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Original Article

To Study Routine Screening with Cranial Ultrasonography for all Preterm Neonates

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Abstract

Background: *Neonatal Care in India is advancing at an impressive pace leading to improved survival of preterm neonates. Due to their anatomical and physiological immaturity, they are prone to develop ischemic and hemorrhagic injuries of the brain. Cranial Ultrasonography has become an essential diagnostic tool that uses fontanelles as windows to "look into the brain". It is cheap, easy to perform, non-invasive and convenient. Single study done early on in life helps detect certain pathologies but may miss certain diagnoses. Hence this study was undertaken to study the pattern of screening Cranial Ultrasonography for preterm neonates*

Method: *The study was a prospective observational study conducted in a tertiary care centre with 80 preterm neonates between 36 to 40 weeks of gestation. USG Skull was done between Day 7 to Day 14 of life and repeated at 36 to 40 weeks gestational age.*

Results: *In the second USG, one neonate each with IVH, PVL and cerebral edema was found; which were considered normal in the previous USG. This was found to be statistically significant. Abnormal USG Skull findings have strong association with mortality.*

Conclusion: *Substantial number of preterm neonates have abnormal cranial ultrasound findings and when repeated may help identify the at risk infants for subsequent early intervention and Long term follow-up and subsequent therapeutic intervention.*

Keywords: *Usg skull, preterm, IVH, screening.*

Introduction

Heading towards the goal "EVERY NEWBORN", by 2030[(1)], Neonatal Care in India is advancing at an impressive pace at the level of the community as well as in tertiary care units. In parallel to the dawn of modern neonatal intensive care, the survival of the "High Risk Neonate" has greatly improved necessitating early detection of neurological abnormalities. Children who are born prematurely have high rates of Intraventricular Hemorrhage, Respiratory illness, Patent Ductus Arteriosus, Sepsis and visual abnormalities like Retinopathy of Prematurity compared with children born at term. Mortality rate shows a 3-

fold increase compared to term born babies. These neonates are more prone to have neurodevelopmental delay. Premature neonate is also vulnerable to both hemorrhagic and ischemic brain injuries. **Pape et al** in **1978** first started using real time ultrasound scanner for detection of IVH in preterm neonates[(2)]

Cranial ultrasonography (CUS) has become an essential diagnostic tool in modern neonatology for depicting normal anatomy and pathological changes in the neonatal brain. In the neonate, many sutures and fontanelles are still open and these can be used as acoustic windows to "look" into the brain [(3)] .It is cheap, easy to perform, non-invasive, free from radiation hazard and can be initiated at a very early stage, even immediately after birth. It can be repeated as often as necessary, and thereby enables visualization of ongoing brain maturation and the evolution of brain lesions. If the quality of CUS is good, timing is carefully chosen, proper transducers are used, and, in the case of preterm birth, serial examinations are continued until term age, most diagnoses will not remain undetected, and the reliability and prognostic value of CUS can be high. Good image quality can be obtained with proper settings and techniques with additional acoustic windows. Conventional colour Doppler sonography has been the main Doppler technique used in conjunction with grey-scale evaluation of the neonatal brain for the assessment of the parenchymal vascularity.

CUS helps in assessing the neurological status of the child as clinical examination and symptoms are often nonspecific. It is often not possible to subject every patient to Magnetic Resonance Imaging (MRI) of the brain because of the nonavailability of this modality and the cost of investigation. Also, the critical clinical condition of the newborn does not allow shifting of the patient to an MRI centre. Because the ultrasound facility is available in the majority of care-providing centers, it can be used by the radiologists and neonatologists for screening the newborn to evaluate the immediate risk and possible long-term neurological outcomes. Ultrasound is an ideal and fast bedside examination.

Appropriate timing of CUS and accurate assessment of the site and extent of lesions is crucial for accurate prediction of neurodevelopment outcome. Several studies have suggested that only in 40–50% of preterm infants with cerebral palsy (CP), lesions are detected on CUS. However, if only one or two early or late CUS scans are performed, the detection of cystic PVL, the most predictive CUS marker for CP, is more reliable. It is the site and extent of cerebral lesions that is important in predicting CP [(4).]. In cases of (suspected) cerebral and/or neurological abnormalities, the intensity and frequency of CUS examinations may need to be increased, depending on the clinical picture and the lesion(s)

Horsch in 2010 found that infants with a normal cranial ultrasound scan had normal or mild white matter changes only on MRI[(5)] .This reaffirms the utility of a simple investigation to help determine neurological outcomes. Similar results were obtained by Karl et al in 2009 where cranial ultrasound scans obtained in NICU predicted cerebral palsy types and severity of motor dysfunction in preterm neonates less than 28 weeks of gestation.

Michael O'Shea T in **2008** studied to describe relationships between cranial ultrasound abnormalities and delayed development at 2 years of age in a large cohort of 1017 extremely premature infants found that the association of cerebral white matter damage and developmental impairments applied to extremely low gestational age newborns and is stronger for motor, as compared with mental development[(6)]

De Vries in 2006 stated that periventricular leukomalacia (PVL) is the most important determinant of neurologic morbidity seen in preterm infants. [(7)]. But PVL can be missed sometimes in early scan.

Tran Kiem Hao et al in 2020 evaluated whether utility of cranial ultrasonography can predict the neurodevelopmental outcomes in preterm neonates[8]. Authors prospectively evaluated the correlation of cerebral lesions found by cranial ultrasound and the developmental delays at the age of 6 months in 79 preterm infants (born before the 37th postmenstrual week). Cerebral ultrasound findings were reported as four categories: 1) Intraventricular hemorrhage; 2) Periventricular leukomalacia; 3) Ventricular dilatation; 4) Other lesions such as congenital anomaly, cystic lesion. Developmental evaluation at the age of 6 months was performed by Denver II screening test and during a neurologic examination. Of 79 preterm infants, 24.1% had delayed mental or psychomotor development or both. Abnormal ultrasound findings, which were significantly correlated with the developmental delays, consisted of intraventricular haemorrhage, periventricular leukomalacia, ventricular dilatation, congenital anomaly and cystic lesion. Some perinatal factors such as Apgar score < 7at 5 mins, the disease of hyaline membranes, and mechanical ventilation were each correlated to increased risk of developmental delays.

Mirmiran M in 2004 suggested routine screening cranial US to be done once between 7 and 14 days of age with repeat US and MRI before discharge between 36 and 40 weeks' postmenstrual age of all at risk VLBW babies for better prediction of cerebral palsy[9]

Detailed review of literature couldn't find any similar Indian studies that have studied the association of regularly repeated Cranial Ultrasonography evaluations in preterm neonates with consequently earlier and better detection of cranial pathologies and their association with neurodevelopmental outcome in the background of earlier initiation of physiotherapy and occupational therapy.

The aim of this study was to determine whether cranial ultrasonography performed for preterm neonates between 30 to 34 weeks of gestation, any time between day 7 to day 14 of life , and repeated between 36 to 40 weeks of gestation, helps predict neurodevelopmental outcome better.

Materials and Methods

The study was a prospective observational study carried out in the Department of Pediatrics in a Tertiary Care centre. Total of 80 preterm neonates born between 30 and 34 weeks of gestation including 30 and 34 weeks were included. Those neonates born before 30 weeks and after 34 weeks and those not vitally stable for transportation were excluded.

Preterm neonates were transported to ultrasound room after adequate feeding by wrapping them in warm clothing to avoid hypothermia. No sedation was used. The baby is laid in supine. The sonograms were performed on a Voluson 630 pro GE machine using a multi-frequency high density volume -TV/TR probe. The images were obtained through the anterior fontanelle and additional sections through the thin part of squamous temporal bone so as give images in axial plane comparable to CT & MRI images. Image quality was maximized by fine adjusting the preset already available for trans-cranial scans. The images were recorded on the hard disc of the ultrasound machine in a digital format for purpose of review. Only still gray scale images were recorded. A software for post processing the images was available.

All ultrasounds were performed by a single radiologist to avoid inter-observer variation and the images were reviewed by the same radiologist later without clinical information to check for the intra-observer variation. The scan was performed in the ultrasound suite after taking care to keep the baby warm. Strict aseptic precautions were taken. The probe was covered by a probe cover. After applying the coupling gel the imaging was carried out in sagittal, modified sagittal, coronal, modified coronal planes. In addition in our study we included scanning in the axial plane through the thin part of squamous temporal bone from right

and left sides. Though the examination was dynamic real time we recorded images in fixed planes through fixed anatomical land marks and with additional images through the pathology.

Sagittal section: Plane (a) Midline, (b) & (c) 15, 30 degree parasagittal angulation on left and right sides. Coronal plane (a) through the frontal horns, (b) through the sylvian fissure, (c) through the 3rd ventricle, (d) through the posterior fossa, (e) through the occipital horn. Additional images of the germinal matrix with a zoom factor of 1.7 was recorded both in coronal and sagittal planes. Axial plane views were recorded through the right and left temporal fontanel at the level of thalamus and caudo-thalamic grooves.

Repeat USG Skull was be done on follow-up between 36 to 40 weeks of gestation to look for abnormal findings in previously normal study to identify the number of cases missed. The total time taken for the examination varied from 10-15mins. After completion of examination, babies were transported back to respective NICU/ Wards with utmost care.

Descriptive statistics like Mean, Median and Mode or Proportion were used to describe the data. Bivariate analysis for association between different variables was done using tests like chi square. Appropriate statistical software was used as and when applicable.

Results

There was a male preponderance of cases in our study with male to female ratio 1.42:1. Almost 50 % of the preterm neonates were less than 32 weeks of gestation. Mean age was found to be 31.76 weeks. Majority of the patients belonged to the Lower Middle Class (Class 4) of the Modified Kuppuswamy Scale of Socioeconomic status. 66% of the mothers were between 21 to 30 years, 29 % between 31 o 40 years and 2 % each below 20 years and above 40 years of age. The mean birth weight of study population was 1.73 kg.

The distribution of the maternal risk factors across abnormal USG findings were found to be statistically significant for PIH and PROM.

Table 1: Distribution of maternal risk factors for preterm delivery

Maternal risk factors	No. of patients (n)	Percentage (%)
APH	18	22.5
PIH	16	20
PROM	10	12.5
MP	6	7.5
None	30	37.5
Total	80	100

*APH- Ante Partum Hemorrhage, PIH- Pregnancy Induced Hypertension, PROM- Premature Rupture of Membranes, MP- Multiple Pregnancies.

First cranial USG was done at the time of birth between 30 to 34 weeks of gestational age. Among 80 preterm neonates, 53 neonates (66.25%) had normal findings whereas 27 neonates (33.75%) had abnormal findings in USG.

Table 2: Distribution based on cranial USG done at 30-34 weeks

Cranial USG	No. of patients (n)	Percentage (%)
Normal USG	53	66.25
Abnormal USG	27	33.75
IVH	11	13.75
PHE	6	7.5
Cerebral edema	2	2.5
Ventricular dilation	3	3.75
PVL	5	6.25

*IVH- Intra Ventricular Hemorrhage, PHE- Peri-ventricular Hyper Echogenicity, PVL- Peri Ventricular Leukomalacia

Second cranial ultrasound was done between 36 to 40 weeks of gestational age. All the preterm neonates were admitted for further treatment and observation. All the neonates were in stable condition and there were no emergencies. In second USG, one neonate each with IVH, PVL and cerebral edema was found; which were considered normal in previous USG.

Table 3: Distribution based on cranial USG done at 36-40 weeks

Cranial USG	No. of patients (n)	Percentage (%)
Normal USG	50	62.5
Abnormal USG	30	37.5
IVH	12	15
PHE	6	7.5
Cerebral edema	3	3.75
Ventricular dilation	3	3.75
PVL	6	7.5

The clinical outcome of the study was –

Table 4: Distribution based on clinical outcome

Outcome	No. of patients (n)	Percentage (%)
Discharged	71	88.75
Expired	9	11.25
Total	80	100

Fetal comorbidities namely, asphyxia, neonatal seizures, sepsis, respiratory distress syndrome and necrotizing enterocolitis were associated with abnormal cranial USG in 6, 2, 5, 11 and 2 neonates respectively. Birth asphyxia (p=0.009) and respiratory distress syndrome (p=0.005) were found to be statistically significant.

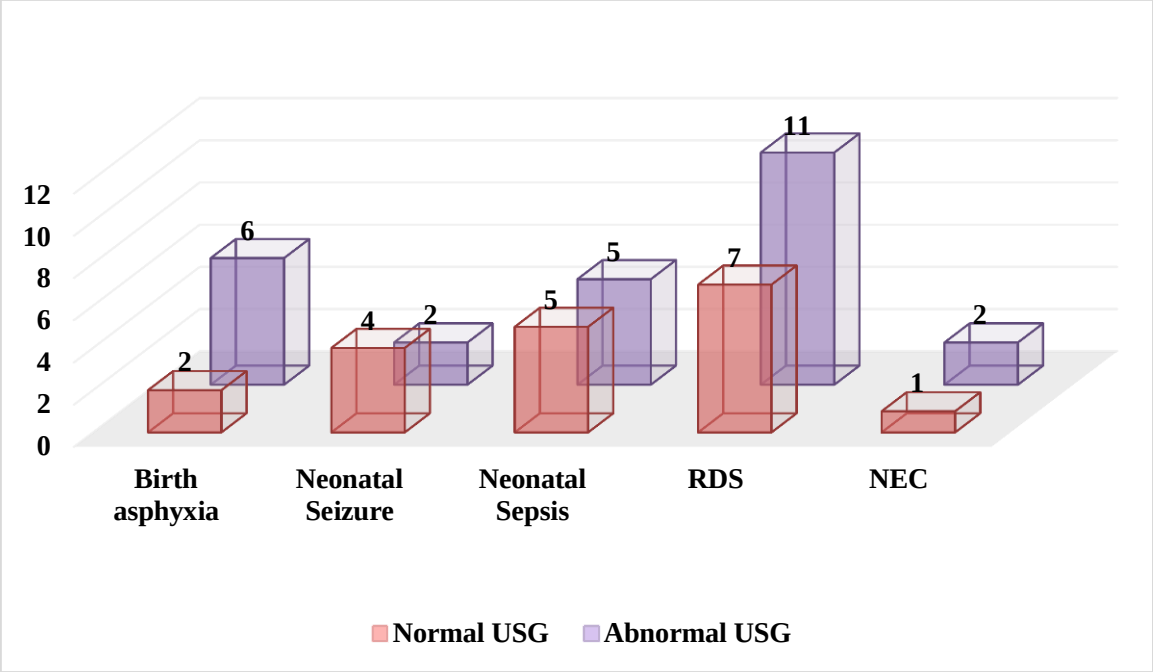

Figure 1: Distribution of fetal comorbidities based on cranial USG

The association between first and second USG was found to be statistically significant. Out of 71 neonates discharged, 51 had normal USG while 20 had abnormal USG findings. Out of 9 neonates expired, 7 neonates had abnormal USG findings. The association between outcome and cranial USG was found to be statistically significant.

Discussion

Badrawy N, Edrees A, and Mohamed El Ghawaset al[(10)]showed in their study that 37% preterms had abnormal CUS findings. Their study had 64% male and 36% female neonates. Our findings correlate with their results with the most common abnormal finding being ICH (Intracranial Hemorrhage). Badrawy Net al[(10)]reported congenital hydrocephalus to be present in 6% among all neonates screened by them. In the present study, one neonate had congenital hydrocephalus with aqueductal stenosis. Out of 9 neonates that expired, 7 neonates had abnormal USG findings that suggest the importance of USG skull to predict outcomes.

All the neonates were in stable condition and there were no emergencies. In second USG, one neonate each with IVH, PVL and cerebral edema was found; which were considered normal in previous USG. Trounce et al[(118)]reported that ultrasonic evidence of hemorrhage was evident within first seven days of life in 78% neonates and second week in 15% neonates, 4% in the third week and 3% in the fourth week. Canadian Paediatric Society Statement in (2001)[(11)] concluded that it is important to consider the value of determining the need for regular repeated routine screening CUS examinations in NICUs. The association between the first and second USG was significant in our study hence validating the recommendation.

Conclusion

Cranial Ultra-Sound (CUS) is an essential diagnostic tool in neonatology. It is very suitable for screening of preterm neonates as it is cheap, easily available, non invasive, free from radiation and portable. Data from this study shows that a substantial number of preterm neonates have abnormal cranial ultrasound findings (33.7%). In repeat USG, this number increases to 37.5% showing the importance of repeat USG Skull after 4 weeks from first USG for which the p value was <0.0001. Babies with abnormal USG skull are likely to have neurological abnormalities as they grow. For this reason early referral to higher centre or Developmental Neurologist is very important. This would also help us to counsel the parents regarding the neurological prognosis of the patient. This will motivate the caretakers for compliance in therapy and long term follow-up.

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