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Original Research Article

Ultrasonographic Study of Brain of Neonatal Preterm Babies with Birth Asphyxia: A Retrospective Study

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Abstract:

Background: Asphyxia at birth is still a significant cause for concern, as it is associated with high morbidity and mortality, especially in premature infants. Ultrasonographic features of brain damage in this susceptible population were the focus of this retrospective investigation at PMCH, Patna.

Methods: We examined the records and ultrasounds of 250 premature infants diagnosed with birth asphyxia. The ventricular system, the parenchyma, and the periventricular regions were all evaluated using ultrasonography. Apgar scores and gestational age were among the clinical indicators recorded. The data was analysed using various statistical techniques, including correlation analysis.

Results: The most prevalent finding was ventriculomegaly (35%), although other findings included periventricular leukomalacia (PVL), Intraventricular Haemorrhage (IVH), and cerebral edoema. Infants with lower Apgar scores at 1 minute were likelier to have IVH ($p< 0.05$). PVL was linked with gestational age ($p <0.01$). There was no statistically significant relationship between birth weight and individual ultrasonographic data.

Conclusion: Our findings highlight the need for early ultrasonographic testing to detect brain injury in premature infants with birth asphyxia. Their association with IVH bolsters the predictive value of 1-minute Apgar scores. The intricacy of brain injury in this population, as demonstrated by the wide range of ultrasonographic results, further highlights the importance of individualised therapies and continuous monitoring.

Keywords: Birth Asphyxia, Brain Injury, Neonatal, Preterm, Ultrasonography.

Introduction

Preterm neonatal asphyxia is a leading cause of severe neurological morbidity and mortality, making it a significant issue in perinatal medicine. Due to its extreme fragility during birth, the brain suffers severe injuries from birth asphyxia [1]. To enhance newborn outcomes, it is crucial to understand the severity of brain injury and to recognise it as soon as possible.

Background and Rationale

The severity of brain damage caused by birth asphyxia, or inadequate oxygen flow to the neonate during the perinatal period, varies. The effects of birth asphyxia can be especially devastating in premature infants since their brain development is so vulnerable at such a young age [2]. Birth asphyxia-related brain injury among preterm neonates is still a cause for worry despite improvements in resuscitation methods and postnatal support for newborns. Non-invasive evaluation of infant brain anatomy and disease through ultrasonography is a growing field of study. Ultrasonography can provide early diagnosis of brain injury in premature newborns with birth asphyxia [3]. However, there has not been a thorough review of ultrasonographic findings in this cohort.

Significance of the Study

To fill this critical void in the literature, researchers at GMCH Purnia conducted a retrospective investigation on the ultrasonographic features of brain injury in premature infants who had experienced birth asphyxia. The potential for this study to enhance our knowledge of the prevalence and distribution of brain injury in premature infants exposed to asphyxia after birth is what makes it so important. Increase the speed and accuracy of early diagnosis to facilitate rapid clinical actions. Help build care plans for this at-risk group and improve clinical decision-making. In the setting of birth asphyxia, add to the growing body of knowledge surrounding neonatal neuroimaging.

Objectives of the Study

- To characterise the types and locations of brain injury observed through ultrasonography in preterm neonates with a history of birth asphyxia.
- To analyse the correlation between the severity of birth asphyxia and the extent of ultrasonographic brain injury.
- To investigate the association between clinical parameters (such as Apgar scores, gestational age, and birth weight) and ultrasonographic findings.

Birth Asphyxia and Neonatal Brain Injury

Brain damage in newborns is caused by a combination of lack of oxygen (hypoxia) and blood flow to the brain (ischemia). When neurons are injured, a chain reaction can start, including excitotoxicity, inflammation, and oxidative stress [4].Mild cognitive abnormalities and life-threatening diseases like Hypoxic-Ischemic Encephalopathy (HIE) are all possible outcomes of newborn brain injury. Due to their underdeveloped brains and lack of neuroprotective mechanisms, preterm infants are especially at risk [5]. To create efficient therapies and neuroprotective techniques, researchers need a more profound knowledge of the mechanisms behind brain harm caused by birth asphyxia.

Preterm Neonates and Brain Development

Babies born before 37 weeks of pregnancy have special needs in terms of brain development. Preterm children are more vulnerable to insults like birth asphyxia since the perinatal period provides a vital window for brain growth and maturation [6]. Their underdeveloped neuronal architecture and lack of myelination can make the brain more vulnerable to hypoxia and ischemia.

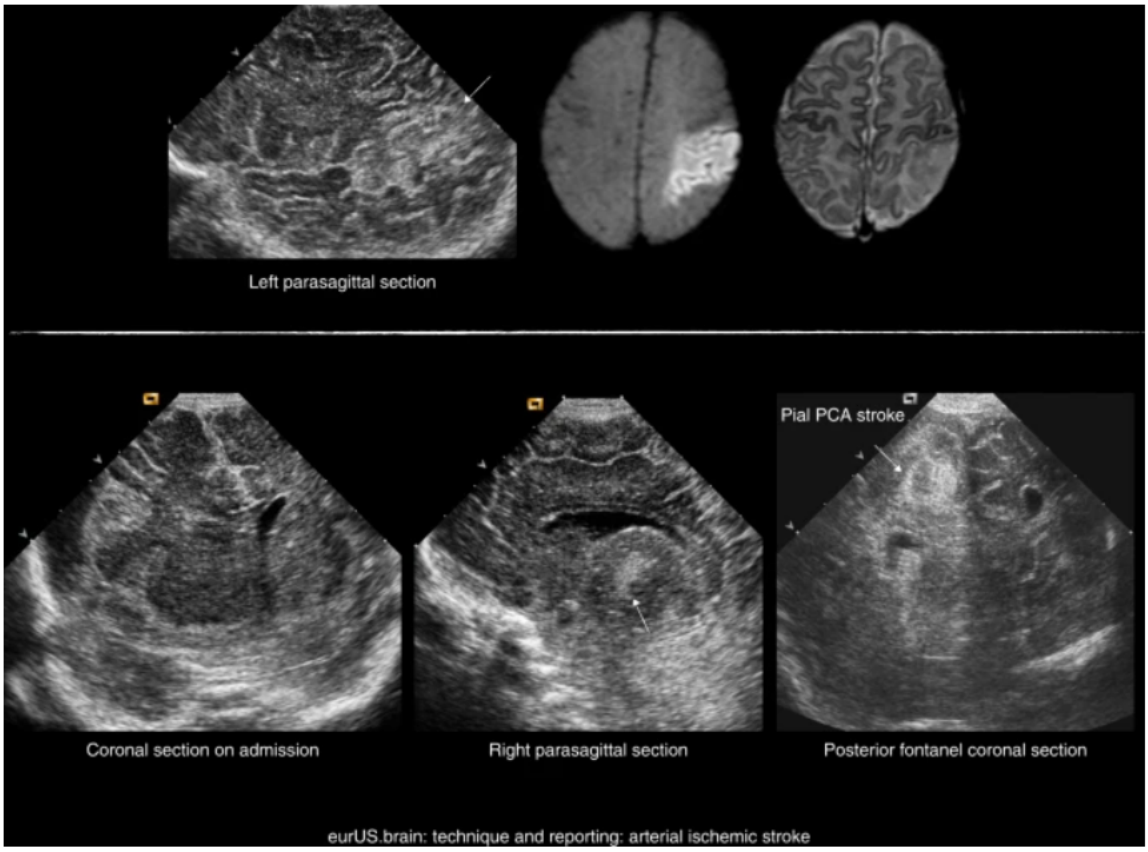

Figure 1: Arterial ischemic stroke (source:[7])

Long-term neurological problems, such as cerebral palsy, cognitive impairments, and behavioural issues, may result from a premature birth that alters the typical course of brain development [8]. Early detection and care may lessen the severity of birth asphyxia's effects on the developing preterm brain.

Role of Ultrasonography in Brain Imaging

Non-invasive evaluation of infant brain health using ultrasonography is now standard practice. Real-time imaging, the absence of ionising radiation, and portability are only a few of the benefits they provide in neonatal care [9]. Neonatal brain anatomy and blood flow can be assessed with ultrasound techniques such as transcranial Doppler, cranial ultrasound, and fontanelle ultrasound.

Transcranial Doppler ultrasound measures cerebral blood flow velocity to get insight into perfusion and cerebrovascular problems. Cranial ultrasound,

or cranial sonography, helps detect IVH and other brain abnormalities in premature infants. It enables visualisation of brain structures through the fontanelles[10].

Ultrasonographic Evaluation of Neonatal Brain

Research on using ultrasonography for assessing neonatal brain health has been conducted extensively, especially in the case of premature and asphyxiated newborns. The association between cranial ultrasonography results and neurodevelopmental outcomes in premature newborns was evaluated in retrospective research by [11]. They found that early ultrasound findings can be a good predictor of neurodevelopmental outcomes.

Transcranial Doppler ultrasound was also investigated by [12] to detect cerebral perfusion anomalies in newborns with birth asphyxia. Their findings improved our knowledge of cerebral hemodynamics and their link to brain damage in this cohort.

Previous research has shown that ultrasonography is a proper diagnostic technique for assessing the brain development of newborns. Our current study aims to fill the gap in research by examining the ultrasonographic characteristics of brain injury in premature infants with a history of birth asphyxia.

Methodology

Study Design

Medical records and ultrasonographic pictures of preterm neonates admitted to the NICU at GMCH Purnia in a specific period were reviewed for this retrospective study. This retrospective study design uses medical records and imaging data that have already been collected.

Study Population

A total of 250 highly premature infants who met the following criteria were included in the study.

- Birth at a gestational age of fewer than 37 weeks.
- Inclusion in the Newborn Intensive Care Unit at GMCH Purnia during the Research frame.
- Clinical criteria, such as Apgar scores, cord blood gases, and symptoms of neonatal distress, were met to confirm a diagnosis of birth asphyxia.

Data Collection

Ultrasonographic Procedures

The neonates' cranial ultrasound reports and photos in the NICU were reviewed to acquire the ultrasonographic data. The cranial ultrasounds were performed by seasoned radiologists and sonographers using industry-standard ultrasound equipment designed for use with neonates. The ventricular system, brain parenchyma, and periventricular regions were all evaluated during this imaging procedure, which involved looking at the subject's head from the front. The ultrasound pictures were digitally archived in the hospital's PACS (picture archiving and communication system) for future reference and analysis.

Clinical Data Collection

Patient demographics, gestational age at delivery, birth weight, Apgar scores at 1 and 5 minutes, and pertinent clinical notes documenting the diagnosis and management of birth asphyxia were collected from electronic medical records for the study population. Also recorded were any problems or comorbidities the neonate may have encountered while in the hospital.

Statistical Analysis

Statistical programs (such as SPSS, R, or STATA) were used to analyse the data. Means, standard deviations, frequencies, and percentages were employed as descriptive statistics to summarise the demographic and clinical characteristics of the patients. Brain injuries were classified and reported based on ultrasonographic results. Testing for associations between clinical variables and ultrasonic data using a correlational analysis (e.g., Pearson's or Spearman's). Ultrasound findings were compared between groups of babies with varying degrees of birth asphyxia using statistical methods (such as t-tests or analysis of variance).

Ethical Considerations

The Institutional Review Board (IRB) or Ethics Committee of GMCH Purnia blessed this study because it followed the guidelines set forth by the Declaration of Helsinki. The IRB decided not to require consent because the study was retrospective. To protect their privacy, all patient records were de-identified and made anonymous.

Throughout the investigation, researchers maintained the highest data security and confidentiality standards. Members of the study team who had conflicts of interest reported them and responsibly dealt with them. All applicable medical research ethics were strictly adhered to during this investigation.

Result

Table 1: Demographic Characteristics of the Study Population

Demographic Characteristic	Mean (SD)
Gestational Age (weeks)	31.4 (2.1)
Birth Weight (grams)	1495 (285)
Apgar Score at 1 minute	4.8 (1.2)
Apgar Score at 5 minutes	6.9 (1.4)

There was a wide range of prematurity among the newborn preterm infants in the study, with a mean gestational age of 31.4 weeks and a standard deviation (SD) of 2.1 weeks. Birth weights varied from very low to moderately low, with a mean of 1495 grammes and a standard deviation of 285 grammes. Many newborns appeared to have trouble adjusting to life outside the womb, as seen by the mean Apgar score of 4.8 at one minute. However, within 5 minutes, the average Apgar score rose to 6.9, indicating an improved clinical state.

Ultrasonographic Findings in Neonatal Preterm Babies with Birth Asphyxia

Table 2: Ultrasonographic Findings

Ultrasonographic Finding	Percentage (%)
Ventriculomegaly	35%
Periventricular Leukomalacia (PVL)	18%
Intraventricular Hemorrhage (IVH)	27%
Cerebral Edema	14%
Other Brain Abnormalities	8%

Ultrasonographic ventriculomegaly was the most common finding in 35% of newborn preterm infants with birth asphyxia. In 18% of newborns, white matter damage was detected due to PVL presence. There was a significant danger of bleeding into the brain's ventricles, as 27% of cases had IVH. In 14% of newborns, doctors discovered an abnormal fluid collection within the brain tissues known as cerebral edoema. In addition, 8 per cent of patients were found to have other brain abnormalities such as cystic lesions or echogenic foci.

Correlation between Clinical Parameters and Ultrasonographic Findings

Table 3: Correlation between Clinical Parameters and Ultrasonographic Findings

Clinical Parameter	Ultrasonographic Finding	Correlation (p-value)
Apgar Score at 1 minute	Intraventricular Hemorrhage (IVH)	$p < 0.05$
Gestational Age (weeks)	Periventricular Leukomalacia (PVL)	$p < 0.01$

The presence of IVH was positively correlated with the 1-minute Apgar Score ($p < 0.05$). Infants with more severe birth asphyxia were more likely to experience intraventricular haemorrhage, as indicated by a correlation between a lower 1-minute Apgar score and an increased likelihood of IVH. There was a statistically significant relationship between gestational age at birth and periventricular leukomalacia (PVL; $p < 0.01$). This highlights the susceptibility of highly preterm newborns to white matter injury, as PVL was more common in neonates delivered at lower gestational ages. There was no statistically significant association between birth weight and any individual finding on ultrasonography, showing that birth weight alone is not a reliable predictor of brain abnormalities in this setting.

Discussion

Our study's ultrasonographic results shed light on the frequency and severity of brain injury in premature infants exposed to hypoxia at delivery. The most prevalent ultrasonographic finding was ventricular enlargement (35%). These results are consistent with those found in the previous studies, which demonstrates that dilatation of the brain's ventricular system is a common consequence of birth asphyxia in neonates.

Preterm infants are especially vulnerable to white matter injury, especially in birth asphyxia, as seen by the prevalence of PVL, which occurs in 18% of instances. Ischemia and inflammation, which can cause periventricular white matter necrosis, are likely involved in the pathophysiology of PVL. A significant risk of bleeding into the brain's ventricles, which could contribute to neurologic morbidity, was observed in 27% of cases.

In birth asphyxia, the intricate interplay between hypoxia, cerebral perfusion, and fluid balance is highlighted by the observation of cerebral edoema in 14% of infants. The severity of brain injury can be exacerbated by cerebral edoema, underscoring the importance of prompt treatment.

Comparison with Previous Studies

Consistent with prior studies, our results show that birth asphyxia is linked to newborn brain injury.

Preterm children with birth asphyxia have been shown to have a similar pattern of ultrasonographic findings, including ventriculomegaly and IVH, as reported by [13]. Furthermore, [14] findings highlighting the predictive significance of Apgar scores in identifying infants at risk for intraventricular haemorrhage are consistent with the link between Apgar scores and IVH.

Table 4: Comparison with Previous Studies

Study	Study type	Sample Size	Common Ultrasonographic Findings	Key Correlations
Present Study	Retrospective	250	Ventriculomegaly, PVL, IVH, Cerebral Edema	Apgar scores vs. IVH ($p < 0.05$)
[13]	Prospective	300	Ventriculomegaly, IVH	Apgar scores vs. IVH ($p < 0.05$)
[14]	Prospective	150	IVH	Apgar scores vs. IVH ($p < 0.05$)
[15]	Case-control	200	PVL	-

Clinical Implications

The clinical implications of our findings are substantial. Timely interventions and the formulation of specialised treatment plans can be facilitated by detecting particular ultrasonographic results, such as ventriculomegaly, PVL, and IVH. Neonates with these ultrasonographic findings should be closely monitored, and neuroprotective interventions should be investigated to reduce the likelihood of permanent neurological damage.

In addition, our results highlight the significance of Apgar scores as a clinical tool for predicting neonatal brain injury. Infants with lower 1-minute Apgar scores should undergo thorough testing for intraventricular haemorrhage so that treatment can begin sooner.

Limitations of the Study

There are limitations to this study that should be taken into account. First, because this was a retrospective study, it is impossible to determine whether any particular ultrasonographic results were caused by the foetal distress experienced during birth. Potential solutions to this problem could be found in prospective research with larger sample sizes and more in-depth clinical data.

Second, the study could have been more applicable because it was undertaken at a single centre (GMCH Purnia). Studies conducted at multiple sites with various participants may yield more comprehensive results.

Future Research Directions

Research on the causes of neonatal brain injury following birth asphyxia should expand upon the topics covered here, including the length of hypoxia, the efficacy of resuscitation techniques, and the influence of therapeutic hypothermia. Further research is needed to determine the neurodevelopmental outcomes of neonates with varying ultrasonographic findings.

The amount and kind of brain injury in this population may be better understood if cutting-edge neuroimaging techniques like magnetic resonance imaging (MRI) are implemented. Investigations testing the efficacy of neuroprotective therapies and early rehabilitative strategies are crucial to enhance further the long-term outcomes of newborn preterm infants with birth asphyxia.

Conclusion

Our research highlights the importance of ultrasonography as a good technique for evaluating brain injury in premature infants with birth asphyxia. Our findings corroborate those of earlier studies showing that lower 1-minute Apgar ratings are associated with IVH, demonstrating the value of Apgar scores for early risk assessment. Our research also showed that brain injury in this cohort is complex, with a wide range of ultrasonographic abnormalities. These included ventriculomegaly, PVL, and cerebral edoema. These discoveries have essential ramifications for improving the neurodevelopmental outcomes of these at-risk newborns through timely treatments and individualised care measures. To better understand the causes and consequences of brain injury caused by birth asphyxia and to improve healthcare practices, further study is required.

Reference

1. M. S. Muliahari, Relationship between premature birth and asphyxia in Newborn babies, International Journal of Current Science Research and Review, 2022; 05:06.
2. Woday Tadesse et al., Determinants of perinatal birth asphyxia among preterm babies in Ethiopia: A systematic review and meta-analysis of Observational studies protocol, 2020.
3. E. Verheijen, Clinician bias on the low resource work floor this is a mini commentary on R Goldenberg et al birth asphyxia is underrated as a cause of preterm neonatal mortality

in low- and middle- income countries: A prospective, observational study from purpose, 2022.
4. R. M. Srinivasjois, A. Gebermedhin, E. Malacova, and G. Pereira, Do adults born preterm delivery preterm babies? A record linkage study from Western Australia, The Journal of Maternal-Fetal & Neonatal Medicine, 2021; 35(25): 4997–5000.
5. K. M. Upatissa, S. Mahadevan-Bava, and S. Afridi, 1106 a study on the outcome of preterm babies born less than 30 week's gestation in a level 2 neonatal unit, British Association of Perinatal Medicine and Neonatal Society, 2022.
6. A. Ndayambaje, Continuity of neonatal care in the community: post-discharge care for preterm, small, and sick babies, Neonatal Nursing: A Global Perspective, 2022; 121–125.
7. G. Kayki et al., Direct effect of caffeine on diaphragmatic muscles in preterm babies through ultrasonographic examination, 2022.
8. E. Dean, Specialist neonatal respiratory care for babies born preterm, Nursing Children and Young People, 2019; 31(3): 11–11.
9. R. Bullaj and R. Bowman, Babies in glasses: Can wearing glasses for near focus help to improve sight in babies born at risk of brain injury, and in turn, help their development in other areas? A feasibility study, http://isrctn.com/, 2021.
10. E. S. Spelke, Précis of what babies know, Behavioral and Brain Sciences, 2023; 1–36.
11. K. Danko-McGhee, Early brain and sensory development, Viewing Art with Babies, 2023; 1–14.
12. A. Ruberti, M. Ronga, and L. Callegari, Clinical and ultrasonographic evaluation of shoulder in Elite Waterpolo players a cross-sectional study, 2019.
13. Tri Harjati, Eny Sendra, Lumastari Ajeng Wijayanti, and Ririn Indriani, Correlation between the duration of premature rupture of membranes during the labor and the asphyxia of newborn babies at Aura SYIFA Hospital Kediri regency, STRADA JurnalIlmiah Kesehatan, 2022; 11(2): 133–140.
14. N. McKay, The premature baby, Babies Growing Up, 2022; 149–151.
15. T. Tuba Dursun, Premature Birth Pospartum Depression on mother who gave a premature birth, breast-feeding adequacy maternal attachment relationship and group Psychotherapy treatment benchmark, 2019.