Effects of Johnstone pressure splints combined with neurodevelopmental therapy on spasticity and cutaneous sensory inputs in spastic cerebral palsy

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The purpose of this study was to investigate the effectiveness of Johnstone pressure splints (JPSs) on spasticity and cutaneous sensory inputs in children with spastic cerebral palsy (CP). Thirty-four children with spastic diplegic CP participated in this study. Children whose motor development levels were similar were divided into a treatment and a control group. Each group consisted of 17 participants (six females and 11 males). Mean age of the treatment group was 48.82 months (SEM 4.42), and the control group, 47.52 months (SEM 5.27). The treatment group underwent Bobath's neurodevelopmental therapy (NDT) combined with JPSs. The control group underwent NDT alone five days a week for three months. Before and after treatments, lower-extremity passive range of motion (ROM) by goniometric measurements, spasticity by Modified Ashworth Scale (MAS), and somatosensory evoked potentials (SEPs) were measured. Passive ROM showed significant improvements in both groups ($p<0.01$). In the treatment group, all MAS scores increased. In the control group, the difference was significant except for values of internal rotator muscles. Improvements in passive ROM in the treatment group were significantly higher than the control group except in hip abduction and external rotation ($p<0.05$). MAS scores of the treatment group were significantly higher than the control group ($p<0.05$). SEP values increased in both groups but values of the treatment group were significantly higher than the control group ($p<0.05$).

Cerebral palsy (CP) is a non-progressive permanent neurological disorder caused by damage to the immature brain. It affects motor and postural development and causes sensory disorders and learning disability. (Bobath and Bobath 1974, 1981; Nelson 1989).

CP has a prevalence rate of 1.5 to 2.5 per 1000 children in the USA (Albright 1996). Although there is no epidemiological research on CP in Turkey, a high prevalence rate is predicted because of the high incidence of factors such as consanguineous marriage, diseases in pregnancy and early childhood, and negative conditions at birth.

Physical therapy and rehabilitation in children with CP is aimed at the prevention of abnormal muscle tone and posture, treatment of muscle and joint deformities, and reduction of cognitive and sensory disorders (Bobath and Bobath 1967, Wilson 1991).

One approach to physiotherapy and rehabilitation is neurodevelopmental therapy (NDT) developed by Berta and Karl Bobath. NDT exercise programmes include facilitation of movement technique and automatic postural responses, and controlling the influence of abnormal movement patterns. The various handling, positioning, and movement techniques used in NDT have the advantage of using, wherever possible, the child's own automatic responses. Facilitation provides a very useful initial technique for use with the young infant, and parents soon learn the key points in handling and controlling movement, the most appropriate positions for daily activities, and the best movement patterns for assisting the development of their child. The techniques of facilitation can be used in association with other techniques in ongoing treatment programs (Bobath and Bobath 1981, Burns et al. 1996, Shepherd 1999).

CP is clinically classified as spastic, athetoid, ataxic, and hypotonic; the most prevalent form is spastic CP (Kuben and Leviton 1994). Inhibition of spasticity is necessary to increase extremity mobilization, prevent postural abnormalities, provide independence in daily living activities, and accelerate walking speed. Various methods including NDT, electric stimulation, inhibitory orthosis and splints, biofeedback, and cold applications are used for the inhibition of spasticity; approaches based on the stimulation of skin receptors have also been used (Cherry 1980, Kluzik et al. 1990, Girolomi and Champell 1994, Barry 1996).

Inflatable splints were designed and used primarily for emergency splinting of fractured limbs. Later they were used for rehabilitation of knee flexion contractures in patients with multiple sclerosis (Kerr 1966).

In 1967 Robson used splints to improve knee and elbow extension when supporting the body weight of children with spasticity, and to provide stability in those with athetoid CP (Robson 1967).

Margaret Johnstone developed transparent inflatable plastic pressure splints to support extremities in postures antagonistic to the spastic posture in the neurophysiological treatment approach. She first applied these splints in 1967 to adult patients with hemiplegia. Johnstone pressure splints (JPSs) are inflated at neutral heat with air from the lungs. They are used to stimulate proprioceptive and cutaneous receptors by application of deep pressure, to provide required support for extremity stabilization during exercise, to control combined motion patterns, and to inhibit pathological reflexes. It has been found that neutral heat and pressure application

reduce stimulation of thermal and tactile receptors which show a rapid adaptation to stimuli. This then decreases excitability of intermediate neurones and motor neurones. Electromyography (EMG) studies have shown that applying JPSs on adult patients with hemiplegia, 30 minutes before exercise, decreases spasticity and increases sensorial input. It is claimed that autogenic inhibition is ensured by the activation of golgi tendon organs. In combination with these splints, traction and approximation can be used to reveal the motor response and to stimulate postural reflexes, especially in adult patients with neurological problems. Johnstone stated that JPSs can be used to control spasticity, increase stability, facilitate motor development, and improve normal motion patterns in children with neurological problems (Johnstone 1983, Poole and Whitney 1990).

Although there are several research studies on the use of JPSs in adults with various neurological problems, to our knowledge, no study has investigated the use of JPSs combined with NDT principles in children with CP, and the effects on somatosensory evoked potentials (SEPs). According to Bobath, the primary goal of NDT in CP rehabilitation is to inhibit abnormal muscle tone and movement patterns. In addition JPSs are used to inhibit spasticity by supporting the extremities in positions antagonistic to the spastic posture, increase sensory cutaneous input, and restore motor function. Therefore, the purpose of this study was to investigate the effects of JPSs combined with NDT on spasticity and cutaneous sensory inputs in children with spastic diplegic CP.

Method

PARTICIPANTS

Thirty-four children with diplegic CP were selected from a population of individuals with spastic diplegic CP who had been followed up at Hacettepe University, Department of Paediatric Rehabilitation in Ankara, Turkey. The inclusion criteria were: (1) having moderate spastic diplegia, (2) being in the apedal to quadripedal, quadripedal, or quadripedal to bipedal periods of motor development levels, (3) not having severe learning disability,* (4) being able to cooperate, (5) not having a history of orthopaedic surgery and not using inhibitory splints or a polyethylene ankle/foot orthosis, and (6) parental consent.

Participants were divided into a treatment group and a control group so as to attain homogeneity with regard to motor developmental levels and ages. Each group comprised six females and 11 males. Mean ages of the treatment and control groups were 48.82 (SEM 5.27) months (range 36 to 82 months) and 47.52 (SEM 5.27) months (range 36 to 82 months), respectively. Motor developmental levels of the participants were evaluated according to Bobath (Bobath and Bobath 1981). The function of apedal, quadripedal, and bipedal participants are described in prone and supine positions, in sitting and crawling positions, standing and walking. In the treatment group, two children were in the range apedal to quadripedal, six were quadripedal, and nine were in the range quadripedal to bipedal. In the control group, two participants were apedal to quadripedal, seven were quadripedal, and eight were quadripedal to bipedal (see Table I). Characteristics of participants are presented in Table I. No statistically significant differences in physical and clinical characteristics of the groups were found before treatment ($p > 0.05$).

*UK usage. US usage: mental retardation.

MEASUREMENTS

Prenatal, natal, and postnatal history of each participant was recorded. Passive range of motion (ROM) of spastic lower extremities was measured using a 360° universal goniometer as an indicator of the static tonus and viscoelastic properties of spastic muscles (Watt 1986). The severity of spasticity of hip adductors, internal rotators, hamstrings, and plantarflexor muscles was evaluated using passive goniometric measurements of hip abduction, external rotation, hip flexion in knee extended position, and dorsiflexion movements (Moore 1978, Twist 1985). In addition, the spasticity of the plantarflexors, hamstring muscles, hip flexors, and hip internal rotators was evaluated manually using the Modified Ashworth Scale (MAS; Bohannon and Smith 1987, Wade 1992, Engsberg et al. 1996). All measurements were repeated three times by the same physiotherapist because children were found to be more cooperative with the therapist they were used to.

SEPs were measured by stimulation using a sensor device (Medilec ER 940 Sensor; Snergy, Surrey, UK) of the posterior tibial nerve while the child was in a calm supine position. SEP electrodes were placed on the C7 and vertex Cz section and a reference electrode was placed in the Fz section according to the International 10-20 system. Pulses were delivered every two seconds for 128 times, or in multiples of 128. In tibial SEP, stimulus was applied to the back of the lateral malleolus of the ankle where the posterior tibial nerve passes. The stimulator cathode was at proximal. Electrical stimulus was applied at an intensity that causes clinical spasms of the toe. Ground electrodes were placed on the forearm and leg. The tibial SEP value was recorded as p1 peak latency at the vertex (De Lisa et al. 1987). Three months after the pretreatments, all measurements were repeated and results compared.

TREATMENT

All participants in the study underwent NDT determined according to Bobath's motor development criteria. In each session exercises included patients sustained on forearms and hands, in sitting, crawling, semi-kneeling, and standing positions with support of the physiotherapist until tone reduction was achieved. Balance and corrective reactions were developed by using Bobath's ball and balance beam after the children had acquired the skill of maintaining the exercise positions. Ambulation training appropriate to the motor development level (crawling, creeping, walking in semi-kneeling position, and walking in parallel bars) was given.

The control group underwent only the exercises. In the treatment group, JPSs (Urias, Preston Abisse Healthcare Company, Jackson, MI, USA) were also applied as follows: the Johnstone long arm splint for the over hands position; the long arm splint and the long leg splint for a sitting position; the long arm and short leg splints for a crawling position; the long arm and short leg splints for kneeling and semi-kneeling positions; and the gaiter splint for a standing position. All were applied bilaterally for 20 minutes during the exercises. Duration of the treatment was five days a week for three months.

STATISTICAL ANALYSIS

Mean (SEM) was calculated for all values. The Mann–Whitney *U* test was used to compare the treatment and control groups. Wilcoxon signed rank test was used for comparison between

pre- and posttreatment in each group. Level of significance was set at $p<0.05$.

Results

After 3 months, the motor developmental level was reassessed. In the treatment group, six children were in the quadripedal group, nine were in quadripedal to bipedal, and two were in the bipedal group. In the control group, one child was in apedal to quadripedal, eight were in quadripedal, seven were in quadripedal to bipedal group, and one was in the bipedal developmental period (see Table I).

Lower-extremity goniometric measurement values were significantly improved in both groups ($p<0.01$). Improvements in the treatment group were significantly higher than in the control group except for hip abduction and external rotation ($p<0.05$; see Table II). The Modified Ashworth Scale (MAS) decreased significantly in the control group except for adductors, and internal rotators, and plantar flexors ($p<0.05$). In the treatment group MAS values significantly improved ($p<0.05$; see Table III).

The pre- and posttreatment values of the posterior tibial nerve SEP vertex peak latencies were recorded in 10 children from the treatment group and 14 from the control group. The other children were excluded because of crying, and being unable to complete the procedure. In both groups, SEP values were significantly improved after treatment ($p<0.05$). However, SEP posttreatment values of the treatment group were significantly higher than those of the control group ($p<0.05$; see Tables IV, V, VI).

Discussion

Physiotherapy and rehabilitation approaches are important components in the treatment of CP. Various physiotherapy methods have been applied to obtain normal motor development, to prevent postural abnormalities and deformities, and to increase functional capacity. Although rehabilitation of CP varies according to clinical types, the basic treatment is based on neurodevelopmental approaches. The aim of treatment is to improve corrective and balance reactions and insufficient muscle tone, to decrease excessive muscle tone, and to improve postural tone by preventing abnormal muscle tone (Valvono and Long 1991, Semans 1995).

Spasticity is frequently observed in hip flexors, adductors, internal rotators, and knee flexors in spastic diplegia. It adversely affects motor development by causing abnormal posture and movement patterns, and delays the acquisition of ambulation skills including sitting, crawling, standing, and walking. Therefore, the inhibition of spasticity is very important in the treatment of children with CP (Bobath and Bobath 1981, Sahrmann et al. 1983).

Several studies have investigated the effects of different methods of inhibiting spasticity. In recent years, inhibitory

Table I: Physical and clinical characteristics of groups

	Treatment	*Control*
Age (mo), Mean (SEM)	48.82 (4.42)	47.52 (5.27)
Height (cm), Mean (SEM)	98.47 (2.72)	94.41 (2.72)
Body weight (kg), Mean (SEM)	14.11 (0.65)	14.00 (0.65)
Head circumference (cm), Mean (SEM)	48.47 (0.53)	47.23 (0.53)
Seizures, *n*	3	4
Visual problems, *n*	9	10
Auditory problems, *n*	1	2
Speech problems, *n*	6	7
Maternal characteristics, *n*	2	2
Hypertension	–	1
Antibiotic usage related to kidney disease	1	2
Cytomegalovirus infection	–	1
Insulin-dependent diabetes mellitus	1	–
Consanguinity, *n*		
1st degree	2	3
2st degree	2	1
Characteristics at birth, Mean (SEM)		
Gestational age (wk)	36.88 (1.25)	35.52 (1.18)
Weight (g)	2471.76 (235.61)	2521.18 18 (9.90)
Incubator stay (d)	11.13 (3.35)	16.21 (1.93)
Length (cm)	47.84 (0.84)	46.84 (1.54)
Developmental period, *n*	Pre/Post	Pre/Post
Apedal to quadripedal	2/–	2/1
Quadripedal	6/6	7/8
Quadripedal to bipedal	9/9	8/7
Bipedal	–/2	–/1

Pre, pretreatment; Post, posttreatment.

casts and orthoses have been a popular approach along with NDT (Sussman 1983, Taylor and Harris 1986, Phillips and Audet 1990). Watt (1986) investigated the long-term effects of a treatment consisting of NDT and inhibitory cast application in children with CP. Participants were evaluated for muscle tone, degree of passive dorsiflexion, developmental level, and walking pattern. Evaluations were carried out before treatment, in week 2 of treatment, and 5 months after treatment. There were no significant differences between pre- and posttreatment muscle tone and motor development. However, the increase in ankle dorsiflexion angle in the group for whom the inhibitor cast was applied was significantly higher in the second week of treatment.

Bertoti (1986) studied the use of inhibitory cast and short leg casting in 16 children with CP undergoing NDT. Eight out of 16 participants were treated with NDT alone. They found that muscle tone decreased and postural control and symmetry improved in the group that combined inhibitory cast with NDT.

Pressure splints and casting have two similar features: neutral heat and total pressure applications. Johnstone (1983) postulated that impulses from cutaneous receptors directly influence motor neurone excitability in the spinal medulla, or indirectly by reticular formation. Neutral heat and pressure applications decrease the excitability of thermal receptors and tactile receptors which show a rapid adaptation to the stimuli. Therefore, they decrease the excitability levels of both interneurones and motor neurones (Johnstone 1983, Barnard et al. 1984).

Table II: Effects of treatment on lower extremity range of motion and spasticity

Range of motion	*Group*	*Pretreatment*	*Posttreatment*	*Wilcoxon*		*Mann–Whitney U*	
		Mean (SEM)	*Mean (SEM)*	*z*	*p*	*U*	*p*
Hip abduction (R)	Treatment	36.58 (1.70)	44.00 (0.98)	3.53	< 0.000	140.5	> 0.888
	Control	33.58 (1.76)	41.41 (0.71)	3.65	< 0.000		
Hip abduction (L)	Treatment	36.17 (1.55)	48.23 (1.00)	3.53	< 0.000	110.5	> 0.237
	Control	33.82 9 (1.76)	42.11 (3.70)	3.52	< 0.000		
Hip external rotation (R)	Treatment	42.29 (0.94)	42.17 (0.55)	3.31	< 0.001	141	> 0.902
	Control	37.76 (1.63)	44.00 (0.64)	3.42	< 0.001		
Hip external rotation (L)	Treatment	43.23 (0.97)	47.76 (0.12)	3.19	< 0.001	127	> 0.541
	Control	38.11 (1.58)	44.23 (0.68)	3.42	< 0.001		
Hip flexion, knee extended (R)	Treatment	65.70 (1.87)	84.35 (1.10)	3.62	< 0.000	44	< 0.000
	Control	64.35 (2.88)	72.94 (1.57)	3.64	< 0.000		
Hip flexion, knee extended (L)	Treatment	64.82 (2.88)	83.23 (1.65)	3.62	< 0.000	39.5	< 0.000
	Control	67.41 (2.18)	76.76 (1.88)	3.63	< 0.000		
Ankle dorsiflexion (R)	Treatment	–12.05 (1.48)	9.60 (0.50)	3.63	< 0.000	51.5	< 0.001
	Control	–10.47 (3.29)	–1.17 (2.28)	3.63	< 0.000		
Ankle dorsiflexion (L)	Treatment	–8.47 (1.27)	10.82 (1.06)	3.02	< 0.003	67.5	< 0.008
	Control	–9.94 (1.82)	1.35 (2.07)	3.63	< 0.000		

R, Right; L, Left.

Table III: Effects of treatment on lower extremity Modified Ashworth Scale

Modified Ashworth Scale	*Group*	*Pretreatment*			*Posttreatment*			*Wilcoxon*		*Mann–Whitney U*	
		Mean	*Min.*	*Max.*	*Mean*	*Min.*	*Max.*	*z*	*p*	*U*	*p*
Hip adductors (R)	Treatment	2	2	4	1	1	3	3.81	< 0.000	54	< 0.000
	Control	3	2	4	2	2	3	2.12	< 0.034		
Hip adductors (L)	Treatment	2	1	4	1	1	2	3.62	< 0.000	73.5	< 0.006
	Control	3	2	4	3	2	4	3.31	< 0.001		
Hip internal rotators (R)	Treatment	2	1	3	1	0	2	3.20	< 0.001	59.5	< 0.001
	Control	2	1	3	2	1	3	1.72	> 0.083		
Hip internal rotators (L)	Treatment	2	1	3	1	0	2	3.46	< 0.001	85	< 0.018
	Control	3	3	4	3	2	4	2.82	< 0.005		
Hamstrings (R)	Treatment	4	3	4	2	1	3	3.78	< 0.000	15	< 0.000
	Control	3	2	4	3	2	4	2.44	< 0.014		
Hamstrings (L)	Treatment	4	3	4	2	1	3	3.78	< 0.000	20	< 0.000
	Control	3	2	4	2	2	3	2.53	< 0.011		
Plantar flexors (R)	Treatment	4	3	4	2	1	3	3.78	< 0.000	15	< 0.000
	Control	3	2	4	3	2	4	2.44	< 0.014		
Plantar flexors (L)	Treatment	4	3	4	2	1	3	3.75	< 0.000	38.50	< 0.000
	Control	2	1	3	2	1	3	1.72	> 0.083		

R, Right; L, Left.

Inhibitory casting and splint applications are local applications and their use during exercise is limited. Moreover, pressure is applied only at some local points on the limb. JPSs apply equal pressure of 40 mm Hg to the entire extremity and they can be worn during exercise.

JPSs have been used in adults with neurological disease for a long time. Johnstone (1983) used pressure splints for the upper extremities in nine patients with hemiplegia, and found that they decreased spasticity which was confirmed by EMG. Poole and Whitney (1990) investigated the effect of splints combined with exercises in nine patients with hemiplegia. The control group underwent only exercise treatment. After 3 weeks of treatment, the decrease in spasticity was significantly higher in the group to which the splints were applied.

There have been no studies on the use of JPSs in spastic diplegic CP. However, Margaret Johnstone stated that they could be used to reduce spasticity, to inhibit the pathological reflexes, and to develop ambulation skills by increasing stabilization at lower extremities in children with CP. In this study we investigated the effectiveness of JPSs combined with NDT on reduction of spasticity in children with spastic diplegia. After 3 months of treatment there was a significantly greater

Table IV: Pre- and posttreatment posterior tibial nerve (msn) vertex peak SEP latencies in control group

Participant	*Right*		*Left*	
	Pretreatment	*Posttreatment*	*Pretreatment*	*Posttreatment*
1	51.60	51.60 NC	45.20	40.00 ↓
2	44.40	42.40 ↓	44.40	42.40↓
3	32.80	32.60 ↓	36.80	34.60 ↓
4	38.40	28.40 ↓	38.40	33.50 ↓
5	49.60	42.40 ↓	41.60	40.00 ↓
6	41.02	37.20 ↓	40.00	38.80 ↓
7	62.08	60.08 ↓	64.08	62.05 ↓
8	31.06	28.06 ↓	45.02	48.00 NC
9	39.06	39.06 NC	68.00	68.00 ↑
10	34.60	35.20 ↑	35.80	37.20 ↓
11	53.60	52.40 ↓	45.60	41.80 ↓
12	37.60	29.60 ↓	44.80	38.40 ↓
13	42.00	32.00 ↓	43.60	31.60 ↓
14	36.80	32.30 ↓	37.20	35.40 ↓

↑, increase; ↓, decrease; NC, not changed.

Table V: Pre- and posttreatment posterior tibial nerve (msn) vertex peak SEP latencies in treatment group

Participant	*Right*		*Left*	
	Pretreatment	*Posttreatment*	*Pretreatment*	*Posttreatment*
1	46.80	39.20 ↓	44.00	38.80 ↓
2	42.80	33.30 ↓	38.20	35.30 ↓
3	67.20	40.00 ↓	69.60	40.00 ↓
4	48.30	42.10 ↓	49.50	46.80 ↓
5	43.20	37.10 ↓	40.40	35.90 ↓
6	69.60	53.50 ↓	71.20	52.30 ↓
7	38.00	31.70 ↓	38.00	32.30 ↓
8	34.00	31.30 ↓	48.00	42.80 ↓
9	28.80	21.60 ↓	30.80	29.60 ↓
10	42.80	35.80 ↓	42.80	39.40 ↓

↑, increase; ↓, decrease; NC, not changed.

Table VI: Posterior tibial nerve (msn) vertex peak SEP latencies in both groups

	Treatment		*Control*	
	Pretreatment Mean (SEM)	*Posttreatment Mean (SEM)*	*Pretreatment Mean (SEM)*	*Posttreatment Mean (SEM)*
Right	46.15 (4.14)	36.56 (2.63)[a,b]	42.47 (2.36)	38.84 (2.65)[a]
Left	47.25 (4.20)	39.32 (2.13)[a,b]	45.03 (2.55)	42.26 (2.81)[a]

[a] Wilcoxon $p<0.05$; [b] Mann–Whitney U test $p<0.05$.

improvement in the group in which JPSs combined with NDT than the group in which only NDT was carried out. These results are similar to findings obtained from adult patients with neurological disorders.

SEPs give important information about developmental disorders in the brain such as traumatic, degenerative, and inflammatory diseases of the spinal cord (De Lisa et al. 1987). The intensity of the stimulus applied to obtain SEPs causes the stimulation of large somasthetic and proprioceptive fibres and alpha motor axons myelinated fibres of peripheral nerves (skin, sub-skin). The cell bodies of myelinated fibres are in dorsal root ganglions. They travel ipsilaterally in the posterior column, and create a synapse at the dorsal column nucleus in the cervical medullar connection, and reach the thalamus, medial lemniscus, and frontoparietal sensory motor cortex. Measurement of SEPs is a basic tool for evaluating sensory function in children where use of other methods may be difficult. An abnormal SEP response (i.e. delay in cortical latencies or depression in amplitude) in children with CP and in patients from high-risk groups, such as preterm infants with periventricular bleeding, is an indicator of a poor prognosis.

Kundi and colleagues (1989) investigated SEPs in children with CP, and found that abnormalities in posterior tibial and sural nerve SEPs improved 26% and 13%, respectively, after selective posterior rhizotomy. There was no change in peroneal nerve SEPs. White and Cook (1994) studied the SEPs of 50 infants with neurodevelopmental disorder. Thirty-one infants were diagnosed with CP. SEPs of 24 infants were normal but there was a latency prolongation in 26 infants. In another study, posterior tibial nerve SEPs were investigated in acute Gullian-Barré syndrome. It was found that latency was prolonged in the acute stage (patient latencies 42.26, SD 1.54), and there was a reduction in the subacute period (Topcu et al. 1993).

In our study, posterior tibial nerve SEP latencies were improved in both the control group and the treatment group. However, improvement was significantly higher in the treatment group where exercises were combined with JPSs.

The significant decrease in posterior tibial nerve peak vertex latency values in both groups after treatment may be due to the reduction of abnormal motion patterns, as a result of the NDT. In addition, stimulation of cutaneal receptors by JPSs, and their ability to facilitate the peripheral sense input through regulating muscle tone by local and general inhibition, could lead to a further decrease in spasticity in the treatment group.

Using JPSs during NDT in children with spastic CP enables the physiotherapist to position the child more easily thereby decreasing the amount of handling the physiotherapist has to do. This leaves the physiotherapist free to perform other exercises. However, there are also some problems in using the JPSs in children. For example, it is difficult to position an extremity in a static position because of lower cooperation and perception levels of children. Therefore, we recommend that it may be beneficial to use them during play activities, and to attract the child's attention to other exercises and objects. We noticed that children were enthusiastic about wearing the splints and remarked that they were 'wearing balloons'. This acceptance will consequently improve cooperation during functional activities. We believe that further studies should be planned with the aim of determining the effects of splints on functional outcomes.

Conclusions

As a result of our study, we believe that JPSs combined with NDT may be effective in inhibiting both spasticity, and abnormal motion patterns, and extending the proprioceptive mechanism.

A limiting factor of this study was that the assessments were not performed by an independent person. This was because the children were not willing to cooperate with a second physiotherapist.

Since there is still no complete and effective therapy for the personal, familial, and social problems caused by CP, it is hoped that in the future, further studies with larger patient groups will be undertaken and new methods of therapy developed.

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