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Cranial ultrasound in critically ill neonates

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Abstract

Introduction: Cranial ultrasound has been widely used in neonates for early detection of intra-cranial abnormalities like intra-ventricular haemorrhage, cerebral oedema, any structural anomalies etc. It is a convenient, non-invasive, safe with least radiation exposure and quick imaging technique to visualize the neonatal brain parenchyma and ventricular system. **Objective**: To study the use of cranial ultrasound in the critically ill neonates admitted in the Neonatal intensive care unit. **Materials and methods**: This was a Cross sectional study done in NICU, GMCH, Miraj in the month of May-June 2017. These 80 critically ill Neonates according to the inclusion and exclusion criteria were subjected to cranial ultrasonography as per the protocols and different abnormalities noted and then evaluated. Clinical correlation with the USG findings was noted. **Results:** 28.75% of the sick neonates admitted in the NICU had abnormal cranial USG findings. Detection of abnormal finding on cranial ultrasound in the sick neonates was found to be significant. Amongst these 30.43% had cerebral oedema, 30.43% had intra-ventricular haemorrhage, 13.04% had cerebral oedema and IVH both, 8.70% had dilatation of ventricles with IVH and 17.40% had dilatation of ventricles. Occurrence of cerebral oedema in term babies and intra-ventricular haemorrhage in Pre-term babies was found to be significant in the study. **Discussion**: The occurrence of abnormal Cranial USG (28.75%) was significant in our study and was in correlation with similar studies which showed occurrence of 31%. Majority of babies had cerebral oedema and intra ventricular haemorrhage. The abnormal USG was significantly associated with HIE-2 and Pre-term (<32 weeks) babies. **Conclusion:** Cranial Ultrasonography is a feasible and effective modality to screen critically ill neonates and aid in early detection and management of these sick neonates.

Keywords: Cranial ultrasonography, Critically ill neonates, Intra-ventricular haemorrhage, Cerebral oedema, Pre-term babies, Term babies.

INTRODUCTION

Cranial ultrasonography is the preferred modality to image the neonatal brain. The advantages of cranial ultrasound are numerous.

1. It can easily be performed bedside.
2. There is no risk of radiation exposure.
3. It can be repeated whenever needed, enabling visualization of ongoing brain maturation and the evolution of lesions.
4. It can be performed without sedation.
5. It is cost- effective as well.

Cranial ultrasound is performed through the fontanelles in the neonate. The fontanelles in the newborn provide unique windows for ultrasonographic examination of the neonatal brain. These gaps between the calvarial bones serve as acoustic windows through which sound waves of the ultrasound probe can be transmitted and received [1].

Any neonate, with low birth weight, small for gestational age size, a pre-term, or who has a higher chance of morbidity or mortality, due to fetal, maternal or placental anomalies or an otherwise compromised pregnancy, especially within the first 28 days of life is categorized as critically ill neonate.

Cranial ultrasound can detect intra-cranial haemorrhages, ischemic and cystic brain lesions, cerebral oedema as well as calcifications, cerebral infections, and major structural abnormalities in critically ill neonates. It is also very helpful in the early diagnosis of the many etiologies of neonatal encephalopathy and seizures in the term infant and the subsequent monitoring of progress of hypoxic-ischemic brain injury [2].

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The quality of neurosonography and its diagnostic accuracy depends on the ultrasound machine and also expertise of the examiner. When performed as per protocol, it is reliable investigation for commonly occurring neonatal events. Neurosonogram can be initiated even immediately afterbirth and hence suitable for screening and can be repeated as often as possible without any adverse- affects and hence helps in proper follow-up of babies with neurological problems.

METHODS

The study was conducted in the NICU at a tertiary care centre.. A total of 80 neonates admitted in the NICU were included in the study.The aim of the study was to assess the utility of cranial ultrasound as a investigatory modality for high risk neonates and to find out the morphology of various cerebral lesions and correlate clinically.

All critically ill neonates admitted to NICU were selected as per the inclusion criteria on non-randomized manner and were subjected to neurosonography and correlated clinically.

Inclusion Criteria

All the preterm babies and babies with intra uterine growth retardation, Hypoxic Ischemic Encephalopathy, sepsis, convulsion, Dysmorphism, congenital heart disease proved to look for any other congenital anamoly.

Exclusion Criteria

Babies with death within 24 hours. Babies whose Guardians did not give consent for the study

Detailed maternal, antenatal, intra-natal and post- natal history was taken. Detailed clinical examination of the baby was done. All the required investigations done and cranial ultrasonography was performed after 24 hours of life.

The cranial ultrasound findings were noted and clinically correlated.

The sonograms were performed on a Mindray Ultrasonography machine using a multi-frequency high-density volume - TV/TR probe.

Precautions taken

All aseptic precautions were taken by the sonographer and the accompanying doctor while the sonography and Baby was kept warm while the sonography was being performed. It was performed after 24 hours of life. Guardians were explained about the details of the study and babies were included after taking their consent.

Statistical Analysis

The findings were tabulated, inference was drawn using the FISSURE'S test. Software used was IBM-SPFF.

Results on categorical measurements presented in number (%). Significance was assessed at 5% level of significance.

RESULTS

The results obtained in the study conducted were as following.

Table 1: Distribution of cases as per the Weight

Weight (kg)	No of patients	Percentage(%)	Mean
<1	8	10	0.8287
1.01-2	37	46.25	1.5174
>2	35	43.75	2.7896
Total	80	100	

Of the 80 babies selected for the study, 8(10%) weighed <1 kg, 37(46.25%) weighed between 1.01 to 2 kg, 35 (43.75%) weighed > 2 kg.

Table 2: Distribution of the cases as per the Gestational age

Age (weeks)	No of patients	Percentage
<32	17	21.25
33-36	21	26.25
>36	42	52.5
Total	80	100

17(21.25%) were of <32 weeks gestational age, 21 babies (26.25%) were between 33-36 weeks of gestational age, and 42(52.5%) were >36 weeks of gestational age. Gestational age was defined according to modified BALLARD'S scoring.

Table 3: Distribution of cases as per Indication of admission

Indication	No of patients	Percentage
HIE-1	7	8.75
HIE-2	6	7.5
HIE-3	2	2.5
ELBW	8	10
VLBW	19	23.75
LBW	11	13.75
IUGR	4	5
LOS	12	15
CHD	5	6.25
CONVULSIONS	4	5
DYSMORPHIC	2	2.5
TOTAL	80	100

HIE- Hypoxic Ischemic Encephalopathy, ELBW- Extremely Low Birth Weight, VLBW- Very Low Birth Weight, LBW- Low Birth Weight, IUGR- Intra Uterine Growth Retardation, LOS- Late Onset Sepsis, CHD- Congenital Heart Disease.

Babies with birth asphyxia-hypoxic ischemic encephalopathy were classified as stage-1, stage-2 and stage -3 according to SARNAT classification.

According to weight,

- Babies < 1 kg- extremely low birth weight (ELBW)
- Babies 1.01-1.5kg- very low birth weight (VLBW)
- Babies 1.5-2.0 kg- low birth weight (LBW)

Fetuses weighing less than the 10th percentile for gestational age are classified as IUGR.

Babies who had clinical or lab evidence of sepsis were included as late onset sepsis.

Babies with Congenital heart disease (proved by 2D-ECHO) and those who appeared dysmorphic were screened for any other associated anamoly.

Babies who presented with convulsions were also included in the study.

Table 4: Distribution of cases as per findings of Cranial Ultrasonography

	Normal cranial usg (n=57)	Abnormal cranial usg (n=23)
HIE-1	6	1
HIE-2	2	4
HIE-3	1	1
ELBW	3	5
VLBW	12	7
LBW	9	2
IUGR	4	0
LOS	10	2
CHD	5	0
CONVULSIONS	3	1
DYSMORPHIC	2	0
P < 0.0001		

HIE- Hypoxic Ischemic Encephalopathy, ELBW- Extremely Low Birth Weight, VLBW- Very Low Birth Weight, LBW- Low Birth Weight, IUGR- Intra Uterine Growth Retardation, LOS- Late Onset Sepsis, CHD- Congenital Heart Disease.

28.75% of the sick neonates admitted in the NICU had abnormal cranial USG findings. Detection of abnormal finding on cranial ultrasound in the sick neonates was found to be significant.

Amongst these 30.43% had cerebral oedema, 30.43% had intra-ventricular haemorrhage, 13.04% had cerebral oedema and IVH both, 8.70% had dilatation of ventricles with IVH and 17.40% had dilatation of ventricles.

Table 5: Significant Cranial Ultrasonography findings

CUS Findings	< 32 (n=17)	33-36 (n=21)	> 36 (n=42)	P Value
Cerebral Oedema	2	0	8	0.0044
IVH	9	1	2	0.0067
PVL	0	0	0	
Ventricular Dilatation	4	2	0	0.1286
	P = 0.0043			

IVH- Intra Ventricular Haemorrhage, PVL- Periventricular Leukomalasia,

Occurrence of cerebral oedema in term babies and intra-ventricular haemorrhage in Pre-term babies was found to be significant in the study.

DISCUSSION

The occurrence of abnormal Cranial USG (28.75%) was significant in our study and was in correlation with similar studies done by Dinkara *et al.* [3] (31%).

The fetal or preterm infant's brain is vulnerable to both haemorrhagic and ischemic injury during the late second and early third trimesters [4].

The maximum risk of intraventricular haemorrhage is in infants born with gestational age < 30 weeks [5]. However as there is occasional evidence of IVH after 30 weeks, it is prudent to screen all the neonates of less than 32 weeks gestational age for IVH as most of these infants are asymptomatic. Premature infants with severe IVH (grade 3 and 4) are at high risk of post haemorrhagic hydrocephalus, cerebral palsy, and mental retardation, while those with milder grades (grade 1 and 2) are at risk of developmental disabilities [6].

Table 6: IVH grading and associated mortality [7]

Grade	Extent	Prognosis
Grade 1	Restricted to subependymal region / germinal matrix	Good
Grade 2	Extension into normal sized ventricles and filling < 50% of the volume	Good
Grade 3	Extension into dilated ventricles	20% mortality
Grade 4	Grade 3 with parenchymal haemorrhage	90% mortality

Cranial Ultrasonographic findings in case of a baby with hypoxic ischemic encephalopathy was also found to be significant. Findings included increased echogenecity in white matter and resultant increased grey matter-white matter differentiation [8]. These findings could be focal or diffuse, and are thought to reflect oedema or necrosis.

Cranial ultrasound can also be used to detect dilatation of ventricles and hydrocephalus. In a study it was found that coronal measurements of the diameters of both the ventricles, are similar when obtained by sonography and MRI [9]. Ultrasound is also particularly useful in detecting some important congenital malformations such as cystic lesions (hydrocephalus, porencephalic cysts, Dandy-Walker cysts complex, and arachnoid cysts), corpus callosal agenesis and aneurysm of the vein of Galen (color Doppler).

Many similar studies have been performed previously. Each study found 100% correlation between neurosonography findings and neuropathologic data [10-12].

CONCLUSION

This study shows diagnostic and prognostic significance of cranial ultrasonography in critically ill neonates in NICU.

It also lays the importance of cranial ultrasonography as a screening tool for early detection of intracranial pathologies as well as for predicting the neurological outcome in critically ill neonates.

Cranial Ultrasonography is used as routine procedure in NICUs and was found to be an excellent and non-invasive and safe tool for brain imaging during the neonatal period. It enables screening of the brain and serial imaging in high-risk neonates. The study concludes that cranial ultrasonography is an important investigatory modality in NICU and effectively documents morphology of brain damage, enabling early intervention and treatment, and may improve clinical outcome.

Limitation

The follow up of these neonates is necessary to assess the neurological outcome of babies with both normal and abnormal cranial ultrasonographic findings.

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