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Original Research Article

A Study on USG And MRI of Brain in Preterm and Term Neonates with Perinatal Asphyxia

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Abstract

Perinatal asphyxia leading to Hypoxic Ischemic Encephalopathy (HIE) is a major concern in newborn morbidity and mortality in India. In this study we have done transcranial USG and MRI brain of both term and preterm newborns to detect the HIE related changes in neonatal brain and also evaluated wheather MRI is better than USG in detecting the lesions.This cross sectional analytical study was conducted at Calcutta National Medical College and Hospital, Kolkata with 57 newborns (26 preterm,31 term) for a period of one year. Cranial USG was done on day 5 to day 7 of the baby and MRI brain of the same baby after 24 hrs of doing USG. We found that cerebral oedema, lesions of basal Ganglia, thalamus and parasagittal subcortical white matter injury were more common in term babies, whereas Germinal Matrix Haemorrage (GMH), IntraVentricular Haemorrage (IVH) and PeriVentricular Leucomalacia (PVL) were common in preterms.When we compared USG and MRI findings we found statistically significant difference in relation to detection of abnormal findings(49 by MRI,33 by USG},deep grey matter insult of basal ganglia, thalamus (22 by MRI, 8 by USG), parasagittal subcortical white matter injury (6 by MRI,0 by USG) with p value less than 0.05.Detection of GMH and IVH was 15 by MRI and 9 by USG. In conclusion, though USG is a less expensive initial screening tool in detecting HIE related lesions and it can detect IVH, GMH very effectively, but MRI brain should be the final investigation of choice to detect both central and peripheral cortical injuries in newborn with perinatal asphyxia.

Keywords: Perinatal asphyxia, HIE, USG brain, MRI brain.

INTRODUCTION

Neonatal encephalopathy developed after the insult of perinatal asphyxia is called hypoxic ischemic encephalopathy (HIE). HIE is the cause of 23% of all neonatal death worldwide. More than a million newborn who survive perinatal asphyxia develop cerebral palsy, learning disability, mental retardation and many other neurodevelopemental problems in future. While few modalities used give information regarding biochemical and neurophysiological aspects of the injury, most forms of brain imaging demonstrate evidence of anatomical alterations of brain including effects of hypoxic and vascular insult on the developing brain. Various forms of brain imaging used in newborns are USG, CT, MRI etc. USG brain provides a noninvasive, convenient, relatively low cost screening tool in developing countries with limited resources with no risk of radiation exposure. On the other hand MRI is one of the best modalities in detecting the hypoxic ischaemic brain injury in newborn at an early stage. So we conducted a study in a tertiary care hospital in Eastern India to know the effectiveness of USG and MRI brain to detect the early HIE changes found in neonatal brain, both term and preterm, after a perinatal hypoxic insult. The data was analysed statistically to demonstrate wheather MRI is better than USG brain in detecting early hypoxic brain damage in HIE cases.

MATERIALS AND METHOD

This cross sectional analytical study was conducted in the Neonatal Intensive Care Unit of Calcutta National Medical College and Hospital, Kolkata from March 2018 to February 2019. Our study included 57 newborns with the following inclusion criteria: 1.Term or preterm newborns of 0 to 7 days age and 2.newborns with a diagnosis of perinatal asphyxia. Exclusion criteria were: 1. Newborns with sepsis, 2.Major congenital anomaly, 3.Respiratory distress syndrome, 4.Intrauterine infection, 5.Hyperbilirubinemia, 6.Inborn error of metabolism and 7.Birth trauma. We labeled a neonate with perinatal asphyxia according to the protocol of FBNC (Facility

Based Newborn Care) and NNF(National Neonatology Forum) of India. Then staging of perinatal asphyxia was done according to the Sarnat and Sarnat staging into stage 1,2 and 3.Gestational age was assessed by Last Menstrual Period(LMP) and by modified Ballard Score done on the day of admission. Less than 37 wks and 37 to 42 wks are classified as preterm and term respectively. Standard treatment of perinatal asphyxia were given to all newborns and after stabilization of the babies informed written consents were taken from parents of each baby before initiation of study as per pre designed schedule. We performed cranial USG on day 5 to day 7 of the baby through the anterior fontanelle in sagittal and coronal plane. We performed MRI brain of the same newborns after 24 hrs of doing USG. T1 weighted spin echo images were done in the axial and sagittal plane. T2 weighted spin echo images and inversion recovery images were obtained in the axial plane. One post graduate student used to accompany the baby during the procedure with resuscitation tools. Results obtained were analysed satistically in comparison of proportion test by MedCalc statistical software with p value less than 0.05 as significant.

RESULTS AND DISCUSSION

Total 70 newborns were available for study as per the exclusion and inclusion criteria. But in 11 cases consent could not be taken and 2 cases expired. So the study was conducted on 57 newborns among whom 26 were preterm and 31 were term. The results are given in the following tables.

Table-1: HIE grading and gestational age

Gestational age	Total case & %	HIE 1	HIE 2	HIE 3
	57	18(31.8)	19(33.3)	20(35.1)
<37 wks(preterm)	26(45.6)	7	9	10
37 –42 wks(term)	31(54.4)_	11	10	10

Table-1 shows that preterm (45.6%) and term (54.4%) neonates are almost equal in number in this study. Among total 57 cases 31.8%, 33.3% and 35.1% cases presented as HIE1. HIE2 and HIE3 respectively.

Table-2: Cranial USG findings in perinatal asphyxia

Cranial USG findings	No & %	Term	Preterm
Normal	24(42.1)	14	10
cerebral oedema	16(28.1)	10	6
Hyperechogenecity of Basal Ganglia,Thalamus	8(14)	5	3
Germinal Matrix Haemorrage(GMH)	5(8.8)	1	4
Intra Ventricular Haemorrage(IVH)	4(7)	1	3

Table-2 shows that out of total 57 babies USG brain was normal in 24(42.1%) cases. 16(28.1%) showed cerebral oedema, 8(14%) showed hyperechogenecity of basal ganglia and thalamus, 5(8.8%) had germinal matrix haemorrage and 4(7%) had intraventricular haemorrage. We found that cerebral oedema and hyperechogenecity of basal Ganglia, thalamus were more common in term babies, whereas GMH and IVH were common in preterms.

Table-3: MRI brain findings in relation to gestational age

MRI brain findings	Total No & %	Term	Preterm
Normal	8 (14.1)	5	3
Increased signal intensity of Basal Ganglia, Thalamus	22 (38.6)	13	9
GMH,IVH,PVL(Peri Ventricular Leucomalacia)	15 (26.3)	4	11
Parasagittal subcortical white matter injury	6 (10.5)	5	1
Mixed features	6 (10.5)	4	2

Table-3 shows that MRI findings were normal in 8(14%) babies, among whom 5 were term and 3 preterm. Increased signal intensity of basal ganglia and thalamus were noted in 22(38.6%) babies among which 13(59%) were term and 9(41%) were preterm. On the other hand germinal matrix haemorrage, intraventricular haemorrage and periventricular leucomalacia were more common in preterm 11(73.3%)) babies as compared to term 4(26.7%)) babies. Parasagittal subcortical white matter injury was more common in term babies 5(83.3%) than preterm babies 1(16.7%) in this study. Mixed features like absent posterior limb sign, diffuse cortical and subcortical white matter injury, extensive cortical damage, dialatations of ventricles are found in total 6 cases with 4 term and 2 preterm.

Table-4: MRI brain findings in relation to HIE grading

MRI brain findings	Total No & %	HIE1	HIE2	HIE3
Normal	8 (14.1)	8	0	0
Increased signal intensity of Basal Ganglia, Thalamus	22 (38.6)	5	7	10
GMH,IVH,PVL	15 (26.3)	3	6	6
Parasagittal subcortical white matter injury	6 (10.5)	1	3	2
Mixed features	6 (10.5)	1	3	2

Table-4 shows that all the 8(14.1%) cases with normal MRI findings are in the HIE1 group. Increased signal intensity of basal ganglia and thalamus were more common in HIE2 & HIE3 (total 17) as compared to HIE1 (5 cases). Similarly GMH, IVH, PVL and parasagittal subcotical white matter injury were more common in HIE2 & HIE3 as compared to HIE1 cases.

Table-5: Comparison of MRI & USG findings

	MRI findings		USG findings	
	No	Percentage	No	Percentage
Abnormal findings	49	85.9	33	57.9
Deep grey matter insult	22	38.6	8	14
GMH,IVH	15	26.3	9	15.8
Parasagittal injury	6	10.5	0	0

Table-5 shows that MRI is more effective than USG in detecting HIE related changes in brain. MRI has detected abnormality in 49 case out of 57(85.9%) whereas abnormal USG findings was found in only 33(57.9%) case. In statistical analysis, by the comparison of proportion test, we found p value 0.0009 (statistically significant). In case of deep grey matter insult, MRI can detect it in 22(38.6%) cases as compared to USG brain 8(14%) with p value 0.0030(statistically significant). MRI was able to detect GMH, IVH in 15(26.3%) cases as compared to 9(15.8%) by USG brain. Statistical analysis shows p value 0.1710 (statistically insignificant). MRI brain could detect parasagittal injury in 6(10.5%) cases whereas no single case by USG brain. Statistical analysis shows p value 0.0123 (statistically significant).

Effects of hypoxic ischemic brain injury in neonatal brain varies according to the gestational age specific neuropathology. Term newborn demonstrates neuronal necrosis of the cortex and parasagittal area whereas preterm baby mainly demonstrates periventricular leukomalacia, intraventricular haemorrage and germinal matrix haemorrage. While USG brain is a fairly sensitive tool in detection of hemorrhage, cerebral oedema and hydrocephalus, parenchymal abnormalities such as periventricular leucomalcia and cortical injury identified by USG are often nonspecific. CT is the least sensitive modality for evaluation of hypoxic brain damage, because high water content of the newborn brain and high protein content of CSF result in poor parenchymal contrast resolution. Also CT has the inherent disadvantage of high radiation exposure. On the other hand MRI gives us early and more sensitive detection of ischemic and hypoxic damage of the neonatal brain and also gives more intricate picture of CNS anatomy and pathophysiology. So we studied conventional T1 and T2 weighted sequences of MRI to find out the extent of hypoxic ischemic injury.

In our study among the 31 term neonate, 10(32.3%) had cerebral edema, 5 (16%) increased echogenecity of deep grey matter, 1(3.2%) intraventricular haemorrage and 14(45%) had normal findings in USG brain.Among the 26 preterm neonate, 4(15.4%) had Germinal matrix haemorrage, 3(11.5%) Intraventricular haemorrage, 6(23%) only cerebral oedema and 10(38%) had normal findings in USG.

In a similar study by Yasmin T *et al*., [1] in case of term HIE neonates,43% showed cerebral oedema,46% showed normal finding and only 2% showed intraventricular hemorrhage. They found germinal matrix hemorrhage in 14%, intraventricular haemorrage in 11%, cerebral edema in 7% and normal findings in 39% in USG done in preterm babies. Other studies also reveal that intraventricular and germinal matrix hemorrhage are common findings In USG in preterm whereas cerebral edema is common in term babies with perinatal asphyxia [2, 3].

In our study, MRI findings revealed increased signal intensity of basal ganglia and thalamus in 22(38.6%) cases among which term(59%) predominates over preterm(41%). GMH, PVH & PVL are detected by MRI in 15(26.3%) cases,where preterm(73.3%) was more than the term(26.7%).Parasagittal subcortical white matter injury was found in 6(10.5%) cases, which was more among term(83.3%) than preterm(16.7%) babies.In our study it was found that severity of injury was more common in HIE2& HIE3 than HIE1 cases. These findings corroborates with some other recent studies like study by Cabaj A *et al*., and Varghese B *et al*., [4, 5]. Preterm babies born with chronic hypoxia mainly develop periventricular leukomalcia (PVL). In

late preterm born after 36 wks gestation subcortical white matter is also involved along with PVL. Acute and severe hypoxia in a term neonate causes damage to the grey matter specially the basal ganglia and thalamus. These lesions are known as selective neuronal necrosis,which are usually bilateral and have three stages mild ,moderate and severe as described by Rutherford [6].

The pattern of injury depends on the brain maturity at the time of insult, severity of hypoxia and hypoperfusion and duration of insult. Mild to moderate hypoxia results in germinal matrix hemorrhage and periventricular leukomalcia in preterm babies and parasagittal watershed territory infarct in term newborns. On the other hand severe perinatal hypoxic insult damages the deep grey matter in both preterm and term neonates [7]. A cardinal finding in a newborn who has experienced severe, total hypoxia is abnormally increased signal intensity on T1 weighted images of the basal ganglia, due to the fact that the deep grey matter structures,i.e., the basal ganglia and thalamus are the most metabolically active structure in the brain. So these structures are more vulnerable to oxidative stress and shows the effects of hypoxia earlier than the rest of the brain [8].

In the present study, we found that MRI was more effective in detecting HIE related brain injury than USG brain.Here MRI has detected some abnormality in 85.9% cases whereas USG brain detected abnormal lesion in 57.9% cases. Detection of deep grey matter insult was also more common by MRI (38.6%) than USG brain (14%). USG have detected GMH & IVH in a better way (15.8%) which is comparable to MRI (26.3%). But no parasagittal injury has been detected by USG brain. It was detected by MRI in 10.5% cases.

In a study by Genedi E A Sh *et al*., [9] in 2016, overall sensitivity and specificity of MRI brain was found to be more in comparison to USG brain(81.8% in MRI, 60% in USG). They showed that USG had better sensitivity for detecting thalamic, basal ganglion & periventricular lesions than lesions in cerebral cortex and subcortical white matter. Study of Steggerda *et al*., [10] also concluded that transcranial USG can detect central abnormalities better than the peripheral lesions. Blankenberg *et al*., [11] also stated that USG brain is less sensitive to detect structural abnormalities in the cerebral convexity, which we have also found in our study where USG was unable to detect parasagittal injury. However Epelman *et al.*, [12] found in their study that both peripheral and central brain lesions are equally detected by USG brain,which is in contrast to our study. A study conducted by Shen W *et al*., [13] suggested that ultrasound detected early cerebral edema better than MRI brain did. Cerebral edema was a common findings in USG brain in our study also.

CONCLUSION

Perinatal hypoxia and resultant hypoxic ischemic encephalopathy are among the leading causes of neonanal morbidity and mortality all over the world. Among the various imaging modalities transcranial ultrasound and MRI are most commonly used methods to detect early HIE related changes in brain. Though USG is a relatively low cost screening tool in developing countries, it cannot detect all hypoxic ischemic brain insults accurately as MRI does.In our study we found USG brain to be effective in detecting central abnormalities like IVH, GMH, whereas MRI was more effective in detecting cortical lesion like parasagittal injury in addition to deep grey matter insult. In term babies, deep grey matter insult and parasagittal subcortical white matter injury were more common, whereas IVH, GMH and PVL were common findings in preterm babies in our study.

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