Brain Computerized Tomography Scans Findings in Children with Cerebral Palsy

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Abstract:

dnuorgkcaB: Cerebral palsy (CP) is a major cause of the disability in children. It is considered a neurological disease occurs due to a non-progressive brain injury or anomaly that occurs while the brain is developing. Intracranial imaging provides a window to see the brain lesion and potentially, provide an insight into the pathogenesis of CP.

Objectives: To reveal the radiological changes of brain using CT scan in different clinical types of CP and in those CP children with functional impairments.

Material and methods: Sixty eight children with previous diagnosis of cerebral palsy were scanned with computed tomography (Philips, brilliance 64) for brain without contrast at Azadi Teaching Hospital/Kirkuk city, from February 2013 to July 2016. Clinical information was obtained from the documentation of pediatricians. The images were reviewed by two board certificate radiologists with at least 6 years of experience.

Result: Sixty-eight patients were included in the study, 42(61.8%) females and 26(38.2%) males with female to male ratio 1.6:1and an overall mean age at presentation was 12 months. Most (79.3%) children with cerebral palsy had abnormal neuro-radiological findings, Diffuse brain atrophy predominantly involving the cortical –subcortical grey matter with and without white matter hypodensities which indicate grey matter injury (35.4%) was the most common finding and it was more in the pyramidal CP (100%), followed by white matter atrophy and hyposensitizes with or without ventriculomegaly indicating white matter injury in (23.5%) which was the most common CT finding in cerebellar CP (50%), congenital malformations found in (8.8%) including pachygyria, and Dandy-Walker malformation, entirely seen in quadriplegic type, focal vascular brain insult seen in (5.9%) occurred only in diplegic type, and the least was ventriculomegaly labeled as miscellaneous (2.9%) occurred only in quadriplegic CP. CT scan was normal in (20.7%), predominantly in cerebellar type. There were significantly more patients with abnormal CT findings among CP children suffering from convulsion ($p<0.05$) than those without convulsion, this was not true in those with microcephaly ($p>0.05$).

Conclusion: CT scan brain is a good modality for detection of structural brain abnormality in cerebral palsy (CP) cases. There was significant correlation between the topographic distribution of motor deficit and brain CT findings. There were significantly more patients with abnormal CT findings among CP children suffering from convulsion but not microcephaly.

Keywards: Cerebral palsy (CP), Computed tomography (CT) scan.

Introduction:

Cerebral palsy (CP) is a group of disorders of the development of posture and movement, causing limitation in the activity that are linked to non progressive disturbance in the development of fetal or infant brain. The motor disorders of CP are often associated with disturbances of perception, cognition, communication, sensation, seizure, and /or by a behavior disorder [1]. The major problem in CP is limitation of motor ability [2]. The first study of children with CP done by little who reported forty-seven cases of permanent spastic rigidity in children who had born in difficult labor circumstances [3].

It is one of the most common causes of physical disability and limitation in children, [4, 5] affecting 1–2.5 per 1000 live births in the western centuries [6], and developing countries [7].

CP has been classified by the number and location of affected limb, into monoplegic, diplegic, or quadriplegic, it's also classified according to the type of motor disability, such as hypotonia, hypertonia, dystonia, and ataxia [7, 8].The diagnosis of CP depends on the clinical information about abnormal motor development that is not progressive in nature, associated with features like(hyper tonicity, increased reflexes, and clonus) on examination pointing in to an intracranial location [9, 10]. The nature of brain lesion may be vascular, infective, inflammatory, or traumatic and the time of insult may be in the prenatal, perinatal or postnatal period [9]. In developing countries, (50%) of cases occur in preterm infants, while in western countries the prevalence of CP in premature infants declined over the past decade [12].

Although there is no adequate supporting evidence [13], the American Academy of Neurology now requires radiological imaging for all cases of CP of unknown origin. The neuro-imaging studies have increased the understanding of the mechanism and the cause of CP [14], and can help to define the nature, extent and time of the brain insult [13, 15, 16]. The time of brain insult of cerebral palsy occur at prenatal, perinatal or neonatal period up to age of 2 years [16].

Computerized tomography (CT) scan imaging can reliably categorize cases into white mater lesions, cortical and deep gray matter lesions or brain malformations [13, 14]. This study was done to reveal the radiological changes of brain using CT scan in children with CP according to clinical types of CP and accompanied functional impairments.

Material and methods:

Sixty eight children with the previous diagnosis of cerebral palsy were scanned with computed tomography (Philips, brilliance 64) of the brain without the administration of contrast medium at radiology department/Azadi Teaching Hospital/Kirkuk city, from February 2013 to July 2016. Patients were 42 females and 26 males, CT scans were performed (2-24) months after the initial diagnosis.

Clinical information was obtained from the documentation of pediatricians. The brain CT images were reviewed by two board certificate radiologists having experience of at least 7 years. Data were analyzed statistically using percentage, chi-square, and p value.

Results:

The total number of children with CP was 68 (42 girls and 26 boys) with female to male ratio 1:6:1. Their mean age at diagnosis was 12months, ranged between 1 and 72 months as seen in figure (1).

The most frequent clinical type of CP was quadriplegic CP (52.9 %), followed by hypotonic (23.6%), diplegic (8.8%), pyramidal and ataxic types in (5.9%), and paraplegic which was the least (2.9%) as in table (1).

Most brain CT scans had abnormal finding (79.3).The frequency of abnormalities in CT scan overall was more pronounced in paraplegic and pyramidal CP (100%), then in quadriplegic (88.9%) and hypotonic (72.2%) followed by diplegic (66.7%) and the least was in cerebellar type (50%) as seen in table(1).

Diffuse brain atrophy predominantly involving the cortical –subcortical grey matter with and without white matter hypodensities indicating grey matter injury (38.2%) was the most common finding and it was more in the pyramidal subtype (100%), followed by white matter atrophy and hyposensitizes with or without ventriculomegaly which indicates white matter injury in (23.5%) and mostly occurred in the cerebellar (50%) CP.

Malformations were found in (8.8%), including pachygyria, and Dandy-Walker malformation seen in quadriplegic type only. Focal brain insult in (5.9%) was seen only in diplegic CP, and the least was ventriculomegaly labeled as miscellaneous (2.9%) occurred only in quadriplegic CP table (2). CT scan was normal in (20.7%), predominantly in cerebellar CP (50%). Brain CT scan changes in different clinical types of cerebral palsy were shown in table (3). In quadriplegic CP, grey matter changes and white matter changes contributed to (36%) for each of them, (8.6%) had malformations, (5.6%) hadventriculomegaly(miscellaneous) and (13.8%) showed normal CT scans. In diplegic CP cases (66.7%) had focal vascular insult and (33.3%) had normal brain CT scans. In paraplegic CP all patients had focal vascular insult. In cerebellar CP (50%) of the patients had white matter changes, while the other (50%) had normal brain CT scans. In hypotonic CP there were grey matter changes in (56.3%), and white matter injury in (25%), while (18.7%) were with normal brain CT scans. All patients with pyramidal CP had grey matter changes.

Mental retardation was the associated abnormality in (21.4%), speech disorder were seen in (20.5%), visual impairment in (9.7%), convulsion in (23.5%), and microcephaly in (11.7%).

The CT scan findings included white matter change and brain malformations for mental retardation; and grey matter change, malformations, focal vascular insult and ventriculomegaly for convulsion. In cases of microcephaly there were focal vascular insult and grey matter change in equal proportions (fig 2).

The CT abnormalities in those cases with speech difficulty were most commonly white matter changes followed by malformations then focal vascular insult. In cases with visual impairments, there were grey matter changes and brain malformation in equal proportion.

There were significantly more patients with abnormal CT findings among CP children suffering from convulsion ($p<0.05$) than those without convulsion; Whilethis was not true in those CP children with microcephaly ($p>0.05$) (table 4 and 5).

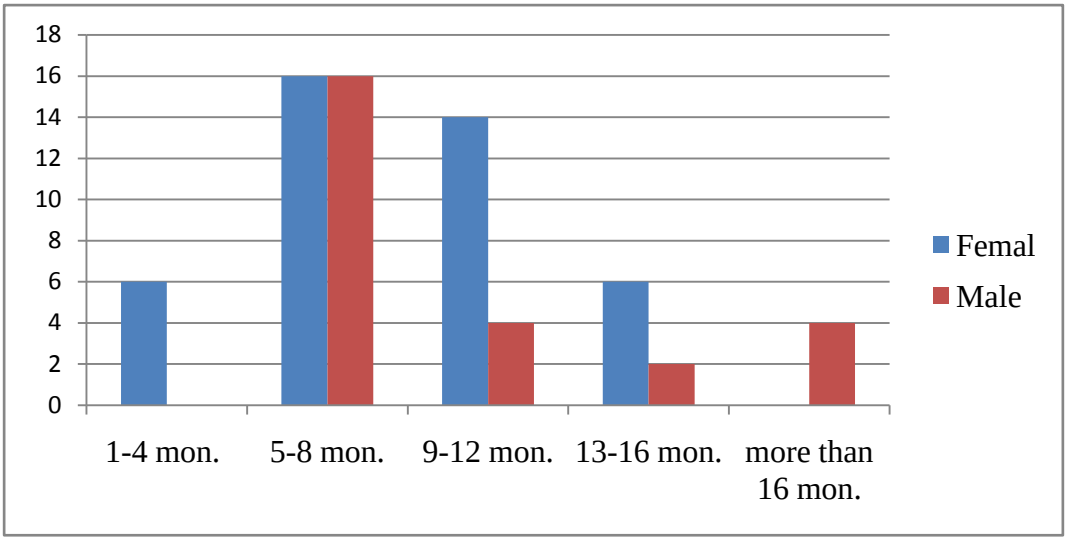

Figure (1): Histogram showing distribution of patients by gender and age.

Table (1): Distribution of clinical types and percentage of positive CT findings.

Clinical type	Number	Total percentage	+ve percentage
Quadriplegic	36	52.9	88.9%
Diplegic	6	8.8	66.7%
Paraplegic	2	2.9	100%
Cerebellar	4	5.9	50%
Hypotonic	16	23.6	72.2%
Pyramidal	4	5.9	100%

Table (2): Brain CT scan changes in cerebral palsy.

CT changes	Number	Percentage
Grey matter changes	26	38.2
White matter changes	16	23.5
Malformation	6	8.8
Focal vascular insult	4	5.9
Miscellaneous	2	2.9
Normal	14	20.7

Table (3): CT scan changes in different clinical types of cerebral palsy.

CP type	Gray mater injury	White mater injury	Malformation	Miscellaneous	Focal vascular insult	Normal CT scan
Quadriplegic	36%	36%	8.6%	5.6%	----	13.8%
Diplegic	----	----	----	----	66.7%	33.3%
Paraplegic	----	----	----	----	100%	----
Cerebellar	----	50%	----	----	----	50%
Hypotonic	56.3%	25%	----	----	----	18.7%
Pyramidal	100%	----	----	----	----	----

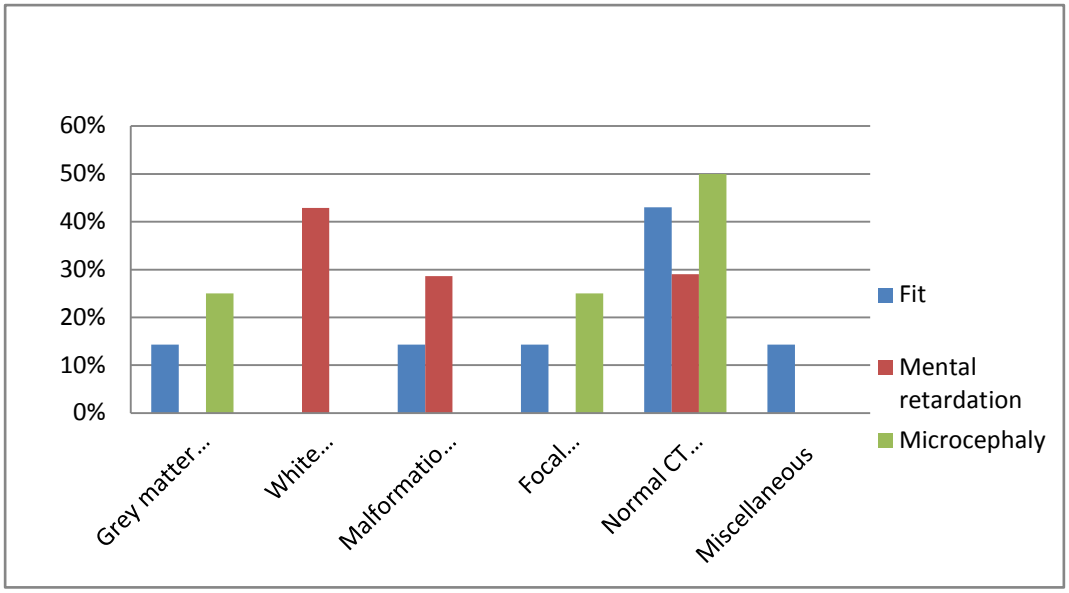

Figure (2): Histogram of percentage of accompanying impairments of CP in relation to CT scan changes.

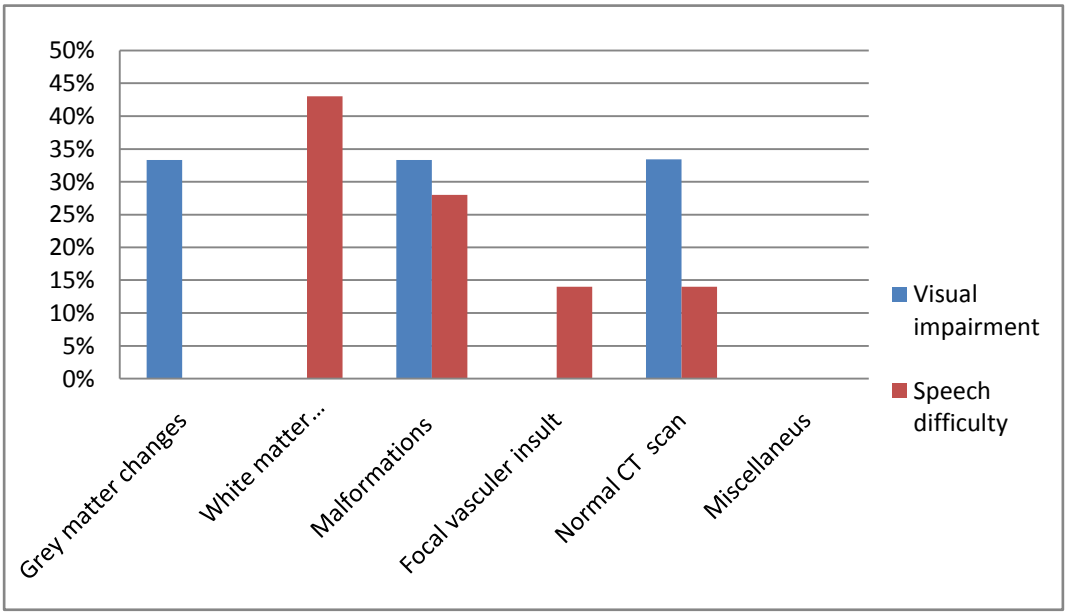

Figure (3): Histogram shows percentage of accompanying impairments of CP in relation to CT scan changes.

Table (4): Correlation between convulsion and Neuroimaging features in CP patients.

	Abnormal CT scan	Normal CT scan	Total
Convulsion	15	1	16
No convulsion	39	13	54
Total	54	14	68

P value=0.02.

Table (5): Correlation between microcephaly and Neuroimaging features in CP patients.

	Abnormal CT scan	Normal CT scan	Total
Microcephaly	6	2	8
No Microcephaly	48	12	60
Total	54	14	68

P value=0.6

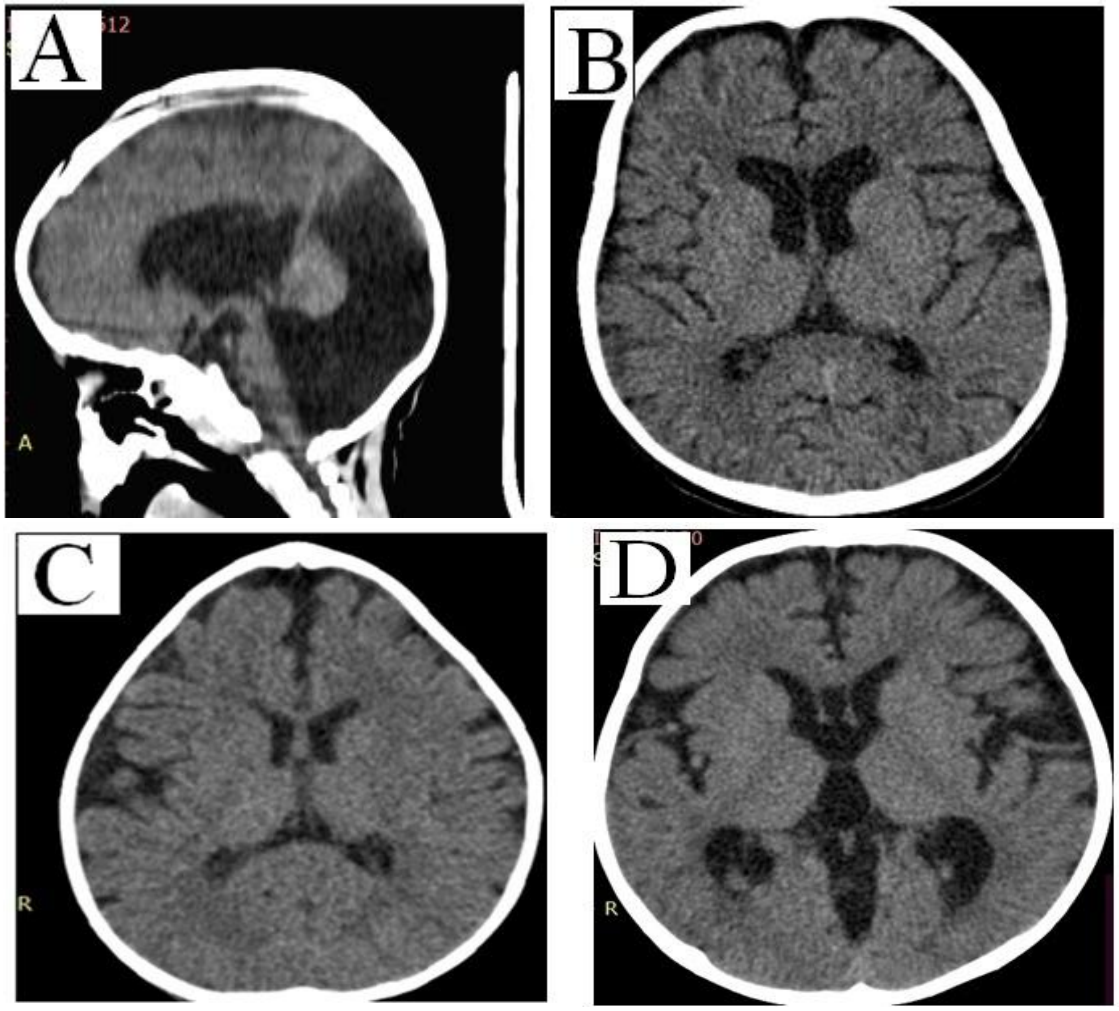

Figure (4): CT scan of brain in different children with CP. (A) Sagittal reconstruction in patient with Dandy-Walker malformation.(B) axial section showing white matter hypodensities, and brain atrophy.(C)Axial section, showing mainly gray matter atrophy. (D) Axial section showing diffuse white and grey matter atrophy with ventriculomegaly.

Discussion:

The mean age of presentation of CP in this study was 12 months, which was younger than other studies [16, 17, 18] probably due to the high percentage (20.6%) of familial incidence in this study leading to earlier consultation and diagnosis. Females were affected more than males with ratio of 1.6:1; however the opposite was true in a study done by Moifo B et al [16]; and another study done by Johnston and Hagberg who suggested that sex hormones protect the female fetal brain from hypoxia and less

predisposed to cerebral palsy compared to the males [19].

The most clinical type was the spastic CP (64.7%), comparable to a study done by Al-Khalidi Mohammed (53.9%) [17], and a study done by Mbonda *et al* (57.8%) [16]. Followed by hypotonic CP (23.6%) and the least common types are ataxic and cerebellar CP. This result was comparable with a study done by Aggarwal A. who stated that the most frequent clinical type of CP was spastic followed by hypotonic, and dystonic (pyramidal) [18].

Most brain CT scans had abnormal finding (79.3%), this was comparable to most studies (76.4%-91%) [13, 20, 21, 22]. Thus, normal CT scan of brain was not a rare finding in cerebral palsy; this might possibly be the result of occult cerebral damage undetected by CT scan, especially in cerebellar CP, as CT scan provides suboptimal visualization of the posterior fossa [23]. Magnetic resonance imaging (MRI) is more sensitive in detection of brain abnormalities as the percentage of an abnormal MRI scan in a child with CP is very high (average of 89%) and greater than that reported using CT (77%) [24].

The most common abnormality on CT scan (38.2%) was gray matter damage; Unlike a study done by korzeniewski Steven et al, in which the white matter abnormalities were the most common finding [13]. As the white matter lesions are more frequent with prematurity [17], in current study it was less common (23.5%) due to the small percentage of preterm babies (5.9%).

About (8.8%) of cerebral palsy was attributable to the brain malformations and (2.9%) to ventriculomegaly (miscellaneous); They occurred only in quadriplegic CP; On the other hand (5.9%) of patients had focal vascular insult which was the only CT brain findings in paraplegic type and 2/3rd of cases of diplegic CP.

There was significant correlation between the topographic distribution of motor deficit and brain CT findings, as most quadriplegic and hypotonic patients had diffuse bilateral grey and white matter injury, (36%) for each type of injury in spastic CP, (56.3%) and (25%) for hypotonic CP respectively; all patients with paraplegic CP had focal vascular insult in cerebral hemisphere contralateral to the motor deficit. Two thirds of diplegic spastic CP had focal vascular insult, and all patients with pyramidal CP had grey mater injury in this study; These results were similar to study done by Kolawole T.et al [20] who also declared that their result about cerebellar CP was restricted to cerebel lumun like current result in which there was no detected changes in the cerebellum; This was same as the result of a study done by Moifo B.[16] as CT scan provides suboptimal visualization of the posterior fossa structures due to obscuration by artifacts produced by the bony structures of the cranial base and early ischemic changes may not be visible [23].

The prevalence of functional abnormality associated with CP including epilepsy, mental retardation, visual impairment, and speech difficulty and microcephaly were less than other studies, [17, 25, 26] this might be because motor difficulties associated with CP and younger age group in current study, made these conditions not readily recognized.

In this study, abnormal CT findings were significantly more seen among patients CP children suffering from convulsion than those without convulsion; this was similar to a study

done by Karan et al [27]. These abnormal brain CT scan findings include grey matter change, malformations, focal vascular insult and ventriculomegaly. The finding that there was no difference in percentage of patients with abnormal CT scan in those with microcephaly than those with normal head circumference was unlike that of other studies [24, 27]; the brain CT findings were focal vascular insult and grey matter change in equal proportions.

There were grey matter change and brain malformation in equal proportions for visual impairments, and most commonly white matter change followed by malformations then focal vascular insult for speech disorders, and white matter change and brain malformations for mental retardation

Conclusion:

CT scan brain is a good modality for detection of structural brain abnormality in different typesof cerebral palsy.

There is a good correlation between the topographic distribution of motor deficit in different clinical types of CP and brain CT findings. .

There were significantly more patients with abnormal CT findings among CP children suffering from convulsion while there were not among patients with microcephaly.

Recommendation:

CT of brain (when MRI was not available) is recommended in suspected cases of CP to establish any brain abnormality. Further metabolic and genetic tests are recommended to exclude underlying genetic or metabolic etiology especially those with malformations. Those with focal vascular insult, coagulation studies are recommended to exclude coagulopathy.

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