Neurosonography in the Detection of Neurologic Abnormalities in High-Risk Neonates

Vineet Kulkarni*, Vijay Kulkarni

Abstract

**Background:** Preterm neonates are susceptible to neurologic abnormalities such as intracranial hemorrhage, perinatal asphyxia, and congenital anomalies. Early identification of these conditions is important for their proper management. Cranial ultrasonography (USG) is an important tool to diagnose these conditions.

**Aim:** To detect neurologic abnormalities using cranial USG and evaluate the usefulness of USG as a diagnostic tool for the early detection of neurologic abnormalities in high-risk neonates.

**Materials and Methods:** A total of 104 preterm neonates with suspected neurologic abnormalities were included in this study and were subjected to cranial USG screening.

**Results:** The most common presentation was lethargy followed by seizures and feed intolerance. Of the 104 preterms, 22.1% were detected with neurologic abnormalities. Among them 8.6% neonates had evidence of germinal matrix hemorrhage (GMH), 3.8% had periventricular flaring, 2.8% had cerebral edema, and 1.9% neonates were suspected with periventricular leukomalacia. Cranial injuries were mostly found in neonates below 32 weeks of gestational age.

**Conclusion:** Cranial USG is the best method for initial screening of preterm neonates with suspected neurologic abnormalities. GMH is the most common finding in preterms with suspected cranial injuries. The ideal time for cranial USG study is within the first week of life.

**Key Words:** Cranial ultrasonography, germinal matrix hemorrhage, periventricular flaring, leukomalacia, cerebral edema, lethargy, feed intolerance, seizure
Introduction

Preterm neonates are a particular group of newborns susceptible to neurologic abnormalities such as intracranial hemorrhage, perinatal asphyxia, and congenital anomalies. Early identification of these conditions is important for their proper management. The use of cranial ultrasonography (USG) to examine these preterms has rapidly increased in the last few years and the relative simplicity of the procedure makes it an ideal method for early detection of complications and follow-up of these patients. Cranial USG can be used to diagnose neurologic abnormalities at the bedside that too noninvasively. 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. It is now an essential part of neonatal care, particularly in high-risk and unstable premature neonates.

Current ultrasound technology allows for rapid evaluation of neonates in the intensive care unit with practically no risk. The other modalities of radiographic investigations for cranial injuries are computed tomography (CT) and magnetic resonance imaging. However, USG has the advantage of being cost effective, easily available, and a bedside procedure that is repeatable and radiation free. Also, a study by Reeder et al shows that USG has a definite edge over CT in demonstrating intraventricular septae. Hence, in this study we used USG to detect neurologic abnormalities in preterm neonates.

Aim

To detect neurologic abnormalities using cranial USG and evaluate the usefulness of USG as a diagnostic tool for the early detection of cranial injuries in high-risk neonates.

Materials and Methods

This was a prospective study conducted from January 1, 2016 to June 1, 2016 in the neonatal intensive care unit (NICU) of SDM College of Medical Sciences and Hospital (Dharwad, Karnataka, India).

Inclusion and exclusion criteria

Neonates born prior to 34 weeks of gestation and weighing < 1800 g at birth and those presenting with neurologic abnormalities such as seizures, lethargy, apnea, sudden onset pallor, increase in muscle tone, bulging anterior fontanel were included in the study. All neonates with congenital malformations, severe infections, and failed resuscitation were excluded from the study.

Study procedure

One hundred four neonates, with suspected neurologic abnormalities, admitted to the NICU were selected as per the inclusion criteria on nonrandomized purposive sampling basis. All neonates were subjected to cranial USG examination. If cranial USG revealed various findings, neurosonography was repeated to follow-up for sequelae if any.

Assessment of factors placing the neonate in a high-risk category was done taking detailed maternal history and reviewing antenatal records. All perinatal details were recorded, detailed clinical examination was done, and anthropometric measurements were taken. Vital parameters were recorded within 24 to 48 hours of admission and complete neurologic examination was done during the neonates’ stay in the NICU. Gestational age was assessed as per modified Ballard scoring method for all preterm neonates. Basic routine investigations such as septic screening, random blood sugar, ionized calcium, chest X-ray (for respiratory symptoms), and lumbar puncture was done in neonates suspected with meningitis. Intraventricular hemorrhage (IVH) grading was done by using Volpe staging method. Clinical correlation of USG findings was done. Neonates were followed up till recovery and discharge from the NICU. Statistical analysis was done using SPSS software.

Results

A total of 104 neonates were enrolled in the study, of which 56% were male and 44% were female. Neurologic abnormalities were detected in 22.1% of preterm neonates. There was no significant correlation between the incidence of abnormal cranial USG findings and sex of the neonate. Correlation of gestational age with cranial USG findings was statistically significant. Study findings revealed that 8.8% (n = 9) neonates had evidence of germinal matrix hemorrhage (GMH); 3.8% (n = 4) neonates had periventricular flaring; 2.8%
(n = 3) had cerebral edema; 1.9% (n = 2) were suspected with periventricular leukomalacia (PVL); 1.9% (n = 2) had choroid plexus cyst; and 0.9% (n = 1) each for subarachnoid hemorrhage, subependymal cyst, and effacement of lateral ventricles (Table 1). Correlation between cranial USG findings and prematurity was statistically significant ($P < .005$). There was no significant correlation between abnormal cranial USG findings and the day of life it was done ($P = .671$). There was a statistically significant correlation between gestational age of high-risk neonates and the day of life cranial USG was done ($P = .004$).

Neonates who showed symptoms such as apnea, respiratory distress, and cyanosis were under oxygen therapy. All neonates were followed up till discharge. Of the enrolled neonates, 56% (n = 60) neonates were cured at the time of NICU discharge, 11.5% (n = 12) died, 15.4% (n = 16) neonates were relieved at the time of discharge, and 15.4% (n = 16) discharged from NICU for various reasons before clinical recovery (DAMA) (Table 2).

**Table 1.** Incidence of Cranial USG Abnormalities in Preterm Neonates

<table>
<thead>
<tr>
<th>Cranial USG</th>
<th>No. of Preterm Neonates (N = 104)</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>81</td>
<td>80.9</td>
</tr>
<tr>
<td>Abnormal</td>
<td>23</td>
<td>21.1</td>
</tr>
<tr>
<td>Intraventricular hemorrhage</td>
<td>9</td>
<td>8.8</td>
</tr>
<tr>
<td>Periventricular flaring</td>
<td>4</td>
<td>3.8</td>
</tr>
<tr>
<td>Cerebral edema</td>
<td>3</td>
<td>2.8</td>
</tr>
<tr>
<td>Periventricular leukomalacia</td>
<td>2</td>
<td>1.9</td>
</tr>
<tr>
<td>Choroid plexus cyst</td>
<td>2</td>
<td>1.9</td>
</tr>
</tbody>
</table>

USG, ultrasonography.

**Table 2.** Clinical Outcome in High-Risk Neonates

<table>
<thead>
<tr>
<th>Outcome</th>
<th>No. of Neonates</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relieved</td>
<td>16</td>
<td>15.4</td>
</tr>
<tr>
<td>Cured</td>
<td>60</td>
<td>57.6</td>
</tr>
<tr>
<td>Died</td>
<td>12</td>
<td>11.5</td>
</tr>
<tr>
<td>DAMA</td>
<td>16</td>
<td>15.4</td>
</tr>
</tbody>
</table>

DAMA, discharge against medical authority.

Discussion

Cranial USG is an ideal tool for initial screening of neonates with suspected cranial injuries, especially preterm neonates admitted to the NICU. Cranial USG is cost effective, radiation free, and is useful in diagnosing neurologic abnormalities at the bedside, when the neonate is unstable for transport. Hence, this study was undertaken to evaluate the usefulness of neurosonography in the diagnosis of cranial injuries in preterm neonates.

In this study, incidence of neurologic abnormalities in high-risk neonates was 22.1%. There were 56% male and 44% female neonates. There was no significant correlation between cranial USG findings and sex of the neonate.

In a study by Chowdhury et al, cranial injuries were detected in 6% of preterm neonates. Nagaraj et al, in their study, have reported that 11.2% preterm neonates had GMH. In this study 8.8% preterm neonates, < 34 weeks of gestational age, had GMH. In their study, Soni et al examined 111 high-risk neonates using cranial USG and found that one quarter of them had intracranial hemorrhage (ICH) within 120 hours of birth. In a study by Rehan et al, 47.5% preterm neonates were detected with IVH. In this study, 22.1% preterms had abnormal findings on cranial USG (GMH, PVL, periventricular flaring, and cerebral edema).

In this study, 1 preterm neonate, on regular follow-up cranial USG, developed findings suggestive of cystic PVL. A study by Maria et al concludes that cranial USG remains an important bedside diagnostic tool for PVL.

In this study, 3.8% high-risk neonates had periventricular echogenicity findings and 1.9% had choroid plexus cyst. Nagaraj et al reported that 1.6% preterm neonates, in their study, had periventricular echogenicity.

In this study, 57.6% neonates were cured at the time of discharge from the NICU; 11.5% died; 17.7% neonates were relieved at the time of discharge from the NICU; and 15.4% neonates were discharged from the NICU, for various reasons, before clinical recovery (DAMA). A study by Nagaraj et al had similar findings, with a cure rate of 61.2% and death rate of 12.9% among the high-risk neonates.
Conclusion

Cranial USG remains a reliable and rapid radiologic method of diagnosis for common neurologic injuries among preterm neonates, a high-risk group. This technique is both sensitive and specific for detecting GMH and PVL. The ideal time for cranial USG is within the first week of life as any incidence of IVH is very likely to have occurred by then. Commonest cranial USG findings in high-risk neonates suspected with cranial injuries are IVH, cerebral edema, PVL, and periventricular flaring.

References