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Relationship between Ultrasonographic Brain Findings and Outcomes of Perinatal Asphyxia

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Abstract **Original Research Article**

Introduction: Perinatal asphyxia is one of the most common causes of neonatal morbidity and mortality in most countries of the world. Asphyxia (insufficient oxygen supply) can lead to severe hypoxic ischaemic organ damage in newborns followed by a fatal outcome or severe life-long pathologies. Ultrasound (US) has emerged as a powerful screening tool for the evaluation of a neonate with suspected perinatal asphyxia. Therefore, this study aimed to find a relationship between Ultrasonographic brain findings and immediate outcomes of perinatal asphyxia. ***Methods:*** This was a prospective analytical study carried out in the Special Care Baby Unit (SCBU), Department of Pediatrics, Shaheed Suhrawardy Medical College Hospital, Dhaka, Bangladesh from January 2018 to June 2018. In our study, we enrolled 200 newborn babies with perinatal asphyxia based on the selection criteria who were admitted to the special care baby unit within 24 hours. ***Results:*** The mean ± SD of age was 5.7±1.1 hours. Cranial sonographic findings show that 36.0% had cerebral oedema, 5.0% intraventricular bleeding, 3.0% showed focal cerebral infarction and 53.0% showed normal findings. Out of 164 patients who recovered from the illness, 98 patients had normal USG findings as opposed to 66 patients with abnormal USG. Among the expired cases, all (100%) had abnormal cranial USG findings. ***Conclusion:*** In our study, we found that there was a significant association between abnormal cranial USG findings and the immediate outcome of the asphyxiated newborn. The most common abnormality was cerebral oedema and IVH and it carried the highest mortality.

Keywords: Relationship, Ultrasonographic brain findings, Perinatal asphyxia, Outcome.

INTRODUCTION

Perinatal asphyxia is characterized by impaired respiratory gas exchange (oxygen and carbon dioxide), leading to hypoxemia and hypercapnia, as well as metabolic acidosis. It is one of the leading causes of newborn mortality and morbidity in most nations throughout the world [1]. The majority of the 1 million annual neonatal deaths attributed to birth asphyxia occur in non-hospital settings in low-middle-income countries [2]. The World Health Organization reports that birth asphyxia causes 4 million deaths annually or 38% of all deaths of children under the age of five. In low-income countries, birth asphyxia accounts for 23% of all neonatal deaths [3]. Neonatal morbidity and mortality are significant global public health issues that account for a growing share of all under-5 child deaths [4]. Bangladesh has made significant progress in improving the health of its children. However, infant and neonatal mortality rates remain high and have not decreased substantially for the past five years. Neonatal mortality, which now makes up more than half of all deaths among children under five, is mostly caused by neonatal asphyxia, infection, low birth weight, and premature deliveries [5].

In perinatal asphyxia, hypoxic-ischemic brain injury (HII) remains the most serious condition causing significant mortality and long-term morbidity. Early detection of intracranial changes and their consequences will enhance timely intervention and better outcomes [6]. Birth asphyxia may predispose to several complications like brain injury, major organ failure, and haemostatic failure. So, early detection and prevention of complications reduced the burden of asphyxia. Cranial sonography can be done to assess the abnormalities of the brain in perinatal asphyxia.

Ultrasound (US) has emerged as a powerful screening tool for the evaluation of a neonate with suspected HII. It has become increasingly effective at determining the injury pattern, timing, and extent of injury in HII as well as differentiating these findings from a host of diagnoses that can result in a similarly appearing clinical picture [7].

In asphyxiated neonates with hypoxic-ischemic injury, color Doppler sonography and bedside sonography of the brain and abdominal organs can provide accurate and thorough information [8]. Brain US has become a powerful, affordable adjunctive, and alternative tool to MRI. Ultrasound is widely accessible, can be performed bedside without sedation, can be repeated as often as needed, has no side effects, and when done by a skilled sonographer using high-end equipment, provides a wealth of anatomical and functional information [7]. Cranial US plays several roles in patient evaluation when there is a concern for neonatal HII. US findings change as the injury itself does [9]. Thus, specific patterns of injury and focal findings can provide important clues as to the severity and duration of the injury. Previous studies demonstrated that cranial ultrasound has become an essential diagnostic tool in modern neonatology for depicting normal anatomy and pathological changes in neonatal brains [6]. To our knowledge, no known study has examined the cranial USG profiles of babies with birth asphyxia in Bangladesh. The present study therefore aimed to determine the relationship between ultrasonographic brain findings and immediate outcomes of perinatal asphyxia.

METHODOLOGY & MATERIALS

This was a prospective analytical study carried out in the Special Care Baby Unit (SCBU), Department of Pediatrics, Shaheed Suhrawardy Medical College Hospital, Dhaka, Bangladesh from January 2018 to June 2018. In our study, we enrolled 200 newborn babies with perinatal asphyxia based on the selection criteria who were admitted to the special care baby unit within 24 hours.

These are the following criteria to be eligible for enrollment as our study participants: a) All the neonates admitted within 24 hours; b)Neonates with perinatal asphyxia; c) Guardians who were willing to participate were included in the study And a) Pre-term and post-term neonates; b) Neonates with septicemia, pneumonia, CNS infection, very LBW(low birth rate) & tetanus; c) Neonates with any history of acute illness (e.g., renal or pancreatic diseases, ischemic heart disease, asthma, COPD etc.) were excluded from our study.

Data Collection Procedure: A thorough history and physical examination were performed and recorded on standard forms. USG of the brain was done in all included patients. Then divide into two groups- either patients with normal ultrasonographic brain findings or patients with abnormal ultrasonographic brain findings. Then correlation of the immediate outcome between two groups was done. Injection phenobarbitone was used as a first-line drug to control convulsion. The dose of phenobarbitone was 20mg/kg loading, then 5-7 mg/kg/day for maintenance. If injection phenobarbitone can't work effectively to control seizure then injection phosphenytoin is added. All the treatment was given according to the unit protocol. Data regarding the demographic and obstetric profile of the mother and, the clinical and biochemical profile of the baby were recorded.

Statistical Analysis: All data were recorded systematically in preformed data collection form. Quantitative data was expressed as mean and standard deviation and qualitative data was expressed as frequency distribution and percentage. Comparison will be done by Chi-Square (χ^2) test and unpaired t-test where necessary. Risk factors will be determined using Odd Ratios. A p-value <0.05 was considered as significant. Statistical analysis was performed by using SPSS 16 (Statistical Package for Social Sciences). The study was approved by the Ethical Review Committee of Shaheed Suhrawardy Medical College Hospital.

RESULTS

Table 1: Demographic characteristics of Baby (n=200)

Variables	Frequency		Total (%)
	Male (n, %)	Female (n, %)	
Age (hours)			
0-6	58(42.0%)	38(61.2%)	96
7-12	76(55.0%)	12(19.3%)	88
>12	4(2.8%)	12(19.3%)	16
Mean ± SD	6.2±1.5	5.7±1.1	5.7±1.1
Gender distribution			
Number	138	62	200
Gender ratio (M:F)		2.2:1	
Residence			
Rural	58(42.0%)	28(45.1%)	86
Urban	80(57.9%)	34(54.8%)	114

In this series, the maximum number of neonates e.g., 48.0% was between 0 to 6 hours of age group, next 44.0% were in the age group of 7 to 12 hours. The Mean ± SD was *5.7±1.1* hours. Out of 200 cases, 138 neonates were male and 62 neonates were female. Male – female ratio was 2.2:1. Large numbers of respondents came from urban areas, e.g., 57.0%, followed by rural areas 43.0%. A comparatively higher proportion of rural patients were female.

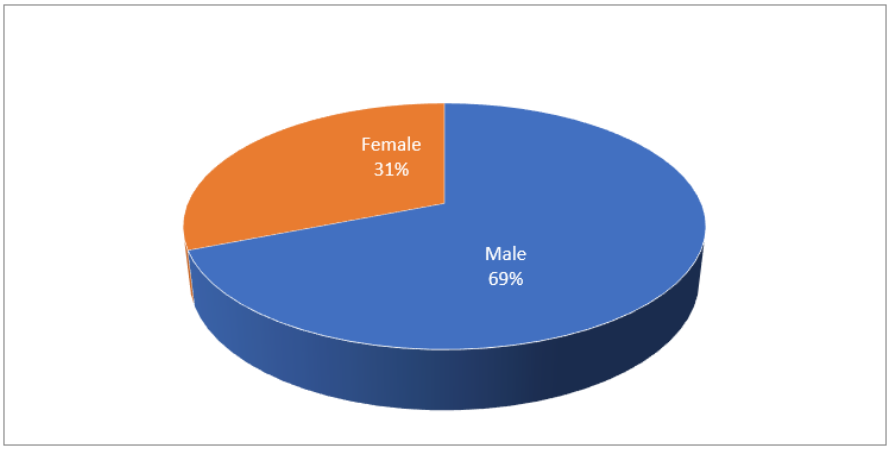

Figure 1: Pie chart showing sex distribution of neonates (n=200)

Gender distribution of the patients revealed that out of 200 cases 69.0% of patients were male and 31.0% were female. Male – female ratio was 2.2:1.

Table 2: Distribution of neonates by clinical profile and obstetrics profile of the mothers (n=200)

Variables		**Frequency**		**Total**
		Male (n=138)	**Female (n=62)**	
Mode of delivery	NVD	86	38	124
	CS	52	24	76
Birth weight (g)	>2500 gm	100	40	140
	1500-2500 gm (LBW)	38	22	60
Obstetrics profile of mothers				
Trends of ANC	Regular	78	38	116
	Irregular	60	24	84
Obstritical risk factors	Maternal PROM	30	16	46
	Meconium stained	36	20	56
	H/O obstructed or prolonged labour	24	14	38
	Hypertensive disorder	22	8	30
	Malpresentation	34	20	54

Among the cases, the majority of the patient had a history of normal vaginal delivery (e.g. 62.0%), and LUCS was done in 38.0% of patients. In this series, the maximum number of cases (65.0%) were normal birth weight babies, followed by low birth weight in 27.0% and very low birth weight in 8.0% of patients. We also found that 58.0% of mothers had regular antenatal checkups, and 42.0%) had irregular ANC. The table shows that in the majority of cases, 57.0% of patients have previous maternal obstetrics risk factors. Among the risk factors meconium stained was in 28.0% of cases, maternal PROM was in 23.0% of cases and, H/O obstructed or prolonged labour in 19.0% of cases.

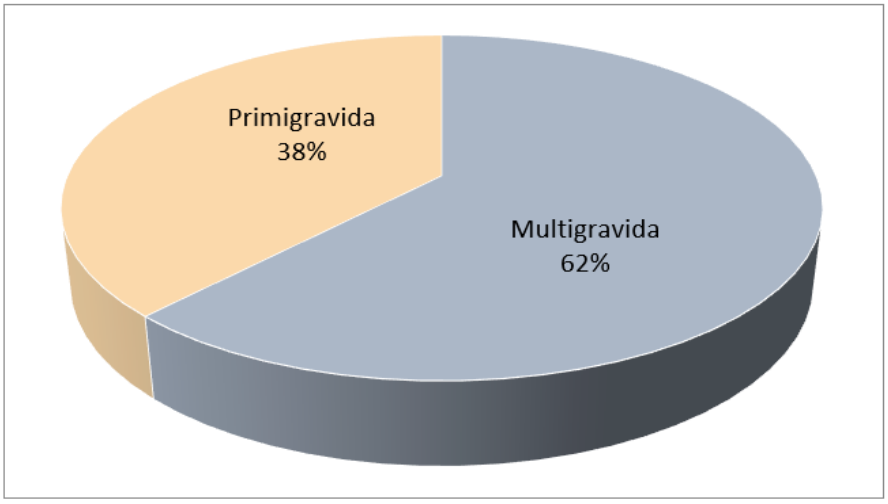

Figure 2: Obstetrics history (Gravidity) of mothers (n=200)

The pie chart shows that most of the women were multigravida (62.0%) and primigravida was seen in (38.0%) of mothers.

Table 3: Assessment of cranial sonographic findings of asphyxiated neonates (n=200)

USG findings	Number of patients	Percentage (%)
Cerebral oedema	72	36.0
IVH (intraventricular hemorrhage)	10	5.0
Focal cerebral infarct	6	3.0
Dilatation of Ventricles	6	3.0
Normal finding	106	53.0

The table shows the common cranial sonographic findings of asphyxiated babies. Out of 200 term newborns, 36.0% showed cerebral oedema, 5.0% showed intraventricular hemorrhage, 3.0% showed focal cerebral infarct, 3.0% showed dilatation of Ventricles, and 53.0% showed normal findings.

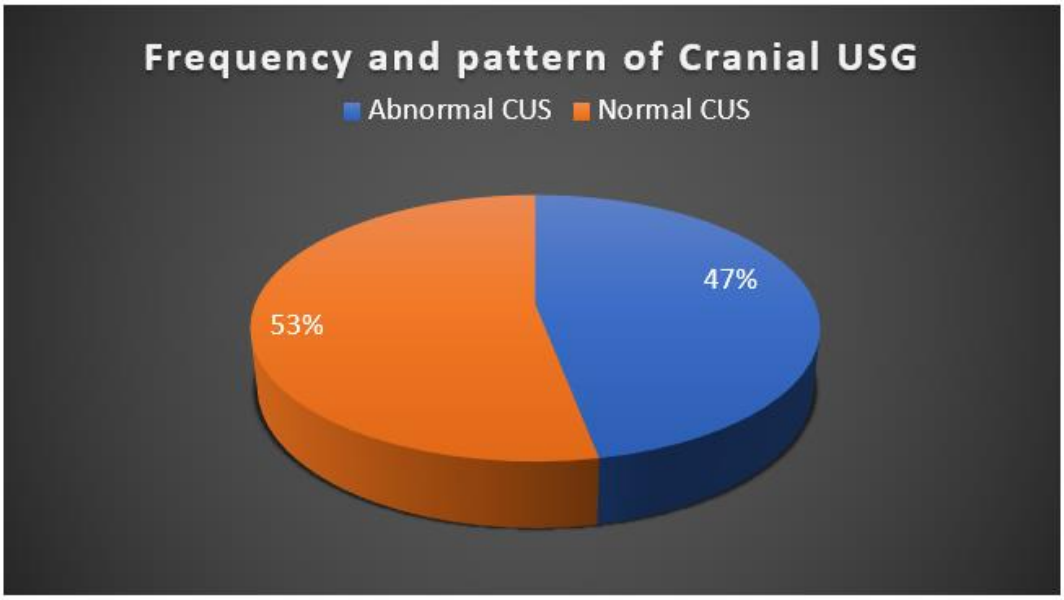

Figure 3: Frequency and pattern of sonographic findings (n=200)

Figure 3 shows that overall findings demonstrated that the frequency of abnormal USG findings was 43.0%.

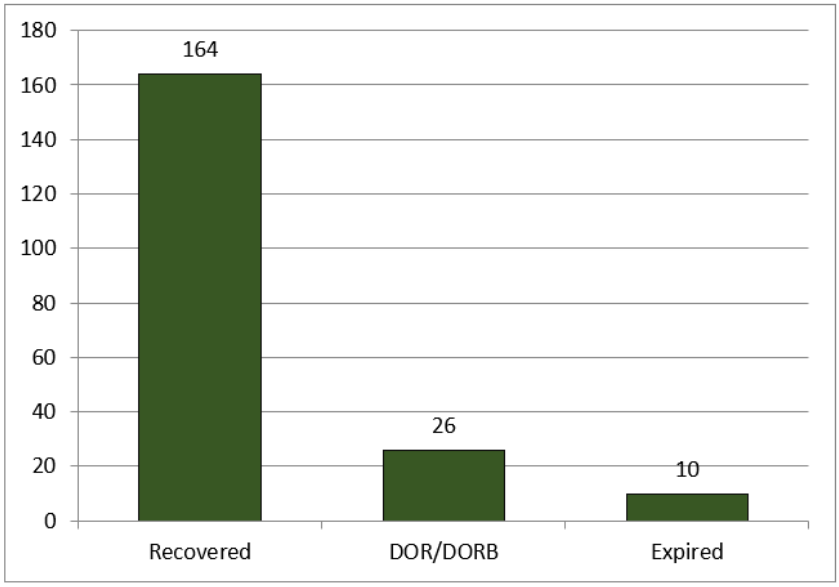

Figure 4: Outcome of the birth of asphyxiated neonates (n=200)

The management and follow-up of all patients were done meticulously. The study shows that 164(82.0%) of the patients recovered completely, 26(13.0%) left the hospital without completion of treatment and 10(5.0%) patients expired during hospital stay.

Table 4: Relationship between Ultrasonographic brain findings and immediate outcomes of perinatal asphyxia (n=200)

Outcome	**Cranial USG findings**		**p-value**
	Normal finding	**Abnormal finding**	
Recovered (n=164)	98	66	0.003[s]
DOR/DORB (n=26)	8	18	0.085[ns]
Expired (n=10)	0	10	0.001[s]
Total	**106**	**94**	

Cranial ultrasonographic findings were significantly different among the three groups. Present study shows that out of 164 patients who recovered from the illness, 98 patients had normal USG finding as opposed to 66 patients with abnormal USG. The chi-square statistic is 8.3476. The p-value is .003862. This result is significant at $p < .05$. While 26 of patients who left the hospital without completion of treatment (DOR/DORB), majority (18) have abnormal finding and 8 baby had normal USG (p-value is .085108). Among the expired cases, all (100%) had abnormal cranial USG findings (p-value is 0.001). So abnormal ultrasonographic brain findings predict the immediate outcomes of perinatal asphyxia.

DISCUSSION

Perinatal asphyxia, a major cause of death and morbidity, is characterized by respiratory failure brought on by a lack of oxygen or delayed crying after birth. It has serious neurological repercussions, with hypoxic-ischemic encephalopathy (HIE) being the most researched and complex disorder [1]. It is also one of the main reasons why newborns die in the first week of life, according to a WHO survey from 2005 [10]. Long-term neurological dysfunction and impairment are caused by it, and it is closely linked to 1.1 million intrapartum stillbirths [10]. It is strongly associated with 1.1 million intrapartum stillbirths and is responsible for long-term neurological disability and impairment [11]. Causes of perinatal birth asphyxia may According to the WHO classification of diseases ICD10, Severe birth asphyxia occurs when the APGAR score at 1 min is 0–3. Mild and moderate birth asphyxia is when the Apgar score at 1 min is 4-7 [12,13].

Demographic characteristics revealed that the maximum number of neonates e.g., 48.0% was between 0 to 6 hours of age group, mean ± SD was 5.7±1.1 hours. Out of 200 cases, 138 neonates were male and 62 neonates were female. Among the cases, the majority of the patient had a history of normal vaginal delivery (e.g. 62.0%), and LUCS was done in 38.0% of patients. In this study, Low birth weight babies was 30.0% and a maximum number of babies were normal birth weight (70.0%).

Findings are consistent with the results of other studies. A study was done on one hundred newborns where 52% were female and 48% were male neonates.

The largest percentage of preterm babies (26, or 59%) were born between 34 and 36 weeks of pregnancy, while the biggest percentage of term babies (38, or 68%) were born between 37 and 39 weeks of pregnancy. For a variety of causes, 54% of neonates were delivered using LUCS, whereas 46% were delivered normally through the vagina. Of term newborns, 40 (71%) had a birth weight of 2.5–3.5 kg, while 16 (29%) weighed >3.5–4 kg [6].

Levene showed in his study that 85.8% full full-term and 14.2% of preterm infants had birth asphyxia [14]. Goldberg *et al.*, showed that 16.6% preterm, 41.66% term, and 41.66% post-term infants had perinatal asphyxia [15]. There were studies where the term babies were in the 2.5 to 3.5 kg weight group [18-20].

On the evaluation of common cranial sonographic findings, the present study shows that out of 200 term newborns, 36.0% showed cerebral oedema, 5.0% showed intraventricular hemorrhage, 3.0% showed focal cerebral infarct, 3.0% showed dilatation of Ventricles, and 53.0% showed normal finding. Overall findings demonstrated that the frequency of abnormal USG findings was 43.0%.

All of the results are in line with one earlier research. In that study, 24% of the neonates experienced intracranial hemorrhage, 17% experienced cerebral oedema and infarction, 5% experienced dilatation of the ventricles, and 7% experienced various conditions [16]. Another study shows intraventricular hemorrhage was the most common (40.42%) followed by periventricular hyper-echogenicity (21.27%), cystic periventricular leukomalacia (8.51%), parenchymal bleed (8.51%), and cysts (8.51%) [17]. In 56 term asphyxiated newborns, 24 (43%) showed cerebral oedema, 3 (5%) showed intracerebral hemorrhage, 2 (4%) showed Focal cerebral infarct, 1 (2%) showed IVH, and 26 (46%) showed normal findings [6]. In a retrospective study, HIE grades (mild, moderate, and severe) were found in 12, 83, and 5 babies respectively, and ultrasound grades 0 (normal/ mild echogenic), grade 1 (moderate echogenic), and grade 2 (severe/generalized echogenic) were found in 32, 52, 16 neonates respectively with r= 0.37 and P-value < 0.05 showing moderate positive correlation [1].

Finally, we correlate the immediate outcome with the USG finding. The present study shows that 164 (82.0%) of the patients recovered completely, 26(13.0%) left the hospital without completion of treatment and 10(5.0%) patients expired during hospital stay. One earlier study revealed a similar finding. Of those who died, 36.1% reported abnormal cranial USG findings. Deaths were most frequently caused by intraventricular hemorrhage (76.4%), followed by parenchymal bleeding (11.7%) [17]. Cranial US is an effective screening method for encephalopathic neonatal diagnosis and treatment. Safety, affordability, and portability are further advantages of the US during the acute period when access to more sophisticated imaging can be challenging. Improvements in US tools and methods have greatly increased its capacity for detection [7].

Limitations of the study

Our study was a single-center study. We took a small sample size due to our short study period. After evaluating those patients, we did not follow up with them for the long term and did not know other possible interference that may happen in the long term with these patients.

CONCLUSION AND RECOMMENDATIONS

In our study, we found that cranial USG is a valuable screening tool in the diagnosis and management of encephalopathic neonates. It was evident from this study that abnormal ultrasonographic brain findings of birth asphyxiated babies' outcomes were poorer than others. This study explores the early diagnostic value of cranial sonograms to identify abnormalities in perinatal asphyxia. Our study reveals that cerebral oedema and IVH are common sonographic findings in term neonates. This study also confirms that the immediate outcome of perinatal asphyxia correlates with abnormal cranial USG findings. So, it is concluded that cranial USG is a reliable technique for demonstrating the most frequently occurring forms of cerebral injury in perinatal asphyxia, assessing the evolution of the lesion, and following brain development.

So further study with a prospective and longitudinal study design including a larger sample size needs to be done to validate the findings of our study.

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Conflict of interest: None declared

Ethical approval: The study was approved by the Institutional Ethics Committee

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