STUDY OF CRANIAL ULTRASOUND FINDINGS IN PRETERM INFANTS ADMITTED TO NEONATAL INTENSIVE CARE UNIT AND CORRELATION WITH PERINATAL RISK FACTORS

Shehata SM¹, Taema MI², Omar Gamal Abdelaziz³, Tamer Aly Elkassas⁴, Sohaila Ali Abd El-Halim⁵, Mohammed AA⁶

¹Assistant Professor of Radiodiagnosis, Faculty of Medicine, Zagazig University
²Professor of Radiodiagnosis, Faculty of Medicine, Zagazig University
³Radiology Resident at El Mataria Teaching Hospital, Cairo
⁴Radiology consultant El Mataria Teaching Hospital, MD radiology
⁵Fellow of Pediatrics, El Mataria Teaching Hospital, MD paediatrics
⁶Assistant Professor of Radiodiagnosis, Faculty of Medicine, Zagazig University

Email: Omaretagamal@gmail.com

ABSTRACT

Background: Fetal brain is at risk for both hemorrhagic and ischemic injuries during late second and third trimesters due to vascular, cellular and anatomical features of developing brain and physiological instability due to limited cerebral circulatory autoregulation.

Aim and objectives: To verify the role of transcranial ultrasound as a screening tool for preterm infant born before 37 weeks of gestation and evaluate the association between cranial ultrasound findings and perinatal risk factors.

Subjects and methods: This cross sectional descriptive screening study was carried out at Radiodiagnosis department, the study including 165 preterm neonates admitted to the NICU from April 2020 to Mars 2021. After obtaining institutional review board approval from our hospital and informed consent from the parents, transcranial ultrasound with Doppler assessment of cerebral blood flow was performed for all neonates at day of admission, if negative, follow up CUS was repeated 3 days later and before discharge. A SONOSITE M-Turb ultrasound machine was used with transcranial transducer of 5-8 MHz.

Results: 69.1% of examined neonates had normal ultrasound findings while 30.9% had abnormal finding in the form of (hemorrhage (47%), followed by hypoxic ischemic injury (41.1%) then hydrocephalus among (25.4%). Neonatal comorbidities associated with abnormal cranial ultrasound were respiratory distress syndrome (58%), neonatal sepsis (9.8%), birth asphyxia (7.8%), neonatal seizures (13.7%) and obstructed labor (6%). There was significant association between abnormal cranial ultrasound and respiratory distress syndrome (grade II and III, P:0.001 and 0.03/ significant association), birth asphyxia (P:0.01/ significant association), hypotonia (P:<0.001/high significant association) and only to be preterm neonate (P:<0.001/high significant association).

Conclusion: There was a significant association between abnormal transcranial ultrasound findings and gestational age and birth weight. Also were respiratory distress syndrome and birth asphyxia had significant association with abnormal ultrasound. Early cranial ultrasound screening could help in prognosticating immediate outcome and early intervention.

Keywords: Transcranial Ultrasound, Preterm, Neonatal Ischemia, Neonatal Cerebral Hemorrhage.
I. INTRODUCTION:

Preterm neonates refer to babies born before the 37th week of gestation. When compared with infants delivered at term, preterm babies have higher incidences of intraventricular haemorrhage (IVH), respiratory sickness, patent ductus arteriosus, sepsis, and visual problems including retinopathy of prematurity (1,10,15).

Premature birth affects around 10% of babies; of those, 10% or more will have neurological damage, resulting in major learning difficulties, motor developmental delays, cerebral palsy, seizures, and mental retardation (2,12,16).

It is often not possible to subject every patient to magnetic resonance imaging (MRI) because of the non-availability of this modality and the cost of investigation. In addition, the critical clinical condition of the newborn does not allow shifting the patient to an MRI center (3,11,14).

Ultrasound is an ideal examination that is accomplished by using one or more transducers placed on the large anterior or the small posterior fontanel, which are used as acoustic windows (3,13).

New advances in sonographic equipment enable high resolution and three-dimensional images, which facilitate obtaining very accurate measurements of various anatomic structures such as the ventricles, the corpus callosum, and the cerebellar vermis (4,17).

The aim of this study was to verify the role of transcranial ultrasound as a screening tool for preterm infant below 37 weeks of gestation and to evaluate the association between cranial ultrasound findings and perinatal risk factors.

II. PATIENTS AND METHODS

A cranial US screening of premature neonates was carried out between April 2020 and Mars 2021. All inborn premature neonates (below 37 weeks gestational age) were considered eligible.

Two cranial US scans were performed: the 1st within the first week of admission, if negative, follow up CUS was repeated 3 days later and the 2nd before discharge. Babies were excluded for parental refusal or when images have poor quality.

Detailed obstetric history was taken as well as neonatal characteristics regarding gender, gestational age (GA), and birth weight (BW). Comorbidities were classified as respiratory distress syndrome, poor suckling, hypotonia, disturbed conscious level, coma, jaundice, HIE treated with hypothermia, congenital anomalies and sepsis. Morbidity at NICU admission was recorded and considered in the analysis.

CUS scans were performed by a radiologist with 7 years’ experience in pediatric imaging according to the clinical protocol of the unit and under the supervision of a team of radiologist with experience in neonatal brain imaging longer than 10 years.

Babies were scanned at bedside in supine position or in parents’ arms. Scans were performed with a (SONOSITE M-Turbo) ultrasound machine – KPI health care with transcranial transducer of 5-8 MHz.

The report included the description of ventricular system, midline structures, parenchymal echogenicity, and posterior fossa structures in addition to Doppler assessment of cerebral blood flow regarding waveform as well as resistive indices (RI) of anterior cerebral (ACA) and middle cerebral (MCA) arteries.

Statistical Analysis:

Data were analyzed using IBM SPSS 23.0 for windows (SPSS Inc., Chicago, IL, USA) and NCSS 11 for windows (NCSS LCC., Kaysville, UT, USA). Quantitative data were expressed as mean ± standard deviation (SD). Qualitative data were expressed as frequency and percentage. Suitable statistical tests of significance were used after checked for normality. The results were considered statistically significant when the significant probability was less than 0.05 (P <0.05). P-value < 0.001 was considered highly statistically significant (HS), and P-value ≥ 0.05 was considered statistically insignificant (NS).
III. RESULTS

Among all studied preterm, 60% were males and 17.6% were of GA less than 30ws. While age of examination ranged from day 1 up to 30 days with mean of (6.04 days ± 5.96), 9.1% were of low birth weight <1.5 kg and 16.4% were of gestational weight ranged from 1.5 kg to 2 kg.

According to the radiological findings patients were subdivided into either normal (69.1%, n: 114) or abnormal (30.9%, n: 51) in the form of (hemorrhage (47%) (fig.1), followed by hypoxic ischemic injury (41.1%) (fig.2) then hydrocephalus among (25.4%).

The commonest clinical finding found among studied preterm on examination was RD II (32.7%), then jaundice (22.4%) and followed by RD III and hypotonia among 18.8% and 4.8% of studied group respectively, while the only cause of admission of 23 neonates was only being preterm.

Among all examined preterm neonates, the commonest risk factor found among studied preterm was neonatal seizures (12.2%), then sepsis (6%) and followed by birth asphyxia among 3% of studied group.

There was a statistically significant increased incidence of abnormal cranial US findings among neonates presented with RD II, RD III, poor suckling, hypotonia and coma (Table 1). In addition, birth asphyxia and obstructed labor were statistically significant predictors for abnormal cranial US findings among high-risk preterm (Table 2).

| Table 1: Association of cranial US abnormalities and clinical data among studied cases. |
|---------------------------------|-----------------|-----------------|-----------------|-----------------|
|                                | Normal          | Abnormal        |                  |                  |
|                                | N=114           | N=51            |                  |                  |
|                                | N (%)           | N (%)           | X²               | P value          |
| RD II (n=54)                   | 24 (21.1%)      | 30 (58.8%)      | 10.1             | 0.001 S          |
| RD III (n=31)                  | 17 (14.9%)      | 14 (27.5%)      | 4.78             | 0.03 S           |
| Jaundice (n=37)                | 31 (27.2%)      | 6 (11.8%)       | 4.36             | 0.12 NS          |
| Poor suckling (n=5)            | 1 (0.9%)        | 4 (7.8%)        | Fisher           | 0.01 S           |
| Hypotonia (n=8)                | 1 (0.9%)        | 7 (13.7%)       | Fisher           | <0.001 HS        |
| DCL (n=3)                      | 3 (2.6%)        | 0 (0.0%)        | Fisher           | 0.26 NS          |
| Metabolic disorder (n=2)       | 1 (0.9%)        | 1 (2%)          | Fisher           | 0.56 NS          |
| Coma (n=2)                     | 0 (0.0%)        | 2 (4%)          | Fisher           | 0.03 S           |
| Preterm neonate (n=23)         | 8 (6.8%)        | 15 (29.4%)      | 14.7             | <0.001 HS        |

| Table 2: Association of cranial US abnormalities and perinatal risk factors among studied cases. |
|---------------------------------|-----------------|-----------------|-----------------|-----------------|
|                                | Normal          | Abnormal        |                  |                  |
|                                | N=114           | N=51            |                  |                  |
|                                | N (%)           | N (%)           | X²               | P value          |
| Birth asphyxia (n=5)           | 1 (0.9%)        | 4 (7.8%)        | Fisher           | 0.01 S           |
| Sepsis (n=10)                  | 5 (4.5%)        | 5 (9.8%)        | 2.26             | 0.13 NS          |
| Neonatal seizures (n=20)       | 13 (11.4%)      | 7 (13.7%)       | 0.39             | 0.54 NS          |
| IUGR (n=1)                     | 0 (0.0%)        | 1 (2%)          | Fisher           | 0.12 NS          |
| Obstructed labour (n=4)        | 1 (0.9%)        | 3 (6)           | Fisher           | 0.05 S           |
| Meconium aspiration (n=4)      | 3 (2.6%)        | 1 (2%)          | Fisher           | 0.86 NS          |
Figure 1: 5-day-old preterm neonate, male, born at 36 weeks gestation, presented with respiratory distress grade III. A: coronal plane (Anterior fontanelle window) showing left lateral ventricle filled with echogenic material (yellow arrow) with left para-ventricular intra-parenchymal hyperechogenic mass (blue arrow), B: sagittal plane (Anterior fontanelle window) showing the previously mentioned finding (yellow circle).

Figure 2: 30-day-old preterm neonate, male, born at 29 weeks gestation, presented with respiratory distress grade II for screening. A & B: coronal planes (Anterior fontanelle window) showing bilateral periventricular echodense lesions (red arrow) represent infarction with multiple small echolucencies represent cystic changes (yellow arrow) and enlarged subarachnoidal space denoting reduced brain
volume (blue arrow). C: sagittal plane (Anterior fontanelle window) showing multiple small echolucencies represent cystic changes (yellow arrow).

IV. DISCUSSION:
The American Academy of Neurology and the Practice Committee of Child Neurology recommends routine cranial ultrasonography screening on all newborns born before 30 weeks of gestational age\(^{(5,11,18)}\). In agreement with previous studies of Prithviraj, D. et al.\(^{(6)}\) and Nazparveen et al.\(^{(7)}\) who reported that 31% and 28.75% of studied cases had abnormal cranial ultrasound findings, our study shows 114 cases (69.1%) with normal cranial ultrasound, and 51 cases (30.9%) with abnormal cranial ultrasound findings.

Jha et al.\(^{(8)}\) and Kinikaret al.\(^{(16)}\) described a significant association between birth asphyxia and abnormal cranial ultrasound. In our study according to perinatal risk factors among our cases, the most common one was neonatal seizures with 12.1% of cases (n:20), then sepsis (6%; n:10), followed by birth asphyxia (3%; n:5). We also found significant association between abnormal cranial ultrasound and birth asphyxia and obstructed labor.

In our study we noted that the most common clinical presentation of our cases was respiratory distress grade II with (32.7%; n:54), and then jaundice with (22.4%; n:37), followed by respiratory distress grade III (18.8%; n:31) and other clinical presentation like poor sucking, hypotonia, disturbed conscious level, metabolic disorder and coma came after.

We found significant association between abnormal cranial ultrasound and clinical data like hypotonia, respiratory distress (especially grade II and III), jaundice and coma, that’s in correlation with Fumagalli et al.\(^{(9)}\) who reported a significant association between abnormal cranial ultrasound findings and respiratory distress.

Our study faces some limitations: Absence of standard reference (MRI), relative small sample size in extreme and very preterm neonates, and short duration of follow up in addition to some technical pitfalls.

V. CONCLUSION
At lower gestational age, the risk of developing brain lesions increases in particular when comorbidities exist.

Recommendations:
We recommend screening for all preterm babies born under 37 weeks of gestational age. If routine screening is not feasible, a targeted screening of infants with at least one risk factor should be modified according to the gestational age and the severity of the postnatal course, in particular the occurrence of respiratory distress syndrome.

Conflict of Interest: No conflict of Interest.

REFERENCES

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