International Journal of Medicine
pISSN 1468-3814 | eISSN 2667-7008
https://theinternationalmedicine.com/

Original Researcher Article *DOI: 10.61336/im/26-1-18*

Cranial Ultrasonography in Preterm Neonates: Association with Perinatal Factors and Neonatal Outcomes

Dr. Ruby[1], Dr. KapilDev Chaudhary[2]
[1]Senior resident, DNB paediatric SJPMC, Bharatpur
[2]Senior consultant, Govt. TBC, Bharatpur.

Correspondence:
Dr. KapilDev Chaudhary

Received: **January 01, 2026**
Revised: **January 10, 2026**
Accepted: **January 15, 2026**
Published: **January 22, 2026**

Abstract

INTRODUCTION: Preterm birth remains a major contributor to neonatal morbidity and mortality worldwide, owing to the physiological and structural immaturity of multiple organ systems. ***AIM:*** To evaluate cranial ultrasonography findings in preterm neonates and to assess their association with maternal factors, neonatal complications, birth weight, APGAR scores, and clinical outcomes, as well as to compare birth weight and APGAR scores between neonates with normal and abnormal cranial ultrasound findings. ***METHODOLOGY:*** This hospital-based observational analytical study was conducted in the Neonatal Intensive Care Unit (NICU) of a tertiary care teaching hospital over a period of one year. ***RESULT:*** Abnormal cranial ultrasound findings were observed in a substantial proportion of preterm neonates and were significantly associated with lower birth weight, lower APGAR scores, and the presence of neonatal complications. Neonatal complications showed a strong association with both abnormal cranial ultrasound findings and adverse outcomes, while maternal history, gravida status, and mode of delivery showed no significant association. ***CONCLUSION:*** Cranial ultrasonography is a useful bedside tool for early detection of brain abnormalities in preterm neonates, particularly in those with low birth weight, poor APGAR scores, and neonatal complications. Routine CUS screening can aid in early intervention and improve clinical management and prognostication in this vulnerable population.

Keywords: cranial, ultrasonography, preterm

INTRODUCTION

Preterm birth remains a major contributor to neonatal morbidity and mortality worldwide, owing to the physiological and structural immaturity of multiple organ systems1. Compared to term infants, preterm neonates are at a significantly higher risk of developing serious complications such as birth asphyxia, respiratory distress syndrome, hypoglycemia, temperature instability, and neonatal sepsis. In addition to these systemic problems, immaturity of the central nervous system renders premature neonates particularly vulnerable to brain injury.2 The developing brain is characterized by fragile vascular architecture, incomplete cellular differentiation, and anatomical immaturity, along with physiological instability caused by limited cerebral autoregulation. These factors collectively predispose preterm infants to both hemorrhagic and ischemic brain injuries3. These conditions are major contributors to neonatal mortality as well as long-term morbidity. Although advances in obstetric care, antenatal steroids, and neonatal intensive care have led to a substantial reduction in mortality rates among preterm neonates, concern has shifted toward long-term neurodevelopmental outcomes. It has been reported that approximately 10–15% of preterm infants eventually develop cerebral palsy, while up to half may suffer from other adverse neurological outcomes such as cognitive impairment, motor delay, learning disabilities, or behavioral disorders.Cranial ultrasound (CUS) has emerged as an indispensable diagnostic tool in neonatal care for the evaluation of the immature brain4. It allows visualization of normal brain anatomy as well as detection of pathological changes in neonates. Cranial ultrasound uses high- frequency sound waves transmitted through the anterior fontanelle, which serves as an effective acoustic window, enabling bedside imaging of the neonatal brain5. CUS is capable of

detecting the majority of hemorrhagic, ischemic, and cystic brain lesions, along with calcifications, cerebral infarctions, and major congenital or acquired structural abnormalities. For preterm infants who survive with cerebral injury, serial CUS examinations help in monitoring lesion evolution, guiding therapeutic strategies during the neonatal period, and planning long-term follow-up and rehabilitation6. One of the

major advantages of cranial ultrasound is that it is inexpensive, non-invasive, radiation-free, easily repeatable, and can be performed at the bedside, even immediately after birth. Serial imaging allows accurate assessment of the timing of injury and progression or resolution of lesions7.Despite its advantages, cranial ultrasound has certain limitations, including operator dependency, difficulty in visualizing some brain regions, and inability to detect subtle or diffuse white matter injuries. Nevertheless, routine screening cranial ultrasound is recommended for all infants born before 34 weeks of gestation. Increasing evidence also suggests that late preterm infants have a higher vulnerability to brain injury compared to term neonates.8 Early identification of cerebral abnormalities in both early and late preterm infants through routine cranial ultrasound can facilitate timely intervention and potentially improve long-term neurodevelopmental outcomes.

AIM

To evaluate cranial ultrasonography findings in preterm neonates and to assess their association with maternal factors, neonatal complications, birth weight, APGAR scores, and clinical outcomes, as well as to compare birth weight and APGAR scores between neonates with normal and abnormal cranial ultrasound findings.

MATERIALS AND METHODS

This hospital-based observational analytical study was conducted in the Neonatal Intensive Care Unit (NICU) of a tertiary care teaching hospital over a period of one year. A total of 238 preterm neonates born at less than 37 weeks of gestation and admitted to the NICU during the study period were included after obtaining informed consent from parents or guardians. Term neonates, neonates with major congenital anomalies, chromosomal

abnormalities, congenital central nervous system malformations, and those in whom cranial ultrasonography could not be performed were excluded from the study. maternal and neonatal data were collected using a predesigned proforma, including gender, maternal history, gravida status, mode of delivery, neonatal complications, birth weight, and APGAR scores at 1 and 5 minutes. Cranial ultrasonography was performed in all enrolled neonates using a high-frequency transducer through the anterior fontanelle during the early course of hospitalization and repeated on follow-up as per NICU protocol. Cranial ultrasound findings

were categorized as normal or abnormal. Data were analyzed using statistical software; categorical variables were expressed as frequencies and percentages, and continuous variables as mean and standard deviation. The unpaired t-test was used to compare mean birth weight and APGAR scores between neonates with normal and abnormal cranial ultrasound findings, while the chi- square test was applied to assess associations between cranial ultrasound findings, maternal and neonatal variables, and outcome. A p-value of less than 0.05 was considered statistically significant.

RESULTS

Table 1: Gender distribution of participants

Gender	Number	Percentage
Female	125	52.5%
Male	113	47.5%
Total	238	100%

Among the 238 study participants, females constituted a slight majority with 125 cases (52.5%), while males accounted for 113 cases (47.5%). Overall, the gender distribution was nearly equal, with a marginal female predominance.

Table 2: Maternal history among the study participants

Maternal history	Number	Percentage
Normal	88	37.0%
Abnormal	150	63.0%
Total	238	100%

Normal maternal history was observed in 88 participants (37.0%), whereas abnormal maternal history was present in 150 participants (63.0%). Thus, the majority of mothers in the study had an abnormal maternal history.

Among the study participants, primigravida mothers constituted the majority with 154 cases (64.7%), while multigravida accounted for 84 cases (35.3%). Regarding mode of delivery, normal vaginal delivery was more common, observed in 156 cases (65.5%), compared to LSCS in 82 cases (34.5%).

Table 3:Showing the distribution of gravida of the mothers and mode of delivery

Gravida	Number	Percentage
Multi	84	35.3%
PRIMI	154	64.7%
Total	238	100%
LSCS	82	34.5%
Normal	156	65.5%
Total	238	100%

Table 4: Showing the various complications of the newborn

Complications	Number	Percentage
Absent	174	73.1%
Present	64	26.9%
Total	238	100%

Neonatal complications were absent in 174 cases (73.1%), while 64 neonates (26.9%) presented with one or more complications. Thus, the majority of the study population did not experience complications during the neonatal period.

Table 5: Showing the mean level of birth weight and APGAR scores

	N	Minimum	Maximum	Mean	SD
Birth weight	238	1.20	4.5	2.63	0.631
APGAR 1min	238	2.00	8.00	5.60	1.52
APGAR 5min	238	3.00	9.00	6.70	1.46

The mean birth weight of the study population was 2.63 ±0.63 kg, with values ranging from 1.20 to 4.5 kg. The mean APGAR score was 5.60
±1.52 at 1 minute and improved to 6.70 ±1.46 at 5 minutes.

Table 6: Comparison of mean level of birth weight and APGAR score among normal and abnormal CUS using unpaired t-test.

	Cranial USG Report				p-value
	Normal		Abnormal		
	Mean	SD	Mean	SD	
Birth weight	2.74	0.60	2.49	.65	0.02*
APGAR 1min	6.30	1.25	4.58	1.32	0.001**
APGAR 5min	7.46	1.05	5.58	1.25	0.001*

Neonates with normal cranial ultrasonography had significantly higher mean birth weight and APGAR scores at both 1 and 5 minutes compared to those with abnormal cranial USG findings. These differences were statistically significant, indicating an association between abnormal cranial USG and lower birth weight as well as poorer immediate neonatal condition.

Table 7: Comparison of distribution of maternal history, gravida, MOD, complications and outcome among normal and abnormal CUS using chi-square test.

		USG Report				Chi-square (p-value)
		Normal (142)		Abnormal (96)		
		Count	%	Count	%	
Maternal History	Normal 83	50	35.2%	38	39.6%	0.084 (0.772)
	Abnormal	92	64.8%	58	60.4%	
Gravida	Multi	60	42.3%	24	25.0%	3.733 (0.053)
	Primi	82	57.7%	72	75.0%	
MOD	LSCS	46	32.4%	36	37.5%	0.331 (0.565)
	Normal	96	67.6%	60	62.5%	
Complications	Absent	120	84.5%	54	56.3%	11.631 (0.001) **
	Present	22	15.5%	42	43.8%	

Maternal history, gravida status, and mode of delivery did not show a statistically significant association with cranial ultr asound findings. In contrast, neonatal complications were significantly more common among neonates with abnormal cranial USG, indicating a strong association between complications and abnormal CUS findings.

Table 8: Comparison of distribution of maternal history, gravida, MOD, and complications with outcome among study participants using chi-square test.

		Out come				Chi-square (p-value)
		Dead (40)		Discharge (198)		
		Count	Column%	Count	Column %	
Maternal History	Normal	18	45.0%	70	35.4%	0.145 (0.703)
	Abnormal	22	55.0%	128	64.6%	
Gravida	Multi	12	30.0%	72	36.4%	0.295 (0.587)
	Primi	28	70.0%	126	63.6%	
MOD	LSCS	16	40.0%	66	33.3%	0.327 (0.567)
	Normal	24	60.0%	132	66.7%	
Complications	Absent	2	5.0%	172	86.9%	56.726 (0.001) **
	Present	38	95.0%	26	13.1%	

Maternal history, gravida status, and mode of delivery did not show a statistically significant association with neonatal outcome. However, the presence of complications was significantly associated with mortality, with a markedly higher proportion of deaths observed among neonates with complications compared to those without.

DISCUSSION

In our study the study population comprised a total of 238 participants, with a slight female predominance. Females accounted for 125 cases, constituting 52.5% of the study sample. Males represented 113 participants, making up 47.5% of the total population. The gender distribution was relatively balanced between males and females. This near-equal representation reduces the likelihood of gender-based selection bias. Similar to present study Nagaraj N et al9 documented, 63% of male and 37% of female neonates, 62% preterm and 38% term high-risk neonates enrolled in the study.

In the present study, a majority of mothers had an abnormal maternal history, accounting for 150 cases (63.0%). Mothers with a normal maternal history constituted 88 cases (37.0%) of the study population. This indicates a higher prevalence of antenatal or perinatal risk factors among the mothers of preterm neonates. The predominance of abnormal maternal history suggests an increased vulnerability to adverse neonatal outcomes. Such maternal factors may play a significant role in influencing neonatal morbidity. These findings highlight the importance of careful antenatal monitoring and timely intervention.

In the present study, primigravida mothers constituted the majority of the study population, accounting for 154 cases (64.7%), while multigravida mothers comprised 84 cases (35.3%). This indicates a higher proportion of first-time pregnancies among mothers of preterm neonates. Regarding the mode of delivery, normal vaginal delivery was more common, observed in 156 cases (65.5%). Lower segment cesarean section (LSCS) was performed in 82 cases (34.5%).

In the present study, the majority of neonates did not develop any complications, with 174 cases accounting for 73.1% of the total study population. Complications were observed in 64 neonates, representing 26.9% of cases. This indicates that nearly one-fourth of the study participants experienced complications during the neonatal period. The predominance of cases without complications reflects relatively stable clinical status in most neonates.

The study included 238 neonates, with birth weight ranging from
1.20 to 4.5 kg and a mean birth weight of 2.63 ± 0.63 kg. The APGAR score at 1 minute varied between 2 and 8, with a mean value of 5.60 ± 1.52. At 5 minutes, APGAR scores ranged from 3 to 9, showing improvement with a mean of 6.70 ± 1.46. Overall, the findings indicate a wide variation in birth weight among the neonates. The increase in mean APGAR score from 1 to 5 minutes reflects early neonatal stabilization.

Preterm neonates with normal cranial ultrasound findings had a higher mean birth weight (2.74 ± 0.60 kg) compared to those with abnormal cranial ultrasound findings (2.49 ± 0.65 kg), and this difference was statistically significant ($p = 0.02$). The mean APGAR score at 1 minute was significantly higher in the normal CUS group (6.30 ± 1.25) than in the abnormal group (4.58 ± 1.32) ($p = 0.001$). Similarly, the mean APGAR score at 5 minutes was greater among neonates with normal cranial ultrasound findings (7.46 ± 1.05)

compared to those with abnormal findings (5.58 ± 1.25). This difference at 5 minutes was also statistically significant (p = 0.001). Neonates with abnormal cranial ultrasound findings demonstrated lower birth weight and poorer immediate postnatal adaptation. These findings indicate a strong association between adverse perinatal parameters and abnormal cranial ultrasound outcomes.

On cranial ultrasonography, 142 neonates had normal findings while 96 showed abnormal findings. Maternal history did not show a significant association with cranial USG results, as similar distributions were observed between normal and abnormal USG groups. With respect to gravida status, abnormal cranial USG findings were more common among primigravida mothers, though this association approached but did not reach statistical significance. Mode of delivery also showed no significant difference between neonates with normal and abnormal cranial USG findings. In contrast, neonatal complications were significantly more frequent in the abnormal cranial USG group compared to the normal group. This highlights a strong association between the presence of complications and abnormal cranial ultrasound findings.Taksande A et al10 study showed that Neurosonography was performed in 105 critically ill neonates, out of whom 21 cases had abnormal neurosonography findings.There was a statistically significant association between mode of delivery and abnormal neurosonography (P=0.00).

Analysis of outcome revealed that maternal history, gravida status, and mode of delivery did not show a statistically significant association with neonatal outcome. The distribution of deaths and discharges was comparable across categories of maternal

history, gravida, and mode of delivery. In contrast, neonatal complications demonstrated a highly significant association with outcome. A markedly higher proportion of deaths occurred among neonates with complications compared to those without complications. Most neonates without complications were successfully discharged. These findings indicate that the presence of complications is a major determinant of adverse neonatal outcome.In similar to present study, Kinikar U et al.11, documented Mortality was 36.1% and all had abnormal cranial USG.

CONCLUSION

The present study demonstrates that cranial ultrasonography is a valuable and effective tool for detecting brain abnormalities in preterm neonates and for identifying those at higher risk of adverse outcomes. Abnormal cranial ultrasound findings were significantly associated with lower birth weight, poorer APGAR scores, and the presence of neonatal complications, highlighting the impact of adverse perinatal factors on neonatal brain health. While maternal history, gravida status, and mode of delivery did not show a significant association with cranial ultrasound findings or outcome, neonatal complications emerged as a major determinant of both abnormal cranial ultrasound results and mortality. The findings emphasize that preterm neonates with complications require closer monitoring, as they are more likely to have abnormal cranial ultrasound findings and unfavorable outcomes. Routine use of cranial ultrasonography in preterm neonates can facilitate early diagnosis, guide clinical management, and help in prognostication, ultimately contributing to improved neonatal care and neurodevelopmental outcomes.

REFERENCES

1. De Vries LS, Benders MJNL, Groenendaal F. Progress in neonatal neurology with a focus on neuroimaging in the preterm infant. Neuropediatrics. 2015;46(04):234–41.
2. Marlow N. Neurocognitive outcome after very preterm birth. Arch Dis Childhood-Fetal Neonatal Ed. 2004;89(3):F224–8.
3. Elshazzly M, Caban O. Embryology, central nervous system. StatPearls Publishing. 2018.
4. Yousefzadeh DK, Naidich TP. US anatomy of the posterior fossa in children: correlation with brain sections. Radiology. 1985;156(2):353–61.
5. Haber K, Wachter RD, Christenson PC, Vaucher Y, Sahn DJ, Smith JR. Ultrasonic evaluation of intracranial pathology in infants: a new technique. Radiology. 1980;134(1):173–8.
6. Heimburger RF, Fry FJ, Franklin TD, Sanghvi NT, Gardner G, Muller J. Two dimensional ultrasound scanning of excised brains—I. Normal anatomy. Ultrasound Med Biol. 1977;2(4):279–85.
7. van Wezel-Meijler G. Cranial ultrasonography: advantages and aims. Neonatal Cranial Ultrason. 2007;3–7.
8. Kaplan KM, Spivak JM, Bendo JA. Embryology of the spine and associated congenital abnormalities. Spine J. 2005;5(5):564–76.
9. Nagaraj N, Berwal PK, Srinivas A, Sehra R, Swami S, Jeevaji P, et al. A study of neurosonogram abnormalities, clinical correlation with neurosonogram findings, and immediate outcome of high-risk neonates in Neonatal Intensive Care Unit. J Pediatr Neurosci. 2016;11(3):200.
10. Taksande A, Rao R. Early Detection of Central Nervous System Abnormalities by Neurosonography in Critically Ill Neonates. Iran J Neonatol IJN. 2021;12(4):15–21.
11. Kinikar U, Dhanawade S. Study of cranial ultrasound its correlation with perinatal risk factors and its outcome in preterm neonates admitted to Neonatal intensive care unit. Pediatr Rev Int J Pediatr Res. 2018;5(4):169–75.