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RESEARCH ARTICLE

THE ROLE OF TRANSCRANIAL ULTRASOUND IN THE EVALUATION OF HYPOXIC ISCHEMIC ENCEPHALOPATHY

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Abstract

Introduction: Hypoxic ischemic encephalopathy is a clinical term used to describe an abnormal neurobehavioral state that consists of a decreased level of consciousness with abnormalities in neuromotor tone. Any neonate, regardless of birth weight, size, or gestational age, who has a greater than average chance of morbidity or mortality, due to fetal, maternal or placental anomalies or an otherwise compromised pregnancy especially within the first 28 days of life is categorized as high-risk neonate. Cranial ultrasonography plays an important role in the diagnosis of significant lesions in infants presenting with hypoxic ischemic encephalopathy (HIE) and seizures and assessing severity, neurodevelopment outcome and neurological prognosis of these high-risk infants. In the neonate, many sutures and fontanelles are still open and these can be used as acoustic windows to "look" into the brain.

Methodology: This was a hospital based descriptive observational study of 100 preterm and term babies with suspected brain injuries who were referred for cranial USG examination to the Radiodiagnosis Department of R.N.T. Medical College, Udaipur with hypoxic ischemic encephalopathy over a period of 18 months from June 2020 to November 2021.

Results: The most common affected age group was 32-37weeks (51%). The abnormalities found on neurosonogram were germinal matrix hemorrhage, periventricular leucomalacia, cystic PVL, cerebral edema and ventriculomegaly. The most common abnormality was germinal matrix hemorrhage (17%) and subependymal hemorrhage (41%) was most common type. Isolated ventriculomegaly (53.8%) was more common than ventriculomegaly with hemorrhage (46.2%).

Conclusion: Neurosonogram remains the accurate, rapid imaging modality of choice for detecting brain injuries in preterm infant. This technique is both sensitive and specific for detecting germinal matrix hemorrhage and periventricular leucomalacia. It is a useful modality to perform frequent follow-up scans. The advantages of neurosonogram are that it is easy to operate, non invasive, accurate, has lack of ionizing radiation, bed side availability for unstable infants, rapid diagnosis, wide availability, cost effectiveness and repeatability.

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Introduction:-

Hypoxic ischemic encephalopathy is a clinical term used to describe an abnormal neurobehavioral state that consists of a decreased level of consciousness with abnormalities in neuromotor tone. It characteristically begins within the first postnatal day and may be associated with seizure-like activity, hypoventilation or apnea, depressed primitive reflexes and the appearance of brainstem reflexes. It is an abnormal neurobehavioral state in which the predominant pathogenic mechanism is impaired cerebral blood flow.[1]

In preterm babies, significant insults to the brain are often clinically silent. They are particularly prone for germinal matrix related hemorrhage (GMH), intraventricular hemorrhage and periventricular leukomalacia (PVL). In full term babies, cerebral angio-architecture of a newborn after 34 weeks is similar to an adult brain resulting in cerebral ischemia due to birth asphyxia, and limited damage can cause focal lesions in the basal ganglia and thalami (BGT), stroke and other focal lesions which may be ischemic and cystic. Cerebral edema is a prominent pathophysiological feature which precedes the brain damage following hypoxic-ischemic insults.[2]

Cranial ultrasonography (CUS) has become an essential diagnostic tool in modern neonatology for depicting normal anatomy and pathological changes in neonatal brain. In the neonate, many sutures and fontanelles are still open and these can be used as acoustic windows to "look" into the brain. Scanning through the posterior and mastoid fontanelles, can help to detect lesions and structural malformations in cerebellum, brainstem and posterior sub cortical white matter. Imaging through the temporal window allows good views of the mesencephalon and brainstem.[3]

In cases of (suspected) ischemic injury, even if apparently mild, it is therefore advisable to intensify cranial ultrasonography examinations until normalization or stabilization of abnormalities has occurred.[4] The current protocol for the timing of scans for intracerebral hemorrhage goes for the initial scan on day 4, if negative to repeat the scan on day 7, for the detection of ventriculomegaly scan on day 14. Late ultrasonography screening is important for the diagnosis of PVL and ventricular enlargement in preterm infants.[5]

Ultrasonography is affordable, easy to perform, non-invasive and can be initiated at a very early stage, even immediately after birth. It can be repeated as often as necessary, and thereby enables visualization of ongoing brain maturation and the evolution of brain lesions. In addition, it can be used to assess the timing of brain damage.[1] There is a dearth of data available for evaluation of HIE by transcranial ultrasonography. In the current study, we aim to study the role of this modality in HIE and ascertain correlation with the clinical diagnosis.

Materials and Method:-

This was a hospital based descriptive observational study of 100 preterm and term babies with suspected brain injuries who were referred for cranial USG examination to the Radiodiagnosis Department of R.N.T. Medical College, Udaipur with hypoxic ischemic encephalopathy over a period of 18 months from JUNE 2020 to NOVEMBER 2021. The study included 100 neonates suspected for hypoxic ischemic encephalopathy with abnormal neurological presentation such as seizures, lethargy, apnoea, increase in muscle tone, hypotonia and bulging anterior fontanel. Babies with gross congenital malformation, babies with only hyperbilirubinemia and babies > 28days were excluded from the study.

Informed consent was obtained from the parents/guardian regarding inclusion of the neonate in the study. Assessment of factors placing the neonate in a high-risk category was done taking detailed maternal history and reviewing antenatal records. All perinatal details were recorded and detailed clinical examination was done. Vital parameters were recorded within 24-48 hours of admission and complete neurological examination was done during baby's stay in NICU. Gestational age was assessed as per modified Ballard's scoring method for all preterm neonates. Evaluation with baseline routine investigations [septic and metabolic work up] and lumbar puncture in case of neonatal convulsions and neonatal sepsis as well as chest X-ray in all respiratory distress cases was done.

All the neonate babies in this study underwent neurosonogram using curvilinear transducer and linear assay high frequency transducer of SAMSUNG RS80A and VINNO E10 ultrasound equipment. Follow up cranial ultrasound was done in case of findings revealed and for preterm neonates. Morphology of cranial ultrasound findings was

studied and recorded and clinical correlation with various findings on cranial ultrasound was done. Neonates were followed till recovery and discharge from NICU.

Neurosonographic examinations were performed through anterior fontanelle in both the coronal and sagittalplane. The examination started in coronal plane along the coronal suture, with transducer angled towards the frontal region. Then brain was examined in various coronal planes by sweeping the transducer from anterior to posterior.

Following the completion of examination in coronal plane, sagittal and parasagittal scans were obtained by placing the transducers on the anterior fontanel, perpendicular to coronal plane and then sweep from midline through the lateral ventricles, lateral parenchyma on each side. Care was taken to maintain symmetry throughout the examination, as densely echogenic choroid plexus appears larger on one side causing a false image of subependymal hemorrhage.

Posterior fossa screening was done by obtaining axial images through posterior and mastoid fontanel.

Collected data and observations were entered in Microsoft Excel and analysed by statistical package for social science version 24 (SPSS 24). p value less than 0.05 was considered as statistically significant.

Results and Discussion:-

Of the 100 neonates, 62 (62%) were male while 38 (38%) were female. Of the 100 neonates, 29 cases (29%) weighed more than 2.5 kg. A maximum of 45 cases (45%) were in the low birth weight (LBW) category of 1.5-2.5 kg, while 16 (16%) weighed less than 1.5 kg and were classified as very low birth weight (VLBW). Of the 100 neonates, 22 cases (22%) were less than 32 weeks. A maximum of 51 cases (51%) were in the range of 32-37 weeks, while 27 (27%) were more than 37 weeks. Normal USG findings were seen in 61 cases (61%) which were more than the 39 cases (39%) with abnormal findings. Eugenio Mercuri, Lilly Dubowitz et al[6]reported an incidence 20% of ultrasound abnormalities in apparently well neonates. Ayala Gover, David Bader et al[7]reported an incidence of 11.2% abnormalities on CUS in apparently healthy asymptomatic term neonates.

Distribution of hemorrhage in various gestational age groups

Out of 22 cases having gestational age less than 32 weeks, 5 cases (22.7%) showed hemorrhage, which was the maximum percentage in any age group. 7 out of 51 cases (13.7%) in the 32-37 weeks age group showed hemorrhage, while 5 out of 27 cases (18.5%) in the age group of more than 37 weeks showed hemorrhage. In all, 17 cases (17%) showed hemorrhage. Badrawy N. et al[8]reported that subependymal intraventricular hemorrhage (SE-IVH) was present in 14%.

Distribution of periventricular echogenicity in various gestational age groups

Out of 22 cases having gestational age less than 32 weeks, 4 cases (18.18%) showed periventricular echogenicity, which was the maximum percentage in any age group. 7 out of 51 cases (13.7%) in the 32-37 weeks age group showed periventricular echogenicity, while 3 out of 27 cases (11%) in the age group of more than 37 weeks showed this finding. In all, 14 cases (14%) showed periventricular echogenicity. Thakkar et all[9] reported that 14 (23.3%) patients had abnormal periventricular echogenicity.

Distribution of cerebral edema in various gestational age groups

Out of 22 cases having gestational age less than 32 weeks, 3 cases (13.6%) showed cerebral edema, which was the maximum percentage in any age group. 6 out of 51 cases (11.7%) in the 32-37 weeks age group showed cerebral edema, while 3 out of 27 cases (11%) in the age group of more than 37 weeks showed this finding. In all, 12 cases (12%) showed cerebral edema.

Table 1:- Distribution of intraventricular haemorrhage with grading.

IVH	NUMBER OF NEONATES	PERCENTAGE
GRADE-I	7	41.17%
GRADE-II	4	23.5%
GRADE-III	4	23.5%
GRADE-IV	2	11.7%

Distribution of intraventricular haemorrhage with grading

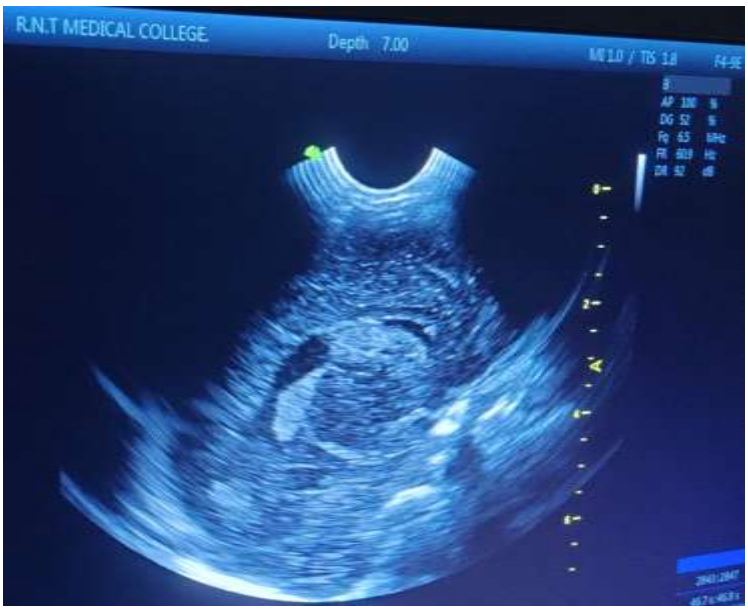
Grade I intraventricular hemorrhage was seen in 7 (41%) out of 17 cases. Grade II and III IVH were seen in 4 cases each (23.5%). Grade IV IVH was seen in 2 (11.7%) cases out of a total of 17 cases(Table-1).

Distribution of ventriculomegaly with and without IVH

Ventriculomegaly was seen in 13 patients. Out of these, it was associated with hemorrhage in 6 cases (46.2%), while it was an isolated finding in 7 cases (53.8%). Badrawy Net al[8]reported congenital hydrocephalus to be present in 6% among all neonates screened by them.

The present study correlates with the study done by Rehan et al., 2009[10].

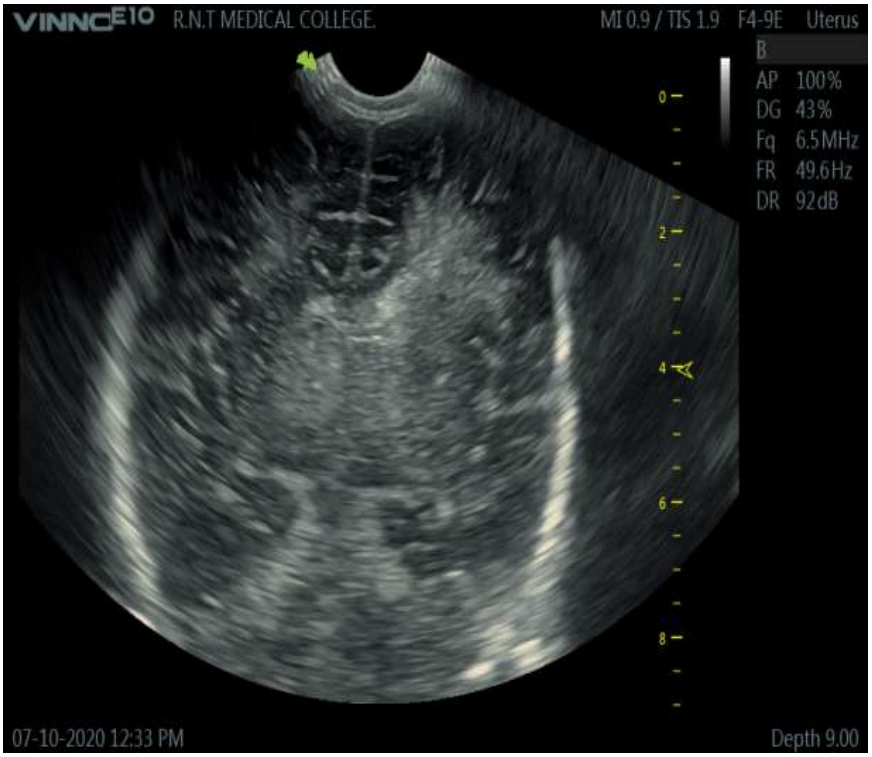
IVH GRADE-I



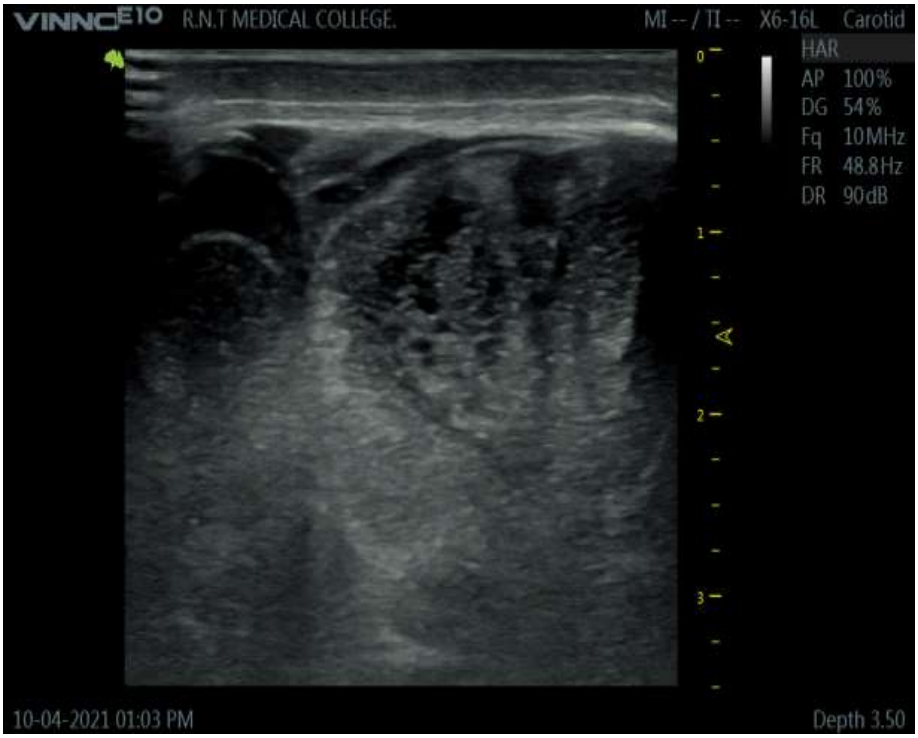
IVH GRADE-II

IVH GRADE III

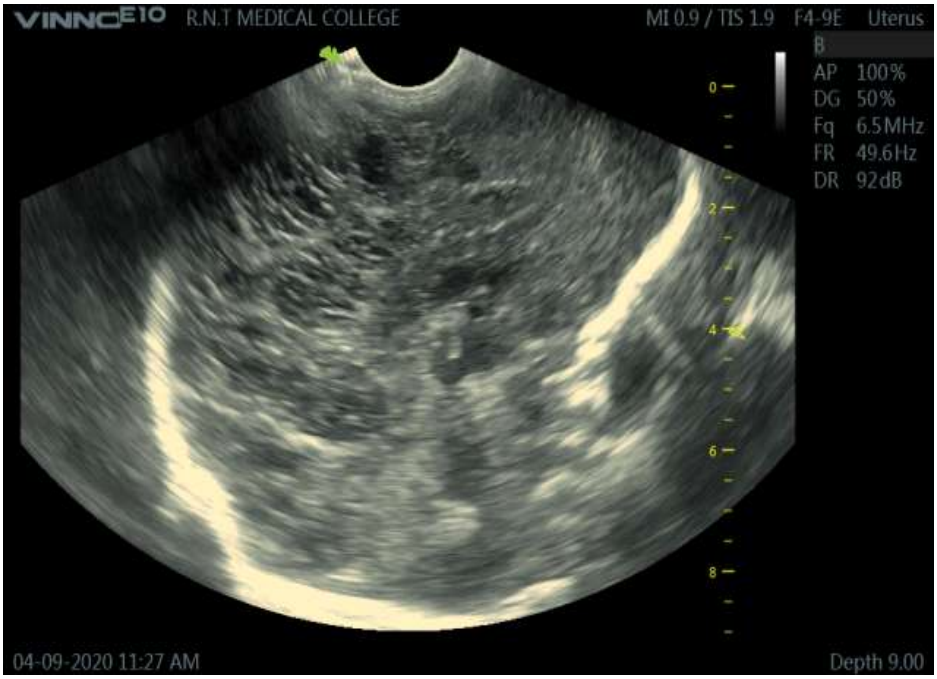
IVH GRADE-IV



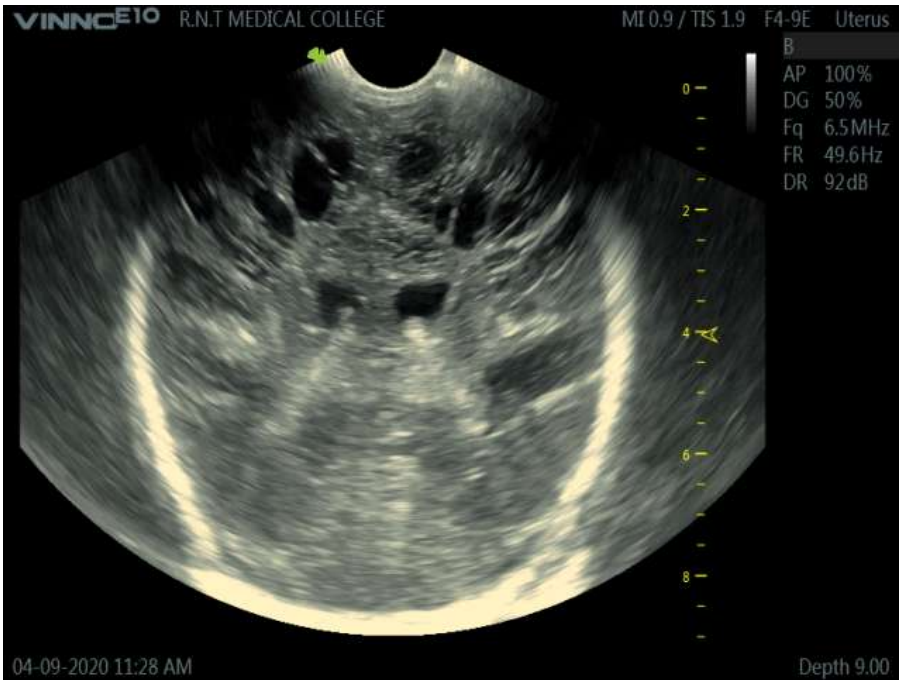
PVL GRADE I



PVL GRADE II



PVL GRADE III



PVL GRADE IV

Conclusion:-

In our study 100 pre-term babies with suspected brain injuries were studied with ultrasound through anteriorfontanel. The study group had male predominance. In our study most common affected age group was 32-37 weeks. The abnormalities found on neurosonogramin our study were germinal matrix hemorrhage, periventricular leucomalacia, cysticPVL, cerebral edema and ventriculomegaly. In our study the most common abnormality was germinal matrixhemorrhage. Among the germinal matrix hemorrhage grade I GMH i.e., subependymal hemorrhage

was mostcommon presentation. Isolated venriculomegaly was more common than ventriculomegaly with hemorrhage.

Neurosonogram remains the accurate, rapid imaging modality of choice for detecting brain injuries in preterminfant. This technique is both sensitive and specific for detecting germinal matrix hemorrhage and periventricularleucomalacia. Neurosonogram helps in satisfactory grading of GMH and PVL which in turn helps in studying the prognosis and possibleoutcome. It is a usefulmodalityto perform frequent follow-up scans. The advantages include easy to operate, non invasiveness, lack of ionizing radiation, accuracy, bed side availability for unstable infants, rapid diagnosis, wide availability, cost effectiveness andrepeatability. Limitation in term neonates is in distinguishing focal parenchymal echo dense lesion from hemorrhagic and non-hemorrhagic etiology, in which case CT scan is complementary to neurosonogram. At present, CT is most accurate in determining lesions, but transport, sedation, IV contrast administration, temperature maintenance and the risk of ionizing radiation limits use of CT in routine assessment of fragile neonates. Thusneurosonogramformsthe best cribside, non-invasive primary method of choice in assessing neonatal brain.

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