ASSOCIATION BETWEEN GROSS MOTOR AND INTELLECTUAL FUNCTIONS AMONG CHILDREN WITH CEREBRAL PALSY

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Abstract

Background: *Cerebral Palsy (CP), a complex neurodevelopmental disorder in children, is often accompanied by comorbidities like intellectual impairments besides core motor dysfunction.*

Aims: *To assess the relationship between gross motor and intellectual functions among the children with CP.*

Methods: *A cross- sectional study was carried out in the Institute of PaediatricNeurodisorder and Autism (IPNA), BSMMU, Dhaka, during Oct. 2017 to May 2018 including 82 children up to 12 years of age having CP. The gross motor function of all the children was evaluated using GMFCS. Psychological assessment was done by professional psychologist using age specific psychometric tools.*

Results: *One third of the children (39.0%) belonged to age 2-4 years. Male to female ratio was 1.7:1. More than three fourths of the children (85.4%) were of term gestational age. Perinatal asphyxia (PNA) was associated in 92.7% children.More than half of the children (57.3%) had spastic quadriplegia. Almost half of the children (48.8%) GMFCS level was II and 28.0% children were of GMFCS level III. Nearly a half (48.8%) of the children was with mild intellectual impairment and 22.0% were with moderate intellectual impairment. There is a significant negative Spearman's correlation (r=-0.639; p=0.001) between GMFCS level and intellectual level.*

Conclusion: *More severe motor impairments in CP might be associated with higher intellectual dysfunction.*

Keywords: Cerebral palsy, children, motor, intellectual, function

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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 nonprogressive 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] CP is thought to be the most common cause of serious physical disability in childhood.[2]

Classification of cerebral palsy evolved over time from aetiological, pathological through clinical and finally a functional one. The clinical classification of CP, done according to the quality and topographic pattern of motor impairment, is more useful than aetiological or pathological ones.[3] Still this classification has limitation in terms of assessing functional ability of a child with CP. Therefore, the new

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function-based classification schemes have been introduced to focus on function, participation, and activity limitations in neurodevelopmental disability.[4] Palisano et al. introduced the Gross Motor Function Classification System (GMFCS) and also the expanded and revised GMFCS (GMFCS E&R)[5,6] that includes an age band for youth aged 12 to 18 years. GMFCS E&R emphasizes the concept inherent in the World Health Organization's International Classification of Functioning, Disability and Health.[6] This grading has been shown to be reliable across observers and invariant with increasing age.[7]

The GMFCS classifies gross motor function on a five-degree ordinal scale (level I represents the best gross motor abilities; level V the least function), with descriptions of skills provided for five age bands for each level: before the second birthday; age 2– 4 years; age 4–6 years; age 6–12 years; adolescence. Although the Gross Motor Function Measure (GMFM) is used most frequently and globally to assess the effectiveness of interventions in children with CP,[8] the GFMCS has had a remarkably rapid uptake into clinical practice and research around the world.[7] Children with cerebral palsy (CP) often demonstrate difficulties in performing complex motor tasks. Motor function and intelligence are crucial aspects of human function and intellectual function is important during the performance of complex motor tasks. As the complexity of a task increases, so does the cognitive demand.[9] The process of learning a complex motor task or relating individual elements into a motor unity is basically an intellectual process.[10]

The proportion of children with CP and intellectual impairment (intelligence quotient [IQ] <70) has been reported to vary between 40% and 65%.[11,12] Furthermore, the results of a systematic review suggested that more severe motor impairments are associated with higher intellectual dysfunction.[13] This study is designed to explore the relationship between gross motor function and intellectual ability in children with cerebral palsy and thus to facilitate quick assessment and early intervention of this group of children.

Materials and Methods

Study Design and Participants

This study was a cross sectional study. It was conducted among the children diagnosed clinically as having cerebral palsy attending inpatient and outpatient departments of the Institute of Paediatric Neurodisorder and Autism (IPNA) of BSMMU from October 2017 to May 2018. A total of 82 children aged up to 12 year of age were enrolled in the study by convenience sampling after informed written consent obtained from the parents.

The following well-established clinical classification was used: (1) spastic quadriplegia (spasticity in all 4 limbs, with equivalent or greater spasticity in the upper extremities), spastic hemiplegia, and spastic diplegia (spasticity in the lower extremities far in excess of any discernible spasticity in the upper extremities); (2) dyskinetic (ie, athetosis, chorea, or dystonia in the absence of objective weakness or tone changes); (3) ataxic; (4) hypotonic ; or (5) mixed (ie, spastic and dyskinetic features both prominent). Similarly, other objective assessments were used to assign the functional mobility according to the GMFCS E&R. Children at GMFCS E&R level I: walk and perform all the activities of age-matched peers, albeit with limitations of speed, balance, and coordination. Children at level V needs to be transported, have extreme difficulties with trunk posture, and have little voluntary control of limb movements.[14]

Intelligence testing was carried out with the Bayley Scales of Infant Development (BSID-III), the Wechsler Preschool and Primary Scale of Intelligence (WPPSI-III) and the Wechsler Intelligence Scale for Children–Revised (WISC-R). BSID is a tool to assess the intelligence for infants and toddler up to 2.5 years of age, WPPSI-III is an intelligence test designed for children aged 2.6 to 7.3 years while WISC-R will be used for children between 7 and 14 years of age.[15,16,17] The following 6 degrees could be specified, reflecting the level of intelligence: normal, borderline, mild intellectual disability, moderate intellectual disability, severe intellectual disability, and profound intellectual disability. These intellectual levels reflect the degree of deviation of the IQ from a mean of 100, with 15 points representing 1 SD (normal, >84: borderline, 71–84; mild intellectual disability, 55– 70; moderate intellectual disability, 35–54; severe intellectual disability, 20–35; profound intellectual disability, <20).[18]

2.2 Procedure

The assessment protocols were followed for all subjects. The distributions of CP subtype and GMFCS E&R level were determined by the researcher. The intellectual score was assessed with the BSID-III, WPPSI-III and WISC-R, by a professional paediatric psychologist of IPNA.

2.3 Statistical Analysis

Data were collected using a pre-designed data collection sheet. Data were presented in tabulated form and analyzed using computer-based program Statistical Package for Social Science (SPSS) for Windows version 23 for Windows (SPSS Inc., Chicago, Illinois, USA). The mean values were calculated for continuous variables. The quantitative observations were indicated by frequencies and percentages. Descriptive analysis was mainly used to describe the distribution of demographic and clinical characteristics of the participants, and the proportions of GMFCS E&R levels, types of CP and intellectual levels. In regard to test the relationship between gross motor function with intellectual ability Spearman's rank correlation coefficient or Spearman's rho test was applied, where gross motor function was the independent variable and intellectual ability was the dependent variable. A "p" value <0.5 was considered as significant.

Results

The demographic characteristics of the study subjects, including age, gender, birth weight, gestational age and history of perinatal asphyxia, are depicted in table 1. Among 82 children, more than one third (39.0%) belonged to age 2-4 years. The mean age was found 5.0±3.45 years with the range from 0.6 to 12 years. Almost two third (63.4%) of the children were male and 30(36.6%) were female. More than two third (68.3%) had normal birth weight, 22(26.8%) belonged to LBW and 4(4.9%) had IUGR. More than three fourth of the children (85.4%) belonged to term gestational age while 11(13.4%) were preterm. History of perinatal asphyxia (PNA) was found in 76(92.7%) children.

Table I

Demographic Characteristics

Variables	No. of children	Percentage (%)
1.Age (Years)		
< 2	16	19.5
2-4	32	39.0
4-6	04	4.9
6-12	30	36.6
Mean±SD	5.0±3.45	
Range(min-max) (year)	0.6-12	
2. Gender		
Male	52	63.4
Female	30	36.6
3. Birth Weight (Kg)		
Normal	56	63.3
Low Birth Weight	22	26.8
Intrauterine Growth Restriction	04	4.9
4. Gestational Age		
Term	70	85.4
Preterm	11	13.4
Post term	01	1.2
5. Perinatal Asphyxia		
Absent	06	7.3
Present	76	92.7

Distribution of the study subjects by clinical types of CP is presented in table II. It was observed that more than half of the children (57.3%) belonged to spastic quadriplegia and 17(20.7%) had spastic hemiplegia. Table III shows the distribution of the study population by GMFCS level. It was observed that almost half of the children's (48.8%) GMFCS level was II and 23(28.0%) GMFCS level was III. Distribution of the children by intellectual level is displayed in table 4 which shows that almost half of them (48.8%) were in mild intellectual level, 18(22.0%) were in moderate intellectual level while 17 (20.7%) children had borderline intellectual function.

Table II

Distribution of the study population by types of CP (n=82)

Types of CP	Number of Children	Percentage (%)
Spastic hemiplegia	17	20.7
Spastic diplegia	7	8.5
Spastic quadriplegia	47	57.3
Dyskinetic	2	2.4
Mixed	9	11.0

Table III

Distribution of the study population by GMFCS level (n=82)

GMFCS level	Number of Children	Percentage (%)
I	11	13.4
II	40	48.8
III	23	28.0
IV	04	4.9
V	04	4.9

The joint distribution of gross motor function level (GMFCS I-V) and the level of intellectual ability (6 levels) among the study population is presented in table 5. Maximum children fell within the range of GMFCS I-III and intellectual levels of borderline functioning, mild and moderate disability (3-5). It is also shown that 100% of the children in GMFCS level V had severe disability in intellectual functioning.

Figure 1 displays the scatter diagram showing negative significant Spearman's correlation (r=-0.639; p=0.001) between gross motor function level and Intellectual level. This scatter gram includes the GMFCS level (I-V) in the X- axis while intellectual levels (1-6) in the Y- axis. The intellectual ability level is denoted by numbers 1-6 from below upwards as follows: 1- profound disability, 2- severe disability, 3- moderate disability, 4- mild disability, 5- borderline and 6- normal intellectual functioning.

Table IV

Distribution of the study patients by intellectual level (n=82)

Intellectual Level	Number of Children	Percentage (%)
Normal	02	2.4
Borderline	17	20.7
Mild	40	48.8
Moderate	18	22.0
Severe	05	6.1

Table V

Joint Distribution of Gross Motor and Intellectual Function Levels in study population (n=82)

GMFCS Level Intellectual Level	I	II	III	IV	V
Normal	-	02 (5%)	-	-	-
Borderline	07 (63.64%)	08 (20%)	02 (8.7%)	-	-
Mild	04 (36.36%)	22 (55%)	12 (52.17%)	01 (25%)	-
Moderate	-	08 (20%)	09 (39.13%)	02 (50%)	-
Severe	-	-	-	01 (25%)	04 (100%)
Profound	-	-	-	-	-

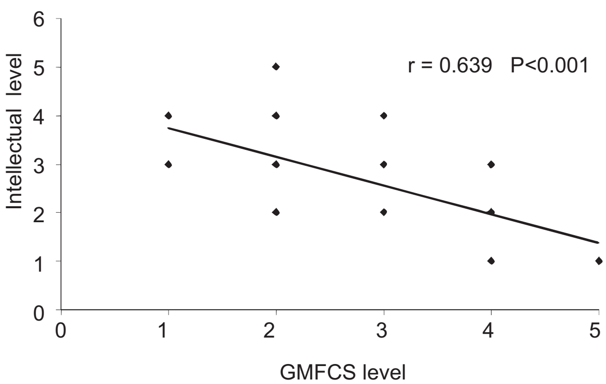

Fig.-1: *Scatter diagram showing negative significant Spearman's correlation (r=-0.639; p=0.001) between gross motor function level and Intellectual level.*

Discussion

Motor disability is the key component for diagnosis of cerebral palsy.[1] However, CP is often accompanied by other impairments, such as feeding, visual, auditory, speech and intellectual problems. The aspects of functioning, disability and health other than motor aspects have attracted increasing interest in recent years.[19] Therefore, the focus on accompanying impairments of CP, particularly for intellectual level has increased nowadays. The present study was undertaken with the view of exploring the correlation between gross motor and intellectual functions that was found in few other studies done over the last decade.

In this study, the severity of the motor deficit associated with CP was classified using the GMFCS. It emphasizes the concepts inherent in World Health Organization's International Classification of Functioning, Disability and Health (ICF).[6] The distribution of patients across different levels of GMFCS varies among different studies depending on the place of the study and the population studied.[20] In this study it was observed that 48.8% patients were at GMFCS level II while 28.0% were at GMFCS level III. Older children who are to be transported were not available for the present study. The underlying fact is presumed to be the difficulty in transporting these children by the caregivers and the inability to assess intellectual function by the assigned psychometric tool in severely disabled children.

All the children in the present study were assessed for intellectual function using age-appropriate psychometric tools. It was observed that 48.8% children had mild intellectual disability, 22.0% had moderate intellectual disability 20.7% had borderline intellectual functioning, while 2.4% had normal intellectual functioning and 6.1% with severe intellectual disability. A total of 76.9% of children had intellectual disability, the finding of which is very much in accordance with that of Pratibha D. Singhi et al who found it being 72.5%.[21] Zhang et al. found intellectual level with borderline activity in 52.1%, moderate 27.1% and severe 20.8%.[22] Dalvand et al. found normal 19.0%, borderline 13.0%, mild 17.0%, moderate 25.0 and severe 19.0%.[20] In the study by Beckung and Hagberg found learning disability (measured by IQ < 70) in 40% of children, with mild in 14% and severe in 26%.[11] The distribution in the level of intellectual functioning also thus varies among different studies depending on the proportion of severity of cerebral palsy of the studied population.

The current study shows a significant correlation between the levels of gross motor function and the intellectual ability among children with cerebral palsy with a negative correlation coefficient (r=-0.639; p=0.001). It indicates that more severe motor impairments are associated with higher intellectual dysfunction. This finding is mostly consistent with those of previous studies. In Dalvand et al. study, children at GMFCS E&R levels I to IV had a higher intellectual level in comparison with children at level V.[20] Similar finding was also observed by Himmelmann et al. where proportion of learning disability increased significantly with GMFCS levels (÷2 trend for learning disability=127.14, degrees of freedom [df]=1, p<0.001).[23] Enkelaar et al also showed an association between mental and motor functioning in two thirds of their cases.[24]

In regards to the strong correlation between gross motor and intellectual function in children with cerebral palsy one plausible explanation might be related to the received stimulation (due to more motor function) from the environment that in respect can affect the intelligence level.[20] Moreover, the nervous system optimizes neural connections during critical periods and the lack of necessary experiences during critical periods in human development of gross motor function and cognition leads to retardation in these areas.[25]

In this study, it was observed that 57.3% children had spastic quadriplegia, 20.7% had spastic hemiplegia while 11.0% had mixed type of CP. Studies from this part of the world showed that the predominant type being spastic quadriplegia, 56.6% in study by Minocha et al[26]& 61% in study by Singhi et al.[21] In the current study, it was observed that 39.0% children belonged to age 2-4 years. The mean age was found 5.0±3.45 years with ranged from 0.6 to 12 years. Among the children 63.4% were male while 36.6% were female. Unlike western figures most (85.4%) of the children belonged to term gestational age, 13.4% were preterm and 1.2% was post term. Singhi et al also showed very similar figures like ours with 86.8% being term babies.[21] More than two third (68.3%) children's birth weight belonged to the normal range, while 26.8% were LBW and 4.9% IUGR. Most (92.7%) 0f the children had Perinatal asphyxia (PNA). The high proportion of birth asphyxia associated with CP is also shown in other studies from less developed countries.[21,26]Singhi et al commented that, although birth asphyxia, in the causation of CP has been challenged, they found history indicative of birth asphyxia in a large number of cases.[21] The current data do not support that birth asphyxia can be recognized reliably and specifically on the basis of clinical signs only and that most CP is due to birth asphyxia.[27] Therefore, history of perinatal asphyxia may be an association but not the aetiology in all cases.

Conclusion

This study has shown that with increasing level of GMFCS, there is a declining trend of intellectual functioning. As the comprehensive rehabilitation programme of children with CP should focus on intellectual function as well as motor function, this finding may help in a quick prediction of both of them, especially in the resource constraint settings. Thus, it may facilitate early detection and intervention of this group of children.

Competing Interests

Authors have declared that no competing interests exist.

Authors' Contributions

This work was completed in collaboration among all authors. Author TS designed the study, wrote the protocol, performed the data collection and statistical analysis and prepared the first draft of the manuscript. Authors KF and KAI managed the analyses of the study. Authors MZU, ARMSHK and MMH managed the literature searches. The whole work was done under supervision of SA. All authors read and approved the final manuscript.

Consent

Informed written consent was obtained from the parents or caregivers of all the children prior to their participation in the study.

Ethical Approval

The study was conducted following approval of The Institutional Review Board of BSMMU.

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