

# Role of Neurosonography in evaluation of brain abnormalities in neonates

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## ABSTRACT:

**Background:** Brain damage in preterm infants may result from a series of events rather than one specific insult. Maturation characteristics with a failing adaptation capacity may predispose the brain to harmful events during both intrauterine and extrauterine life. The study aimed to detect anomalies in the brain of neonates with neurosonography.

**Methods :** the study was conducted on patients with clinically suspected lesions in the brain, undergoing NSG for evaluation of brain abnormalities in Prathima Institute of medical sciences, Karimnagar. Neurosonographic examinations were performed through anterior fontanelle in both the coronal and sagittal planes. The examination started in the coronal plane along the coronal suture, with a transducer angled towards the frontal region. Then brain was examined in various coronal planes by sweeping the transducer from anterior to posterior.

**Results :** The most common abnormality found on neurosonogram in 3 – 5 days was germinal- matrix haemorrhage comprising n=13 (31%) followed by PVL n=12 (28.6%), cyst n=5 (11.9%), flaring n=5 (11.9%), cerebral edema n=4 (9.5%), congenital lesions n=2 (4.8%) and infections n=1 (2.4%). Follow up scan was performed around 2nd week of life, n=24 (57.1%) neonates were showing normal neurosonogram findings, remaining 18 (43%) showing abnormal findings, which are PVL n=6 (14.3%), GMH n=9 (21.4%), cyst n=1 (2.4%), cerebral edema n=1 (2.4%) and congenital lesions n=1 (2.4%).

**Conclusion:** High incidence of brain injuries was detected in babies born less than 32 weeks of gestation, weighing less than 1500 gm. The commonest clinical presentation was seizures followed by absent suckling and lethargy. The abnormalities found on the neurosonogram in our study were germinal matrix hemorrhage, periventricular leukomalacia, cystic PVL, corpus callosum agenesis, and TORCH infection. The mortality

rate was high in grade III and grade IV GMH. 10-14 days follow-up scan detected new cases of cystic PVL which were not diagnosed in the initial scan.

**Keywords:** Neurosonography, Brain Anomalies, Preterm Neonates.

## INTRODUCTION :

The new-born brain is vulnerable to injury from many causes, like preterm delivery, hypoxia, trauma, etc, resulting in significant mortality and morbidity despite recent improvements in neonatal intensive care. Neurosonography is a tool in the diagnosis of hemorrhage and other acquired and congenital brain pathology of the new-born. Premature neonates are especially at risk for intracranial problems. Neuroimaging assessment of premature is becoming increasingly important as the number of premature births is increasing and survival rate of very low birth weight babies is also increasing, and survivors remain at great risk for neurodevelopment impairments.<sup>[1]</sup> Approximately 10% of newborn are born prematurely. Of these children, more than 10% will sustain neurological injuries leading to significant learning disabilities, motor developmental delay, cerebral palsy, seizures, and mental retardation.<sup>[2]</sup> Several types of brain injuries may occur secondary to hemodynamic alterations in premature infants including white matter injury, germinal matrix hemorrhage, intraventricular hemorrhage, periventricular leukomalacia, and cerebellar hemorrhage and atrophy. The hemodynamic instability associated with preterm birth is related to these brain injuries as 40% have their onset within 5 hours of birth and 90% within the first 4 days. They are unusual after 34 weeks of gestation.<sup>[3]</sup> Neonatal sonography of the brain is now an essential part of new-born care, particularly in high-risk and unstable premature infants. Current ultrasound technology allows for rapid evaluation of infants in intensive care nurseries with virtually no risk.<sup>[4]</sup> CT is not typically used in the premature infant because of

the instability of the infant and the lack of good grey / white matter differentiation from the high-water content in the newborn brain. The advantages of sonography over computed tomography (CT) / magnetic resonance imaging (MRI) include portability, lower cost, speed, no ionizing radiation, and no sedation. Screening of premature infants for intracranial hemorrhage has proven highly sensitive and specific. Ultrasound is essential to the neonatal evaluation and follows up of hydrocephalus and periventricular leukomalacia (PVL).<sup>[4]</sup> We in the current study tried to assess the severity of brain injury by grading the neurosonographic findings.

### Material and Methods

A prospective study of n=42 preterm neonates with suspected brain injuries was conducted in the department of Radiodiagnosis, Prathima Institute of medical sciences, Naganoor, Karimnagar.

#### Inclusion criteria

1. Neonates with abnormal neurological presentation seizures, lethargy,
2. apnoea, sudden onset pallor, increase in muscle tone, bulging anterior
3. fontanel.
4. All preterm and term neonates.

#### Exclusion criteria

1. All cases were suspected to have trauma and failed resuscitation.
2. Age greater than one month of age

Based on the inclusion criteria, we enrolled n=42 patients admitted in Data for the study were collected from patients with clinically suspected lesions in the brain, undergoing NSG for evaluation of brain abnormalities in Prathima Institute of medical sciences, Karimnagar.

#### Preparation of the patient

- Neonates were transported to the ultrasound room by wrapping them in warm clothing to maintain normal body temperature.
- The baby was fed adequately before the examination.
- No sedation was used
- The baby was laid supine.
- Hand washing and cleansing of the transducer was done.

**Equipment:** All the neonates in this study underwent neurosonogram using a curvilinear transducer and linear assay high-frequency transducer of Philips ultrasound equipment.

**Sonography technique:** Neurosonographic examinations were performed through anterior fontanelle in both the coronal and sagittal plane. The examination started in the coronal plane along the coronal suture, with the 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 an examination in the coronal plane, sagittal and parasagittal scans were obtained by placing the transducers on the anterior fontanel, perpendicular to the 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 appear 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. An initial neurosonogram was done within 7 days of birth and a follow-up scan was done at 10-14 days of age.

**Statistical analysis:** Descriptive statistical analysis has been carried out in the present study. Results on continuous measurements are presented on Mean  $\pm$  SD (Min-Max) and results on categorical measurements are presented in number (%). Repeated measures analyses of variance were conducted and analyzed by paired t-test. The constituents of lesions in each phase were compared by student t-test. A p-value less than 0.05 was considered statistically significant at the 95% confidence interval. Chi-square test has been used to find the significance of the association of NSG scan findings with the final diagnosis. Diagnostics statistics such as sensitivity, specificity, PPV, NPV, and accuracy has been used to find the correlation of NSG with the final diagnosis.

### Results

Our study comprising of n=42 neonates with suspected brain injuries showed the following results. The study group had male predominance 29 (69%) comparatively with female neonates 13 (31%). The majority of babies were born to multiparous women 28 (66.7%) compared with primigravida 14 (33.3%). The most common abnormality found on neurosonogram was germinal matrix hemorrhage comprising n=13 (31%) followed by PVL n=12 (28.6%), cyst n=5 (11.9%), flaring n=5 (11.9%), cerebral edema n=4 (9.5%), congenital lesions n=2 (4.8%) and infections n=1 (2.4%) (Table 1).

**Table 1:** Lesion wise distribution of cases

Neurosonography findings	No. of cases	Percentage
Flaring	5	11.9
PVL	12	28.6
GMH	13	31.0

Cyst	5	11.9
Cerebral edema	4	9.5
Congenital Anomalies	2	4.8
Infections	1	2.4
Total	42	100

In our study Out of the n=42 neonates studied, n=32 (76.1%) were preterm and n=10 (23.9 %) were term. The most common abnormality in preterm found on neurosonogram was germinal- matrix haemorrhage comprising n=11 (34.4%) followed by PVL n=10 (31.3%), cyst n=4 (12.5%), flaring n=3 (9.4%), cerebral edema n=3 (9.4%), congenital anomalies n=1(3.1%). The most common abnormality in term found on neurosonogram was germinal- matrix haemorrhage comprising 3 (30%) followed by PVL 2 (20%), cyst 1 (10%), cerebral edema 2 (20%), congenital anomalies 1 (10%) and infections 1 (10%) (table 2).

**Table 2:**Preterm wise distribution of cases

Neurosonography findings	Preterm Neonates		Term Neonate	
	No. of cases		No. of cases	Percentage
Flaring	3	9.4	0	00
PVL	10	31.3	2	20
GMH	11	34.4	3	30
Cyst	4	12.5	1	10
Cerebral edema	3	9.4	2	20
Congenital anomalies	1	3.1	1	10
Infections	0	0.0	1	10
Total	32	100	10	100

The study group comprises babies born between the gestational age of 28 to 39 wks of which the majority of them were between 30-34 wks and 34-37wks comprising n=12 (28.6%) and n=12 (28.6%) respectively. Others were comprising < 30 wks n=10 (23.8%) and > 37 wks n=8 (19%). Birth weight was ranging from 0.8 to 3.1 kg of which most babies were between <1.5 kg 14 (33.3%). Others comprising of 2-2.5 kgs were 12(28.6%), > 2.5kgs were 8 (19%) and 1.5 -2 kgs were 8 (19%).

The most common abnormality found on neurosonogram in 3 – 5 days was germinal- matrix haemorrhage comprising n=13 (31%) followed by PVL n=12(28.6%), cyst n=5 (11.9%), flaring n=5 (11.9%), cerebral

edema n=4 (9.5%),congenital lesions n=2 (4.8%) and infections n=1 (2.4%). Follow up scan was performed around 2nd week of life, n=24 (57.1%) neonates were showing normal neurosonogram findings, remaining 18 (43%) showing abnormal findings, which are PVL n=6 (14.3%), GMH n=9 (21.4%), cyst n=1(2.4%), cerebral edema n=1 (2.4%) and congenital lesions n=1 (2.4%).

**Table 3:** Neurosonography findings between 10-14 days

Findings	No. of cases	Percentage
Normal	24	57.1
Flaring	0	0.0
PVL	6	14.3
GMH	9	21.4
Cyst	1	2.4
Cerebral edema	1	2.4
Congenital anomalies	1	2.4
Infections	0	0.0
Total	42	100

The commonest clinical manifestation of babies with suspected brain injuries in our study was seizures n=11 (26.11%) followed by absent suckling n=8 (19%) and lethargy n=7 (16.7%).

**Table 4:** Distribution of various clinical presentations

Clinical presentations	No. of cases	Percentage
Seizures	11	26.2
Lethargy	7	16.7
Absent suckling	8	19.0
Flaccidity	8	19.0
Irritable/excessive cry	4	9.5
Sudden onset pallor	1	2.4
Hypotonia	2	4.8
Hypertonia	1	2.4
Bulging anterior fontanelle	2	4.8
Total	42	100

Grade I GMH was found in 7 babies (53.8%) accounting for the majority of GMH, grade II was found in 2 (15.4%), grade III in 3 (23.1%), and grade IV in 1 baby (7.7%). The study group showed mortality in 18 (43%) neonates. Highest mortality was observed in GMH 9 (51%) followed by PVL 6 (33.3%), cyst 1 (5.6%), cerebral edema 1 (5.6%) and congenital lesions 1 (5.6%). Grade I GMH was found in 4 babies (22.2%) accounting for the majority of GMH, grade II was found in 1 (5.6%), grade III in 3 (16.7%), and grade IV in 1 baby (5.6%).

### Discussion

Neurosonography has now been routinely performed in premature infants. This has produced a wealth of information about the central nervous system like GMH, PVL, and ventriculomegaly. This information has included the timing and evolution of these lesions and their eventual correlation with outcome. The commonest clinical manifestation of babies with suspected brain injuries in our study was seizures n=11 (26.11%) followed by absent suckling n=8 (19%) and lethargy n=7 (16.7%). The most common abnormality found on neurosonogram was germinal matrix hemorrhage comprising n=13 (31%) followed by PVL n=12 (28.6%), cyst n=5 (11.9%), flaring n=5 (11.9%), cerebral edema n=4 (9.5%), congenital lesions n=2 (4.8%) and infections n=1 (2.4%). The study group showed mortality in 18 (43%) neonates. Highest mortality was observed in GMH 9 (51%) followed by PVL 6 (33.3%), cyst 1 (5.6%), cerebral edema 1 (5.6%) and congenital lesions 1 (5.6%). The initial sonogram was performed within 7 days of birth followed by a repeat scan at 10-14 days of life. An initial neurosonogram study performed within 7 days of birth showed abnormal findings in 42 neonates. Follow up scan was performed around the 2nd week of life, 24 (57.1%) neonates were showing normal neurosonogram findings, the remaining 18 (43%) showing abnormal findings, which are PVL 6 (14.3%), GMH 9 (21.4%), cyst 1 (2.4%), cerebral edema 1 (2.4%) and congenital lesions 1 (2.4%). The term flaring is used to describe the slightly echogenic periventricular zones, that are seen in many premature infants in the first week of life. During this first week, it is not sure if this is a normal variant or a sign of PVL grade. Flaring persisting beyond the first week of life is PVL grade 1. Follow up is needed to differentiate flaring from PVL grade I. The case on the left shows a premature infant with flaring. At follow up no cyst formation was found and after the first week, a normal periventricular white matter was seen. In our total study, 5 (11.9%) neonates were having flaring, 3 (9.3%) neonates were preterm and 2 (20%) were term, weighing between 1600 to 2500 grams. N Nagaraj et al;<sup>[5]</sup> In their prospective study conducted over 62 preterm babies with suspected neurological injuries were included, concluded abnormalities in preterm neonates is 16.1%. There were 62.9% male and 37.1% female neonates. 11.2% of these had evidence of intracranial bleed, 1.6% periventricular echogenicity, 1.6%

had ventriculomegaly and 1.6% had periventricular leukomalacia. The most common abnormality was grade I GMH (about 27.4%). Prithviraj D et al;<sup>[6]</sup> found the incidence of neurosonographic abnormalities in high-risk neonates is 31% in the study. Of this 41%, had evidence of intracranial bleed, 25% had cerebral edema, 6% periventricular leukomalacia, 16% hyperechogenic thalami, and one had ventriculomegaly. VP Chinta et al;<sup>[7]</sup> N=48 found Germinal matrix hemorrhage (GMH) was the commonest abnormality (67.02%). In 199 asymptomatic premature babies, cranial sonography was abnormal in 51 (25.62%) cases. A Priyadarshi et al;<sup>[8]</sup> revealed abnormalities in cranial ultrasound in 26.7% of preterm neonates. 12.5% of those had evidence of intracranial hemorrhage, 7.1% with transient periventricular echogenicity (TPVE), 1.7% had ventriculomegaly, 3.5% had periventricular leukomalacia and 1.7% had a cystic lesion. J G Flores et al;<sup>[8]</sup> in a retrospective study of n=28 patients who underwent a fetal MRI study for suspected congenital neurological anomalies. The diagnoses obtained by neurosonography and MRI were collected and compared. The fetal MRI examination revealed fetal ventriculomegaly, posterior fossa anomalies, suspected midline defects, small-for-gestational-age cephalic biometry, and confirmed congenital CMV infection.

### Conclusion

A high incidence of brain injuries was detected in babies born less than 32 weeks of gestation, weighing less than 1500 gm. The commonest clinical presentation was seizures followed by absent suckling and lethargy. The abnormalities found on the neurosonogram in our study were germinal matrix hemorrhage, periventricular leukomalacia, cystic PVL, corpus callosum agenesis, and TORCH infection. The mortality rate was high in grade III and grade IV GMH. 10-14 days follow-up scan detected new cases of cystic PVL which were not diagnosed in the initial scan.

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