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Original Article

Magnetic Resonance Imaging Evaluation of Brain in Developmental Delay Children

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Abstract

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.

Materials and Methods: An observational and descriptive study of MRI brain in 100 paediatric patients with developmental delay for the duration of 2 years from December 2014-December 2016.

Results: Normal MRI Findings were seen in 36% cases and abnormal findings were seen in 64% (64 cases). Further the etiological factors as been classified as traumatic/neurovascular (30%), congenital/developmental (12%), metabolic/degenerative (8%), neoplastic (4%) and non-specific (10%). Most common features observed in the study were PVL, gliosis with volume loss, thinning of corpus calosum. Common anatomical abnormalities are corpus callosum agenesis and nodular heterotopia.

Conclusion: MRI brain study is an effective tool in identifying causative factor in developmental delay children with high yielding results.

Key words: Magnetic resonance imaging, Developmental delay, Brain

INTRODUCTION

Developmental in its broadest sense encompasses physical and mental growth that leads to the anatomical, physiological and behavioural changes that occur throughout childhood. For most paediatricians, child development relates to the changes in children's ability to move,perform fine movements with their hands,communicates, learns new knowledge, self-care and interact with others.

Development is a dynamic process that is determined by interaction of genetic, biological and environmental factors.[1] Developmental delay is defined as significant delay (more than 2 standard deviations below the mean) in one or more developmental domains.[2] Cognitive and motor development observed in infants and children are a reflection of postnatal brain development. 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.[3]

Prevalence of developmental delay in children has been reported 5-10%.[4] 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.[5,6] 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.

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MATERIALS AND METHODS

An observational and descriptive study of MRI of the Brain in 100 paediatric patients referred to department of Radio-diagnosis in Chettinad Hospital and research institutefor a duration of 2 years from December 2014-december 2016 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 18 years presented with global developmental delay.

Exclusion Criteria

- Children aged more than 18 years.
- Children with known genetic disorder, such as Down's syndrome, Turner's syndrome, etc., associated with delayed developmental milestones
- History of head injury.

All the children with developmental delay was subjected to MRI brain, on GE Signa HDxt 1.5 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.*[7] 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[5]
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 64% (64 cases). Further theetiological factors as been classified as traumatic/neurovascular (30%), congenital/developmental (12%), metabolic/degenerative (8%), neoplastic (4%) and non-specific (10%).

Category II: Includes metabolic/degenerative disease, were found in 8 cases all of which had white matter and ventricle related abnormalities including mucopolysaccharidosis(1 case), cerebral atrophy (4 cases), metachromatic leukodystrophy (1 case),central pontine myelinosis (1 case), and tuberous sclerosis (1 case).

Category III: Includes traumatic/neurovascular diseases of brain.30 out of 100 patients had traumatic and neurovascular diseases. Among them most common findings were hypoxic ischemic encephalopathy(12 cases), encephalomalacia(8 cases), and periventricular leukomalacia(10 cases).

Category IV: Includes congenital/developmental disorders of brain(12 cases), the findings were corpus calosum agenesis(4 cases), heterotopia (4 cases), chiari malformation (2 cases),and agyria/pachygyria (2 cases).

Category V: Neoplastic category includes 4 casesout of which medulloblastoma (2 cases), pilocytic astrocytoma (1 case), and teratoma (1 case).

Category VI: Non-specific findings were found in 10 cases out of which ventriculomegaly (4 cases), delayed myelination (3 cases), enlarged subarachnoid space (2 cases), hypomyelination (1 cases).

The other area included in the study were seizures.30 out of 35 patients with history of seizures had abnormal MRI findings (Table 1 and Figures 1-9).

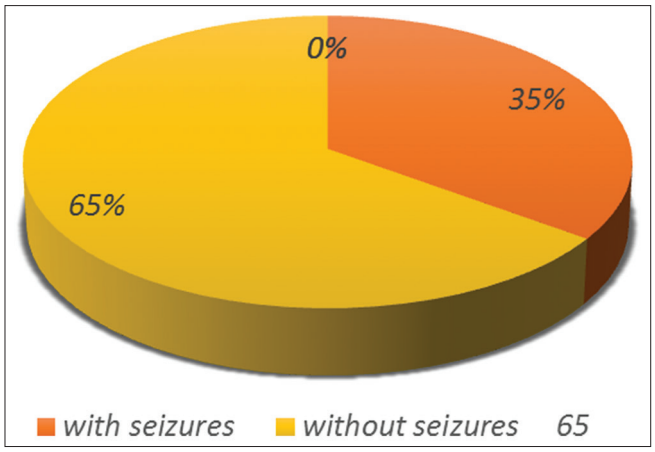

Figure 1: The Clinical presentation of study population with normal and abnormal MRI

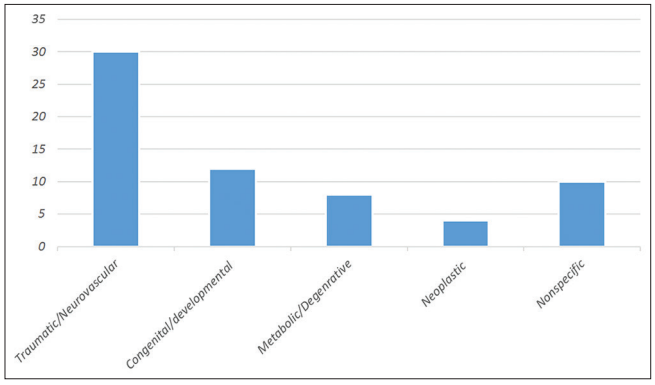

Figure 2: Percentage classification of different etiological factors

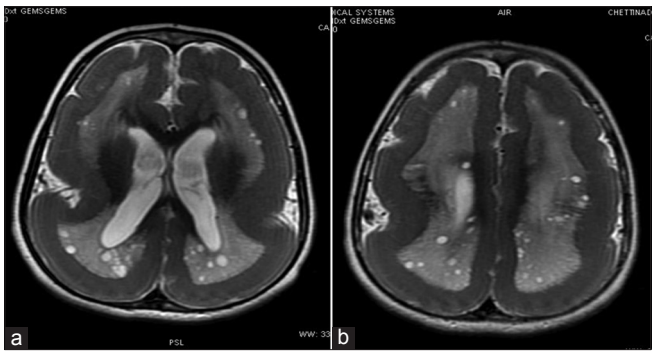

Figure 3: (a and b) Lissencephaly with band heterotopia. Axial T2WI shows agyria/pachygyria complex, band of GM isointense area with in b/l cerebral white matter hyperintensity-representating band heterotopia

DISCUSSION

Evaluation of MRI brain was done in 100 paediatric patients with developmental delay of age group three months to 18 years. The proportions of children having abnormal MRI findings in our study of 100 cases could get a definitive diagnostic yield of 64% (64 cases). Similar yield of abnormal MRI has been reported by Momen *et al.*,[3]

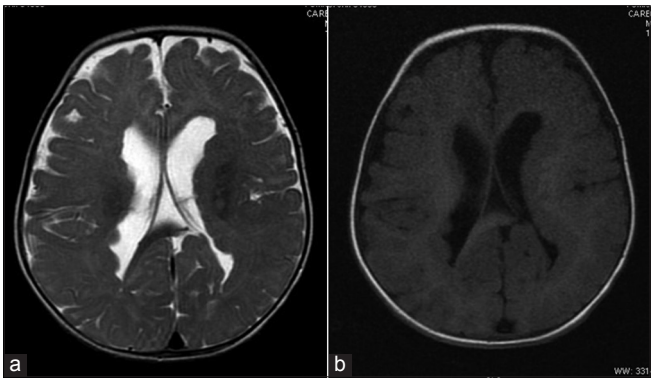

Figure 4: (a and b) Axial T1/T2WI shows periventricular subependymal nodules in GM representating subependymal GM heterotopia

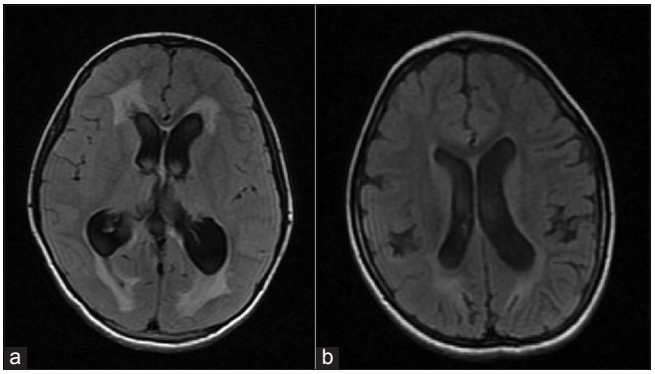

Figure 5: (a and b) T2 FLAIR hyperintensity noted in bilateral peritrigonal region-representating b/l periventricular leukomalacia

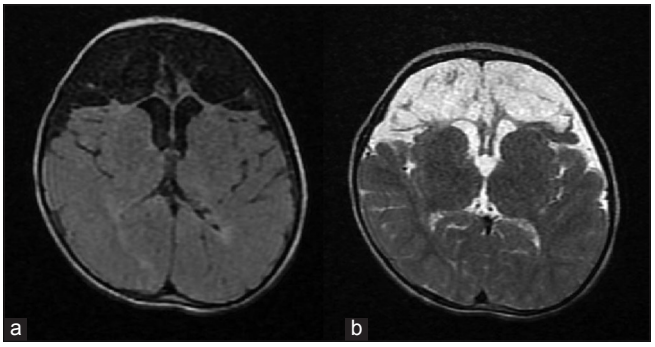

Figure 6: (a and b) Axial T1/T2WI shows encephalomalacic changes with surrounding gliosis noted in b/l frontal and temporal lobes with exvacuo dilatation of b/l frontal and temporal horns of lateral ventricle

Table 1: Clinical presentation of study population with normal and abnormal MRI

Parameter	Number	
	Abnormal MRI (*N*=64)	Normal MRI (*N*=36)
Clinical presentation		
Only developmental delay	34	31
Developmental delay with seizures	30	5

MRI: Magnetic resonance imaging

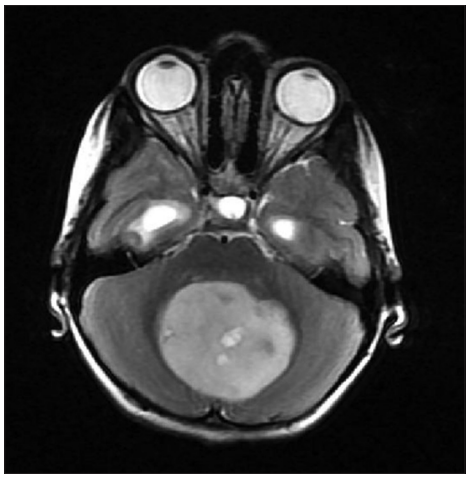

Figure 7: Medulloblastoma, axial T2WI shows midline intra-axial mass arising from cerebellum with obstructive hydrocephalus

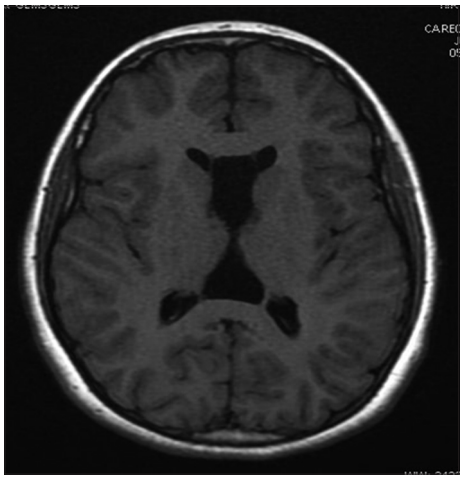

Figure 8: Axial T1WI shows dilated cavum septum pellucidum, cavum vergae, cavum vellum interpositum cyst

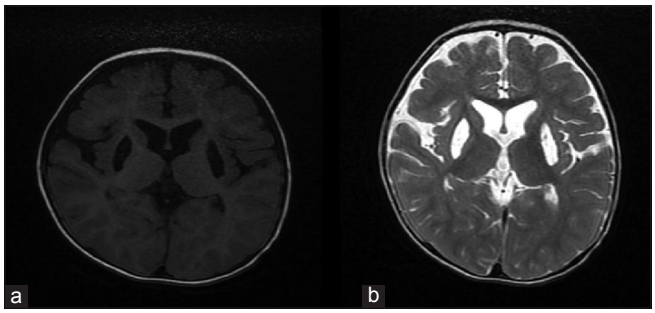

Figure 9: (a and b) Axial T1/T2WI shows gliotic changes with volume loss in bilateral lentiform nucleus

Shevell *et al.*,[4] and Widjaja *et al.*,[7] who had a yield of 58.6%, 65.5%, and 84% respectively.

Prevalence of developmental delay in children has been reported 5-10%.[4] The determination of cause is important for a number of reasons including prognostication, surveillance and prevention of secondary disability, potential

Table 2: Aetiological classification based on MRI findings

MRI findings	*N* (%)
Normal study	36 (36)
Metabolic and neurodegenerative	8 (8)
Traumatic/neurovascular diseases	30 (30)
Congenital and developmental	12 (12)
Neoplastic	4 (4)
Non specific	10 (10)
Total	100 (100)

MRI: Magnetic resonance imaging

treatment, and appropriate genetic counselling.[8] 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.Neuroimaging as an second line investigation in patients with developmental delay yields an high variable results from 9-80%.However yield of result increases with specific problems such as microcephaly, focal neurological deficit, seizure disorder.[10]

After evaluating the MRI findings, according to the findings we divided them into various etiological factors as described above (Table 2). Momen *et al.*,[3] has classified their MRI findings into aetiological categories; in which Traumatic/ Neurovascular Diseases (Hypoxic Ischemic Brain Injury) ranked the highest similar to our study followed by congenital/developmental anamolies(12%).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.*,[11] 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.[5,6,12]

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. By using advanced MRI techniques such as diffusion tensor imaging, MR spectroscopy, Functional MRI and Tractography helps to yield high results particularly in patients with structurally normal brain.

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