

A Study On Cranial Ultrasound Examination In High Risk Term And Preterm Neonates Admitted In Rims Hospital, Imphal.

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Abstract: Objectives: To determine the importance of cranial ultrasound as an investigatory modality for high risk term and preterm neonates. To determine the role of cranial ultrasound in evaluation of brain injuries in high risk term and preterm neonates.

Materials And Methods: The cross sectional study was conducted in the Department of Paediatrics in Regional Institute of Medical Sciences, Imphal in collaboration with Department of Radio-Diagnosis, Regional Institute of Medical Sciences, Imphal after obtaining informed consent, 72 high risk term and preterm neonates admitted in RIMS hospital based on inclusion criteria. History and clinical examination was followed by appropriate investigations were done. These high risk term and preterm neonates were subjected to cranial ultrasound on selected days and different patterns of morphology abnormalities were noted. Chi-square test was employed to test the association and p-value of <0.05 was taken as significant.

Results: The incidence of cranial ultrasound abnormalities in high-risk term and preterm neonates is 18.1% (13 out of 72). Of this Intraventricular hemorrhage (IVH) was seen in 5 cases (6.9%), cerebral oedema (4.2%), thalamic hyperechogenicity (2.8%), corpus callosum agenesis (1.4%) and germinal matrix cyst (2.8%). Of the 13 (18.1%) high risk term and preterm neonates with abnormal findings on cranial ultrasound, 53.8% are preterm and 46.2% are term neonates.

Conclusion: This study highlights the convenience and diagnostic efficiency of cranial ultrasound in detecting intracranial lesion in high-risk term and preterm neonates. It also emphasis cranial ultrasound is a sensitive non-invasive initial investigation for detection of the various brain lesions in the high risk term and preterm neonates, most common intracranial lesion noted in high risk neonates is intraventricular hemorrhage, cerebral oedema, thalamic echogenicity, germinal matrix cyst. Emphasizes its use as an initial investigatory modality for high risk term and preterm neonates.

Key words: Cranial ultrasound, High risk neonates, Intraventricular hemorrhage, Birth asphyxia.

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I. Introduction

The newborn brain is vulnerable to injury from many causes like preterm delivery, hypoxia, trauma etc. resulting in significant mortality and morbidity. Cranial ultrasonography has become an essential diagnostic tool in modern neonatology for depicting normal anatomy and pathological changes in neonatal brain. The high risk infant is a newborn, regardless of gestational age or birth weight, who has greater than average chance of morbidity or mortality because of conditions or circumstances superimposed on the normal course of events associated with birth and adjustment to extra uterine causes.

The high-risk period begins at the time of viability (the gestational age at which survival outside the uterus is believed to be possible, or as early as 23 weeks of gestation) up to 28 days after birth. That includes threats to life and health that occur during the prenatal, perinatal, and postnatal periods. Cranial ultrasound plays an important role in assessing neurological prognosis of these high risk neonates.

Spontaneous hemorrhage in and around the cerebral ventricle is a phenomenon that occurs in premature neonates and is now being increasingly observed in the high risk term neonates.

Cranial USG detects most of the hemorrhagic, ischemic and cystic brain lesions as well as calcifications and major structural abnormalities in high risk neonates. It's a reliable tool for detecting congenital and acquired abnormalities of the prenatal brain and most frequent patterns of brain injury in preterm and full term neonate.³In high risk neonates vulnerable for intra-ventricular haemorrhage (IVH) and periventricular leucomalacia (PVL) cranial ultrasound is done on day 2 of life.

Incidence of IVH is approximately 40-45% in newborns weight less than 1500 g or born before 35 weeks of gestational age. It is due to rupture of the fragile capillaries of the germinal matrix. Cranial ultrasounds are widely used to identify neonates at risk for brain injury and subsequent neurodevelopmental defects most commonly as a consequence of severe intraventricular hemorrhage (IVH). Early identification of intracranial lesion may facilitate future preventive strategies in preterm infant at highest risk for the subsequent development of this lesion.

Cranial ultrasound is cheap, easy to perform, non-invasive and easily repeatable and its portability allows for bedside evaluation in gravely ill infants. Our study evaluates the importance of cranial ultrasound as an early investigatory modality in high risk neonates.²⁸

AIMS AND OBJECTS: To determine the importance of cranial ultrasound as an investigatory modality for high risk term and preterm neonates. To determine the role of cranial ultrasound in evaluation of brain injuries in high risk term and preterm neonates.

II. Materials And Methods

This was a hospital based cross sectional study conducted in The study was conducted in the Department of Paediatrics in Regional Institute of Medical Sciences, Imphal in collaboration with Department of Radio-Diagnosis, Regional Institute of Medical Sciences, Imphal. The study was conducted between September 2016 to August 2018 over a period of two years.

Study population: The study population was high risk term and preterm neonates (<28days) admitted in RIMS hospital, Imphal.

Inclusion criteria: Following criteria for high risk term and preterm neonates was included in study: Neonatal convulsions, birth asphyxia & hypoxic ischemic encephalopathy (HIE) Respiratory distress, meconium aspiration syndrome, neonatal sepsis, neonates born out of traumatic/instrumental labour, congenital malformation of CNS & neural tube defects, neonates born out of high risk pregnancy (GDM, PIH, PROM, APH etc.), intrauterine growth restriction neonates

Exclusion criteria: Transient tachypnea of newborn, newborn > 28 days of life, impending respiratory failure, neonates with congenital heart disease and any other heart disease, neonates which were incompletely examined due to early discharge and died during the study period babies with inborn error of metabolism, very sick newborn needing mechanical ventilation for more than 7 days, recognized major congenital anomalies, central nervous system injury, parents not willing to give consent.

Sample size: The sample size of this study group was comprised of total 72 high risk term and preterm neonates <28 days of life.

Sampling procedure: Consecutive sampling

Study variables:

- Demographics profiles - Age, gender, birth weight, gestational age.
- Clinical features of high risk neonates that was studied:
- History of difficulty feeding
- Muscle tone/cry/reflex
- Pallor/icterus/cyanosis
- History of convulsions/seizures
- Skin manifestation like petechial, purpura etc.
- Respiratory rate and heart rate

Outcome variables: Cranial ultrasound examinations in high risk term and preterm neonates allows initial diagnosis of intraventricular hemorrhage (IVH)/germinal matrix hemorrhage (GMH), cerebral oedema, subependymal cyst, thalamus hyperechogenicity, periventricular leukomalacia, and corpus callosum agenesis.

III. Results

A cross-sectional study was conducted from September 2016 to August 2018 in the Department of Paediatrics and Radio-Diagnosis, Regional Institute of Medical Sciences, Imphal (Manipur). Total 72 high risk term and preterm neonates were selected for this study to determine the role of cranial ultrasound in evaluation of brain injuries and to determine the importance of cranial ultrasound as an investigatory modality.

Table 1: Age distribution of respondents

Age in hours	Frequency	Percentage
Upto 24 hours	17	23.6
>24-72 hours	34	47.2
>72 hours	21	29.2
Total	72	100.0
Mean ± SD	33.07±17.65	

Table 1 shows that majority of the respondents were 24-72 hours (34 out of 72, 47.2%) at the time of presentation followed by >72 hours (21 out of 72, 29.2%) and upto 24 hours (17 out of 72, 23.6%) of cases. Mean age was 33 hours with a standard deviation of 17 hours.

Table 2: Distribution of respondents by sex

Sex	Frequency	Percentage
Male	50	69.4
Female	22	30.6
Total	72	100.0

Table 3: Distribution of respondents by religion

Religion	Frequency	Percentage
Hindu	40	55.5
Muslim	21	29.2
Christian	11	15.3
Total	72	100.0

Table 4: Distribution of respondents by gestational age

Gestational age	Frequency	Percentage
Preterm	45	62.5
Term	27	37.5
Total	72	100.0

Table 4 shows that most of the respondents were preterm in 61.1% of cases and term in 38.9% of cases.

Table 5: Distribution of respondents by birth weight

Birth weight in kg	Frequency	Percentage
≤1.5	10	13.8
>1.5-<2.5	32	44.4
≥2.5	30	41.8
Total	72	100.0

Table 5 shows that majority of the respondents were in the weight group >1.5-<2.5 kg in 44.4% (32 out of 72) followed by >2.5 kg in 41.8 % (30 out of 72). Less than or equal to 1.5 kg was seen in few cases in 13.8% (10 out of 72).

Table 6: Distribution of respondents by clinical examination finding

Clinical examination	Frequency	Percentage
Poor activity	65	90.2
Poor/abnormal tone	43	59.7
Abnormal cry	32	44.4
Presence of icterus	27	37.5
Tachycardia	19	26.4
Poor reflex	10	13.8
Presence of cyanosis	16	22.2
Tachypnea	13	18.0
Abnormal temperature	9	12.5
Abnormal posture	8	11.1
Presence of pallor	5	6.9

Table 6 shows that most of the respondents had poor activity in 90.2% of cases at the time of presentation. Poor tone was found in 59.7% of cases, abnormal cry in 44.4% of cases, presence of icterus in 37.5% of cases, tachycardia in 26.4% of cases, poor reflex in 13.8% of cases, cyanosis in 22.2% of cases, tachypnea in 18% of cases, abnormal temperature in 12.5% of cases, abnormal posture in 11.1% of cases and pallor in 6.9% of cases.

Table 7: Distribution of respondents by clinical diagnosis

Diagnosis	Frequency	Percentage
Birth asphyxia	21	29.2
Neonatal sepsis	15	20.8
Neonatal seizure	11	15.3
Meconium aspiration syndrome (MAS)	10	13.9
Respiratory distress syndrome (RDS)	10	13.9
Birth trauma	5	6.9

Table 7 shows that birth asphyxia was the most common presented diagnosis in 29.2% (21 out of 72) of cases followed by in neonatal sepsis in 20.8% (12 out of 72), neonatal seizure (15.35%, 11 out of 72), meconium aspiration syndrome (13.9%), respiratory distress syndrome (13.9%) and birth trauma (6.9%).

Table 8: Distribution of respondents by antenatal history

Antenatal history	Frequency	Percentage
No	26	36.2
Yes	46	63.8
Premature rupture of membrane (PROM)	12	16.6
Pregnancy induced hypertension (PIH)	11	15.3
Antepartum hemorrhage (APH)	9	12.5
Antenatal infections	9	12.5
Multiple births	5	6.9

Table 8 shows that positive antenatal history was present in 63.8% and PROM was the most common antenatal history found in 16.6% followed by PIH (15.3%), APH (12.5%), antenatal infections (12.5%) and multiple births (6.9%).

Table 9: Distribution of respondents by cranial ultrasound findings

USG findings	Frequency	Percentage
Normal	59	81.9
Abnormal	13	18.1
Intraventricular hemorrhage (IVH)/Germinal matrix hemorrhage (GMH)	5	6.9
Cerebral oedema	3	4.2
Thalamic hyperechogenicity	2	2.8
Corpus callosum agenesis	1	1.4
Germinal matrix cyst	2	2.8
Periventricular leukomalacia (PVL)	0.0	0.0
Total	72	100.0

Table 9 shows that abnormal cranial ultrasound finding was found in 18.1% (13 out of 72). Intraventricular hemorrhage (IVH) was seen in 5 cases (6.9%), cerebral oedema (4.2%), thalamic hyperechogenicity (2.8%), corpus callosum agenesis (1.4%) and germinal matrix cyst (2.8%).

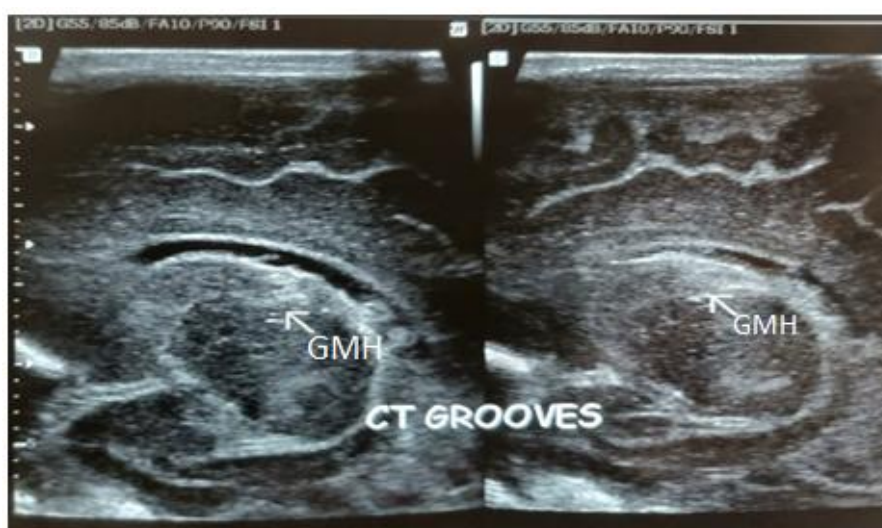


Figure 10: USG cranium showing germinal matrix hemorrhage (GMH) grade I

Table 10: Distribution of abnormal cranial ultrasound with age

Age in hours	Frequency	Percentage
Upto 24 hours	3	23.0
>24-72 hours	6	46.2
>72 hours	4	30.8
Total	13	100.0

Table 11: Relation between abnormal cranial ultrasound with gender

USG findings	Male n(%)	Female n(%)	Total n(%)	Chi-square test
Abnormal	10(76.9)	3(23.1)	13(100.0)	Value=0.418 p=0.517
Normal	40(67.8)	19(32.2)	59(100.0)	
Total	50(69.4)	22(30.6)	72(100.0)	

Table 11 shows that abnormal cranial ultrasound was more in males than females (76.9% vs 23.1%) but the finding was statistically insignificant ($p>0.05$).

Table 12: Relation between abnormal cranial ultrasound with antenatal history

Antenatal history	Cranial USG		Total n(%)	Chi-square test p-value
	Abnormal n(%)	Normal n(%)		
No*	2(15.4)	24(40.6)	26(36.2)	Value=2.945 p=0.08
Yes*	11(84.6)	35(59.4)	46(63.8)	
Premature rupture of membrane (PROM)	1(7.6)	11(18.6)	12(16.6)	
Pregnancy induced hypertension (PIH)	3(23.0)	8(13.6)	11(15.3)	
Antepartum hemorrhage (APH)	4(30.8)	5(8.4)	9(12.5)	
Antenatal infections	2(15.4)	7(11.8)	9(12.5)	
Multiple births	1(7.6)	4(6.8)	5(6.9)	
Total	13(18.1)	59(81.9)	72(100.0)	

*rows were analyzed

Table 12 shows that positive antenatal history was more in abnormal cranial ultrasound but the finding was statistically insignificant. Among the antenatal history APH was the most common in 30% of cases.

Table 13: Relation between abnormal cranial ultrasound with gestational age

USG findings	Preterm n(%)	Term n(%)	Total n(%)
Normal*	38(66.2)	21(33.8)	59(100.0)
Abnormal*	7(53.8)	6(46.2)	13(100.0)
Intraventricular hemorrhage (IVH)/Germinal matrix hemorrhage (GMH)	4(80.0)	1(20.0)	5(100.0)
Cerebral oedema	2(66.6)	1(33.4)	3(100.0)
Thalamic hyperechogenicity	1(50.0)	1(50.0)	2(100.0)
Germinal matrix cyst	0(0.0)	2(100.0)	2(100.0)
Corpus callosum agenesis	0(0.0)	1(100.0)	1(100.0)
Periventricular leukomalacia (PVL)	0(0.0)	0(0.0)	0(0.0)
Total	45(62.5)	27(37.5)	72(100.0)

Chi-square test performed for *rows and was not significant. (chi-square value=1.49, p=0.221): Table 13 above shows that abnormal cranial ultrasound was more in preterm than term (53.8% vs. 46.2%). Intraventricular hemorrhage (IVH)/germinal matrix hemorrhage (GMH) and cerebral oedema was more in preterm than term neonates and germinal matrix cyst were more in term neonates except thalamic hyperechogenicity which occurred in equal numbers.

Table 14: Relation between abnormal cranial ultrasound and birth weight

USG findings	≤1.5 kg n(%)	>1.5-<2.5 kg n(%)	≥2.5 n(%)	Total n(%)
Normal	7(70.0)	27(81.2)	25(82.0)	59(81.9)
Abnormal	3(30.0)	5(18.8)	5(18.0)	13(18.1)
Intraventricular hemorrhage/Germinal matrix haemorrhage	3(30.0)	2(6.2)	0(0.0)	5(6.9)
Cerebral oedema	0(0.0)	1(3.1)	2(7.2)	3(4.2)
Thalamic hyperechogenicity	0(0.0)	1(3.1)	1(3.6)	2(2.7)
Germinal matrix cyst	0(0.0)	1(3.1)	1(3.6)	2(2.7)
Corpus callosum agenesis	0(0.0)	0(0.0)	1(3.6)	1(1.3)

Periventricular leukomalacia (PVL)	0(0.0)	0(0.0)	0(0.0)	0(0.0)
Total	10(100.0)	32(100.0)	30(100.0)	72(100.0)

Chi-square test not applicable

Table 14 shows that three cases of birth weight ≤ 1.5 kg were abnormal (30%) and all had intraventricular hemorrhage (IVH)/germinal matrix hemorrhage (GMH) by cranial ultrasound. In >1.5 - <2.5 kg group 18.8% were abnormal and hemorrhage was the most common (6.2%) and oedema, hyper echogenicity and cyst were found in equal numbers (3.1%). Abnormal cranial ultrasound was found in 18.0% in birth weight ≥ 2.5 kg and the most common abnormality was cerebral oedema.

IV. Discussion

In this study majority of the patients were in 24-72 hours of life (47.2%) at the time of presentation for cranial ultrasound followed by >72 hours of life (29.2%) and upto 24 hours of life in (23.6%) of cases. Mean age was 33 hours with a standard deviation of 17 hours. This finding was consistent with the finding by Prithviraj D et al⁴⁹ where majority (32%) of them were in >24 -72 hours at the time of cranial ultrasound followed by >72 hours (25%) and <24 hours in 16% of high risk neonates.

In this study male constituted majority of the respondents in 69.4% of cases. Male predominance was also seen in the study conducted by Jernail SB et al⁵⁵ where male constituted 54% of cases. This finding of male predominance was also found in the study by Jha R et al⁵⁸, Islam MZ et al⁶⁰ and Nagaraj N et al.⁵⁶

In this study most of the respondents were preterm in 62.5%. This finding was consistent with the finding by Prithviraj D et al⁴⁹ where 63% of the high risk neonates were preterm. Same was noted in the study conducted by Prasad SB et al⁵⁹ and Nagaraj N et al⁵⁶ where preterm prevalence was 63.4% and 62% respectively.

In this study majority of the respondents were in the weight group >1.5 - <2.5 kg in 44.4% followed by >2.5 kg in 41.8%. Less than or equal to 1.5 kg was seen in few cases in 13.8%. Most of the respondents had poor activity in 90.2% of cases. Poor tone was found in 59.7% of cases, abnormal cry in 44.4% of cases, presence of icterus in 37.5% of cases, etc. Birth asphyxia was the most common presented diagnosis in 29.2% of cases followed by in neonatal sepsis in 20.8%, convulsion (15.35), meconium stained (13.9%), respiratory distress (13.9%) and birth trauma (6.9%). Positive antenatal history was present in 63.8% of cases and premature rupture of membrane (PROM) was the most common antenatal history found in 16.6% followed by PIH (15.3%), APH (12.5%), antenatal infections (12.5%) and multiple births (6.9%).

In this study abnormal cranial ultrasound was found in 18.1% of high-risk neonates. This finding was consistent with the study conducted by Shankar P et al⁴⁷ and Jha R et al⁵⁸ where abnormal cranial ultrasound was noted in 24% and 25.4% respectively of high-risk neonates. But in the study by Prithviraj D et al⁴⁹ the incidence of abnormal cranial ultrasound in high risk neonates was 31%. Study by Nagaraj N et al⁵⁶ had prevalence of 38%. This might be because their cranial ultrasound was only in critically ill neonates in NICU. In some studies, it was as high as 45.6% and 24% in Islam MZ et al⁶⁰ and Susmita G et al⁵⁴ respectively. These high incidence studies were mostly done on preterm high risk neonates.

Authors	Prevalence/incidence of abnormal cranial ultrasound Percentage
This study	18.1%
Shankar P et al ⁴⁷	24%
Jha R et al ⁵⁸	25.4%
Prithviraj D et al ⁴⁹	31%
Nagaraj N ⁵⁶	38%
Islam MZ et al ⁶⁰	45.6%
Susmita G et al ⁵⁴	24%

Intraventricular hemorrhage was seen in 5 cases (6.9% of total), cerebral oedema(4.2%), thalamic hyperechogenicity (2.8%), corpus callosum agenesis (1.4%) and germinal matrix cyst (2.8%). So, intraventricular hemorrhage was the most common cranial ultrasound finding in the study conducted by Shankar P et al⁴⁷ in 10% of cases and in the same study cerebral oedema was found in 4% of cases which was consistent with this study. But thalamic hyperechogenicity was found in 7% of cases which was higher than this study i.e. 2.8%. Similar finding was also noted in the study by Prithviraj D et al⁴⁹ where intracranial bleed was the most common cranial ultrasound abnormality in 13% of cases followed by cerebral oedema in 8% of cases and thalamic hyperechogenicity in 5% of cases. And also in the study by Susmita G et al⁵⁴, intracranial hemorrhage (ICH) was found in 24 babies (24%), cerebral oedema in 17 babies (17%), various degrees of dilatation of ventricles in 5 babies (5%). The most common abnormality found on neurosonogram was germinal-matrix hemorrhage (GMH) in the study by Kavya MK et al.⁵² But in the study conducted by Jha R et al⁵⁸ most common cranial ultrasound abnormality was periventricular hyperechogenicity (10.6%), intracranial hemorrhage (8%),

periventricular leukomalacia (4%) and cerebral edema (2.4%). In the study conducted by Islam MZ et al⁶⁰ 22 (21.4%) had cerebral edema, 17 (16.5%) had IVH and 8 (7.8%) had ventricular dilatation. In this study abnormal cranial ultrasound was more in males than females (20% vs. 13.6%) but the finding was statistically insignificant.

There was no significant correlation of incidence of abnormal cranial ultrasound findings in male and female in the study conducted by Nagaraj N et al⁵⁶ which was almost same as noted in this study. But in the study by Jha R et al⁵⁸ where incidence of abnormal cranial ultrasound was significantly higher in males compared to females.

Positive antenatal history was more in abnormal cranial ultrasound but the finding was statistically insignificant. Among the antenatal history antepartum hemorrhage (APH) was the most common in 30% of cases. Among the perinatal risk factors, correlation of abnormal cranial ultrasound with APH and birth asphyxia was statistically significant. This finding in Jha R et al⁵⁸ study was consistent with this study. Abnormal cranial ultrasound was more in preterm than term (53.8% vs. 46.2%) in this study. In the study by Prithviraj D et al⁴⁹ abnormal cranial ultrasound was found in 72% of cases which was consistent with this study.

In this study intraventricular bleed and cerebral edema was more in preterm than term and others were more in term except thalamic hyperechogenicity which occurred in equal numbers. In the study by Prithviraj D et al⁴⁹ majority (46%) of the intracranial bleed were in preterm but cerebral edema was found more in term patients and also thalamic hyperechogenicity was found more in term which was contradictory to this present study. Of the neonates with gestational age <32 weeks abnormal findings on cranial ultrasound, 41.2% had germinal matrix hemorrhage (GMH) in Nagaraj N et al⁵⁶ study which was in concordance with this study. Carson SC et al³⁴ studied on 35 preterm neonates, with serial cranial ultrasonography out of which 20 preterm shows intracranial hemorrhages (ICH).

In this study three cases of birth weight ≤ 1.5 kg were abnormal (30%) and all had intraventricular hemorrhage (IVH)/germinal matrix hemorrhage (GMH) by cranial ultrasound. 18.8% were abnormal and intraventricular hemorrhage was the most common (6.2%). In birth weight >1.5 - <2.5 kg group cerebral oedema, hyper echogenicity and cyst were found in equal numbers (3.1%). Abnormal cranial ultrasound was found in 18.0% in birth weight ≥ 2.5 kg and the most common abnormality was cerebral oedema. This finding was in concordance with the study by Agha M et al⁶¹ where intraventricular hemorrhage was significantly high in preterm neonates with birth weight <1.5 kg. Incidence of intracranial hemorrhage (ICH) among low birth weight new-borns was 29% in the study by Rajesh D et al⁵¹ and among different types of intracranial hemorrhage, intraventricular hemorrhage (IVH) comprises the larger part in their study (68.1%) which was in concordance with this study as all cranial hemorrhage was this type only. Moreover, there was a direct association between birth weight and ICH and significant ($p=0.03$) association was found especially in babies below 1 kg in that study. In the study conducted by Jha R et al⁵⁸ 68.4% of the neonates who had birth weight <1.2 kg had abnormal cranial ultrasound. In the study by Prasad SB et al⁵⁹ intracranial hemorrhage was the most common in neonates <2 kg in about 50% of cases and in birth weight between 2-2.5 kg cyst was the most common finding.

V. Conclusion

This study highlights the convenience and diagnostic efficiency of cranial ultrasound in high-risk neonates. Cranial ultrasound is a sensitive non-invasive initial investigation for detection of the various brain lesions in the high risk term and preterm neonates.

Most common intracranial lesion noted in high risk neonates is intraventricular hemorrhage followed by cerebral oedema, thalamic echogenicity, germinal matrix cyst. This study concludes that cranial ultrasound is critical as an initial investigatory modality in high risk term and preterm neonates and effectively documents morphology of brain damage.

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