

Intelligence, Functioning, and Related Factors in Children with Cerebral Palsy

Serebral Palsili Çocuklarda Entelektüel Gelişim ve İlişkili Faktörler

Gözde TÜRKÖĞLU¹, Serhat TÜRKÖĞLU², Canan ÇELİK³, Halil UÇAN⁴

¹Clinic of Physical Medicine and Rehabilitation, Konya Training and Research Hospital, Konya, Turkey

²Department of Child and Adolescent Psychiatry, Selçuk University School of Medicine, Konya, Turkey

³Department of Physical Medicine and Rehabilitation, Giresun University School of Medicine, Giresun, Turkey

⁴Clinic of Physical Medicine and Rehabilitation, Ankara Physical Medicine and Rehabilitation Training and Research Hospital, Ankara, Turkey

ABSTRACT

Introduction: Cerebral palsy (CP) is the most common significant motor impairment in childhood. CP is defined as a primary disorder of posture and movement; however, intellectual impairment is prevalent in children with CP. The purpose of this study was to examine the intelligence level associated with gross motor function and hand function, type of CP, the presence of comorbid disorders such as epilepsy, and other factors.

Methods: In total, 107 children with CP were included. Age, gender, prenatal/natal/postnatal risk factors, type of CP, and presence of other neurodevelopmental disorders were recorded as demographic findings. Intellectual functions of the patients were determined by clinical assessment, adaptive function of daily life, and individualized, standardized intelligence testing. The gross motor function and hand function of the patients were classified using the "Gross Motor Function Classification System" and "Bimanual Fine Motor Function" measurements, respectively.

Results: The mean age of the patients was 8.10±3.43 years (2–16 years). The study included 63 (58.9%) male patients and 44 (41.1%)

female patients. During clinical typing, 80.4% of the patients were spastic, 11.2% were mixed, 4.7% were dyskinetic, and 3.7% were ataxic. Intellectual functioning tests found 26.2% of the children within the intellectual norm and that 10% of the children had a borderline intellectual disability, 16% of them had a mild intellectual disability, 17% of them had a moderate intellectual disability, and 30.8% of them had a severe intellectual disability. No significant relationship was determined between the CP type and intellectual functioning ($p>0.05$). Intellectual functioning was found to be significantly correlated with hand functions and motor levels ($p<0.001$). Factors related with intellectual functioning were neonatal convulsion, epilepsy, and speech disorders.

Conclusion: Intelligence assessment should be an essential part of CP evaluation and research. There is not enough reliable knowledge, unanimity regarding validity data, and population-specific norms in the intelligence assessments of children with CP. Research is required to assess properly intelligence for children with CP.

Keywords: Intelligence functioning, cerebral palsy, motor function, neurodevelopmental disorders

ÖZ

Amaç: Serebral Palsi (SP) çocukluk çağında en sık görülen ciddi motor bozukluktur. SP'li çocuklarda her ne kadar entelektüel bozukluk yaygın olsa da, SP primer olarak postür ve hareket bozukluğu olarak tanımlanır. Bu çalışmanın amacı, epilepsi gibi eşlik eden komorbid durumların varlığı, SP tipi ve kaba motor fonksiyon ve el fonksiyonu ile ilişkili entelektüel düzeyi incelemektir.

Yöntem: SP'li 107 çocuk çalışmaya alındı. Tüm hastaların yaş, cinsiyet, prenatal/natal/postnatal risk faktörleri, SP tipi, diğer nörogelişimsel bozuklukları kaydedildi. Çocukların entelektüel fonksiyon düzeyleri; klinik muayene, günlük yaşamda uyumsal işlevselliğin değerlendirilmesi ve bireye uygulanan, kabul gören bir zeka ölçümü ile doğrulamayla belirlendi. Çocukların kaba motor fonksiyon ve el fonksiyonları "Kaba Motor Fonksiyon Sınıflama Sistemi (KMFSS)" ve "Bimanuel İnce Motor Fonksiyon (BİMF)" ölçümü kullanılarak sınıflandırılmıştır.

Bulgular: Yaş ortalamaları 8,10±3,43 yıl (2-16 yaş) olan 107 olgu çalışmaya alındı. Olguların 63'ü (%58,9) erkek, 44'ü (%41,1) kızdı. Klinik

tiplendirmede, spastik tip %80,4, mikst tip %11,2, diskinetik tip %4,7 ve ataksik tip %3,7 olarak bulundu. Çocukların %26,2'si normal entelektüel gelişim düzeyine sahip iken, %10'unda sınıır, %16'sında hafif, %17'sinde orta ve %30,8'sinde ağır düzeyde entelektüel yetiyitimi saptandı. SP tipi ile entelektüel düzey arasında anlamlı ilişki bulunmadı ($p>0,05$). Entelektüel düzey, el fonksiyonları ve motor düzeyin ikisi ile de korele bulundu ($p<0,001$). Konvülsiyon, epilepsi ve konuşma bozukluğu varlığının, entelektüel kapasite ile ilişkili olduğu bulundu.

Sonuç: Entelektüel değerlendirme, SP ile ilişkili değerlendirmenin ve araştırmaların temel parçasıdır. SP'li çocuklarda entelektüel düzeyi değerlendirmek için güvenilir ve fikir birliği sağlanmış geçerli veriler ve toplumlara spesifik normlar yeterli değildir. SP'li çocuklarda entelektüel değerlendirmenin doğru yapılmasına yönelik araştırmalara gereksinim vardır.

Anahtar kelimeler: Entelektüel fonksiyon, serebral palsi, motor fonksiyon, nörogelişimsel bozukluklar



Yazışma Adresi / Correspondence Address: Gözde Türkoğlu, Konya Eğitim ve Araştırma Hastanesi, Fiziksel Tip ve Rehabilitasyon Kliniği, Konya, Türkiye
E-posta / E-mail: drgozdet@gmail.com

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INTRODUCTION

Cerebral palsy (CP) is a disorder that appears depending upon non-progressive damage and causes activity limitation in the ever-developing brain; it affects permanent motional, postural, and sensory functions, which might have a serious impact on an individual's quality of life (1,2). CP is observed in 0.2% of live births, and its prevalence has been increasing in recent years (3). It is accompanied by intellectual disabilities and many neurodevelopmental disorders (4,5). This is a situation that reflects brain damage instead of motor system damage (6). According to data from the "Surveillance of Cerebral Palsy in Europe Group," it has been indicated that disorders accompanying CP the most are speech-language disorders (71%), intellectual disability (ID) (62%), epilepsy (39%), and visual disability (22%) (7). While the intellectual level is a significant indicator for determining the functional performance and prognosis, it is also quite important for the selection of an appropriate treatment (8). Different from Diagnostic and Statistical Manual of Mental Disorders-4-Text revised (DSM-4-TR), in the diagnostic criteria of DSM-5, ID is evaluated according to adaptive qualities instead of intelligence points acquired from intelligence tests (9). Therefore, evaluating momentary and adaptive functions in conceptual, social, and practical domains are quite important for determining the level of ID. Even though there are findings proving that the level of motor function disorder is related to the level of ID, in reality, it is quite difficult to determine the intellectual level correctly because of accompanying neurodevelopmental disorders (10). That is why individuals with CP might give the impression of an ID, even if their cognitive level is normal. Therefore, the union of a generally accepted intelligence test and a clinical examination that includes measurements for evaluating daily functioning and adaptive qualities is quite important in terms of making a true diagnosis (11).

In our study, factors concerning the intelligence level of children with CP were evaluated, and the relationship between the upper/lower extremity motor function disorder level and the intellectual level was analyzed. To this end, the relationship between the type of CP, accompanying problems, and risk factors was examined.

METHODS

Patient group

Throughout 2009, 107 children diagnosed with CP who were between the ages of 2 to 16 years and who were monitored in Clinic of Physical Medicine and Rehabilitation were included. During the study period, the research method and purpose were explained to the families of the children monitored in our clinic and diagnosed with CP, and informed consent was received from the families who participated in this study. All children and adolescents who were accepted into the study in this manner were included in the research. The diagnosis of patients who were accepted into the study was made by a pediatric neurologist and physiatrist and was then verified by analyzing the detailed clinical examination findings and radiological images. Demographic attributes of the patients, etiological risk factors (prenatal, natal, and postnatal periods), and comorbid medical problems (epilepsy, visual disorders, hearing disorders, speech disorders, and psychiatric problems) were investigated and recorded. The type of CP was determined in accordance with the classification suggested by the "Surveillance of European Cerebral Palsy Group" by the same physiatrist for each patient (12). According to this classification, patients were divided into four main groups: spastic (unilateral or bilateral), dyskinetic (dystonic or choreoathetoid), ataxic, and mixed. The intellectual level of the patients was determined by a generally accepted intelligence test, and a clinical examination that included the evaluation of daily adaptive functions was conducted by a child psychiatrist. For measuring intelligence, the Wechsler Intelligence Scale for Children-Revised (WISC-R), Stanford-Binet Intelligence Test, and Ankara Developmental Screening Inventory were used. As a result of this evaluation, the patients were divided into five groups (normal, borderline, mild, moderate, and severe loss of intellectual ability). Gross motor functions of the children

were divided into five groups using the "Gross Motor Function Classification System" and their hand functions were divided into five groups using the "Bimanual Fine Motor Function (BFMF)" measurement. Approval from the ethics committee for this study was received from Ankara Physical Therapy and Rehabilitation Training and Research Hospital.

Tools

Gross Motor Function Classification System (GMFCS): A classification system developed for children with CP. Functional capacity was used to evaluate general motor functions. Children with CP were divided into five levels depending upon their gross motor functions, such as self-activated movements, sitting, and walking (13). GMFCS Level 1: Runs independently. There is a limitation in advanced gross motor skills. GMFCS Level 2: Runs without an auxiliary tool. There is a limitation in walking in daily life. GMFCS Level 3: Runs with an auxiliary tool. There is a limitation in walking in daily life. GMFCS Level 4: There is a limitation. The child is self-sustained but a wheel chair or other portable device is used in daily life. GMFCS Level 5: Even if auxiliary technologies are used, the child's mobility is seriously limited.

Bimanual Fine Motor Function (BFMF): A classification for the upper extremity motor functions (14). BFMF Stage I:—Dominant hand: Used without limitations. Other hand: Used without limitations or finer motor skills might be more difficult. BFMF Stage II: a) Dominant hand: Used without limitations. Other hand: It can only clutch or hold. b) Both hands: Movements might be forced in when engaging finer motor skills. BFMF Stage III: a) Dominant hand: Used without limitations. Other hand: has no function. b) Dominant hand: There are limitations in harder fine motor skills. Other hand: Restricted to clutching or worse. BFMF Stage IV: a) Both hands: They can only clutch. b) Dominant hand: Restricted to clutching. Other hand: Restricted to clutching or worse. BFMF Stage V: The child can only hold using both hands or worse.

Ankara Developmental Screening Inventory: Developed as an evaluation tool that is applied by a friend through interviewing the parents. A child's development in the first 6 years of his/her life is evaluated in 154 items and 5 categories (cognitive skills, fine motor skills, gross motor skills, social/self-care skills, and overall skills). For three age groups (0-12 months, 13-44 months, and 45-72 months), the test and retest test reliability was calculated to be 88-99%, and its internal consistency was calculated to be 80-99% (15).

Stanford-Binet Intelligence Test: Developed by Terman and Merrill and adapted to Turkish by Uğurel-Şemin (16). It is an oral and performance test applied individually. Fifteen different sub-tests of Stanford-Binet were organized in the manner that would measure four types of intelligence regarded as the indicators of intelligence. These are verbal judgment, abstract/visual judgment, quantitative judgment, and short-term memory. These tests can be applied on children between 2 and 16 years of age.

Wechsler Intelligence Scale for Children-Revised: Developed by Wechsler in 1949 in order to determine the general intelligence levels. The scale was readjusted in 1974 and named as WISC-R (17). Its Turkish standardization was made by Savaşır and Şahin (18). The WISC-R that was applied on the children between 6 and 16 years of age, individually, contained two sections (verbal and performance) that consisted of 12 sub-tests measuring various intelligence functions.

Statistical Analysis

Evaluations were carried out by using the SPSS package program, version 15.0 (SPSS, Chicago, IL, USA). The relationship between risk factors, accompanying problems, and intellectual level was analyzed by the chi squared test; and the relationship between BFMF, GMFCS, and cognitive level, was

analyzed by Spearman's correlation test. Logistic regression analysis was carried out for features whose p-value was less than 0.05 in univariate analysis. Statistical significance was accepted when the p-value was less than 0.05.

RESULTS

In total, 107 patients with CP, 44 girls (41.1%) and 63 boys (58.9%) whose average age was 8.10 ± 3.43 years, were accepted into our study. Examination of the clinical CP types revealed that 86 (80.4%) of these children belonged to the spastic type, 70 (65.4%) of these children constituted the spastic bilateral type, and 16 (15%) of these children constituted the spastic unilateral type. Among other clinical types, 5 (4.7%) children were dyskinetic type, 4 (3.7%) children were ataxic type, and 12 (11.2%) children were mixed type.

When we evaluated the entire group with CP in terms of intellectual level, we can see that 28 (26.2%) children had a normal ID level. It was found out that 11 (10%) children had borderline, 17 (16%) had mild, 18 (17%) had moderate, and 33 (30.8%) had severe ID.

No significant relationship was found between the involvement type and the ID. This means that the intelligence level was not affected by the disease types significantly ($\chi^2=22.578$, $p>0.05$). Intellectual functional levels, according to the involvement type, are indicated in Table 1.

When the distribution of intellectual levels was examined in reference to BFMF stages, it was found out that at stage I and II, the intellectual level was normal; at stage III, ID was mild; and at stages IV and V, ID was severe (Table 2). While the BFMF stage of 85.7% of the children who had a normal intellectual level, was I or II, the BFMF stage of 81.8% of the children who had severe ID was IV or V. A significant correlation was found between the intellectual level and BFMF stages ($r=0.642$, $p<0.001$). As BFMF stage increases, the intensity of ID also increases.

When the distribution of intellectual levels of children/adolescents with CP was analyzed in reference to GMFCS stages, it was found out that the GMFCS level of 75.8% of the children who had severe ID was level V; and that this ratio was only 3.6% for the children who had normal intellectual levels. In addition, the GMFCS level of 85.7% of the children who had normal intellectual levels, and GMFCS levels of 72.7% of the patients

who had borderline mental functionality were I, II or III (Table 3). A significant correlation was found between GMFCS level and intelligence level ($r=0.617$, $p<0.001$). As the GMFCS level increased, the intensity of the loss of intellectual abilities also increased.

In terms of comorbid problems, epilepsy was detected in 31 (29%) patients, visual disability in 41 (38.3%) patients, hearing disorders in 6 (5.6%), and speech disorders were detected in 62 (58%) patients (Figure 1). A significant relationship was observed between epilepsy and intellectual level ($\chi^2=29.221$, $p<0.001$). When the presence of epilepsy was compared with intellectual levels, it was found that 67.7% of the children with epilepsy had severe ID, and that 63.6% of the children who had severe ID were also epileptic. It was also observed that 42% of the patients had normal speech, that 31.8% of these had dysarthric speech, and that there was no speech at all in 26.2% of the children. A significant relationship was found between speech disorder and intellectual level ($\chi^2=23.29$, $p<0.001$). In the logistic regression sample, acquired from the features whose p value was less 0.05 in univariate analysis, speech disorder was determined as the independent risk factor for children with CP (odds ratio: 2.85–2.93). No relationship was found between the intelligence level and the presence of visual disabilities and hearing disorders.

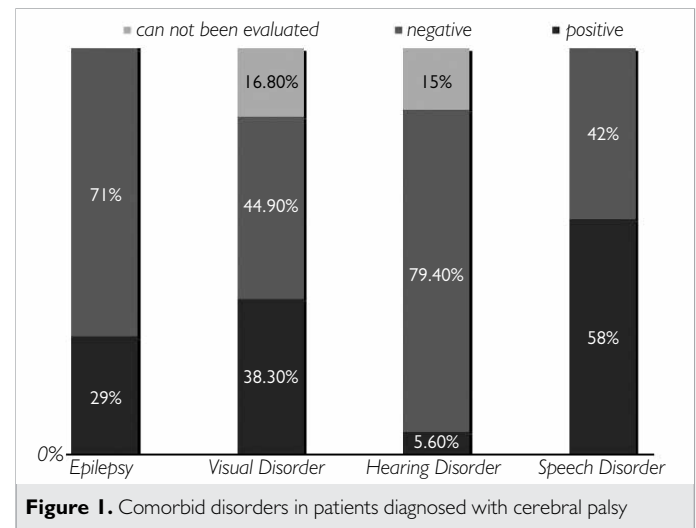


Figure 1. Comorbid disorders in patients diagnosed with cerebral palsy

Table 1. Intellectual level of patients diagnosed with cerebral palsy

CP type	Normal	Borderline	Mild	Moderate	Severe	Total (n)
Spastic bilateral (n=70)	21 (30%)	5 (7.1%)	11 (15.7%)	8 (11.4%)	25 (35.7%)	70 (100%)
Spastic unilateral (n=16)	5 (31.2%)	3 (18.7%)	2 (12.5%)	5 (31.2%)	1 (6.2%)	16 (100%)
Dyskinetic type (n=5)	-	1 (20%)	1 (20%)	-	3 (60%)	5 (100%)
Ataxic (n=4)	1 (25%)	1 (25%)	1 (25%)	1 (25%)	-	4 (100%)
Mixed (n=12)	1 (8.3%)	1 (8.31%)	2 (16.6%)	4 (33.3%)	4 (33.3%)	12 (100%)

CP: cerebral palsy

Table 2. The distribution of intellectual level of patients diagnosed with cerebral palsy according to BFMF stages

BFMF stage	Normal	Borderline	Mild	Moderate	Severe	Total (n)
Stage I	10 (52.6%)	2 (10.5%)	2 (10.5%)	5 (26.3%)	-	19 (100%)
Stage II	14 (36.8%)	6 (15.7%)	9 (23.6%)	6 (15.7%)	3 (7.8%)	38 (100%)
Stage III	3 (20%)	2 (13.3%)	4 (26.7%)	3 (20%)	3 (20%)	15 (100%)
Stage IV	1 (5.8%)	1 (5.8%)	-	4 (23.5%)	11 (64.7%)	17 (100%)
Stage V	-	-	2 (11.1%)	-	16 (88.9%)	18 (100%)

BFMF: bimanual fine motor function

When etiological risk factors were listed according to the order of frequency, hypoxia (54.2%) was determined as the most frequent risk factor. This was followed by prematurity (44.8%), neonatal convulsion (36.4%), hyperbilirubinemia (33.7%), low birth weight (31.7%), and prolonged labor (29.9%). While no relationship was found between the intelligence level and prenatal-perinatal features, a relationship was found with neonatal convulsions among postnatal features ($\chi^2=12.97$, $p=0.002$).

DISCUSSION

As intellectual development is related to many areas, such as communication, self-care, home experiences, social adaptation, health and safety, self-leadership, functional activities, leisure activities, and work spaces; correctly determining intellectual development it is quite significant for setting targets in a treatment (19).

It was observed that the distribution of CP types in our study, were similar to the general distribution in the literature, so it is considered that the data acquired might reflect the general population. In their study, Sigurdardottir et al. (20) described CP types as 82% spastic, 11% dyskinetic, 4.7% ataxic, and 2.3% unclassified. For a substantial portion of children/adolescents with CP, intellectual skills were lower than the general population (20). In our study, when we evaluated all the patients with CP in terms of their intelligence level, we can see that 36.2% of these had normal/borderline intellectual development levels, 33% had a mild/moderate level of ID, and 30.8% had severe ID. Sigurdardottir et al. (20) found that 42% of the children with CP also had a normal mental capacity, and 21% had a severe ID; and they observed that the majority of children with CP who had a severe ID were diagnosed with spastic bilateral and dyskinetic types of CP. In the same study, it was also observed that hemiplegic children had the best cognitive skill points. In another study, it was indicated that the patients who had been diagnosed as dyskinetic type were in a much better condition intellectually, and that quadriplegics were much more affected when compared to diplegics and hemiplegics (20). In our study, no significant relationship could be found between CP type and intellectual level. In fact, that there were differences between the studies should not be surprising. When we looked at the reasons, the most important difference was the lack of reliable information and consensus on which community-oriented specific norms and valid information were taken into consideration for the intellectual evaluation of children with CP. For instance, different evaluation materials and tests were required for the children who had visual and communication problems and who had a high level of motor involvement (19). Another piece of data that supports this assertion, 15–20% of the children with CP could not be evaluated with the classically conducted tests from previous studies such as the WISC-R (20). The significant correlations found between the intellectual level and GMFCS and BFMF levels, also found in our study, were also indicated in other studies found in the literature (21). In our study, we observed that 81.8% of the children who had severe ID were at BFMF stage IV-V and that 97% were at GMFCS level IV-V. This finding proves that there is a relationship between motor function disorder and intelligence level, particularly at stage IV-V, and severe ID. In their study, Gabis et al. (21) found out that 72.4% of patients with CP at GMFCS level IV-V had ID; this ratio was 0% for patients at level I and 40.9% for patients at level II-III. In their study, Himmelmann et al. (22) evaluated 411 children with CP and found that as GMFCS and BFMF levels increased, the frequency of problems such as comorbid learning disability, visual disorders, and hearing disorders also increased. From this aspect, we can see how important the motor function disorder stage is.

Among the findings of our study, severe ID was present in 67.7% of the children with epilepsy and epilepsy was present in 63.6% of the children severe ID. This can be considered as an important data on common etiology. Epilepsy, which is a comorbid neurodevelopmental disorder, is also important for the presence of ID. It has been indicated that ep-

ilepsy had accompanied ID at a rate of 25 to 45% (29% in our study) (23). Attention, memory, and language problems that epileptic children experience are commonly reported (24). In a study conducted on 50 patients with CP, Selassie et al. (25) found out that epilepsy caused a significant decrease in the total score gained from intelligence tests. In their study, Sigurdardottir et al. (20) indicated that epilepsy had an impact on intelligence quotient (IQ) as an independent factor. Similar to the findings found in our study, a negative correlation was indicated between the intellectual level and epilepsy. In their study, Gabis et al. (21) found that 33% of patients who were diagnosed with epilepsy had severe ID. It was also found that 15% of patients who had a normal intellectual level had epilepsy. In our study, patients who had been evaluated in terms of strabismus, visual acuity, nystagmus, refractive disorders, and retinopathy were diagnosed with visual disorder at a rate of 38.30%. Visual disorders were not found to have a significant relationship with intellectual skills. There are data indicating that for children diagnosed with CP, brain damage and impaired motor development might adversely affect ophthalmic development (26). Visual disorders are directly related to the severity of lesions in the brain. Therefore, overcoming visual problems will develop daily living skills, and it will enable patients to benefit more from rehabilitation programs (27). It was found that the degree of visual disorders was much more in the group with patients diagnosed with higher motor function disorder stages. It can be said that this also applies for hearing and speech disorders (28). It was indicated that like other disorders included in neurodevelopmental disorders, the frequency of speech-language disorders increased in children who had been diagnosed with CP. In their study, Yalçinkaya et al. (29) indicated the frequency of speech-language disorders in children diagnosed with CP was 32% in the age group between 2 and 18 years; Russman and Ashwal (30) found this frequency to be 38%. In our study, the relationship between the intellectual level and speech-language disorders in children with CP was related to the fact that common etiological factors affect these two neurodevelopmental disorders (31,32).

When the relationship between the intellectual level and etiological risk factors was taken into consideration, we can see that the issues of birth weight and gestational age were generally focused on in previous studies. When preterm infants (gestational age < 37 weeks) were compared with full-term infants, they had an increased risk of cognitive and motor disorders (33). In a study in which 107 children whose average birth weight was 930 g and average gestational age was 27 weeks, 11.2% of them were diagnosed with CP. Moreover, the possibility of other neurodevelopmental disorders such as hearing and visual disorders, convulsion, and ID increased (34). In another study in which factors affecting the intellectual levels of children/adolescents with CP were examined, similar to our research data, gestational age and birth weight had no additional effect on these scores (20). In our study, it was observed that among etiological risk factors, only neonatal convulsion had a relationship with intellectual levels. The degree of ID in patients with a neonatal convulsion history was determined to be significantly higher than that in patients who did not have a neonatal convulsion history. No other study on this risk factor was encountered. In their study, Lodha et al. (34) found that in the regression model acquired, a score obtained from a newborn's gestational age, birth weight, and sex characteristics was significantly correlated with neurodevelopmental disorders (decrease in cognitive level, hearing and visual losses, intellectual ability loss, and speech-language disorders) in the long term. In the regression analysis in our study, only speech disorder was determined to be an independent risk factor for the intellectual capacity of children with CP.

The most significant limitation of our study was our small sample size. For the purpose of generalizing the data, it is important that more dyskinetic, ataxic, and spastic unilateral patients with CP be included in a study.

In conclusion, intellectual disabilities are more common for children/adolescents who are diagnosed with CP. Therefore, the evaluation of the

intellectual level must be one of the fundamental points for evaluating CP. Because the intellectual level is a significant indicator for determining functional performance and prognosis, it can also affect the treatment choice. To this end, the determination and intervention of relevant factors including prenatal/natal/postnatal periods affecting the intellectual level must be an inseparable part of treatment.

Ethics Committee Approval: Ethics committee approval was received for this study from the ethics committee of Ankara Physical Medicine and Rehabilitation Training and Research Hospital.

Informed Consent: Written informed consent was obtained from patients' parents who participated in this study.

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