

Role of Intracranial Ultrasonography in the Evaluation of Premature Babies

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Abstract

Background and Objective: In this study, the role of intracranial ultrasonography was evaluated in detecting intracranial abnormalities in premature neonates; furthermore, some maternal risk factors were evaluated for increasing incidence of intracranial abnormalities. **Materials and Methods:** A prospective cross-sectional study was done on 60 preterm neonates admitted in the neonatal care unit in both Raparin pediatric teaching hospital and maternity teaching hospital over a 5-month period. Neurosonogram was carried out for all within 1 week of life, and then, a second brain ultrasound (US) scan performed for them after 1 week if the first one was abnormal and the third scan for those who were abnormal at the second visit. **Results:** Incidence of intracranial abnormalities by ultrasonography in preterm neonates is 13.3% in the present study. There were 50% male and 50% female neonates. Ten percent of the study sample had evidence of intraventricular bleeding, and 3.3% had ventricular dilatation. There is a significant association between maternal risk factors and incidence of intracranial abnormalities ($P = 0.01$), and furthermore, there is a significant association between weight and gestational age ($P = 0.001$). There is no significant association between US finding with each of weight, gestational age, gender, and mode of delivery. **Conclusion:** Neurosonogram is the best initial method of investigation for preterm babies in the evaluation of intracranial abnormalities even if clinically silent. Maternal risk factors should be taken into consideration in increasing incidence of intracranial abnormalities. It is best to perform neurosonogram studies on all preterm babies within the 1st week of birth. It is widely available, cheap, and repeatable.

Keywords: Evaluation, intracranial ultrasonography, premature babies

INTRODUCTION

Preterm neonates are defined as childbirth occurring at <37 completed weeks of gestation. Children who are born prematurely have high rates of intraventricular hemorrhage (IVH), respiratory illness, patent ductus arteriosus, sepsis, and visual abnormalities such as retinopathy of prematurity compared with children born at term. These neonates are more prone to have neurodevelopmental delay.^[1]

Approximately 10% of newborns are born prematurely; of these, children >10% will sustain neurological injuries leading to significant learning disabilities, motor developmental delay, cerebral palsy, seizures, and mental retardation.^[2] The immature blood-brain barrier combined with fluctuation in cerebral blood flow, or platelet and coagulation disorders, form the basis for IVH pathogenesis.^[3]

Cranial ultrasonography (CUS) was introduced into neonatology in the late 1970s and has become an essential diagnostic tool in the modern neonatology.^[4,5] It was in the 1980s when Aaslid *et al.* could demonstrate that blood flow of the intracranial arteries can be analyzed by transcranial Doppler sonography.^[6] Cranial ultrasound is a safe, inexpensive, no ionizing radiation, no sedation and noninvasive; bedside technology has made it different from magnetic resonance imaging and computed tomography scan. As the suture lines and fontanel are open in infants and neonates, this can be used as acoustic windows to look into the brain.^[7,8] Neonatal sonography of the brain is now an

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essential part of newborn care, particularly in high-risk and unstable premature infants.^[9]

Cranial ultrasound (US) detects most of the hemorrhagic, ischemic, and cystic brain lesions; calcifications; cerebral infections; as well as major structural abnormalities in preterm and full-term infants.^[1]

This procedure is helpful in neonates who are hemodynamically unstable, and imaging can be done without shifting the baby to the radiology department for CUS. It can be initiated even at a very early stage, even immediately after birth. It is safe, can be repeated as often as necessary, and thereby enables visualization of ongoing brain maturation, the evolution of brain lesions, and also, it can be used to assess the timing of brain damage.^[10-12]

The American Academy of Neurology and the Practice Committee of the Child Neurology recommend CUS as routine screening on all newborns born before 30-week gestational age because of their higher risk of brain lesions.^[13]

Our primary aim is to determine the number of patients with abnormal CUS, even if clinically silent, and to determine maternal risk factors (premature rupture of membrane, breech presentation, prolonged labor, and intrauterine infection) associated with intracranial abnormalities.

MATERIALS AND METHODS

Study design and patients

A prospective cross-sectional study was conducted from October 1, 2018, to March 1, 2019, on 60 preterm neonates admitted to neonatal care unit in both Raparin pediatric teaching hospital and maternity teaching hospital in Erbil city, Kurdistan region, Iraq. The inclusion criteria were all preterm infants admitted to the neonatal care unit in both Raparin pediatric teaching hospital and maternity hospital. The exclusion criteria included term admitted neonates.

For all neonates included in the study, birth weight was measured with an electronic weighing scale and gestational age was calculated using last menstrual period, antenatal US scans, and New Ballard scoring system. All neonates included in the study underwent the first neurosonography before the 7th day of life after birth and a follow-up scan after 1 week from the first scan for those were abnormal and then these were repeated a third time only if the second scan was abnormal.

The protocol of the study was approved by the Research Ethics Committee of Kurdistan Board for Medical Specialties before the beginning of the study. Informed consent (oral and written) was taken from all child parents.

Statistical analysis

Data were recorded on a specially designed questionnaire, collected and entered in the computer, and then, analyzed using the Statistical Package for the Social Sciences, version 22 (SPSS, IBM Company, Chicago, IL, USA), and the results were compared between patients with

different variables. $P < 0.05$ was considered statistically significant.

RESULTS

A total of 60 neonates were enrolled in this study, of which 30 (50%) of them were male and 30 (50%) were female neonates. Regarding gestational age, the highest number 25 (41.7%) was between 32 and 35 weeks of gestation. Of the study sample, 21 neonates (35%) had a birth weight between 1500 and 2000 g. First intracranial US was done for 19 neonates (31.7%) before the age of 3 days of life, whereas for 41 neonates (68.3%), first scan was done between 3 and 7 days of life. The US finding was normal in 52 (86.7%) of neonates, 6 neonates (10%) had IVH, and 2 (3.3%) had ventricular dilatation.

Of these 60 neonates of our study, 41 of them (68.3%) were vaginally delivered and 19 (31.7%) were delivered by cesarean section. Thirty-four neonates (56.7%) had no maternal risk factors, 10 neonates' mother (16.7%) had premature rupture of membrane, 10 of them (16.7%), the maternal risk factor, were breech presentation, 5 neonates (8.3%) had prolonged labor, and 1 of them (1.7%) mother had intrauterine infection as shown in Table 1.

The results of Table 2 show a significant association between maternal risk factors and US findings. Forty percent of prolonged labor and 20% of premature rupture of membranes cases were associated with intraventricular hemorrhage findings during

Table 1: Descriptive data of different variables

Variable	Category	Frequency (%)
Gender	Male	30 (50)
	Female	30 (50)
Gestational age (weeks)	<28	9 (15.0)
	28-32	16 (26.7)
	32-35	25 (41.7)
	>35	10 (16.7)
Weight (g)	<1000	9 (15.0)
	1000-1500	19 (31.7)
	1500-2000	21 (35.0)
	>2000	11 (18.3)
Age at the first scan (days)	<3	19 (31.7)
	3-7	41 (68.3)
US findings	Normal	52 (86.7)
	Intraventricular hemorrhage	6 (10.0)
	Ventricular dilatation	2 (3.3)
Mode of delivery	Vaginal	41 (68.3)
	Cesarean section	19 (31.7)
Maternal risk factors	None	34 (56.7)
	Premature rupture of membranes	10 (16.7)
	Breech presentation	10 (16.7)
	Prolonged labor	5 (8.3)
	Intrauterine infection	1 (1.7)
Total		60 (100)

US: Ultrasound

US scan of newborn brains, and 20% of breech presentation conditions had ventricular dilatation per the US scans in contrary to pregnancies without complications or intrauterine infection cases in which almost all of them had normal US findings (97.1% and 100%, respectively). *P* value was 0.01.

The data of Table 3 reveal a nonsignificant association between the weight of newborns and US findings. Regardless of their weight, the majority of newborns had normal findings during US scan of their brain. In the same way, there was no significant relationship between gestational age and US

findings, i.e., 84%–90% of all cases in different gestational age groups had normal US findings. Chi-square test was performed, and *P* values were more than 0.05.

In our study, there was no significant correlation in the incidence of abnormal US finding in male and female (*P* = 0.26); both male and female were 86.7% normal, and 13.3% were abnormal.

The result of Table 4 shows that also there was no significant association between US finding and mode of delivery (vaginal and cesarean) (*P* = 0.61).

Table 2: Association between maternal risk factors and ultrasound findings (*P*: 0.01)

Maternal risk factors	US findings			Total (%)
	Normal (%)	Intraventricular hemorrhage (%)	Ventricular dilatation (%)	
None	33 (97.1)	1 (2.9)	0 (0.0)	34 (100)
Premature rupture of membranes	8 (80.0)	2 (20.0)	0 (0.0)	10 (100)
Breech presentation	7 (70.0)	1 (10.0)	2 (20.0)	10 (100)
Prolonged labor	3 (60.0)	2 (40.0)	0 (0.0)	5 (100)
Intrauterine infection	1 (100.)	0 (0.0)	0 (0.0)	1 (100)
Total	52 (86.7)	6 (10.0)	2 (3.3)	60 (100)

US: Ultrasound

Table 3: Association between gestational age, the weight of newborns, and ultrasound findings

Variables	Category	US findings			Total (%)	<i>P</i>
		Normal (%)	Intra-ventricular hemorrhage (%)	Ventricular dilatation (%)		
Weight (g)	<1000	8 (88.9)	1 (11.1)	0	9 (100)	0.38
	1000-1500	15 (78.9)	4 (21.1)	0	19 (100)	
	1500-2000	19 (90.5)	1 (4.8)	1 (4.8)	21 (100)	
	>2000	10 (90.9)	0	1 (9.1)	11 (100)	
Gestational age (weeks)	<28	8 (88.9)	1 (11.1)	0	9 (100)	0.75
	28-32	14 (87.5)	2 (12.5)	0	16 (100)	
	32-35	21 (84)	3 (12)	1 (4)	25 (100)	
	>35	9 (90)	0	1 (10)	10 (100)	
Total		52 (86.7)	6 (10)	2 (3.3)	60 (100)	

US: Ultrasound

Table 4: Association between ultrasound finding and mode of delivery

Mode of delivery	US findings			Total (%)
	Normal (%)	Intraventricular hemorrhage (%)	Ventricular dilatation (%)	
Vaginal	35 (85.4)	5 (12.2)	1 (2.4)	41 (100)
Cesarean section	17 (89.5)	1 (5.3)	1 (5.3)	19 (100)
Total	52 (86.7)	6 (10)	2 (3.3)	60 (100)

US: Ultrasound

Table 5: Association between ultrasound finding and age of neonate at the first scan

Age at the first scan (days)	US finding			Total (%)
	Normal	Intraventricular hemorrhage	Ventricular dilatation	
<3	16 (84.2)	2 (10.5)	1 (5.3)	19 (100)
3-7	36 (87.8)	4 (9.8)	1 (2.4)	41 (100)
Total	52 (86.7)	6 (10.0)	2 (3.3)	60 (100)

US: Ultrasound

Table 5 shows that those neonates <3 days of age whom US was done for them, 84.2% of them were normal, 10.5% had IVH, and 5.3% had ventricular dilatation. While those whom US was done for them between 3 and 7 days of life, 87.8% were normal, 9.8% had IVH, and 2.4% had ventricular dilatation. The less the age after birth, the more sensitivity of US finding, but there is no significant association between US finding and the postnatal age of the first scan ($P = 0.84$).

DISCUSSION

Intracranial ultrasonography is an ideal tool for the primary screening of the neonatal brain. This study is undertaken to evaluate the usefulness of neurosonogram in the diagnosis of the various lesions in preterm neonates.

In the present study, the incidence of intracranial US abnormalities in preterm neonates was 13.3%, while in another study, the incidence of intracranial US abnormality was 12%^[14] In our study, there was no significant correlation of incidence of abnormal cranial US findings in male and female. In the present study, regarding the types of abnormalities, 10% had an IVH which was the principal abnormality, in comparison to another study which also detected IVH as a principal abnormality (7.8%)^[15]

Regarding the age of detection of abnormalities, the most common abnormality (IVH) detected mostly between the age of 3 and 7 days 66.6% of the total, same as another study which detected commonest abnormality between 3 and 7 days.^[15] Regarding gestational age and US finding in the present study, the highest incidence of IVH (12%) was found in the gestational age between 32 and 35 weeks. While other study documented that the highest incidence of IVH (15.4%) in the gestational age <28 weeks, concluded that more incidence of abnormalities were in lower gestation age.^[15] Regarding weight and US finding in the present study, the highest incidence of IVH (21.1%) was found in those weighing 1000–1500 g, in comparison to another study found the incidence of IVH in preterm neonates of <1500 g from 20% to 40%.^[16]

In our study, there was no significant association between abnormal CUS and mode of delivery, similar to earlier reports.^[17,18] In our study, there was a significant association between maternal risk factors and US findings; 40% of prolonged labor and 20% of premature rupture of membrane cases had IVH, while in another study, there was no association between premature rupture of membrane and intracranial abnormality^[19] Regarding follow-up a scan (second and third scan) of those whom first scan was abnormal, all that had IVH developed mild posthemorrhagic hydrocephalus, while in another study, 50% of them developed posthemorrhagic hydrocephalus.^[20] while the 2 with ventricular dilatation remained the same as the first scan in the follow-up scans.

CONCLUSION

In the review of this study, we can conclude that brain US is the best initial method of investigation for preterm babies

with suspected intracranial abnormalities. It is best to perform neurosonogram studies on preterm babies within the 1st week of birth. Moreover, US scanning succeeded in detecting intracranial abnormalities in infants even they were clinically silent (10% IVH and 3.3% ventricular dilatation). Mothers with prolonged labor and premature rupture of the membrane had a significant chance of having babies developing intracranial hemorrhage compared to those having pregnancies without complications.

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Conflicts of interest

There are no conflicts of interest.

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