Original Research Article

Cranial ultrasound in preterm neonates

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Abstract

Aims and Objectives: 1.To study brain abnormalities with cranial ultrasound in preterm infants. 2.To study association of various risk factors and cranial ultrasound abnormalities. 3.To assess the progression of abnormalities and treatment outcome. **Results:** Out of the 47 preterms included in our study, 20(42.6%) had abnormal cranial ultrasound done within 48 hrs of admission. When these preterms were followed up as per the protocol of the study, we found that at the mean follow up age of 35 wks, the cranial USG abnormalities reduced to 15 (31.9%). At term, these abnormalities were further reduced to 6 (12.8%). The results obtained above was statistically significant. In the present study, 64.7% were male and 38.3% were female. In addition, 40.4% were SGA, 53.2% were AGA and 6.4% were LGA. Most of the mother were primigravida (55%). Birth weight, Gestational age and Apgar score at 1 min and 5 min were statistically significant related with the abnormal cranial USG on admission. Age of the mother, Gravida, complications in the pregnancy and use of antenatal steroids were not statistically significant. Mode of ventilation, surfactant administration, presence of PDA, requirement of inotropes, presence of sepsis and abnormal neurological examination at term were statistically significant **Conclusion:** 1.Cranial USG abnormalities frequently occur in preterm infants. Many of them may resolve over a period of time especially when checked at full term. 2. The smaller the baby by gestational age, more chances of presence of cranial USG abnormalities. 3.Presence of cardiorespiratory risk factors increases the chance of cranial USG abnormalities.

Key Words: Cranial USG, Follow up, Preterm, Risk factors, Screening.

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INTRODUCTION

Cranial ultrasonography (CUS) has become an essential diagnostic tool in modern neonatology for depicting normal anatomy and pathological changes in neonatal brain. In the neonate, many sutures and fontanels are still open and these can be used as acoustic windows to "look" into the brain[1]. It is cheap, easy to perform, non-invasive and can be initiated at a very early stage, even immediately after birth. It can be repeated as often as necessary, and thereby enables visualisation of ongoing brain maturation and the evolution of brain lesions. In addition, it can be used to assess the timing of brain damage.[1] As a result of ongoing development in ultrasonography, image quality is high nowadays, provided optimal settings and techniques are applied. Using additional acoustic windows, we can significantly augment the diagnostic power of CUS. Scanning through the posterior and mastoid fontanelle, can help to detect lesions and structural malformations in cerebellum, brainstem and posterior sub cortical white matter. Imaging through the temporal window allows good views of the mesencephalon and brainstem.[2] Cranial ultrasound (CUS) provides bedside imaging access to the neonatal brain. It is a reliable tool for detecting congenital and acquired abnormalities of the perinatal brain and most frequent patterns of brain injury in preterm and full term neonate. It detects most of the hemorrhagic, ischemic and cystic brain lesions as well as calcifications, cerebral infections and major structural abnormalities in preterm and full term infants.[1] 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. Serial CUS examinations enable assessment of the onset of injury and the evolution of lesions.[1] The quality of CUS imaging and its diagnostic accuracy depends on the suitability of the ultrasound machine for neonatal work, appropriate settings and probes and also the experience and expertise of the examiner. Modern ultrasound machines and probes and the use of a variety of acoustic windows and adequate scanning protocols give high- quality images that are diagnostically accurate[3]. Most newborn intensive care unit centres perform serial cranial ultrasound evaluations early in the course of hospitalization for premature infants and often, a follow-up examination is done at a later age. These evaluations are done to document the presence of intracranial haemorrhage, to guide choice of therapies that may exacerbate risk of further haemorrhage, and to counsel families about neurodevelopment outcomes.[4] This prompted us to take up this study and to study abnormal and normal variants of ultasonographic findings of preterm brain and to sequentially follow up for the improvement or deterioration ultrasonographically and clinically after appropriate treatment and care.

METHODS AND MATERIALS

Study centre: Level III Inborn NICU of N.W.M. hospital during the period from November 2014 to April 2015.

Inclusion Criteria

- All preterm born < 32 weeks of gestation.

Exclusion Criteria

- All cases suspected to have congenital malformations,

Duration of study: 6 months

Method of Data Collection: Informed consent was obtained from the parents/guardian regarding inclusion of the neonate in the study. Detailed maternal history reviewing antenatal records was taken. All perinatal details were recorded and detailed clinical examination was done including anthropometric measurements. Vital parameters were recorded within 24-48 hrs of admission and neurological examination was done routinely during baby's stay in NICU using Amiel-Tison Neurological assessment scale and Brazelton Neonatal Behaviour Assessment Scale. Gestational age was assessed as per New Ballard's scoring method for all preterm neonates. Clinical Course of the babies was noted in the predesigned proforma. First Cranial ultrasound was performed within 48 hrs of admission. Follow up cranial ultrasound was done at 1st week then subsequently at 2 weeks interval till the baby becomes 40 weeks (term) for gestational age. Morphology of cranial ultrasound findings was studied and recorded and clinical correlation with various findings on cranial ultrasound was done.

Instrumentation: The sonograms were performed on a SONOSITE GE machine using a multifrequency high density volume -TV/TR probe. The images were obtained through the anterior fontenella and additional sections through the thin part of squamous temporal bone so as give images in axial plane comparable to CT and MRI images. Image quality was maximized by fine adjusting the pres *et al* ready available for transcranial 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.

Technique of Sonography: 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. 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. Sagittal section: Plane (a) Midline, (b) and (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 fontenella at the level of thalamus and caudothalamic grooves.

Data Analysis: Results were expressed as frequency of occurrence and percentages of various lesions which will be compared with clinical findings and other investigations along with cranial ultrasound findings.

RESULTS

In the present study, mean birth weight of the babies was 1.16 kg and mean gestational age was 29 wks. Mean age of the mother was 29 yrs. Mean Apgar score at 1 min was 6 and at 5 min was 8. There were 29 (61.7%) male and 18 (38.3%) were female. Out of 47 babies19 (40.4%) of babies were small for gestational age, 25(53.2%) were appropriate for gestational age and 3(6.4%) were large for gestational age. In the present study, 36(76.6%) of the mother received steroids antenatally (2 doses of betamethasone 12 hrs apart) whereas 11(23.4%) didn't get the chance to receive 2 doses and sometimes not even 1 dose). In the present study, 55% of the mothers were primigravida (G1).

Table 1: Distribution of the babies according to antenatal complications in the mother

Complications		Frequency	Percent
Valid	TWIN	7	14.9
	PIH	9	19.1
	PROM	12	25.5
	PT LABOUR	6	12.8
	OTHERS	13	27.7
	Total	**47**	**100**

TWIN-Twin pregnancy, PIH-Pregnancy induced Hypertension, PROM-Prelabour rupture of membrane, PT LABOUR—Preterm labour According to above table, the most common cause of preterm delivery was PROM (25.5%)This was followed by PIH (19.1%), Twin pregnancy (14.9%), Preterm labor (12.8%). Others were cervical insufficiency, Placental abruption, Non reassuring fetal heart rate and abnormal Doppler of the umbilical artery.

Table 2: Distribution of the babies according to mode of ventilation

		Frequency	Percent	Valid Percent
Valid	Cpap	23	48.9	48.9
	Cpap To Venti	2	4.3	4.3
	Venti To Cpap	12	25.5	25.5
	Not Req	10	21.3	21.3
	Total	**47**	**100.0**	**100.0**

CPAP-Those who required only CPAP after birth (48.9%), CPAP TO VENTI-Those who required CPAP initially weaned to room air then again required ventilator support (4.3%). VENTI to CPAP-Those with severe RDS requiring ventilator to begin with later put on cpap (25.5%). NOT REQ-Those who didn't require any support. (21.3%) In the present study, 18(38.3%) babies required surfactant administration whereas 29(61.75%) didn't require any surfactant. Only12 (25.5%) of the babies required use of inotropes whereas35 (74.5%) didn't require any inotropes. Seven (14.9 %) of the babies had haemodynamically significant PDA. Twelve (25.5%) developed culture positive sepsis whereas 35(74.5 %) didn't develop any sepsis**.**

Table 3: Distribution of the babies according to cranial USG at the time of admission

		Frequency	Percent
Valid	Normal	27	57.4
	Abnormal	20	42.6
	Total	**47**	**100.0**

Table 4: Distribution of the babies according to follow up cranial USG

		Frequency	Percent
Valid	Normal	32	68.1
	Abnormal	15	31.9
	Total	**47**	**100.0**

Table 5: Distribution of the babies according to cranial USG at term

	Frequency	Percent
Normal	41	87.2
Abnormal	6	12.8
Total	**47**	**100.0**

Table 6: Comparison of Cranial Ultrasound (Cus) At Admission and Follow Up

Paired Difference in CUS	CUS on ADM		P-VALUE
	Normal	Abnormal	
Follow up CUS	25	7	0.180
	2	13	
Term CUS	26	15	0.001
	1	5	

Comparison is done using Mc Nemar test.

Table 7:

	Normal	Abnormal	P value
CUS on Adm	57.4	42.6	
Follow up CUS	68.1	31.9	0.180
TERM CUS	87.2	12.8	0.001

Mc Nemar test is used to check whether Proportion of abnormalities at baseline and at follow up has increased or decreased and is statistically significant or not. Here Abnormalities at admission is 42.6% but at follow up is 31.9%, but this difference of 10.7% is not statistically significant (p value 0.18) Whereas Abnormalities at Admission is 42.6**%** but at Term is 12.8 **%,** this difference is statistically significant (p value 0.001). i.e. for term CUS abnormalities has decreased compared to baseline.

Table 8: Distribution according to various cus abnormalities

		Frequency	Percent
Valid	Normal	27	57.4
	GMH	6	12.8
	GMH-IVH	2	4.3
	TB ECHO	5	10.6
	Mild Ventr	5	10.6
	PV ECHO	2	4.3
	Total	**47**	**100.0**

GMH-Germinal matrix hemorrhage, GMH IVH-Germianl matrix hemorrhage with intraventricular extension, TB ECHO-Thalamus and Basal Ganglia echogenicity. MILD VENTR-Mild ventriculomegaly, PV Echo-Periventricular echogenicity.

Table 9:

Bt. Wt	1267.22	1028.75	0.016
Gest Age	30.356	29.26	0.006
AGE	29.04	29.85	0.329
APGAR_1	7.1481	6.05	0.005
APGAR_2	8.37	7.65	0.032

Above table clearly states that Birth weight, Gestational age and APGAR_1 and APGAR _5 minutes are statistically significant in comparison with cranial USG on admission.

Table 10: Comparison Of Various Factors And Cus Adm

		Normal	Abnormal	P Value
Sex	Male	10	8	0.836
	Female	17	12	
SAL-GA	SGA	9	10	
	AGA	15	10	0.215
	LGA	3	0	
GRAVIDA	G1	16	10	
	G2	3	7	
	G3	4	2	0.318
	G4	3	1	
	G5	1	0	
Steroids	YES	22	14	0.489
	NO	5	6	
Complication	TWIN	3	4	
	PIH	4	5	
	PROM	10	2	0.317
	PT LABOUR	3	3	

From the previous table, it can be observed that the mentioned antenatal risk factors didn't show statistically significant association with the cranial USG on admission.

Table 11: Distribution according to abnormal neurological examination at term

		Frequency	Percent
Valid	YES	5	10.6
	NO	42	89.4
	Total	**47**	**100.0**

Five (10.6%) of the babies had abnormal neurological examination at term and when compared with the cranial ultrasound at term the p value is <0.001 which is highly significant.

Table 12: Comparision of cus on follow up and other risk factors

Surfacant	YES	5	13	0.001
	NO	22	7	
Inotropes	YES	2	10	0.001
	NO	25	10	
PDA	YES	0	7	0.001
	NO	27	13	
Sepsis	SEPSIS	4	8	0.05
	NO	23	12	
CPAP VENTI	CPAP	15	8	
	VENTI	1	0	
	CPAP to VENTI	2	0	0.004
	VENTI to CPAP	1	10	
	NOT REQ.	8	2	

Above table explains that cranial ultrasound in follow up (mean age 35 wks) and use of surfactant, mode of ventilation, inotropes, PDA and presence of sepsis are statistically significant in the present study.

DISCUSSION

De Vries and Cowan *et al* have suggested that head ultrasound and MRI are complementary modalities, with ultrasound as an especially useful tool in the early days, when the infant is unstable for transport and ultrasound findings may be sufficient for major clinical decisions. Present study aims at proving the same.[5] The American Academy of Neurology and the Practice Committee of Child Neurology recommend routine cranial ultrasonography screening on all newborns born before 30 weeks of gestational age[6]. The Canadian Pediatric Society suggests the need for cranial ultrasonography before 32 weeks of gestational age.[7] In the present study Incidence of CUS abnormalities in preterm <32 weeks is 42.6% on admission which decreased to 31.9% on follow up and became 12.8% at term.(TABLE NO3-5). There were 61.7% male and 38.3% female neonates enrolled in the study. Badrawy N, Edrees A, and Mohamed El Ghawas*et al* showed in their study that 37% preterms had abnormal CUS findings. Their study had 64% male and 36% female neonates and the sample size was 175 preterms.[8] Van wezel-Meijler G et[9] al in their study found that In preterm neonates, diffuse homogeneous Echogenicity of the Basal Ganglia and Thalami is a frequent and normal prematurity-related finding. Incidence of abnormal USG and initial follow up is nearly same in the present study and the study conducted by Badarwy *et al*[8]. At term it is around 12.8 % which can be explained by the findings of Van Wezel-Meijler G *et al*[9]. Also the difference in the sample size and consideration of other risk factors explains the difference. In the Present Study, 40.4%babies were SGA, 53.2% were AGA and 6.4% were LGA babies. The incidence of cranial USG abnormalities were not statistically significant.(TABLE NO 9). Similar results were obtained in the study by Ballardini E *et al*[10]. Few studies suggests that there is association between Gravida of the mother, antenatal steroids in the mother and complications during delivery in the mother with the presence of cranial USG abnormalities in the baby. McElarth *et al*[11] found that use of antenatal steroids lowers the risk of abnormal brain USG. In the present study although 76 % of mother received antenatal steroids, the incidence of abnormal cranial USG was not statistically significant in those who didn't receive it (TABLE NO9). Also the presence of PROM, PT Labor, and Cervical insufficiency significantly increases the risk of abnormal cranial USG as found by McElarth *et al*[11], this was not the case with our study (TABLE NO 1 and TABLE NO 9). These variations can be explained by the Large sample size 1145 infants in their study because we got the higher incidence of some of the variables mentioned above in our study but because of smaller sample size they turned out to be statistically non significant. Those who require invasive ventilation have more chances of abnormal cranial USG at follow up as compared to those who

didn't require any ventilator support or those who required CPAP (TABLE NO2 and TABLE NO 12). Similar result was obtained by Ballardini E *et al*.[10] The Presence of PDA and requirement of inotropes significantly increased the risk of abnormal brain USG. (TABLE NO 12). Septic preterm baby has more chances of developing brain abnormalities as compared to non septic babies. (TABLE NO 12). Similar findings were obtained by Kim KR, Jung SW, Kim DW.[12] and Ballardini E *et al*. Gestational age and Birth weight are significantly associated with cranial ultrasound abnormalities (p value 0.006 and 0.016 respectively). Also there is significant association between apgar score at 1 minute and 5 minute. (p value 0.005 and 0.03). Similar findings were obtained in the study by Kim KR, Jung SW, Kim DW.[12]

CONCLUSION

- Cranial USG abnormalities frequently occur in preterm infants. Many of them may resolve over a period of time especially when checked at full term.
- The smaller the baby by gestational age, more chances of presence of cranial USG abnormalities.
- Presence of cardiorespiratory risk factors increases the chance of cranial USG abnormalities.
- Abnormal clinical examination strongly correlates with the abnormal USG findings at term.
- Appropriate treatment of the sepsis along with other cardiorespiratory risk factors helps in improvement in cranial abnormalities clinically and ultrasonographically.

LIMITATIONS OF THE STUDY

1. Although MRI brain forms a definitive diagnosis of cranial abnormalities and neurosonography is a corroborative evidence, we have not included this as an investigative parameter due to financial constrains.
2. More studies with larger sample size and longer follow up period in preterm babies would help in supporting our findings.

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