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ORIGINAL ARTICLE

Association Between CT Scan Findings of the Head and Motor Impairment Patterns in Paediatric Cerebral Palsy

Khadija Rahman[1], Dipanwita Saha[2], Nanda Lal Das[3], Rifat Zaman[4], Meher Nigar Nishi[5], Mohuya Mondal[6], Ferdousi Hossain Poly[7], Hazera Akter[8]

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Correspondence to
Khadija Rahman

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ABSTRACT

Introduction: *Cerebral palsy (CP) comprises a group of permanent movement and posture disorders resulting from non-progressive disturbances in the developing brain. Neuroimaging, especially CT scans, plays a vital role in determining etiology, particularly in resource-limited settings where it remains a primary diagnostic tool.* ***Objective:*** *To categorize the CT findings of the head and examine their correlation with the types of motor disturbances in children with CP.* ***Methods & Materials:*** *Conducted at the Paediatric Neurology unit of BSMMU between July 2009 and July 2010, this cross-sectional study included 120 children with CP. These children were randomly selected, and each underwent a brain CT scan. The CT findings were then correlated with the patients' motor disturbances.* ***Results:*** *The study involved 120 children with CP, with a male-to-female ratio of 1.4:1. Most children were aged 49-60 months (29.2%). Abnormal CT scans were present in 85.0% of patients, whereas 15.0% had normal results. Cerebral atrophy was identified as the most frequent abnormality (55.8%). Hemiplegia was the most common form of motor disturbance (30.0%), with 86.1% showing abnormalities on CT. The highest incidence of cerebral atrophy was seen in hemiplegic (32.8%), hypotonic (20.9%), and diplegic (19.4%) types. Additionally, diplegic CP showed the highest rate of cerebral infarction (6 cases), while dyskinetic CP had the lowest abnormality rate (15.4%). Bilateral involvement was observed in 4.2% of cases despite unilateral clinical signs.* ***Conclusion:*** *The findings suggest that the clinical pattern of motor disturbance correlates with brain CT results. Generally, more abnormal CT findings indicate a higher likelihood of motor impairment in children with CP.*

Keywords*: Cerebral palsy, CT scan, Motor disturbances, Brain imaging, Children, Cerebral atrophy, Hemiplegic, Neuroimaging.*

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1. *Assistant Professor, Department of Pediatrics, Shaheed Suhrawardy Medical College & Hospital, Dhaka, Bangladesh (ORCID: 0009-0006-5872-429X)*
2. *Assistant Professor, Department of Pediatrics, Shaheed Suhrawardy Medical College & Hospital, Dhaka, Bangladesh (ORCID: 0009-0003-2542-2656)*
3. *Assistant Professor, Department of Pediatrics, Shaheed Suhrawardy Medical College & Hospital, Dhaka, Bangladesh (ORCID: 0009-0002-8229-549X)*
4. *Assistant Professor, Department of Pediatrics, Shaheed Suhrawardy Medical College & Hospital, Dhaka, Bangladesh (ORCID: 0000-0003-243401486)*
5. *Registrar,, Department of Pediatrics, Shaheed Suhrawardy Medical College & Hospital, Dhaka, Bangladesh (ORCID: 0009-0006-7177-4275)*
6. *Assistant Professor, Department of Pediatrics Gastroenterology and Nutrition, Shaheed Suhrawardy Medical College & Hospital, Dhaka, Bangladesh (ORCID: 0000-0001-5328-2599)*
7. *Assistant Professor, Department of Pediatrics, Shaheed Suhrawardy Medical College & Hospital, Dhaka, Bangladesh (ORCID: 0009-0005-2626-2484)*
8. *Junior Consultant, Department of Pediatrics Gastroenterology and Nutrition, Shaheed Suhrawardy Medical College & Hospital, Dhaka, Bangladesh (ORCID: 0000-0003-0059-3048)*

INTRODUCTION

Cerebral palsy (CP) describes a group of permanent disorders of movement and posture that cause activity limitations, attributed to non-progressive disturbances that occurred in the developing fetal or infant brain[1,2]. The motor disorders of CP are often accompanied by disturbances of sensation, perception, cognition, communication, and behavior, as well as epilepsy and secondary musculoskeletal problems[2,3]. This complex interplay of symptoms makes CP one of the most challenging neurodevelopmental conditions requiring comprehensive multidisciplinary management. The global incidence of CP remains relatively stable at approximately 2.0 to 2.5 per 1,000 live births in high-resource settings[2,4]. However, prevalence rates vary considerably across different populations, with studies from low- and middle-income countries reporting rates of 3.6 per 1,000 children in Uganda and 2.9 per 1,000 children in Egypt[5]. The clinical classification of CP has traditionally grouped children into phenotypic subtypes based on the distribution of limb weakness and type of tone abnormality—hemiplegic, diplegic, quadriplegic, ataxic, hypotonic, dyskinetic, and mixed. Bilateral spastic CP consistently emerges as the most prevalent type across diverse populations, accounting for 46-63% of cases[3,4]. The diagnostic process integrates medical

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history with neurologic examination findings that localize the deficit to a cerebral abnormality[6]. Serial examinations may be necessary to confirm the diagnosis, particularly when historical information is limited or unreliable. While laboratory tests are not routinely required to confirm CP, they serve an important role in excluding alternative diagnoses when atypical features are present[7]. Recent advances in genetic research have transformed our understanding of CP etiology. Large-scale studies using hypothesis-free exome sequencing have revealed that up to 30% of cases labelled as "cerebral palsy" have a monogenic etiology[8,9]. This genetic overlap between neurodevelopmental disorders and movement disorders has significant implications for diagnostic workup and genetic counseling[10]. Beyond genetic causes, CP represents a clinical syndrome with diverse acquired etiologies. Brain malformations, congenital infections, and hypoxic-ischemic injuries to the developing brain constitute the primary causative pathways. In low- and middle-income countries, perinatal asphyxia and cerebral malaria remain the predominant probable causes[5,11]. Determining the specific etiology has profound implications for treatment planning, prognostic counseling, recurrence risk assessment, and implementation of prevention strategies[12]. Neuroimaging plays a pivotal role in the etiologic evaluation of children with CP. According to the American Academy of Neurology practice parameter, neuroimaging is recommended to establish that a brain abnormality exists, which may suggest an etiology and prognosis[7,13]. A recent study comparing imaging modalities in 94 children with CP found that the diagnostic positivity rate for MRI was 91.49%, which was significantly higher than that for CT (70.21%)[14,15]. Cranial computed tomography offers an atraumatic method to evaluate pathophysiological findings in children with CP, particularly in settings where MRI is unavailable or contraindicated[15]. With this background, the present study evaluates the role of CT imaging in children diagnosed with CP at a tertiary care center in Bangladesh, where access to MRI may be limited, and CT remains an important diagnostic tool for establishing etiology and guiding management.

OBJECTIVE

The objective of this study was to assess the association between CT abnormalities in the head and motor impairment patterns in paediatric cerebral palsy.

MATERIALS & METHODS

This cross-sectional study was conducted in the Department of Pediatric Neurology at Bangabandhu Sheikh Mujib Medical University (BSMMU), Dhaka, Bangladesh, over one year from July 2009 to July 2010, to evaluate the correlation between CT scan findings and motor disturbances in children with cerebral palsy. The study population comprised children diagnosed with cerebral palsy attending the Child Neurology Outpatient Department, enrolled using purposive sampling based on predefined inclusion and exclusion criteria. The sample size was calculated using the formula $n = (Z^2 \times p \times (1-p)) / d^2$, where Z=1.96 (95% confidence interval), p=expected proportion of abnormal CT findings (approximately 77% based on previous literature), and d=0.05 (degree of precision), yielding a minimum required sample of 120 children. Inclusion criteria included children aged 0-12 years with a confirmed diagnosis of cerebral palsy by a pediatric neurologist, while exclusion criteria comprised progressive neurological disorders, head trauma, cerebrovascular events, genetic syndromes, or contraindications to CT imaging. Parents or legal guardians were interviewed face-to-face using a structured questionnaire emphasizing demographic characteristics, perinatal and postnatal risk factors, antenatal history, developmental milestones, type of motor impairment, and associated comorbidities. All enrolled children underwent non-contrast computed tomography of the brain following standard pediatric protocols, with CT images independently reviewed by a radiologist blinded to clinical findings to minimize bias. CT findings were classified, including cerebral atrophy, ventricular dilatation, encephalomalacia, basal ganglia infarct, hydrocephalus, encephalocele, mixed findings, or normal study, and subsequently correlated with clinical subtypes of cerebral palsy (hemiplegic, diplegic, quadriplegic, hypotonic, dyskinetic, and mixed). Data were manually verified and analyzed using SPSS version 26, with descriptive statistics calculated for demographic and clinical variables, and the association between type of cerebral palsy and CT abnormalities assessed using Pearson's chi-square test, considering a p-value <0.05 as statistically significant. The study protocol received ethical approval from the Institutional Review Board of BSMMU, and written informed consent was obtained from all parents or legal guardians before participation.

RESULTS

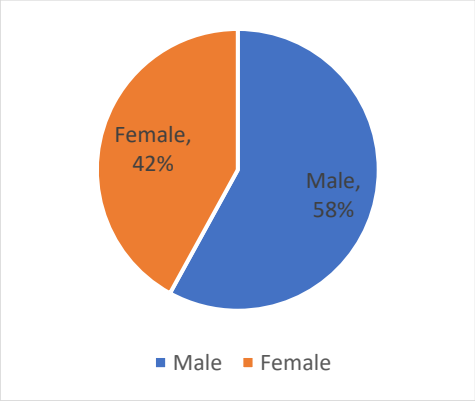

Figure – 1: Gender distribution of the study patients with cerebral palsy (*n*=120)

The study population consisted of 70 male (58.3%) and 50 female (41.7%) patients, with a male-to-female ratio of approximately 1.4:1 (*Figure 1*).

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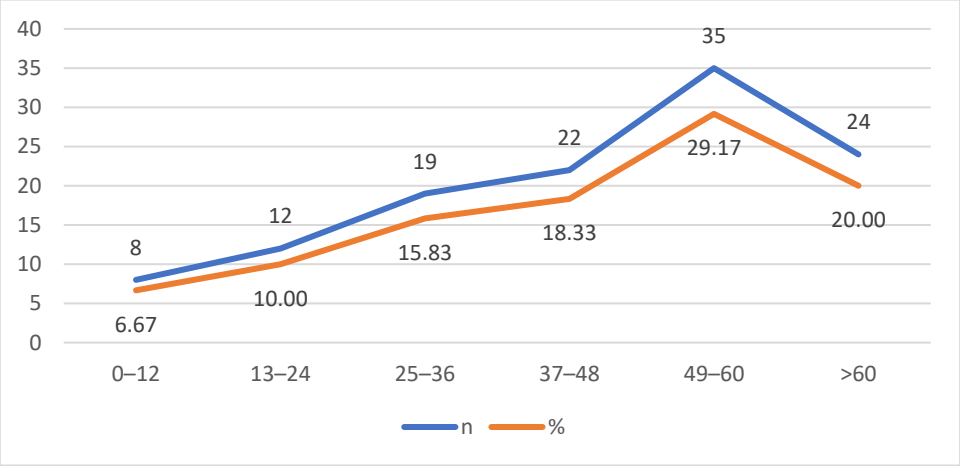

Figure – 2: Age distribution of the studied patients with cerebral palsy (*n*=120)

The age distribution of patients ranged from 0 to over 60 months, with the majority of patients in the 49-60 months age group (29.2%), followed by those aged above 60 months (20.0%) *Figure 2*.

Of the 120 patients studied, 102 (85.0%) had abnormal CT findings while only 18 (15.0%) had normal CT scans. Hemiplegic cerebral palsy was the most common type (30.0% of all patients) and also showed the highest number of abnormal CT findings (31 out of 36 hemiplegic patients, 86.1%) *Table I*.

Table – I: Abnormal CT scan of the brain in different types of cerebral palsy (*n*=120)

Type of cerebral palsy	Normal CT	Abnormal CT	Total patients	Percentage of total (%)
Hemiplegic	5	31	36	30.00
Diplegic	2	22	24	20.00
Quadriplegic	1	16	17	14.17
Hypotonic	4	15	19	15.83
Dyskinetic	2	11	13	10.83
Mixed	4	7	11	9.17
Total	18	102	120	100.00

Cerebral atrophy was the most common CT scan abnormality, observed in 67 patients (55.8% of the total study population and 65.7% of those with abnormal findings). Cerebral infarct was the second most common finding (8.3%), followed by ventricular dilatation (5.8%) *Table II*.

Table – II: Types of abnormal CT scan of the brain among studied cases (*n*=120)

CT scan finding	Number of patients	Percentage (%)
Cerebral atrophy	67	55.83
Cerebral infarct	10	8.33
Ventricular dilatation	7	5.83
Encephalomalacia	5	4.17
Basal ganglia infarct	2	1.67
Bilateral involvement	5	4.17
Mixed findings	6	5.00
Normal CT scan	18	15.00

Among the 67 patients with cerebral atrophy, hemiplegic CP accounted for the largest proportion (32.8%), followed by hypotonic CP (20.9%) and diplegic CP (19.4%) *Table III*.

Table III: Proportion of cerebral atrophy (n=67) in different types of cerebral palsy

Type of cerebral palsy	Number of patients	Percentage (%)
Hemiplegic	22	32.84
Diplegic	13	19.40
Quadriplegic	12	17.91
Hypotonic	14	20.90
Dyskinetic	2	2.99
Mixed	4	5.97
Total	67	100.00

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Hemiplegic CP demonstrated the highest frequency of cerebral atrophy (23 patients) and ventricular dilatation (4 patients), while diplegic CP showed the highest frequency of cerebral infarction (6 patients). Encephalocele was observed in hemiplegic, diplegic, hypotonic, and mixed types, with 2 cases in hemiplegic CP (*Table IV*).

Table IV: Types of abnormal CT scan in different types of cerebral palsy (*n*=102)

Types of CP	Cerebral atrophy	Cerebral infarction	Ventricular dilatation	Encephalocele
Hemiplegic	23	2	4	2
Diplegic	13	6	1	1
Quadriplegic	12	1	1	0
Hypotonic	14	0	1	1
Dyskinetic	2	0	0	0
Mixed	3	1	0	1
Total	67	10	7	5

DISCUSSION

This study aimed to evaluate the correlation between CT scan findings and motor disturbances in children with cerebral palsy (CP) at a tertiary care center in Bangladesh. Among 120 children with CP, 85.0% demonstrated abnormal CT findings, with cerebral atrophy being the predominant abnormality (55.8% of all patients). These findings are consistent with the established understanding that structural brain abnormalities underlie the clinical manifestations of CP[16].

The study population consisted of 70 male (58.3%) and 50 female (41.7%) patients, with a male-to-female ratio of 1.4:1. This male predominance is consistent with recent epidemiological data from a large Brazilian study published in 2026 involving 302 children with CP, which reported 57.6% males in their cohort[17]. The consistent male excess across diverse populations suggests potential biological vulnerability of male infants to perinatal brain injury.

Of the 120 patients studied, 102 (85.0%) had abnormal CT findings while only 18 (15.0%) had normal CT scans. This high prevalence of abnormalities is comparable to recent international data. The Brazilian study reported neuroimaging abnormalities in 92.1% of cases[17], while a Ugandan CT study found that 91% of children with CP had abnormal findings[18]. The slightly lower rate in our study may reflect differences in population characteristics, imaging modalities, or etiological profiles between Bangladesh and other regions.

Cerebral atrophy was the most common CT scan abnormality, observed in 67 patients (55.8% of the total study population and 65.7% of those with abnormal findings). This finding aligns with recent volumetric neuroimaging studies demonstrating significant brain volume reductions in children with CP. A Turkish study published in February 2026 using VolBrain-based MRI analysis found that volumes of total cerebral tissue, white and gray matter, cerebellum, and corpus callosum were significantly reduced in premature children with CP compared to healthy controls, with positive correlations between brain volumes and motor function scores[19].

Hemiplegic cerebral palsy was the most common type (30.0% of all patients) and showed the highest number of abnormal CT findings (31 out of 36 patients, 86.1%). This finding is consistent with the systematic review by Korzeniewski and colleagues, who reported that hemiplegic CP demonstrates the highest yield on neuroimaging [20]. In our series, hemiplegic patients showed predominantly cerebral atrophy (23 patients) and ventricular dilatation (4 patients), consistent with middle cerebral artery territory involvement commonly described in hemiplegic CP[21].

Diplegic CP accounted for 20.0% of our study population and demonstrated cerebral atrophy in 13 patients and cerebral infarction in 6 patients. The presence of infarcts in diplegic patients is noteworthy, as diplegic CP is traditionally associated with periventricular white matter injury in preterm infants[19]. However, our findings suggest that some diplegic patients may have alternative or additional pathologies, highlighting the heterogeneous nature of CP.

Dyskinetic CP showed the lowest rate of specific abnormalities on CT, with only 2 patients showing cerebral atrophy among 13 cases (15.4% of dyskinetic patients). This finding aligns with recent genetic studies demonstrating that dyskinetic and ataxic cerebral palsy are more often associated with normal neuroimaging[6]. The Brazilian study identified 29 distinct genes in patients undergoing genetic testing, notably in cases with preserved imaging or kernicterus[17]. This reinforces that normal imaging does not exclude underlying genetic causes, especially in patients lacking perinatal complications or exhibiting dyskinetic patterns[22].

The finding of bilateral pathology in 5 patients (4.2%) despite predominantly unilateral clinical findings is noteworthy. A 2025 study using morphological brain network analysis demonstrated that children with spastic CP displayed increased characteristic path length in cortical thickness-based networks, correlated with cognitive and motor function scores[23]. These findings suggest that even apparently unilateral pathology may have bilateral network effects with functional consequences.

LIMITATIONS

This study has several limitations, including its single-center design, which limits generalizability, use of CT instead of MRI, which may have under-detected subtle abnormalities, cross-sectional nature precluding causal assessment, lack of genetic testing in normal CT cases, incomplete perinatal data, small sample size for subgroup analyses, and absence of long-term follow-up, restricting prognostic conclusions.

CONCLUSION

In this study, the clinical pattern of minor abnormalities in cerebral palsy patients correlated with the findings of the CT scan of the brain. Hemiplegic CP has more CT scan abnormalities in cerebral palsy patients than other types. CT scan helps to find out the pathological findings in patients with cerebral palsy. It is thought that further study is needed to determine the exact mechanism in patients with spastic CP who have a normal CT finding. Even if brain imaging is a very useful tool to visualize the cause of problem in the cases of abnormal findings on CT scan.

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