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Role of Neuro-ultrasound in Evaluation of Intracranial Pathologies in Preterm Neonates and Infants with Abnormal Neurological Presentation

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Abstract: ***Trans-fontanel ultrasound has become widely used technique and is regarded as the primary imaging procedure for neonatal and infantile brain to identify various intracranial pathologies. The inclusion of color and pulsed wave Doppler has added to the versatility of ultrasound imaging through the cranium. The non-invasive, benign nature of neurosonography results in excellent initial test for high risk preterm infants suspected of having germinal matrix hemorrhage, intraventricular hemorrhage and then consequences like ventriculomegaly, subependymal cysts and porencephalic cystic changes. It also helps in early detection and proper management of neonates, helps in preventing neonatal morbidity, mortality and further mal-development. The present study is prospective study of "Role of Neuro-ultrasound in evaluation of intracranial pathologies inpreterm neonates and infantsabnormal neurological presentation" conducted in our department. Total 100 preterm neonates were studied, In preterm neonates most common lesion noted was SEH/IVH (Incidence of SEH/IVH in present study was 26%). Incidence of Grade-i hemorrhage is 34.6%, Grade-2 hemorrhage is 30.7%, Grade-3 hemorrhage is 15.3% and Grade-4 hemorrhage is 19.2%. Periventricular echogenicity was next common finding noted in preterm neonates in our study with incidence of PVE in present study is 3%.***

Keywords: Transfontanel, pulsed wave Doppler, neonatal brain

1. Introduction

Neonatal sonography of the brain is now essential part of newborn care, particularly in high risk and unstable premature infants. Current ultrasound technology allows for rapid evaluation of infants in the intensive care unit with virtually no risk.The advantage of sonography over computed tomography (CT) or magnetic resonance imaging (MRI) include portability, lower cost, speed, no ionizing radiation, and no sedation. . 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 neonates. CUS is also very helpful in early diagnosis of the many etiologies of neonatal encephalopathy and seizures in the term infants and the subsequent monitoring of progress of hypoxic-ischemic brain injury.

2. Review of Literature

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 fontanelles are still open and these can be used as acoustic windows to "look" into the brain [1] . Currently, most brain sonographic examinations are performed through anterior fontanelles in both coronal and sagittal plane. Using additional acoustic windows can significantly augment the diagnostic power of CUS. Scanning through posterior and mastoid fontanelle, can help to detect the lesions and structural malformation in the cerebellum, brainstem and posterior sub cortical white matter. Imaging through temporal window allows the best views of mesencephalon and brainstem[2]. Good skin to transducer coupling can be achieved by an acoustic coupling gel. The anterior fontanelle remains open until approximately two years of age but is suitable for scanning till 12-14 months. Cranial ultrasound (CUS) is reliable tool for detecting congenital and acquired abnormalities of the perinatal brain and most frequent patterns of brain injury in preterm and full term neonates.

Trans-fontanel ultrasound has become widely used technique and is regarded as the primary imaging procedure for neonatal and infantile brain to identify various intracranial pathologies. The inclusion of color and pulsed wave Doppler has added to the versatility of ultrasound imaging through the cranium [3,4]. Newer advances in recording images from the static conventional photographic film, video tape to the newest of digital recording on the hard disc with the capability of post-processing the images has added a new dimension-to neonatal brain ultrasound examination. As a result of ongoing development in ultrasonography, image quality is high now-a-days, provided optimal settings and techniques are applied.

3. Problem Definition

Preterm neonates (born prior to 32 weeks of gestation and weight less than 1500g at birth) with abnormal neurological presentation seizures, lethargy, increase in muscle tone, bulging anterior fontanel. Neonates with gross congenital malformation and twin gestations were excluded from study

Aims and Objectives

1) Identify the ultrasound characteristics of various intracranial pathologies in preterm neonates with neurological symptoms
2) To assess the diagnostic value and prognostic accuracy of ultrasound in neonates with abnormal neurological presentation

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Indications

Real time Neuro-sonogram is a sensitive non-invasive first investigation for detection of the various brain lesions in the neonates and infants.

Indications for neuro-sonography in preterm and term neonates and infants include but are not limited to the following:

1) Screening for hemorrhage or parenchymal abnormalities in preterm infants:
2) Evaluation and assessment of hemorrhage;
3) Evaluation and assessment of hydrocephalus;
4) Screening for presence of vascular abnormalities;
5) To evaluate for possible or suspected hypoxia ischemic encephalopathy.
6) To evaluate for the presence of congenital malformations;
7) To evaluate patients with signs and/or symptoms of central nervous system disorderseg., seizures and facial malformations:
8) For follow-up or surveillance of previously documented abnormalities, including prenatal abnormalities;
9) For screening before surgical procedures.

There are no contraindications to neurosonography.

Methodology and Approach

Source of data

This prospective study was done in our department. This study comprises of 100 neonates, referred to the Department of Radio diagnosis for cranial ultrasonography.

Equipment

Neuro-sonogram were obtained by using 3.5-5 MHz convex and 7.5-10 MHz |linear and TVS probes of Xario™ SSA-660A ultrasound units.

Technique:

Neonates were transported to ultrasound room after adequate feeding by wrapping them in warm clothing to avoid hypothermia. Some studies were also being carried out in the NICU in critical cases. No sedation was used. The baby is laid in supine.

The transducer and transmitting media gel (profuse coupling agent) were placed on the anterior fontanelle of neonatal head and images are obtained in coronal and sagittal planes. The examination started in coronal plane along the coronal suture, with transducer angled towards the frontal region. Then brain examined in various coronal plane by sweeping the transducer from anterior to posterior.

Following the completion of examination in coronal plane, sagittal and parasagittal scans were obtained by placing the transducer on the anterior fontanel, perpendicular to coronal plane and then sweep from midline thorough the lateral ventricles, the cerebral parenchyma on each side.

Care was taken to absolute symmetry of scans which was maintained throughout the examination, as densely echogenic choroid plexus appears large on each side causing a false image of Subependymal hemorrhage. The total time taken for the examination varied from 10-15mins.

Cranial ultra-sonogram done at 1st, 3rd, 7th days and on 28th day or pre-discharge. The ultra-sonogram scans were evaluated with special attention to theechogenicity of cerebral parenchyma, ventricle size, SEH/IVH, any focal incidence or cystic changes and for PVE.

4. Results and Observation

Table 1: Gestational age wise distribution of cases

Gestitional age (wks)	No. of cases
28-30 wks	11 (11%)
30-32 wks	24 (24%)
32-34 wks	30 (30%)
34-36 wks	35 (35%)

Table 2: Incidence of SE/IVH among different gestational age

SE/IVH	28-30 wks	30-32 wks	32-34 wks	34-36 wks
Grade I	2	5	1	1
Grade II	2	3	2	1
Grade III	1	2	1	0
Grade IV	2	2	0	1
Total %	63.6 %	50 %	13.3 %	8.5 %

Table 3: Birth weight wise distribution of case

Birth weight (Kgs)	No. of cases
< 1.5 kg	15 (15%)
1.5-2 kg	25 (25%)
>2 kg	60 (60 %)
Total	100

Table 4: Sex wise distribution of cases

Sex	No. of cases
Male	54 (54 %)
Female	46 (46 %)
Total	100

Table 5: Distribution of various clinical Presentations

Clinical presentations	*No. of neonates*
Seizures	55 (55 %)
Lethargy	35 (35 %)
Flaccidity	19 (19 %)
Pallor	9 (9 %)
Abnormal reflexes	15 (15 %)
Bulging fontanelles	10 (10 %)

Table 6: Distribution of various lesions in 1st scan

Lesions	*No. of cases*
GMH/IVH	26 (26 %)
PVL	03(03 %)
Cerebellar hemorrhage	00 (00 %)
Total	29 (29 %)

Table 7: Distribution of various grades of hemorrhage

GRADE	*N*	*%*
GRADE-1	9	34.6 %
GRADE-2	8	30.7 %
GRADE-3	4	15.3 %
GRADE-4	5	19.2 %

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Table 8: mortality rate among different grades of hemorrhage

SE/IVH	*No.*	*Mortality*	*%*
Grade I	9	1	11.11 %
Grade II	8	1	12.5 %
Grade III	4	2	50 %
Grade IV	5	3	60 %
Total	26	7	26.92 %

Table 9: Distribution of findings at follow up

SE/IVH	Follow up scan	%
Subependymal cyst	3	11.53 %
Post hemorrhagic Hydrocephalus	4	15.38 %
Porencephalic cyst	2	7.69 %
Remains same	5	19.23 %
Resolution	10	19.23 %
Expired	7	26.92 %

5. Discussion

Neurosonography has now been routinely performed in premature neonates and infants. Daneman A, Epelman M et al [5] proved that CUS remains an extremely useful modality for evaluation of the neonatal brain.

De Vries and Cowan et al [6] 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.

In this prospective study of 100 preterm neonates enrolled among these 54 were male and 46 were female. Among 100 babies, 71 (71%) showed normal study and remaining 29 (29%) showed abnormal scan.

Badrawy N. et al[7] reported that sub ependymal intraventricular hemorrhage (SE-IVH) was present in (38%), hypoxic ischemic changes in (11%), subependymal cysts (8%) post-hemorrhagic hydrocephalus in (9%) as a complication of SE-IVH.

In our study among in preterm neonates which were abnormal on scan most common finding was SEH/IVH (26 %) and next commonest was hypoxic ischemic changes (PVE-3 %)

Although the incidence once was as high as 55%, most NICU have experienced a significant drop in GMH and IVH now range from 10-25 %.

Out of fifteen neonates with SEH/IVH, (33.3%) neonates belongs to Grade1 hemorrhage, (33.3%) belongs to Grade-2 hemorrhage, (13.3%) belongs to Grade-3 hemorrhage and (20%) neonate belong to Grade-4 hemorrhage.

This study is also compared with other studies as shown below. Our study correlate with study done by Carol Rumack et al.

Grade	Carol Rumack et al. (1985) [8]	Nilgun koksal et al. (2002)[9]	Kadri et al. (2011) [10]	Ramenghi La et al. (2011) [11]	Present study
Grade-1	32 %	50.0 %	52.4 %	57.9 %	34.6 %
Grade-2	32 %	17 %	30.95 %	19.3 %	30.7 %
Grade-3	12 %	11 %	11.9 %	24.15 %	15.3 %
Grade-4	18 %	22 %	4.76 %	4.8 %	19.2 %

Timing of Intracranial Hemorrhage

In our study out of 15 neonates with IVH 9 cases (65%) were detected within 48 hrs after birth by neuro-sonogram. In a study done by Tsiantos A et al [12] found that 60% of the hemorrhages took place between 15 to 48 hours of age with mean age of 38 hours.

In another study done by Carol M Rumack MD et al[84] found that 64% of the hemorrhage took place within 24 hours. A study done by Leven Ml et al states that most hemorrhages occurred during first two days of life.

Badrawy N. et al[7] reported that Grade I comprising 48% of all hemorrhages detected among SE/IVH followed by Grade II (20%), and Grade III & IV (16% each).

In our study the incidence we reported the same as the Grade l SE/IVH compromising the most cases (34.6 %) followed by Grade II (30.7%), Grade III (15.3 %) and IV (19.2 %)

Badrawy N et al [7] also reported that the incidence of SE/IVH increased with decreasing gestational age, where the incidence was 37.5% in patients <30 wks, 23% in patients between 30-<34 wks and 6% in patients between 34-<37 Wks.

In another study by llikkan et al. [13] reported gestational age < 33 wks as a significant risk factor for IVH. In our study the incidence of SE/IVH is more in 28-30 wks (63%) followed by 30-32 wks (50%), 32-34 wks (13.3%) and 8.5% in 34-36 wks gestational age group.

Mortality Rates

In our study we reported high mortality rate among Grade IV (60%) and Grade III (50%) hemorrhages followed by Grade II (12.5%) and Grade I (11.1%). The overall mortality was 26.9%.

Badrawy N. et al [7] reported overall mortality rate of 30%. The mortality rate in relation to severity was high in Grade IV (75%) and Grade III (66%) followed by Grade II and Grade I (40% and 25%).

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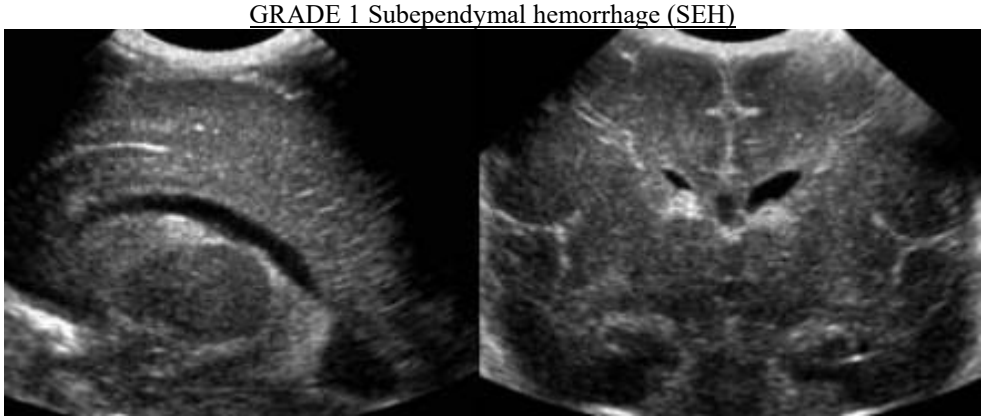
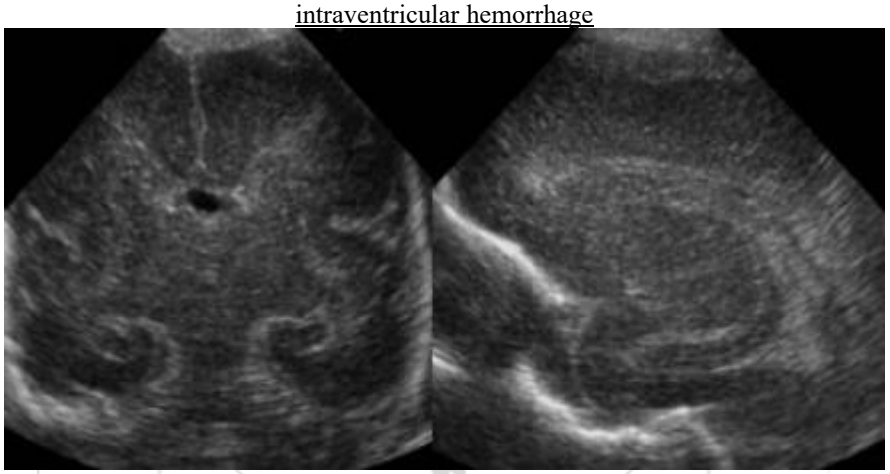
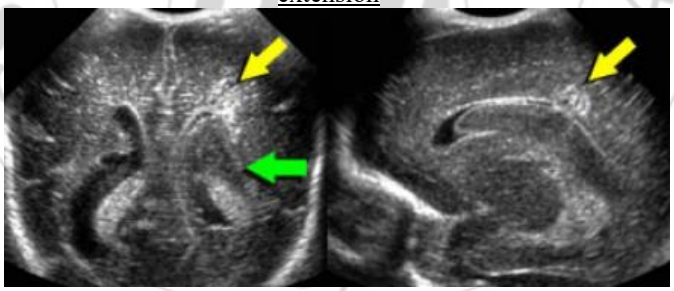
Neurosonogram showing sagittal and Coronal plane through anterior horns showing GRADE 1 Subependymal hemorrhage (SEH)



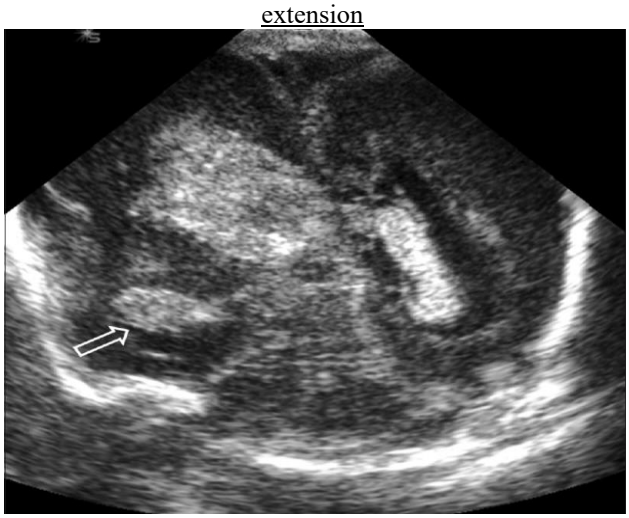
Neurosonogram Coronal and sagittal plane through anterior horns of lateral ventricles showing GRADE 2 Bilateral intraventricular hemorrhage



Neurosonogram coronal and sagittal plane showing GRADE 3 Bilateral intraventricular hemorrhage (IVH) with parenchymal extension



Coronal plane through frontal lobes showing Grade 4 Bilateral intraventricular hemorrhage (IVH) with parenchymal extension



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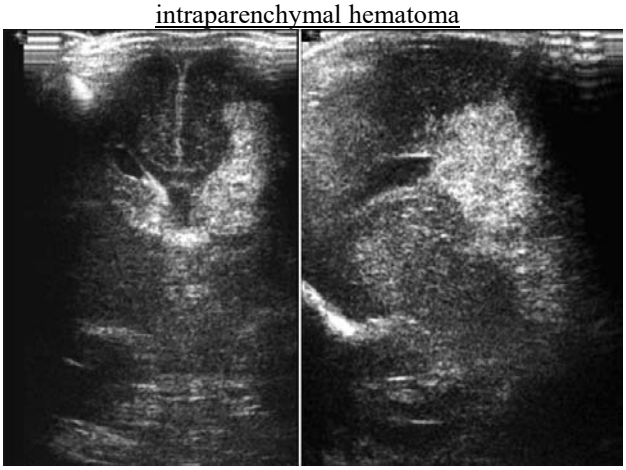
Neurosonogram Midline sagittal plane showing large intraparenchymal hematoma



6. Conclusions

Real time Neuro-sonogram is a sensitive non-invasive initial investigation for detection of the various brain lesions in the neonates and infants, most common intracranial lesion noted in preterm neonates is different grades of intracranial hemorrhage and are detected within first 48 hours, Mortality rate was high in Grade III& grade IV SE-IVH and high incidence of brain injuries were detected in babies born less than 32 weeks. The non-invasive, benign nature of neurosonography results in excellent initial test for high risk preterm infants suspected of having germinal matrix hemorrhage, intraventricular hemorrhage and then consequences like ventriculomegaly, subependymal cysts and porencephalic cystic changes. It also helps in early detection and proper management of neonates, helps in preventing neonatal morbidity, mortality and further mal-development. Finally, the technique is relatively economical and can be reviewed any number of times without hazards.

7. Summary

The present study is prospective study of "Ultra-sonographic evaluation of intracranial lesions in neonates and infants" conducted in our department

Total 100 preterm neonates were studied,

Fifty-four were males and forty-six were females.

- In preterm neonates most common lesion noted was SEH/IVH.
- Incidence of SEH/IVH in present study is 26%
- Most of the SEH/IVH is detected by Neuro-sonogram within first 48 hours of life
- Neonates, which survived with intracranial hemorrhage, showed Subependymal cysts, ventriculomegaly and porencephalic cysts on follow up study
- Incidence of Grade-i hemorrhage is 34.6%, Grade-2 hemorrhage is 30.7%, Grade-3 hemorrhage is 15.3% and Grade-4 hemorrhage is 19.2%, in present study
- Periventricular echogenicity was next common finding noted in preterm neonates in our study
- Incidence of PVE in present study is 3%.

8. Future Scope

Newer advances in recording images from the static conventional photographic film, video tape to the newest of digital recording on the hard disc with the capability of post-processing the images has added a new dimension-to neonatal brain ultrasound examination.

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