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Relation between Gross Motor Abilities, Manual Abilities, Intellectual Impairment and Speech in Different Types of Cerebral Palsy in Al-Fayoum.

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Abstract
Background: *Cerebral palsy (CP) is the most frequent cause of physical disability in children, it occurs in approximately 2 to 2.5 per 1000 live births. Cerebral palsy is associated with impairments in gross motor abilities, manual abilities, speech and intellectual functions. There is no documented data about relation between types of CP and gross motor abilities, manual abilities, speech and intellectual impairment in Al-Fayoum governorate.*
Aim: *to detect relation between gross motor abilities, manual abilities, speech and intellectual impairments of children with cerebral palsy in Al-Fayoum.*
Subjects and Methods: *328 cerebral palsy children from both sexes received physical therapy at different hospitals and private centers; they were collected from hospitals and Physical therapy centers in Al-Fayoum governorate. Gross Motor Function Measure (GMFM), Manual Ability Classification System (MACS), and Viking Speech Scale (VSS) were used for outcome measures.*
Results: *The results revealed that there was a relation between gross motor abilities, manual abilities, and speech in spastic quadriplegia and hemiplegia. In children with diplegia and hypotonia there was a relation between gross motor abilities and speech. Spastic type of CP was the most common type.*
Conclusion: *Spastic quadriplegic type of CP was the most common between types of CP. There was relation between manual abilities and intellectual impairment in children with diplegia and hypotonia while no relation between intellectual impairment and gross motor abilities or manual abilities in quadriplegia and hemiplegia.*
Keywords: *Cerebral palsy, Al-Fayoum, GMFM, MACS.*

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I. Introduction

Cerebral palsy refers to a group of disorders with a diverse range of etiological pathways, pathophysiologies, and clinical features that persist through the life span. The most recent definition is a group of developmental disorders of movement and posture, causing activity restriction or disability attributed to disturbances occurring in the fetal or infant brain. The motor impairments may be accompanied by a seizure disorder, impairment of sensation, cognition, communication, behavior and secondary musculoskeletal problems.**[1].**

Cerebral palsy has often been classified according to the nature of the movement disorders (spasticity, ataxia, dystonia, and athetosis), additionally there is a mixed type and hypotonic type. The predominant type is spasticity, referring to a velocity dependent increase in muscle tone. Dyskinetic cerebral palsy, which is less proportion than spastic type of CP, the predominant abnormality is either dystonia or choreo-athetosis. With ataxic cerebral palsy there is a loss of orderly muscular coordination, so that movements are performed with abnormal force, rhythm, and accuracy, a traditional classification of children with spastic cerebral palsy includes spastic diplegia, spastic hemiplegia, or quadriplegia **[2].**

Motor impairments are present in all cases of CP, but other possible impairments related to brain damage include epilepsy, intellectual delays, and psychosocial abnormalities. Difficulty with swallowing and poor oromotor skills are among the first clinically identifiable symptoms in the neonatal period, and often precede more noticeable abnormalities, such as delays of developmental milestones **[3].** Primary musculoskeletal impairments such as muscle weakness and hypertonia translate into secondary impairments in balance and

postural control which in turn influence gross motor functions. Imbalance and postural instability are largely due to deficiencies in muscle coordination and force production [4].

Limitations of hand functions are common in all types of CP, but characteristics of the disability vary considerably between different CP types. The Manual Ability Classification System (MACS) is useful tool to evaluate ability of children to handle objects in daily activities, in children with hemiplegic CP, 87% of them were considered to be independent in age-relevant manual activities (MACS I and II), which reflects that these children often find adaptive strategies to compensate for a poor bimanual abilities. Hand functions in spastic diplegic CP was distributed between all MACS levels. All children with tetraplegic CP had severe hand problems and most children with dyskinetic CP in the present study had poor hand function, and only 20% of children with dyskinetic CP were independent in age-relevant manual activities [5].

Cognitive deficits are found in around 50% of children with CP [6]. The proportion of children with CP who have intellectual impairment has been reported to vary between 40% and 65% of CP children[7]. It was conducted that the concept of "severe CP" combining tow meanings; severe motor disability (ie, inability to walk) with severe learning disability (ie, IQ<50)[8]. Also, the results of **Vilibor** and **Vaz** reported that more severe motor impairments are associated with higher intellectual dysfunctions[9].

Children with CP often have speech, language and/or communication disorders [10]. However, the prevalence of communication disorders, including speech disorders such as dysarthria, are scarce and studies differ considerably when it describe the speech abilities of children with CP. Different studies reported that impaired speech occurs in around 20% of children with CP [11].

II. Subjects and methods

Subjects:

Three hundred and twenty eight cerebral palsy children of both genders who received physical therapy from different hospitals and centers participated in this study. Those children were collected from general, health insurance and teaching hospitals as well as private physical therapy centers that provide physical therapy services in Al-Fayoum governorate. The assessment procedures and the purpose of the study were explained to the parents. All children included in this study diagnosed as CP, ranged in age from birth to 18 years old. They live in Al- Fayoum governorate. Children excluded from the study if they were not diagnosed as CP or if they did not live in Al-Fayoum governorate. This study was conducted from May 2018 to November 2018.

Methods:

- **Evaluation form:** The evaluation form used in this study was adopted from Australian Cerebral palsy register, which contains personal data, prenatal history, perinatal history, present history, past history, family history, types of CP and associated impairments[12].
- **Gross Motor Function Measure scale(GMFM):** GMFM-88 are grouped into five dimensions: lying and rolling (17 items), sitting (20 items), crawling and kneeling (14 items), standing (13 items), and walking, running and jumping (24 items) [13].
- **Manual Ability Classification System (MACS):** MACS contain five levels; the distinctions (just as in the GMFCS) are intended to be clinically meaningful and are based on the way in which a child handles objects and the need for assistance or adaptations to perform manual tasks in everyday life. Level I: Handles objects easily and successfully. Level II: Handles most objects but with somewhat reduced quality and/or speed of achievement. Level III: Handles objects with difficulty; needs help to prepare and/or modify activities. Level IV: Handles a limited selection of easily managed objects in adapted situations Level V: Does not handle objects and has severely limited ability to perform even simple actions.[14].
- **Viking Speech Scale (VSS):** The Viking Speech Scale is developed to be used with children aged 4 years and above. The scale has four levels: level I indicates that speech is not affected by motor disorder. Level II demonstrates that speech is imprecise but usually understandable to unfamiliar listeners. Loudness of speech is adequate for one to one conversation. Level III indicates that speech is unclear and not usually understandable to unfamiliar listeners out of context. Level IV demonstrates no understandable speech [15].

III. Procedures

The data collected from parents or medical reports concerning birth information, personal history, types of CP, associated impairments as speech and intellectual impairments. In addition, physical examination and clinical details of each child with CP determined by GMFM scores, MACS and VSS results. A consent form assigned from the caregivers to approve participation in the study.

1- **Gross Motor Function Measure scale (GMFM):** The child was given a specific description for each item of GMFM score then the child was allowed to do a maximum of three trials and the best trial was scored.

The time taken is about 45 minutes. All items in lying, rolling, sitting, crawling and kneeling were performed on mat. All items in standing, walking, running and jumping were performed on the floor.

Scoring of each item:

0= does not initiate
1= initiate
2= partially complete
3= complete

2- **Manual Ability Classification System (MACS):** The position of the child was supported and comfortable to do his or her best effort independently. The parents or the caregivers were asked about what the child can do during activities of daily living then the child was asked to carry small toy, large toy, sweets and use pens to write anything if he/she can, then his/her level was recorded. The time taken was about 10 minutes.

3- **Viking Speech Scale (VSS):** The caregiver was asked about the speech, communication and repeated words of the child then the researcher tried to make conversation with each child and scored the usual speech performance of the child. The time taken was about 10 minutes.

Statistical analysis: Data were analyzed using statistical package for the social science (SPSS) version 18. Variables were presented as number and percentage. Results were analytically tested using chi-squared (x^2) to test the relation between study variables. For all tests ($P<0.05$) was considered to be statistically significant**.**

IV. Results

328 children with CP from Al-Fayoum governorate in Egypt were included in this study.

Table (1) demonstrated the frequency (number) and the percentage of participants according to types of CP; spastic CP type was the most common type accounting for 267 children including 71 hemiplegic children representing 21.6%, 39 diplegic children representing 11.9%, 149 qaudriplegic children representing 45.4%, 6 triplegic children representing 1.8%, 2 monoplegic children representing 0.6%, 6 dyskinetic children representing 1.8% from total sample, 5 ataxic children representing 1.5%, 45 hypotonic children representing 13.7% and 5 mixed type children representing 1.5% from total sample.

Table 1: Distribution of types of cerebral palsy

CP type	Number	Percentage
Spastic hemiplegia	71	21.6%
Spastic diplegia	39	11.9%
Spastic quadriplegia	149	45.4%
Spastic triplegia	6	1.8%
Spastic monoplegia	2	0.6%
Dyskinetic	6	1.8%
Ataxic	5	1.5%
Hypotonic	45	13.7%
Mixed	5	1.5%
Total	**328**	**100%**

According to gross motor function measure, children were classified to four categories; less than 30%, from 30%-60%, from 60%-90% and more than 90%. Children in the category of less than 30 represent the highest percentage as shown in table (2).

Table 2: Level of impairment according to Gross Motor Function Measure (GMFM)

			Types of cerebral palsy									
			Spastic hemiplegia	Spastic diplegia	Spastic quadriplegia	Spastic triplegia	Spastic monoplegia	Dyskinetic	Ataxic	Hypotonic	Mixed	Total
Gross Motor Function Measure (GMFM):	Less than 30	Count	11	4	117	3	0	5	0	21	2	163
		% of Total	3.4%	1.2%	35.7%	.9%	0.0%	1.5%	0.0%	6.4%	.6%	49.7 %
	From 30-60	Count	17	10	24	3	1	0	1	16	1	73
		% of Total	5.2%	3.0%	7.3%	.9%	.3%	0.0%	.3%	4.9%	.3%	22.3 %
	From 60-90	Count	25	21	8	0	1	1	3	8	2	69
		% of Total	7.6%	6.4%	2.4%	0.0%	.3%	.3%	.9%	2.4%	.6%	21.0 %
	More than 90	Count	18	4	0	0	0	0	1	0	0	23
		% of Total	5.5%	1.2%	0.0%	0.0%	0.0%	0.0%	.3%	0.0%	0.0%	7.0%
	Total	Count	71	39	149	6	2	6	5	45	5	328
		% of Total	21.6%	11.9%	45.4%	1.8%	.6%	1.8%	1.5%	13.7%	1.5%	100. 0%

There were 184 children less than 4 years representing 56.09% so total number evaluated by the scale was 144 children representing 43.91% from the total sample (328 children) as the scale is not used for children below 4 years of age. According to MACS the highest level was level I as shown in Table (3).

Table 3: Level of impairment according to Manual Ability Classification System (MACS)

			Types of cerebral palsy									
			Spastic hemiplegia	Spastic diplegia	Spastic quadriplegia	Spastic triplegia	Spastic monoplegia	Dyskinetic	Ataxic	Hypotonic	Mixed	Total
Manual Ability Classification System(MACS):	Level I	Count	7	19	7	1	1	1	0	11	0	47
		% of Total	4.9%	13.2%	4.9%	.7%	.7%	.7%	0.0%	7.6%	0.0%	32.6%
	Level II	Count	8	1	4	1	0	1	4	0	0	19
		% of Total	5.6%	.7%	2.8%	.7%	0.0%	.7%	2.8%	0.0%	0.0%	13.2%
	Level III	Count	14	3	12	2	0	1	0	3	2	37
		% of Total	9.7%	2.1%	8.3%	1.4%	0.0%	.7%	0.0%	2.1%	1.4%	25.7%
	Level IV	Count	3	3	15	0	0	0	0	0	0	21
		% of Total	2.1%	2.1%	10.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	14.6%
	Level V	Count	1	0	15	0	0	1	0	2	1	20
		% of Total	.7%	0.0%	10.4%	0.0%	0.0%	.7%	0.0%	1.4%	.7%	13.9%
Total		Count	33	26	53	4	1	4	4	16	3	144
		% of Total	22.9%	18.1%	36.8%	2.8%	.7%	2.8%	2.8%	11.1%	2.1%	100%

There were 184 children were less than 4 years representing 56.09% so total number of children evaluated by the scale was 144 children representing 43.9% from the Total sample (328 children) as the scale is not used below age of 4 years. According to Viking speech scale the highest level was level IV as demonstrated in table (4)

Table 4: Level of impairment according to Viking Speech Scale (VSS)

			Types of cerebral palsy									
			Spastic hemiplegia	Spastic diplegia	Spastic quadriplegia	Spastic triplegia	Spastic monoplegia	Dyskinetic	Ataxic	Hypotonic	Mixed	Total
Viking Speech Scale(VSS)	Level I	Count	11	10	2	2	1	0	1	0	0	27
		% of Total	7.6%	6.9%	1.4%	1.4%	.7%	0.0%	.7%	0.0%	0.0%	18.8%
	Level II	Count	6	2	4	0	0	0	1	0	0	13
		% of Total	4.2%	1.4%	2.8%	0.0%	0.0%	0.0%	.7%	0.0%	0.0%	9.0%
	Level III	Count	4	4	9	1	0	1	1	3	0	23
		% of Total	2.8%	2.8%	6.3%	.7%	0.0%	.7%	.7%	2.1%	0.0%	16.0%
	Level IV	Count	12	10	38	1	0	3	1	13	3	81
		% of Total	8.3%	6.9%	26.4%	.7%	0.0%	2.1%	.7%	9.0%	2.1%	56.3%
	Total	Count	33	26	53	4	1	4	4	16	3	144
		% of Total	22.9%	18.1%	36.8%	2.8%	.7%	2.8%	2.8%	11.1%	2.1%	100.0 %

In this study 247 children had speech impairment representing 75.7% from total sample, while 81children had normal speech with parents representing 24.7% as shown in table (5).

Table 5: Distribution of speech impairment

			Types of cerebral palsy:									
			Spastic hemiplegia	Spastic diplegia	Spastic quadriplegia	Spastic triplegia	Spastic monoplegia	Dyskinetic	Ataxic	Hypotonic	Mixed	Total
Speech impairment:	Normal	Count	35	16	15	3	2	2	2	6	0	81
		% of Total	10.7%	4.9%	4.6%	.9%	.6%	.6%	.6%	1.8%	0.0%	24.7%
	Affected	Count	36	23	134	3	0	4	3	39	5	247
		% of Total	11.0%	7.0%	40.9%	.9%	0.0%	1.2%	.9%	11.9%	1.5%	75.3%
	Total	Count	71	39	149	6	2	6	5	45	5	328
		% of Total	21.6%	11.9%	45.4%	1.8%	.6%	1.8%	1.5%	13.7%	1.5%	100%

Related to intellectual impairment, there were 104 children had intellectual impairment representing 31.7% from total sample and 224 children had no intellectual impairment representing 68.3% from total sample as shown in table (6).

Tables 6: Distribution of intellectual impairment

			Types of cerebral palsy:									
			Spastic hemiplegia	Spastic diplegia	Spastic quadriplegia	Spastic triplegia	Spastic monoplegia	Dyskinetic	Ataxic	Hypotonic	Mixed	Total
Intellectual impairment:	Normal	Count	60	29	93	5	1	2	3	29	2	224
		% of Total	18.3%	8.8%	28.4%	1.5%	.3%	.6%	.9%	8.8%	.6%	68.3%
	Affected	Count	11	10	56	1	1	4	2	16	3	104
		% of Total	3.4%	3.0%	17.1%	.3%	.3%	1.2%	.6%	4.9%	.9%	31.7%
	Total	Count	71	39	149	6	2	6	5	45	5	328
		% of Total	21.6%	11.9%	45.4%	1.8%	.6%	1.8%	1.5%	13.7%	1.5%	100.0 %

According to statistical analysis there were significant relations between types of CP and GMFM scores, MACS, VSS, intellectual impairment and speech impairment as showed in table (7).

Table 7: Relation between measured variables and types of cerebral palsy

	Chi- square	Contingency Coefficient	P- Value	Sig.	Indication
1- Gross Motor Function Measure score (GMFM)	171.09	0.585	0.001**	Sig.	There is Significant relation
2- Manual Ability Classification System (MACS)	102.49	0.645	0.001**	Sig.	There is Significant relation
3-Viking Speech Scale (VSS)	45.08	0.488	0.006**	Sig.	There is Significant relation
4- Speech impairment	59.64	0.392	0.001**	Sig.	There is Significant relation
5- Intellectual impairment	18.30	0.230	0.019*	Sig.	There is Significant relation

V. Discussion

This study included 328 children with CP in Al-Fayoum governorate in Egypt, to establish data regarding gross motor abilities, manual abilities, speech and intellectual impairments in children with cerebral palsy in Al-Fayoum.

The current study showed that spastic CP was the most common type representing 81.3% from the total sample while hypotonic type was 13.7%, ataxic type was 1.5%, dyskinetic type was 1.8% and mixed type was 1.5%.These results come in agreement with the study conducted on children with CP who were receiving physical therapy services of both genders, ranged in age from 4 months to 16 years old in Tanta, Egypt by Altonoby et al. who reported that spastic type of CP was 79.5% [16] , also this current study comes in accordance with Blair and Waston who recorded that spastic CP type cited as the predominant motor type and occurring in about 77% to 93% of children with CP[17].

In the present study, spastic type of CP was estimated to be spastic quadriplegia 45.4%, spastic hemiplegia 21.6%, spastic diplegia 11.9%, spastic triplegia 1.8% and spastic monoplegia 0.6% from the total

sample. These results revealed that spastic quadriplegia was the most common subtype of spastic CP type. These results are reinforced by El-Tallawy et al. who recorded that spastic quadriplegia was 42.3% from children with CP born in (1990–2007) in El-Kharga District- new Valley, Egypt[18].While these findings disagree with Johnson who explained that spastic diplegic subtype was the most common subtype followed by spastic quadriplegia in Europe [19] and Scheil et al. in South Australia whom work was applied on children with cerebral palsy born in the years (1993 – 2009) and he recorded that spastic hemiplegia was (38.2%) [20]

The results showed that there was a significant relation between CP types and Gross Motor Function Measure scores. Children with CP were divided into four categories according to GMFM scores ; less than 30 (49.7%), from 30 to 60 (22.3%), from 60 to 90 (21%) and more than 90 (7%). The highest percentage was less than 30 and this means that the severity is high. This agrees with Darwish et al., who reported that children with CP had low motor abilities in their study in Imbaba, North Giza, Egypt, [21], but disagree with Mostafa et al., who revealed that the percentage between 26% and 74% was the highest percentage in children with CP of both genders ranged in age from 3 months to 17 years in Sohag city, Egypt [22].

According to Manual Ability Classification System, the current study revealed that percentage of children who were assessed to be level I was 32.6%, level II was 13.2%, level III was 25.7%, level IV was 14.6% and level V was 13.9% while 56.1% were below age of 4 years. The highest percentage according to MACS was level I and the least percentage was level II which disagree with Yasser et al., who stated that the highest percentage in MACS levels was level V in his study on CP children in Mitghamr city, Egypt [23].The majority of children were in level I according to MACS despite of the most common CP subtype was the spastic quadriplegia, because MACS is used for children above 4 years while majority of spastic quadriplegic children in this study were below 4 years old. Results revealed significant relation between CP types and MACS.

According to Viking Speech Scale, the current study showed that percentage of children who were assessed to be level I was 18.8%, level II was 9%, level III was 16% and level IV was 56.3% so the highest percentage was level IV, this comes in agreement with the work of Nagy et al., in North Cairo, Egypt, which revealed that the highest percentage was level IV (46.2%) [24]. Also the results of this study revealed that 75.3% of CP children had speech impairments which come in agreement with Park et al. who recorded that CP is associated with communication difficulties due to restrictions in the production of movement for speech and facial expression[25] and with the study of Radwan and Abdalazim who showed that speech impairment was in 73.8% from children with CP who were receiving physical therapy services, ranged in age from 6 months to 15 years, in Almontazah District, Alexandria, Egypt[26]. Results revealed significant relation between CP types and VSS, this highlights the importance of speech therapy in rehabilitation of children with CP and the need to provide high qualified speech therapists in hospitals and pediatric centers in Al-Fayoum..

The children with CP in the current study have associated impairments as intellectual impairment representing 31.7% that comes in agreement with results of Serdaroglu et al. in Turkey who conducted the study on children with CP between the ages of 2 and 16 years, reported that 25%-80% of CP children had cognitive disorders and other problems as epilepsy, auditory, language and visual[27].

According to the findings of this study, there was a relation between gross motor abilities, manual abilities and speech in children with quadriplegic and hemiplegic CP which could be explained as the affection in gross motor abilities was associated with affection in manual abilities and speech, that might be related to the involvement of the four limbs and trunk muscles in quadriplegic CP and affection in one side in hemiplegic CP which lead to impairment in bimanual hand function and gross motor activities. These results match with other studies[28, 29] which reported that there was a significant relation between gross motor abilities and manual activities in CP, also match with Himmelmann et al. who reported that there was significant relation between communication function, gross motor abilities and manual abilities in children with CP (unilateral spastic CP, bilateral spastic CP and dyskinetic CP) in Western Sweden[30]. These results don't come in agreement with Choi et al. who supported the significant effect of manual abilities on communication functions, rather than gross motor abilities[31]. Also results of this current study don't agree with the work of Park et al. who showed relative weak relation between gross motor abilities and manual abilities, this was reported in children with spastic hemiplegic CP compared with that in children with spastic bilateral CP. Children with unilateral CP usually walk or try to walk, but sometimes cannot use the affected arm at all, leading to serious problems in bimanual hand function. Therefore, they often present better gross motor abilities than manual abilities[32].Sigurdardottir et al. in Iceland revealed that the majority of children with CP who had severe cognitive impairments were diagnosed as spastic bilateral types of CP (quadriplegia and diplegia). It was observed that hemiplegic children had the best cognitive skill points and quadriplegics were much more affected when compared to diplegics and hemiplegics[33]. Other studies reported that there were significant correlations between the intellectual functions, motor abilities and manual abilities levels in children with CP[34, 35]. This is not in accordance with the results of this current study which demonstrated no relation between intellectual impairment and gross motor abilities, manual abilities or speech in both spastic quadriplegic and hemiplegic CP.

Regarding to diplegic type of CP and hypotonic type of CP in this study, there was no relation between gross motor abilities and manual abilities or intellectual impairment. This finding is consistent with Hidecker et al. who recorded that there was a good relation between mobility and hand functions in children with hemiplegia and quadriplegia but was less well correlated in those with diplegia. This lower correlation between mobility and hand function was related to those children with diplegic CP who had more affection in lower limbs than upper limbs so they had good hand function and difficulties with leg use[36]. In diplegic CP the gross motor function was more limited than manual ability[37]. But the result of the current study does not match with Menkes who demonstrated that there was general correlation between severity of motor deficit and level of retardation in children with spastic diplegia[38], Al-Nemr and Abdelazeim. Who reported presence of correlation between cognitive function and gross motor function in children with spastic diplegia at different ages[39], and Gajewska et al. who recorded that there was close relation between manual abilities, cognitive capacities and motor control[40]. The findings of Lee et al., reported that the extents of functioning, activity and participation all depend on the ability of the school-aged children with CP to handle and manipulate objects[41]. Also the findings of Türkoğlu et al. proved that there was a relation between fine motor ability disorder and intelligence level[42]. The result of the present study showed that there was a relation between manual abilities and intellectual impairment in diplegic CP and hypotonic CP, also there was a relation between gross motor abilities and speech in these two types of CP. Both expressive language function and speech status were highly associated with gross motor abilities in children with CP[43]. Andersen et al. found that a significant proportion of Norwegian children with CP had speech problems and that such problems were associated with CP types and gross motor function[44]. At the end of the study , it can be summarized that there was a relation between gross motor abilities, manual abilities, speech in quadriplegic and hemiplegic types of CP while no relation between these variables and intellectual impairment. There was a relation between gross motor abilities and speech in diplegic and hypotonic CP types while no relation between manual abilities and gross motor abilities or speech.

VI. Conclusion

The findings of the present study help to establish data regarding gross motor abilities, manual abilities, speech and intellectual impairments in children with cerebral palsy in Al-Fayoum that enhance health services and awareness about CP. These results will help the physiotherapists to develop treatment plans and how to deal with children with CP. Also these results stress the importance of consolidating data about types of CP in the light of predominant neurological findings and functional evaluations. The results concluded that the spastic quadriplegic type was the most common type of CP. Children with CP encounter varying degrees of gross motor, fine motor and speech impairments in the light of the findings of GMFCS, MACS and VSS. In children with spastic quadriplegia and hemiplegia there was a relation between gross motor abilities, manual abilities and speech. In children with diplegia and hypotonia there was no relation between gross motor abilities and manual abilities or intellectual impairment.

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