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EVALUATION OF THE EFFECT OF BOBATH THERAPY ON SPASTICITY IN CHILDREN WITH CEREBRAL PALSY USING SUBJECTIVE AND OBJECTIVE METHODS

Veysel AKDUMAN
Uzm. Fzt., Marmara Üniversitesi, Sağlık Bilimler Enstitüsü, Fizyoterapi ve Rehabilitasyon Bölümü, veysel.akduman@marmara.edu.tr, İstanbul/Türkiye, 0000-0002-4981-6049

Zübeyir SARI
Prof. Dr., Marmara Üniversitesi, Sağlık Bilimler Fakültesi, Fizyoterapi ve Rehabilitasyon Bölümü, zubeyir.sari@marmara.edu.tr, İstanbul/Türkiye, 0000-0003-1643-5415

Onur AYDOĞDU
Dr.Öğr. Üyesi, Marmara Üniversitesi, Sağlık Bilimler Fakültesi, Fizyoterapi ve Rehabilitasyon Bölümü, fztonuraydogdu@hotmail.com, İstanbul/Türkiye, 0000-0001-5200-9611

Abstract

The positive effects of Bobath therapy on spasticity are known, but studies using objective data tools that can evaluate these positive effects are limited. The purpose of this study is to examine the changes in lower extremity muscle tone and viscoelastic properties of children with spastic cerebral palsy who received Bobath therapy. Thirty-three children with CP, aged between 5 and 15 (18 girls, 15 boys) years were included in the study. Based on the evaluation parameters, initial evaluations were conducted using the Modified Ashworth Scale and Myoton®PRO Digital Palpation Device, and all children continued to receive neurodevelopmental therapy (NGT) twice a week for six weeks following the initial evaluation. Muscle tone was measured with Modified Ashworth Scale, and muscle tone, stiffness, and elasticity levels were measured with Myoton®PRO Digital Palpation Device. According to the results of this study, it has been determined that the sensitivity of the MyotonPRO digital palpation device is higher and more reliable than MAS in evaluating spasticity in patients with cerebral palsy. Therefore, it is recommended to use MyotonPRO digital palpation device, which is more objective and reliable in evaluating spasticity in children with cerebral palsy in future studies.

Keywords: Cerebral Palsy, Muscle Spasticity, Rehabilitation, Muscle Tonus

SEREBRAL PALSİLİ ÇOCUKLARDA BOBATH TERAPİSİNİN SPASTİSİTE ÜZERİNE ETKİSİNİN SUBJEKTİF VE OBJEKTİF YÖNTEMLERLE DEĞERLENDİRİLMESİ

Özet

Bobath tedavisinin spastisite üzerinde olumlu etkileri bilinmektedir fakat bu olumlu etkileri değerlendirebilecek objektif veri araçlarını kullanan çalışmalar sınırlıdır. Bu araştırmanın amacı; bobath tedavisi alan spastik Serebral Palsi tanılı çocukların alt ekstremite kas tonularında ve viskoelastik özelliklerinde meydana gelen değişiklikleri incelemektir. Çalışmaya 5 ile 15 yaş arası (18 kız, 15 erkek) 33 SP'li çocuk alındı. Değerlendirme parametrelerine göre ilk değerlendirmeleri Modifiye Ashworth Skalası ve Myoton®PRO Dijital Palpasyon Cihazı ile yapıldı ve ilk değerlendirme sonrası tüm çocuklar 6 hafta boyunca haftada iki kez almış oldukları nörogelişimsel tedaviye (NGT) devam etti. Modifiye Ashworth Skalası ile kas tonusu, Myoton®PRO Dijital Palpasyon Cihazı ile kas tonusu, sertlik ve esneklik düzeyleri ölçüldü. Çalışmanın sonuçlarına göre; Serebral palsili hastalarda spastisiteyi değerlendirmede MiyotonPRO dijital palpasyon cihazının MAS'a göre hassasiyetinin daha yüksek ve güvenilir olduğu saptanmıştır. Bu nedenle daha sonraki çalışmalarda spastisiteyi değerlendirmede daha objektif ve güvenilir olan MiyotonPRO dijital palpasyon cihazının kullanılması önerilmektedir.

Anahtar Kelimeler: Serebral Palsi, Kas Spastisitesi, Rehabilitasyon, Kas Tonusu

1. INTRODUCTION

Cerebral Palsy (CP) is defined as a permanent disorder in the development of posture and movement, which develops because of non-progressive damage to the brain for any reason in the prenatal, neonatal, or postnatal period, causing activity limitation (1).

The lesion in the brain is static and the effect of the lesion on the musculoskeletal system is progressive. (2). The most common type of cerebral palsy which is an upper motor neuron disease (UMN) is the spastic type (approximately 70%), and this type is characterized by increased muscle tone (3).

Increased muscle tone is defined as spasticity. Prolonged spasticity causes joint subluxation, joint contractures, and changes in the anatomical structure of the fibrotic tissue of the muscles. The elongation of the muscle fibers of spastic muscles causes problems in the motor unit and neuromuscular junction (4). One of the most used methods in the treatment of spasticity is Bobath therapy. The Bobath therapy is aimed to reduce spasticity by using reflex inhibitor patterns (5).

Bobath therapy is one of the neurodevelopmental therapies (NDT) methods. NDT is used as a worldwide concept based on the Bobath teachings. It has been accepted that Bobath and NDT are part of the same treatment approach and are interchangeable approaches in the literature (6). Although the effectiveness of Bobath therapy on spasticity is known, in the literature, it is seen that this efficiency is evaluated with more subjective methods (5). The Modified Ashworth Scale (MAS) and Modified Tardieu Scale (MTS) are the most used methods for assessing spasticity in both adults and children for the past 30 years (7). But these methods are subject to biases inherent in human perception. Therefore, they are considered as subjective methods (8).

One of the most used methods to objectively evaluate spasticity in recent studies is the digital palpation device. However, most of these studies were conducted in stroke patients (9-11), and no study was found that objectively evaluated spasticity in patients with cerebral palsy. Based on these data in the literature, this study aimed to objectively examine the changes in lower extremity muscle tone and viscoelastic properties of children with spastic CP who received Bobath therapy.

2. MATERIALS AND METHODS

2.1. Study Design and Participants

This study protocol was conducted following the principles of the Declaration of Helsinki. This experimental study was conducted in a Special Education and Rehabilitation Center between September 2020 and April 2021. This study protocol was conducted following the principles of the Declaration of Helsinki and approved by Marmara University Ethical Committee of Non-Invasive Clinical Research (14.11.2019/131).

A total of 33 (18 hemiparesis, 13 diparesis) children aged 5 to 15 years, diagnosed with spastic CP, able to understand simple verbal instructions and signed a voluntary consent form by their parents were included in the study. Exclusion criteria were as follows: sensory problems, acute convulsions that cannot be controlled with drug, severe epileptic attacks that cannot be controlled, cognitive problems, levels 3,4 and 5 according to the Gross Motor Function Classification System (GMFCS), vision and hearing problems. In addition, those who had undergone surgery in the last 6 months and those who received botonilium toxin were excluded from the study.

The assessment of the extremities in the hemiparetic group included only the affected side. However, both extremities of the diparetic group were evaluated. In the last case, 23 right (13 diparetic, 10 hemiparetic) and 21 left (13 diparetic, 8 hemiparetic) extremities were evaluated.

2.2. Outcome Measurements

The demographic characteristics of the patients (age, gender, height, body weight) were recorded in the socio-demographic data form (Table 1). The children included in the study were evaluated using the Modified Ashworth Scale and Myoton®PRO Digital Palpation Device. All evaluations were performed before treatment and repeated after the treatment program.

2.2.1 Modified Ashworth Scale (MAS)

Modified Ashworth Scale (MAS) was used to assess spasticity. Muscle tone is graded in the range of 0-4 on the MAS. "0" indicates no increase in muscle tone, and "4" indicates that the affected muscle is rigid in extension or flexion. The MAS level is determined by the amount of resistance shown by the spastic muscle during the passive movement of the antagonist muscle. MAS is a reliable and valid scale for assessing muscle tone (12).

All evaluations were conducted supine with the head positioned midline. To avoid calcaneal valgus or varus, a neutral hindfoot position was maintained. As part of the evaluation of the ankle plantar flexors, the hip and knee joints were positioned at their maximum extension. Following this, the foot was moved from maximum plantar flexion to maximum possible dorsiflexion. As part of this study, the gastrocnemius muscle was evaluated using hypertonia from the ankle plantar flexors with the knee extended. Afterwards, the knees and hips were flexed at 90° in order to evaluate the soleus muscle (12).

2.3.2 Myoton®PRO Digital Palpation Device

Myoton® PRO evaluates the biomechanical properties of soft tissues in an inexpensive, easy, quick, objective, and non-invasive way. Connective tissues such as ligaments and tendons, superficial skeletal muscles and other soft tissues are evaluated with Myoton® PRO. It is a reliable method to evaluate the elasticity, stiffness, and muscle tone (13). Logarithmic decrement (D), Dynamic Stiffness [N/m] (S), and Oscillation Frequency [Hz] (f) values are acquired with Myoton® PRO. The oscillation frequency (f) indicates the tone (intrinsic tension) of the tested muscle without any voluntary contraction. The lower the value, the lower the tone or state of tension (14). Dynamic stiffness (S) is the biomechanical property of a muscle that defines resistance to a contraction or to an external force that deviate its initial shape. The lower the value, the lower the hardness. The logarithmic decrement of the natural oscillation of a muscle demonstrates the elasticity of the muscle and the distributing of mechanical energy when the tissue recovers from being deformation. Elasticity is the biomechanical feature of a muscle that defines its ability to regain its initial shape after elimination of an external force or contraction. The lower the value of the logarithmic decrement, the higher the elasticity and the lower the distributing of mechanical energy when the tissue regains its shape (14).

In the course of the myoton evaluations, participants were asked to lie prone on a therapeutic bed. The points to be measured on the medial and lateral parts of the gastrocnemius and soleus muscles were determined and marked with a pen. Participants were instructed to remain calm and relaxed prior to the evaluation. Then, evaluations were made at the points marked with the MyotonPro device (15).

2.4. Statistical Analysis

All test results were analyzed using Statistical Package for Social Sciences (SPSS) Version22 (SPSS inc, Chicago, IL, USA) statistical software. The normal distribution suitability of the variables was examined using Kolmogorov– Smirnov test. Due to the $p<0.05$ of Kolmogorov Smirnov test and the skewness of the histogram graphs, it was decided that the distributions did not fit the normal. Therefore, analyzes were performed using non-parametric statistical methods. The comparison of the evaluations of the cases at the beginning and after the Bobath treatment was analyzed with the "Wilcoxon signed-rank test". All data were evaluated at the 95% confidence interval, significance level of $p<0.05$.

Table 1. Characteristics of The Participants

		n	%
Gender	**Female**	18	54.5
	Male	15	45.5
CP type	**Hemiparetic**	19.0	57.6
	Diparetic	14.0	42.4
GMFCS level	**1**	15.0	45.4
	2	18.0	54.6
Age (Mean ± SS)		8.91 ± 3.45	
Body weight (Mean ± SS)		30.52 ± 10.83	
Body height (Mean ± SS)		1.30 ± 0.17	
Body Mass Index (Mean ± SS)		18.24 ± 0.68	

3. RESULTS

The study was conducted with 18 female and 15 male participants aged between 5 and 15 years. The mean body weight of the participants was 30.52 ± 10.83 cm and the mean height was 1.30 ± 0.17 kg. When the cerebral palsy type of the participants was examined, it was determined that 82.4% of them were hemiparetic and 17.6% of them were diparetic. When gross motor function classification was examined, it was determined that 64.7% of them were level 1 and the rest were level 2 (Table 1). When the changes in spasticity according to MAS before and after the Bobath treatment applied to the participants were compared (Table 3), significant differences were found only in the left soleus muscle ($p<0.05$). The changes in the results of myometric measurements after the Bobath treatment applied to the participants were examined (Table 2). It was determined that the level of elasticity increased in the lateral part of the left gastrocnemius muscle and in the left soleus muscle (elasticity increases when the decrement (D) decreases) ($p<0.05$). In addition, it was determined that the muscle tone (F) and muscle stiffness (S) of the left and right soleus muscles decreased ($p<0.05$).

Table 2. Comparison of Changes in Myometric Measurement Results After Bobath Treatment Of Children with CP

			Before treatment		After treatment		z	p value
			Median	Min-Max	Median	Min-Max		
Gastrolateral	**RIGHT**	F (Hz)	15.25	13.00-18.20	15.2	12.90-17.00	-1.15	.24
		S (N/m)	272.0	212.00-359.00	271	221.00-344.00	-.63	.52
		D	1.00	0.74-1.47	0.92	0.73-1.32	-1.66	.09
	LEFT	F (Hz)	15.25	12.80-16.70	15	12.90-17.60	-.89	.36
		S (N/m)	273	193.00-348.00	272.5	194.00-333.00	-1.81	.06
		D	1.04	0.80-1.39	0.98	0.74-1.46	-2.04	.04*
Gastromedial	**RIGHT**	F (Hz)	14.20	12.20-16.0	14.75	12.30-18.40	-.59	.59
		S (N/m)	242	156.00-305.00	246.5	187.00-311.00	-.34	.72
		D	1.11	0.82-1.44	1.03	0.78-1.94	-1.17	.23
	LEFT	F (Hz)	13.90	12.30-16.30	14.55	12.60-18.40	-.27	.78
		S (N/m)	234.00	178.00-283.00	246.5	193.00-316.00	-.84	.40
		D	1.16	0.80-1.56	1.04	0.64-1.41	-1.25	.21
Soleus	**RIGHT**	F (Hz)	16.2	13.80-22.30	15.65	13.60-20.70	-2.76	.00*
		S (N/m)	306.5	218.00-589.00	295.5	213.00-364.00	-2.85	.00*

	D	0.96	0.72-1.33	0.99	0.76-1.96	-1.55	.11
LEFT	F (Hz)	16.45	13.20-18.90	15.75	13.00-18.70	-2.41	.01*
	S (N/m)	307	207.00-428.00	286.00	200.00-406.00	-1.99	.04*
	D	0.94	0.81-1.23	0.94	0.73-1.15	-2.81	.00*

Wilcoxon test was applied. *p<0.05

Table 3. Comparison of Changes in Spasticity According to MAS After Bobath Treatment in Children with CP

		Before treatment		After treatment		z	p value
		Median	Min-Max	MEdian	Min-Max		
Right	Gastrocnemius	2.0	0-3	2.0	0-3	-1.00	.31
	Soleus	1.0	0-3	1.0	0-3	-1.34	.18
Left	Gastrocnemius	2.0	0-3	2.0	0-3	-1.00	.31
	Soleus	1.0	0-3	1.0	0-3	-2.00	.04*

Wilcoxon test was applied. *p<0.05

4. DISCUSSION AND CONCLUSION

To our knowledge, this is the first study to objectively evaluate the effectiveness of Bobath therapy on spasticity in patients with cerebral palsy. The Bobath therapy aims to apply a patient-specific treatment program based on the current functional status of the patient. The aims of therapy are to impact muscle tone and correct posture through specific usage techniques, and then work towards better active participation and practice of specific functional skills. Bobath therapy is appropriate for treating of any motor control disorder within the spectrum of CP. Treatment programs in the Bobath therapy are goal-oriented (16). Although many studies have been conducted on how Bobath treatment affects functional development, studies on how this approach affects muscle tone and viscoelastic properties are insufficient in the literature. No study has been found that specifically evaluated the muscle tone and viscoelastic properties of spasticity. Although spasticity in patients with CP is evaluated with clinical tests such as MAS and MTS in the literature, there are reliability problems as these tests results can vary from one individual to another (17). Therefore, objective methods are needed. MyotonPro digital palpation device is a noninvasive method that can objectively evaluate the viscoelastic and biomechanical properties of muscle fibers.

MyotonPro has a probe made of polycarbonate and generates a short mechanical impulse when the probe is applied perpendicularly to the case over the skin. The resulting impulse (applies a constant force of 0.4 N to the tissue) triggers the electromagnetic impulse. This electromagnetic impulse causes an elastic deformation in muscle tissues. It ensures that naturally damped oscillations are produced, which are recorded by precision measuring accelerometer sensors during the recovery of the muscle tissue to its original shape. This provides an objective evaluation of the muscle's viscoelastic properties (tonus, stiffness, and elasticity) (18). This objective device has been used in the literature to evaluate the viscoelastic properties of muscles in healthy young and old adults (19), stroke patients (20) and Parkinson's patients (21).

Chuang et al. used the MyotonPRO device to evaluate upper extremity spasticity in stroke patients and found that it was highly reliable in extensor digitorum, flexor carpi ulnaris and flexor carpi radialis muscles (20). Similarly, Pruyn et al. MyotonPro digital palpation device has been shown to have high reliability in the evaluation of viscoelastic properties of lower extremity muscles (Gastrocnemius and soleus) (22). In this study, we used the MyotonPRO digital palpation device, which has proven to be highly reliable in evaluating the spasticity of the lower extremity muscles (Gastrocnemius and soleus) of patients with CP. In our study, we detected a decrease in spasticity in the lower extremity muscles after 6 weeks of Bobath therapy with the MyotonPRO digital palpation device. On the other hand, no significant difference was found in lower extremity spasticity before and after treatment in the evaluation with the Modified Ashworth Scale. According to the results of this study, it can be stated that the sensitivity of the MyotonPRO digital palpation device in evaluating spasticity is higher than the modified Ashworth Scale. The Modified Ashworth Scale (MAS) is the most widely used method for assessing muscle tone and provides a practical and rapid assessment for measuring muscle tone; however, it is not sensitive enough to determine small changes in muscle tone. However, it was emphasized in the study of Yoo et al. that it is not possible to evaluate the tone of an isolated muscle with the Modified Ashworth scale (23). Similarly, Fazekas et al. (24) randomly divided patients who developed hemiparesis as a result of upper motor neuron lesions into 2 groups, robotic and control and applied Bobath therapy to the patients in both groups. Their study, in which upper extremity functionality was evaluated with the Fugl-Meyer rating scale, and spasticity with MAS, there was a statistically significant difference in the functionality results of elbow flexors and shoulder adductors in the control group who received only Bobath therapy, but no significant difference was found in MAS values (24). On the other hand, in the literature, it is reported that the functionality decreases with the increase in spasticity (25, 26). This result supports the low sensitivity of MAS in evaluating spasticity. For this reason, we believe that the evaluation of spasticity with more objective methods such as the MyotonPRO digital palpation device will contribute to the clinical research results.

The strengths of this study can be listed as follows: It enables the effect of Bobath treatment on spasticity to be evaluated more objectively, and it also shows that the MyotonPRO digital palpation device has a higher sensitivity than MAS in the evaluation of spasticity. However, the lack of a control group and the inability to evaluate the long-term results of the effect of Bobath therapy are among the limitations of this study. The positive effects of Bobath therapy on spasticity are known, but studies using objective data tools that can evaluate these positive effects are limited.

In conclusion, we think that this study can evaluate the effectiveness of Bobath therapy on spasticity, especially in patients with CP, with an objective measurement tool and can guide clinicians in terms of the effectiveness of the treatment.

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