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Original Research Paper

Pediatrics

EVALUATING MRI FINDINGS AND CLINICAL PROFILES IN CHILDREN WITH CEREBRAL PALSY AT A TERTIARY CENTRE IN MUMBAI

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ABSTRACT

Background: Cerebral palsy (CP) continues to be one of the most significant causes of chronic childhood motor disability worldwide. Magnetic resonance imaging (MRI) offers crucial insight into brain structure, helping to determine the timing and etiology of brain injury. **Objective:** To evaluate MRI abnormalities among children with CP and correlate these findings with clinical profiles and perinatal factors. **Methods:** This cross-sectional observational study included 90 children aged 2–12 years diagnosed with CP. Detailed clinical evaluation, perinatal history, and MRI brain findings were analyzed. MRI abnormalities were categorized as white matter, grey matter, malformations, vascular insult, or normal. Statistical analysis was done using Chi-square and Fisher's exact tests. **Results:** Among 90 participants (mean age 3.8±2.1 years; 59% male), the spastic subtype was most common (76.7%), with quadriplegia predominating (58.9%). MRI abnormalities were seen in 91.1%, with white matter injury being most frequent (76.7%), followed by grey matter (10%), malformations (7.8%), and vascular insult (1.1%). White matter injury showed a significant association with prematurity and diplegia ($p<0.001$), while grey matter lesions correlated with dyskinetic CP ($p=0.0001$). **Conclusion:** MRI abnormalities are highly prevalent in children with CP. White matter injury remains the dominant pattern, particularly in preterm infants. MRI serves as an essential diagnostic and prognostic tool for understanding etiology, guiding management, and facilitating family counseling.

KEYWORDS : Cerebral Palsy, MRI, White Matter Injury, Dyskinetic CP, Prematurity, Neuroimaging

INTRODUCTION

Cerebral palsy (CP) represents a group of non-progressive motor disorders caused by disturbances in the developing fetal or infant brain. It remains the most frequent cause of long-term motor disability in childhood, with significant impacts on functional independence, quality of life, and healthcare burden.

Globally, CP prevalence is estimated between 2–3 per 1000 live births, though higher rates are observed in low- and middle-income countries such as India, where limitations in perinatal and neonatal care contribute to its increased incidence.

The etiology of CP is multifactorial and includes prenatal, perinatal, and postnatal causes such as prematurity, intrauterine infections, hypoxic-ischemic injury, intracranial hemorrhage, and trauma. The survival of preterm infants has improved in recent decades; however, this has also resulted in a growing number of children with neurodevelopmental impairments.

Magnetic resonance imaging (MRI) has emerged as a cornerstone in the diagnostic evaluation of CP. It provides detailed visualization of brain structure, enabling detection of periventricular leukomalacia (PVL), grey matter injury, malformations, and vascular insults. MRI abnormalities are found in approximately 70–100% of children with CP.

Despite international literature documenting clinical–radiological associations, Indian data remain limited. The current study was undertaken to describe MRI findings among children with CP and analyze their correlation with clinical subtypes and perinatal risk factors in an Indian tertiary care setting.

MATERIALS AND METHODS

Study Design and Setting:

This hospital-based cross-sectional observational study was conducted in the Department of Pediatrics, Bharatratna Dr. Babasaheb Ambedkar Municipal General Hospital, Mumbai, from May 2023 to November 2024.

Participants:

Ninety children aged 2–12 years with a clinical diagnosis of CP were included, based on the Surveillance of Cerebral Palsy in Europe (SCPE) criteria.

Inclusion Criteria:

- Clinically confirmed CP cases.
- Age between 2–12 years.
- MRI brain performed at the study center.

Exclusion Criteria:

- Progressive neurodegenerative disorders.
- Severe head trauma unrelated to CP.
- Lack of parental consent.

Clinical Evaluation

Detailed antenatal, perinatal, and postnatal histories were recorded. Motor type was classified as spastic, dyskinetic, ataxic, hypotonic, or mixed. Spastic CP was further categorized topographically as quadriplegia, diplegia, hemiplegia, or monoplegia. Motor severity was graded using the Gross Motor Function Classification System (GMFCS). Associated comorbidities such as epilepsy, visual or auditory impairment, and cognitive deficits were documented.

MRI Protocol:

All MRI examinations were conducted using a 1.5 Tesla scanner. Sequences included T1-weighted, T2-weighted, FLAIR, DWI, and GRE images. Lesions were classified as:

- White matter injury (WMI): PVL, diffuse volume loss.
- Grey matter injury: basal ganglia, thalamic, or cortical lesions.
- Structural malformations: cortical malformations, lissencephaly.
- Vascular insult: stroke or infarction.
- Normal: no significant abnormality.

Statistical Analysis

Data were analyzed using SPSS version 26. Continuous variables were expressed as mean ± SD, and categorical variables as percentages. Associations between MRI findings and clinical variables were assessed using Chi-square or Fisher's exact tests. A p-value <0.05 was considered statistically significant.

Ethical Approval
Institutional Ethics Committee approval was obtained. Written informed consent was secured from parents or guardians.

RESULTS
Demographic and Clinical Characteristics
Among 90 children, the mean age was 3.8±2.1 years. Males constituted 58.9% (n=53). Preterm births accounted for 24.4% (n=22), while 75.6% (n=68) were full-term. Low birth weight (<2.5 kg) was observed in 56.6%.

Motor Subtypes and Severity
The spastic subtype was predominant (76.7%), followed by hypotonic (8.9%), mixed (7.8%), dyskinetic (5.6%), and ataxic (1.1%). Quadriplegia was the most frequent topographical distribution (58.9%), followed by diplegia (36.7%) and hemiplegia (3.3%). According to GMFCS, 87.8% were classified as levels III–V, indicating moderate to severe impairment. Epilepsy was present in 56.7% of cases.

MRI Findings
MRI was abnormal in 91.1% of children. White matter injury was most frequent (76.7%), followed by grey matter injury (10%), structural malformations (7.8%), and vascular insult (1.1%). Only 4.4% had normal scans.

Associations
White matter injury was significantly associated with prematurity (p<0.001) and diplegic CP, while grey matter injury correlated with dyskinetic CP (p=0.0001). Malformations were mainly found in quadriplegic CP cases.

DISCUSSION
The current study highlights the strong correlation between MRI findings and clinical subtypes in children with CP. MRI abnormalities were found in over 90% of cases, consistent with international data reporting 70–100%.

White Matter Injury
WMI was the most common pattern, especially among preterm infants. This aligns with studies by Krägeloh-Mann and the European CP Consortium, which attribute PVL to the vulnerability of pre-oligodendrocytes in the immature brain. The association between WMI and diplegic CP mirrors findings from Western and Indian literature, confirming that lesion location predicts motor phenotype.

Grey Matter Injury
Grey matter lesions, predominantly affecting the basal ganglia and thalami, were significantly associated with dyskinetic CP and term hypoxic-ischemic encephalopathy. These injuries often result in dystonic movements and poorer neurocognitive outcomes. The correlation is consistent with previous reports emphasizing the basal ganglia's susceptibility to hypoxia in term infants.

Structural Malformations
Malformations accounted for 8% of cases and were linked to severe quadriplegia. Such findings imply a prenatal origin of brain injury, often with genetic or developmental roots. Similar observations in Indian studies highlight the need for genetic counseling and targeted family support.

Vascular Insults
Vascular lesions were rare (1.1%) and usually presented as hemiplegic CP, in line with previous literature suggesting lower contribution of focal infarcts to the overall CP burden in developing countries.

Clinical Relevance
MRI plays a vital role not only in confirming diagnosis but also in prognosis and parental counseling. Recognition of specific lesion patterns allows clinicians to predict functional outcomes, design individualized therapy plans, and plan for early rehabilitation.

Public Health Implications
The predominance of WMI underscores the need for improved perinatal and neonatal care, particularly for preterm infants. Preventive measures such as antenatal steroid administration, infection control, timely neonatal resuscitation, and use of therapeutic hypothermia in term HIE can reduce the incidence of CP.

Strengths and Limitations
This study's strength lies in its relatively large sample size and systematic classification of MRI lesions in the Indian context. Limitations include its single-center nature and the absence of advanced imaging modalities such as DTI or MRS, which could provide deeper insights into microstructural brain injury.

Table 1: Demographic Profile (n=90)

Vairable	n	%
Age 1–3y	47	52.2
Age 4-6y	28	31.1
Age 7–10y	15	16.7
Male 53	53	58.9
Female 37	37	41.1
Preterm	22	24.4
Full-term	68	75.6
Birth weight 2.6 to 3.0 kg	32	35.6
Birth weight 1.6 to 2.0 kg	24	26.7
Birth weight 2.1–2.5 kg	17	18.9
Birth weight 1.0 to 1.5 kg	9	10.0
Birth weight >3.0 kg	8	8.9

Table 2: Clinical Profile (n=90)

Variable	n	%
Spastic	69	76.7
Dyskinetic	5	5.6
Ataxic	1	1.1
Hypotonic	8	8.9
Mixed	7	7.8
Diplegia	33	36.7
Quadriplegia	53	58.9
Hemiplegia	3	3.3
Monoplegia	1	1.1
GMFCS I–II	11	12.2
GMFCS III–V	79	87.8
Epilepsy present	51	56.7

Table 3: MRI Findings (n=90)

Finding	n	%
White matter	69	76.7
Grey matter	9	10.0
Malformations	7	7.8
Stroke	1	1.1
Normal	4	4.4

Table 4: PVL vs Gestational Age

Gestation	PVL+	PVL-	P
Preterm	17	5	<0.001*
Full-term	53	15	<0.001*

Table 5: MRI Findings vs Motor Type

Motor Type	WM	GM	Malf	Stroke	Normal	P
Spastic (n=69)	57	1	7	1	3	0.004*
Dyskinetic (n=5)	0	4	0	0	1	0.0001*

Ataxic (n=1)	1	0	0	0	0	-
Hypotonic (n=8)	8	4	4	0	0	-
Mixed (n =7)	7	0	0	0	0	-

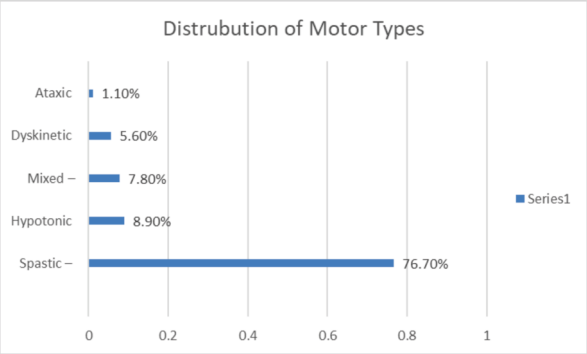

Figure 1. Distrubition of motor Types

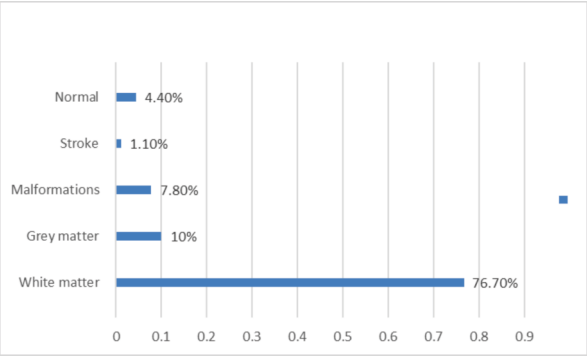

Figure 2: Spectrum of MRI Findings

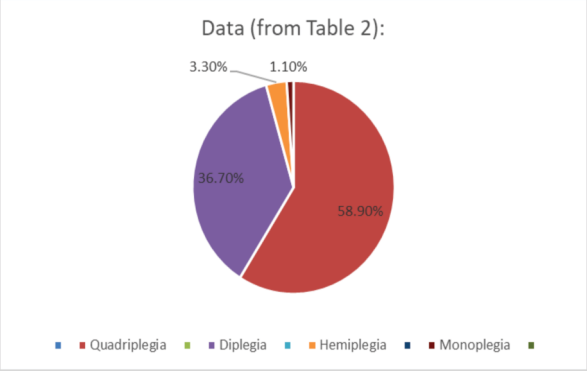

Figure 3: Topographical Classification

CONCLUSION

MRI abnormalities were identified in over 90% of children with CP.

White matter injury was the most prevalent pattern, significantly associated with prematurity and spastic diplegia.

Grey matter injury correlated with dyskinetic CP, and structural malformations indicated prenatal origins.

MRI remains an indispensable tool for understanding the pathogenesis, prognosis, and management of cerebral palsy.

Declarations

Ethical Approval: Approved by Institutional Ethics Committee (Approval No: [Insert]).
Conflict of Interest: None declared.
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Author Contributions:
Dr. Pritee Chincholkar – Concept, data collection, analysis, manuscript drafting.
Dr. Rajaram Weling – Supervision, validation, and critical revision.
Dr. Nilima Narkhede – MRI interpretation and technical review.

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