



RESEARCH

Effects of hippotherapy on upper extremity functions in children with cerebral palsy

Serebral palsili çocuklarda hippoterapinin üst ekstremitte fonksiyonları üzerine etkisi

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Abstract

Purpose: The purpose of our study was to investigate the effects of hippotherapy on upper extremity functions in children with cerebral palsy (CP).

Materials and Methods: The study was carried out with a quasi-hippotherapy design by evaluating the hippotherapy and control groups with pretests and posttests. Sixteen children with CP who were treated with 30 minutes of additional hippotherapy three times a week for five weeks were included in the hippotherapy group. Eleven children with CP who had conventional physiotherapy were recruited for the control group. Upper extremity functions were evaluated before and after the intervention using the Box and Block Test (BBT) and the Jebsen Taylor Hand Function Test (JTHFT).

Results: There were no significant differences between the hippotherapy and control groups in terms of their baseline BBT and JTHFT scores. After 5-weeks, no statistically significant difference was found between the BBT scores of the hippotherapy and control groups. Significant increases were detected in all parameters of JTHFT in the posttest in the hippotherapy group, compared to the pretest. Moreover, in the posttest, a statistically significant difference was found between the hippotherapy and control groups in the parameters of turning over cards and picking up small objects, which subscales of JTHFT.

Conclusion: In children with CP, hippotherapy provided in addition to conventional treatment was an effective practice, especially in improving fine motor skills in the hands.

Keywords: Cerebral palsy, hippotherapy, upper extremity

Öz

Amaç: Bu çalışmanın amacı serebral palsili (SP) çocuklarda hippoterapinin üst ekstremitte fonksiyonları üzerine etkilerini araştırmaktır.

Gereç ve Yöntem: Araştırma, deney ve kontrol gruplarının ön test ve son test değerlendirilmesiyle yarı deneysel olarak gerçekleştirildi. Çalışmanın deney grubuna, beş hafta boyunca haftada üç kez 30 dakikalık ek hipoterapi uygulanan 16 SP'li çocuk dahil edildi. Kontrol grubuna geleneksel fizyoterapi uygulanan 11 SP'li çocuk alındı. Üst ekstremitte fonksiyonları girişim öncesi ve sonrasında Kutu Blok Testi (KBT) ve Jebsen Taylor El Fonksiyon Testi (JTEFT) kullanılarak değerlendirildi.

Bulgular: Hippoterapi ve kontrol grupları arasında başlangıç KBT ve JTEFT puanları açısından anlamlı bir fark yoktu. Beş hafta sonrasında, hippoterapi ve kontrol gruplarının KBT puanları arasında istatistiksel olarak anlamlı bir fark bulunamadı. Hippoterapi grubunun, son testinde ön teste göre, JTHFT'nin tüm parametrelerinde anlamlı artışlar tespit edildi. Bununla birlikte, son testte hippoterapi ve kontrol grupları arasında JTEFT'nin alt boyutu olan kartları ters çevirme ve küçük nesnelere alma parametrelerinde istatistiksel olarak anlamlı farklılık bulundu.

Sonuç: Çalışmada SP'li çocuklarda, konvansiyonel tedaviye ek olarak uygulanan hippoterapinin özellikle ince motor el becerilerini geliştirmede etkili bir uygulama olduğu belirlenmiştir.

Anahtar kelimeler: Serebral palsy, hippoterapi, üst ekstremitte

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INTRODUCTION

Hippotherapy is a treatment that is provided by rehabilitation professionals accompanied by a horse trainer^{1,2}. The purpose of hippotherapy is to improve the balance, posture, function, and mobility of the individual³. In this practice, which is implemented in a very natural setting, the child with cerebral palsy (CP), who constantly interacts with a living being, usually displays positive motivation and participation in the treatment⁴. The horse at a walk serves as the therapeutic medium by transmitting movement. With the patient in a sitting position, posture reflexes are practiced with the help of the horse's walk-specific forward movement, and delicate coordination responses elicit balance reactions^{5,6}. Proprioceptive sensorimotor stimulation leads to improved posture and facilitates the finding and strengthening of the best possible movement patterns of the body, as measured against its hypothetical norm. At the same time, this movement correction trains the musculature by dispelling its imbalance and regulating muscle tone. It also maximizes the possible or remaining range of motion of the joints^{2,7}. When mounted for 30–45 min, a rider experiences 3000–5000 repetitions of a trunk challenge and recovery exercise⁶.

Hippotherapy is an individualized treatment that utilizes an interdisciplinary team approach³. In hippotherapy, the occupational therapist or physiotherapist uses the movements of the horse as a medium or method of treatment and focuses on the development of gross motor functions and balance reactions that are associated with gait, balance, posture, and mobility by considering the functional limitations of the child^{4,8}.

Today, hippotherapy has become a popular method of maximizing functional performance and preserving muscle tone in children with CP^{2,5,9}. Previous studies have reported that hippotherapy has positive effects on balance and postural control in children with CP^{1,3,9-14}. Nonetheless, studies on the effectiveness of hippotherapy in improving the upper extremities of children with CP are quite limited¹⁵. However, in children with CP, the upper extremities are affected more severely compared to the lower extremities¹⁶. In addition to increased muscle tone and reduced range of motion, children with CP

experience dysfunctions in the areas of grip strength, force coordination, speed, and hand skills⁷. This study was conducted to investigate the effects of hippotherapy on upper extremity functions in children with CP. It is expected that this study will shed light on whether hippotherapy could be beneficial in the improvement of upper extremity involvement which leads to significant deficiencies and limitations in children with CP. In this context, the hypothesis of the study is stated below.

H1: Hippotherapy applied in addition to physiotherapy provides improvements in the upper extremity motor functions of children with CP.

MATERIALS AND METHODS

Study design and participants

This study was conducted with a quasi-hippotherapy design in which the hippotherapy and control groups were assessed with pretests and posttests. It was carried out between 01 April and 29 August 2019 in the rehabilitation unit of a university hospital located in western Türkiye. The hippotherapy application was carried out in the open and closed manege area within Kocaeli University Kartepe Equine Vocational School. One of the researchers worked at this institution.

Children with CP who met the inclusion and exclusion criteria constituted the sample of the study. The inclusion criteria were as follows: 1) age 5 to 15 years, 2) having participated in a physical therapy program for at least 5 years in the clinic, and 3) being on a gross motor function classification system (GMFCS) level I to III. The exclusion criteria were as follows: 1) no head control, 2) having a static deformity in the extremities, 3) moderate to severe intellectual disability, and 4) having an allergy to horsehair.

A physiotherapist blind to the study screened 41 children based on the inclusion criteria. Among these 41 children, eight children did not meet all the eligibility criteria. We informed the legal guardians of the recruited children about the study and asked if they wanted their children to receive hippotherapy and could feasibly join riding sessions. The parents of 32 children agreed for them to participate (Figure 1).

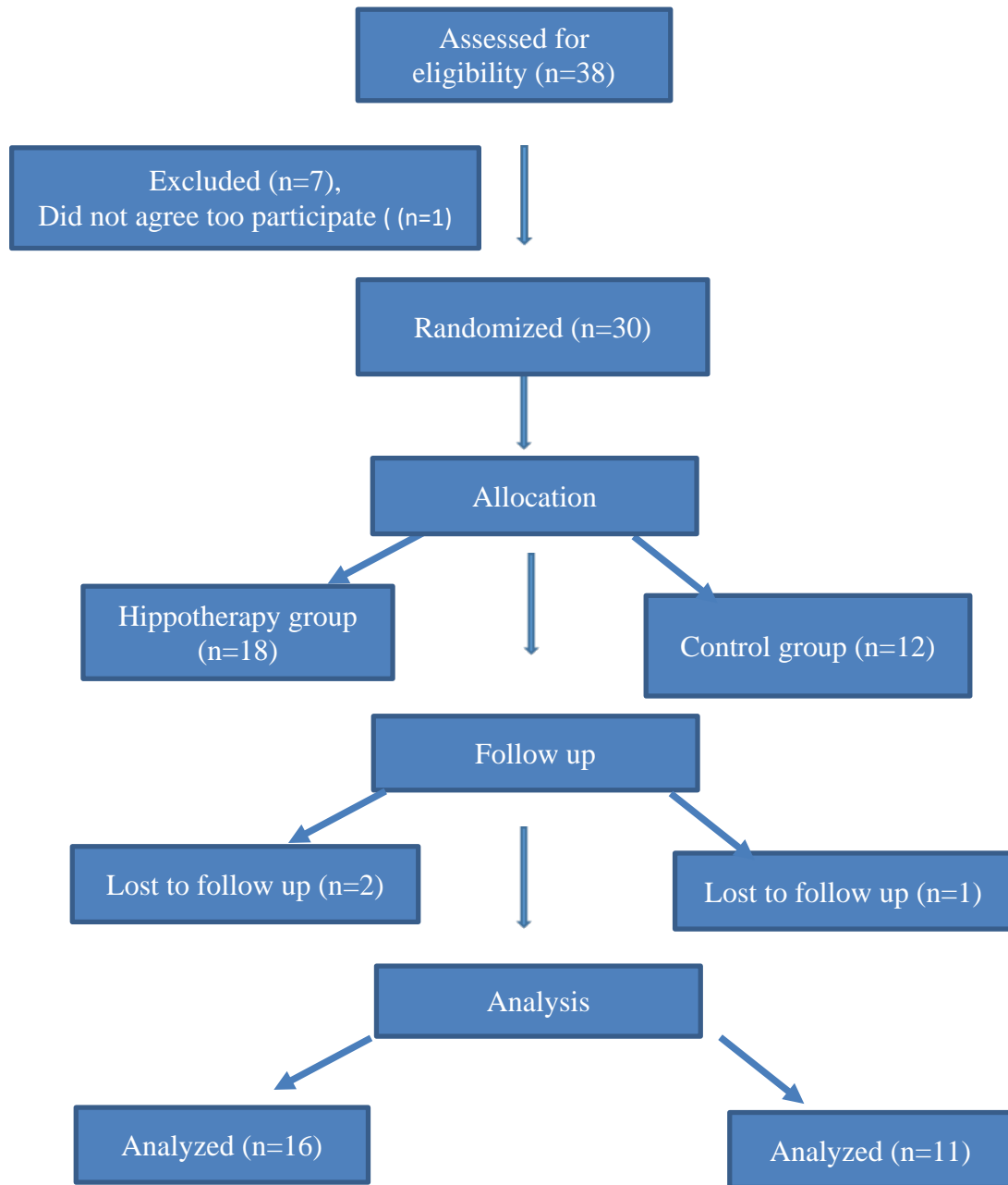


Figure 1. Flowchart of the study

The 32 children were randomly allocated by drawing lots, using a table of random numbers for the hippotherapy and control groups. During the study, five children dropped out because of familial problems. Thus, data from a total of 16 children (10

boys, 6 girls) were used to investigate the effects of hippotherapy. As controls, we recruited 11 children (7 boys, 4 girls) with CP who were undergoing conventional physiotherapy programs. The conventional therapy consisted of range of motion,

stretching and strengthening exercises, proprioception, weight-bearing, balance, and coordination training. The children in both the hippotherapy and control groups had been attending 60-minute sessions of outpatient conventional therapy on weekdays.

Instruments

The Box and Block Test (BBT)

It is a quick, inexpensive, and simple test which measures unilateral gross manual dexterity. It can be used in a wide range of populations, including CP patients, patients with stroke, multiple sclerosis patients, medulla spinalis injuries, and neuromuscular disorders. The test was developed by Mathiowetz et al.¹⁷. BBT uses a wooden box that has two compartments and 150 blocks. The application of BBT consists of asking the person to move the maximum number of blocks from one compartment of the box to the other, equally sized compartment, one by one, within 60 seconds. The box must be oriented lengthwise and placed at the person's midline, with the compartment holding the blocks oriented towards the hand being tested. The test should begin with the unaffected upper extremity to practice and register baseline scores. Additionally, a 15-second trial period is permitted at the beginning of the tests of each side¹⁸.

The Jebsen Taylor Hand Function Test (JTHFT)

It was developed by Jebsen et al. to evaluate the effectiveness and disability outcomes of a treatment applied after hand injury¹⁹. It is an objective and standardized measure of fine and gross motor hand functions using simulated activities of daily living. JTHFT has seven subsets which are writing, simulated page-turning, lifting small objects, simulated feeding, stacking, and lifting large, lightweight, and heavy objects. JTHFT was preferred in this study because it involves basic skills in activities of daily living, allows the comparison of both upper extremities, and is an objective measurement tool. On the other hand, in this study, writing skills were not measured as not all children in the sample knew how to read and write. During the implementation of JTHFT, the child and the physiotherapist sat across from each other at a table, and the child was asked to perform the instructions in the shortest time possible. The physiotherapist kept time using a stopwatch, each stage of the test

was repeated three times, and the average of the three measurements was taken as the result of each stage²⁰.

Hippotherapy intervention

The children in the hippotherapy group participated in 30-min hippotherapy sessions three times a week for five consecutive weeks. The implementation period was determined by considering similar studies in the literature. The sessions were conducted by a qualified hippotherapy team based on each child's abilities and needs, and they took place in an indoor arena (30 meters in diameter) and an open-air track. Five people were involved in the hippotherapy session: the patient, the physiotherapist, two side walkers, and the horse trainer (holding the reins to guide the horse). The task of the side walkers was to ensure the safety of the child while the physiotherapist was coordinating the activities. The hippotherapy sessions were divided into three categories: preparation (activities before riding, safety precautions, and riding procedure), sitting in the saddle and balance, and upper extremity exercises on horseback⁵.

Two Haflinger horses trained for hippotherapy by a horse trainer were used for the hippotherapy sessions. Before the children sat on the horse, they got closer to the horse and pet the horse. Each session started with the child wearing a helmet and a protective vest. The fit of the helmet was checked by both the physiotherapist and a staff member at the riding center. The child then sat on the horse with the help of a two-step ramp, and the stirrup was adjusted. In the following sessions, the assistance required to position the child on the horse was reduced.

Sitting in the saddle and balance

The horse trainer led the horse from the left, between the horse's shoulders and head, by a lead rope. Two side walkers walked on both sides of the horse to assist the child. There were different types of support depending on the amount of help the children needed. Two specific grips were used: full support (from the child's pelvis) and limited support (from the child's ankle). The horse walked through the arena in clockwise and counterclockwise circles for 10 minutes. Most children rode at a steady and slow walking pace.

Upper extremity exercises

The therapists established the treatment plan and goals for each child and were responsible for

choosing appropriate exercises. These exercises aimed to increase range of motion, muscle strength, and improve the coordination of the upper extremities. Additionally, by pulling the hands off the horse, the trunk muscles worked to maintain balance in the sitting position. The upper extremity exercises that were completed in the process were throwing a small ball back and forth, throwing a basket, attaching plastic rings to iron bars above shoulder level, delivering them to the walkers on the left and right, leaning forward and touching the horse's right ear with the left hand (same movement with the other side), raising the upper limbs straightened to the front, then moving them to the sides and rotating the trunk to the right and left, putting the hands on the back of the head, keeping the elbows wide apart, and maintaining this position for the whole lap²¹. An additional activity that was completed in the process was using the reins to help control the horse's direction and imitating similar movements necessary to guide the experiment. Wooden block exercises, painting games, and paper folding activities were applied on the horse's rump as other exercises.

The children adjusted well to hippotherapy, and no adverse effects or unanticipated events were observed.

Statistical analysis

The statistical analyses were carried out with the IBM SPSS 20.0 (IBM Corp., Armonk, NY, USA) package program. The G*Power version 3.1.9.2 (Kiel University, Kiel, Germany) package program was used to determine the power/sample size of the study. Conformity to normal distribution was evaluated with the Shapiro-Wilk Test.

The numeric variables are presented as mean \pm standard deviation, median (25th to 75th percentiles), and frequency (percentage) values. For the quantitative data, in the hippotherapy and control comparisons of the parameters showing non-normal distribution between the experimental and control groups, the Mann-Whitney U test was used. The differences between the pretest and posttest for BBT and JTHFT scores were evaluated with the Wilcoxon t-test for the continuous variables with normal distribution or paired-samples t-test for the

continuous variables with normal distribution. In the comparison of the qualitative data (sex, affected side, type of CP, and level of GMFCS category), Chi-squared and Fischer's Exact Chi-squared test were used. The Significance level for statistical evaluations was accepted as $p < 0.05$. The power of the study was calculated as 99% in the post hoc power analysis performed with the G*Power 3.1.9.4 program for $\alpha = 0.05$ using the percentage change values of the pretest and posttest measurements of the picking up small objects subscale scores in the hippotherapy and control groups.

RESULTS

Patient characteristics are summarized in Table 1. There was no significant difference between the groups in terms of their mean age, sex, affected side, type of CP, and GMFCS categories ($p > 0.05$).

No statistically significant difference was found between the hippotherapy and control groups before and after the treatment in terms of their BBT results ($p > 0.05$). From the pretest to the posttest measurements, the BBT scores of both groups were found to increase significantly ($p < 0.05$) (Table 2).

The pretest and posttest results of the JTHFT evaluations of the hippotherapy and control groups are given in Table 3. There was no statistically significant difference between the hippotherapy and control groups in their pretest measurements regarding any activity covered in JTHFT ($p > 0.05$). Statistically significant differences were found between the two groups in the JTHFT parameters of turning over cards and picking up small objects in the posttest ($p < 0.05$). In the intragroup comparisons of the hippotherapy group, statistically significant increases were found in all parameters of JTHFT in the posttest measurements compared to the pretest measurements ($p < 0.05$). In the intragroup comparisons of the control group, significant differences were found in the parameters of turning over cards, picking up small objects, stacking checkers, and lifting large light objects ($p < 0.05$).

Table 1. Characteristics of the patients

Characteristics	Hippotherapy group (n=16)	Control group (n=11)	p
Age, mean±SD	9.56±3.03	9.09±2.43	0.672
Sex, n (%)			
Female	6 (37.5)	4 (36.4)	1.000
Male	10 (62.5)	7 (63.6)	
Affected side, n (%)			
Left	6 (37.5)	4 (36.4)	1.000
Right	10 (62.5)	7 (63.6)	
Type of CP, n (%)			
Hemiplegia	13 (81.3)	9 (81.8)	1.000
Total	3 (18.8)	2 (18.2)	
Level of GMFCS category, n (%)			
1	2 (12.5)	2 (18.2)	0.568
2	5 (31.3)	5 (45.5)	
3	9 (56.2)	4 (36.3)	

CP: Cerebral palsy GMFCS: Gross Motor Function Classification System SD; standard deviation

Table 2. Box and Block Test scores

Box and Block Test	Pretest Median (25-75%)	Posttest Median (25-75%)	p
Hippotherapy group	38.06±6.93	44±7.66	< .001*
Control group	36.91±6.92	39±6.45	0.002*
p	0.674	0.088	

*p<0.01

Table 3. Jebsen Taylor Hand Function Test scores

The Jebsen Taylor Hand Function Test		Pretest Median (25-75%)	Posttest Median (25-75%)	p
Turning over cards	Hippotherapy group	47.63±27.35	30.5±17.99	<0.001**
	Control group	53.36±27.73	50.64±27.13	0.017*
	p	0.599	0.028	
Picking up small objects	Hippotherapy group	96(51.75-112.75)	70(40.5-78.75)	<0.001**
	Control group	96(84-260)	85(75-240)	0.005**
	p	0.645	0.030	
Simulated feeding	Hippotherapy group	95(61.75-187)	84.5(53-189.5)	0.003**
	Control group	99(59-200)	95(51-205)	0.234
	p	0.942	0.610	
Stacking checkers	Hippotherapy group	51.5(29.25-94)	30(16.25-69)	<0.001**
	Control group	63(33-99)	59(30-94)	0.028*
	p	0.865	0.162	
Moving large light cans	Hippotherapy group	63.25±34.43	52.38±30.79	0.001**
	Control group	59.55±28.42	56.36±28.95	0.040*
	p	0.771	0.738	
Moving large heavy cans	Hippotherapy group	102(39-193)	94(28-178.75)	0.001**
	Control group	108(38-141)	105(39-145)	0.205
	p	1.000	0.610	

*p<0.05; **p<0.01

DISCUSSION

In this study, the effects of hippotherapy on upper extremity functions in children with CP were investigated. In line with the findings obtained in the study, it was observed that hippotherapy contributed to the improvement in upper extremity functions in addition to routine physiotherapy.

While it was observed in this study that hippotherapy contributed to the improvement of gross hand motor skills, this improvement did not significantly differ compared to the improvement in the control group consisting of patients receiving only conventional therapy. Bae et al.¹⁵ did not find a change in the upper extremity functions of children with CP following a hippotherapy intervention implemented for 10 weeks. In a study that included children with multiple disabilities, it was determined that hippotherapy did not lead to a significant change in hand-eye coordination²². In contrast, Shurtleff et al.²³, found improvements in the usage of the hands for daily functional activities in children with CP following a hippotherapy intervention. The result of our study may have stemmed from factors such as the duration of the intervention and the clinical characteristics of the patients. Additionally, since gross motor skill development is included in conventional treatment, the mean BBT score may not have differed between the two groups.

Children with CP who have upper extremity involvement have difficulties in performing coordinated movements¹⁶. In this study, with the hippotherapy intervention that was provided in addition to conventional therapy, improvements were seen in hand functions including turning cards over, picking objects, simulated feeding, stacking checkers, moving large-light objects, and moving large-heavy objects. In comparison to the group of patients receiving only conventional therapy, it was observed that hippotherapy was more beneficial in the areas of turning cards over and picking up objects. Váczi et al.²⁴, also reported improvements in the grip strength and range of motion parameters of children who participated in a 12-week hippotherapy program. Other studies have also revealed the positive effects of hippotherapy on muscle strength and balance. For instance, McGibbon et al.²⁵ stated that a 12-week hippotherapy intervention significantly improved adductor muscle asymmetry in children with CP. Strashko et al.² found that compared to conventional physiotherapy,

hippotherapy provided greater sensorimotor and psychomotor effects, preserved muscle tone for longer (up to three months), and normalized it. In another study, improvements were reported in the control of head and trunk movements among children with CP after hippotherapy⁶. Similarly, it was determined that in children with CP, hippotherapy led to improvements in head position control, arm function, and trunk control and enhanced body posture and the functioning of individual body parts in a sitting position²⁶. We think that the finding obtained in this study was due to the fact that hippotherapy application requires more attention²⁷ and improves fine motor skills in the form of a fun game activity. However, in this study, hippotherapy appears to contribute to fine motor development related to manual skills. This beneficial effect of hippotherapy can provide ease in the performance of activities of daily living by children with CP.

In the literature in general, it is seen that hippotherapy provides certain benefits for children with CP in various areas of health. In a systematic review, it was emphasized that hippotherapy had beneficial effects at varying degrees in the areas of physical, psychological, cognitive, and social health in children with CP¹. In another systematic review study, hippotherapy was reported to improve gross motor function, independent sitting, walking speed, stride length, and postural head alignment in children with CP²⁸. A study that was performed in Türkiye showed that the hippotherapy group displayed more enhancement in terms of lying-rolling, crawling-standing on knees, standing up, and walking speed⁴. These studies have demonstrated that hippotherapy is a beneficial method in the maximization of performance in not only the upper extremities but also the entire body among children with CP.

This study had limitations in terms of location and time as it was carried out in a single center and within a certain period. Due to the small sample size, the results of the study cannot be generalized. Moreover, the researcher observed only the gross and fine hand motor skills of the patients in the context of the hippotherapy intervention, but the balance parameter was excluded from the assessment process. Besides, this study presented the short-term effects of hippotherapy in children with CP. Future studies should investigate the effects of hippotherapy on long-term functional changes.

In this study, it was determined that in children with CP, hippotherapy provided in addition to

conventional treatment was an effective practice, especially in improving fine motor skills in the hands. The results of this study were promising in terms of the performance of activities of daily living by children with CP. Accordingly, physiotherapists and other health professionals with appropriate qualifications can be recommended to apply hippotherapy in addition to conventional physiotherapy in the treatment of children with CP. It is also recommended for the clarification of the effects of hippotherapy on both fine and gross hand motor skills to conduct controlled clinical studies with the participation of much more patients and the implementation of longer treatment durations (8-12 weeks).

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