

Original Article



Role of Computed Tomography Scan in The Evaluation of Cerebral Palsy in Children

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Abstract

Background. Cerebral palsy is one of the common childhood neurological problem which occurs due to defect or lesion in immature brain. The worldwide incidence of cerebral palsy is approximately 2-2.5 per 1000 live births. There have been many works on the role of computed tomography scan in the diagnosis of cerebral palsy. **Objective:** The objective information available from careful review of imaging information such as CT brain scans, is an important adjunct to clinical data. **Materials and Methods:** This cross sectional study was carried out in the department of Radiology and Imaging, BSMMU and department of Paediatric Neurology unit over a period of 12 months from January 2019 to December 2019. We calculated the sensitivity, specificity, positive predictive value, negative predictive value and accuracy of CT scan in diagnosis of CP in children. **Results:** This cross sectional study was carried out on consecutively selected 94 children below 15 years having clinical evidence of cerebral palsy. Among the study subjects 86.2% were diagnosed as cerebral palsy through CT scan. **Conclusion:** The sensitivity and specificity of CT scan of present study was found to be quite high in children which suggests a CT scan as an effective investigation for the diagnosis of cerebral palsy.

Keywords: Computed Tomography Scan , Cerebral Palsy, Children.

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Introduction

The common childhood neurological problem cerebral palsy occurs due to defect or lesion in immature brain. The worldwide incidence of cerebral palsy is approximately 2-2.5 per 1000 live births.¹ Cerebral palsy describes a group of permanent disorders of the development of movement and posture causing activity limitations, that are attributed to non progressive disturbances that occurred in the developing foetal or infant brain.

The motor disorders of cerebral palsy are often accompanied by epilepsy and by secondary musculoskeletal problems.² The types and severity of cerebral palsy are well established.

Epidemiologic studies of CP have traditionally grouped children with CP into phenotypic subtypes based on distribution of limb weakness and type of tone abnormality-hemiplegic, diplegic, quadriplegic, ataxic, hypotonic, mixed and dyskinetic. A Scandinavian study reported that 33% of the CP population was hemiplegic, 44% diplegic and 6% quadriplegic.¹

The brain abnormality may occur prenatally, perinatally or postnatally.³ CP is known to be associated with a host of proven etiologic factors - brain malformation birth asphyxia, birth trauma, kernicterus, hypoglycaemia, CNS infection like meningitis, encephalitis. The established risk factors - being

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a twin, low birth weight maternal genital tract infection in pregnancy. Patients with arm dominant hemiparesis tends to have large lesions involving the cerebral cortex and subcortical white matter (e.g. major arterial territory infarcts, porencephaly, polymicrogyria, cortical and subcortical atrophy).

Computed tomography (CT) scan of brain is a diagnostic imaging procedure that uses a combination of X-rays and computer technology to produce cross sectional image of the brain both horizontally and vertically. CT scan of brain has been used to evaluate potential etiologies of cerebral palsy. It shows the structure of brain in detail so the physicians can locate the brain damage or brain malformation clearly.⁴

A CT scan in a child with cerebral palsy may on occasion detect conditions that are surgically treatable and might not be detected by neurological examination. One study reported that 22.5% of 120 patients had potentially treatable lesions identified- hydrocephalus, porencephaly, arteriovenous malformations, subdural hematoma, hygromas and vermiantumours.⁵ Abnormal CT scans also indicates the presence of coexisting conditions such as mental retardation and epilepsy.⁶

Accurate determination of the etiology of CP has specific implications regarding treatment, prognosis and ongoing medical management of associated conditions. The importance of determining whether there is malformation or injury and whether the injury is due to acquired pre-, peri-or postnatal process has obvious significance from the point of view of assessment of recurrence risk, counseling of families and implementation of prevention programs.⁷

Materials and Methods

This cross sectional study was carried out in the department of Radiology and Imaging, Bangabandhu Sheikh Mujib Medical University Hospital and department of Paediatric Neurology unit over a period of 12 months from January 2019 to December 2019. This study was carried out on consecutively selected 94 children below 15 years having clinical evidence of cerebral palsy. All these children were with poor neck control, unable to sit, stand or walk according to chronological age and also associated with seizure, vision and hearing impairment and speech defect. The selected patients underwent CT scan of the brain and their findings were evaluated. Their motor abnormalities were categorized - hemiplegic / diplegic / quadriplegic/ ataxic /hypotonic / mixed /dyskinetic. Finally their CT scan findings and clinical findings were correlated and analyzed.

The follow outcome variables were observed

The children were interviewed with a pretested questionnaire after clinical assessment and then CT scan of brain was done by CT scanner with 5-10 mm axial slice. All the relevant data were compiled and then organized by scientific calculator and standard appropriate statistical formulae. Statistical analysis of the results were obtained by window based computer software devised with statistical packages for social science (SPSS-13).

Results

The cross sectional study conducted at Department of Paediatric-Neurology, and Department of Radiology & Imaging of BSMMU to see the diagnostic ability of computed tomography in the diagnosis of cerebral palsy in children. The study subjects were recruited based on set inclusion and exclusion criteria for the interview. The children were interviewed with a pretested questionnaire after clinical assessment and then CT scan of brain was done by CT scanner with 5-10 mm axial slice. (Table-I) shows mean age of the children in the study was 5.49 ± 4.07 year, among them 56.4% were aged below 5 year, 27.7% were aged between 5-10 year and 16% were aged above 10 years. Mean age of the children was 5.49 ±4.07 years. Among the children 62.8% were male and 37.2% were female. Mean weight of them was 14.75±5.76 kg. Among the children 63.0% were preterm at delivery and 37.0% were full term at delivery. (Figure-1)

Table I: Distribution of the children by age (n=94)

Age group	Frequency	Percent
< 5 years	53	56.4
5 - 10 years	26	27.7
> 10 years	15	16.0
Total	94	100.0

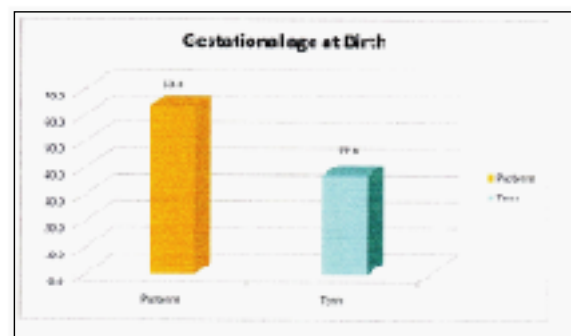


Figure 1: Distribution of the children by gestational age at birth (n=94)

Table II: Distribution of presenting feature (n=94)

Presenting feature □ □	Response □ □	Percentage
Unable to walk □ □	81 □ □	86.2%
Unable to stand □ □	62 □ □	66.0%
Speech delay □ □	60 □ □	63.8%
Unable to sit from lying □ □	52 □ □	55.3%
Seizure □ □ □ □	46 □ □	48.9%
Unable to sit □ □	36 □ □	38.3%
unsupported		
Hearing impairment □ □	25 □ □	26.6%
Poor neck control □ □	23 □ □	24.5%
Vision impairment □ □	18 □ □	19.1%

Table III: Distribution of Clinical type of Cerebral palsy (n=94)

Clinical type	Response	Percentage
Spastic hemiplegia	28	31.1%
Spastic diplegia	23	25.6%
Spastic quadriplegia	20	22.2%
Ataxic	06	06.4%
Hypotonic	06	06.7%
Mixed	07	07.4%
Dyskinetic	05	05.3%

There are different types of CP and they are classified by the type of movement disorder or muscle tone the child has and which parts of the body are affected. In the current study 31.1% had spastic hemiplegia, 25.6% had spastic diplegia, 22.2% had spastic quadriplegia, 06.4% were ataxic, 06.7% were hypotonic, 07.4% were of mixed variety and 05.3% were dyskinetic. (Table III)

Table IV: Distribution of various lesion in brain according to CT scan.

CT features of brain	Response	Percentage
Cerebral atrophy	26	27.66%
Cerebral infarct	23	24.47%
Ventricular dilatation	14	14.89%
Encephalomalacia	28	29.79%
Porencephaly	6	6.38%
Schizencephaly	7	7.45%
Lissencephaly	3	3.19%
Basal ganglia infarct	5	5.32%
Bilateral involvement	39	41.49%

According to the CT feature, among the children 27.66% had cerebral atrophy, 24.47% had cerebral infarct, 14.89% had ventricular dilatation, 29.79% had encephalomalacia, 06.38% had porencephaly, 7.45% had schizencephaly, 3.19% had lissencephaly, 05.32% had Basal ganglia infarct and 41.49% had bilateral involvement. (Table IV)

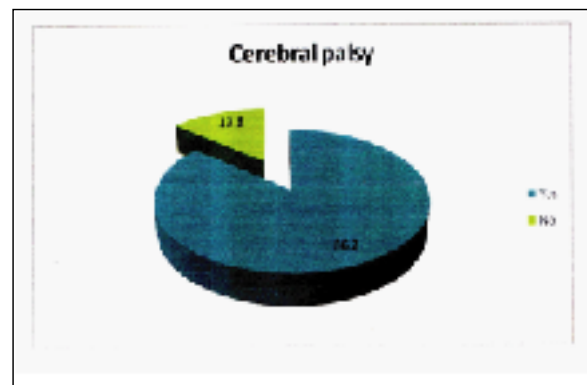


Figure 2: Distribution of CT scan abnormalities among the studied children (n=94)

Among the study subjects 86.2% were diagnosed as cerebral palsy through CT scan. (Figure-2)

Table V: Diagnostic accuracy of CT scan (n=94)

Parameter	Percentage
Sensitivity	89.0%
Specificity	75.0%
Positive predictive value	99.0%
Negative predictive value	53.0%
Accuracy	88.0%

Sensitivity, specificity, positive predictive value, negative predictive value and accuracy of CT scan in diagnosis of CP in children was calculated. In the current study Sensitivity of the test in diagnosis of cerebral palsy was 89.0%, Specificity 75.0%, Positive predictive value 99.0%, Negative predictive value 53.0% and the overall diagnostic accuracy was 88.0%. The sensitivity and specificity of CT scan was found to be quite high, which suggests a CT scan as an effective investigation for the diagnosis of cerebral palsy.

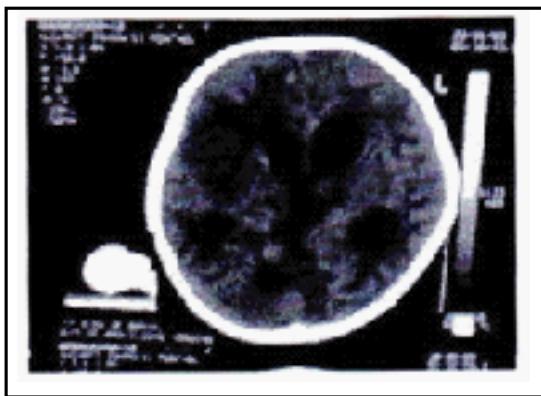


Figure 3: CT scan of brain showing diffuse cerebral atrophy and encephalomalacia with secondary enlargement of the ventricle and sulci

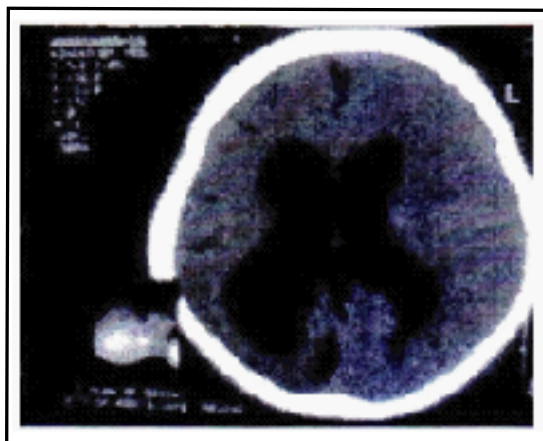


Figure 4: CT scan of brain showing right sided cerebral infarct (occipital lobe) with enlargement of lateral ventricles

Discussion

Cerebral palsy (CP) is a group of non-progressive motor impairment syndromes caused by lesions of the brain arising early in development.⁸ It is not a disease in itself, but rather it is a clinical syndrome that can have many different causes. Although it is not always possible to figure out what exactly caused CP in a child, it is related to an injury to the immature brain, either during pregnancy, around the time of birth. The etiology of CP remains unexplained in most cases, and the prevalence of CP, between 1.0 and 2.4 per 1000 live births,⁹ has not diminished in recent decades despite advances in obstetric and neonatal care. The risk of CP among term infants may in fact have increased between the years 1975 and 1991, from 1.7 to 2.0 per 1000 live births.¹⁰

Current study was a cross sectional study conducted at department of paediatric neurology, and department of radiology of BSMMU to see the diagnostic ability of computed tomography in the diagnosis of cerebral palsy in children. A total of 94 subjects of the study were interviewed with pretested questionnaire and underwent CT scan of brain by CT scanner with 05-10 mm axial slice.

As the diagnosis of CP does not specify a particular etiology or pathology, epidemiologic studies of CP have traditionally grouped children with CP into phenotypic subtypes based on the distribution of limb weakness and type of tone abnormality.¹¹ To devise rational and improved strategies for prevention, however, it is crucial that CP be recognized as a heterogeneous group of brain disorders with potentially different risk factors and causal pathways. With the increasing availability of head computed tomography (CT) and MRI, several types of brain injury underlying CP have been described, including brain malformations, hypoxic-ischemic brain injury, focal arterial infarction, and peri-ventricular white matter injury.¹ (Figure 3 & 4)

Most children are suspected to have CP when they have a delay in their motor development. This is usually after six months of age, and many children with CP aren't diagnosed until they are 18 months old. Some early signs and symptoms of CP can include excessive crying or irritability, feeding problems, excessive stiffness when dressing, changing diapers, or bathing.

There are different types of CP and they are classified by the type of movement disorder or muscle tone the child has and which parts of the body are affected. Most children have spastic CP, with muscle stiffness and increased muscle tone, increased reflexes and muscle weakness. Subtypes of spastic CP depend on which parts of the body are affected, including hemiplegia, quadriplegia, and diplegia. A less common type of CP is dyskinetic CP, which includes involuntary movement disorders. The last and least common type is ataxic CP, although children can have mixed CP, with features of more than main type. Regarding clinical type of Cerebral palsy in the current study (Table-III) shows 31.1% were Hemiplegic, 25.6% were Diplegic, 22.2% were Quadriplegic, 06.4% were Ataxic, 06.7% were Hypotonic, 04.4% were of Mixed variety and 07.8% were Dyskinetic and 35.6%. Among the suspected Cerebral palsy patients 35.5% had Epileptic seizure.

The diagnosis of cerebral palsy has historically rested on the patient's history and physical examination. Once diagnosed with cerebral palsy, further diagnostic tests are optional. The American Academy of Neurology published an article in 2004 reviewing the literature and evidence available on CT and MRI imaging. They suggested that neuroimaging with CT or MRI is warranted when the etiology of a patient's cerebral palsy has not been established.¹² Neuroimaging is not necessarily required for diagnosis of cerebral palsy because the disorder is based on clinical findings. The principal contribution of imaging is to the understanding of etiology and pathogenesis, including ruling in or out conditions that may have implications for genetic counselling, such as malformations.¹³

In this study (Figure 2) shows among the study subjects 86.2% were diagnosed as cerebral palsy through CT scan. We calculated the sensitivity, specificity, positive predictive value, negative predictive value and accuracy of CT scan in diagnosis of CP in children. In the current study Sensitivity of the test in diagnosis of cerebral palsy was 89.0%, Specificity 75.0%, Positive predictive value 99.0%, Negative predictive value 53.0% and the overall diagnostic accuracy was 88.0%. The sensitivity and specificity of CT scan was found to be quite high, which suggests a CT scan as an effective investigation for the diagnosis of CT scan.

Published evidence also goes equivocal. According to several literatures CT is considered to be a proven useful method of correlating morphology with clinical features in CP.^{14,15}

Neuroimaging can provide insight into the pattern and severity of cerebral injury underlying cerebral palsy providing a neuroanatomic understanding of the motor and related deficits. Early identification of injury before the establishment of marked motor deficits provides an opportunity for neuroprotection. Neuroimaging provides a robust manner for early delineation of the risk and nature of cerebral palsy that an infant or child may face. In the future, imaging may provide more functional methods, including novel methods such as optical tomography, map regeneration, adaptation, and functional recovery.¹⁶

Conclusion

The sensitivity and specificity of Computed tomography scan of present study was found to be quite high, which suggests a Computed tomography scan as an effective investigation for the diagnosis of cerebral palsy. Computed tomography scan can provide insight about the understanding of etiology and pathogenesis, including ruling in or out differential diagnosis.

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