Open Journal of Therapy and Rehabilitation, 2019, 7, 120-130
http://www.scirp.org/journal/ojtr
ISSN Online: 2332-1830
ISSN Print: 2332-1822

Effects of the Neurodevelopmental Treatment (NDT-Bobath) in the Mobility of Adults with Neurological Disorders

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How to cite this paper: Besios, T., Nikolaos, A., Vassilios, G. and Giorgos, M. (2019) Effects of the Neurodevelopmental Treatment (NDT-Bobath) in the Mobility of Adults with Neurological Disorders. *Open Journal of Therapy and Rehabilitation*, **7**, 120-130.
https://doi.org/10.4236/ojtr.2019.73008

Received: June 27, 2019
Accepted: August 2, 2019
Published: August 5, 2019

Abstract

Background: Bobath method was initially applied in adults and then in children with cerebral palsy. Studies conducted in recent years have shown that the NDT-Bobath method improves function and mobility among persons with Multiple Sclerosis (MS) and Hemiplegia. **Purpose:** The purpose of the present study was to investigate the effect of NDT-Bobath method in the mobility of patients with neurological disorders (hemiplegia, multiple sclerosis), as evaluated using the TUG, BBS, TMT, and MAS tests. **Methods:** The study included 20 persons with neurological disorders (11 persons with multiple sclerosis and 9 persons with hemiplegia). The mean age of the participants was 38.7 ± 13.9 years and mean body mass was 65.1 ± 13.1 kg. The participants in the two groups Low Frequency (LF) and High Frequency (HF) followed two different intervention Bobath-NDT programs in terms of frequency. For the statistical analysis a two-way repeated measures analysis of variance (ANOVA) was performed. **Results:** Bobath-NDT method improves both mobility and functionality of patients with neurological disorders (BBS, $p = 0.095$ and Tinetti test, $p = 0.099$) but did not improve spasticity according to the results of MAS scale, $p = 0.095$. **Conclusions:** Overall, the results of the present investigation provided considerable evidence suggesting that Bobath-NDT method improves mobility according to the tests (BBS, TMT), but did not improve spasticity according to the results of MAS scale. Therefore, it was concluded that Bobath-NDT method improves both mobility and functionality of patients with neurological disorders. More researches will have to be done in the future.

Keywords

Bobath, NDT, BBS, TMT, MAS, Hemiplegia, MS

1. Introduction

The Neurodevelopmental treatment (Bobath-NDT) method is a physical therapy technique for the treatment and rehabilitation of people with motor difficulties due to acquired neurological conditions (such as Stroke, Brain Injuries, Multiple Sclerosis, Spinal cord injuries) and other neurological conditions such as Cerebral Palsy. The Bobath method is based on the knowledge of motor control, motor learning, as well as neural and muscular tissue plasticity. Bobath method was initially applied in adults and then in children with cerebral palsy [1] (Graham, Eustace, Brock, Swain & Irwin-Carruthers, 2009).

In the Bobath-NDT approach, controlling the normal alignment of the joints is the basis on which patients start developing their skills. Patients undergoing this treatment usually learn how to control their postures and movements, and then the tasks they perform. Therapists analyse the postures and movements, and then they correct any abnormalities that may exist when performed by patients. This approach requires the patient's active participation, while the physiotherapist facilitates movement [2] (O'Sullivan & Schmitz, 2007).

The goal of applying the Bobath concept is to promote motor learning for efficient motor control in various environments, thereby improving functioning. This is performed through specific patient handling by the therapists, who guide patients through the initiation and completion of functional tasks [3] (International Bobath Instructors Training Association, 2006).

This approach to neurological rehabilitation is multidisciplinary, primarily involving physiotherapists, occupational therapists and speech and language therapists. In the United States, the Bobath concept is also known as "neurodevelopmental treatment" (NDT) [4] (Lennon & Ashburn, 2000).

Studies conducted in recent years have shown that the NDT method improves mobility among persons with Multiple Sclerosis (MS), the most important of which are the studies of [5] Smendal *et al.* (2006), in which patients reported improved balance and walking function, and [6] Keser, Kirdi, Meric, Kurne and Karabudak (2013), which demonstrated that Bobath exercises are effective in improving trunk and balance. As far as hemiplegia is concerned, studies have concluded that NDT improves patient mobility, such as the studies conducted by [7] Krutulyte, Kimtys and Krisciūnas (2002) and Lennon, Baxter and Ashburn (2001). Moreover, [8] Mikołajewska (2013), observed statistically significant and favourable changes in the health status of patients, described by gait parameters, changes in hand functions, and activities of daily living (ADL) following interventions based on the Bobath rehabilitation approach. In addition, the NDT-Bobath method is widely used by therapists in children with cerebral palsy and in patients after stroke. Nevertheless, an extended review of randomised controlled trials (RCTs) using the Bobath method in hemiplegia rehabilitation, reported that only three trials had observed significant differences favouring the Bobath method [9] (Kollen *et al.*, 2009).

In 2016, the American Stroke Association concluded that although the effectiveness of the NDT-Bobath method has not been demonstrated in comparison to other therapeutic approaches, it can be still considered a therapeutic choice for mobility rehabilitation. Furthermore, in 2016, the revised guidelines for hemiplegia did not even mention the NDT-Bobath method, while many other alternative solutions were proposed. They also reported that therapists using such methods should review objectively their options, taking into account the relevant evidence supporting the proposed alternative solutions [10] (National Clinical Guideline for Stroke, 2016).

2. Purpose of the Study

The purpose of the present study was to investigate the effect of NDT-Bobath method in the mobility of patients with neurological disorders (hemiplegia, multiple sclerosis), as evaluated using the Time Up and Go (TUG), Berg Balance Scale (BBS), Tinetti Mobility Test (TMT), and Modify Asworth Scale (MAS) tests.

3. Sample

The study included 20 persons with neurological disorders (11 persons with multiple sclerosis and 9 persons with hemiplegia). The mean age of the participants was 38.7 ± 13.9 years, and mean body mass was 65.1 ± 13.1 kg. The diagnosis of all participants was made by a specialised neurologist. Participants should not have undergone any orthopaedic surgery or medical treatment affecting spasticity during the previous 6 months, and they should not have participated in other therapeutic programmes, apart from physiotherapy, to avoid any effects on the study results.

4. Materials and Methods

All participants were also selected using the method of continuous sampling.

Each participant was randomly assigned to one of the two groups: a) group of 10 patients with neurological disorders following low frequency intervention (LF), b) group of 10 patients with neurological disorders following high frequency intervention (HF). The details of participants in both groups are presented in more detail below (**Table 1**).

Data were obtained with the use of the following instruments: Time Up and Go (TUG), Berg Balance Scale (BBS), Tinetti Mobility Test (TMT), and Modify Asworth Scale (MAS) tests. The performance of all participants was recorded and for the GMFM and TUG tests, testing procedures for all participants for all attempts were also videotaped with a camcorder (JVC mini DV).

The participants in the two groups (LF & HF) followed two different intervention programmes in terms of frequency: in the (LF) the NDT-Bobath intervention programme was scheduled once (1) a week (with a duration of one hour each time), and in the (HF) the NDT-Bobath intensive intervention programme was scheduled three (3) times a week (with a duration of one hour each time).

Table 1. Details of persons with hemiplegia multiple sclerosis (MS) who participated in the study [age in years, weight in kg, and height in cm, time from onset of disease (T.O.D.)].

NAME	AGE	WEIGHT	HEIGHT	CONDITION	T.O.D.
PL01	48	63	164	HEMIPLEGIA	4
KO02	58	80	183	HEMIPLEGIA	2
AR03	49	63	169	MS	2.5
TS04	38	78	175	MS	3
MA05	42	85	165	MS	5
BL06	50	70	160	MS	1.5
ZA07	18	30	150	HEMIPLEGIA	6
NT08	42	70	176	HEMIPLEGIA	3
TZ09	31	77	176	HEMIPLEGIA	3.5
PS10	69	62	160	HEMIPLEGIA	2.5
GA11	18	56	161	HEMIPLEGIA	1.5
SA12	33	56	173	MS	2
KO13	61	80	173	HEMIPLEGIA	5
MP14	34	55	157	MS	5
TR15	25	70	170	MS	3
PA16	29	65	150	MS	6
TA17	30	45	160	MS	3.5
PA18	34	57	163	MS	4
NA19	26	70	188	MS	5
KO20	40	70	170	HEMIPLEGIA	4.5

The total duration of each of the two programmes was eight (8) weeks. The measurements were performed at the beginning of the study (T1), the end of the study (T2) and one month after the completion of the intervention (T3), the same tests (Time Up and Go, Berg Balance Scale, Tinetti Mobility Test, and Modify Asworth Scale) were performed in each group to evaluate the extent to which the effects of the NDT-Bobath intervention were maintained.

5. Statistical Analysis

To study the effect of the NDT-Bobath method in patients with neurological disorders (hemiplegia, multiple sclerosis) and evaluate the effects of the intervention, for each test a two-way repeated measures Analysis of Variance (ANOVA) was performed; the repeated factor was the time of test (T1, T2 & T3) and the independent factor was the group, according to frequency of intervention (low frequency and high frequency). The Bonferroni test was used for the multiple comparisons of the means of the variables among the different levels of the above factors. In all the analyses, the level of statistical significance was $p < 0.05$.

6. Results

In the study of the effect of NDT-Bobath method frequency of intervention in persons with hemiplegia or multiple sclerosis, the following were demonstrated: (Table 2).

TUG

According to the two-way analysis of variance (3 × 2) for repeated measures, with "measurement" (initial, final, maintenance) as the repeated factor and "group" (HF & LF) as the independent factor, it was found that the interaction of the factors "measurement" and "group" was not statistically significant ($p = 0.959$). Similarly, there was no statistically significant main effect of the factor "measurement" ($p = 0.052$), neither with factor "group" ($p = 0.916$).

Therefore, according to the results it was demonstrated that in both groups, the NDT-Bobath method did not improve significantly the performance of patients with hemiplegia and multiple sclerosis in the TUG test, independently of the frequency of intervention (Table 3).

TINETTI

According to the two-way analysis of variance (3 × 2) for repeated measures, with "measurement" (initial, final, maintenance) as the repeated factor and "group" (HF & LF) as the independent factor, it was found that the interaction of the factors "measurement" and "group" was not statistically significant ($p = 0.735$). To the contrary, a statistically significant main effect of factor "measurement" was observed ($p < 0.001$), but no statistically significant main effect of factor "group" ($p = 0.650$). Furthermore, according to the results of the Bonferroni multiple comparison test, statistically significant differences were identified between the initial and final measurement ($p < 0.001$) and between the initial measurement and the maintenance measurement ($p < 0.05$), but there was

Table 2. Mean (±SD) performances in the TUG test for the patients of the high frequency of intervention group (HF) and those of the low frequency of intervention group (LF), in the initial measurement, the final measurement and the maintenance measurement.

Measurement	HF	LF	Total
Initial	17.45 ± 14.24	18.21 ± 13.93	17.83 ± 13.72
Final	16.10 ± 12.54	16.85 ± 15.25	16.47 ± 13.59
Maintenance	15.47 ± 9.67	15.85 ± 13.44	15.66 ± 11.40

Table 3. Mean (±SD) performances in the TINETTI test for the patients of the high frequency of intervention group (HF) and those of the low frequency of intervention group (LF), in the initial measurement, the final measurement and the maintenance measurement.

Measurement	HFIG	LFIG	Total
Initial	20.20 ± 6.54	19.20 ± 7.20	19.70 ± 6.72
Final	22.70 ± 5.73	21.30 ± 7.73	22.00 ± 6.66
Maintenance	22.80 ± 4.91	21.00 ± 8.64	21.90 ± 6.90

no statistically significant difference between the final measurement and the maintenance measurement (p = 0.999).

Therefore, according to the results it was demonstrated that in both groups, patients with hemiplegia and multiple sclerosis improved significantly their performances in the TINETTI test between the initial and the final measurement, with no further improvement between the final measurement and the maintenance measurement, one month later. Hence, the intervention programme had a positive influence when considering the TINETTI test, independently of the frequency of intervention (Table 4).

BBS

According to the two-way analysis of variance (3 × 2) for repeated measures, with "measurement" (initial, final, maintenance) as the repeated factor and "group" (HF & LF) as the independent factor, it was found that the interaction of the factors "measurement" and "group" was not statistically significant (p = 0.332). To the contrary, a statistically significant main effect of factor "measurement" was observed ($p < 0.001$), but no statistically significant main effect of factor "group" (p = 0.606). Furthermore, according to the results of the Bonferroni multiple comparison test, statistically significant differences were identified between the initial and final measurement ($p < 0.05$) and between the initial measurement and the maintenance measurement ($p < 0.01$), but there was no statistically significant difference between the final measurement and the maintenance measurement (p = 0.095).

Therefore, according to the results it was demonstrated that in both groups, patients with hemiplegia and multiple sclerosis improved significantly their performances in the BBS scale between the initial and the final measurement, with no further improvement between the final measurement and the maintenance measurement, one month later. Hence, the intervention programme had a positive influence when considering the BBS scale, independently of the frequency of intervention (Table 5).

MAS-Adductor muscles

Adductors

According to the two-way analysis of variance (3 × 2) for repeated measures, with "measurement" (initial, final, maintenance) as the repeated factor and "group" (HF & LF) as the independent factor, it was found that the interaction of the factors "measurement" and "group" was not statistically significant (p =

Table 4. Mean (±SD) performances in the BBS scale for the patients of the high frequency of intervention group (HF) and those of the low frequency of intervention group (LF), in the initial measurement, the final measurement and the maintenance measurement.

Measurement	HF	LF	Total
Initial	39.20 ± 14.96	37.20 ± 15.27	38.20 ± 14.75
Final	42.70 ± 11.16	38.90 ± 15.80	40.80 ± 13.45
Maintenance	43.60 ± 10.50	39.50 ± 16.35	41.55 ± 13.53

0.071). To the contrary, a statistically significant main effect of factor "measurement" was observed ($p < 0.01$), but no statistically significant main effect of factor "group" ($p = 0.490$). Furthermore, according to the results of the Bonferroni multiple comparison test, no statistically significant differences were identified between the initial and final measurement ($p = 0.063$) neither between the final measurement and the maintenance measurement ($p = 0.992$), but statistically significant differences were found between the initial measurement and the maintenance measurement ($p < 0.05$).

Therefore, according to the results it was demonstrated that in both groups, patients with hemiplegia and multiple sclerosis did not improve significantly their adductor scores (MAS) between the initial and the final measurement, with no further improvement between the final measurement and the maintenance measurement, one month later. Hence, the intervention programme did not have a significant positive effect on the adductor scores (MAS) in patients with hemiplegia and multiple sclerosis, independently of the frequency of intervention (Table 6).

7. Gastrocnemius Muscles

According to the two-way analysis of variance (3 × 2) for repeated measures, with "measurement" (initial, final, maintenance) as the repeated factor and "group" (HF & LF) as the independent factor, it was found that the interaction of the factors "measurement" and "group" was not statistically significant ($p = 0.784$). Similarly, there was no statistically significant main effect of the factor "measurement" ($p = 0.268$), neither with factor "group" ($p = 0.173$).

Therefore, according to the results it was demonstrated that in both groups,

Table 5. Mean (±SD) values of the adductors according to MAS for the patients of the high frequency of intervention group (HF) and those of the low frequency of intervention group (LF), in the initial measurement, the final measurement and the maintenance measurement.

Measurement	HF	LF	Total
Initial	1.30 ± 1.25	1.30 ± 0.94	1.30 ± 1.08
Final	1.20 ± 1.54	0.60 ± 0.84	0.90 ± 1.25
Maintenance	1.10 ± 1.59	0.60 ± 0.84	0.85 ± 1.26

Table 6. Mean (±SD) values of the gastrocnemius muscles according to MAS for the patients of the high frequency of intervention group (HF) and those of the low frequency of intervention group (LF), in the initial measurement, the final measurement and the maintenance measurement.

Measurement	HF	LF	Total
Initial	2.00 ± 1.15	3.00 ± 1.24	2.50 ± 1.27
Final	1.70 ± 1.63	2.60 ± 1.43	2.15 ± 1.56
Maintenance	1.90 ± 1.85	2.60 ± 1.43	2.25 ± 1.65

the NDT-Bobath method did not improve significantly the gastrocnemius scores (MAS) in patients with hemiplegia and multiple sclerosis, independently of the frequency of intervention.

8. Discussion

In the study of the effects of NDT-Bobath in patients with neurological disorders, it was found that the interaction of the factors "measurement" and "group" was not statistically significant ($p = 0.959$). Similarly, there was no statistically significant main effect of the factor "measurement" ($p = 0.052$), neither with factor "group" ($p = 0.916$).

Therefore, according to the results it was demonstrated that in both groups, the NDT-Bobath method did not improve significantly the performance of patients with hemiplegia and multiple sclerosis in the TUG test, independently of the frequency of intervention. The results are not consistent with the study of [11] Kilinç *et al.* (2016), which was designed as a blind, randomised, controlled study. In total, 22 patients participated voluntarily in the study, and with the Bobath method they improved the performance of their torso, their balance, and their gait, as well as TUG ($p < 0.05$) in patients with hemiplegia more as compared to conventional exercise programmes.

As far as the Tinetti test is concerned, according to the results of the Bonferroni multiple comparison test, statistically significant differences were identified between the initial and final measurement ($p < 0.001$) and between the initial measurement and the maintenance measurement ($p < 0.05$), but there was no statistically significant difference between the final measurement and the maintenance measurement ($p = 0.999$). Therefore, according to the results it was demonstrated that in both groups, patients with hemiplegia and multiple sclerosis improved significantly their performances in the Tinetti test between the initial and the final measurement, with no further improvement between the final measurement and the maintenance measurement, one month later. Hence, the intervention programme had a positive influence when considering the Tinetti test, independently of the frequency of intervention. The results are consistent with previous studies, which actually employed different functional assessment scales, the purpose of which was to investigate the effects of Bobath on the functional status and quality of life of patients with hemiplegia [12] [13] [14] (Hafsteinsdottir *et al.*, 2007; Mikołajewska, 2012; Vliet *et al.*, 2005).

For the BBS test, the results of the Bonferroni multiple comparison test demonstrated statistically significant differences between the initial and final measurement ($p < 0.05$) and between the initial measurement and the maintenance measurement ($p < 0.01$), but there was no statistically significant difference between the final measurement and the maintenance measurement ($p = 0.095$).

Therefore, according to the results it was demonstrated that in both groups, patients with hemiplegia and multiple sclerosis improved significantly their performances in the BBS scale between the initial and the final measurement, with no further improvement between the final measurement and the maintenance measurement, one month later. Hence, the intervention programme had a positive influence when considering the BBS scale, independently of the frequency of intervention. The results are consistent with those of [5] Smedal *et al.* (2006), which demonstrated that patients with multiple sclerosis had improved balance after the intervention according to the Berg Balance Scale (BBS) results: from 42.3 the final score was 47.7. [15] Ilke *et al.* (2016), investigated a rehabilitation programme with trunk exercises based on Bobath concept in patients with multiple sclerosis. The analysis of the results of both groups using the TIS, BBS, ICARS and MSFC scales demonstrated that the scores and the strength of the abdominal muscles was significantly different after the intervention ($p < 0.05$). In two other studies, it was concluded that personal rehabilitation programmes with the Bobath method improved trunk performance, balance, and gait in patients with hemiplegia more than conventional exercise programmes ($p < 0.05$) [11] [16], (Kilinç *et al.*, 2016; Wang *et al.*, 2004).

According to the results of MAS scale, it was found that in both groups, patients with hemiplegia and multiple sclerosis did not improve significantly their scores (MAS) in the adductor-gastrocnemius muscles between the initial and final measurement, with no further improvement between the final measurement and the maintenance measurement, one month later. Hence, the intervention programme did not have a significant positive effect on the adductor-gastrocnemius scores (MAS) in patients with hemiplegia and multiple sclerosis, independently of the frequency of intervention. The results of the study are consistent with the relevant results of [5] Smedal *et al.* (2006) study, in which the results demonstrated that no change was achieved both in gait analysis and in the other tests ($p < 0.001$).

In general, it has been demonstrated that NDT-Bobath improves mobility of people with neurological disorders [5] [7] [11] [13] [16] [Kilins *et al.* (2016); Krutulyte *et al.* (2002); Mikolajenska *et al.* (2012); Wang *et al.* (2004); Smedal *et al.* (2006)].

The results are different from those demonstrated in the studies of [17] Hafsteindottir *et al.* (2005), [18] Nadina *et al.* (1999), and [19] Tyson (2007). Nevertheless, the study of [18] Nadina *et al.* (1999) is a very old study, and the method has been modified over time. Furthermore, all the above studies had used different measurement instruments and the duration of the intervention programme was shorter.

9. Conclusion

In the study of persons with hemiplegia and MS, it was demonstrated that the NDT method improves both mobility and functionality of patients with neurological disorders, but did not improve spasticity according to the results of MAS scale. This was not consistent with the studies of [17] Hafsteindottir *et al.* (2005), [19] Tyson and Selley (2007), and [18] Nadina *et al.* (1999) which were old studies, and the method has been modified over time.

Limitation of the Study

1) As to the sample: the sample was only from a small city of Trikala in Greece as the investigation was carried out there.

2) The Bobath intervention program was carried out from two different physiotherapists.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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