completeness and consistencies. Non numeric entries will be coded numerically into nominal / ordinal distribution before analysis. Categorical variables were summarized in frequency and percent distribution and Chi-square or Fishers exact test will be performed as appropriate.

**TABLE NO. 1**
**Age wise distribution of Hydrocephalus**

| Age group(months) | Number of cases |
|---|---|
| 0-2 | 10 (20%) |
| 2-4 | 15 (30%) |
| 4-6 | 25 (50%) |
| Total | 50 (100%) |

AGE RANGE FROM 4-6 MONTHS HAD A HIGHEST PROPORTION OF CASES BY 50%., 2-4 MONTHS OF AGE GROUP OBSERVED IN 30 % OF THE STUDIED CASES, WHILE 20% CASES OBSERVED UP TO 2 MONTHS OF AGE.

**TABLE NO. 2**
**CAUSES OF HYDROCEPHALUS**

| **Anomaly** | **Number of cases** | **Percentage** |
|---|---|---|
| Cerebral aqueduct stenosis | 18 | 36% |
| Obstruction at foramina of Luschka and megandy | 10 | 20% |
| Foramen of monro obstruction | 07 | 14% |
| Arachnoid cyst | 05 | 10% |
| Meningolocoel | 04 | 8% |
| Encephalocoel | 03 | 6% |
| Dandi Walker S yndrome | 02 | 4% |
| Chiari II Malformation | 01 | 2% |
| **TOTAL** | 50 | 100% |

MOST COMMON CASUSE OF HYDROCEPHALUS WAS CEREBRAL AQUEDUCT STENOSIS (36%) AND LEASTCOMMON CAUSE WAS CHIARRI II MALFORMATIO (2%).

## IV. Discussion:

The study was conducted in thedepartment of Radiodiagnosis at Narayan Medical college and Hospital Sasaram to evaluate the role of high-resolution ultrasound and CT scan in evaluation of hydrocephalus. A total of 50 patients were included in this study. The early diagnosis of neonatal hydrocephalus in children is the key to management to avoid neurological damages associated with it. The most common type of hydrocephalus is non-communicating and cause is intraventricular hemorrhage Balthelemy EJ et al. [(6)]

The management via surgical approaches is best, but the type of surgery depends upon where the accumulation of CSF occurs Bawa M et al and Kable KT et al. [(7,8)] Initial diagnosis of hydrocephalus is always clinical when the head circumference is increased. The use of USG, CT, and MRI is focused on the ventricular volumes and sizes. The use of advanced radiological investigations helps in determining the possible cause and effects ofhydrocephalus. Nalcahira R and Trost MJ et al [(9,10)] Cranial sonography is the best initial radiological investigation due to its availability andportability Bhat V et al. [(11)] The preterm infants with the possibility of germinal matrix hemorrhages are not able to tolerate transport for CT or MRI, USG provides good early diagnostic information Dincer A et al. [(12)] Ultrasonography through the anterior fontanelle in infants is helpful for the evaluation of subependymal and intraventricular hemorrhage. Cranial sonography is also beneficial in the diagnosis of various neonatal pathologies other than hydrocephalus Gupta N et al.[(13)] MRI is the best diagnostic and prognostic modality but availability and cost are the major concerns over it. CT scan exposes patients to a high dose of radiation and sedation of patient. In my study, the accuracy of USG was 79.36% and 82.76% for the age <50 and >150 days respectively. No significant difference was noted between age groups. This makes sonography is best screening method for detecting hydrocephalus. All cranial pathologies can be more accurately assessed by sonography when the neonatal skull windows are wider. So, the prematurity and diagnostic accuracy of sonography are directly proportional. USG, usually sufficient to assess and monitor ventricular size, is used most commonly in preterm infants who have germinal matrixhemorrhages.

Although CT can demonstrate gross dilatation of ventricles, in most cases, it will be necessary to more closely define the nature of the obstruction, either functionally or anatomically.

Hydrocephalus divided into:

1.Communicating and non-communicating: addressing "where" the obstructionis located.

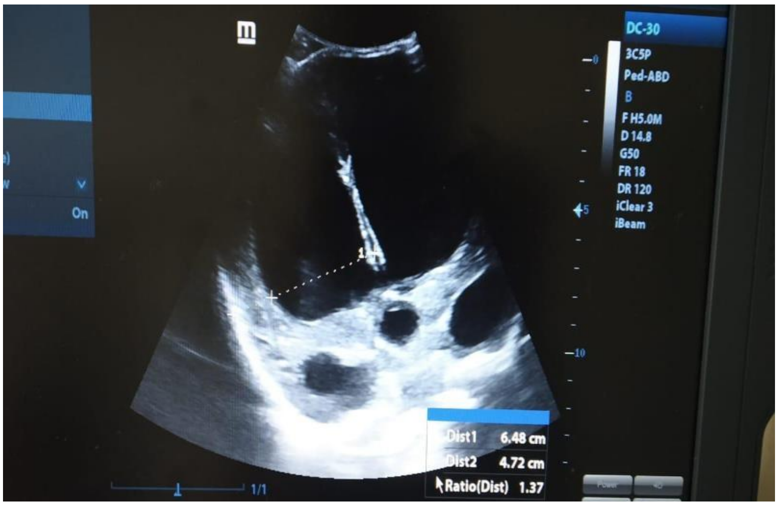
2.Obstructive and non-obstructive: on the grounds of whether or not there is obstruction of CSF pathways in the ventricles or the subarachnoidspace Nelson IS et al and Shah HM et al [14, 15].

**Ventricular / Hemispheric Ratio**

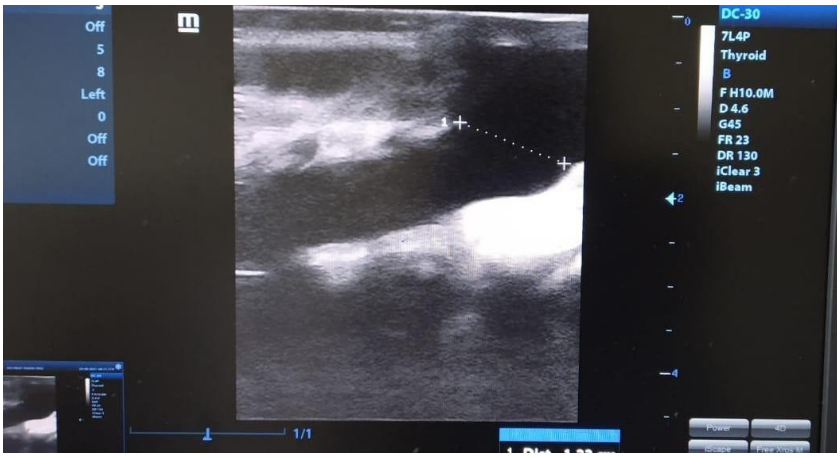
V/H ratio is a standard method for grading Hydrocephalus. It is ideally taken at the level of the foramen of Monroe/third ventricle in the coronal section. The distance of the lateral wall of the lateral ventricle from the midline to the hemispheric width, if more than 0.35, is a suggestion of ventricular enlargement

**CSF Flow dynamics and hydrocephalus**

The CSF is secreted by choroid plexus epithelium in the ventricles and through the ventricular system, it enters the spinal and cerebral subarachnoid spaces, and is absorbed by the arachnoid granulations into the superior sagittal sinus, to enter the systemic venous system. We now know that brain interstitial fluid is the source of 30-40% of CSF Bardley WG et al [16] and 20-40% is absorbed by cranial and spinal nerve sheaths and at the cribriform plate rather than arachnoidgranulations. Batenam GA et al [17].




**ULTRASOUND IMAGE OF DILATED LATERAL AND THIRD VENTRICALS S/O HYDROCEPHALUS**




**SAGITAL IMAGE OF SAME PATIENT SHOWING HYDROCEPHALUS**

**EVAN INDEX** – Evan's index is the ratio of maximum width of the frontal horns to the maximum width of the inner table of the cranium. An Evan's index more than 0.31 indicates hydrocephalus Ishii Mitsuaki et al [18]. In the CT scan, the prominent temporal horns are the primary indicators among other observations. Usually, with the transverse direction, the third ventricle in diameter of >5 mm has been notified as the abnormality. Chatzidakis E. M et al [19]. Balloon appearance of the frontal horn with periventricular hypodensity can be found in obstructive hydrocephalus. Additionally, the ventricular SRC index has also been utilized. The Ventricular SRC Index is estimated by the distance between the anterior tips of frontal horn/bifrontal diameter at the same level (it is from the inner tableof the skull).

## V. Conclusion:

The goal of this study is to diagnose hydrocephalus in babies using high resolution ultrasound as the initial imaging and CT scan as needed. The results of 50 instances seen might be compared to those of other authors. Patients aged up to 6 months were included in the trial group. The study was limited to an early diagnostic approach and a cost-effective strategy. When possible, the correlation with CT is performed. MRI could not be performed because the goal of this study was to deliver maximum information at the lowest possible expense to the patient. As a result, the research was limited to ultrasonographic examination and CT scans wherever possible. In conclusion, ultrasonography is a good first step in the diagnosis of hydrocephalus in infants under six months old. CT scanning ensures more precision and diagnostic information. The larger-scale investigation would aid in more accurate cranial sonography evaluation. Ultrasound, as a non-invasive, fast, and repeatable tool, plays an important role in the diagnosis of hydrocephalus. The ultrasonic waves, however, are unable to penetrate the bone skull. It is still employed in neonatal brain imaging, where the acoustic window is the open anterior fontanelle. Routine coronal and sagittal imaging can detect neonatal hydrocephalus. As a result, diagnosis and progression can be assessed.

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