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Original article:

A study of MRI and MR spectroscopy of brain in children with developmental delay

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Abstract:

Introduction: Developmental delay is a common term used to describe children who are not meeting their developmental milestones at the expected age.

Material and methods: This study was a prospective and descriptive study aimed at investigating the role of MRI and MR spectroscopy in children with developmental delay. A total of 100 children with developmental delay, aged between 6 months and 18 years, were included in the study. The children were referred to the Department of Radiodiagnosis, JJM Medical College Hospital, for neuroimaging as part of their evaluation.

Results: In our analysis, neurovascular illnesses have the maximum percentage of children (52%) and a higher incidence in the 1–3-year-old age range. The majority of the cases followed hypoxic-ischemic damage. Children with normal MRI results showed no significant differences in the neuro metabolite ratios of the children studied by MR spectroscopy.

Conclusion: Various illnesses associated with developmental delay can be more precisely diagnosed with MRI with reasonable sensitivity. In most cases, careful analysis of the MRI aids in determining the likely cause. Additional clinical factors also aid in the diagnostic efficacy of MRI. A promising method for assessing children with developmental delays is MR spectroscopy. When assessing older children with developmental delays, proton MR spectroscopy is a must be included as routine imaging.

Keywords: MRI , developmental delay , MR spectroscopy

Introduction:

Developmental delay is a common term used to describe children who are not meeting their developmental milestones at the expected age. It can affect various areas of development, including cognitive, motor, speech and language, social, and emotional development. Developmental delay is a significant concern for parents and caregivers as it can impact a child's quality of life and future prospects.[1,2,3]

Magnetic Resonance Imaging (MRI) and Magnetic Resonance Spectroscopy (MRS) are advanced imaging techniques that can provide detailed information about the structure and function of the brain. These techniques are particularly useful in studying children with developmental delay, as they can help to identify any abnormalities in brain structure or chemistry that may be contributing to the delay.[4,5]

Several studies have investigated the use of MRI and MRS in children with developmental delay. These studies have found that these techniques can provide valuable information about brain structure, function, and metabolism, which can help to diagnose the underlying cause of developmental delay. Additionally, MRI and MRS can help to monitor changes in brain structure and function over time, which can inform treatment decisions and improve outcomes for children with developmental delay.[6]

In this study, we aim to investigate the use of MRI and MRS in children with developmental delay. We will examine the relationship between brain structure, function, and metabolism and developmental delay in children, and we will explore the potential of these techniques for diagnosis and treatment planning. Our findings will contribute to the growing body of literature on the use of advanced imaging techniques in pediatric neurology and inform clinical practice in the management of children with developmental delay.

Material and methods:

This study was a prospective and descriptive study aimed at investigating the role of MRI and MR spectroscopy in children with developmental delay.

A total of 100 children with developmental delay, aged between 6 months and 18 years, were included in the study. The children were referred to the Department of Radiodiagnosis, JJM Medical College Hospital, for neuroimaging as part of their evaluation.

Inclusion Criteria: Children with developmental delay, aged between 6 months and 10 years, who were referred to the radiology department for Brain Magnetic Resonance Imaging to evaluate the cause of developmental delay, were included in the study.

Exclusion Criteria: Children younger than 6 months and older than 10 years of age, children with progressive neurodevelopmental disorders, children with congenital CNS infections, meningitis, and encephalitis, and children with recognized syndromes including chromosomal disorders were excluded from the study.

Study Protocol: Preliminary Screening: A paediatrician with experience in developmental paediatrics conducted a clinical evaluation of the children presenting with developmental delay before referring them to the Department of Radiodiagnosis for brain magnetic resonance imaging. The Trivandrum Developmental Screening Chart and DENVER II were used to evaluate developmental delay. The patient's clinical and demographic information were recorded, and informed consent was obtained from the child's parents or legal guardians before any neuroimaging procedures were performed.

MRI and MR Spectroscopy: All the children underwent brain MRI and MR spectroscopy using a 1.5 Tesla MRI scanner. The imaging protocol included standard T1-weighted, T2-weighted, FLAIR, and diffusion-weighted sequences. MR spectroscopy was performed using a single-voxel spectroscopy sequence with the voxel placed in the parieto-occipital region of the brain.

Image Analysis: All images were reviewed by an experienced radiologist who was blinded to the clinical information. Brain MRI findings were classified according to the type and location of abnormalities. MR spectroscopy data were analyzed to determine the levels of N-acetylaspartate (NAA), choline (Cho), and creatine (Cr).

Data were analyzed using descriptive statistics, including means and standard deviations for continuous variables and frequencies and percentages for categorical variables.

This study was approved by the institutional ethics committee, and all procedures were performed in accordance with the ethical standards laid down in the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. Informed consent was obtained from the child's parents or legal guardians before any neuroimaging procedures were performed.

Results:

The distribution of 100 patients, with ages varying from 6 months to 10 years is depicted in the table above. There are 55 males and 45 females in total, with 20 patients (11 male and 9 female) aged between 6 months - 1 year, 50 patients (26 male and 24 female) aged between 1 year- 3 years, 23 patients (14 male and 9 female) aged between 4 - 6 years, and 7 patients (4 male and 3 female) aged between 7 - 10 years. According to the study, there is the majority of children between the ages of 1-3 have developmental delay. Indicating that there is no association between age and developmental delay (P = 0.926).

Table 1: Table showing the prevalence of various neurological deficits.

Neurological Deficits	N	Percentages
Hypotonia	11	68.75
Spasticity	8	50
Gait abnormality	3	18.75
Hemiplegic cerebral palsy	2	12.5

The table above displays the frequency of different neurological deficits out of a possible 100 patients. A neurological deficit affected 24 patients, of whom 11 had hypotonia, 8 had spasticity, 3 had an abnormal gait, and 2 had hemiplegic cerebral palsy.

Table 2: Table showing the relative frequencies of the affected brain structures on MRI.

Affected Brain Structures	N	Percentages
Ventricles	35	35
White Matter	53	53
Grey matter	18	18
Corpus callosum	26	26
Limbic system	4	4
Basal ganglia	6	6
Brain stem	1	1
Cranial vault	4	4
Others	11	11

The table above displays the relative frequency of the MRI-visible brain regions that are affected. 35 patients had involved ventricles, 53 had abnormal white matter, 18 had abnormal grey matter, 26 had abnormal

corpus callosum, 4 had an abnormal limbic system, 6 had abnormal basal ganglia, 4 had an abnormal cranial vault, 1 had abnormal brain stem, 11 had involvement of other structures.

Table 3: Table showing the prevalence of normal and abnormal MRI findings.

MRI Features	Frequency	Percent
Normal	21	21
Abnormal	79	79
Total	100	100

The aforementioned table displays the frequency of aberrant and normal MRI findings in the study's 100 total patients. 79 (79%) patients had abnormal MRI findings, while 21 (21%) patients had normal MRI findings.

Out of 100 points, the table above categorises various MRI findings. 52 patients (52%) had neurovascular/traumatic findings. Congenital and developmental abnormalities were seen in 12 (12% of patients), nonspecific imaging findings were present in 11 (%), neoplastic and cystic lesions were present in 3 (%), multifactorial findings were present in 1 (%), and normal MRI findings were present in 21 (21%) of the patients.

Table 4: Table showing the average neuro metabolite ratios in the children evaluated with MR Spectroscopy.

NAA/Cr	Cho/Cr
2.37	1.35

In our study, an MRI was normal in 21 children. 14 of the 22 children who participated in the study got their MR spectroscopy evaluated. Multivoxel MR spectroscopy was used to calculate various neuro metabolite ratios. Voxels were positioned in the parieto-occipital and bilateral frontal subcortical white matter. The NAA/Cr and Cho/Cr metabolite ratios were determined.

In 14 children with normal MRIs, MR spectroscopy using the multivoxel approach was performed. This included children who cooperated well and who weren't at concern about deep sedation. The use of this technique is restricted by several technical issues, including motion artifacts caused by the child's lack of cooperation and the risk of sedation overdose, particularly in younger children and infants, because the spectroscopic evaluation is performed prospectively after evaluating the preliminary MRI. Additionally, the benefit against risk.

Discussion:

Our study was conducted in Bapuji hospital and Chigateri general hospital, JJM Medical College, Davangere from August 2020 to February 2022. It was approved by the ethical and scientific committee of JJM Medical college. Written informed consent was taken from the parents before the enrolment of children after explaining the study. The primary aim of the study was to study MRI and MR spectroscopy of the brain in children with developmental delay. The secondary aim was to estimate the relation of gestational age with MRI findings.

We enrolled 100 children aged between 6 months to 10 years. In our study, out of 100 cases, 45 were female (45%) and 55 were male (55%)

A 3 year and 5 months old term male child presented with seizures and developmental delay

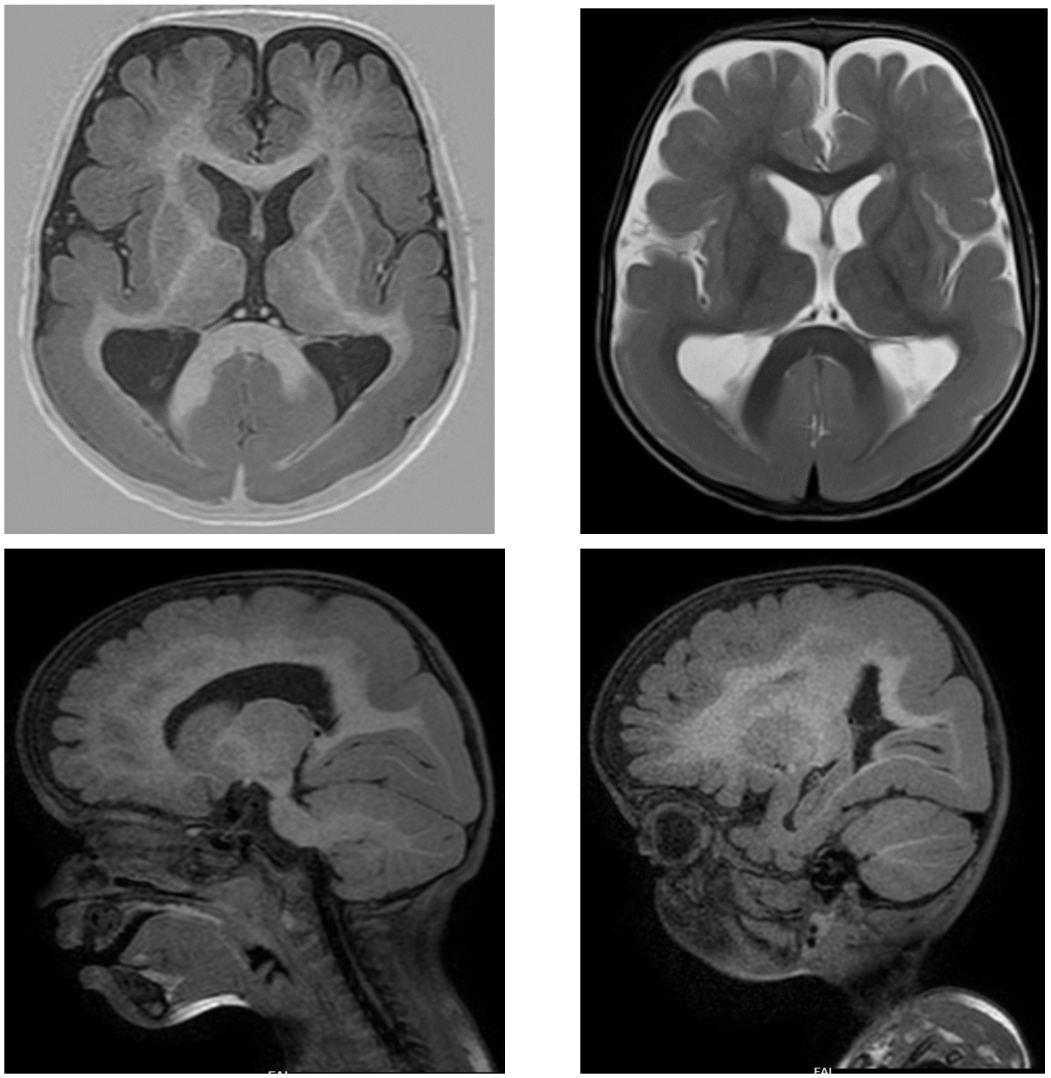

Figure 1: T1 IR, T2 Axial, T1 Sagittal MR brain sections showing loss of sulci and gyrations in bilateral parieto-occipital regions with prominent occipital horns of bilateral lateral ventricles-Parieto-Occipital Pachygyria Lissencephaly.

The objective of this study was to assess the range of MRI brain changes in children with developmental delay. In children with normal MRI results, the function of MR Spectroscopy was also investigated. Around 50 of the 100 children assessed for this study were in the 1–3-year age range. Based on gestational age, the children were divided into groups, with 43% of children are preterm most of them are associated with abnormal MRI. Additionally, it was discovered that 55% of the children experienced related seizures. The children with concomitant seizures were assumed to have a higher percentage of abnormal MRI results (49 out of the 55 children with seizures).Similar results were found in different other studies. [7-11]

The objective of this study was to assess the range of MRI abnormalities in children with developmental delay. The MR Spectroscopy function. The numerous affected brain regions were extensively

investigated as well. In the majority of instances, the corpus callosum (26%) and white matter (53%) were affected. In our study, overall, 79% of children have an abnormal MRI. The different MRI anomalies are divided into groups. In our analysis, neurovascular illnesses have the maximum percentage of children (52%) and a higher incidence in the 1–3-year-old age range. The majority of the cases followed hypoxic-ischemic damage. Children with normal MRI results showed no significant differences in the neuro metabolite ratios of the children studied by MR spectroscopy. The use of MR Spectroscopy in younger children and infants is restricted due to motion artifacts and the risk of extended sedation because it extends the time of the traditional MR procedure and is largely dependent on the patient being still for the whole duration of the examination.

Conclusion:

Various illnesses associated with developmental delay can be more precisely diagnosed with MRI with reasonable sensitivity. In most cases, careful analysis of the MRI aids in determining the likely cause. Additional clinical factors also aid in the diagnostic efficacy of MRI. A promising method for assessing children with developmental delays is MR spectroscopy. When assessing older children with developmental delays, proton MR spectroscopy is a must be included as routine imaging.

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