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Original Article

Role of Cranial Ultrasonography in the Evaluation of High-Risk Neonates

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ABSTRACT

Introduction: The survival rate of high-risk neonates has increased tremendously in recent years due to significant advances in the medical field, particularly in neonatal intensive care. **AIM**: To assess the clinico-neurosonographic abnormalities to find out the types of cerebral lesions in high-risk neonates. **Methodology**: The study was conducted in the Department of Paediatrics at Civil Hospital, Aizawl, and included high-risk neonates admitted to the Special Newborn Care Unit (SNCU) of the same department. **Result**: Out of 119 high-risk neonates studied, cranial ultrasonography revealed abnormal findings in 40.3%, with periventricular flare, communicating hydrocephalus, and intraventricular hemorrhage being the most common abnormalities. Neonates with abnormal cranial USG had significantly lower birth weight and APGAR scores, higher complication rates, and a greater mortality compared to those with normal scans. Overall mortality was 16.8%, with significantly higher deaths observed among neonates with abnormal cranial ultrasonography findings, highlighting its prognostic value. **Conclusion**: The study demonstrates a significantly higher incidence of abnormal cranial ultrasonography findings among preterm, low birth weight, and other high-risk neonates, with a correspondingly higher mortality rate compared to those with normal scans. Abnormal cranial USG findings showed a strong association with pregnancy-related complications and adverse neonatal outcomes. Routine use of cranial ultrasonography as a screening and follow-up tool is recommended to aid early detection of brain injury, guide clinical management, and improve prognostication and neurodevelopmental outcomes in critically ill and preterm neonates.

Keywords: High-risk neonates, Cranial ultrasonography, Neurodevelopment outcome.

INTRODUCTION

The survival rate of high-risk neonates has increased tremendously in recent years due to significant advances in the medical field, particularly in neonatal intensive care[1]. While this improvement has led to a decline in neonatal mortality, it has also resulted in an increased incidence of neurological deficits, some of which can profoundly affect a child's growth, development, and overall quality of life[2]. High-risk neonates are especially vulnerable to neurological injury, commonly resulting from impaired oxygenation and reduced cerebral blood flow during the perinatal period[3]. A substantial proportion of admissions to neonatal intensive care units consist of high-risk neonates, including term newborns with hypoxic ischemic encephalopathy (HIE) and preterm newborns[4]. It has been estimated that approximately 10–15% of high-risk neonates may develop cerebral palsy, while nearly 50% may experience some form of adverse neurological outcome. Neonatal encephalopathy occurs in about 1–3 per 1000 live births in high-income countries; however, in low- and middle-income countries such as India, neonatal encephalopathy contributes to nearly 99% of neonatal deaths. Among neonates who survive encephalopathy, around 40% develop significant brain injury leading to lifelong disability.[5] Importantly, many of these injuries and adverse outcomes are potentially preventable or treatable if identified at an early stage.[6] Early detection of neurological abnormalities is therefore crucial for predicting poor developmental outcomes and instituting timely interventions.[7] The pattern of brain injury in neonates depends on several factors, including the severity and duration of hypoxia as well as the degree of brain maturation, and consequently differs between term and preterm neonates.

Neuroimaging modalities such as ultrasonography, computed tomography, and magnetic resonance imaging play a vital role in identifying the location, extent, and severity of neonatal brain injury. Accurate imaging facilitates the selection of appropriate preventive and therapeutic strategies, thereby reducing long-term neurodevelopmental deficits. However, neonatal neurological injury is multifactorial, involving complex interactions between pathological processes, genetic susceptibility, and environmental influences, and therefore often requires more than a single intervention.[8] Among available imaging modalities, cranial ultrasonography is the most widely used tool for detecting neurological abnormalities in neonates due to its ease of use, low cost, portability, absence of ionizing radiation, and lack of requirement for sedation or anesthesia. It allows safe and repeated serial imaging, enabling assessment of the timing and progression of brain lesions during maturation.[9] Cranial ultrasonography is effective in detecting hemorrhagic, ischemic, cystic lesions, calcifications, cerebral infarctions, and major congenital or acquired structural anomalies, and is particularly valuable in the early diagnosis, severity assessment, and prognostication of hypoxic ischemic encephalopathy. With improving neonatal survival rates in India, comparable to those in developed nations, there is an increasing need for early identification of neurological abnormalities in high-risk neonates to enable timely treatment, prevention, and improved outcomes.[10] Cranial ultrasonography remains one of the most practical and effective investigatory modalities for neonatal neurological assessment, especially in resource-limited settings, and its wider use should be strongly encouraged.

AIM

To assess the clinico-neurosonographic abnormalities to find out the types of cerebral lesions in high risk neonates

METHODOLOGY

The study was conducted in the Department of Paediatrics at Civil Hospital, Aizawl, and included high-risk neonates admitted to the Special Newborn Care Unit (SNCU) of the same department. A cross-sectional observational study design was adopted. Data collection was carried out over a period of 18 months, from November 2020 to April 2022. The study population comprised all high-risk neonates fulfilling the inclusion criteria, which included newborns presenting with neonatal convulsions, birth asphyxia and hypoxic-ischemic encephalopathy, respiratory distress, neonatal sepsis, prematurity, and those born following traumatic or instrumental delivery. Neonates with metabolic disturbances associated with convulsions, as well as those with congenital malformations of the central nervous system and neural tube defects, were also included in the study. Stillborn neonates were excluded from the study population.

RESULT

Table 1: Gender distribution of participants

		Frequency	Percent
Gender	Female	60	50.4
	Male	59	49.6
	Total	119	100.0

Out of the 119 neonates included in the study, 60 (50.4%) were female and 59 (49.6%) were male. Thus, the gender distribution of the study population was almost equal, with a slight female predominance.

Table 2: Maternal history among the study participants

		Frequency	Percent
Maternal history	ANEMIA	4	3.4
	APH	6	5.0
	GDM	20	16.8
	Hypothyroid	3	2.5
	MSAF	7	5.9
	Normal	44	37.0
	PIH	23	19.3
	PPROM	6	5.0

	Pre-eclampsia	1	.8
	Twin	5	4.2

The most common maternal history observed was a normal antenatal course in 44 cases (37.0%), followed by pregnancy-induced hypertension in 23 cases (19.3%) and gestational diabetes mellitus in 20 cases (16.8%). Other maternal risk factors included meconium-stained amniotic fluid (5.9%), antepartum hemorrhage (5.0%), preterm premature rupture of membranes (5.0%), twin pregnancy (4.2%), anemia (3.4%), hypothyroidism (2.5%), and pre-eclampsia (0.8%).

Table 3: Showing the distribution of gravida of the mothers.

		Frequency	Percent
Gravida	G2	32	26.9
	G3	8	6.7
	G4	2	1.7
	PRIMI	77	64.7
	Total	119	100.0

Among the 119 mothers, the majority were primigravida, accounting for 77 cases (64.7%), while 32 (26.9%) were second gravida. Third gravida and fourth gravida constituted 6.7% and 1.7% of cases, respectively.

Table 4: Showing the term of pregnancy

		Frequency	Percent
Gestational age	Preterm	50	42.0
	Term	69	58.0
	Total	119	100.0

Of the 119 neonates studied, 69 (58.0%) were term babies, while 50 (42.0%) were born preterm. Thus, term neonates constituted the majority of the study population.

Table 5: Mode of Delivery

		Frequency	Percent
MOD	LSCS	41	34.5
	Normal	78	65.5
	Total	119	100.0

Out of the 119 neonates, 78 (65.5%) were delivered by normal vaginal delivery, while 41 (34.5%) were delivered by lower segment cesarean section. Normal delivery was the predominant mode of delivery in the study population.

Table 6: Showing various abnormal cranial USG findings among study participants

Cranial USG finding	**Frequency**	**percent**
Flow obstruction	2	4.1
Bilateral Grade 1 GMH	6	12.5
Resolving Grade 1GMH	2	4.1

Cerebral edema	5	10.4
Communicating Hydrocephalus	7	14.6
Decompressed subarachnoid space	4	8.2
Focal grade 1 PVL	6	12.5
PVF	11	23.4
SOL	1	2.0
IVH	4	8.2
Total	48	100.0

Cranial ultrasonography abnormalities were observed in 48 neonates, with the most common finding being periventricular flare (23.4%), followed by communicating hydrocephalus (14.6%) and bilateral grade I germinal matrix hemorrhage (12.5%). Other findings included focal grade I periventricular leukomalacia, cerebral edema, intraventricular hemorrhage, decompressed subarachnoid space, flow obstruction, resolving grade I germinal matrix hemorrhage, and space-occupying lesion in smaller proportions.

Table 7: Showing the various complications of the newborn

		Frequency	Percent
Complications	Absent	87	73.1
	Present	32	26.9
	Total	119	100.0

Complications were absent in the majority of neonates, accounting for 87 cases (73.1%). However, 32 neonates (26.9%) developed complications during the course of the illness.

Table 8: Showing the outcome of the participants included in the study

		Frequency	Percent
Outcome	Dead	20	16.8
	Discharge	99	83.2
	Total	119	100.0

Out of the 119 neonates studied, 99 (83.2%) were successfully discharged, while 20 (16.8%) succumbed during the hospital stay. Thus, the survival rate in the study population was 83.2%.

DISCUSSION

This cross sectional observation study was conducted in the Department of paediatrics, at CIVIL HOSPITAL, AIZAWL among the high risk neonates admitted to the SNCU. The data collection for the study was conducted between November 2020 to April 2022, for a duration of 18 months. Approval of the institute Human Ethics committee was obtained. Informed written consent was obtained from the parents/guardian of all the participants, after explaining the objectives of the study, risks, and benefits involved. The personal details of the patients were kept confidential throughout the study.

Evaluation with baseline routine investigations was done for all babies and cranial ultrasonography of the high risk neonate fulfilling the inclusion criteria was performed. Follow up cranial ultrasonography was done in case of findings revealed and for preterm neonates. Morphology of cranial ultrasonography findings were studied and recorded and clinical correlation with various findings on cranial ultrasonography was done. Neonates were followed till recovery and discharge from SNCU. The sonograms were performed on a Voluson 630 pro GE machine using a multi frequency high density volume -TV/TR probe.

The present study demonstrated a significant role of cranial USG among the high risk newborn admitting to the intensive care unit.

In the present study a total of 119 patients fulfilling inclusion criteria were included in the study after obtaining the informed consent from the mother or caretaker. Among the admitted newborn, 50.4% were female newborn and 49.6% were male newborn. On assessment of maternal history, 63.1% were abnormal among which 16.8% were with gestational diabetes mellitus, 19.3% with pregnancy induced hypertension and others included PPROM, preeclampsia, APH, and hypothyroidism. In the present study, 42% were born out of preterm pregnancy and 58% with term pregnancy, with 65.5% by normal vaginal delivery and 34.5% with LSCS. Similar to present study Nagaraj N et al[11] documented, 63% of male and 37% of female neonates, 62% preterm and 38% term high-risk neonates enrolled in the study.

In the included newborn, on cranial USG assessment 40.3% showed the presence of abnormal report and 59.7% reported normal result. Similar to present study Kinikar U et al.[12], documented out of 100 newborn, 53% had normal CUS findings while 47% had abnormal finding. Complications among the newborn was seen in 26.9% newborn. On assessment of the mean birth weight of the newborn, it was found that the birth weight among the abnormal (2.49±0.65kg) cranial USG report was significantly lower compared to the newborn with normal (2.74±0.6kg) cranial USG report. There was a significantly lower APGAR score among the newborn with abnormal cranial USG report compared to the normal cranial USG report, measured at 1 and 5min of birth.

The complications were significantly higher among the newborn with abnormal cranial USG report (43.8%) compared to the normal cranial USG report among the newborns (15.5%). Similar to present study, Jha R et al.[13], documented the abnormal cranial USG among the 25.4% of neonates. They also documented the abnormal cranial USG findings among the low birth weight newborns.

Among the abnormal CUS findings intraventricular hemorrhage was the most common (40.42%) followed by periventricular hyper-echogenicity (21.27%), cystic periventricular leukomalacia (8.51%), parenchymal bleed (8.51%), cysts (8.51%), cerebral edema (6.38%), ventriculomegaly (4.25%) and thalamic injury (2.12%).

Neonatal comorbidities associated with abnormal cranial ultrasound were RDS (25.53%), neonatal sepsis (21.27%), birth asphyxia (17.02%), neonatal seizures (8.51%), NEC (6.38%) and others (21.27%). There was significant association between abnormal cranial ultrasound and RDS ($p=0.014$) and birth asphyxia ($p=0.008$).

In present study, majority of newborn shown the presence of PVF (23.4%) followed with 14.6% with communicating hydrocephalus, 12.5% with grade 1 GMH and focal grade I PVL, 10.4% with cerebral edema, 8.2% with IVH and decompressed subarachnoid space, 4.1% with flow obstruction and resolving grade I GMH and 2% with SOL.

Assessment of the outcome of the newborn, 16.8% of death was reported and 83.2% discharged from hospital. There was higher incidence of death among the newborn with abnormal cranial USG findings (29.2%) compared to the normal cranial USG findings (8.5%).($p<0.05$) The complications were significantly higher among the newborn with the worst outcome (95.0%) compared to the better outcome with discharge among the newborns(13.1%).Similar to present study, Deepa S et al[14] and Ruchi J et al[13] also documented that Cranial Ultrasonography is a feasible and effective modality to screen critically ill neonates and aid in early detection and management of these sick neonates.

CONCLUSION

The study identified a significant higher incidence of abnormal cranial USG with preterm, low birth weight and other high risk neonates. The study also documented a significant mortality rate among the newborn with abnormal cranial USG finding compared to the normal findings also correlated strongly with the complications of pregnancy. The study recommends the use of cranial USG in detecting presence of brain damage and its evolution on regular follow-up to guide the clinical decisions and prognosis. This will help in management of the critically ill newborn infants appropriately. It also emphasizes its use as a screening modality for preterm neonates influencing their neurodevelopmental outcome.

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