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**Original Research Article**

# Intracranial ultrasonographic screening of premature babies meeting the criteria

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## ABSTRACT

**Background:** The preterm infant brain is most vulnerable to both haemorrhagic and ischemic injury during the late second and early third trimesters. This is due to vascular, cellular, and anatomical features of the developing brain and the tendency of preterm infants to experience periods physiological instability at a time when they have limited cerebral circulatory auto regulation. CUS is useful for recording PVH, PVL, measurement of resistive index and ventricular dilatation. The study was to determine the magnitude of abnormal intracranial findings among the preterm neonates admitted in NICU of S.S. Institute of Medical Science and Research Centre, Davangere by using cranial ultrasonography.
**Methods:** The study was intended to do CUS in pre-terms with gestation age of less than 32 weeks or those with birth weight of less than 1500 grams irrespective of gestational age and Preterm with abnormal neurological presentation. Infants enrolled were divided in to groups according to gestational age, birth weight and results analysed by using Epi info version 6 software, p value <0.05 is considered significant.
**Results:** Most common abnormalities found is intra ventricular haemorrhage (7.8%), ventricular dilatation (1%), agenesis of corpus callosum (1%). There is significant correlation between birth weight and gestational age (p value <0.05) and prevalence of intra ventricular haemorrhage in <28 weeks (group 1) is more (15. 4%), compared to group 2 (28-32weeks), and group 3 (>32 weeks).
**Conclusions:** The prevalence of Intra ventricular haemorrhage is significantly higher as the gestational age decreases. Neonatologist can take ethical decisions depending on intracranial abnormalities as it changes line of management. CUS helps in directing the families of affected infants towards most appropriate follow up and to promote early intervention for chronic neurodevelopmental sequelae of haemorrhagic or ischemic injury. So, all neonatologist working in NICU should be trained in CUS.

**Keywords:** Cranial ultrasound, Germinal matrix, Infant, Intraventricular haemorrhage, Preterm, Periventricular haemorrhage, Periventricular leukomalacia, Ventricular dilatation, Very low birth weight

## INTRODUCTION

Cranial Ultrasonography (CUS) was introduced into neonatology in the late 1970s and has become an essential diagnostic tool in the modern neonatology.[1,2] CUS is a safe, inexpensive, no ionising radiation, no sedation, non-invasive, bedside technology has made it different from MRI and CT scan. As the suture lines and fontanel are open in infants and neonates, this can be used as acoustic windows to look into the brain.[3,4]

This procedure is helpful in neonates who are haemo dynamically unstable and imaging can be done without shifting the baby to radiology department for CUS. It can

be initiated even at very early stage, even immediately after birth. It is safe, can be repeated as often as necessary and therapy enables visualisation of ongoing brain maturation, evolution of brain lesions and also it can be used to assess timing of brain damage. It is a reliable tool for detection of most haemorrhagic, cystic and ischaemic brain lesions and also calcification, cerebral infections, major structural brain anomalies in both preterm and term neonates.[5,6] For all these reasons CUS is an excellent tool for brain imaging during neonatal period.

The aims of CUS are to assess brain maturation, presence of structural brain anomalies or brain injury, timing of cerebral injury, neurological prognosis of infant. In seriously ill neonates and in neonates with cerebral abnormalities it plays an important role in deciding on continuation or withdrawal of intensive treatment in neonates surviving with cerebral injury. It may help to optimize treatment of infant and support the infants his/her family members during neonatal period thereafter.[7-9] Approximately 10% of newborns are born prematurely, of these children more than 10% will sustain neurological injuries leading to significant learning disabilities, motor developmental delay, C. P, seizures and mental retardation.[10]

So, present study is intended to screen all these infants at risk of neurological complications, detecting structural malformation and predicting neuro developmental outcome and helps in counselling the parents in such a way and motivate the family to do early intervention.

The aim of the study was to estimate the magnitude of abnormal intracranial findings among the preterm neonates admitted in NICU of S.S. Institute of Medical Science and Research Centre, Davangere by using cranial, ultrasonography and to evaluate the possible use in determining prognosis and to promote early diagnosis and interventions for chronic neurodevelopmental sequelae at the end of study.

## METHODS

The prospective observational study was conducted from September 2014 to August 2016 on 102 preterm infants in S.S. Institute of Medical Science and Research Centre, Davangere. The study was approved by Ethical committee of our institute and written informed consent was obtained from parents of all preterm infants.

The inclusion criteria were gestational age less than 32 weeks or less than 1500 grams of any gestation age and pre-term with abnormal neurological presentation, seizures, lethargy, apnoea, sudden onset pallor, rapidly enlarging head, increased muscle tone, bulging anterior fontanel, serial follow up of post haemorrhagic hydrocephalus, hypoxic ischemic encephalopathy. The exclusion criteria include suspected to have severe infection and failed resuscitation. Birth weight was measured with an electronic weighing scale, gestational age is calculated by using LMP and also New Ballard scoring system. All infants included in the study were undergone neurosonography using standard USG machine equipped linear array of 5-7.5 Hz and sector transducer coupled with colour Doppler. Serial ultra-sonogram for an infant and follow up scan couldn't be done in this study, and instead one-time scan done at various postnatal days and results analysed.

The details of infants, clinical examination is recorded in a specially designed Proforma. Before subjecting the patients to investigation, they are provided with patient's information sheet or they are briefly explained about the procedure done. Informed written consent will be taken from each patient before the start of study.

Infants enrolled in this study were divided in to 2 groups according to gender male and female (Table 1). Infants were also divided in to 3 groups according to birth weight (Table 2).

(<1000gm; group 1) 1000 to 1500 gm (group 2),>1500 gm (group 3), and also divided in to 3 group according to their gestational age (table 3) <28 weeks (group 1), 28-32 weeks (group 2), >32 weeks (group 3) and day of examination (Table 4) in to <3 days, 3-7 days, 7-14 days, and >14 days.

### *Statistical analysis*

Data were analysed with Epi Info version 6 software. Results were expressed as pie chart and Bar diagram to make statistical comparison. A p-value <0.05 was considered statistically significant.

At the end of study neurodevelopmental outcome is analysed and parents of each affected infants are counselled and directed towards early interventions methods, psychological support provided.

## RESULTS

**Table 1: Distribution of sex among infants.**

| Sex | No. of Infants | Percentage |
|---|---|---|
| Male | 57 | 55. 9 |
| Female | 45 | 44. 1 |
| Total | 102 | 100. 0 |

**Table 2: Distribution of infants according to birth weight.**

| Birth weight (grams) | No. of Infants | Percentage |
|---|---|---|
| <1000 | 11 | 10. 8 |
| 1000-1500 | 52 | 51. 0 |
| 1500-2000 | 39 | 38. 2 |
| Total | 102 | 100. 0 |

A total of 102 infants 57 male (55. 9%),45 females (44. 1%) were recruited in to the study (table 1). Of them 11 infants (10. 8%) had extreme low birth weight (<1000gms), 52 infants (51. 0%) had very low birth weight (1000 to 1500gms) and 39 infants (38.2%) had low birth weight (1500 to 2000gms) (Table 2).

**Table 3: Co-relation between postnatal age and birth weight.**

| Postnatal age (days) | Birth weight (grams) | | | Total | P-value |
|---|---|---|---|---|---|
| | <1000 | 1000-1500 | >1500 | | |
| <3 | 9 | 27 | 23 | 59 | 0. 269 |
| | 15. 3% | 45. 8% | 39. 0% | 100. 0% | |
| 3-7 | 2 | 15 | 14 | 31 | |
| | 6. 5% | 48. 4% | 45. 2% | 100. 0% | |
| 7-14 | 0 | 5 | 1 | 6 | |
| | 0. 0% | 83. 3% | 16. 7% | 100. 0% | |
| >14 | 0 | 5 | 1 | 6 | |
| | 0. 0% | 83. 3% | 16. 7% | 100. 0% | |
| Total | 11 | 52 | 39 | 102 | |
| | 10. 8% | 51. 0% | 38. 2% | 100. 0% | |

**Table 4: Magnitude of abnormalities according to gestational age.**

| Gestational age (weeks) | Findings | | | | | Total |
|---|---|---|---|---|---|---|
| | Normal | Haemorrhage | Ventricular dilatation | Dilated cavum septum pellucidum | Corpus callosal agenesis | |
| <28 | 10 | 2 | 1 | 0 | 0 | 13 |
| | 76. 9% | 15. 4% | 7. 7% | 0. 0% | 0. 0% | 100. 0% |
| 28-32 | 46 | 3 | 0 | 1 | 1 | 50 |
| | 92. 0% | 6. 0% | 0. 0% | 1. 0% | 1. 0% | 100. 0% |
| >32 | 35 | 3 | 0 | 1 | 0 | 39 |
| | 89. 7% | 7. 7% | 0. 0% | 2. 6% | 0. 0% | 100. 0% |
| Total | 91 | 8 | 1 | 1 | 1 | 102 |
| | 89. 2% | 7. 8% | 1. 0% | 1. 0% | 1. 0% | 100. 0% |

**Table 5: Magnitude of abnormalities according to birth weight.**

| Birth weight | Remarks | | | | | Total |
|---|---|---|---|---|---|---|
| | Normal | Haemorrhage | Ventricular dilatation | Dilated cavum septum pellucidum | Corpus callosal agenesis | |
| <1 | 11 | 0 | 0 | 0 | 0 | 11 |
| | 100. 0% | 0. 0% | 0. 0% | 0. 0% | 0. 0% | 100. 0% |
| 1-1. 5 | 46 | 4 | 1 | 0 | 1 | 52 |
| | 88. 5% | 7. 7% | 1. 9% | 0. 0% | 1. 9% | 100. 0% |
| >1. 5 | 34 | 4 | 0 | 1 | 0 | 39 |
| | 87. 2% | 10. 3% | 0. 0% | 2. 6% | 0. 0% | 100. 0% |
| Total | 91 | 8 | 1 | 1 | 1 | 1 |
| | 89. 2% | 7. 8% | 1. 0% | 1. 0% | 1. 0% | 100. 0% |

Of these 102 infants 13 infants (12. 7%)were gestational age of <28 weeks,50 infants (49. 0%) were gestational age of 28-32 weeks, 39 infants (38.2%) were >32 weeks (Table 3).

Of these infants 59 infants (57.8%) examined at postnatal day of <3 days, 31 infants (30.4%) at 3-7 days,6 infants (5.9%) at 7-14 days, and another 6 infants examined at >14 days.

The correlation between birth weight and gestational age is significant (p value <0.05). CUS shows 8 infants (7.8%) had intra ventricular haemorrhage of which 7 had Grade II and 1 had grade IV,1 infant (1.0%) had ventricular dilatation, 1 had (1%) dilated septum pellucidum and 1 had cprpus callosal agenesis (1%).

**Table 6: Magnitude of abnormalities according to post-natal age.**

| Postnatal age (days) | Remarks | | | | | Total |
|---|---|---|---|---|---|---|
| | Normal | Haemorrhage | Ventricular dilatation | Dilated cavum Septum Pellucidum | Corpus callosal agenesis | |
| <3 | 58 | 1 | 0 | 0 | 0 | 59 |
| | 98. 3% | 1. 7% | 0. 0% | 0. 0% | 0. 0% | 100. 0% |
| 3-7 | 23 | 6 | 0 | 1 | 1 | 31 |
| | 74. 2% | 19. 4% | 0. 0% | 3. 25% | 3. 25% | 100. 0% |
| 7-14 | 6 | 0 | 0 | 0 | 0 | 6 |
| | 100. 0% | 0. 0% | 0. 0% | 0. 0% | 0. 0% | 100. 0% |
| >14 | 4 | 1 | 1 | 0 | 0 | 6 |
| | 66. 7% | 16. 7% | 16. 7% | 0. 0% | 0. 0% | 100. 0% |
| Total | 91 | 8 | 1 | 1 | 1 | 102 |
| | 89. 2% | 7. 8% | 1. 0% | 1. 0% | 1. 0% | 100. 0% |

## DISCUSSION

Cranial ultrasonography is the most widely used neuroimaging procedure in the neonatal period. It plays a central role in the detection and management of neurological disease and provides prognostic, as well as diagnostic, information to neonatologists in the intensive care setting. This will provide a standard for clinicians in order to detect abnormalities that will alters management, and guide parental counselling. There are a diverse group of infants who will require scanning and ultimately a decision to perform a scan on any unwell neonate can be taken by the consultant responsible for that child. Advances in imaging techniques have contributed significantly to early detection of abnormalities of the brain. Ultrasonography, which is now ubiquitously available, is an ideal tool for the primary screening of the neonatal brain. Despite the wide availability of ultrasound machines in the hospitals, the penetration of cranial ultrasonography (CUS) in Indian NICU's is still very little.

This study showed that intra ventricular haemorrhage is more prevalent in lesser gestatioal age. CUS is efficient and more sensitive modality in detecting intracranial abnormalities like intra ventricular haemorrhage, congenital malformations, ventricular dilatation. In a study by De Vries et al, total of 87 autopsies performed on PT infants, US was 76% to 100% accurate in detecting grade 1 lesions of >5 mm and grade 3 and grade 4 haemorrhages. Detection of grade 2 haemorrhages was much less accurate. Correlation of US findings of cystic periventricular leukomalacia (PVL) with neuropathologic data was evaluated in two studies.[11,12] Each study found 100% correlation between US S.S. Institute of Medical Science and Research Centre findings and neuropathologic data. In our study, we found that one infant had dilated bilateral ventricles with grade IV intra ventricular haemorrhage, one infant had agenesis of corpus callosum which is haemodynamicaly stable and went uneventfully.

In a study by Perlman et al screening ultrasound in VLBW neonates identified abnormalities in 57% of neonates. Of the 318 infants screened the US was normal in 156 neonates (49%) and abnormal in 161 (57%). The principal abnormalities included intra ventricular haemorrhage (IVH) (n=74), peri ventricular echogenicity (PVE) (n=68), ventriculomegaly (n=7), and solitary cysts (n=9). Present study is similar to this study in detecting IVH as a principal abnormality (7. 8%), Of 102 infants we found 91 infants (89%) were normal, abnormal in 11%, incidence of abnormality is less compared to this study because of influential risk factors may vary from one geographical area to other.

Review of some studies suggests that although CUS in infants with BW of <1500 grams or GA of <33 weeks shows some abnormalities in 12% to 51% of infants in the first 2 weeks of life, major US abnormalities such as grades 3 and 4 IVH or bilateral cystic PVL occur in <20% of infants.[13-15] While compared to these studies current study results shows CUS abnormalities in GA of <28 weeks the incidence is 15.4% and 6.0% in 28-32 weeks, 7.7% in GA of >32 weeks concluding that in this study it was found that more incidence in lesser gestation age compared to previous studies, and principal abnormalities found more in postnatal age of 3-7 days (6%) where as in previous studies much later. CUS in infants with birth weight of 1000gms-1500gms shows

abnormalities in 10. 3% in first week of life, this in contrast to studies by BMUS where 12% in BW of <1500 grams. So, doing CUS in 3-7 days of infant age could be able to pick more number of abnormalities.

In few studies compared US findings with the incidence of CP for almost 2,250 VLBW PT children at ages 2 to 9 years. Significant associations between grades 4 IVH, PVL, and/or ventriculomegaly and CP were noted in all these studies. In the largest of these studies, both grade 4 IVH and PVL were associated with CP [odds ratio (OR)=15.4;95% CI=7.6-31.1], any grade IVH alone was also associated with CP (OR=3.14;95% CI=1.5-6.5). When the same groups assessed, the correlation of neonatal US findings with the developmental quotient, grade 4 IVH and moderate to severe ventriculomegaly were strongly associated with the risk of mental retardation at 2 to 9 years of age. These prospective studies, OR ranged from 9.97 to 19.0. In addition, Whitaker et al. demonstrated that for infants with BW of 500 to 2,000 grams who had grade 4 IVH and/or moderate to severe ventriculomegaly, the OR for the development of any neuropsychiatric disorder at the age 6 years was 4.4. Maalouf et al performed paired MRI and US studies on the same day for 32 infants with GA of <30 weeks. US accurately detected the presence of germinal matrix, IVH, and parenchymal haemorrhage confirmed by MRI (positive predictive values of 0.8, 0.85, and 0.96, respectively).

Finally, the sex of preterm infants doesn't have any effect on intracranial abnormalities. Intra ventricular haemorrhage is the principal abnormality which is inversely proportional to gestational age and birth weight and found more incidence at 3-7 day of life.

## CONCLUSION

Cranial ultrasonography is the best initial neuroimaging technique in newborns. The quality of CUS imaging and its diagnostic accuracy, as with any other imaging technique. Compliance of findings were well appreciated and validated by radiologist. Doing Cranial ultrasonography in NICU is most needed as shifting infants to radiology department is cumbersome because it needs vitals monitoring equipments, arrangement and carrying resuscitation kits,monitoring saturation during imaging, skilled person to accompany the infant, disturbance in thermo control environment can lead to hypothermia, chances of getting cross infection is more and waiting for the procedure can be avoided. As preterm infants were haemodynamically unstable by doing Cranial ultrasonography in bedside in the unit we can imaging and find out abnormalities without disturbing. CUS helps in determining incidence of abnormalities like intra ventricular haemorrhage, structural anomalies, hypoxic insults etc. and predicting neurological outcome of infant so that early intervention measures can be taken and helps in parental counselling for example with drawl of treatment where significant findings were present, if we had continued treatment which leads to increased morbidity and mortality. So CUS helps to take ethical decision in these types of infants. CUS can also be useful in neonates on ventilator support, in which abnormalities can be picked up easily and helps in taking ethical decision and directs neonatologist to further management. So, this study suggests that all neonatologist who are working in NICU should undergo training in CUS which helps in overall better management of neonates.

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