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Original Research

The Effect of the Function of Forearm Supination on Participation Activities and Communication Skills of Children with Hemiparetic Cerebral Palsy

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Abstract

Objective: The aim of this study is to investigate the effect of forearm supination function of children with hemiparetic CP on their participation activities and communication skills.
Materials and Methods: This study was carried out with 58 children aged 7-14 who were diagnosed with hemiparetic CP and regularly followed up in special education and rehabilitation centers. In addition to the demographic information of the children, outcome measurements of Gschwind Tonkin Classification System, Child and Adolescent Scale of Participation (CASP), and Communication Function Classification System (CFCS) were also recorded.
Results: It was found that participation activities and communication skills levels of children with hemiparetic CP were statistically different according to forearm supination function ($p<0.05$).
Conclusions: It was investigated that participation activities and communication skills levels of children with hemiparetic CP were decreased with the decrease in the function of forearm supination according to the Gschwind Tonkin Classification System. While planning rehabilitation programs to increase participation activities and communication skills levels of children with hemiparetic CP, it can be suggested to consider increasing children's function of supination level and treatment practices that increase this function.

Keywords: *Hemiparetic, participation activities, supination, cerebral palsy*

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Introduction

Cerebral Palsy (CP) is defined as a group of permanent disorder in the development of movement and posture that are associated with non-progressive disorders in the developing fetus or infant's brain, and it causes activity limitations. These disorders are generally accompanied by problems such as sensory, perception, cognitive, behavioral disorders, epilepsy, and secondary musculoskeletal problems (Morris, 2007; Rosenbaum et al., 2007). As for that, hemiparetic CP is a type of spastic CP in which one side of the lower and upper extremities are affected. In hemiparetic CP, the upper extremity is affected more than the lower extremity, and the distal involvement is more than the proximal in the upper extremity. As a result, the process of muscle and bone development on the affected side is interrupted and this results in a decrease in joint range of motion (Rosenbaum et al., 2007). The reported cause of the occurrence of these secondary problems is the inability to control abnormalities of muscle tone that changes depending on the posture, movement, or position in CP (Papavasiliou, 2009; Rosenbaum et al., 2007).

Spastic movement patterns in CP often causes deformities and dysfunctions in the shoulder joint, elbow, wrist, and fingers in the upper extremity (Plasschaert, Ketelaar, Nijnuis, Enkelaar, & Gorter, 2009). In this way, because of bone and muscle imbalances, muscle contracture in some spastic muscles of the upper extremities develops faster than other muscles and accelerates the development of additional problems. For example, when the muscle contracture that takes place in the pronator teres and wrist flexors is not treated, it causes rotational deformities and subluxations of the radius and ulna (Das, Mohanty, & Das, 2002). Thus, limiting the muscle function in any joint in the upper extremity is an important issue since it can cause a decrease in functionality and leads up to many problems.

Forearm supination and pronation movement forms the basis of most of the daily life activities such as eating, drinking from a glass, brushing teeth, washing hand and face, combing hair, shaving, writing, handshaking, applauding, using a walker, and using a wheelchair (Gopura & Kiguchi, 2008). These functions are fulfilled thanks to the balance between pronator teres, pronator quadratus and supinator muscles. The frequent pronation contracture that occurs in CP significantly affects these functions and as a result, social and functional limitations might show up (Čobeljić et al., 2015; Manske, 1990). These limitations also affect the communication

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of children with CP with their surroundings and this makes it difficult for them to be independent and functional in their daily life activities.

Communication difficulty is one of the most common problems in individuals with CP (Zhang, Oskoui, & Shevell, 2015), and it is a significant problem that negatively affects the overall quality of life, school, and social participation. (Hidecker et al., 2011) Although motor, sensory, and cognitive disorders were given as the cause of children's communication problems (Pennington, 2008), it was indicated that educational, behavioral, and environmental factors also have an effect (Sigurdardottir & Vik, 2011; Voorman, Dallmeijer, Van Eck, Schuengel, & Becher, 2010). When considered from this point of view, it is significant to determine the communication skills of children with CP and factors that influence these skills.

In the literature, although there are limited studies examining the relationship between forearm supination and participation in children with hemiparetic CP (Beckung & Hagberg, 2002); there is no study examining the effect of forearm supination on the level of communication skills. Thus, the aim of this study is:

1) Does forearm supination have an effect on participation activities in children with hemiparetic CP?

2) Does forearm supination affect communication skill level in children with hemiparetic CP?

Materials and Methods

The ethics committee approval was obtained from Muş Alparslan University, Non-Interventional Clinical Research Ethics Committee with the decision numbered E.1527 and numbered 3-31 on 28.01.2021 to conduct the study. An informed consent form was obtained from each participant or parent who agreed to participate in the study.

Participants

The study was conducted with 58 children aged 7-14 years who were followed up with the diagnosis of hemiparetic CP in special education and rehabilitation centers located in Muş city center. To determine the sample size of the study, version 3.1.9.4 of the G * Power program (Heinrich-Heine-Universität Düsseldorf, Germany) was used. (Faul, Erdfelder, Lang, & Buchner, 2007) The power ratio of the sample was calculated, based on similar articles (Klingels et al., 2012), as β = %80 and α=0.05, and 58 children with hemiparetic CP were

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included in the study accordingly. The determined inclusion criteria of the study are as follows: having a diagnosis of hemiplegic CP, having no uncontrollable seizures, having no vision problems that would prevent the performed tests, no orthopedic surgery and botulinum toxin treatment performed in the last six months, and being able to cooperate with the physiotherapist's instructions. Children who did not meet the inclusion criteria were excluded from the study (Figure 1).

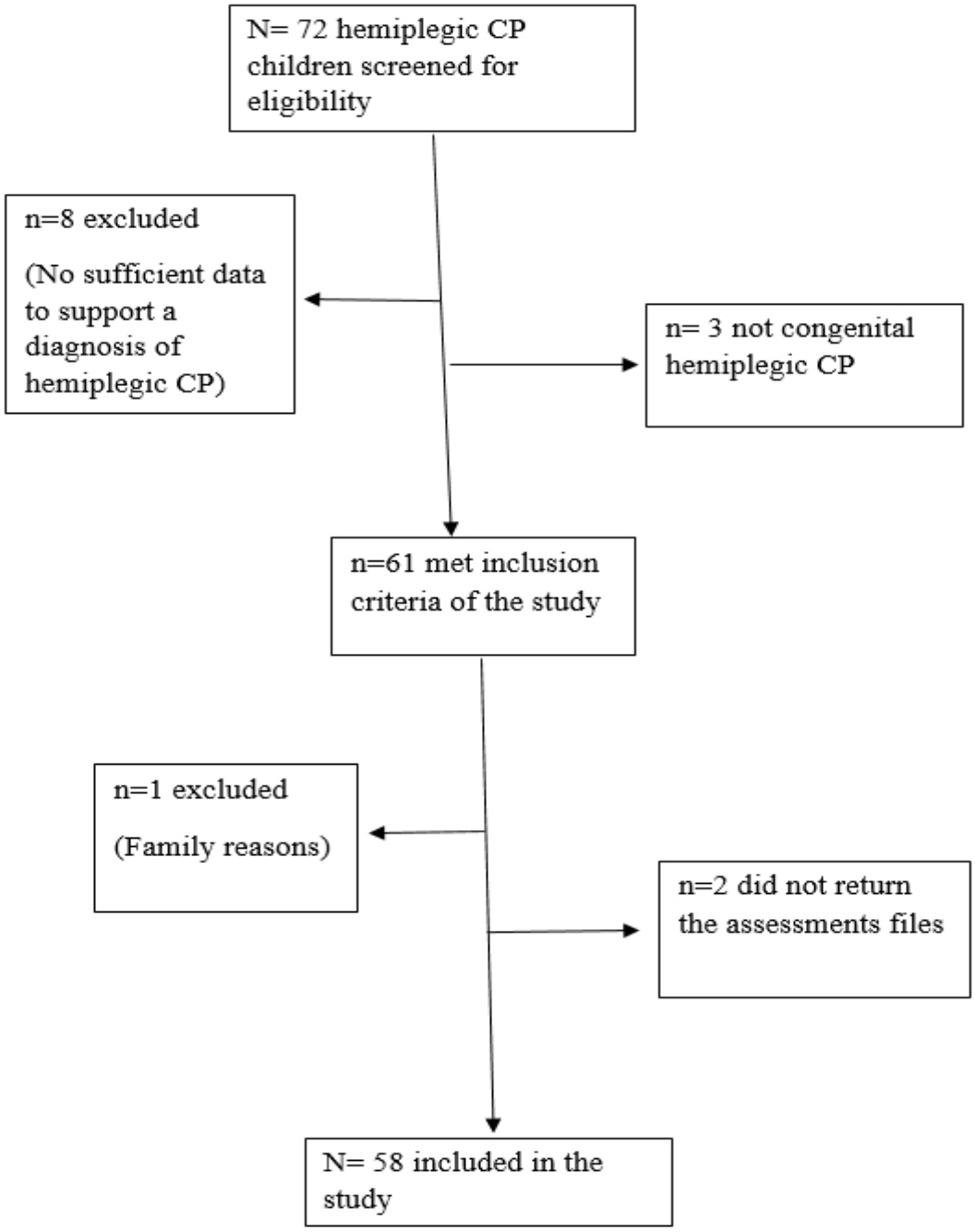

Figure 1: Recruitment process to the study

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Classification Instruments

In addition to the children's demographic information such as age and gender, data that were collected through the classification systems, including CFCS and Gschwind and Tonkin classification system for the pronated forearm were recorded. Functional motor and communication skills, and severity of forearm deformity were carried out in one session for each child and by an expert Physiotherapist, who has 10 years of experience in pediatric rehabilitation. Each child was evaluated respectively within a period of approximately 60 minutes. Determination of functional levels and severity of pronation deformity for each child regarding to classification tools were made based on the observations of the physical therapist in clinic setting and parent perceptions regarding their children's actual performance in home environment.

Communication Function Classification System (CFCS) was used to determine the communication skills level of children. CFCS classifies daily communication performance of individuals with CP between I-V levels. The effectiveness, fluency, and speed of communication are decreasing from Level I to Level V and the individual's communication becomes less effective even with familiar partners as the levels go up. "At Level I, the individual can communicate effectively with familiar and unfamiliar partners, at Level V, the individual's communication is seldom effective even with familiar partners". Information obtained from family, caregiver and / or health professional is used to determine the communication skills level of the individual with CP (Hidecker et al., 2011). The test–retest reliability of CFCS has been demonstrated to good with an ICC of 0.82 (Hidecker et al., 2011). Since the children included in our study spoke Turkish, we used the Turkish version of this classification system in the study (Mutlu et al., 2018).

The Gschwind and Tonkin classification system was used to evaluate the forearm supination of children with hemiparetic CP. This classification system, which evaluates forearm supination function at four different levels in children with CP, is also known as the forearm pronation deformity classification system (Gschwind & Tonkin, 1992). Supination functions of children were classified as "Level I: active supination enough to pass neutral position, Level II: active supination to neutral position or less than neutral position, Level III: no active supination, passive supination, Level IV: no active and passive supination". This scale was carried out to the affected side extremity of the children.

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Child and Adolescent Scale of Participation (CASP) is a questionnaire that is applied to families to investigate to what extent children participate in home, school, and community activities (Bedell, 2004). The CASP consists of four sub-sections (Home participation: 6 items, neighborhood and community participation: 4 items, school participation: 5 items, and home & community participation: 5 items) and consists of 20 items in total. Both the total and subsection summary score of the CASP is calculated based on the sum of all "applicable" assessment items divided by the maximum possible score of the applicable items. Then, the calculated score is multiplied by 100 to fit to a 100-point scale. Thus, the maximum possible score of the CASP ranges from 0 to 100 points. Validity and reliability processes have been implemented for the questionnaire in Turkish language. The questionnaire is administered on a 5-point scale: full participation, somewhat limited, very limited, unable, and not applicable (Atasavun Uysal et al., 2018). Test-retest reliability of the CASP has been introduced to be sufficient (ICC=0.94) for a wide range of disability population (Bedell, 2004). The CASP questionnaire is a parent/caregiver-report instrument that explore parents' perception of their children's participation in different life situations. Therefore, a series of debriefing sessions were conducted to enhance parents' familiarity with the questionnaire by asking the families' comprehension of the test items. Further, before the study entry, parents were asked to perform a few assessments to prevent scoring errors. Finally, the parents' competency about performing questionnaire items was evaluated by the assessor by asking them to score ten items.

Statistical Analysis

Statistical analyses were carried out with "IBM® SPSS © 24 software". Compliance of numerical variables to normal distribution was performed using visual (histogram and probability graphs) and analytical methods (Kolmogorov-Smirnov / Shapiro Wilk tests). Descriptive analyzes were given using mean and standard deviation for normally distributed variables. For nominal variables, number and % were given. One-way Analysis of Variance (ANOVA) was used to compare three groups with normal distribution, while Chi-square test was used to compare three categorically independent groups. Statistical significance level was accepted as $p < 0.05$.

Results

Demographic information of participating children with CP and descriptive characteristics of other variables were shown in Table 1.

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Table 1: Descriptive features of data on children with Hemiparetic CP included in the study

		(n=58)
		Mean ± SD
Age (year)		9.50 ± 3.13
		n (%)
Gender	Female	27 (46.6)
	Male	31 (53.4)
Affected Side (Non-dominant)	Right	28 (48.3)
	Left	30 (51.7)
Gschwind and Tonkin	Level 1	25 (43.1)
	Level 2	16 (27.6)
	Level 3	17 (29.3)
		Mean ± SD
CASP	Home participation	77.85 ± 14.37
	Neighborhood and community participation	73.40 ± 15.60
	School participation	71.12± 15.48
	Home and community participation	59.72 ± 15.98
		n (%)
CFCS	I	23 (39.7)
	II	26 (44.8)
	III	9 (15.5)

CP; Cerebral Palsy, CASP; Child and Adolescent Scale of Participation, CFCS; Communication Function Classification System, SD; Standard Deviation

When participation activities were compared according to the Gschwind and Tonkin classification system in children with hemiparetic CP, it was found that participation activities of children were statistically different ($p < 0.05$). While the participation activity scores of the children with CP according to the Gschwind and Tonkin in Level 1 had the highest average, it was found that the participation activities of a child in Level 3 were the lowest. According to this result, it was observed that with the decrease in forearm supination function in children with hemiparetic CP, the participation activities of children with CP were deteriorated (Table 2).

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Table 2: The effect of supination function on participation activities in children with hemiparetic CP

		Gschwind and Tonkin				
		Level 1[a] (n=25) Mean ± SD	**Level 2[b] (n=16) Mean ± SD**	**Level 3[c] (n=17) Mean ± SD**	**p**	**Post-Hoc**
CASP	Home participation	87.13 ± 11.65	78.63 ± 10.20	63.46 ± 8.92	0.000**	a>b>c
	Neighborhood and community participation	80.50 ± 14.69	73.02 ± 14.57	63.31 ± 12.52	0.001**	a>c
	School participation	80.40 ± 13.76	68.75 ± 13.10	59.71± 11.38	0.000**	a>b>c
	Home and community participation	67.80 ± 15.07	61.56 ± 11.65	46.10 ± 11.77	0.000**	a>c, b>c

One-way ANOVA, CP; Cerebral Palsy, CASP; Child and Adolescent Scale of Participation, SD; Standard Deviation, *; p<0.05, **; p<0,01

When communication skill levels were compared according to Gschwind and Tonkin classification system, a statistically significant difference was found in children with hemiparetic CP (p <0.05). As a result of the post-hoc analysis, it was found that the statistical difference was between Level 1 and Level 3. In other words, according to the forearm supination function, it was observed that a child with CP at Level 1 had a statistically higher communication skill level than a hemiplegic child at Level 3 (Table 3). Thus, it can be said that if the supination function level decreases in children with hemiparetic CP, the level of communication skills in these children may also decrease.

Table 3. The relationship between forearm supination function level and communication skills in children with hemiparetic CP

		Gschwind and Tonkin			**p**	**Post-Hoc**
		Level 1[a] n (%)	**Level 2[b] n (%)**	**Level 3[c] n (%)**		
CFCS	I	14 (56)	7 (43.8)	2 (11.8)	0.017*	a>c
	II	10 (40)	7 (43.8)	9 (52.9)		
	III	1 (4)	2 (12.5)	6 (35.3)		

Chi-square test, CP; Cerebral Palsy, CFCS; Communication Function Classification System, *; p<0.05

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Discussion

The effect of forearm supination function on participation activities and communication skills in children with hemiparetic CP was investigated in this study and it was observed that participation activities and communication skill levels of children with CP deteriorated as the forearm supination function decreased.

Forearm supination function has a significant place as it forms the basis of many activities of daily life (Gopura & Kiguchi, 2008). These functions are significantly affected by pronation contracture that frequently occurs in CP, and this effect might create limitations in the participation activities of children with CP (Čobeljić et al., 2015; Manske, 1990). Beckung et al. conducted a study with 176 children with CP and they reported that with the decrease in hand functions according to the bimanual fine motor classification scale, children experience deterioration in mobility, school participation, and social participation. Moreover, the authors also indicated that functional independence and participation activities were affected by the increase in the severity of the gross motor dysfunction (Beckung & Hagberg, 2002). The study that was conducted by Beckung et al. investigated participation in children with CP according to the bimanual hand function classification scale. However, because the current study investigated participation activities according to forearm supination function, it has a different over the study of Beckung et al. In addition, when considered in terms of the sub-parameters of the "*International Classification of Functioning, Disability and Health",* the fact that the study was carried out using only a scale (CAPS) measuring participation according to the forearm supination function makes our study stronger. Because there are studies investigating upper extremity activities in children with CP according to upper extremity deformities and hand function classifications (Öhrvall, Krumlinde-Sundholm, & Eliasson, 2013; Park, Sim, & Rha, 2011; Van Eck, Dallmeijer, van Lith, Voorman, & Becher, 2010). In a study that used the Gschwind and Tonkin classification scale, it was found that there is a negative relationship between forearm function and upper extremity functions in children with CP (Park et al., 2011). In the same vein, there are studies that investigated the effect of level of hand skills on upper extremity functions in children with CP and the findings of these studies showed that upper extremity functions deteriorate as the level of hand skills decreases (Öhrvall et al., 2013; Van Eck et al., 2010). In this study, in accordance with the aforementioned studies, it was observed that the participation activities of children with CP deteriorated as the forearm supination function decreased in children with hemiparetic CP. In this way, it is thought that it is important

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to consider treatment practices for forearm supination in rehabilitation programs that are planned to increase participation activities, in addition to looking at the forearm supination function of children with hemiparetic CP and inferring practical information about their participation activities.

Evaluating children with CP in terms of communication skills and determining the risk factors that affect communication are important for the necessary interventions to reduce social isolation and increase their participation in social life (Küçükakkaş, Bairamov, Yurdakul, & Buğra, 2019). It was emphasized that there are many factors regarding communication performance in CP (Kavlak & Tekin, 2019; Küçükakkaş et al., 2019; Vos et al., 2014). No previous study has investigated the relationship between the level of forearm supination function and communication skill level in CP, which is the basis of most of the daily life activities (Gopura & Kiguchi, 2008). While it is the strength of this study that the issue has not been investigated before and this situation makes the study unique, the fact that the study cannot be compared with the literature might be a disadvantage.

On the other hand, there are studies that examined general relationships between levels of hand skills and communication skills. Hidecker et al. conducted a study with 222 children with hemiplegic, diplegic and quadriplegic CP and they found a moderate positive correlation between MACS levels and CFCS levels (Hidecker et al., 2012). Similar results were found in the studies of Mutlu et al., which was conducted with 102 children with CP (Mutlu et al., 2018) and Compagnone et al., which was conducted with 87 children with CP (Compagnone et al., 2014). In accordance with the literature, it was investigated in this study that there is a relationship between forearm supination function level and communication skill level in children with hemiparetic CP. In other words, according to forearm supination function, it was observed that a child with CP at Level 1 had a statistically higher communication skill level than a child with hemiplegic level 3. It can be said that with the deteriorating of the forearm supination function level in children with hemiparetic CP, the communication skill levels of children with CP have also worsen. According to this result, communication skill levels of children with hemiparetic CP who have different levels of forearm supination function are investigated and it was also revealed that forearm supination function is a factor that affects the communication skill level of children. One of the reasons that makes our study stronger is that unlike the MACS general relationship studies mentioned above, specific forearm supination reveals the cause and effect relationship between forearm supination and CFCS. From a general

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perspective, the decrease in forearm supination is related to the decrease in upper extremity function. A less functional upper extremity may mean that the damage is more severe in CP. Because of this, their communication skills may also be worse. In other words, optimum hand functions are necessary for independent daily living activities, communication and learning social skills. Therefore, physiotherapy practices, occupational therapy and orthosis use to improve forearm supination functions are extremely important in order to improve social participation and communication skills of children with hemiparetic CP who have impaired forearm supination functions.

Our study has some limitations. Firstly, this study was conducted only in the eastern part of the country due to limited means and all children who are enrolled in the rehabilitation center could not be reached because of the covid-19 outbreak. Secondly, in order to reduce the contact in the covid-19 outbreak process, the evaluation of outcome measures in the study by a one physiotherapist can be shown as a limitation. Thirdly; studies involving children at all levels according to forearm supination function, evaluating the communication levels of hemiparetic children in detail, and having larger sample sizes are needed.

In conclusion, it was found that as the forearm supination function decreased in children with hemiparetic CP, participation activities and communication skill levels of children with CP also deteriorated. It can be suggested that while Physiotherapists / Occupational Therapists plan rehabilitation programs to increase participation activities and levels of communication skills of children with hemiparetic CP, they can consider children's supination function levels and treatment practices that increase this function.

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Declaration of interest statement

The authors have no potential conflicts of interest to disclose.

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