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Original Research Article

Cranial ultrasonography and doppler in neonates: an observational study

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ABSTRACT

Background: The CUS and transcranial doppler sonography is an emerging technique used in neonatal intensive care unit. It is noninvasive, ionizing, portable, safe and inexpensive for serial and long-term studies. Objectives of this study were to study intracranial abnormalities in neonates using ultra sonography on 3rd and 7th day of life and to study ACA blood flow velocity and RI (Resistive index) in neonates on 3rd and 7th day of life.
Methods: It was a prospective observational study conducted on 229 neonates at NICU, Department of Pediatrics, Dr. D. Y. Patil Hospital and Research Institute, Kolhapur. During August 2015 to August 2017. After obtaining Informed consent from the parents/guardian details were recorded in a pre-designed pretested, structured proforma. Detailed clinical examination and Cranial ultrasound and doppler evaluation was performed on 3rd and on 7th post-natal day.
Results: In the present study, out of 229 study participants, 65.5% were preterm, 34.5% were term. 67.2% had abnormal CUS findings. The PVHE, ICH, PVL, cyst and edema were common cranial abnormalities. These were statistically significant on 3rd day with gestational age, birth weight, low APGAR Score. Out of 229 neonates 58.9% had low, 35.3% normal and 5.8% had high RI index. Statistically significant association was found between gestational age, birth weight and APGAR score. Doppler analysis done on 3rd and 7th day showed rise in systolic and diastolic velocities regardless of the gestational age.
Conclusions: Study concludes that CUS and Doppler is an ideal tool to detect various intracranial lesions efficiently in non-invasive manner.

Keywords: Abnormalities, CUS, Cranial, Doppler, Neonates

INTRODUCTION

The importance of term 'intact survival' of the neonates has lead way to the techniques which identify neurological abnormalities at the earliest. In the neonate, the sutures and fontanels are open and can be used as acoustic window for CUS and Doppler evaluation.[1] The neonatal brain is prone to injuries from several causes, like hypoxia, preterm delivery, trauma etc. IVH (Intraventricular haemorrhage) and PVL (periventricular leukomalacia) are the most common lesions in the neonatal brain.[2] IVH was found in 40% of preterm neonates whose weight is less than 1.5 kgs; 90% of IVH are found in first 3 days of life and the others by 10 days.[2]

PVL is major form of brain injury in preterm neonates and major cause for several neurological sequelae.[3,4] The incidence of spontaneous haemorrhage is 40-45% in neonates whose weight was less than 500g or gestational age less than 35 weeks.[5]

CUS detects many congenital anomalies like ventriculomegaly, hydrocephalus, closed spinal dysraphisms, porencephaly, myelomeningoceles, etc.

Immediately after birth, further medical and surgical measures can be initiated at earliest.[3,4] Whereas transcranial Doppler sonography is an emerging technique. It is non-invasive, ionizing, portable, safe and inexpensive for serial or long-term studies. The transcranial Doppler calculates the peak systolic velocity (PSV), End diastolic velocity (EDV) the resistive index (RI) and the mean velocity of blood flow in the targeted vessel (ACA).[2] With the modern ultrasound machines protocols, using various acoustic windows and probes it's easy to get high quality images which improve diagnostic accuracy.[6,7] This was planned to study intracranial abnormalities in term and preterm neonates on cranial ultrasonography and Doppler

Objectives of this study were to study intracranial abnormalities in neonates using ultra sonography on 3rd and 7th day of life and to study ACA blood flow velocity and RI (Resistive index) in the neonates on 3rd and 7th day of life.

METHODS

A prospective observational study was conducted at Neonatal intensive care unit, Department of Pediatrics, Dr. D. Y. Patil Hospital and Research Institute, Kolhapur from August 2015 to August 2017. Total 229 neonates were included in study.

Inclusion criteria:

- All the neonates (0-28 days) admitted in NICU, (preterm and term).

Exclusion criteria:

- Neonates incompletely examined (once or twice) due to early discharge (<7th days of post-natal admission).
- Those who died during the study period.

After obtaining Informed consent from the parents' details were recorded in a pre-designed pretested, structured proforma. Detailed clinical examination and Vital parameters were recorded within 24-48 hours. of admission and complete neurological examination was done in NICU. Gestational age was assessed as per modified Ballard's scoring method for all preterm neonates.

Cranial ultrasound and doppler evaluation was performed on 3rd postnatal day. Follow up cranial ultrasound was done on 7th post-natal day. Cranial ultrasound findings were recorded and correlated with clinical findings. The Doppler indices PSV, EDV and RI were calculated. The new-born infants were placed in three groups: low (<0.61), normal (0.61 - 0.85) or high (>0.85) RI.[2] SPSS version 18.0 software (trial version) was used for analysis of the data. The numerical variables were analyzed by mean and standard deviation and categorical data was summarized by using percentages. Chi square test was used to find the association.

RESULTS

In the present study, out of 229 study participants, 150 (65.5%) were preterm, 79 (34.5%) were term, 77 (33.6%) were females and 152 (66.4%) were males. Among the total participants studied 129 (56.3%) were less than 2.5 Kg of birth weight. Out of total, 123 (53.7%) had normal score and 106 (46.3%) had low APGAR score.

Among the total neonates studied, 154 (67.2%) had abnormal CUS findings and 75 (32.8%) were normal. The PVHE, ICH, PVL, Cyst and edema were common observations (Figure 1).

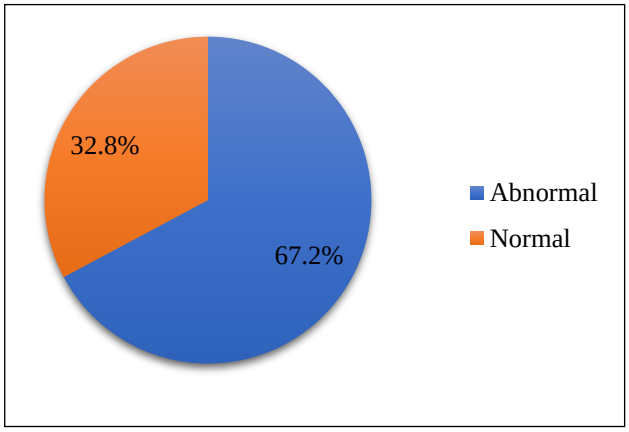


Figure 1: Distribution of study participants according to CUS findings.

The incidence of cranial abnormalities 102 (68.0%) was high in the preterm, then the term neonates 52(65.8%) (Table 1).

Table 1: Association between gestational age of study participants and CUS findings.

AGE (in weeks)	Abnormal		Normal		Total
	No.	%	No.	%	No.
Preterm	102	68.0	48	32.0	150
Term	52	65.8	132	34.1	79
Total	154		75		229

$X^2 = 0.11$; df = 1; p = 0.73

Among neonates, the incidence of cranial abnormalities 61 (79.2%) was high among female neonates, then the male neonates 93 (61.1%). There was statistically significant association between gender and CUS abnormalities (P <0.05). The mean birth weight of neonates with abnormal CUS (2.15±0.68) was less than those normal CUS (2.21±0.74).

Table 2: Association between birth weight and cranial USG findings.

Birth weight	Abnormal		Normal		Total
	No.	%	No.	%	No.
<2.5	80	62.0	49	38.0	129
2.6 to 3.0	35	79.5	9	20.5	44
3.1 to 3.5	31	77.5	9	22.5	40
>3.6	8	50.0	8	50.0	16
Total	154		75		229

x2 = 15.0; df = 3; p = 0.01

Table 2, Among 129 neonates having birth weight <2.5 kg, 80(62.0%) had abnormal findings. There was statistically significant (P<0.05) association between birth weight of neonates and abnormal CUS findings. Those who had low APGAR score, 66(62.3%) had abnormal CUS findings. The association between CUS findings of neonates with APGAR score was statistically significant (p <0.05).

Table 3: Association between gestational age and cranial abnormalities on 3rd day CUS.

Cranial abnormalities	Preterm		Term		Total
	No.	%	No.	%	No.
Normal	40	64.0	27	36.0	75
Flaring/ PVHE	36	58.1	26	41.9	62
ICH	26	60.4	17	39.5	43
PVL	4	100	0	0	4
Cyst	14	60.9	9	39.1	23
Cerebral edema	22	100	0	0	22
Total	150		79		229

x2 = 15.9; df = 5; p = 0.007

Table 3 shows out of all, 62 neonates those who had flaring/ PVHE, 36 (58.1%) were preterm, 43 neonates had ICH amongst these 26 (60.4%) were preterm. The preterm neonates had PVL and cerebral odema 4 (100%) and 22 (100%) respectively on 3rd day of CUS. The association between gestational age and cranial abnormalities on 3rd day was statistically significant (P<0.05).

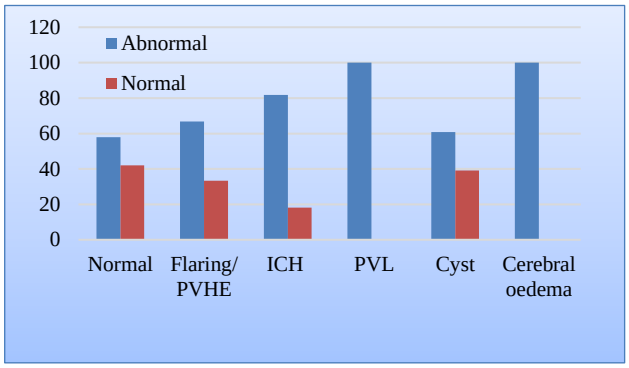


Figure 2: Association between gestational age and cranial abnormalitiies on 7th day CUS.

Figure 2 distribution of study participants on 7th day scan, out of all, 27 neonates those who had flaring/PVHE, 18 (66.7%) were preterm, 22 neonates were having ICH among them 18 (81.8%) were preterm. The preterm neonates had PVL and cerebral edema 4(100%) and 17(100%) respectively on 7th day of CUS. Out of 23 who had cyst 14 (60.9%) were preterm. There was no association between gestational age and cranial abnormalities on 7th day on CUS (P<0.05).

Table 4: Characteristics of study participants according to RI.

Characteristics	Resistance index			P
	Low	Normal	High	
Ga (weeks)	29.08±2.04	30.20±3.50	31.50±3.31	0.038
Birth weight (grams)	1,345.00±257.45	1,554.45±688.06	1,677.66±361.46	0.026
APGAR score	7.5±1.48	7.90±1.55	7.80±2.22	0.036
Ri	0.45±0.051	0.76±0.05	0.94±0.04	
total (%)	135 (58.9)	81 (35.3)	13 (5.8)	

Expressed in Mean±SD

Table 5: Association between gestational age and cranial Doppler evaluation on 3rd and 7th day.

	Findings	3rd day	7th day
GA vs ACA	GA vs PSV (cm/sec)	0.059	0.610
	GA vs EDV (cm/sec)	0.062	0.043
	GA vs RI	0.043	0.015

Out of 229 neonates 135(58.9%) had low, 81(35.3%) had normal and 13(5.8%) had high RI INDEX. Statistically significant association was found between gestational age, birth weight and APGAR score (p<0.05) (Table 4).

Table 5 shows association of Doppler analysis done on 3rd and 7th day rise in systolic and diastolic velocities regardless of the gestational age.

DISCUSSION

Daneman A, et al proved that cranial ultrasonography remains a useful modality for evaluation of neonatal brain.[8] De Vries and Cowan et al suggested that ultrasound is a useful tool in the early days, for unstable infant and CUS findings are sufficient for major clinical decisions.[9] In that 150 (65.5%) preterm and 79(34.5%) term neonates enrolled in the present study which was similar to study done by Badrawy N, et al.[10]

In the present study incidence of positive CUS findings was 154 (67.2%) among all neonates. Those who had abnormal findings among them PVHE, ICH, PVL, Cyst and oedema were more common. Mercuri E, Lilly Dubowitz et al[10] reported an incidence 20% and Ayala Gover, David Bader et al[11] reported an incidence of 11.2% abnormalities on CUS in neonates. Mercuri E, et al found periventricular and thalamic densities (8%), and intracranial haemorrhagic lesions (6%) on CUS.[10] Badrawy N et al reported that subependymal intraventricular hemorrhage (SE-IVH), brain edema, hypoxic ischemic changes, Posthemorrhagic hydrocephalus (PHH).[9] In the present study, the incidence of cranial abnormalities 102 (68.0%) was high in the preterms, than the term neonates 52 (65.8%). Badrawy N, et al showed in their study that 37% preterms had abnormal CUS findings.[9]

In the present study among neonates with abnormal findings on CUS 88 (71.5 %) had normal and 66 (62.3%) had low as per APGAR scoring (APGAR <7). The association between CUS findings of neonates with APGAR score was statistically significant which was similar to study done by Shankar P et al.[12]

In the present study on 3rd day scan out of all, 36 (58.1%) preterm neonates had flaring/PVHE, 43 neonates had ICH among them 26 (60.4%) were preterm. Those who had PVL and cerebral odema were preterm.

On 7th day scan, out of all, 27 neonates those who had flaring/ PVHE, 18 (66.7%) were preterm, 22 neonates were having ICH among them 18 (81.8%) were preterm. Those who had PVL and cerebral odema were preterm respectively on 7th day of cranial ultrasonography.

There was significant association of gestational age and cranial abnormalities on 3rd day and 7th day. Similarly, Prasad S et al studied, cranial ultrasonography and doppler in preterm and term neonates.[2]

Out of 229 neonates 133 (58.1%) had low RI, 83 (36.2%) had normal and 13 (5.7%) had high RI. There is statistically significant association between RI and gestational age, birth weight and APGAR score. Similar findings were found in study done by Nayara et al and Argollo et al.[13] The Several factors like respiratory distress syndrome, birth weight and gestational age have been described to influence CBF and RI. Ginette M et al lower RI values were associated with neurodevelopmental deficits in motor skill attainment and concluded that RI values may be a useful prognostic tool for neonates.[14]

El-Atawi K et al concluded, RI and EDV have shown a good correlation with the changes in CBF.[15] In the present study statistically significant association is seen between RI and brain lesions on 3rd day (p value = 0.004) and ACA velocity. With increasing gestational age, the resistive index is seen to fall, and these findings were similar as study done by Prasad S et al, Muniz et al found a as there is reduction in CBF, RI increase, whereas Scherjon et al detected an increase in CBF levels there is reduction in RI.[2,16,17]

CONCLUSION

The CUS is used as a powerful and primary screening modality for early detection of cranial abnormalities which guides in taking prompt clinical decisions and assess the prognosis. In the present study, flaring/PVHE, periventricular leukomalacia, ICH, cysts and cerebral edema were detected. CUS along with the Doppler study, RI and ACA is calculated, showed significant clinical correlation with gestational age, birth weight, and APGAR score. Serial studies help to evaluate presence of brain lesions. High efficacy of CUS with Doppler study can be done on 3rd day and followed up CUS done on 7th day to diagnose evolution of brain damage. Association between cranial abnormalities and RI on 3rd day CUS and Doppler was statistically significant. Study concludes that CUS and Doppler is an ideal tool to detect various intracranial lesions efficiently in non-invasive manner. Because of its accuracy and ease of repeatability makes it suitable for primary screening method for neonates at risk.

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Conflict of interest: None declared
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