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A STUDY OF MAGNETIC RESONANCE IMAGING AND SPECTROSCOPY OF BRAIN IN CHILDREN WITH DEVELOPMENTAL DELAY

Radiology

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ABSTRACT

AIMS AND OBJECTIVES To identify the spectrum of abnormalities in brain magnetic resonance imaging in children with developmental delay and categorize the morphologic abnormalities. Secondly, the role of Proton Magnetic Resonance Spectroscopy (MRS) to ascertain the magnitude and severity of various neurometabolite ratios in children with normal brain imaging will also be studied. **Patients And Methods:** Our study involves the evaluation of 100 children presenting with developmental delay to the Department of Radio diagnosis, JJMMC Hospital between January 2022- January2023. The children were evaluated with a standard MRI protocol. Clinical and demographic parameters were noted. **Conclusion:** MRI has good sensitivity in diagnosing various disorders of developmental delay. Careful evaluation of the MRI helps identifying the probable etiology in most cases. ProtonMRS is an emerging technique in evaluating children with developmental delay and should be incorporated in the standard MRIprotocol in cases where it feasible. Hence, appropriate diagnosis on MRI helps in guiding the physician to plan further patient management.

KEYWORDS

MRS-Magnetic Resonance Spectroscopy, MRI-Magnetic Resonance Imaging

INTRODUCTION

Development is a continuous process which begins from conception and continues throughout an individual's life. Developmental delay denotes significant delay in one or more developmental domains. It poses a social stigmata upon the child and his or her family. Developmental delay has an estimated prevalence of 1-3% worldwide. Developmental delay needs careful evaluation to ascertain the etiology which is evident in around 50-70% of the cases.

The evaluation of developmental delay is complex and involves various modalities including cytogenetic testing, biochemical and hormonal assays, enzyme assays, electroencephalography (EEG) and neuroimaging. Magnetic resonance imaging has evolved over the years as one of the most sensitive modality in imaging a child with developmental delay. Around 60% of the children with developmental delay have an abnormal MRI Further, MRI provides detailed anatomical evaluation of the brain and also provides information on the extent of myelination and its associated micro structural changes. Appropriate categorization of patients based on neuroimaging guides the clinicians in further evaluation of the child which helps them at arriving at a diagnosis more promptly and with ease.

Identifying the involved brain structures and the associated morphologic abnormalities also help in appropriately categorizing the patients which has a significant impact on patient management.

MATERIALS AND METHODS

Our study involves the evaluation of 100 children presenting with developmental delay to the Department of Radio diagnosis, JJMMC Hospital between January2022- January2023. The children were evaluated with a standard MRI protocol. Clinical and demographic parameters were noted.

The various involved brain structures were studied systematically and the morphologic abnormalities were categorized.

INCLUSION AND EXCLUSION CRITERIA

INCLUSION CRITERIA:

Children with developmental delay aged between 6 months and 10 years, referred to our department for Brain Magnetic Resonance Imaging to evaluate the cause of developmental delay.

EXCLUSION CRITERIA:

i) Children younger than 6 months and older than 10 years of age.
ii) Children with progressive neuro-developmental disorders.
iii) Children with congenital CNS infections, meningitis and encephalitis.
iv) Children with recognized syndromes including chromosomal disorders.

CATEGORIZATION OF THE PATIENTS

STEP 1:

The children were categorized based on their gestational age into preterm, term and late preterm based on the following table

	Definition
Preterm	Born at 37 weeks gestation or less
Late preterm	Born between 34-0/7 and 36-6/7 weeks of gestation
Term	Born between beginning of week 38 and end of week 41 of gestation

Table 2: Table showing classification of neonates on the basis of gestational age.

The following brain structures were systematically evaluated based on a study by Widjaja et al
-Ventricle, corpus callosum, gray matter, white matter, limbic system, basal ganglia, brain stem, cerebellum, cranial vault

STEP 3:
The proportion of patients with a normal MRI were noted. The various abnormal MRI findings and their corresponding diagnosis were categorized based on a study by Williams et al [4]. The various morphologic abnormalities were categorized into one or more of the following categories

i. Normal
ii. Non specific findings like cavum septum pellucidum, cavum vergae, ventriculomegaly, prominent Virchow-Robin spaces (VRS), prominent cisterna magna etc.,
iii. Neurovascular including periventricular leukomalacia, hypoxic - ischemic injury, encephalomalacia, atrophy, gliosis etc.,
iv. Congenital and developmental including vascular malformations
v. Neoplastic and cystic lesions
vi. Combined or multifactorial
vii. The results were analyzed systematically and relevant observations were made. All data were analyzed with a statistical software package – Statistical Package for the Social Sciences (SPSS), version 16.0 for Windows.

RESULTS

The prevalence of abnormal MRI findings was 78% among the evaluated children. Our study showed predominant involvement of the white matter (50%), ventricles (37%) and corpus callosum (24%). The relative proportion of various morphologic abnormalities was Neurovascular diseases (50%), Congenital and developmental (12%), Non-specific findings (11%), Neoplastic and cystic lesions (3%) and combined etiology (2%). 10 children with a normal MRI were

subjected to MR Spectroscopy which revealed no significant difference in the neurometabolite ratios among the patients.

CONCLUSION:

The current study was undertaken to evaluate the spectrum of abnormalities on MRI in children with developmental delay. The role of MR Spectroscopy in children with normal MRI was also studied.

Out of the 100 children evaluated in our study around 35 children were in the age group 3-5 years. The children were categorized based on gestational age with 39% of the children being preterm. Further, these children had an associated abnormal MRI in most cases. It was also noted that 61% of the children had associated seizures. It was inferred that the children with associated seizures had a larger proportion of abnormal MRI (56 out of the 61 children with seizures).

Among the rest of the children, 24% presented with one or more neurological deficits. It was also noted that there existed a significant correlation between the occurrence of an abnormal MRI and the presence of additional clinical features along with developmental delay (developmental delay "plus").

Among the 80 children presenting with developmental delay "plus", 69 had an abnormal MRI.

The various involved brain structures were also studied systematically. The white matter (50%), ventricles (37%) and corpus callosum (24%) were involved in most cases. Around 78% of the children had an abnormal MRI in our study.

The various MRI abnormalities were categorized. The category of Neurovascular diseases showed the highest proportion of children in our study (50%) with an increased incidence in the age group 3-5 years. Most of the cases were a sequel to hypoxic ischemic injury.

MR Spectroscopy in children with normal MRI revealed no significant difference in the neurometabolite ratios among the children evaluated. Since MR Spectroscopy adds to the time period of the conventional MR protocol and is by far dependant on the patient being motionless for the entire duration of the study, this limits its use in younger children and infants due to motion artifacts and risk of prolonged sedation.

MR imaging has good sensitivity in diagnosing various disorders of developmental delay. Careful evaluation of the MRI helps identifying the probable etiology in most if not all cases. Proton MR Spectroscopy is an emerging technique in evaluating children with developmental delay and should be incorporated in the standard MRI protocol in cases where it is feasible.

Hence, appropriate diagnosis on MRI helps in guiding the physician to plan further patient management.

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