ISSN Print: 2394-7500
ISSN Online: 2394-5869
Impact Factor: 8.4
IJAR 2022; 8(6): 188-192
www.allresearchjournal.com
Received: 18-02-2022
Accepted: 22-04-2022

Dr. Jaspreet Singh
Junior Resident, Department of Radiodiagnosis, S.P Medical College & A.G. of P.B.M Hospitals, Bikaner, Rajasthan, India

Dr. Ridhima Gupta
Professor & Guide, Department of Radiodiagnosis, S.P Medical College & A.G. of P.B.M Hospitals, Bikaner, Rajasthan, India

Corresponding Author:
Dr. Ridhima Gupta
Professor & Guide, Department of Radiodiagnosis, S.P Medical College & A.G. of P.B.M Hospitals, Bikaner, Rajasthan, India

The diagnostic role of neurosonogram in the evaluation of neonatal convulsions: An observational study at a tertiary hospital

Dr. Ravi Kasniya and Dr. Ridhima Gupta

Abstract
Aim:
1. Ultrasonographic evaluation of the brain in all neonates presenting with history of convulsions.
2. Localization and sonomorphological characterization of the lesions detected in positive cases.
3. To determine the role of other first-line investigations like cerebrospinal fluid study and biochemical analysis of blood in the evaluation of neonatal seizures.
4. Finally, to determine the place of ultrasonography of the brain in the work- up of neonatal convulsions.

Materials and Methods: Study was carried out in the Department of Radiodiagnosis & Modern Imaging, S.P. Medical College and Associate group of P.B.M. Hospitals, Bikaner, Rajasthan. This hospital is a tertiary care centre equipped with GE Logiq P9 Ultrasound Machine. The duration of the study was about one year(From Nov 2020 to Nov 2021).
Study population: All the patients referred for USG Cranium from Paediatric Medicine indoor, Nursery and Paediatric Medicine.
Study design: This is an observational hospital based study.
Sampling Technique: Done by consecutive sampling.
Sample size: 100 patients with convulsions (In patients and Out patients).
Study duration: 1 year or till 100 patients are taken.
Inclusion criteria:
- Neonatal age group (i.e. up to 4 weeks/ 1 month of age).
- Clinical diagnosis of convulsions.

Exclusion criteria:
The following patients were excluded from the study -
- Neonates with kernicterus and cardiopulmonary disease.
- Babies having history of inadvertent local anaesthetic injection
- Babies born to mothers with history of drug intake.

Results and Conclusion: In our series, the cause of neonatal convulsion could be diagnosed by the first line investigations (cranial USG and laboratory tests) in 75.58% cases. In 61.63% cases (53 cases) USG alone was able to provide a diagnosis. In 4 other cases US detected only ventriculomegaly, 2 of which were attributed to meningitis (as already discussed). Two other cases detected with dilated lateral and third ventricles with normal sized fourth ventricle and where the first-line laboratory tests could not find any abnormality, were diagnosed as hydrocephalus due to congenital aqueduct stenosis. CT scan done in these patients could not reveal any other morphological abnormality apart from ventriculomegaly.

Keywords: Ultrasound, imaging, cranial, premature, new born, hypoxia, hydrocephalus

Introduction
The neonatal period extends from birth to 4 weeks of age. A neonate is called preterm when born before 37th week of gestation irrespective of birth weight. Convulsion is a common but serious problem in the neonatal period. In fact, seizures are more frequent during the first month of life than at any other time [1, 2]. A cerebral or biochemical abnormality is most often the underlying cause of neonatal convulsion. The incidence of seizure varies from 0.5 – 0.8% in the term neonates and 6-12% in preterm neonates weighing less than 1500 grams (about 32 weeks) [3].
The most common cause of neonatal seizures is hypoxic-ischaemic encephalopathy (HIE) [4, 5].

Other important causes are intracranial haemorrhage (ICH) developmental defects of the brain, intrauterine or perinatal or neonatal infections and metabolic causes like hypoglycaemia, hypocalcaemia and hypomagnesaemia. Neonates are at particular risk of developing seizures because these causes are more likely to be manifested during this period of life [6].

The present day imaging techniques have opened up many excellent methods to look into the brain. The modalities available are ultrasonography (USG), CT scan, MRI etc. The technique of ultrasound examination of the brain is called echoencephalography, a term introduced by Lecksell in 1955. In 1980, Dewbury and Aluwihare and Babcock *et al*. first reported the use of anterior fontanelle as a bone free window through which brain can be imaged using B- mode ultrasound [7, 8]. USG is a safe, easily available, non-invasive technique and the results are highly reproducible. Till date, real time cranial USG is the most common form of brain scan in the neonatal age group. USG offers a number of advantages over CT scan like lower cost, less time consumption, no requirement of sedation and no hazard of ionising radiation; making it the investigation of choice in all high risk neonates.

USG of the brain plays a very important role in the evaluation and work- up of neonatal convulsions, particularly in the high- risk premature neonates. It can demonstrate the normal brain structure and different morphological lesions in considerable details. The coronal sections are particularly valuable for showing focal abnormalities, taking the advantage of the brain's symmetry. The utility of USG in detecting ICH, lesions of HIE, brain malformations or lesions associated with brain infections has been well established.

Materials and Methods

Study area

Study was carried out in the Department of Radiodiagnosis & Modern Imaging, S.P. Medical College and Associate group of P.B.M. Hospitals, Bikaner, Rajasthan. This hospital is a tertiary care centre equipped with GE Logiq P9 Ultrasound Machine. The duration of the study was about one year (From Nov 2020 to Nov 2021).

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Data collection procedure

Each patient underwent a thorough clinical evaluation including a detailed history with special reference to the presenting complain i.e. seizure and other significant problems like prematurity, low birth weight, birth asphyxia, apnoea, cyanosis, respiratory distress or fever was obtained. History of maternal illness, antenatal and intranatal complications were taken. The duration of the complaints were noted in each patient. All the patients were made to undergo Ultrasound scan as the radiological examination after taking an informed consent for the same.

Equipment

USG scan of brain was performed using GE Logiq P9 Ultrasound Machine with 2 types of high-resolution electronic transducers *viz.* (i) a linear transducer with divergent beam (virtual convex) having frequencies 5MHz, 7.5 MHz and 10 MHz and (ii) a curvilinear transducer with frequencies 3.5 MHz and 5 MHz.

Films were taken using SONY matrix video imager camera.

Technique

1. Real-time, grey-scale USG of the brain through the anterior fontanelle was performed in all neonates. Thorough scans were done in coronal and sagittal planes. In coronal scan the brain was imaged in 6 standard planes during anterior to posterior sweep of the transducer. In sagittal scan midline and 2 standard parasagittal sections for either side was used for imaging by moving the probe between midline and far lateral (through the sylvian complex) on each side.

Important, landmarks and structures were identified in each coronal and sagittal plane.

In premature infants, the 7.5 MHz frequency of the linear transducer and for term infants both 7.5 MHz and 5 MHz frequencies of the linear transducer was used. However the curvilinear transducer and the lower (3.5 MHz) and the higher (10 MHz) frequencies available with the ultrasound system was also utilized depending on individual situations.

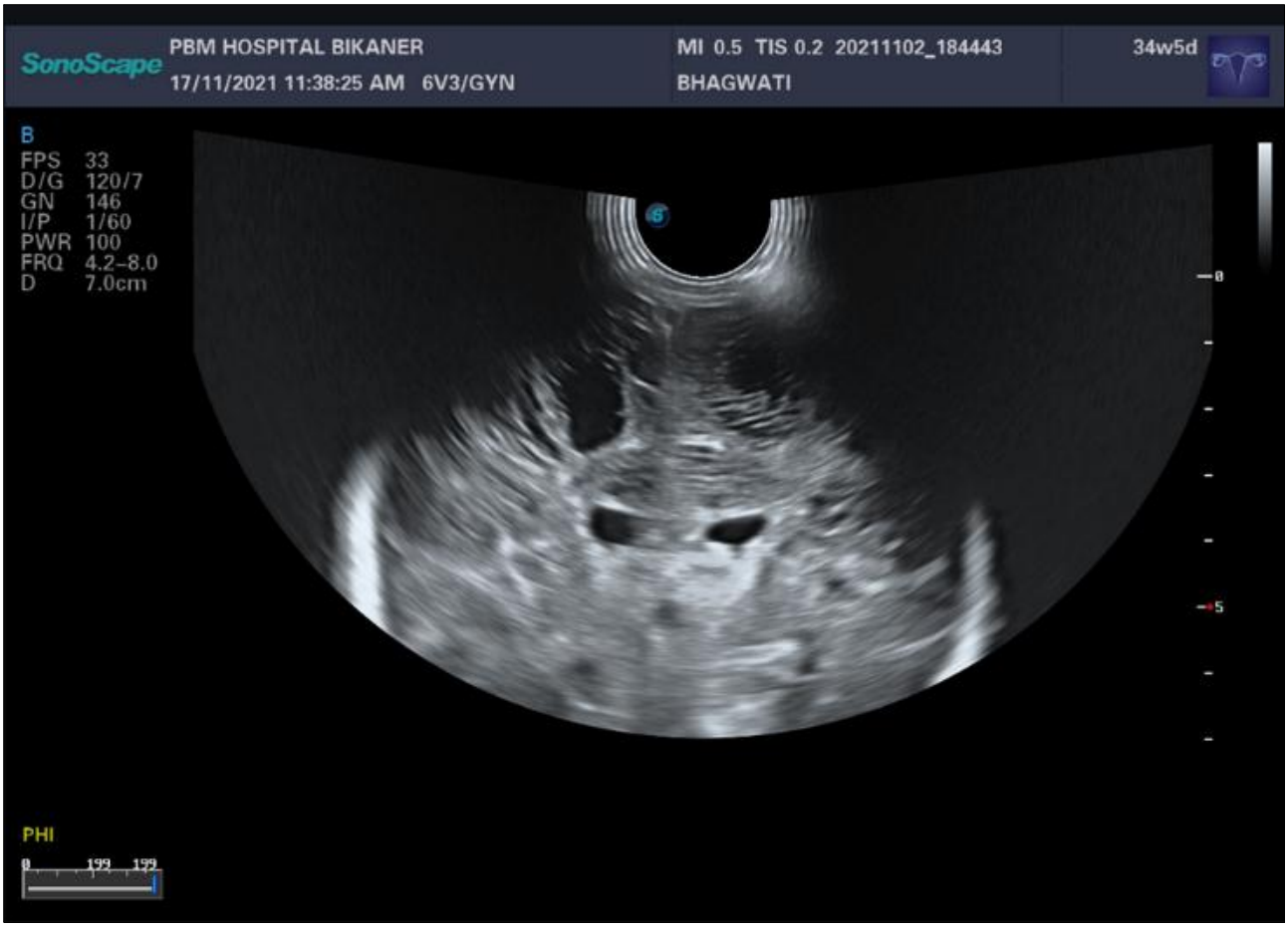

Fig 1: Neurosonogram showing prominent ventricles with dangling choroid.

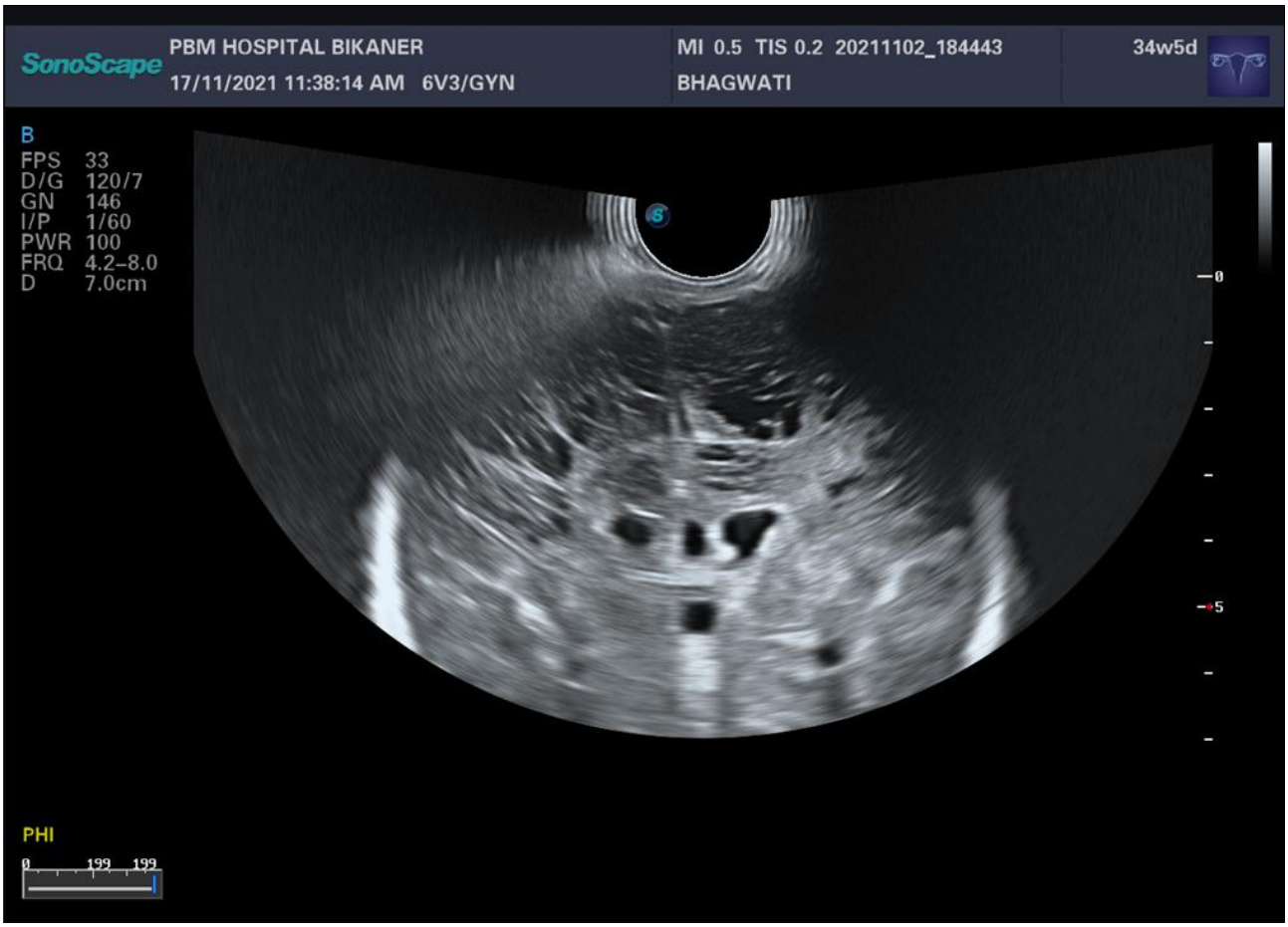

Fig 2: Neurosonogram showing pan ventriculomegaly.

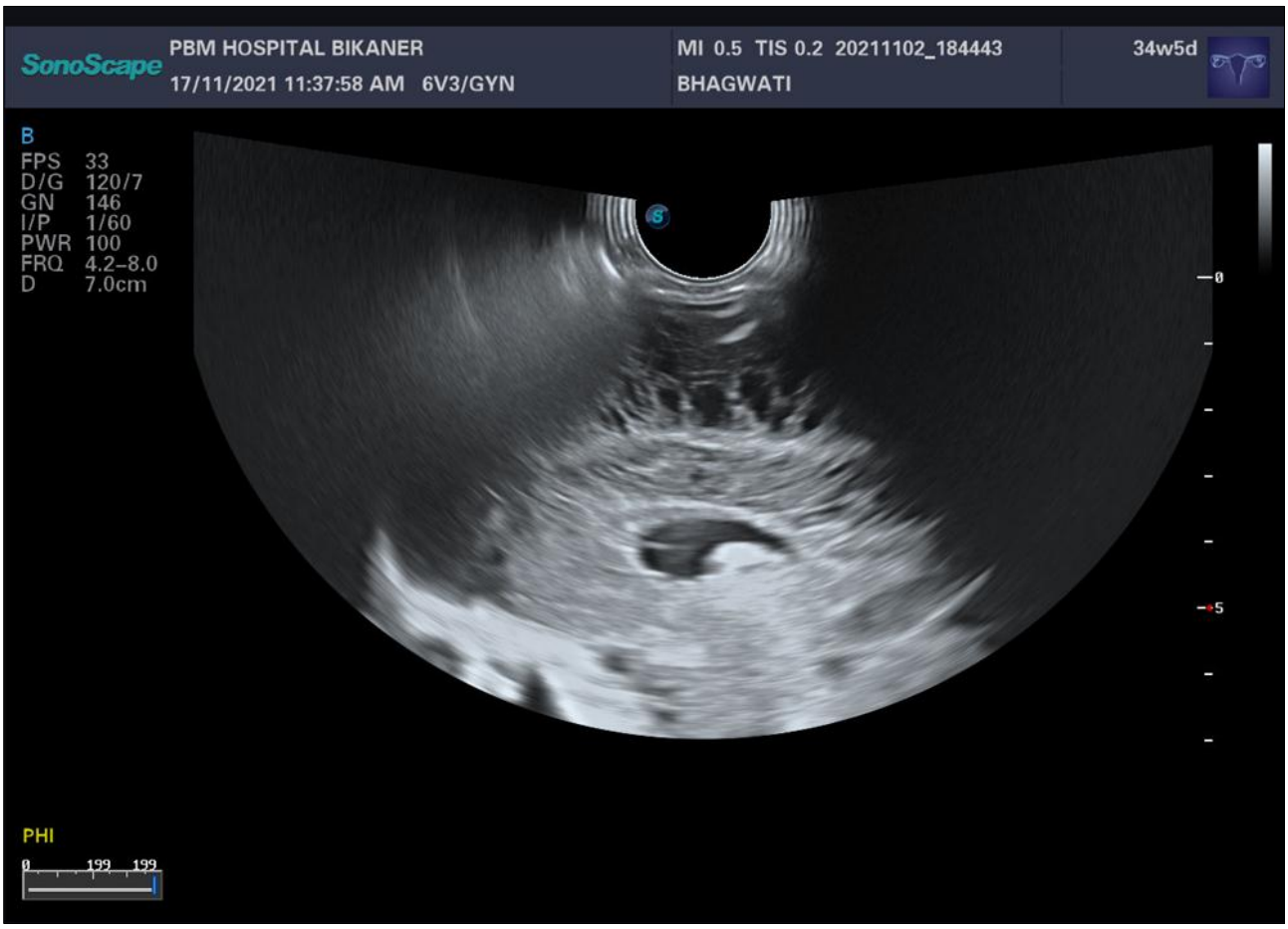

Fig 3: Neurosonogram showing cystic encephalomalacia in advanced HIE case.

Results and Conclusion

We found that in all except 2 cases of hypoxia–ischaemia induced brain injury (HIE and ICH) and in all 3 cases of hypoglycaemia the convulsion started within first 3 days. In 1 case of HIE where seizure started on day 5, there was no history of ante/intranatal asphyxia, but this preterm baby experienced frequent apnoeic spells from second day of life. Convulsion started on twelfth day in a term neonate with history of birth asphyxia, where we diagnosed SDH to be the underlying cause. In all cases diagnosed as CNS infection, brain anomalies and hypocalcaemia, the seizure onset was beyond first 3 days. These observations relating to the time of onset of seizure and its aetiology, corroborated well with the published literature [16].

According to the recent studies half of the cases of neonatal convulsions are seen in preterm neonates [14]. In the present study in 54.66% of neonates with convulsions were preterm. According to Rumack C.M. *et al*. GMH/PVH occurs mainly in premature neonates and is very uncommon in term infants [9]. We also found that all except 1 case with GMH/PVH occurred in preterm neonates. Prematurity also emerged as a significant risk factor for HIE lesions as 50% of neonates with these lesions was born premature.

Hypoxic-ischaemic insult (asphyxia) during ante/intra/postnatal period manifest as ischaemic lesions (HIE) or ICH or as a combination of both [9, 10, 19]. In our study there was history suggestive of hypoxia-ischaemia in all cases diagnosed with HIE lesions; in majority of cases (19 out of 22) with GMH/PVH and in the only case where SDH was detected. In fact in every case of HIE and GMH/PVH, either prematurity or history of hypoxic-ischaemic insult or both were present emphasizing that these two are very significant risk factors associated with these lesions. SDH is typically known to occur in term infants as a result of birth trauma or asphyxia [10, 15]. The case with SDH (case no. 44) was seen in a term neonate with history of birth asphyxia. It is worth mentioning that we did not find any case of ICH secondary to birth trauma, the incidence of which is rare now-a-days [10].

We observed that the cases diagnosed by the first-line investigations including cranial US, belonged to 4 major aetiological categories *viz*. hypoxia-ischaemia, CNS infections (meningitis and congenital), congenital brain anomalies (including congenital hydrocephalus) and metabolic abnormalities. Hypoxic-ischaemic insult is the most common cause of neonatal seizure [16, 15]. Hypoxia-ischaemia induced brain lesions (HIE and ICH) detected by cranial US scan accounted for 54.65% of all cases in our study. This was quite close to the observations by Watanbe *et al*. (53%) and Gupta D. (53.5%) [50, 55]. The stated figure in the world literature (for hypoxic-ischaemic aetiology of seizure) varied between 48% and 77%.

In our study 9.30% of all cases of neonatal seizure was caused by CNS infection. Different workers have detected this cause in 8-12.2% of cases in their studies. In our study bacterial meningitis was responsible in 7% of cases. Levene and Traunce diagnosed meningitis in 8% cases of neonatal convulsions [12].

Brain anomalies were detected by cranial US in 4.65% cases in our series. Bergman *et al*. and Goldberg in their studies of neonatal seizures found brain malformation in 4% and 8% cases respectively [15, 16]. In our study we could not detect a

case with band heterotopia by USG of brain, but where the lesion was picked up by CT scan.

We found that metabolic disturbances accounted for nearly 7% of cases of neonatal convulsions, of which hypoglycaemia and hypocalcaemia each was responsible in about 3.5% of cases. According to Forfar and Arneil's Text Book of Pediatrics, all metabolic causes taken together are the primary cause of seizure in less than 10% neonates at present [15].

Thus in the present study hypoxia-ischaemia related brain lesions were by far the most common cause of neonatal convulsions among the 4 major aetiological categories.

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