Role of MRI in Evaluation of Hypoxic Ischemic Encephalopathy and Correlation with Clinical Outcome

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ABSTRACT
INTRODUCTION: Despite the rapid radiological advances and also the advances in neonatal care, the management of neonatal hypoxic ischemic encephalopathy (HIE) remains a clinical challenge. This prospective study was undertaken to evaluate the various MRI appearances of term HIE and to correlate the MRI appearances with clinical outcome. It was also undertaken to compare wherever possible, the neurosonographic appearances with the MRI findings.

METHODS: All term neonates with history of birth asphyxia, referred to the Department of Radiodiagnosis with clinically suspected HIE were taken up for MRI brain over 18 months period from July 2015 to December 2016. Appropriate MRI sequences were performed for every patient. MRI scans were performed on a 1.5 Tesla Philips Acheiva unit.

Wherever possible neurosonographic examination was undertaken using ALOKA alpha 6 unit and findings were compared with MRI findings.

RESULTS: 60 patients who were clinically suspected to have neonatal HIE underwent MRI studies of the brain. Out of 60 patients, 8 demonstrated lesions other than neonatal hypoxic ischemic encephalopathy. The remaining 52 patients had the following distribution of lesion patterns: 32(53.33%) patients had a central pattern, 18(30%) patients had a mixed pattern of injury, one(1.7%) patient had a purely periventricular pattern of involvement, and one(1.7%) patient had bilateral watershed territorial infarction.

MRI proved to be more sensitive and specific in evaluation of this condition compared to other imaging modalities. Neurosonogram was performed in 39 patients, was abnormal in 17 patients and normal in 22 patients. We found that neurosonography had a low sensitivity, but a high positive predictive value.

INTERPRETATION AND CONCLUSION The results obtained in our study compare well with other studies undertaken in the past. Differences in the pattern of hypoxic ischemic encephalopathy are likely to result from severity of birth asphyxia. MRI is non-invasive and has no radiation hazards associated with it. The excellent gray–white matter resolution and multiplanar imaging capabilities provide an advantage to MRI over other modalities. The addition of DWI improves the diagnostic capacities of MRI and in prognosticating lesions.

1.INTRODUCTION: Hypoxic-ischemic encephalopathy is characterized by clinical and laboratory evidence of acute or sub-acute brain injury due to asphyxia (i.e. Hypoxia, acidosis). Most often, the exact timing and underlying cause remain unknown. The incidence of long-term complications depends on the severity of hypoxic-ischemic encephalopathy. As many as 80% of infants who survive severe hypoxic-ischemic encephalopathy develop serious complications, 10-20% develop moderately serious disabilities, and as many as 10% are healthy. Infants with mild hypoxic-ischemic encephalopathy tend to be free from serious CNS complications.

BRAIN MRI
MRI is the imaging modality of choice for the diagnosis and follow-up of infants with moderate-to-severe hypoxic-ischemic encephalopathy (HIE). Conventional MRI sequences (T1w and T2w) provide information on the status of myelination and pre-existing developmental defects of the brain. When performed after the first day (and particularly after day 4), conventional images may accurately demonstrate the injury pattern as area of hyperintensity. Conventional images are most helpful at age 7-10 days, when the diffusion-weighted imaging (DWI) findings have pseudonormalized.
DWI allows earlier identification of injury patterns in the first 24-48 hours. The MRI sequence identifies areas of edema and, hence, injured areas. DWI changes peak at 3-5 day and pseudonormalizes by the end of the first week. In neonates, DWI changes may underestimate the extent of injury, most likely because of the importance of apoptosis in the ultimate extent of neurological injury.

**PATTERN OF HYPOXIC ISCHEMIC INJURY IN TERM INFANTS**

Following a severe asphyxial event, a central pattern of injury is seen with injury to (1) the deep grey matter (i.e., putamina, ventrolateral thalamus, hippocampi, dorsal brainstem, or lateral geniculate nucleus) and (2) the perirolandic cortex. These areas contain the highest concentration of N-methyl-D-aspartate (NMDA) receptors and are actively myelinating. Less severe or partial insult results in injury to the intervascular boundaries areas and is also called watershed injury. This type of lesions manifests in the infants as proximal extremity weakness or spasticity. Decreased signal in the posterior limb of the internal capsule (PLIC) on T1W images may be noted. The absence of normal signal (high intensity on T1w images) in the PLIC of infants older than 38 weeks' gestation is a strong predictor of abnormal motor outcomes in these infants.

**2. AIMS AND OBJECTIVES OF THE STUDY:**

1. Identification of MRI findings in Hypoxic Ischemic Encephalopathy

2. Identification of the advantages and drawbacks of MRI as a diagnostic tool in Hypoxic Ischemic Encephalopathy

3. Assessment of the sensitivity of MRI scan in confirmation of clinically suspected MRI

4. Correlation of MRI findings with clinical outcome

**3. MATERIALS AND METHODS**

**SOURCE OF DATA**

This hospital based study was conducted in the Department Of Radio diagnosis, Dr. S.N. Medical College and Associated Group of Hospitals, Jodhpur. All MRI scans were performed on a 1.5 Tesla Philips Achieva unit. Sequences used were T1W axial, T2W axial, FLAIR axial, T1W sag, T2W coronal, T2W GRE axial, DWI axial and ADC maps. Wherever possible neurosonographic examination was undertaken using a Aloka A6 and findings were compared with MRI findings. Following MRI patients were followed up for a period of six months to assess for neurological outcome. The study required that the patients be adequately sedated to tolerate the prolonged examination time inside the MRI machine. All patients who fulfill the criteria for the study, referred to the department of Radio diagnosis with clinically suspected Hypoxic Ischemic Encephalopathy during the period of MAY 2015 to DEC 2016 were be subjected for the study. The study excluded: Preterm neonates with birth asphyxia. Haemodynamically unstable patients who may not tolerate prolonged examination times in the isolated setting of MRI. General contraindications to MRI examination such as pacemakers, metallic implants or metallic foreign body.

**4. RESULTS**

60 patients who were clinically suspected to have neonatal hypoxic ischemic encephalopathy underwent MRI studies of the brain. Out of 60 patients, 8 demonstrated lesions other than neonatal hypoxic ischemic encephalopathy. The remaining 52 patients had the following distribution of lesion patterns. 32 patients had a central pattern, 18 patients had a mixed pattern of injury. One patient had a purely periventricular pattern of involvement, and one patient had bilateral watershed territorial infarction.

**5. INTERPRETATION AND CONCLUSION:**

This is a prospective study. The results obtained in our study compare well with other studies undertaken in the past. Differences in the pattern of hypoxic ischemic encephalopathy are likely to result from severity of birth asphyxia. MRI is non-invasive and has no radiation hazards associated with it. The excellent gray – white matter resolution and multiplanar imaging capabilities provide an advantage to MRI over other modalities. The addition of DWI improves the diagnostic capacities of MRI. There is a strong relation between the MRI appearances of birth asphyxia and the clinical outcome. Therefore MRI has a strong role in prognosticating lesions.

**6. References**


FIG1 CENTRAL TYPE OF HYPOXIC ISCHEMIC ENCEPHALOPATHY IN A 6 DAY OLD NEONATE

Restricted diffusion in the genu of the corpus callosum and both internal capsules

Diffusion restriction in the corpus callosal splenium

Corresponding ADC images
FIG2 MIXED PATTERN OF HYPOXIC ISCHEMIC ENCEPHALOPATHY IN A NEO NATE

Restriction of diffusion in the splenium of the Corpus Callosum and the posterior limbs of bilateral internal capsules

Restriction of water diffusion in thalami bilateral basal ganglia

Corresponding At

Restricted diffusion in bilateral perirolandic cortices, indicative of cortical involvement.