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Role of High Resolution Ultrasonography and CT scan in Hydrocephalus.

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Introduction – Ultrasonography for the evaluation of suspected hydrocephalus is a safe, cheap, portable, readily available and radiation-free option. CT and MRI modalities are considered a gold standard for the diagnosis of hydrocephalus.
Objectives: To determine the accuracy of cranial ultrasonography in the diagnosis of hydrocephalus keeping CT scan as a gold standard.
Study design: Prospective study.
Place and duration of study: Department of Radiodiagnosis, NSCB Medical college Jabalpur (M. P.) from August 2005 to August 2006.
Materials and Methods: A total of 50 infants with a clinical diagnosis of hydrocephalus were selected and subjected to ultrasound of the head. Subsequently, a CT scan of the head was done when possible.
Results: The maximum cases were 4-6 months of age with male infants pre dominance as 35 (70%) patients were males 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.
Conclusion: Trans cranial sonography is a valuable screening tool for the diagnosis of hydrocephalus.
Keywords: Hydrocephalus, Computed tomography, Ultrasonography, trans cranial, infants.

I. BACKGROUND

Hydrocephalus can be defined broadly as a disturbance of cerebrospinal fluid (CSF) at the level of formation, flow, or absorption. This leads to an increase in the volume occupied by CSF in the central nervous system (CNS). Hydrocephalus is one of the most common pathologies in newborns, which affects 4.65 per 10,000 live births. Garne E et al. (1)The most common acquired cause is the brain hemorrhage associated with premature birth. The males are affected more when the condition is congenital. The excessive fluid in the skull may lead to brain compression and mental retardation . Estey CM et al (2) .

The Hydrocephalus is diagnosed clinically and adjuncts of radiological investigations can give insight regarding confirmation of diagnosis and its etiology.

Ultrasonography (USG) is considered a basic screening tool for macrocephalic infants . Tabrizi PR et al (3) . Moreover, sensitivity and specificity are more than 75%. The prognosis of the disease can be monitored by serial imaging . Ultrasonography of macrocephaly skull is an important imaging method for detecting hydrocephalus without any danger of radiation hazards. Radadiya K et al (4).

Among the advanced neuro imaging, a CT scan is a cost-effective tool for the evaluation of hydrocephalus. CT scan coupled with myelography is an effective alternative of magnetic resonance imaging (MRI) where the facilities are limited. Etiological and pathological features of hydrocephalus are better studied with CT scanning and it is more than 90% sensitive and specific for this disease. Joriczyk Potoczria K et al (5) USG for the evaluation of suspected hydrocephalus is a safe, cheap, portable, readily available and radiation- free option.

II. AIMS AND OBJECTIVES-

The aim of my study is to evaluate the diagnostic accuracy of USG for hydrocephalus in

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infants keeping CT scans as a gold standard. The results can help us to use USG as a good alternative for CT scan as limited availability of this entity in our country.

III. MATERIALS AND MEHTODS –

In this prospective study, after ethical committee approval, 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 Pediatrics and paediatric surgery, NSCB Medical College Jabalpur. The duration of the study was September 2005 t0 September 2006 .

Criteria for patient selection- The age limit was kept up to 6 months and both male and female infants were included. Informed written consent was taken from all guardians.

Technical consideration- All patients underwent cranial USG by Siemens SONOLINE G-50 machine with a 5-7MHzprobe . Trans cranial usg examination of anterior, middle and posterior cranial fossa structures and CSF circulating in the ventricular chain was made in recommended standard views using open fontanelles . The patients were labeled as having hydrocephalus when the mean transverse diameter of the lateral ventricle at the level of atria was more than 10 mm on cranial USG. The same diagnostic criteria were used in CT scan images i.e. the width of more than 10 mm at the level of atria.

Technique of screening -
The patient was made to sit on her mother's or adult relation's laps. The coupling gel was then applied over the anterior fontanelles. The infant's brain was then scanned in the sagittal, and parasagittal, as well as the coronal planes. The images were then recorded accordingly. Any associated lesions, for example, encephalocoeles , chiarry ii malformation Dandi Walker variants etc. were subsequently examined to visualize their contents and diagnose them.
USG proved to be a good screening modality with a sensitivity of 82.7 %, specificity 95.6% PPV 82.7% and NPV 95.6 (p value < 0.001 and kappa value 0.678).
Inclusion criteria - Cases of hydrocephalus detected by ultrasonography during the study period up to 6 months of age at Radiodiagnosis department of NSCB Medical college.Jabalpur (M.P.)
Exclusion criteria- Infants more than 6 months age.

Statical Analysis plan : 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 was 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 hydrocephallus:

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 case	Percentage

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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 LEAST COMMON CAUSE WAS CHIARRI II MALFORMATIO (2%).

Discussion -The study was conducted in the department of Radiodiagnosis at NSCB Medical college Jabalpur 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 are help in determining the possible cause and effects of hydrocephalus. Nalcahira R and Trost MJ et al (9 ,10) Cranial sonography is the best initial radiological investigation due to its availability and portability 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, so 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 matrix hemorrhages . 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 obstruction is located
2. obstructive and non-obstructive: on the grounds of whether or not there is obstruction of CSF pathways in the ventricles or the subarachnoid space 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

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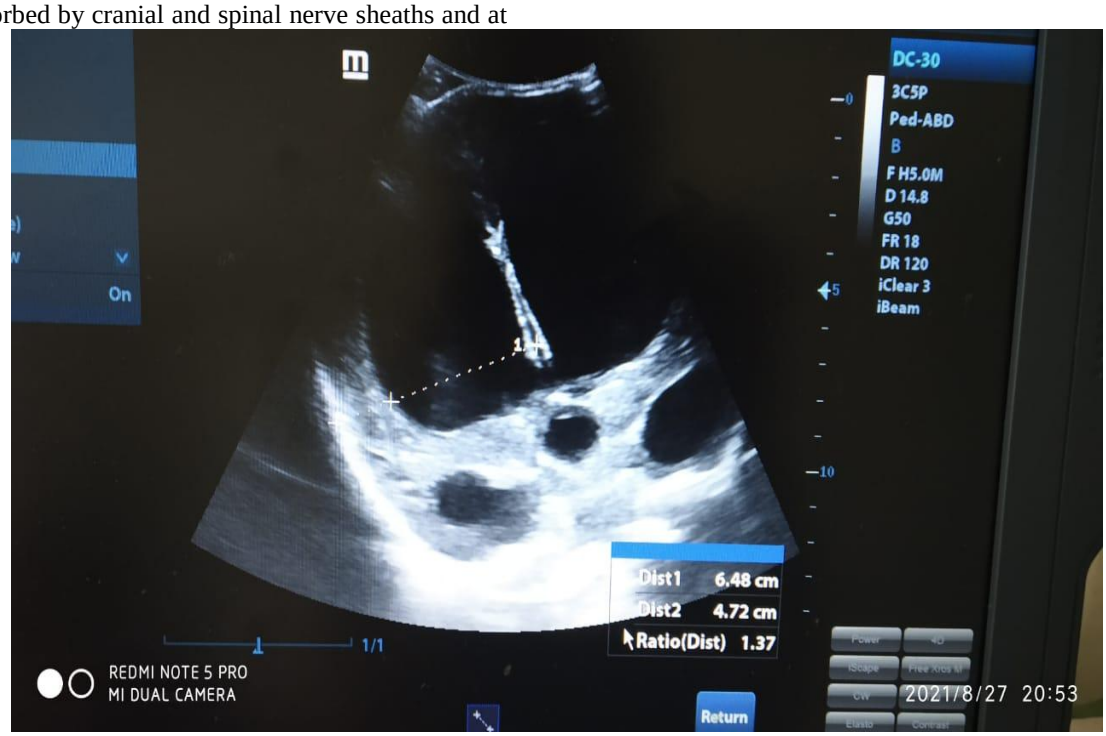
now know that brain interstitial fluid is the source of 30-40% of CSF [Bardley WG (et al 16) and 20-40% is absorbed by cranial and spinal nerve sheaths and at the cribriform plate rather than arachnoid granulations. Batenam GA et al (17).



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

SAGITAL IMAGE OF SAME PATIENT SHOWING HYDROCEPHALUS.

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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 table of the skull).

Summary - The objective of this study to diagnose the hydrocephalus in infants by performing high resolution ultrasound as the initial imaging and CT scan when possible . The study was conducted in Radiodiagnosis Department of NSCB Medical College Jabalpur. Results of 50 cases recorded in observation, could be compared to other authors,. The study group consist of the patients in the age group up to 6months of age The study was only for the early diagnostic procedure and with minimal cost effective method. The correlation with CT is done whenever possible. MRI could not be done as the purpose of this study was to provide maximum information with minimum cost to patient. So, study was only ultrasonographic evaluation and CT scan whenever possible.

IV. CONCLUSION-

In conclusion, ultrasonography in infants under six months, for the diagnosis of hydrocephalus is a good initial investigation. CT scanning ensures more accuracy and diagnostic information.The larger-scale study would help to evaluate cranial sonography more accurately. 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. Neonatal hydrocephalus is easy to recognize by routine coronal and sagittal imaging. Thus, diagnosis and progression can be evaluated

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