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EVALUATION OF NEONATAL BRAIN HEMORRHAGE (NBH) BY TRANSCRANIAL ULTRASOUND IN PRETERM BABIES ADMITTED IN NICU

Radio-Diagnosis

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ABSTRACT

Background: Neurosonography (NSG), also known as transcranial ultrasound (TCU), is an essential bedside imaging tool for evaluating neonatal brain pathology, particularly in preterm infants. Neonatal Brain Hemorrhage (NBH), including Germinal Matrix Hemorrhage (GMH) and Intraventricular Hemorrhage (IVH), is a significant cause of morbidity and mortality in preterm neonates. Early detection using NSG can aid in timely intervention and improve outcomes. **Aim:** This study aimed to evaluate neonatal brain hemorrhage (NBH) in preterm neonates admitted to the Neonatal Intensive Care Unit (NICU) using transcranial ultrasound, determine the frequency and grading of NBH, assess associated risk factors, and analyze ultrasound findings related to other neonatal brain abnormalities. **Methods:** A hospital-based observational study was conducted over 18 months at the Department of Radio-diagnosis, G.S.L Medical College, India. A total of 110 preterm neonates **(gestational age <37 weeks) admitted to the NICU were included. Data on** maternal history, perinatal events, neonatal factors, and imaging findings **were collected. Transcranial ultrasound was performed using a** PHILIPS Affinity 70G machine **with a** high-frequency linear probe (7 – 12 MHz)**. Statistical analysis was conducted to evaluate the correlation between** NBH, gestational age, birth weight, and clinical outcomes**.**

Results

- **62.7%** of preterm neonates had **abnormal TCU findings**, while **25.45%** had **NBH**.
- NBH was more frequent in **neonates <28 weeks gestation (47%)** compared to **26.9% in 28–32 weeks** and **14.6% in 33–36 weeks** (p=0.03).
- **Low birth weight** significantly correlated with NBH, affecting **55.5% of very low birth weight (VLBW) infants (<1500g)**.
- The **most common ultrasound findings** included **GMH (23.1%)**, **periventricular flare (18.8%)**, and **IVH (15.94%)**.
- **83% of NBH cases** were detected **within 72 hours of life**.
- **Clinical complications** were more frequent in NBH cases, including **hypoxic-ischemic encephalopathy (HIE) (25%), post-hemorrhagic hydrocephalus (10.7%), and sepsis (7.14%)**, though mortality was **not significantly impacted**.
- **Neonates with NBH** had significantly **lower APGAR scores** at **1 minute (5.21±1.13)** and **5 minutes (6.50±1.00)** compared to those without NBH.

Conclusion: Neurosonography is an effective **non-invasive, bedside imaging modality** for early detection of **neonatal brain hemorrhage (NBH)** in preterm infants. It remains the **preferred primary imaging tool** in NICUs due to its **high sensitivity, bedside accessibility, and safety**. Gestational age, **low birth weight, and APGAR scores** were significant predictors of NBH. Early TCU screening in high-risk neonates can aid in better clinical decision-making and improved neonatal outcomes.

KEYWORDS

Neonatal Brain Hemorrhage (NBH), Intraventricular Hemorrhage (IVH), Germinal Matrix Hemorrhage (GMH), Transcranial Ultrasound (TCU), Preterm Neonates, NICU, Neurosonography, Periventricular Hemorrhagic Infarction (PHI), Neonatal Imaging, Ultrasonography.

INTRODUCTION

Neurosonogram (NSG) currently the essential diagnostic tool in modern neonatology for depicting neonatal brain normal anatomy and pathological changes in neonatal brain. Neurosonogram (NSG) is also termed as cranial ultrasound (CUS). Neurosonogram (NSG) can be used as bedside imaging tool access to the neonatal brain. It is also a reliable tool for identifying congenital and acquired anomalies of the neonate brain and frequent patterns of brain insults in preterm and terms. It almost detects most of the hemorrhagic, ischemic and cystic brain lesions, calcifications, infections and structural abnormalities in preterm and terms babies.[1]

The most frequent neonatal brain cerebral hemorrhage in preterm infants is intraventricular hemorrhage (IVH) or bleeding inside the ventricles. Although the rate of IVH for very low birth weight new-born (VLBW <1500 grams) is 25% to 30%, current assessments indicate that very premature babies are now more likely to survive thanks to advancements in specialized obstetric and neonatal intensive care over the previous few decades[2]Preterm neonates usually have a higher morbidity and mortality rates because they are highly prone to intraventricular hemorrhage (IVH) and hypoxic ischemic encephalopathy (HIE). Intraventricular hemorrhage (IVH), often referred to as subependymal or germinal matrix hemorrhage (GMH).

Intraventricular hemorrhage often presents clinically without any symptoms. According to Brustein et al., children with extremely low birth weights have a frequency of silent hemorrhages of as high as 68%.[3]By anticipating and promptly detecting IVH with cranial ultrasonography, the death rate and long-term impairments of surviving neonates can be decreased.[4]

There are risk factors, like patent ductus arteriosus, vaginal delivery, lower APGAR score, RDS, pneumothorax, hypoxia, seizures, thrombocytopenia, infection, and several others will lead to the development of IVH.[5-6]

Both the ultrasound equipment and the examiner's level of skill determine the results of CUS imaging and its diagnostic accuracy. It is a reliable examination for often occurring new-born events when carried out according to protocol. It can also be repeated as often as needed without causing any negative side effects, which aids in the appropriate follow-up of infants with neurological issues[7]

AIM AND OBJECTIVES

- The study aims to evaluate the neonatal brain hemorrhage (NBH) by transcranial ultrasound in preterm babies admitted in NICU
- To determine ultrasound characteristics of Neonatal Brain Hemorrhage (NBH) and identify the grading of NBH by transcranial ultrasound.
- To estimate the frequency of NBH and any other neonatal brain insults using TCU in NICU admitted preterm.
- To determine the risk factors associated with NBH in preterm admitted in NICU.

MATERIALS AND METHODS

Study Setting: This study was conducted in the Department of Radio-diagnosis, G.S.L Medical College, Rajamahendravaram.

Study Design: Observational study

Study Period: The study was conducted over the period of 18 months from 1st July 2022 to 1st Jan 2024 with the approval of institutional ethical committee

Study Sample: 110 preterm neonates admitted in neonatal intensive care unit were selected as per inclusion criteria and they were subjected imaging to study.

Inclusion Criteria

1. All asymptomatic and symptomatic pre term infants admitted in Neonatal intensive care unit who were referred to Department of Radiology for Trans Cranial ultrasound/ Neurosonogram(All preterm infants were subjected to screening NSG as a part of protocol)
2. Parents who gave informed consent.

Prematurity is defined as infants, who born alive before 37 week of gestation age and further subcategorized as: (1) Extremely preterm - Less than 28 week 2) very preterm - 28 - 32 week and late preterm (32 - 37 weeks)

Exclusion Criteria

1. Parents who are not willing to give consent for study.
2. All infants, who born alive after 37 weeks of gestation.

Study Procedure

After obtaining informed consent from the parents or guardians, eligible preterm neonates were identified based on the inclusion criteria. A thorough antenatal history was documented, followed by a comprehensive clinical assessment, including perinatal events.

Maternal History And Obstetric Parameters recorded included:

- Maternal age, gravida status, and history of fertility treatment.
- Gestational age, confirmed through ultrasonographic fetal biometry.
- Amniotic fluid index (AFI) assessment via ultrasound.
- Presence of chorioamnionitis.
- Mode of delivery (Caesarean section vs. vaginal delivery).
- History of preeclampsia or premature rupture of membranes.
- Administration of antenatal corticosteroids.

Neonatal And Postnatal Factors assessed were:

- Birth weight, gender, and Apgar scores at 1 and 5 minutes.
- Use of an umbilical artery or vein catheter.

All preterm neonates (gestational age <37 weeks) admitted to the NICU underwent **transcranial ultrasound (TCU)** as part of the study.

Transcranial Ultrasound (TCU) Examination:

- The procedure was explained to the parents before being performed through the fontanelles.
- The neonate was positioned in a supine posture, and a warmed ultrasound gel was applied over the anterior, mastoid, and posterior fontanelles.
- The transducer was systematically maneuvered across these fontanelles to obtain sagittal, parasagittal, and coronal views.
- Posterior fossa screening was conducted through the mastoid and posterior fontanelle.

The findings were documented regarding the **presence or absence** of **Germinal Matrix Hemorrhage (GMH), Intraventricular Hemorrhage (IVH),** and their grading using the **Volpe grading system** (Grades I–IV). If hemorrhage was present bilaterally, the higher grade was recorded. Other intracranial hemorrhages, including **subarachnoid, subdural, and epidural hemorrhages,** were excluded from the study.

Additionally, **other neonatal brain abnormalities** such as **periventricular leukomalacia, hydrocephalus, and brain malformations** were documented during the scans.

EQUIPMENT AND TECHNIQUES USED

ULTRASONOGRAPHY MACHINE

This study was performed on the PHILIPS Affinity 70G using a high-frequency linear probe (7-12 MHZ), transvaginal probe

Statistical Analysis

- Data was presented as absolute numbers, mean and standard deviation or percentages.
- Values of continuous variables were expressed as a mean ± standard deviation (SD).
- Categorical variables are represented as frequency distributions and single percentages. Categorical variables will be compared by $\chi 2$ and Fisher's exact test, where appropriate. Binary logistic regression was performed to find the predictors and ROC analysis done to find the sensitivity and specificity of the clinical and TCU diagnosis.
- All statistical tests were of two-sided. Results were considered statistically significant at a level of p less than 0.05.
- All analysis will be performed using Minitab version 19software version and MS EXCEL 2007.

RESULTS

The table presents demographic and clinical characteristics of 110 preterm infants admitted to the NICU.

Out of the 110 preterms, 15.4% preterm were less than 28 weeks, 47.2% preterm were between 28 and 32weeks, 37.2% were in between 33 and 36 weeks. The mean APGAR score at 1 minute is 6.02±1.06, while at 5 minutes, it was 7.20±0.99.

Variable	Unit	N=110 n(%)
Sex	F	52(47.27)
	M	58(52.73)
Age	Mean±SD	3.40±1.20
GA (in weeks)	Mean±sSD	31.33±2.52
GA	<28	17(15.45)
	29-32	52(47.27)
	33-36	41(37.27)
APGAR at 1 Min	Mean±SD	6.02±1.06
APGAR at 5 Min	Mean±SD	7.20±0.99
BW	Mean±SD	1.97±0.48
Gravida	G2	2(1.82)
	G2	24(21.82)
	G3	4(3.64)
	G4	4(3.64)
	PRIMI	76(69.09)
MOD	CS	50(45.45)
	NVD	60(54.55)

Correlation Of Gestational Age With IVH In Preterm Neonates.

Age(weeks)	NSG FINDINGS	
	NORMAL	IVH
<28	9	8(47%)
28-32	38	14(26.9%)
33-36	35	6(14.6%)

Presence of Neonatal Brain Hemorrhage in a Sample Population

Finding	Unit	N=110 n(%)
NBH	Absent	82(74.55)
	Present	28(25.45)

Percentage Distribution Of Trans Cranial Ultrasound Findings (TCU) In Preterm Infants Admitted To NICU

Variable	Unit	N=110	(%)
Cranial USG Findings	No	41	37.27%
	Yes	69	62.73%
Cranial USG Findings (yes=69)	CEREBRAL EDEMA	8	11.59%
	CORPUS CALLOSAL CYSTS	6	8.70%
	HYDROCEPHALUS	5	7.2%
	GMH	16	23.1%
	IVH	11	15.94%
	IVH,PVL(I)	1	1.45%
	PARTIAL AGENESIS OF CC	1	1.45%
	PVL	6	8.70%
	PVF	13	18.8%
	SOL(space occupying lesion)	1	1.45%
	SUBGALEAL HEMATOMA	1	1.45%

Comparison Of Characteristics Between Neonates With And Without Neonatal Brain Hemorrhage (NBH)

Variable	Unit	NBH (Absent) N=82	NBH(Present) N=28	P value
Sex	F	38(46.34)	14(50.00)	0.73
	M	44(53.66)	14(50.00)	
Age	mean±SD	3.44±1.31	3.28±0.85	0.48
GA (in weeks)	mean±SD	31.72±2.37	30.21±2.67	0.01
APGAR at 1 Min	mean±SD	6.30±0.88	5.21±1.13	0.001
APGAR at 5 Mn	mean±SD	7.45±0.87	6.50±1.00	0.001
BW	mean±SD	2.17±0.34	1.40±0.37	0.03
Gravida	G2	20(24.39)	6(21.43)	0.87
	G3	1(1.22)	3(10.71)	
	G4	4(4.88)	0(0.00)	
	PRIMI	57(69.51)	19(67.86)	
MOD	CS	37(45.12)	13(46.43)	0.90
	NVD	45(54.88)	15(53.57)	
POD	IB	48(58.54)	13(46.43)	0.26
	OB	34(41.46)	15(53.57)	

COMPARISON OF DEMOGRAPHIC CHARACTERISTICS, OUTCOMES, AND COMPLICATIONS ACROSS BIRTH WEIGHTS GROUPS

Variable	Unit	<1.5 (N=18)	2.5 (N=12)	1.5 to 2.5 (N=80)	P value
Sex	F	8(44.44)	6(50.00)	38(47.50)	0.95
	M	10(55.56)	6(50.00)	42(52.50)	
Age	mean±SD	3.61±1.37	3.50±1.00	3.33±1.20	0.65
GA	mean±SD	29.38±2.50	32.58±2.77	31.58±2.28	0.001
NBH	Absent	8(44.44)	11(91.66)	63(78.75)	0.03
	Present	10(55.55)	1(9.00)	17(21.25)	
Outcome	Dead	9(50.00)	1(8.33)	7(8.75)	0.01
	Dis	9(50.00)	11(91.66)	73(91.25)	
Grades	G-I	4(40.00)	1(100.0)	11(64.70)	
	G-II	3(30.00)	0(0.00)	4(23.50)	
	G-III	2(20.00)	0(0.00)	1(0.05)	
	G-IV	1(10.00)	0(0.00)	0(0.00)	
	Lt-Grade IV Rt-GRADE III	0(0.00)	0(0.00)	1(0.05)	

Results Based On Place Of Delivery Of Place Of Delivery And IVH

DELIVERED	IVH	
	NORMAL	ABNORMAL
OUTBORN	34	15
INBORN	48	13
	CHI SQUARE TEST	
	P VALUE - 0.26	
	NON SIGNIFICANT	

Distribution Of Maternal Conditions Among Preterm Infants Admitted To NICU

Clinical Findings Of Preterm Infants Admitted To NICU

Variable	Unit	N=110n(%)
AN-H O	Oligo	4(3.64)
	Anaemia	7(6.36)
	APH	5(4.55)
	Elderly	1(0.91)
	GDM	11(10.00)
	Hypo Thyroid	5(4.55)
	MSAF	7(6.36)
	Normal	39(35.45)
	Obesity	2(1.82)
	PIH	21(19.09)
	Polyhydramnios	1(0.91)
	PPROM	4(3.63)
	Short Stature. PIH	1(0.91)
	Twin geastation	1(0.91)

Comparison of Complications, Outcomes, and Mechanical Ventilation in Neonates with and without Neonatal Brain Hemorrhage (NBH)

Variable	Unit	NBH (Absent) N=82	NBH(Present) N=28	P value
Complications	APNEA	0(0.00)	1(3.57)	0.07
	HIE	12(14.63)	7(25.00)	
	NIL	62(75.60)	16(57.14)	
	PHH	0	3(10.7)	
	SEPSIS	8(9.76)	2(7.14)	
Outcomes	DEAD	10(12.67)	7(25.00)	0.10
	DIS	72(87.80)	21(75.00)	
MV	No	60(73.17)	18(64.29)	0.37
	Yes	22(26.83)	10(35.71)	

Comparison of Demographic Characteristics, Outcomes, and Complications Across Gestational Age Groups

Variable	Unit	<28	29-32	33-36	P value
Sex	F	7(41.18)	26(50.00)	19(46.34)	0.80
	M	10(58.82)	26(50.00)	22(53.66)	
Age	mean±SD	3.94±1.60	3.40±1.17	3.17±0.99	0.08
BW	mean±SD	1.57±0.61	1.90±0.39	2.25±0.37	0.001
NBH	Absent	9(52.94)	38(73.08)	35(85.37)	0.03
	Present	8(47.06)	14(26.92)	6(14.63)	
Outcomes	Dead	9(52.94)	6(11.54)	4(9.76)	0.001
	Dis	8(47.06)	46(88.46)	37(90.24)	
Complications	APNEA	0(0.00)	0(0.00)	1(2.44)	0.07
	HIE	5(29.41)	8(15.28)	6(14.63)	
	NIL	5(29.54)	41(78.85)	31(75.61)	
	PHH	2(11.76)	0(0.00)	1(2.44)	
	SEPSIS	5(29.41)	3(5.77)	2(4.88)	

SENSITIVITY AND DIAGNOSTIC ACCURACY OF TCU IN DETECTING NBH IN COMAPRISION TO PRESUMED CLINICAL DIAGNOSIS

Variable	Unit	NBH Absent	Present	P value
TCU diagnosis	Negative	77(93.90)	1(3.57)	0.001
	Positive	5(6.10)	27(96.43)	
Clinical diagnosis	Negative	53(64.63)	5(17.86)	0.001
	Positive	29(35.37)	23(82.14)	

Performance Comparison of Clinician Diagnosis and Transcranial Ultrasound (TCU) Diagnosis for Neonatal brain haemorrhage(NBH)

Test Result Variable(s)	Area	Sensitivity	specificity	P value	Asymptotic 95% Confidence Interval	
					Lower Bound	Upper Bound
Clinical diagnosis NBW	.734	821	646	000	630	838
TCU diagnosis of NBW	946	964	927	000	894	997

DISCUSSION

In modern day neonatology, trans cranial ultrasound(TCU) , also known as neurosonogram(NSG) is used as new reliable diagnostic tool to know anatomical abnormalities in neonatal brain. Neurosonogram (NSG) is the only method, which can be used for bed side examination for imaging purpose.

Usually all neonates have sutures and fontanelles they will be open, and used as acoustic windows for imaging brain.[1] Neurosonogram plays an important role in assessment of early diagnosis , management and neurological outcome.

GMH-IVH usually occurs in the 1st week of life and 97% of cases are detected by the transcranial US [8]. It is most frequent and feared complication in the preterm and its risk decreases significantly after the 32 weeks of gestation. It is rarely observed after 32 weeks of gestation.

Time Of Onset

Almost it occurs in the first week of life. The development of GMH-IVH occurs on the first day of birth in at least 50% of affected infants, and within 72 hours(3 days), approx. 90% of the lesions are found. [8]. Moving up to a higher grade happens quickly in one to three days. Regardless of gestational age, it is remarkable that premature children are largely resistant to haemorrhage beyond the first week of life. In our study, The mean age of the infants was 3.40 days with a standard deviation of 1.2 days.

Patho Physiology

GMH-IVH have multiple pathophysiology. The most significant individual independent risk factor is gestational age. About 25 weeks of gestation is when the germinal matrix achieves its maximal volume. [9]

Perinatal hypoxic-ischaemia, inflammation, cardiovascular instability, severe respiratory disease, pneumothorax, inotropic usage, and many other clinical disorders have been linked to GMH-IVH. They all cause variations in CBF, which raises the possibility of bleeding from weak venules.

Clinical Presentation

Many of them were clinically silent and detected on routine USG examination. In the hours to days following the IVH, some babies exhibit mild decrease in the degree of consciousness, abnormal limb movement, tone, and eye movement. Anaemia can coexist with GMH-IVH and PHI. Stupor, "decerebrate" posturing, generalized tonic seizures, and hypotonia may occur in babies with significant haemorrhage.[1]

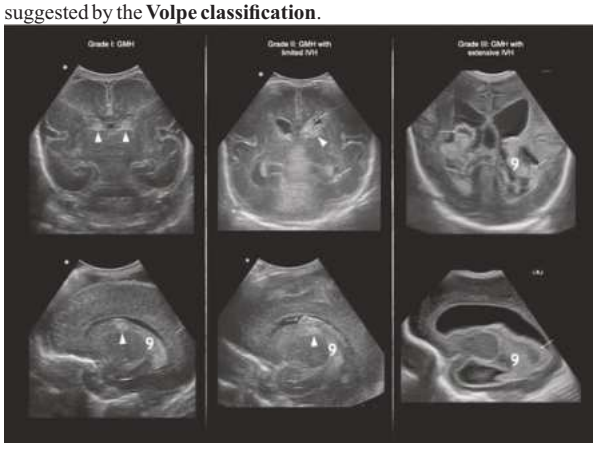
Grading Of Germinal Matrix Hemorrhage – Intraventricular Hemorrhage (GMH-IVH)

The **Papile grading system**, introduced in 1978 by **Papile et al [10]**., remains one of the most widely used classification methods for **GMH-IVH**, despite the development of several other ultrasound-based

grading systems. This classification helps in assessing the severity of hemorrhage and predicting potential complications.

- **Grade I:** Hemorrhage confined to the germinal matrix (subependymal bleeding).
- **Grade II:** Intraventricular hemorrhage extending into the ventricular system but filling **less than 50%** of the ventricular lumen, with no associated ventricular dilation.
- **Grade III:** Intraventricular hemorrhage occupying **more than 50%** of the ventricular lumen, accompanied by **ventriculomegaly (ventricular dilation).**
- **Grade IV:** Intraventricular hemorrhage with **parenchymal extension**, leading to brain tissue involvement.

However, the **previously termed Grade IV hemorrhage** is now recognized as **Periventricular Hemorrhagic Venous Infarction (PHI)** rather than true parenchymal extension due to direct rupture. PHI can be associated with **any grade of IVH**, prompting the use of a three-tiered grading system with **PHI classified separately**, as suggested by the **Volpe classification**.



TCU grading of GMH-IVH, where arrowheads indicate GMH, and arrows point to clots within the ventricular cavity

During the **first week of life**, **cranial ultrasound (CUS)** typically reveals **subependymal hyperechoic thickening** when **germinal matrix hemorrhage (GMH)** is present. This finding may persist for weeks. Careful **coronal and para-sagittal scans** are essential to distinguish small **GMH** from the adjacent **hyperechoic choroid plexus**, which varies in thickness along the **caudo-thalamic groove**.

Complications

- **Periventricular Hemorrhagic Infarction (PHI):** Appears as a **triangular, fan-shaped echogenicity** in the periventricular white matter. Initially separate from the ventricle wall, it may merge with **GMH-IVH**, forming a **large hyperechoic lesion**.
- **Post-Hemorrhagic Ventricular Dilatation:** Seen in **severe IVH**, characterized by **ballooning of frontal horns** and **dilation of lateral and third ventricles** in the **midsagittal plane**.

This study aimed to assess the **effectiveness of Neurosonography (NSG/TCU)** as a **first-line imaging tool** for detecting **neonatal brain hemorrhage (NBH)**. It serves as an **effective screening method** for ruling out **severe intracranial pathologies**, especially in preterm neonates.

Methodology

A hospital-based **observational study** was conducted at **GSL Medical College, Rajahmundry**, over **18 months (July 2022 – Jan 2024)**. A total of **110 preterm neonates** admitted to the **NICU** underwent **transcranial ultrasound (TCU)** to evaluate NBH. Of these, **52.73% were male and 47.27% were female**. The mean **gestational age (GA) at birth** was **31.33 ± 2.52 weeks**, with the majority (47.27%) being between **29–32 weeks GA**. The mean age at the time of ultrasound was **3.40 ± 1.20 days**.

Incidence of NBH and Other TCU Abnormalities

- **62.7% of preterm neonates** had abnormalities on transcranial ultrasound (TCU), with **25.45% showing NBH**.
- Among 76 primigravida mothers, **19 neonates (25%) had NBH**, while **9 neonates (36%)** from 25 multigravida mothers had NBH (p=0.08).
- No significant **gender difference** was observed in NBH incidence (**p=0.73**).

Distribution of TCU Findings

- The most **common abnormalities** were **GMH (23.1%)**, **periventricular flare (18.8%)**, and **IVH (15.94%)**.
- Other findings included **cerebral edema (11.59%)**, **PVL (8.70%)**, **hydrocephalus (7.2%)**, and **subgaleal hematoma (1.45%)**.

Timing of NBH Detection

- **83% of NBH cases** were detected **within the first 72 hours of life**, while **17%** were diagnosed later.

Grading And Distribution Of IVH

- **57.1% of NBH cases were Grade I**, followed by **25% (Grade II), 10.7% (Grade III), and 3.6% (Grade IV)**.
- One case showed **Grade IV on one side and Grade III on the other**.

Age-Wise Distribution of IVH

- **47% of neonates <28 weeks GA** had IVH, compared to **26.9% (28–32 weeks)** and **14.6% (33–36 weeks)** (p=0.03).
- **73.9% of preterms <32 weeks GA** had IVH, with incidence **dropping to 14.6% after 32 weeks**.

IVH and Birth Weight

- **NBH incidence was inversely related to birth weight**: **16.3% in neonates <1500g, 72.7% in 1500–2500g, and 10.1% in >2500g**.

Ventriculomegaly and IVH

- **11 neonates had ventriculomegaly**, with **54.5% associated with IVH** and 45.5% due to other conditions like **aqueductal stenosis**.

TCU Accuracy and Clinical Correlation

- **75% of preterm infants requiring mechanical ventilation** had **IVH**, reinforcing the association between **IVH, low APGAR scores, and respiratory distress**.

SUMMARY AND CONCLUSION

- The incidence of **transcranial ultrasound (TCU) abnormalities** in preterm neonates was **62.7%**.
- **Neonatal Brain Hemorrhage (NBH)** was observed in **25.45%** (28 out of 110) of preterms.
- There was no significant **gender correlation** with NBH incidence.
- **Gestational age and NBH** showed a statistically significant correlation, with **47% of neonates <28 weeks** developing NBH, compared to **26.9% in 28-32 weeks** and **14.6% in 33-36 weeks**.
- **GMH (23.1%)**, **periventricular flare (18.8%)**, and **IVH (15.94%)** were the most common ultrasound findings.
- **Lower birth weight was significantly associated** with NBH, with **55.5% of very low birth weight (VLBW) neonates** affected.
- **APGAR scores** at 1 and 5 minutes were significantly lower in neonates with NBH.
- Clinical features such as **seizures (15.38%), tone abnormalities (17.31%), and respiratory distress (15.38%)** were frequently observed.
- NBH cases had **higher rates of complications** such as **HIE (25%), PHH (10.7%), and sepsis (7.14%)**, though **mortality and mechanical ventilation rates were not significantly impacted**.
- **3% of NBH cases** were detected **within 72 hours of life**, and the overall **mortality rate among preterm neonates with NBH was 25%**.

Neurosonography remains the **most effective, non-invasive, and bedside imaging technique** for detecting **neonatal brain hemorrhage (NBH) and associated conditions**. It provides **high specificity and sensitivity** in detecting **GMH and periventricular leukomalacia (PVL)**, aiding in grading and prognosis. While **CT remains the gold standard**, practical limitations make **transcranial ultrasound (TCU) the preferred primary modality in NICUs**.

This study confirms that **gestational age, low birth weight, and APGAR scores** significantly correlate with NBH risk. **High-resolution ultrasound should be used as the first-line imaging tool** for early diagnosis and clinical decision-making in neonates at risk.

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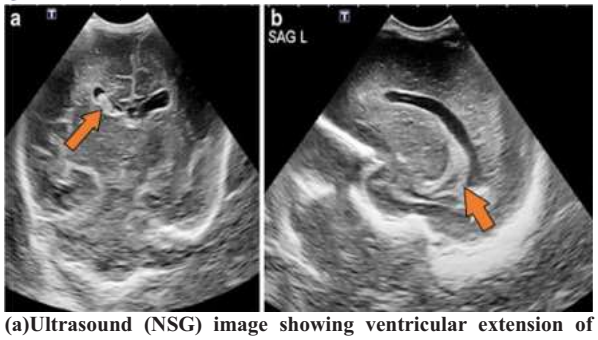
REPRESENTATIVE CASES

GRADE I IVH

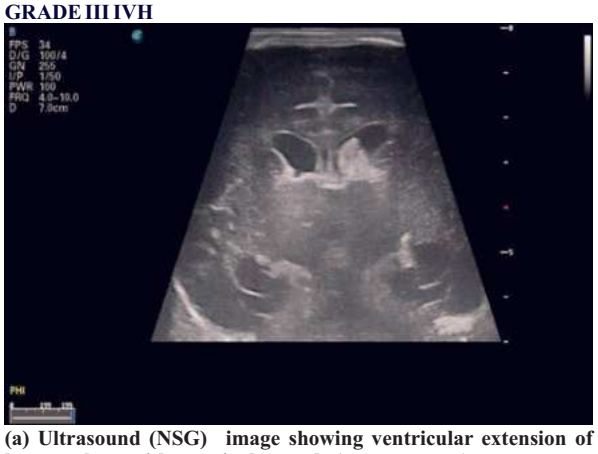
Ultrasound (NSG) coronal plane image showing germinal matrix hemorrhage in the left caudo-thalamic groove

GRADE II IVH



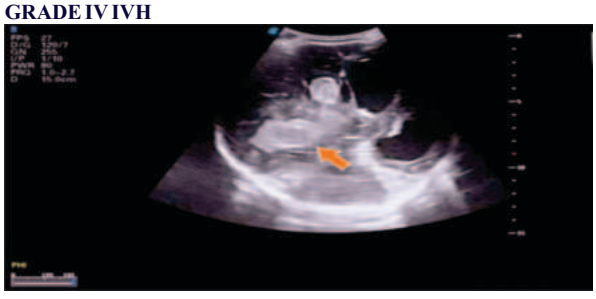
(a)Ultrasound (NSG) image showing ventricular extension of hemorrhage with no ventriculomegaly (white arrow heads)

GRADE III IVH



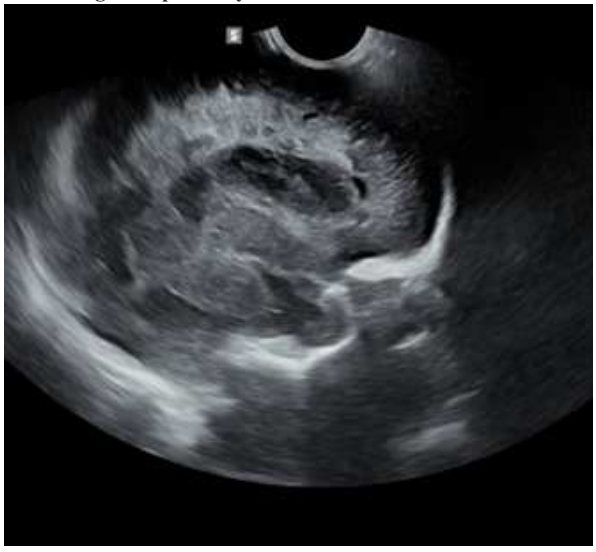
(a) Ultrasound (NSG) image showing ventricular extension of haemorrhage with ventriculomegaly (orange arrow)

GRADE IV IVH

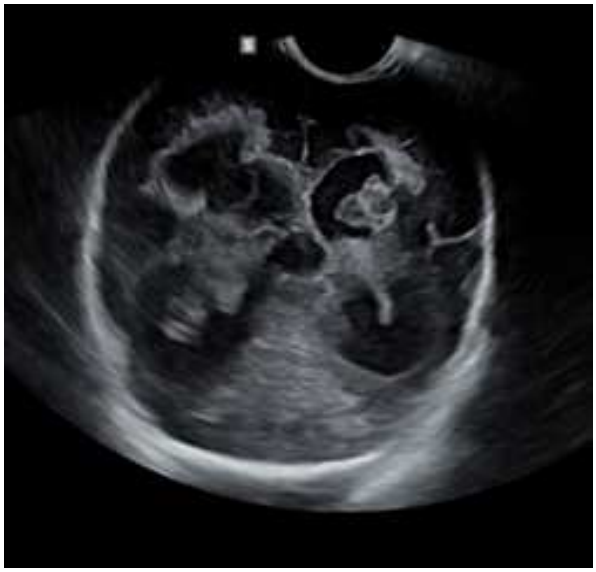


Ultrasound (NSG) image showing extension of IVH into the cerebral parenchyma (orange arrow)

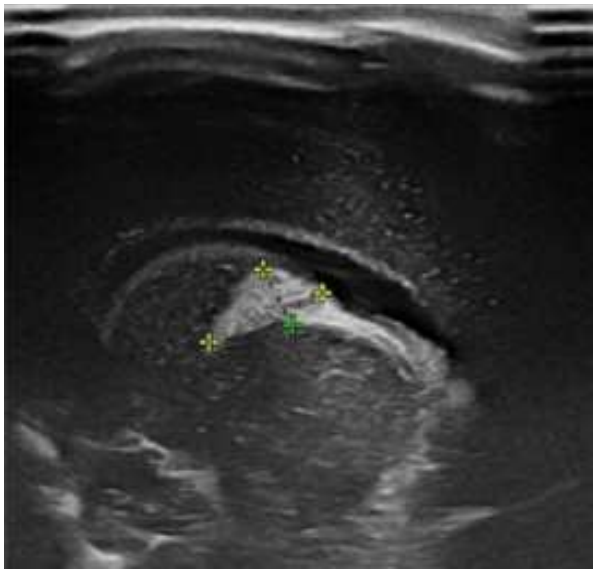
Ultrasound (NSG) coronal plane image showing intraventricular hemorrhage with parenchymal extension



Ultrasound image showing parenchymal extension of IVH along with ventriculomegaly- Grade IV



21 week old preterm showing germinal matrix hemorrhage (GMH) in the caudo thalamic groove.



Ultrasound Image Showing Ventriculomegaly Associated With Grade IV Hemorrhage

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