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Research Article

Role of MRI Evaluation of Paediatrics with Global Developmental Delay

Dr. Bharat M. P[1], Dr. Deepak K. S[2*]
[1,2]Assistant Professor, Department of Radiodiagnosis, Subbaiah Institute of Medical Sciences, Shimoga, Karnataka, India

***Corresponding author**
Dr. Deepak K. S

Abstract: ***Objective:*** To make evidence-based recommendations concerning the evaluation of the child with a non-progressive global developmental delay. ***Material and Methods****:* This is prospective and observational study conducted at Department of Radiodiagnosis, Subbaiah Institute of Medical Sciences, Shimoga, where in thirty consecutive children aged between 1 month to 13 years with clinical diagnosis of developmental delay, who were referred for magnetic resonance imaging of the brain were included in the study. The study was conducted between the months of February 2013 to August 2013. Intravenous sedation using midazolam in appropriate doses were administered when required. ***Results:*** In our study total 30 children with developmental delay were enrolled. Among them 17 were males and 13 were females. Maximum number of abnormalities were detected in age group of 7 to 10 years in 40 % of children, followed by 11 to 13 years age in 23.3% of children. Out of 30 children 19 (63.3%) had abnormal MRI findings and 11 (36.6%) has normal MRI brain. Maximum number of patients were atrophic changes 20%, followed by Congenital malformations and least were infection, vascular lesions, CSF disorder. ***Conclusions:*** A specific aetiology can be determined in the majority of children with global developmental delay. Certain routine screening tests are indicated and depending on history and examination findings, additional specific testing may be performed.
Keywords: Global Developmental Delay, Magnetic resonance imaging, Congenital malformations.

INTRODUCTION

Global developmental delay is a subcategory of developmental disabilities defined as significant delay in two or more of the following developmental domains: gross/fine motor, speech/language, cognition, social/personal, and activities of daily living [1]. Global developmental delay describes a clinical presentation that has a heterogeneous etiologic profile and is associated with age-specific deficits in adaptation and learning skills [2]. The term global developmental delay is usually reserved for younger children (i.e., typically less than 5 years of age), whereas the term mental retardation is usually applied to older children when IQ testing is more valid and reliable [3]. A child with the clinical picture of global developmental delay is not necessarily destined to be mentally retarded. Infants and children may have global developmental delay owing to conditions such as cerebral palsy, certain neuromuscular disorders, and other conditions such as early environmental deprivation, yet when they are old enough to measure cognitive level they do not score in the mentally retarded range [4].

The diagnosis of mental retardation, according to the American Association of Mental Retardation and the Diagnostic and Statistical Manual of Mental Disorders, 4th ed., text revision, requires accurate and valid assessment of intelligence, which is generally not possible in infants and young children in addition to deficits in adaptive function [5]. Available valid instruments for assessing intelligence (such as the Stanford-Binet or Wechsler Preschool Primary Scale of Intelligence) are not generally applicable under age 3 years [6].

The precise prevalence of global developmental delay is unknown. Estimates of 1% to 3% of children younger than 5 years are reasonable given the prevalence of mental retardation in the general population [7]. Estimates of the etiologic yield (10% to 81%) in children with global developmental delay/mental retardation are highly variable [8]. Developmental surveillance is recognized as an integral component of paediatric care. Professional organizations dedicated to the medical care of children recommend routine monitoring of a child's developmental progress [9]. Formal screening, together with reliance on parental reporting measures, constitutes the primary means by which children with global developmental delay are identified [10].

Moreover, children possessing either biologic or social risk factors for later developmental delay are often targeted through specific follow-up programs that incorporate routine periodic assessments evaluating developmental performance [11]. Environmental influences such as culture, parental skills, neglect, and opportunity may modify the cause's expression as well as the detection and diagnosis of global developmental delay. Accumulating evidence also demonstrates the benefits of early intervention through a variety of programs (e.g., Head Start) with respect to short term outcomes and suggests that early diagnosis of a child with global delay may improve outcome. Initial screening is important not only in identifying children

with developmental delay but also is the first step in determining whether a child has global delay, a language disorder, or an autistic spectrum disorder. This parameter is focused specifically on the child who has global developmental delay. Previous parameters have reviewed the evaluation of children and adolescents with language disorders and autistic spectrum disorders [12].

Globally developmental delayed identification in young child by routine paediatric screening in the first years of life mandates a careful search for an underlying etiology [13]. The reported variability in diagnostic yield can be attributed to differences in a variety of factors including sample population characteristics, severity of delay in the children studied, extent of diagnostic investigations, and technological advances over time, especially with respect to genetic and neuroimaging techniques. Considerable uncertainty exists among practitioners evaluating young children with global developmental delay with respect to the appropriate extent of laboratory investigations and referral for ancillary services [14].

MATERIAL AND METHODS

This is prospective and observational study conducted at Department of Radiodiagnosis, Subbaiah Institute of Medical Sciences, Shimoga, where in thirty consecutive children aged between 1 month to 13 years with clinical diagnosis of developmental delay, who were referred for magnetic resonance imaging of the brain were included in the study. The study was conducted between the months of February 2013 to August 2013. Intravenous sedation using midazolam in appropriate doses were administered when required.

Inclusion Criteria: Children aged between 1 months to 15 years who presented with developmental delay were included in the study.

Exclusion Criteria: Children aged 15 years Children with known genetic disorder, such as Down's syndrome, Turner's syndrome, etc., associated with delayed developmental milestones Contraindication to magnetic resonance imaging- claustrophobia, cochlear implant. History of head injury and non-cooperative sick patients

Clinical data such as (age, sex), birth history, history of admission and history of seizures were taken along with findings of physical examination included weakness of limbs, abnormal posturing, hypo/hypertonia of limbs, language and speech deficits and particulars of developmental milestones attained. Imaging Protocol and categorization of imaging findings: MRI of the brain was performed using 0.35T Siemens Magnetom C imaging system. The sequences used were Axial T1, T2 FLAIR FSE, T1 Sagittal FSE, T2 Coronal FSE, DWI, Gradient axial. The imaging findings were categorized into the following groups: I. Normal II. Neurovascular diseases like hypoxic ischemic injury and others such as delayed Myelination, hypoplasia of corpus callosum, ventriculomegaly. III. Structural malformations- corpus callosum agenesis, Schizencephaly, Chiari malformations.

RESULTS

Table-1: Sex Distribution of Children with Developmental Delay

Development Delay	Gender		Total
	Male	Female	
Number of Children	17	13	30
Percentage	56.6	43.3	100

In our study total 30 children with developmental delay were enrolled. Among them 17 were males and 13 were females in Table-1.

Table-2: Age distribution of study population

Age	Number of Children	Percentage
3 months – 1 Year	2	6.6
1 – 3 Years	4	13.3
4 – 6 Years	5	16.6
7 – 10 Years	12	40
11 – 13 Years	7	23.3

In Table-2, maximum number of abnormalities were detected in age group of 7 to 10 years in 40 % of children, followed by 11 to 13 years age in 23.3% of children.

Table-3: MRI Findings in Children with Developmental Delay

Development Delay	MRI Findings		
	Normal	Abnormal	Total
Number of Children	11	19	30
Percentage	36.6	63.3	100

In Table-3, out of 30 children 19 (63.3%) had abnormal MRI findings and 11 (36.6%) has normal MRI brain.

Table-4: MRI Findings of Children with Developmental Delay

MRI Diagnosis	Number of Patients	Percentage
Infection	1	3.3
Congenital malformations	3	10
Vascular Lesions	1	3.3
White Matter Disorders	4	13.3
Atrophic Changes	6	20
HIE	3	10
CSF Disorder	1	3.3

In Table-4, maximum number of patients were atrophic changes 20%, followed by Congenital malformations and least were infection, vascular lesions, CSF disorder.

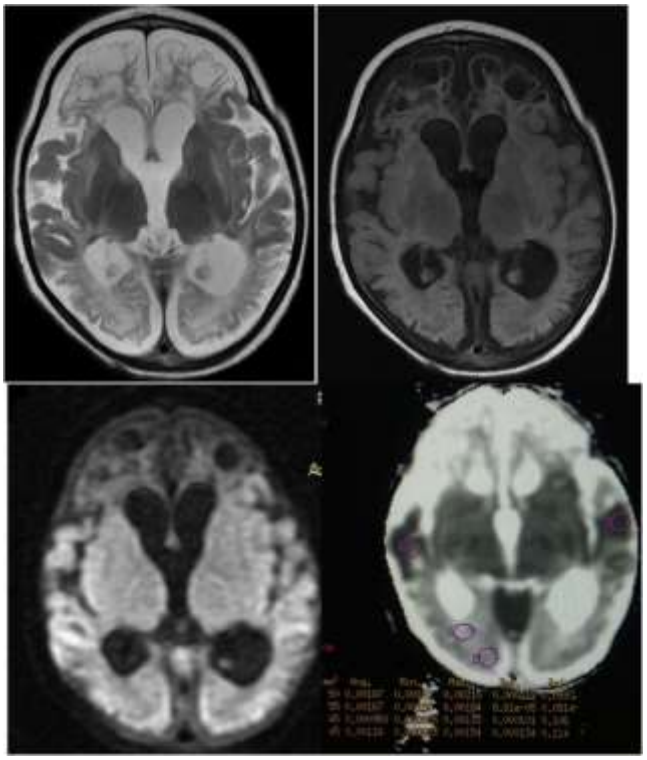

Fig-1: Hypoxic ischemic encephalopathy

DISCUSSION

The results of this study suggest that, although the specific cause of developmental delay often remains unknown, MRI provides useful diagnostic information in a relatively high percentage of retarded children resistant to diagnosis by non-imaging methods. The sensitivity of MRI in this population (autistics excluded), with a 34% rate of positivity, far exceeds that of all other laboratory tests. When neurologic factors were associated with the retardation, not only was the likelihood of an MRI abnormality increased, but the type of lesion appeared different. Such patients were more apt to have congenital malformations of brain structure and delayed myelination. Moreover, MRI abnormalities were seen in almost a quarter of the retarded children who lacked distinguishing neurologic features, a large group that is especially baffling to clinicians seeking to establish cause. Though sometimes confined to atrophy, focal white matter lesions were also seen in this group [15].

Overall, the MRI findings did not establish specific causations for the developmental retardation, but in many cases the MRI findings focused attention on a specific period when the development was disrupted. Four general categories of MRI findings were seen. The most frequent MRI finding was atrophy, enlargement of ventricles and sulci in a patient with normal or a small head size. Besides reflecting a brain that was small in relation to the surrounding skull (which is not necessarily abnormal in infants), it was indicative of reduced brain volume, since head circumference was small in most of these patients and normal in the remaining ones [16]. Increased CSF spaces can also be seen in children with large heads. Without knowing the head size, atrophy and hydrocephalus may be difficult to distinguish from benign macrocephaly of infancy. Atrophy, by itself, is relatively nonspecific and provides few etiologic clues because it is the end result of many pathologic processes. Because small brain size is accompanied by enlargement of both ventricles and sulci, it suggests that the brain initially may have grown normally and then been subjected to a destructive process. Conversely, in patients with a small brain but no atrophy-for example, without ventricular and sulcal enlargement-the process may be primarily one of restriction of brain growth from an early period with little loss of tissue [17].

Congenital morphogenetic abnormalities represent disorders in development occurring early in gestation. In our series, three of the seven patients in this category had neuronal migration abnormalities. Neuroblasts migrate radially from the subependymal germinal matrix to the cerebral cortex in two major waves over a 2-month period extending from 8 to 16 weeks' gestation. Additional neuronal migration continues until about 24-26 weeks [18]. Any insult to the brain during this period can disrupt this process; the end result is a thickened, disorganized cortex in the involved regions. Clinically, these disorders are associated with seizures as well as retardation. Genetic abnormalities also may be associated with disorders of neuronal migration [19]. Causative factors were unknown in our patients, but all were in the retarded-neurologic subgroup, all had a small head circumference for age, and all had seizures. Agenesis of the corpus callosum, seen in one patient, also represents a defect occurring early in gestation (8-15 weeks) [20]. Because this is a critical period of brain development (the cerebrum and cerebellum are forming), abnormalities of the corpus callosum are often associated with a multitude of other malformations.

Our patient with agenesis of the corpus callosum also had delayed myelination and cerebellar atrophy. In humans and in experimental animals, delayed myelination has been associated with inborn errors of metabolism (amino and organic acidopathies), congenital rubella, and severe malnutrition [21]. In some of these processes the histologic and structural findings suggest a primary demyelination as well as a delay in myelination. Five of the six children with delayed myelination in this series exhibited abnormalities of muscle tone, predominantly spasticity. In two of these six cases of delayed myelination and in an additional child with atrophy, there was white matter hypoplasia on MRI. This combination of pathologic findings has been reported as a severe, nonprogressive

disorder characterized by intellectual impairment and spastic quadriparesis [22].

The striking neuropathologic finding is hypoplasia of the cerebral white matter, particularly centrum semiovale, with relatively normal cortex and deep nuclei. No gliosis or inflammatory changes are seen in the white matter, corresponding to the lack of a known intrauterine event and to a typical history of a normal pregnancy and delivery. The multiple focal white matter lesions seen in four patients most likely represent areas of necrosis or demyelination from a previous, nonspecific insult. These children all had normal head sizes and did not have delayed myelination, morphogenetic congenital abnormalities, or abnormal neurologic findings. They appear to be a distinct group whose difficulties relate to pathology occurring late in development, after axonal and dendritic ramifications have occurred, perhaps not before the perinatal period. Although these relatively minor lesions may not cause significant developmental delay by themselves, they may be markers for more extensive brain disease not visible on MRI.

In this series, no qualitative MRI abnormalities were found in the retarded-autistic patients. Although gross alterations have been reported in the brains of autistic patients, there is little agreement in the literature about the characteristic lesions in this condition. Recently, it has been reported that the volume of the posterior lobule of the cerebellar vermis is hypoplastic in autistic patients [23]. Lacking appropriate age-matched normal controls, we did not measure the relative volume of the lobules of the vermis. Therefore, we can neither exclude nor substantiate small, but significant, vermian hypoplasia. The use of MRI did not lead to a specific treatment in any patient in this series or alter the patient's developmental status. Nevertheless, the clinicians and the children's parents found MR helpful in confirming a physical basis for the retardation, seizures, and other neurologic findings. MR was also useful in counselling the parents. Faced with the virtual certainty of lifelong mental impairment in their child, bewildered by not knowing how the problem arose, and distressed by the failure of previous diagnostic efforts, parents viewed the procedure as important even when the results were negative. When positive, many families could find some solace that there was a physical factor in the brain beyond their control that accounted for their child's developmental abnormality or from knowing that no genetic condition was implicated [24].

CONCLUSION

Magnetic resonance Imaging is an important line of investigation in children with delayed developmental milestones, in our study there was a high proportion of abnormal brain MRI. Magnetic resonance imaging due to soft tissue resolution and helped in reaching to a diagnosis in many cases.

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