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NEUROSONOGRAM FINDINGS IN HIGH RISK NEONATES AND THEIR ASSOCIATION WITH NEURODEVELOPMENTAL OUTCOME

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ABSTRACT

Background: Neurosonogram (NSG) has become an essential diagnostic tool in modernneonatology for depicting normal anatomy and pathological changes in neonatal brain**.**It is easy to perform, non-invasive and can be initiated at a very early stage, even immediately after birth. Any neonate, regardless of birth weight or gestational age, who has a greater than average chance of morbidity or mortality, due to fetal, maternal or placental anomalies or an otherwise compromised pregnancy, especially within the first 28 days of life is categorized as high risk neonate. NSG provides bedside imaging access to the neonatal brain, reliable tool for detecting congenital and acquired abnormalities of the perinatal brain and most frequent patterns of brain injury in preterm and term neonate.

Objectives: To find out incidence of NSG abnormalities in high risk neonates, to study various intracranial findings and correlate them with clinical neurological examination, to follow up high risk neonates till 6 months of age for their neurodevelopmental outcome.

Materials and Methods: The present one year prospective analytical study was conducted at ASRAM Hospital, Eluru during the period of March 2023 to March 2024 among 60 high risk neonates. After taking the informed written consent from the Parent or Guardian, the relevant information regarding pregnancy, delivery were collected from the parents and the newborn details recorded in a predesigned proforma. A neurological examination is done to detect neurological deficits and tone abnormalities. Tone, reflexes, anthropometry, seizures, feeding difficulties were noted at the time of discharge. These babies were assessed at 3 and 6 months of age in the outpatient department. At each follow-up, tone assessed by Amiel -Tison angles at 3 and 6 months of age, detailed developmental milestones and occipitofrontal circumference (OFC) were assessed, hearing and vision tested clinically, seizures during follow up and use of antiepileptic drugs.

Results: In the present study, incidence of NSG abnormalities in high risk neonates is 30% in which the mostcommon finding is Intracranial hemorrhage (ICH) and next common is periventricular hyperechogenecity and Cerebral edema. On regular follow up of these high risk newborns at 3 months and 6 months of age, 8 infants were developmentally delayed out of 60 high risk infants.

Interpretation and conclusion:

NSG is critical as a investigatory modality in NICU and effectively documents morphology of brain damage and on regular follow ups, we can intervene early and limits the complications.

KEYWORDS:

Neurosonogram, high risk neonates, neurodevelopmental outcome

INTRODUCTION

Neurosonogram (NSG) has become an essential diagnostic tool in modern neonatology for depicting normal anatomy and pathological changes in neonatal brain. It is 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 visualization of ongoing brain maturation and the evolution of brain lesions and assess the timing of brain damage.Any neonate, regardless of birth weight or gestational age, who has a greater than average chance of morbidity or mortality, due to fetal, maternal or placental anomalies or an otherwise compromised pregnancy, especially within the first 28 days of life is categorized as high risk neonate. NSG plays an important role in assessing neurological prognosis of these high risk infants. It 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.Current studies aim more at detecting subtle white matter disease, assessing brain growth and maturation and predicting neurodevelopment outcome from NSG. Appropriate timing of NSG and accurate assessment of the site and extent of lesions is crucial for accurate prediction of neurodevelopment outcome. NSG is very helpful in assessing severity and neurodevelopment outcome in infants with HIE. In cases of (suspected) ischemic injury, even if apparently mild. it is therefore advisable to intensify NSG examinations until normalization or stabilization of abnormalities has occurred. NSG is reliable for detecting common markers of metabolic disease in neonates, such as germinolytic cysts, lenticulostriate vasculopathy and more extensive BG calcification, cortical and other structural abnormalities.Meningitis and brain infections can have a very rapid, fulminantcourseandshouldthereforebeintensivelymonitored by repetitive NSG.Neurodevelopmental assessment in the first year of life is important for determining the presence or absence of brain damage. By thorough neurodevelopmental assessment and follow up of high risk neonates, neurodevelopmental abnormalities can be identified early and subject for early intervention, thus long-term morbidity can be minimized.

METHODOLOGY

STUDY PLACE: The presen tstudy was conducted in the ASRAM Hospital, Eluru during the

period of March 2023 to March 2024.

STUDY DESIGN: The present study is one year prospective analytical study on high risk

SAMPLE SIZE: Totalof60high risk neonates were included in the study.

INCLUSION CRITERIA: High risk neonates with any of the following:

Maternal factors:

1. Age at delivery – Age <16 yrs and > 40 yrs
2. Personal factors – Poverty, smoking, alcohol, poor diet, trauma, etc.
3. Medical conditions – DM , Thyroid, Renal problems , UTI, hypertension , heart diseases , Anaemia, etc.
4. Obstetric history: PROM, TORCH infections, bleeding, maternal medications

Fetal factors:

1. Multiple gestations, LGA &/ Macrosomia , IUGR
2. Abnormal fetal position / presentation, abnormality of fetal heart rate or rhythm, decreased activity
3. Polyhydramnios, oligohydramnios

Labor and delivery factors:

1. Preterm delivery, post-term delivery
2. Maternal fever, maternal hypotension
3. Rapid labor, prolonged labor, abnormal presentation
4. Uterine tetany, meconium-stained amniotic fluid, prolapsed cord
5. Cesarean section, obstetric analgesia and general anesthesia
6. Placental anomalies- Small placenta,Large placenta,Torn placenta and/or umbilical vessel, Abnormal attachment of vessels to placenta

Postnatal factors:

1. Low 5-minute and 10-minuteApgar score
2. Pallor or shock
3. Foul smell of amniotic fluid or membranes
4. SGA, LGA, post maturity

EXCLUSION CRITERIA: 1. Babies died within 24 hours. 2. Babies whose parents did not give consent for the study. 3. Babies died during follow up.

METHODSANDCOLLECTIONOFDATA

Data collection:

After taking the informed written consent from the Parent or Guardian, the relevant information regarding pregnancy, delivery were collected from the parents and the newborn details recorded in a predesigned proforma. A neurological examination is done to detect neurological deficits and tone abnormalities. Sixty term neonates including those born in Alluri Sitarama Raju Academy of medical sciences and outborn babies referred from other hospitals to ASRAM who fulfilled the inclusion criteria formed the study group. NSG done to all high risk neonates. Tone, reflexes, anthropometry, seizures, feeding difficulties were noted at the time of discharge. These babies were assessed at 3 and 6 months of age in the outpatient department. At each follow-up, tone assessed by Amiel -Tison angles at 3 and 6 months of age, detailed developmental milestones and occipitofrontal circumference (OFC) were assessed, hearing and vision tested clinically and seizures during follow up and use of antiepileptic drugs.

INVESTIGATIONS

NSG was done to all high risk neonates.

RESULTS

An observational correlation clinical study of 60 high-risk neonates is undertaken to assess the importance of cranial ultrasound as a investigatory modality and find out incidence and the morphology of various cerebral lesions and correlate them with clinical neurological examination and also to follow up high risk neonates till 6 months of age for their neurodevelopmental outcome.

TABLE 1: INCIDENCE OF DIFFERENT NSG ABNORMALITIES IN HIGH RISK NEONATES

Neurosonogram		
	Number of high risk neonates (n=60)	**Percentage (%)**
Normal	42	70

Abnormal	18	30
ICH	5	8.3
PV HYPERECHOGENECITY	4	6.5
Cerebral edema (CE)	4	6.5
HIE	2	3.3
Other findings	3	5.4
Total	60	100

On NSG, 30% of neonates had abnormal findings. 8.3% of these had evidence of intracranial bleed, 6.5% periventricular hyperechogenicity, 6.5% cerebral edema, 3.3% definite HIE and 5.4% others.

TABLE 2: INCIDENCE OF ABNORMAL CLINICAL EXAMINATION IN HIGH RISK NEONATES WITH NSG FINDINGS AND THEIR CORRELATION

Clinical examination	**NSG**		**Significance**
	Normal (n=42)	**Abnormal (n=18)**	**P value**
Abnormal cry	0	1 (5.5%)	0.123
Poor activity	0	4 (22.2%)	0.002
Poor/ abnormal tone	0	11 (61.1%)	0.001
Poor reflexes	0	9 (50%)	0.001
Abnormal posture	0	0	-
Presence of pallor	0	13 (72%)	0.001
Presence of icterus	0	1 (5.5%)	0.001

Presence of cyanosis	23 (54.7%)	6 (33.3%)	0.128
Tachycardia (HR>160)	9 (21.4%)	14 (77.7%)	0.001
Tachypnea (RR>60)	15 (35.7%)	3 (16.6%)	0.140

Of the 30% neonates having abnormal CUS, 33.3% were cyanosed, 22.2% had poor activity, 61.1% had abnormal tone, 5.5% were icteric, 72% were pale, 50% had poor neonatal reflexes. There was statistically significant correlation between abnormal tone, abnormal activity, poor reflexes and presence of pallor, icterus and tachycardia on clinical examination and presence of abnormalities on cranial ultrasound.

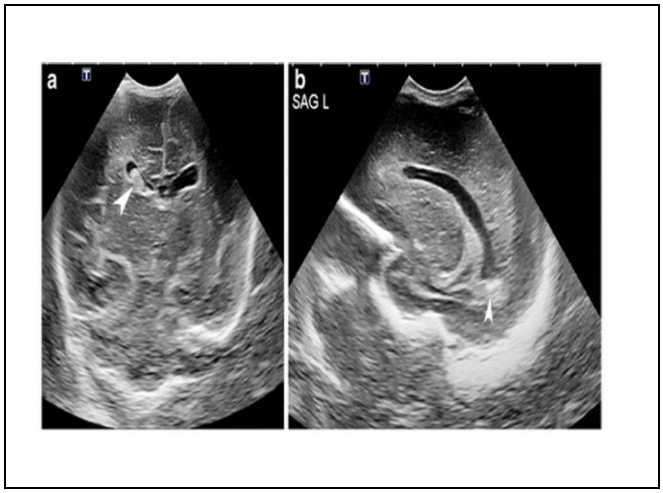
Table 3:NSG FINDINGS IN HIGH RISK NEONATES CORRELATING WITH DAY OF LIFE OF NSG.

NSG findings	**Number of high risk neonates (n=60)**	**Day of life of NSG**			
		<24 hrs	**24 to 72 hrs**	**>72 hrs**	**P value**
ICH	5 (8.3%)	2 (40%)	2 (20%)	1 (33.3%)	0.001
PV HYPERECHOGENECITY	4 (6.6%)	2 (40%)	2 (20%)	1 (33.3%)	0.002
CEREBRAL EDEMA	4 (6.6%)	1 (20%)	3 (30%)	0	0.004
HIE	2 (3.3%)	0	2 (20%)	0	0.016
OTHER FINDINGS	3 (5%)	0	1 (10%)	1 (33.3%)	0.019
TOTAL	18	5	10	3	

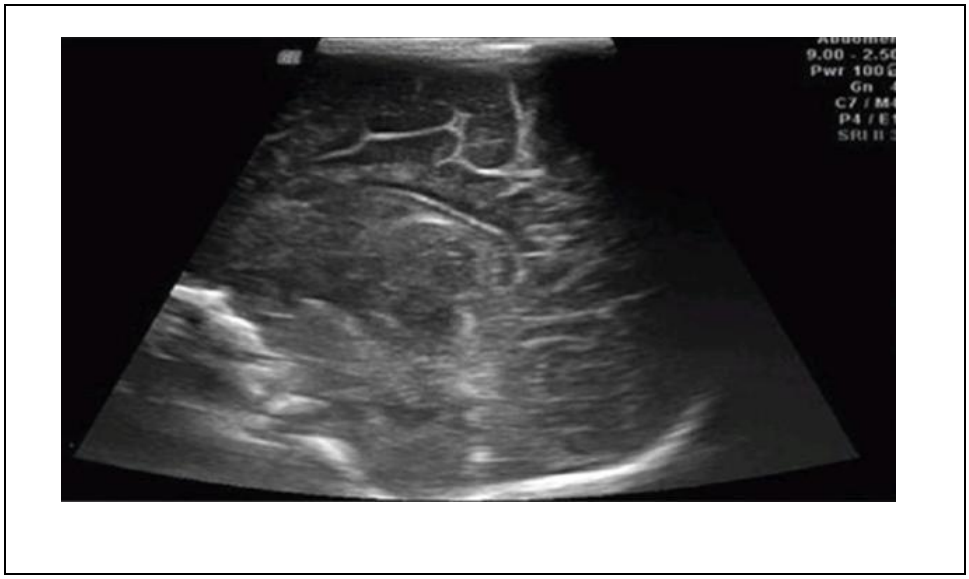
Of all the CUS scans done for those neonates less than 24 hours old, 61.6% were normal. Of the CUS scans done for neonates between 24 to 72 hours of life, 70.5% were normal and 29.9% were abnormal.Of all the CUS scans done for those neonates more than 72 hours old, 77% were normal. Of the high risk neonates with term gestation, 20% had normal and 80% had abnormal CUS. Of the high risk neonates with preterm gestation, 74.6% had normal and 25.4% had abnormal CUS. Of the high risk neonates with term gestation having abnormal findings on CUS, 25% had ICH, 25% had periventricular hyperechogenecity, 25% hadcerebral edema, 25%

had HIE. Of the high risk neonates with preterm gestation having abnormal findings on CUS, 28.5% had intracranial bleed, 21.4% had periventricular hyperechogenecity, 21.4% had other findings and 7.1% had HIE.

NSG showing grade 2 Intra ventricular hemorrhage (IVH)



NSG showing periventricular hyperechogenecity.



TABLE–4: ASSESSMENT OF DEVELOPMENTAL MILESTONES AT 3 MONTHS AND 6 MONTHS OF AGE.

Developmental milestones	**At 3 months**		**At 6 months**		**P value**	**Significance**
	Normal	**Developmental**	**Normal**	**Developmental**		

	development	**delay**	**development**	**delay**		
Gross motor-attained	**52**	**0**	**52**	**0**	<0.001	Significant
Gross motor-not attained	**0**	**8**	**0**	**8**	<0.001	Significant
Fine motor-attained	**52**	**0**	**52**	**0**	<0.001	Significant
Fine motor- not attained	**0**	**8**	**0**	**8**	<0.001	Significant
Language-attained	**52**	**0**	**52**	**0**	<0.001	Significant
Language- not attained	**0**	**8**	**0**	**8**	<0.001	Significant
Social- attained	**52**	**0**	**52**	**0**	<0.001	Significant
Social- not attained	**0**	**8**	**0**	**8**	<0.001	Significant

On follow up at 3 months and 6 months of age, 8 out of 18 infants in whom NSG abnormalities are present, had not attained all gross motor, fine motor, language and social milestones. There is statistically significant correlation between milestones and outcome.

TABLE–5:**ASSESSMENT OF AMIEL TISON ANGLES AT 3 MONTHS AND 6 MONTHS OF AGE.**

NSG findings	**At 3 months**		**At 6 months**		**P-value**	**Inference**
	Normal	**Delay**	**Normal**	**Delay**		
Adductor angle-normal	48	0	48	0	0.001	Significant
Adductor angle abnormal-	4	8	4	8	0.001	Significant
Popliteal angle-normal	48	0	48	0	0.001	Significant
Popliteal angle-abnormal	4	8	4	8	0.001	Significant
Dorsiflexion- normal	48	0	48	0	0.001	Significant
Dorsiflexion-abnormal	4	8	4	8	0.001	Significant
Scarf sign- normal	48	0	48	0	0.001	Significant

Scarf sign- abnormal	4	8	4	8	0.001	Significant

On follow up at 3 months and 6 months of age, developmental assessment by Amiel Tison angles, 8 out of 12 infants were found to be abnormal in infants whose NSG showed abnormal findings.

DISCUSSION:

Incidence of CUS abnormalities in high risk neonates is 30 % in the present study. Out of total 60 newborns 78.3% (47) are inborn and 21.7% (13) are outborn. There were 58% male and 42% female neonates enrolled in the study. There was no significant correlation of incidence of abnormal cranial ultrasound findings in male and female high risk neonates in the present study. There were 91% preterm and 9% term high risk neonates enrolled in the present study. Of these, 34% preterm were less than 32 weeks, 57% preterm were between 33 and 37 weeks and rest 9% were term neonates.Correlation between gestational age and CUS findings was statistically significant.There was no statistical correlation between different findings on CUS and gestational age of high risk neonate.Of the neonates with gestational age less than 32 weeks having abnormal findings on CUS 11% had ICH, 6% had cerebral edema.Of the neonates with gestational age between 33 and 37 weeks having abnormal findings on CUS, 8.6% had ICH and 8.6 % had periventricular hyperechogenecity. Of the neonates with gestational age more than 37 weeks having abnormal findings on CUS 20% had periventricular hyperechogenecity, 20% had cerebral edema and 20% had intracranial bleeds.There was statistical correlation between CUS findings and birth weight of high risk neonates. Correlation of birth weight of high risk neonates with abnormal cranial ultrasound findings revealed that 61.1% low birth weight neonates and 11.1 % very low birth weight neonates had abnormal NSG. In the present study, 52% neonates were born via normal labor and 48% via LSCS for various reasons. Of the 30%

neonates having abnormal NSG, 33.3% were cyanosed, 22.2% had poor activity, 61.1% had abnormal tone, 5.5% were icteric, 72% were pale, 50% had poor neonatal reflexes. There was statistically significant correlation between abnormal tone, abnormal activity, poor reflexes and presence of pallor, icterus and tachycardia on clinical examination and presence of abnormalities on NSG,. On NSG, 30% of neonates had abnormal findings. 8.3% of these had evidence of intracranial bleed, 6.5% periventricular hyperechogenicity, 6.5% cerebral edema, 3.3% definite HIE and 5.4% others. Of all the high risk neonates with perinatal asphyxia, 77.8% had abnormal and 22.2% had normal NSG findings. Correlation between NSG findings of neonates with perinatal asphyxia was statistically significant. There was statistically significant correlation between findings on NSG and day of life of neonate when NSG was done. Majority of the abnormal findings (55.5%) on NSG were picked up during 24-72 hours of life, 27.8% in less than 24 hours and 16.7% after 72 hours of life.There was no statistically significant correlation between gestational age of the high risk neonates included in the study and day of life NSG was done for them. Of all the NSG scans done for those neonates less than 24 hours old, 61.6% were normal. Of the NSG scans done for neonates between 24 to 72 hours of life, 70.5% were normal and 29.9% were abnormal. Of all the NSG scans done for those neonates more than 72 hours old, 77% were normal. Of the high risk neonates with term gestation, 20% had normal and 80% had abnormal NSG. Of the high risk neonates with preterm gestation, 74.6% had normal and 25.4% had abnormal NSG. Of the high risk neonates with term gestation having abnormal findings on NSG, 25% had ICH, 25% had periventricular hyperechogenecity, 25% had cerebral edema, 25% had HIE. Of the high risk neonates with preterm gestation having abnormal findingson NSG, 28.5% had intracranial bleed, 21.4% had periventricular hyperechogenecity, 21.4% had other findings and 7.1% had HIE.On follow up at 3 months of

age, 8 out of 18 infants in whom NSG abnormalities are present, had not attained all gross motor, fine motor, language and social milestones. There is statistically significant correlation between milestones and outcome. On follow up at 3 months of age, developmental assessment by Amil Tieson angles, 8 out of 12 infants were found to be abnormal in whom NSG showed abnormal findings. On follow up at 6 months of age, 8 out of 18 infants in whom NSG abnormalities are present, had not attained all gross motor, fine motor, language and social milestones. There is statistically significant correlation between milestones and outcome. On follow up at 3 months of age, developmental assessment by Amil Tieson angles, 8 out of 12 infants were found to be abnormal in infants whom NSG showed abnormal findings. Assessment of outcome at 6 months of age, out of 60 high risk infants, 52 infants (86.6%) were developmentally normal and 8 infants (13.4%) has developmental delay. Out of 18 infants in whom NSG showed abnormal findings, 10 infants (55.5%) were developmentally normal and 8 infants (44.5%) was developmental delayed. There was statistically significant correlation between various findings on NSG and neurodevelopmental outcome of the neonate. Of all the high risk neonates in the study group, 70 % had normal NSG and 30% had abnormal findings in NSG, of which 8.3% had evidence of ICH, 6.5% had Periventricular hyperechogenecity, 6.5% had cerebral edema, 2.2% had HIE 5.4% had other findings. Of these 8 infants who are developmentally delayed, NSG findings for two of them has ICH, two of them has Cerebral edema, two of them has Periventricular hyperechogenecity, one has HIE, one due to other findings. On regular follow up after discharge from NICU, final assessment of neurodevelopmental outcome was done clinically. Out of 18 neonates, in whom NSG showed abnormal findings, 8 of them (44.5%) were developmentally delayed.

CONCLUSION:

Neurosonography is an excellent instrument for the initial screening of neonatal brain. As evidenced by the results of the present study, neurosonography assumes great importance as an analysis tool which efficiently records the anatomy of brain injury in neonates. It is a mandatory screening for all high risk neonates. In the present study, incidence of NSG abnormalities in high risk neonates is 30%. Of all the high risk neonates, 70% had normal and 30% had abnormal findings in which most common finding is ICH and next common is Periventricular hyperechogenecity and cerebral edema. On regular follow-up of these high risk newborns at 3 months and 6 months of age, 8 infants were developmentally delayed out of 60 high risk infants. Hence, NSG is particularly important in the anticipation of potential preventive, protective, and rehabilitative strategies for the management of critically ill newborn infants. This Study concludes Neurosonography is critical as a investigatory modality in NICU and effectively documents morphology of brain damage and on regular follow ups, we can intervene early and limits the complications.

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