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Magnetic Resonance Imaging Evaluation of Brain in Developmental Delay Children

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Abstract **Original Research Article**

Introduction: Developmental delay is termed as gross or significant delay in more than one developmental domains. Aetiology of the developmental delay is the wide spectrum. MRI is the best modality to evaluate such children. Other than early diagnosis and treatment, helps in counselling parents regarding their outcome and risk of recurrence in the siblings. Study aimed to observe the efficacy of MRI Brain in children with developmental delay. ***Conclusion:*** MRI brain study is an effective tool in identifying causative factor in developmental delay children with high yielding results.

Keywords: Magnetic resonance imaging, Developmental delay, Brain.

INTRODUCTION

Developmental delay is not a disease nor a diagnosis but it is a symptom or clinical presentation [1-4]. The diagnosis of developmental delay is not immediately done after birth, but done during infancy or early childhood. Many times the diagnosis is done one the child enters the school [5, 6]. The definition of developmental delay is termed as significant delay in one or more developmental domains [2]. The diagnosis significantly impedes quality life of the patient and full participation in the life of the family, school and community. In such cases it depends on the clinician's ability to detect and diagnose the cause with a multimodality approach which always includes neuroimaging. Development is a dynamic process that is determined by interaction of genetic, biological and environmental factors [17].

There are wide range of etiologies which include genetic, metabolic, endocrine, vascular, malformation syndromes, traumatic, infections, toxins and environmental causes [1, 3].

Myelination and synaptogenesis are considered the biological correlates of this developmental process and have been studied extensively. Any delay in neurodevelopment is likely to have a biological correlate. Brain MRI is one of the major investigation of these patients and based on previous studies, about 60% of cases have abnormal findings in MRI [19].

MR imaging is an important part of the comprehensive evaluation of children with developmental delay, as many specific etiologic and pathophysiologic conditions that lead to developmental delay can be detected easily [8, 9]. Aim of the study is to know the most common MRI brain findings in children with global developmental delay and prevalence of normal and abnormal findings in patients in global developmental delay.

MATERIALS AND METHODS

An descriptive study of MRI of the Brain in 20 paediatric patients referred to department of Radiodiagnosis in Rural medical college, PMT, for a duration of 1 year from september 2020-september 2021 from Paediatric department for the cause of developmental delay. The patients were diagnosed for developmental delay after taking detailed history. Both sexes were included in the study.

Inclusion Criteria

- Children aged between 3 months 12 years presented with developmental delay.
- No h/o allergy to iodinated contrast.

Exclusion Criteria

- Non consenting patients.
- Children aged less than 3 months and more than 12 years.
- Children with known genetic disorder, congenital heart diseases, muscular myopathies.
- Non co-operative sick patients.
- Contraindication to MRI: claustrophobic, cochlear implant, pacemaker, metallic foreign body, internal infusion pump.

All the children with developmental delay was subjected to MRI brain, on 3 Tesla MRI after making the child sleep or sedated.

Sequences used were: Our routine brain sequence comprises of an axial T1, T2-W, Axial and coronal FLAIR, and coronal and sagittal T1-W images. DWI is acquired in all children and an ADC is calculated using automated computer software and provided for reporting.

The following structures were systematically evaluated following to Widjaja *et al.,* [5] protocol.

1. Ventricles: Size and morphology.
2. Corpus callosum: Thickness and morphology.
3. Gray and white matter: The sulcation and gyration of the gray matter based on normal MR brain anatomy.
4. Basal ganglia: Morphology.
5. Brain stem: Morphology.
6. Cerebellum: Morphology. The term cerebellar atrophy was used if the cerebellum was small with shrunken folia and large cerebellar fissures or if it had been shown to undergo progressive volume loss. A structure was considered dysplastic if disorganized in development, such as abnormal folial pattern or presence of heterotopic nodules of gray matter [8].

The findings presented in the MRI reports were divided in six categories [9]:

1. Normal.
2. Metabolic and neurodegenerative diseases such as demyelination
3. Traumatic/neurovascular diseases including hypoxic ischaemic injury or encephalopathy, periventricular leukomalacia, encephalomalacia, atrophy, and gliosis.
4. Congenital and developmental disorders.
5. Neoplastic diseases.
6. Nonspecific findings-includes ventriculomegaly, cavum septum pellucidum, cavum vergae, hypoplasia of corpus callosum, enlarged subarachnoid spaces and delayed myelination.

RESULTS

Normal MRI Findings were seen in 36% (representing 36 cases) of paediatric patients with global developmental delay. Further evaluation was advised for these children to know the cause of developmental delay. Abnormal findings were seen in 75% (15 cases). Further the etiological factors as been classified as traumatic/ neurovascular (30%), congenital/developmental (12%), metabolic/degenerative (8%), neoplastic (4%) and nonspecific (10%).

Category II: Includes metabolic/degenerative disease, were found in 1 case which had cerebral atrophy.

Category III: Includes traumatic/neurovascular diseases of brain. 7 out of 20 patients had traumatic and neurovascular diseases. Among them most common findings were hypoxic ischemic encephalopathy (4 cases), encephalomalacia (2 cases), and periventricular leukomalacia (1 case).

Category IV: Includes congenital/developmental disorders of brain (3 cases), the findings were corpus calosum agenesis (1 case), chiari malformation (1 cases), and open lip schizencephaly (1 case).

Category VI: Non-specific findings were found in 4 cases out of which ventriculomegaly (2 cases), delayed myelination (1 cases), enlarged subarachnoid space (1 cases).

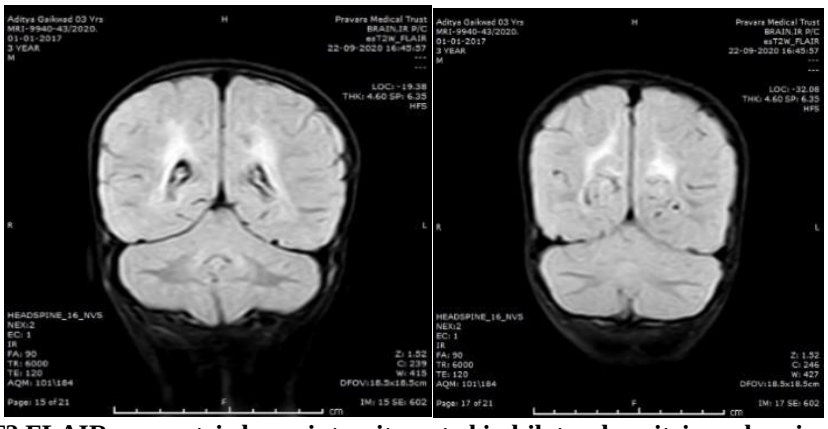

Figure 1: (a and b) T2 FLAIR symmetric hyperintensity noted in bilateral peritrigonal region-representating HIE

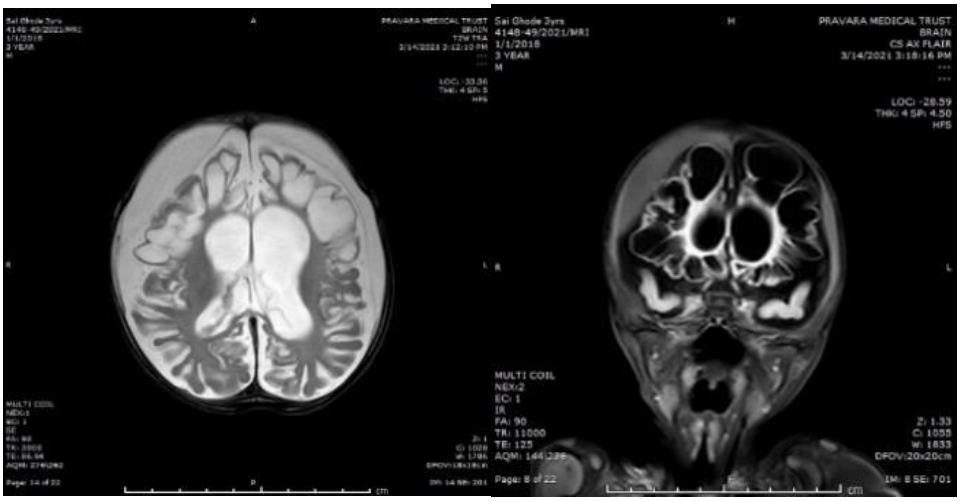

Figure 2: (a and b) T2 and FLAIR shows multiple cystic areas of varying sizes-representating Multicystic Encephalomalacia

Figure 3: (a and b) T2 sag. and CSF drive sag. shows peg like herniation of cerebellar tonsil with no e/o syrinx noted-representating Chiari malformation type I

Figure 4: (a and b) T2 and FLAIR shows large smooth CSF filled cleft that extends from the ependymal surfaces of brain through the white matter to the pia matter with the cleft communicating with the lateral ventricle-representating Open lip schizencephaly with large CSF cleft

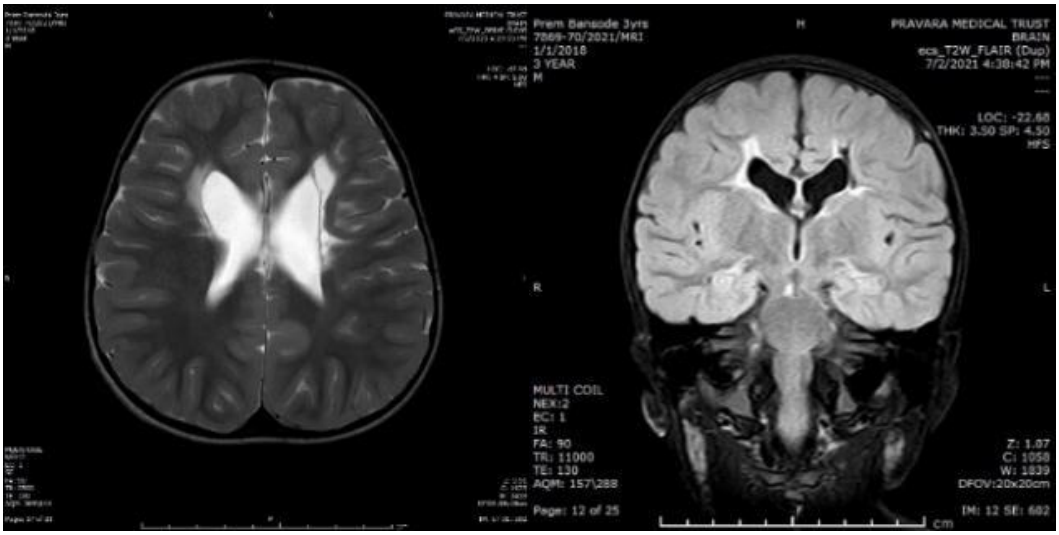

Figure 5: (a and b) T2 axial. and FLAIR images shows periventricular white matter hyperintensities with cystic areas-representating Periventricular leukomalcia

DISCUSSION

Evaluation of MRI brain was done in 20 paediatric patients with developmental delay of age group three months to 12 years. Normal MRI brain findings were seen in 5 of pediatric patients presenting with developmental delay. These children were advised further evaluation to diagnose the etiology of developmental delay. The proportions of children having abnormal MRI findings in our study of 20 cases could get a definitive diagnostic yield of 75% (15 cases). Similar yield of abnormal MRI has been reported by Momen *et al.*, [3] Shevell *et al.*, [4] and Widjaja *et al.*, [7] who had a yield of 58.6%, 65.5%, and 84% respectively.

Table 2: Aetiological classification based on MRI findings

MRI findings	***N* (%)**
Normal study	5(25)
Metabolic and neurodegenerative	1 (5)
Traumatic/neurovascular diseases	7 (35)
Congenital and developmental	3 (15)
Non specific	4 (20)
Total	20 (100)

MRI: Magnetic resonance imaging

In India, sources have found prevalence of 1.5-2.5% of developmental delay in children under 2 years of age [10, 11]. These impairments impact not only the child and the family, but also the society, in terms of the cost of providing health care, educational support, and treatment services [12]. Evidence supports that early treatment of developmental disorders leads to improved outcomes for children and reduced costs to society [12-14]. Prevalence of developmental delay in children has been reported 5-10% [20]. The determination of cause is important for a number of reasons including prognostication, surveillance and prevention of secondary disability, potential treatment, and appropriate genetic counselling [6]. Apart from clinical history, physical examination, chromosomal analysis and biochemical testing, neuroimaging plays an important role in the etiologic profiling of these developmentally delayed children. A study done in Korea between 1993–1991 on 34 children with developmental delay showed 76.5% patients had abnormal findings on brain MRI while 23.5% patients had normal MRI brain [16].

After evaluating the MRI findings, according to the findings we divided them into various etiological factors as described above (Table 2). Momen *et al.*, [19] has classified their MRI findings into aetiological categories; in which Traumatic/ Neurovascular Diseases (Hypoxic Ischemic Brain Injury) ranked the highest similar to our study. The parents of children with congenital/developmental anamolies had consangious marriage and religious belief when proper history was taken. A study done by Momen *et al.*, reported that in their study there was slightly higher incidence of congenital and developmental disease as a cause of developmental delay which could be explained by the religious beliefs that these patients follow, of not terminating the pregnancy in antenatally diagnosed abnormality.

Our present study included 8 cases of metabolic and neurodegenerative, 4 cases of neoplastic origin and nonspecific findings includes 10 cases. A study conducted by Moes *et al.*, [21] also observed similar incidence of Degenerative/Metabolic Diseases causing global developmental delay.

MR imaging is an important part of the comprehensive evaluation of children with developmental delay, as many specific etiologic and pathophysiologic conditions that lead to developmental delay can be detected easily [8, 9, 22].

CONCLUSION

MRI brain study is an effective tool in identifying causative factor in developmental delay children with high yielding results and should be considered as a second line investigation in children's with developmental delay. Developmental delay have variety of causative factors which can be identified on MRI and aids the clinician for proper diagnosis, treatment and counselling of the parents. The chance of increasing the yield of diagnosis increases with not only MRI brain but further imaging advances like Functional MRI, MR Spectroscopy, Diffusion Tensor Imaging and Tractography especially in structurally normal brain of these children.

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