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Role of transcranial ultrasound in evaluation of intracranial haemorrhage in preterm neonates- A Prospective Observational Study

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ABSTRACT

Background

Intracranial hemorrhage (ICH) is a critical concern in preterm neonates, impacting long-term neurological outcomes. Traditional cranial ultrasound (US) has been essential for detecting ICH, but transcranial ultrasound (TUS) offers enhanced imaging capabilities. TUS utilizes high-frequency sound waves to provide detailed visualization of the brain structures, particularly valuable in preterm infants with more pliable skulls. This advanced imaging technique improves the detection of hemorrhagic events, differentiates between stages of bleeding, and guides timely interventions**. Objective**: To determine the incidence of intracranial haemorrhage in preterm neonates and correlate ultrasound finding with clinical profile in intracranial haemorrhage in preterm neonates and also to correlate gestational age with grades of IVH in preterm neonates. **Methods**: A prospective observational study was conducted in the Department of Radiodiagnosis at M.G.M. Medical College & M.Y. Hospital, Indore, Madhya Pradesh, India, from July 2023 to June 2024. The study included 790 preterm neonates referred for transcranial ultrasound between January 2020 and October 2023. Transcranial ultrasound was performed using a7 – 15 Mhz probe, with images analyzed using Papille et al. classification for intraventricular hemorrhage.
Results: Out of total 790 preterm neonates on transcranial ultrasound, 161 (20.25%) preterm neonates were diagnosed to have IVH. The incidence of intraventricular haemorrhage in our study was 20.25%. Out of 161 preterm neonates, majority of preterm neonates 57.5% having grade 1 IVH were born between 31 - 32 weeks of gestation. Majority of preterm neonates 28.9% having grade 2 IVH were born between 29 - 30 weeks of gestation. Majority of preterm neonates 21% having grade 3 IVH were born between 29 – 30 weeks of gestation.
Conclusion:In conclusion, transcranial ultrasound (TUS) significantly enhances the evaluation of intracranial hemorrhage (ICH) in preterm neonates.

Keywords : Intraventricular hemorrhage (IVH), Transcranial ultrasound (TCUS), neonatal intensive care unit (NICU).

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INTRODUCTION

Intracranial hemorrhage (ICH) is a major concern in the management of preterm neonates, often resulting in significant neurological impairments and long-term developmental challenges. The incidence of ICH is notably higher in preterm infants due to their underdeveloped cerebral vasculature and fragile germinal matrix, a key area susceptible to bleeding. Early and accurate detection of ICH is crucial for implementing timely interventions that can mitigate potential damage and improve clinical outcomes. Historically, cranial ultrasound (US) has been the primary imaging modality for assessing ICH in neonates. It is favored for its non-invasive nature, ease of use, and ability to be performed at the bedside in neonatal intensive care units (NICUs). Standard cranial US, however, may have limitations in resolution and depth, particularly when assessing subtle or evolving hemorrhagic events. Transcranial ultrasound (TUS) emerges as an advanced alternative that enhances the capabilities of conventional cranial US. TUS utilizes high-frequency sound waves to provide superior imaging of brain structures through the fontanelles and, in some cases, the thin skull. This advanced technique offers improved resolution and deeper penetration, allowing for better visualization of intracranial hemorrhages and associated brain structures. TUS is particularly useful in preterm neonates due to their less ossified skulls, which facilitate better acoustic windowing. The use of TUS has shown promise in detecting various types and stages of ICH, including germinal matrix-intraventricular hemorrhage (GM-IVH), a common and severe form of bleeding in preterm infants. By providing more detailed and accurate images, TUS enables clinicians to better monitor hemorrhagic progression and assess potential complications. This can lead to more informed decision-making regarding management strategies and interventions.Exploring the role of TUS in the evaluation of ICH in preterm neonates is essential for optimizing neonatal care.

MATERIAL AND METHODS

This is a time-bound, prospective observational study, conductedin the Department of Radio-diagnosis, M.G.M. Medical College Indore,MadhyaPradesh,Indiaafterreceivingapproval from the Institutional Scientific and Ethical Committee. The duration of thestudy was from September 2022 to September 2023.

A total of 790 preterm neonates who werereferred to the Department of Radiodiagnosis for transcranial ultrasound by the paediatrics departments in M.Y hospital and MGMMC and associated hospitals who are clinically suspected with intraventricular haemorrhage were includedinthestudy.

INCLUSION CRITERIA –Preterm neonates born between 28 – 32 weeks of gestations.

EXCLUSION CRITERIA –Preterm neonates with developmental malformations and chromosomal anomalies.

STUDY PROTOCOL

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Transcranial ultrasound was performed within 72 hours of birth, transcranial ultrasound should be performed using appropriate scanning probe (7 – 15 Mhz); then the preterm neonates are placed in supine position and quite state. The preterm neonates is continuously scanned from front to back, from center to both sides on the coronal and sagittal planes, through the deflection probe. According to the different scanning positions, transcranial ultrasound can be divided into four parts, namely, anterior fontanel scanning, lateral fontanel scanning, mastoid fontanel scanning, and posterior fontanel scanning. Among them, the anterior fontanelle is the preferred inspection site. During scanning, attention should be paid to comparing the parenchymal structure and echo of the two cerebral hemispheres and observing the changes in the shape and position of the ventricle and midline. Scans of the posterior fontanelle reveal brain structures close to the horizontal position, which can be used to compensate for the lack of detection of acoustic images of the bottom of the brain when scanning the anterior fontanelle. Transcranial fontanel scanning, which is equivalent to observing a cross-sectional view of the brain from one side, is often used as an acoustic window for cerebrovascular hemodynamics. The mastoid fontanelle can be used to observe the posterior fossa. During the scan, attention should be paid to the boundary between the cerebellar hemisphere, cerebellar vermis, cortex and medulla, material echoes, and changes in the cerebellar medullary cistern.

Figure 1: Axial image of infant's brain on Transcranial Ultrasound showing different structures.

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Figure 2

Preterm neonate female presented with poor feeding and excessive sleep, scanned at 36 hours and at day 7.

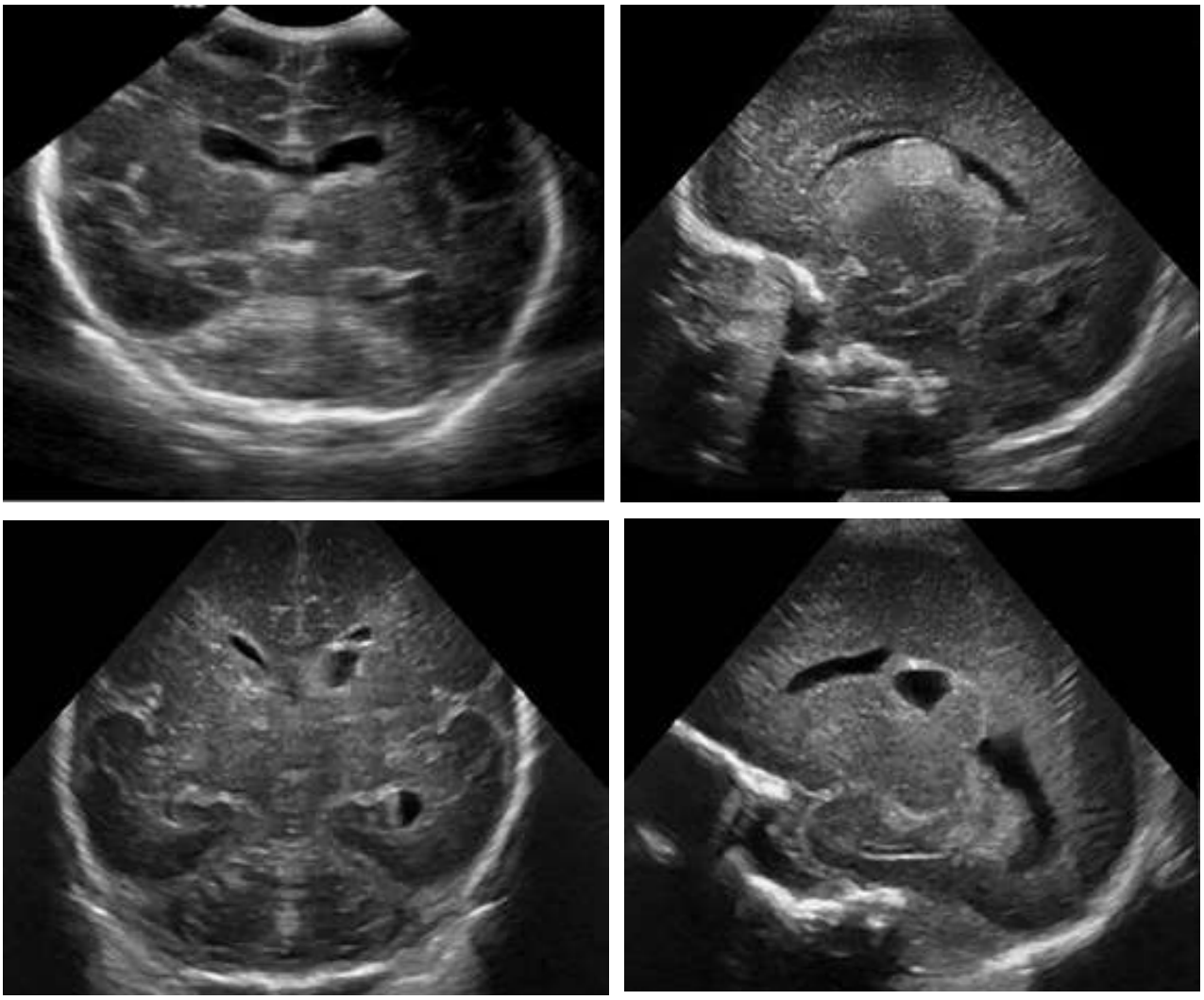

Fig (a) – coronal section at 36 hrs

Fig (b) – Sagittal section at 36 hrs

Fig (c) – coronal section at day 7

Fig (d) – Sagittal section at day 7

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Cranial ultrasound of premature infant shows grade I IVH in left lateral ventricles. Scan done at day 7 showing little resolution of IVH.

Figure 3

Preterm neonate male presented with fever and seizure, scanned at 36 hours and at day 7.

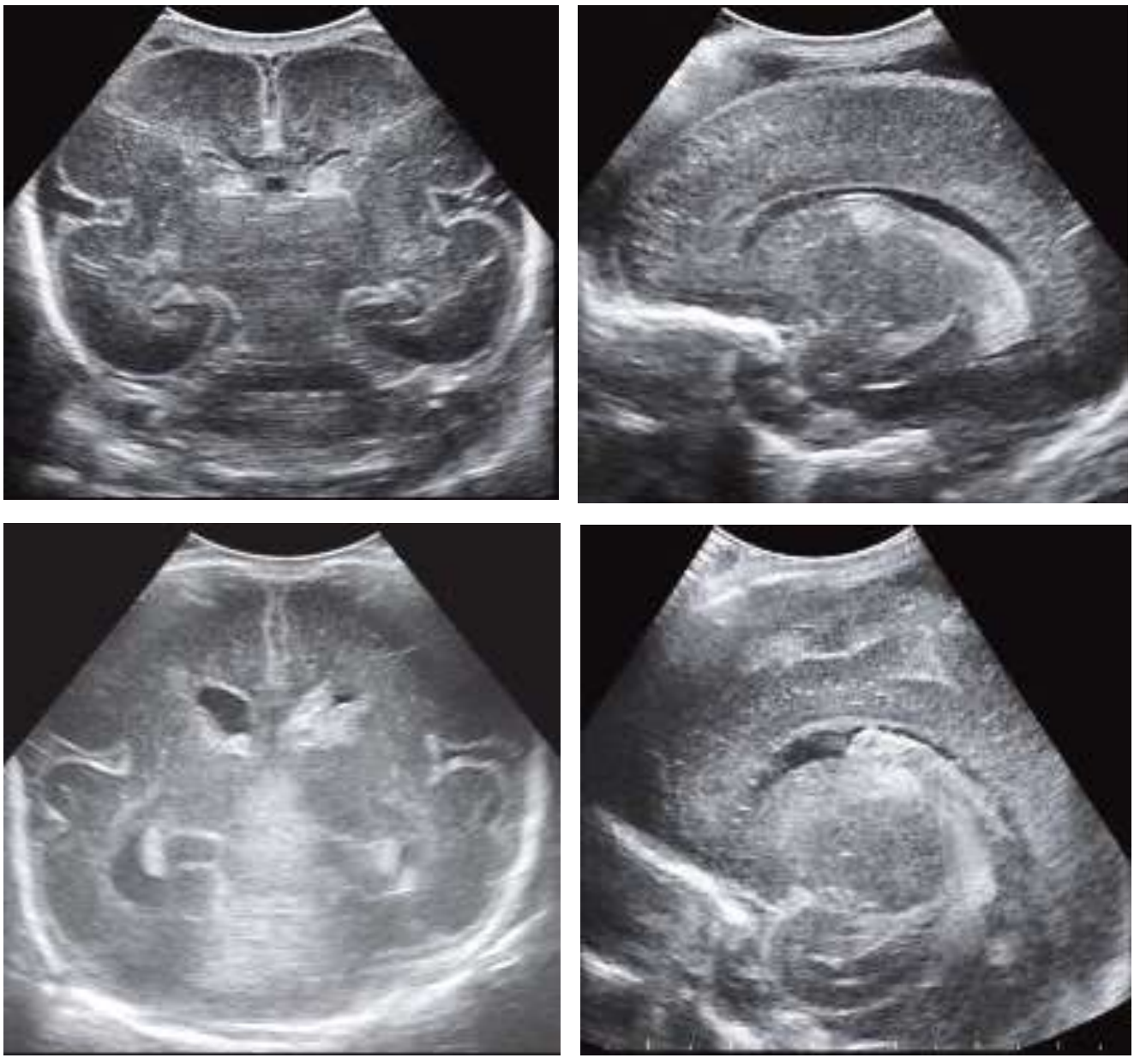

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Fig (a) – coronal section at 36 hrs Fig (b) – Sagittal section at 36 hrs

Fig (c) – coronal section at day 7 Fig (d) – Sagittal section at day 7

Cranial ultrasound of premature infant shows grade I IVH in left lateral ventricles.

Figure 4

Preterm neonate male presented with decreased muscle tone and seizure, scanned at 36 hours and at day 7.

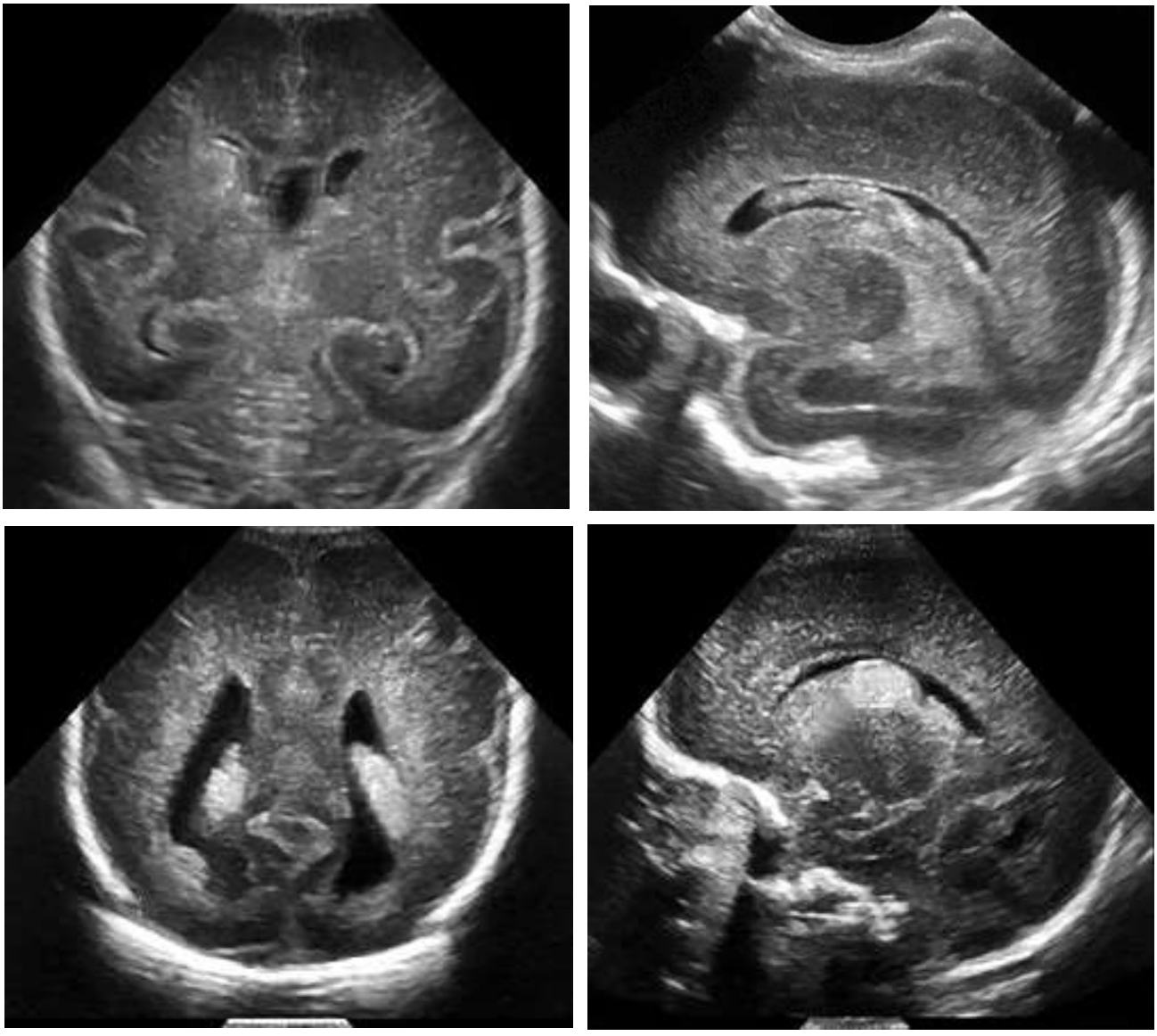

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Fig (a) – coronal section at 36 hrs Fig (b) – Sagittal section at 36 hrs

Fig (c) – coronal section at day 7 Fig (d) – Sagittal section at day 7

Cranial ultrasound of premature infant shows grade II IVH in right lateral ventricles.

RESULTS

Out of total 790 preterm neonates on transcranial ultrasound, 161 (20.25%) preterm neonates were diagnosed to have IVH. The incidence of intraventricular haemorrhage in our study was 20.25%. Out of 161 preterm neonates, majority of preterm neonates 57.5% having grade 1 IVH were born between 31 - 32 weeks of gestation.Majority of preterm neonates 28.9% having grade 2 IVH were born between 29 - 30 weeks of gestation.Majority of preterm neonates 21% having grade 3 IVH were born between 29 – 30 weeks of gestation.Majority of preterm neonates 9.6% having grade 4 IVH were born between 28 – 29 weeks of gestation. Out of 160 preterm neonates, majority of preterm neonates 53.7% having grade 1 IVH were in birth weight category 1000 – 1500 grams.Majority of preterm neonates 27% having grade 2 IVH were in birth weight category 1500 – 2000 grams.Majority of preterm neonates 26.3% having grade 3 IVH were in birth weight category <1000 grams.Majority of preterm neonates 15.7% having grade 4 IVH were in birth weight <1000 grams. Out of 23 preterm neonates developing complications, 7.5% preterm neonates had grade 1 IVH, followed by 16.6% preterm neonates had grade 2 IVH, 28.5% preterm neonates had grade 3 IVH and 33.3% preterm neonates had grade 4 IVH. Out of 65 preterm neonates who died due to intraventricular haemorrhage, 24% preterm neonates had grade 1 IVH, followed by 12% preterm neonates had grade 2 IVH, 96% preterm neonates had grade 3 IVH, and 100% preterm neonates had grade 4 IVH. Out of 161 preterm neonates having IVH on transcranial ultrasound, 96 (59.3%) preterm neonates were discharged, while 65 (40.67%) preterm neonates died. Majority of preterm neonates who couldn't survive were suffering from higher grades (grade 3 and 4) IVH and also some of them had coexisting morbidities.

TABLES

Table No.1 – Distribution of preterm neonates based on presence of intraventricular haemorrhage on Transcranial Ultrasound.

IVH	NumberofPreterm neonates (N)	Percentage(%)
Absent	629	79.75
Present	161	20.25
TOTAL	790	100

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Out of total 790 preterm neonates on transcranial ultrasound, 161 (20.25%) preterm neonates were diagnosed to have IVH

Table No.2 – Correlation between gestational age at birth with grading of intraventricular haemorrhage in preterm neonate on transcranial ultrasound.

Grade of IVH	**Preterm born b/w 28-29 weeks**		**Preterm born b/w 29-30 weeks**		**Preterm born b/w 30-31weeks**		**Preterm born b/w 31-32weeks**	
	(N)	**(%)**	**(N)**	**(%)**	**(N)**	**(%)**	**(N)**	**(%)**
1	25	48	16	42	18	48.6	20	57.5
2	13	25	11	28.9	10	27	8	24.2
3	9	17.3	8	21	7	18.9	4	12
4	5	9.6	3	7.8	2	5.4	2	6
Total	52		38		37		34	

Out of 161 preterm neonates, majority of preterm neonates 57.5% having grade 1 IVH were born between 31 - 32 weeks of gestation followed by grade 2 IVH were born between 29 - 30 weeks of gestation and 21% having grade 3 IVH were born between 29 – 30 weeks of gestation. Whilw 9.6% having grade 4 IVH were born between 28 – 29 weeks of gestation.

Table No. 3 – Correlation between grades and developing complications of preterm neonates having intraventricular haemorrhage on Transcranial Ultrasound.

Grades of intraventricular haemorrhage	**Numberof complications**	**Percentage(%)**
Grade 1 (n = 79)	6	7.5
Grade 2 (n = 42)	6	16.6
Grade 3 (n =28)	7	28.5
Grade 4 (n = 12)	4	33.3
total	23	

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Out of 23 preterm neonates developing complications, 7.5% preterm neonates had grade 1 IVH, followed by 16.6% preterm neonates had grade 2 IVH, 28.5% preterm neonates had grade 3 IVH and 33.3% preterm neonates had grade 4 IVH.

Table No.4- Correlation between grades and mortality of preterm neonates having intraventricular haemorrhage on Transcranial Ultrasound.

Grades of intraventricular haemorrhage	**Numberof preterm died**	**Percentage(%)**
Grade 1 (n = 79)	19	24
Grade 2 (n = 42)	7	12
Grade 3 (n =28)	27	96
Grade 4 (n = 12)	12	100
Total	65	

Out of 65 preterm neonates who died due to intraventricular haemorrhage, 24% preterm neonates had grade 1 IVH, followed by 12% preterm neonates had grade 2 IVH, 96% preterm neonates had grade 3 IVH, and 100% preterm neonates had grade 4 IVH.

Table No. 5 - Distribution according to the outcome of preterm neonates having intraventricular haemorrhage on Transcranial Ultrasound.

Outcome	**Numberof preterm neonates**	**Percentage (%)**
Discharged	96	59.3
Death	65	40.62
total	161	100

Out of 161 preterm neonates having IVH on transcranial ultrasound, 96 (59.3%) preterm neonates were discharged, while 65 (40.67%) preterm neonates died. Majority of preterm

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neonates who couldn't survive were suffering from higher grades (grade 3 and 4) IVH and also some of them had coexisting morbidities.

DISCUSSION

Transcranial ultrasound scans were done for all the 790 preterm neonates within 72 hrs of birth, 629 (79.75%) preterm neonates had normal transcranial ultrasound findings, while intraventricular hemorrhage were found in 161 (20.25%) preterm neonates. In preterm neonate highly vascular germinal matrix is the site of haemorrhage and maturation of germinal matrix occurs after 32 weeks of gestation. In our study, out of 161 preterm neonates, 53 (32.5%) preterm neonates were in the age group 28 – 29 weeks of gestation, followed by 38 (23.7%) preterm neonates in the age group 29 – 30 weeks of gestation, 37 (23.1%) preterm neonates in the age group 30 - 31 weeks of gestation and 33 (20.6%) preterm neonates in the age group of 31- 32 weeks of gestation. The reason behind this is preterm newborn born before 32 weeks of gestation have immature germinal matrix leads to intraventricular haemorrhage. out of 79 preterm neonates having grade 1 IVH, 7.5% preterm neonates had developing complications. Among 42 preterm neonates of grade 2 IVH, 16.65% preterm neonates had developing complications. Among 28 preterm neonates having grade 3 IVH, 28.5% preterm neonates had developing complications. Among 12 preterm neonates having grade 4 IVH, 33.3% preterm neonates had developing complications. Grade 3 and 4 IVH involve more extensive bleeding, increasing risks of hydrocephalus, neurological deficits, and mortality in preterm infants. , among 65 preterm neonates with IVH on transcranial ultrasound, 100% preterm neonates of grade 4 IVH died, followed by 96% preterm neonates of grade 3 IVH died.Grade 3 and 4 IVH in preterm infants are more severe, causing increased brain damage and complications, leading to higher mortality. among the 161 preterm neonates having IVH on transcranial ultrasound, 96 (59.3%) were discharged, while 65 (40.67%) died.IVH in preterm neonates has high mortality due to fragile blood vessels, immature brain development, and limited treatment options.

CONCLUSION

The study also highlights the importance of transcranial ultrasound in evaluation of intraventricular haemorrhage in preterm neonates. Monitoring preterm neonates with transcranial ultrasound could be a useful approach for paediatrician to identify potential IVH and address them before they escalate. This study demonstrates correlation between gestational age, birth weight, grades of intraventricular haemorrhage, clinical profile and its outcome.

REFERENCES

1) Bassan H. Intracranial hemorrhage in the preterm infant: understanding it, preventing it. Clinics in perinatology. 2009 Dec 1;36(4):737-62.

ISSN: 0975-3583, 0976-2833 VOL15, ISSUE 8, 2023

2) Atienza-Navarro I, Alves-Martinez P, Lubian-Lopez S, Garcia-Alloza M. Germinal matrix-intraventricular hemorrhage of the preterm newborn and preclinical models: inflammatory considerations. International journal of molecular sciences. 2020 Nov 6;21(21):8343.
3) Rabinstein AA. Neurocritical Care, An Issue of Neurologic Clinics. Elsevier Health Sciences; 2017 Oct 11.
4) Mosilhy EA, Alshial EE, Eltaras MM, Rahman MM, Helmy HI, Elazoul AH, Hamdy O, Mohammed HS. Non-invasive transcranial brain modulation for neurological disorders treatment: a narrative review. Life Sciences. 2022 Oct 15;307:120869.
5) Baek H, Lockwood D, Mason EJ, Obusez E, Poturalski M, Rammo R, Nagel SJ, Jones SE. Clinical intervention using focused ultrasound (FUS) stimulation of the brain in diverse neurological disorders. Frontiers in Neurology. 2022 May 9;13:880814.
6) Pujar P. *A Study to Evaluate the Role of Neurosonogram in Detecting the Intracranial Abnormalities in High-Risk Neonates Admitted in Neonatal Intensive Care Unit* (Doctoral dissertation, Rajiv Gandhi University of Health Sciences (India).