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Original Articles

Correlations of CT Scan Findings in Different Types of Cerebral Palsy: A Study in a Tertiary Care Centre in Bangladesh

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Abstract

Introduction: *Cerebral palsy (CP) is one of the most common causes of chronic childhood disability. CT scan is helpful for identification of structural abnormalities, etiology, categorize the types of brain lesions and planning of intervention in the child with CP.*

Objective: *This study was done to find relationship between types of CP and CT scan findings of brain.*

Materials and methods: *This cross sectional descriptive study was done among 110 clinically diagnosed CP case from department of Paediatric Neurology & IPNA, BSMMU, during March 2016 to August 2017. Demographic, clinical characteristics & physical examination were done & collected data were recorded. CT scan of brain was done in all cases & all data were analyzed.*

Results: *The mean age of the studied children was 2.6±2.2 years (1 to 14 years). Among them quadriplegic CP were the most common (39.1%), followed by 28.2% cases of hemiplegic CP, 16.4% were of mixed type, 7.3% were diplegic. Most common finding on CT scan of brain was cerebral atrophy (62.7%), followed by encephalomalacia (15.5%), calcification (13.6%), and brain malformations (11.8%). Abnormal CT scan findings were found in 88.2% of studied children. Children with hemiplegic CP had brain atrophy in 87% of cases, calcification was found mostly in quadriplegic CP. Brain malformation was found mostly in mixed type of CP.*

Conclusion: *Most common CT scan finding was brain atrophy and commonly found in hemiplegic CP. Encephalomalacia and calcifications were commonly found in quadriplegic CP. Brain malformation were commonly found in mixed type of CP.*

Keywords: C*erebral palsy (CP), Computed tomography (CT).*

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Introduction:

Cerebral palsy (CP) describes a group of permanent disorders of the development of movement and posture, causing activity limitation, that are attributed to non - progressive disturbances that occurred in the developing fetal or infant brain. The motor disorders of cerebral palsy are often accompanied by disturbances of sensation, perception, cognition, communication, and behavior, by epilepsy, and by secondary musculoskeletal problems.[1] It is an important cause of childhood disability. [2] The prevalence of cerebral palsy in the world is about 2-2.5/1000 live birth.[3-5]

The types and severity of cerebral palsy are well established. Historically, cerebral palsy has been classified either by topography of signs, as indicated by the terms monoplegic, diplegic, hemiplegic, quadriplegic indicating the number of limbs affected or by type of motor manifestations, such as spastic, hypotonic, athetoid, mixed.[6] The current parameter addresses the role of neuroimaging in the infant or child who has been diagnosed with or is suspected of having CP based upon a motor deficit. This study has been done to obtain more detailed information about the localization of lesion of the brain, structural changes in children with CP and their relationship to CP-type, etiology and the presence of other functional cerebral defect.[7]

Materials and Methods:

This cross sectional descriptive study was carried out in the Department of Paediatric Neurology and Institute of Pediatric Neurodisorder and Autism (IPNA), Bangabandhu Sheikh Mujib Medical University (BSMMU), Dhaka, over a period of 1 year and 6 months from March 2016 to December 2017. CT scan of total 200 patients had been done. Then 90 patients were excluded having the features of metabolic disorder, neurodegenerative disease and age under 1 year.

One hundred and ten patients who were diagnosed as case of cerebral palsy were studied. The CT scan of all these patients was reported by a single expert radiologist from the Department of Radiology and Imaging at BSMMU. Demographic and clinical characteristics were recorded, physical examination mainly detail neurological examination was done to identify the type of CP and associated co-morbid conditions. The psychologists of pediatric neurology unit did the psychological tests by using appropriate tools. Cognitive level designated as normal or impaired with cut off IQ of 70. All the children had a formal visual and hearing assessment. Brainstem Auditory-Evoked Responses/Auditory Brainstem Responses (BAER/ABR) or Otoacoustic Emissions (OAEs) test were done to assess hearing. CT scan was done by 64 slice spiral CT machine. Informed written consent was taken from the parents or caregiver & ethical approval was taken from local ethical review board.

Result:

Most of the patients aged between 1-5 year (90%) of age. Sixty nine patients were male and 41 were female (37.3%). Most of them were socioeconomically poor 77 (70.0%) and majority (60.9%) from rural areas (Table-I). Regarding birth order, more than two third of patients were first born (68%). About 77% were born in term and 22 % were preterm. Most common perinatal problem in the studied subject was perinatal asphyxia (81.8%). All the patients had developmental delay in motor component, while 91% had cognitive impairment, 88% had speech delay. More than one third of the children had visual (35%) impairment and 31% had hearing impairment. Epilepsy was the commonest co morbidity and was present in 49 patient. (Table-I)

Table-I

Demographic and socioeconomic characteristics of child with cerebral palsy (n=110)

Demographic variables	Frequency (%)
Age of the child	
1-5 years	99 (90%)
>5- 12 years	10 (9.1%)
>12- 18 years	1 (0.9%)
Sex of child	
Male	69 (62.7%)
Female	41 (37.3%)
Place of birth	
Rural	67 (60.9%)
Urban	43 (39.1%)
Socioeconomic condition	
Poor	77 (70%)
Middle class	33 (30%)
Rich	0
Birth order of the child	
First born	75 (68.1%)
Second child	28 (25.5%)
Third or later born	7 (6.4%)
Twin	8 (7.3%)
Gestational age	
Term	85 (77.27%)
Preterm	24 (21.82%)
Post term	01 (0.91%)
Perinatal problems	
Perinatal asphyxia	90 (81.8%)
Preterm	24 (21.8%)
Multiple birth	8 (7.3%)
Development	
Cognitive delay	100 (90.9%)
Speech delay	97 (88.2%)
Vision impairment	39 (35.5%)
Hearing impairment	35 (31.8%)
Epilepsy	
Yes	49 (44.4%)
No	61 (55.6%)

Seven types of CP were found in the study group. Among them, quadriplegic CP were the most common (39.1%), followed by 28.2% cases of hemiplegic CP and mixed type was 16.4% (Figure 1).

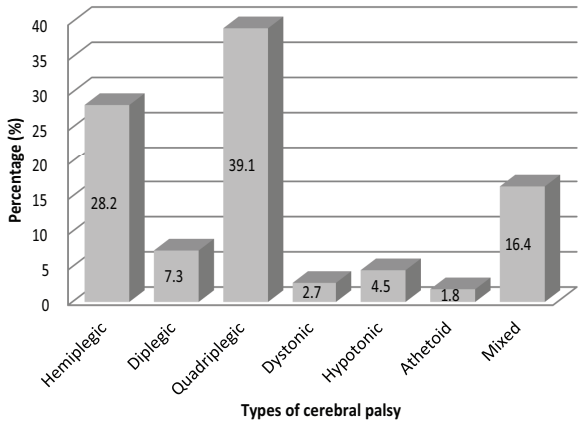

Fig.-1: *Bar diagram showing the type of cerebral palsy (n=110).*

Table-II

Distribution of the findings of CT scan of brain (n=110)

CT scan findings	Number of Patients (%)
Brain atrophy	69 (62.7%)
Brain malformation	13 (11.8%)
Periventricular Leukomalacia (PVL)	2 (1.8%)
Encephalomalacia	17 (15.5%)
Calcification due to TORCH infection	15 (13.6%)
Delayed myelination	1 (0.9%)
Focal arterial infarction	1 (0.9%)
Normal	13 (11.8%)

Table-II: showing the number and percentage of different type of cerebral palsy.

Most common CT scan findings in CP patients was cerebral atrophy, found in 69 cases (62.7%), 2nd common findings was encephalomalacia 15.5%. (Table-II) Cortical atrophy was mostly present in hemiplegic and quadriplegic CP which was statistically significant. Encephalomalacia was mostly present in quadriplegic CP which was also statistically significant. None of the patient with diplegic and athetoid CP had encephalomalacia (p value: <0.05). Calcification was mostly present in quadriplegic CP. None of the hemiplegic, diplegic, hypotonic and athetoid CP had calcification. Brain malformation was mostly present in mixed type CP which had significant p value. None of the hemiplegic, diplegic, and athetoid CP patients had brain malformation (Table-III, IV. V & VI).

Table-III

Relations of types of CP with brain atrophy (n=110)

Types of CP	No. of patients	CT scan findings Brain atrophy Present No. (%)	Absent No. (%)	P value
Hemiplegic				
Present	31	27(87.1%)	4(12.9%)#	<0.0001*
Absent	79	42(53.1%)	37(46.8%)	
Diplegic				
Present	8	1(12.5%)#	7(87.5%)	<0.0001*
Absent	102	68(66.6%)	34(33.3%)	
Quadriplegic				
Present	43	30(69.8%)	13(30.2%)	<0.001*
Absent	67	39(58.2%)	28(41.7%)	
Dystonic				
Present	3	2(66.6%)#	1(33.3%)#	0.656
Absent	107	67(62.6%)	40(37.3%)	
Hypotonic				
Present	5	2(40.0%)#	3(60.0%)#	0.932
Absent	105	67(63.8%)	38(36.1%)	
Athetoid				
Present	2	2(100.0%)#	0(0.0%)#	<0.0001*
Absent	108	67(62.0%)	41(37.9%)	
Mixed				
Present	18	5(27.8%)	13(72.2%)	0.0186*
Absent	92	64(62.5%)	28(30.4%)	
Total	110	69(62.7%)	41(37.2%)	

P value reached from Chi-square test, *=significant, # = P value reached from Fisher's exact test

Table-III: shows in patients with hemiplegic CP brain atrophy was the commonest finding (87.1%, p value <0.001). Isolated brain atrophy was present in 46 cases, among them 26 (83.9%) were hemiplegic CP, 15 cases (34.9%) were quadriplegic CP.

Table IV

Relations of types of CP with encephalomalacia(n=110).

Types of CP		Number of patients	CT scan findings Encephalomalacia		P value
			Present	Absent	
Hemiplegic	Present	31	1(3.2%)#	30(96.7%)	0.0002*
	Absent	79	16(20.2%)	63(79.7%)	
Diplegic	Present	8	0(0.0%)#	8(100.0%)	<0.0001*
	Absent	102	17(16.6%)	85(83.3%)	
Quadriplegic	Present	43	12(25.5%)	31(74.4%)	0.0025*
	Absent	67	5(8.9%)	62(91.0%)	
Dystonic	Present	3	1(33.3%)#	2(66.6%)#	0.0046*
	Absent	107	16(14.9%)	91(85.0%)	
Hypotonic	Present	5	1(20.0%)#	4(80.0%)#	0.4570
	Absent	105	16(15.2%)	89(84.7%)	
Athetoid	Present	2	0(0.0%)#	2(100.0%)#	<0.0001*
	Absent	108	17(15.7%)	91(84.2%)	
Mixed	Present	18	2(11.1%)#	16(88.8%)	0.4083
	Absent	92	15(16.3%)	77(83.6%)	
Total		110	17 (15.4%)	93(84.5%)	

P value reached from Chi-square test, *=significant, , # = p value reached from Fisher's exact test

Table-IV shows that 17 patients had encephalomalacia in CT scan of brain. More than one third (33.3%) patients with dystonic CP and 25.5% of quadriplegic CP had encephalomalacia.

Table V

Relations of types of CP with calcification (n=110).

Types of CP		No. of patients	CT scan findings Calcification		P value
			Present	Absent	
Hemiplegic	Present	31	0(0.0%)#	31(100.0%)	<0.0001*
	Absent	79	15(18.9%)	64(81.0%)	
Diplegic	Present	8	0(0.0%)#	8(100.0%)	<0.0001*
	Absent	102	15(14.7%)	87(85.2%)	
Quadriplegic	Present	43	11(25.5%)	32(74.4%)	0.0002*
	Absent	67	4(5.9%)	63(94.0%)	
Dystonic	Present	3	1(33.3%)#	2(66.6%)#	0.0013*
	Absent	107	14(13.0%)	93(86.9%)	
Hypotonic	Present	5	0(0.0%)#	5(100.0%)	<0.0001*
	Absent	105	15(14.2%)	90(85.7%)	
Athetoid	Present	2	0(0.0%)#	2(100.0%)#	<0.0001*
	Absent	108	15(13.8%)	93(86.1%)	
Mixed	Present	18	3(16.6%)	15(83.3%)	0.5530
	Absent	92	12(13.0%)	80(86.9%)	
Total		110	15(13.6%)	95(86.3%)	

P value reached from Chi-square test, *=significant, # = P value reached from Fisher's exact test

Table-V: Shows calcification was present in 15 cases. Among them 11 were quadriplegic CP and others were dystonic and athetoid CP.

Table VI

Relations of types of CP with brain malformation (n=110).

Types of CP		No. of patients	CT scan findings Brain Malformation		P value
			Present	Absent	
Hemiplegic	Present	31	0(0.0%)#	31(100.0%)	<0.0001*
	Absent	79	13(16.4%)	66(83.5%)	
Diplegic	Present	8	0(0.0%)#	8(100.0%)	0.0002*
	Absent	102	13(12.7%)	89(87.2%)	
Quadriplegic	Present	43	2(4.6%)#	41(95.3%)	0.0192*
	Absent	67	11(16.4%)	56(83.5%)	
Dystonic	Present	3	1(33.3%)#	2(66.6%)#	0.0002*
	Absent	107	12(11.2%)	95(88.7%)	
Hypotonic	Present	5	1(20.0%)#	4(80.0%)#	0.1170
	Absent	105	12(11.4%)	93(88.5%)	
Athetoid	Present	2	0(0.0%)#	2(100.0%)#	0.003*
	Absent	108	13(12.0%)	95(87.9%)	
Mixed	Present	18	9(50.0%)	(50.0%)	<0.0001*
	Absent	92	4(4.3%)	88(95.6%)	
Total		110	13 11.8%)	97(88.1%)	

P value reached from Chi-square test, *=significant,, # = P value reached from Fisher's exact test

Table VI: Shows among 31 hemiplegic CP none of them had brain malformation, p value 0.028, it is significant. Brain malformation present 11 cases. Most of them 8 cases (44.4%) had mixed type of CP, it is significant. One had quadriplegic CP, one had dystonic and one had hypotonic CP.

Discussion:

CT scan is an important modality of investigation of children with cerebral palsy in limited resource countries like Bangladesh. Apart from diagnosis it also correlates with the type of the cerebral palsy. Thus it play pivotal role in ascertaining the modalities of management particularly physiotherapy and medical management. Our study, highlighted the correlation of findings of CT scan of brain of children with CP with that of different type of CP.

In our study subjects, the commonest form of CP was quadriplegic CP comprising about 39.1%. The second common form was hemiplegic CP (28.2%). Other forms were mixed CP (16.4%), diplegic (7.3%), hypotonic (4.5%), dystonic (2.7%) and athetoid CP(1.8%). This findings has similarity with study done by Moifo B et al.[10] where quadriplegic CP 26.67%, hemiplegic CP 15.83%, Diplegic CP 6.67%, dyskinetic 3.33% and mixed form were 22.50%. Though Martin Bax et al.[8] found diplegic CP as the most common form of CP (34.4%). This may be due to advanced level of neonatal care in developed country where survival of preterm low birth weight babies are much more.

In our study we found 88.18% had abnormal CT scan findings, which was similar to studies of Kolawole TM et al.[7] as they reported that 72.5% CP patient had positive CT scan findings. TaudorfK et al.[9] found abnormal findings in 67% of CP patients. So in the aspect of establishing the clinical diagnosis, CT scan can play an important role in resource limited facilities.

The commonest pathological CT findings in this study was cortical atrophy (62.7%,). This finding shows similarity with study by [9-11] Moifo B who found atrophy in 52.7% cases. Kolawole TM[7] found atrophy in 30.8% cases. Taudorf K et al. found that brain atrophy present in 44 children among 56 pathological CT scan findings. The second most common finding here was encephalomalacia (15.5%) followed by calcification

(13.6%). Other features found here were brain malformations in 11.8% of children with CP. The pattern of brain malformations found in this study were – hydrocephalus with Dandy Walker malformation , corpus callosal agenesis, cortical dysplasia and arachnoid cyst, poor myelination, giant cisterna magna, open lip schizencephaly, corpus callosal agenesis, porencephaly, holoporencephaly, hypoplastic cerebellar vermis, posterior fossa cyst, cortical dysplasia etc. Thus we could diagnose a variety of brain malformations with the help of CT scan.

In a good number of patients (26) we found multiple features . All of them had two/more findings at a time which included-atrophy with calcification (3), atrophy with encephalomalacia (7), atrophy with infarct (4), atrophy with encephalomalacia with calcification (2), hydrocephalus with encephalomalacia (2), atrophy with calcification with subdural hematoma (1), atrophy with calcification with infarct (2), atrophy with encephalomalacia with subdural hematoma (1), atrophy with malformation (1), atrophy with encephalopathy (1), atrophy with calcification with malformation (1) and infective encephalopathy (1). In 13.6% patients we found enephalomalacia, calcification was found in 15.5% of children and periventricular leukomalacia was found in 1.8%.

Regarding the correlation of type of CP with brain imaging we got some important findings. In the patients with quadriplegic CP more than two third (69.8) had cortical atrophy and it was statistically significant. While a study done by Susan M Reid et al[11], about 34% had cortical atrophy. Brain atrophy was also present in most of the patients in this study in hemiplegic CP (87.1%). While it was absent in most of the cases of diplegic CP and it was present in all cases of athetoid CP.

Encephalomalacia is an important CT finding of CP. In this study it was found mostly in dystonic CP (33.3%) and quadriplegic CP (25,5%). However, it was absent in diplegic and athetoid CP. In a study done by Aggarwal A et al.[12], they found cystic encephalopmalacia in 47.8% of the patients with CP but they did not mention which type of CP had it most.

Intracranial calcification is a common finding on neuroimaging finding in patient with CP. It is mostly attributed by congenital infection like congenital CMV, toxoplasma infection. Basal ganglia calcification is found in case of hypoxic ischemic insult of brain. It was found in 13.6% cases in our study. Here , it was found mostly in dystonic CP (33.3%), quadriplegic CP (25.5%) and mixed CP (16%). However, it was not found in any case of other type of CP. In this regard, Saleh ED et al.[13] found in their study that about 12% of the patients with hemiplegic CP had calcification. However, none of the cases of hemiplegic CP had calcification in our study.

There are different types of congenital malformation of brain found in cases of CP. These are thinned cerebral mantle type, hydrocephalus, microgyria pachygyria type, schizencephaly. lissencephaly, cortical dysplasia etc. Yoshihiro Tsutsui et al.[14]found 11 patients (10%) had brain malformation in different forms. Among them 8 cases were mixed CP, others were quadriplegic CP, dystonic CP and hypotonic CP. None of the patients of hemiplegic CP had brain malformation. Garne E et al.[15] found that about 11.9% cases in their study population of 4384 cases of CP had congenital malformation of brain. The majority (8.6% of all children) were diagnosed with a cerebral malformation.

Regarding the demographic features, 62.7% were male and 37.3% were female. (Table:1) and M:F ratio was 1.68:1. This male predominance was also found in a study done by Karumuna and Mgone (1990) et al.[16] Stanley et al.[17] suggested that lower socioeconomic status and male sex may increase risk factors for cerebral palsy. Likewise, in our study we found most of the CP patient came from low socioeconomic background that is 77% poor and 33% middle class (Table-I). We also found most of the patients came from rural area (60.9%)(Table-I).

In this study group, more than two third (77.27%) were born at term, 21.82% born at preterm and post term 0.91%.(Figure: 4.2).This study also found 64.5% child had normal birth weight and 35.5% had low birth weight. Most predominant risk factor in perintal period was perinatal asphyxia which was present in 90 (81.8%) patient . About 7.3% had multiple birth. (Figure: 4.3). Among the children in this study almost all children (100%) had motor delay, 2nd common feature was cognitive delay, which was present in 90% case, speech delay was present in 88.2% case, visual impairment in 35.5% case and hearing impairment in 31.8% case. Seizure was present in 44.4% patient (Figure: 4.4). A study done by Moifo B et al.[10] found language impairment in 45.6% patients, mental retardation in 40.2% patients and epilepsy in 37.8% patient.

Conclusion:

CT scan of brain contributes in the understanding of etiology, pathogenesis, exclusion of differential diagnosis most importantly it can give impression of the pattern of CP and thus it can help in the planning of management and prognosis. In this study we found most of the hemiplegic CP had atrophy in CT findings, quadriplegic CP had mainly calcification and encephalomalacia. Brain malformation was present in most of the mixed type of CP cases.

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