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Original Research Article

Role of neurosonography in neonates with clinically suspected intracranial pathology

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ABSTRACT

Background: Preterm neonates have a higher mortality and morbidity because of their greater risk for intracranial hemorrhage (ICH), hypoxic ischemic encephalopathy(HIE) which can lead to poor neurodevelopmental outcomes. The present study was conducted to evaluate neonates with clinically suspected intracranial pathology by neurosonography.
Methods: Included neonates were those with clinically suspected intracranial pathology admitted to neonatal intensive care unit of the Bharati Vidyapeeth Medical College and Hospital (Deemed to be University), Sangli from October 2018 till December 2018. First cranial neurosonography was done between first and third day, second between 7th and 10th day of birth. HIE also known as Periventricular leukomalacia (PVL) grading was done using the De Varies et al, grading. Severity of ICH was graded according to Papile and Burstein classification(1978).
Results: Of the total 60 neonates, 61.7% were preterm and rest at term. Mean APGAR score at 1 minute was 8.6 (range 5 to 10) and at 5 minutes was 9.58 (range 8 to 10). Mean ventricular index at the first assessment was 26.78% and 26.89% at the second assessment. Grade 1 HIE was found in 17 neonates on first assessment, and two had grade 2 HIE. Second assessment revealed grade 1 HIE in 20 neonates and grade 2 in two. First assessment revealed two neonates with grade 1 and grade 2 ICH, out of which one grade 2 ICH worsened to grade 3. Two neonates were found to have corpus callosal agenesis.
Conclusions: Transcranial neurosonography stands as an excellent and reliable investigation of choice for neonates to detect HIE,ICH and intracranial congenital anomalies.

Keywords: Low birth weight neonates, , Premature, Transcranial neurosonography, Ultrasonography

INTRODUCTION

Preterm neonates have a higher mortality and morbidity because of their greater risk for intraventricular hemorrhage (IVH) and hypoxic ischemic encephalopathy (HIE) also known as periventricular leukomalacia (PVL), which can lead to poor neurodevelopmental outcomes. Premature neonates have impaired cerebrovascular autoregulation, including pressure-passive cerebral circulation. Elevations in arterial or venous pressure lead to increases in cerebral blood flow and potential hemorrhage in the germinal matrix region, where there are fragile single-celled vessels as well as neuroblasts that normally migrate and develop as neurons in the peripheral gray matter. Episodes of hypotension result in reduced cerebral flow, hypoxia and reperfusion injury that can also result in germinal matrix hemorrhage.[1] Early diagnosis of hemorrhage allows for clinical neonatology efforts to minimize subsequent sequelae. The first description of using US-Doppler technique for evaluation of pulsatile flow in an intracranial artery in premature neonates was done by Bada et l.[2] These authors studied

the pathophysiology of intracranial hemmorhage and IVH in neonates under clinical conditions of hypoxemia.[3] The neurological manifestations of injury to the premature brain can range from cognitive defects to the major motor defects of cerebral palsy.[4] Findings on follow-up ultrasound can serve as a prognostic indicator for long-term neurodevelopmental outcome. The present study was conducted to evaluate neonates with clinically suspected intracranial pathology by neurosonography to detect intracranial haemorrhage and hypoxic ischemic encephalopathy.

METHODS

Study design

The present observational study included neonates with clinically suspected intracranial pathology admitted to neonatal intensive care unit of the Bharati Vidyapeeth Medical College and Hospital (Deemed to be University), Sangli from October 2018 till December 2018. All those considered clinically at risk of ICH and HIE due to their prematurity and low birth weight were included in the study. Informed consent was obtained from one of the parents of each infant before the study.

Ultrasound evaluations

The study used transcranial neurosonography of neonates two time points; one between first and third day and second between 7th and 10th day during admission in the neonatal intensive care unit. Their ultrasound examination included searching for ICH,HIE,VI.

Authors selected this timing because ICH and HIE has been shown to develop during the first days of life in preterm neonates.[5] The US-Doppler equipment was transported to the neonatal intensive care unit for the initial evaluation and in the follow up studies.

All necessary precautions for dealing with these at-risk neonates like complete aseptic conditions were followed. Anterior fontanel approach was the mainstay of neonatal transcranial neurosonography in present study. Authors used 6 to 8 MHz sector transducer and 3 to 5 MHz convex transducer and 7 to11-MHz linear transducer (Sonosite turbo and Phillips HD 15). The transducer was placed on the anterior fontanel and angled to produce images in coronal section and then rotated 90° and angled to produce sagittal images.

Data collection and analysis

Data were collected using a pre-designed semi-structured patient related chart. Neonates with gestational age less than 37 weeks were labelled preterm. APGAR score was assessed at 1 and 5 minutes. Ventricular index, grading of HIE and ICH were done at two time points; one between first and third day and second between 7th and 10th day during admission in the neonatal intensive care unit. HIE grading was done using the De Varies et al grading (1992).[6]

Severity of ICH was graded according to Papile and Burstein classification (1978).[7] Ventricular index measured as ratio of distance between lateral sides of ventricles and biparietal diameter. Data were described as mean and standard deviation and frequency distribution.

RESULTS

Authors included 60 neonates in the present study. Males comprised 55% of the neonates and mean weight of the neonates was 1.93±0.65 kgs.

There were 61.7% preterm neonates and rest were born at term. Mean APGAR score at 1 minute was 8.6 (range 5 to 10) and at 5 minutes was 9.58 (range 8 to 10). Mean ventricular index at the first assessment was 26.78% and 26.89% at the second assessment (Table 1). Table 2 describes the distribution of neonates according to their severity of HIE and ICH (Figure 1 and 2).

Majority of the neonates did not have HIE during both the assessments. First assessment revealed grade 1 HIE in 17 neonates as they had transient periventricular echodensities persisting for more than seven days and two had grade 2 HIE, who had transient periventricular echodensities evolving into small, localized fronto-parietal cysts.

Table 1: Characteristics of the patients included in the study.

Patient characteristics	Mean	Standard deviation	Minimum	Maximum
Birth weight (kg)	1.93	0.65	0.94	3.78
APGAR score at 1 minute	8.6	1.26	5	10
APGAR score at 5 minutes	9.58	0.71	8	10
Ventricular index at first assessment (%)	26.78	2.48	24	34
Ventricular index at second assessment (%)	26.89	2.51	24	34

Table 2: Distribution of patients according to their grading for hypoxic ischemic encephalopathy and intracranial hemorrhage.

	Grade	First assessment (1 to 3 days after birth)	Second assessment (7 to 10 days after birth)
Hypoxic ischemic encephalopathy (De Varies et al, grading)	Nil	41 (68.3%)	38 (63.3%)
	1	17 (28.3%)	20 (33.3%)
	2	02 (3.3%)	02 (3.3%)
Intracranial hemorrhage (Papile Burstein grading)	Nil	56 (93.3%)	56 (93.3%)
	1	02 (3.3%)	02 (3.3%)
	2	02 (3.3%)	01 (1.7%)
	3	00 (00)	01 (1.7%)

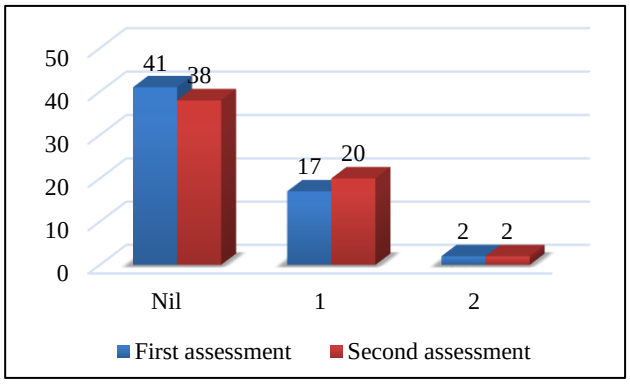

Figure 1: Distribution of patients according to their grading for hypoxic ischemic encephalopathy.

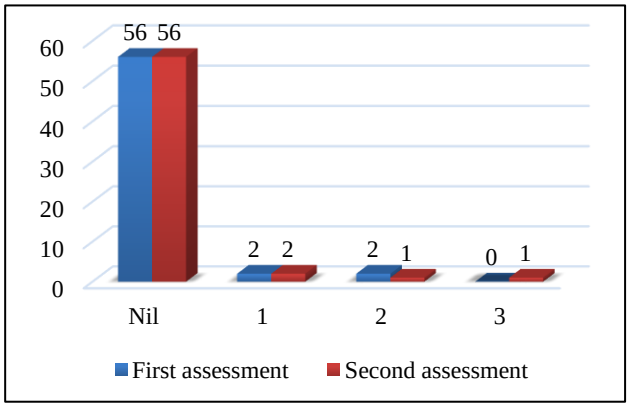

Figure 2: Distribution of patients according to their grading for intracranial haemorrhage.

Figure 3 shows a coronal section taken from anterior fontanella at the level of ventricles showing hyperechoic stripes adjacent to ventricles with no cysts, gyri and sulci are normal in echogenicity and echotexture, suggestive of grade 1 HIE changes.

Second assessment revealed grade 1 HIE in 20 neonates and grade 2 in two neonates. ICH was not found in 93.3% of the neonates. First assessment revealed two neonates with grade 1 ICH as they had a small haemorrhage confined to the germinal matrix.

Coronal section taken from anterior fontanella of neonatal cranium taken at the level of ventricles showing hyperechoic stripes adjacent to ventricles with no cysts (shown by arrows).

Figure 3: Neurosonography showing grade 1 Hhypoxic ischemic encephalopathy.

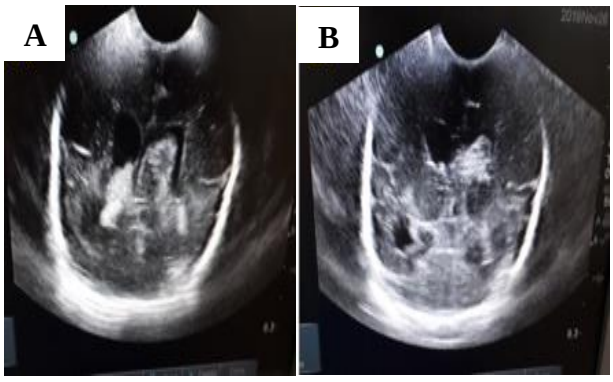

Figure 4: Neurosonography showing grade 3 intracranial haemorrhage. (A): Coronal section taken from anterior fontanella showing hyperechoic lesion within both lateral ventricles with dilatation of these ventricles, (B): Coronal section image taken from anterior fontanella at the level of frontal horns of lateral ventricles showing hyperechoic lesion in frontal horns of both lateral ventricles.

Two cases had grade 2 ICH in which haemorrhage originated from the germinal matrix but leaked into the lateral ventricle. While on second assessment one grade 2

ICH worsened to grade 3 ICH as the haemorrhage was large enough to result in acute ventricular dilatation.

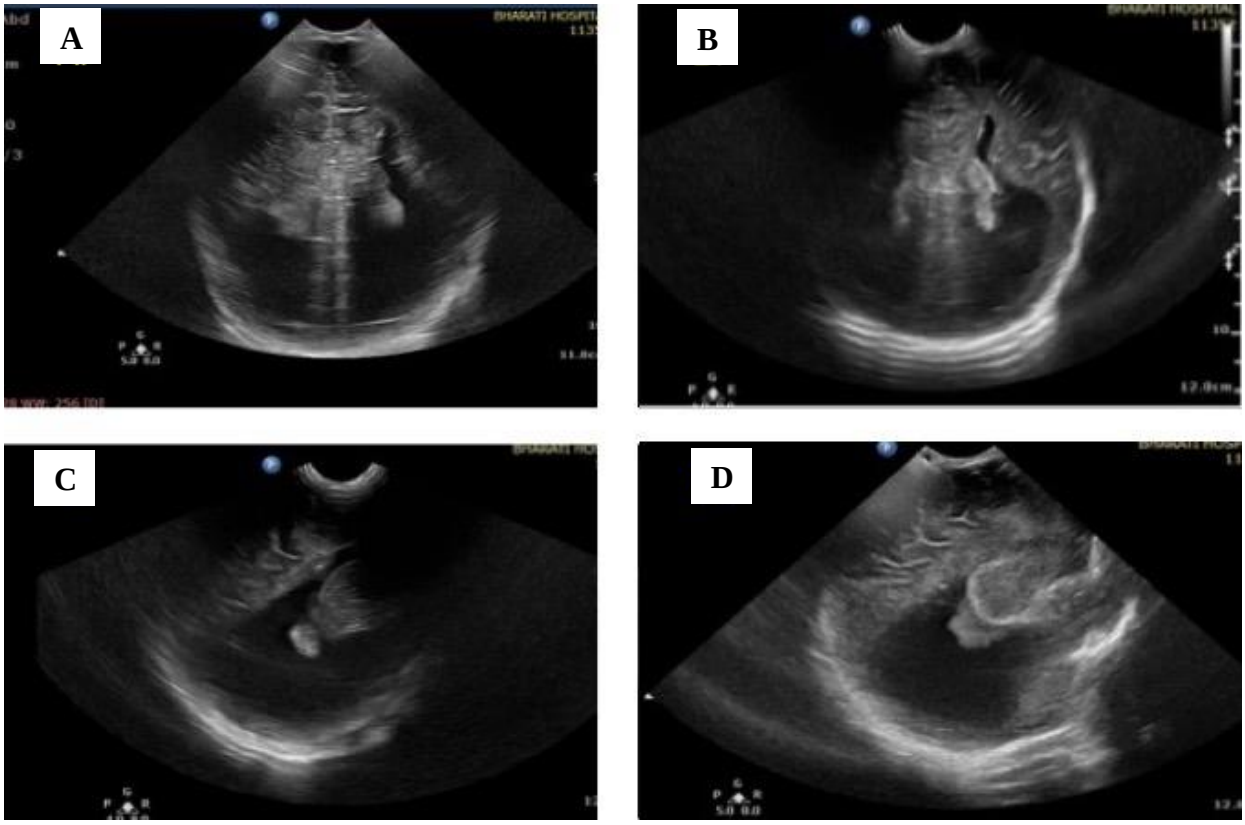

Figure 5: Neurosonography showing corpus callosum agensis. (A and B): Coronal section images taken from anterior fontanella of neonatal cranium showing dilatation of occipital horns of both lateral ventricles and narrowing of frontal horns of both lateral ventricles suggestive of "Tear drop" sign. (C and D): Sagittal section images taken from anterior fontanella of same neonatal cranium showing dilatation of occipital horn and normal choroid plexus is seen with in the ventricle.

DISCUSSION

In premature neonates, ICH is found to be more common in the subependymal, intraventricular and/or intraparrenchymal regions, while in term neonates ICH is rare but when it occurs, the subdural and subarachnoid spaces are the most common sites. The ICH severity in premature neonates is most commonly evaluated according by Papile et al, which was used in the present study as well. Transcranial neurosonography is the method of choice for a better approach during the intensive care of the premature neonate, which allows the imaging diagnosis. Scan is performed by anterior and temporal transfontanellar approach, it allows a better visualization of cerebral hemispheres, cerebellum, corpus callosum and blood vessels.[8] In present study, 61.7% preterm neonates with mean ventricular index at the first assessment was 26.78% and 26.89% at the second assessment. Majority of the neonates did not have HIE during both the assessments. Grade 1 HIE was found in 17 neonates on first assessment, and two had grade 2 HIE. Second assessment revealed grade 1 HIE in 20 neonates and grade 2 in two neonates. ICH was not found in 93.3% of the neonates. First assessment revealed two neonates with grade 1 and grade 2 ICH, while on second assessment one grade 2 ICH worsened to grade 3 ICH. Two neonates were found to have corpus callosal agenesis.

Burstein et al, used computed tomography (CT) to demonstrate a high percentage of intracranial hemorrhage in premature infants.[9] However, CT based imaging present logistic issues. Many years later, the first description of using head ultrasouund using the anterior fontanelle as a window led to bedside real-time evaluation of the premature neonate.[10] Transcranial neurosonography was able to detect subependymal and intraventricular hemorrhage in premature infants.[11] With recent advances in ultrasonography and Doppler software and hardware, increased resolution and improved image quality with much more sensitive vascular flow analysis is available. Some authors found that most cases of

Germinal matrix hemorrhage-intraventricular hemorrhage (GMH-IVH) occurs in the first week of life as approximately 50% of their cases occurred in the first day of life, and about 65% occur by the end of the first week.[12] Others found that 70% of their cases was classified as Grade I ICH, while in our study only 37.5% of neonates in hemorrhage group was classified as grade I.[13] Antoniuk et al, found that the incidence of GMH-IVH in those weighing less than 1500 g was 36%, while Wildrick and Mancini et al, noted in their studies that 20% and 30%, respectively, of premature neonates with birth weight <1500 g had IVH.[11,14,15]

CONCLUSION

Transcranial neurosonography stands as an excellent and reliable investigation of choice for neonates due to its effective detection of HIE, ICH and intracranial congenital anomalies like corpus callosal agenesis due to its easy availability, low operating cost, portability and non radiation imaging, therefore can be repeated. It not only detects abnormalities but gives excellent clue to clinicians for management of neonates. Therefore, authors recommend it as a routine test in all neonates admitted in neonatal intensive care unit and in those suspected for any intracranial congenital anomalies.

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Ethical approval: The study was approved by the Institutional Ethics Committee

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