International Journal of
Therapies and Rehabilitation Research [E-ISSN: 2278-0343]
http://www.scopemed.org/?jid=12
IJTRR 2015, 4: 4 I doi: 10.5455/ijtrr.00000060

Case Report Open Access

The effects of neurodevelopmental (Bobath) therapy based goal directed therapy on gross motor function and functional status of children with cerebral palsy

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ARTICLE INFO
Article History:
Received: Feb 25, 2015
Accepted: April 12, 2015
Published: April 28, 2015

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ABSTRACT

AIM: The aim was to investigate the effects of the neurodevelopmental based goal directed therapy (GD-NDT) on the motor functions, daily living activities of children with CP.

METHOD: 26 children with spastic CP, 14 males (53.8%) and 12 females (46.2%) ,mean age 9.5 ± 3.2 years were included. GMFCS levels were, I in 42.3%, II in 3.8% level, III in 15.4%, IV in 11.5% and V in 26.9%. GD-NDT was applied 3 times a week for 12 weeks.

RESULTS: Positive developments after therapy were identified in the gross motor functions of the children (p<0,01), in the self-care, transfer, and locomotion subscales of the independence levels measured with WeeFIM (p<0.05), the "Physical Function", "Role Limitations due to the Emotional/Behavioral Causes", "Pain", "Behavior", "Mental Health", "Self Care", "General Health", and "Family Activities," subscales of CHQ-PF50 (p<0.05). There was no change in muscle tone and ankle dorsiflexion selective motor control after treatment (p>0.05). The goals identified for the children before treatment were involved self-care 15.4%, physical activity 17.9%, locomotion and transfer 37.2%, social status and living activities 29.5%. 76.9% of the goals identified were reached; 23.1% were not reached.

CONCLUSION: Improvements were found in gross motor functions, independence in daily life and health related quality of life of children with CP who were taken GD-NDT.

INTRODUCTION

Cerebral palsy (CP) is a developmental disorder characterized by a group of movement and postural disorders that occur as a result of a lesion in the cerebral motor centers[2] and one of the most common reason for childhood physical disability[1]. Although the lesion is not progressive[3], the disorder influences the child's life from an early stage and the effects on the musculoskeletal system changes with the growing of the child. Emerging problems may affect the child's daily living skills and planning treatment program should support the motor function development and goal facilitating the child's participation in activities and adaptation to daily living[4,5].

Goal-directed therapy (GDT) aims to gradually increase independence in daily living activities and improve functional performance[5]. This approach is based on the neuronal group selection theory and dynamic systems theory that make up the theoretical framework of motor control[6,8]. GDT includes

activities directed at the individualized goals, taking the child's learning potential into account. Phased grading of the child's designated enables developing an individualized plan for the child to learn goal-directed activities and reach the goals and also makes it possible to individually evaluate treatment results. GDT approach is a family-centered attitude which requires the compliance of the child and the family[4,6]. General treatment approaches usually focus on normalizing the dysfunctional control of posture and movement in these children[6,7]. Neurodevelopmental treatment (NDT) consists of regulating neural-based motor responses in the central nervous system. The NDT approach is continuing to develop and is now considered an approach instead of a method. It includes the principles of providing CP children with a normal movement experience to minimize motor-sensory disturbances and provide functional independence during activities. Other important principles it includes are emphasizing the child's personal development and cognitive characteristics[8].

The goal attainment scale (GAS) is used for determine goal-directed treatment's effectiveness and it is a sensitive evaluation tool that demonstrates changes in the performance of the goal that is important for the child and family[9] and is widely used to individually evaluate the progress of rehabilitation[10]. This scale evaluates clinically significant qualitative changes and developments and individual goal achievement according to the age group. The sensitivity of GAS for the activity and accuracy dimensions is higher than the commonly used standardized functional scales. While GAS enables the measurement or achievement of movement development or functional objectives, it also associates these goals with sociability and functionality[11]. The international classification of health, disability and functionality for children and young people (ICF- CY) is the structural basis for physiotherapy and rehabilitation assessments and program planning[12,13]. ICF-CY, provides a conceptual framework to define health information such as diagnosis and functionality and therefore defines the child's problems in association with the function and anatomical features, activity limitations and participation problems[12,14,15]. It is very important for physiotherapists to adopt the ICF-CY model when in determining their assessment methods, both in terms of the decision making process and to obtain meaningful results[14]. In line with this framework, the goals chosen in GAS in compliance with the ICF basis are selected with the cooperation of the rehabilitation team and the family including the child as they will define the problems of the child and guide the treatment. The identified goals should be specific, measurable, achievable, relevant and timed (SMART). The right goal increases the motivation of the child and family and supports the child's learning[6].

How the goal will be realized is also very important in NDT. therefore we wanted to see the effect of adding the ability to perform the selected goal-directed motor functions without pathological movements and without disturbing the body alignment in the children. We identified the aim of our study as investigating the effects of neurodevelopmental based goal-directed treatment approach on motor functions of children with CP and their daily living activities.

METHOD

Participants:

A total of 30 children with CP were included in the study. At the beginning of the study the parents of the children were informed about the research study and signed an informed consent form stating that they participated voluntarily. Our study was approved by the Hacettepe University ethical committee for non-interventional clinical trials. (Ethical Committee: GO 13/97). Inclusion criteria: a) CP diagnosis, b) between 5 and 17 years of age; Exclusion criteria: a) Administration of Botulinum Toxin-A injection or surgery within the last 6 months. One of the children was undergone to surgical procedure, 1 was administered Botulinum Toxin-A and2 left the study so these children were excluded from the study. The study was completed with 26 children with CP. A total of 26 spastic children with CP consisting of 14 males and 12 females were included in the study. The mean age of the children included in the study was 9.5 ± 3.2 years. The GMFCS levels were I in 42.3%, II in 3.8% level, III in 15.4%, IV in 11.5% and V in 26.9%. The MACS levels were I in 23.1%, II in 26.9%, III in 15.4%, IV in 15.4% and V in 19.2%.

Research Design:

Our study was a prospective interventional study aiming to reveal the effectiveness of the GD-NDT. The parents of the children who participated in the study were asked for information on the socio-demographic and descriptive characteristics of themselves and the children. The gross motor function levels of the children, the severity of CP, muscle tone, ankle dorsiflexion, selective motor control function, the topographic distribution of CP, hand functions, loss of function and health related quality of life levels were evaluated.

Three goals were identified for each child before the treatment process. The GD-NDT program was applied to the children three times in a week for 12 weeks. The goals were selected based on the cooperation of the professional rehabilitation team and the family including the child itself. We made sure the goals were specific, achievable and appropriate for the purpose. The outcome measurements were repeated before the therapy and after 12 weeks of therapy.

Intervention:

The daily environment, gross motor function level, and cognitive, social and emotional status of the child were taken into account for goal selection while considering the ICF. The activities the child had difficulty in performing, how often they were performed during the day and how they were performed were determined. In addition, we determined how much the activities the child had difficulty with were reflected. in his/her daily life. The goals were selected based on cooperation of the profesionel rehabilitation team and the family

including the child. Accordingly, individual GDT was planned by considering the learning potential of the child in line with the selected goals. The obstacles the child encountered while working towards the goals were identified in the therapy program. The main problem of each child was determined and an attempt made to solve it in stages. For standardizing environment, all children's interventions were undergone in a same rehabilitation center with same team.

Outcome Measurements:

The gross motor function measurement scale (GMFM) was used to determine the level of gross motor function of children. GMFM is a measurement system developed to identify the motor functions of children with CP. It includes consecutive normal physiological development activities such as supine, prone, four-point position, sitting, over the knee, standing, walking and climbing stairs[16].

The severity of CP was identified using the Gross Motor Function Classification System (GMFCS & ER). GMFCS & ER is a 5-level system used to classify the motor involvement severity. Level I is ambulation in the community or at home without restriction while Level V is no independent mobility at all[17,18].

The "Manual Abilities Classification System" (MACS) was used in the evaluation of children's manual abilities. MACS evaluates the movements both hands perform together in children with CP between the ages of 4 and 18. MACS classifies manual abilities with 5 levels. Level I is holding and using objects easily and successfully while objects cannot be held or used at level V where there is severely limited ability to perform even simple activities[19-20].

The muscle tonus of the children was evaluated using the Modified Ashworth Scale (MAS). The muscle tonus is graded between "0" and "4" with this scale. "0" shows no increase in muscle tone while "4" shows that the affected part is rigid in flexion and extension[21].

The selective motor control (SMC) scale was used to evaluate the ankle dorsiflexors. The SMC scale has good intra-observer and re-tests reliabilities[22].

The functional status of the children was determined with the *Functional Independence Measure for Children* (WeeFIM), a pediatric functional independence scale. WeeFIM contains a total of 18 items in 6 fields including self-care (6), sphincter control (2), transfers (3), locomotion (2), communication (2), and social status (3). While "7" shows level of full independence, "1" indicates that the child is fully dependent[23,24].

The parent form (CHQ-PF50) of the Child Health Questionnaire (CHQ) consisting of 50 questions was used to determine the health-related quality of life of the children. CHQ-PF50 consists of 12 subscales including "Physical Function", "Role Limitations due to Physical Causes ", "Pain", "General Health", "Role Limitations due to Emotional/Behavioral Causes", "Self Esteem", "Mental Health", "Behavior", "Emotional Impact on Parents", "Influence of Time on Parents", "Family Activities", and "Family Harmony"[25].

Success in realizing the goals identified for the children was determined with the goal attainment scale. GAS focuses on individualized progress and is therefore a reliable evaluation method for the measurement of changes after the treatment in both clinical and research applications. Each goal in GAS is scored as -2 for poor, -1 for no change, 0 for goal realized, +1 for goal realized above expected, and +2 for goal realized way above expected[26,27].

Table I: A goal example for a child at GMFCS Level V.

GAS Score	Improvement example for turning activity
+2	Can turn in bed from one side to the other independently in 12 weeks.
+1	Can turn in bed from one side to the other with minimal physical help of the parent in 12 weeks.
0	Can turn in bed from one side to the other with moderate physical help of the parent in 12 weeks.
-1	Cannot turn in bed from one side to the other without minimum physical help of the parent in 12 weeks.
-2	Cannot turn in bed from one side to the other without moderate physical help of the parent in 12 weeks.

Table II: A goal example for a child at GMFCS Level I.

GAS Score	Improvement example for cycling activity goal
+2	Can cycle more than 50 meters independently by using reciprocal leg.
+1	Can cycle 50 meters by using reciprocal leg.
0	Can cycle 10 meters by using reciprocal leg.
-1	Progresses by cycling with unilateral leg on bicycle.
-2	Has difficulty balancing on bicycle, needs minimal physical support

Statistical Analysis:

The statistical analyses were performed on the SPSS for Windows Version 15.0 package program. The numerical variables were summarized as mean ± standard deviation or median [min- max] values. The qualitative variables were shown as numbers and percentages. The difference between preliminary and final test results was evaluated with the Wilcoxon sign test. The relationship between the numerical variables was assessed with

RESULTS

The socio-demographic characteristics, MACS and GMFCS levels and topographic distribution of the children who participated in our study are shown in Table III.

Table III: Socio-demographic characteristics

Table III: Socio-demographic characteristics	N= 26
Age, X ± SD, year	9.5 ± 3.2
Gender, n (%)	
Male	14 (53.8)
Female	12 (46.2)
CP Type:	
Diplegia:	5 (19.2)
Quadriplegia:	13 (50)
Hemiplegia	8 (30.8)
GMFCS	
Level I	11 (42.3)
Level II	1 (3.8)
Level III	4 (15.4)
Level IV	3 (11.5)
Level V	7 (26,9)
MACS	
Level I	6 (23.1)
Level II	7 (26.9)
Level III	4 (15.4)
Level IV	4 (15.4)
Level V	5 (19.2)

Statistically significant increases were found in the gross motor functions of the children after treatment (p= .00). No change was seen in muscle tone and ankle dorsiflexion selective motor control post-treatment evaluation (p>0.05). We also found no change in the disability severity of the children after the treatment (p>0.05).

The goals identified involved self-care in 15.4%, physical activity in 17.9%, locomotion and transfer in 37.2%, and social state and life activities in 29.5%. We were able to achieve 76.9% (60/78) of the goals we had identified before GDT use. 23.1% (18/78) were not realized. There was a significant difference between pre-treatment and post-treatment GAS scores of the children (p<0.05).

Table V presents the data regarding the independence levels of the children measured with WeeFIM before and after treatment. Although there was no statistically significant difference in the sphincter control, communication and social state subscales before and after treatment (p> 0.05), there was a statistically significant increase in the self-care, transfer and locomotion subscales (p<0.05). This increase was also reflected in the total WeeFIM score(p<0.05).

Table IV: İndependence levels of the children measured with WeeFIM before and after treatment.

WeeFIM Subscale scores	Based GDT X ±SD	After GDT X ±SD	P Value†
Self-care	18.4 ± 15.4	19.9 ± 14.4	**.000**
Sphincter control	8.3 ± 2.0	8.3 ± 2.0	1.000
Transfers	9.8 ± 8.1	10.71 ± 7.9	**.004**
Locomotion	7.03 ± 5.7	8.46 ± 5.0	**.001**
Communication	10.61 ± 4.9	10.61 ± 4.9	1.000
Social status	14.6 ± 7.5	14.6 ± 7.5	1.000
Total motor score	43.3 ± 32.8	46.8 ± 31.2	**.000**
Total cognitive score	25.2 ± 12.2	25.2 ± 12.2	1.000
Total WeeFIM score	65.8 ± 43.9	72.5 ± 40.9	**.000**

† : Wilcoxon sign test.

Statistically significant increases were obtained in the "Physical Function", "Role Limitations due to the Emotional/Behavioral Causes", "Pain", "Behavior", "Mental Health", "Self Esteem", "General Health", "Family Activities," subscales of the CHQ-PF50 questionnaire filled by the parents compared to pre-treatment (p<0.05). However, no statistically significant differences were found in the "Role Limitations due to the Physical Causes ", "Family Harmony", "Emotional Impact on Parents", and "Influence of Time on Parents" subscales (p>0.05). (Table VI)

DISCUSSION:

We found an increase in gross motor functions and certain fields of health-related quality of life in this study where we investigated the effects of GD-NDT on motor functions and daily living activities in children with CP.

This study combines the goal directed therapy with the NDT. The importance of GDT is well explained in the literature but there is not any study with goal directed therapy based on NDT principles. Additionally, relationship between goal directed therapy and quality of life is also important for the literature.

CP has been described in recent years as movement and posture disorders creating activity restrictions. ICF-CY is currently the structural basis in physiotherapy and rehabilitation evaluations and program planning. Using the ICF- CY model as the basis is important to obtain meaningful results when planning therapy[12,13,14,15]. The most important outcome of GDT determined jointly by the rehabilitation team and the family and child according to the principle of motor learning is

Table V: Socio-demographic characteristics

Table III: Socio-demographic charact	Gender	Age (year)	Distribution of CP	GMFCS	MACS	GMFM (pre)	GMFM (post)	WeeFIM (pre-Motor score)	WeeFIM (post-motor score)	WeeFIM Pre-cognitive score	WeeFIM Post-cognitive score	WeeFIM Pre-total score	WeeFIM Post-total score	1. goal achive	,2. goal achive	3. goal achive
1	G	9	hemipl	Level	Level II	100	100	79	79	35	35	124	124	Y	Y	Y
2	B	11	hemipl	Level	Level II	99,44	100	91	91	35	35	126	126	Y	N	N
3	B	8	Diplegi	Level	Level I	85,13	87,26	67	74	35	35	102	109	Y	Y	N
4	G	7	quadrip	Level	Level III	64,65	67,03	16	24	31	31	47	55	Y	Y	Y
5	B	7	quadrip	Level	Level V	17,11	21,03	13	20	5	5	18	25	Y	Y	N
6	G	7	quadrip	Level	Level IV	51,56	54,89	13	17	24	24	37	41	N	Y	Y
7	B	5	diplegi	Level	Level II	61,19	64,36	29	33	35	35	64	68	N	Y	Y
8	G	10	diplegi	Level	Level I	61,54	64,72	13	17	5	5	18	22	Y	Y	N
9	B	9	quadrip	Level	Level IV	59,61	62,56	13	18	5	5	18	23	Y	N	Y
10	G	12	diplegi	Level	Level I	96,75	99,44	91	91	35	35	126	126	Y	Y	Y
11	B	5	quadrip	Level	Level III	59,2	63,36	25	34	32	32	57	66	Y	Y	N
12	G	7	quadrip	Level	Level IV	49,33	52,56	13	20	27	27	40	47	Y	N	Y
13	B	12	hemipl	Level	Level II	100	100	91	91	35	35	126	126	Y	Y	N
14	G	13	quadrip	Level	Level V	29,33	32,61	13	21	5	5	18	26	Y	Y	N
15	B	5	hemipl	Level	Level III	68,36	72,16	16	18	23	23	39	41	Y	Y	Y
16	G	12	hemipl	Level	Level I	98,65	100	91	91	35	35	126	126	Y	Y	Y
17	G	15	diplegi	Level	Level I	89,89	94,85	91	91	35	35	126	126	Y	Y	Y
18	B	5	hemipl	Level	Level II	94,55	97,81	35	42	7	7	42	49	Y	Y	Y
19	G	15	quadrip	Level	Level III	54,89	59,61	13	15	5	5	18	20	Y	Y	N
20	B	5	quadrip	Level	Level IV	21	22,78	13	20	16	16	29	36	Y	Y	Y
21	G	11	hemipl	Level	Level II	95,13	98,65	75	77	31	31	106	108	N	Y	N
22	G	5	hemipl	Level	Level I	94,85	91,92	55	59	35	35	90	94	Y	Y	Y
23	B	15	quadrip	Level	Level V	45,89	49,33	26	29	35	35	61	64	Y	N	Y
24	B	13	hemipl	Level	Level II	97,81	99,44	88	88	35	35	123	123	Y	Y	N
25	B	9	quadrip	Level	Level V	15,67	17,11	13	13	20	20	33	33	Y	N	Y
26	B	10	quadrip	Level	Level IV	62,13	64,65	44	46	35	35	79	81	Y	Y	Y

Table V: Descriptive data of the children G: Girl, B:Boy N: no, Y: yes

Table VI: Child Health Questionnaire Subscales

Child Health Questionnaire Subscales	Pre-treatment X ±SD	Post-treatment X ±SD	P Value†
Physical function	31.6 ± 33.4	35 ± 35.7	0.018
Role Limitations due to the Emotional/Behavioral Causes	63.2 ± 29.9	66.6 ± 31.8	0.020
Role Limitations due to Physical Causes	58.9 ± 34.0	60.2 ± 33.0	0.317
Pain	81.9 ± 21.3	86.1± 20.2	0.026
Behavior	71.3 ± 16.0	75.5 ± 45.0	0.009
Mental health	59.2 ± 12.8	66.1 ± 11.9	0.001
Self esteem	65.3 ± 12.5	68.1 ± 12.3	0.014
General health	34.2 ± 15.7	37.7 ± 16.3	0.011
Emotional impact on the parent	44.5 ± 22.3	46.7 ± 20.6	0.066
Time impact on the parent	43.5 ± 28.4	46.5 ± 27.5	0.357
Family activities	53.5 ± 21.1	59.2 ± 20.5	0.001
Family harmony	59.4 ± 25.0	57.5 ± 23.8	0.157

† : Wilcoxon sign test.

the establishment of a relationship between activity and participation[6,28].

An increase was found in the gross motor functions of the children in our study. Considering that a significant part of the goals identified before the treatment were related to gross motor functions, this increase can be said to be expected and is supported by various studies in the literature[4,30]. When we take into account the effect of this increase in gross motor functions on the quality of life, an increase is found in the field of physical activity of the CHQ PF-50. In addition, it can be said that the motor learning is not only at the repetition stage and is adapted to daily life. The treatment expectations of the family and the child play an important role in the rehabilitation of children with CP[6,31].

Asking for the child and family's views when determining the goal seems to increase the participation of the child to family activities in the family's opinion. Although GDT is not a behavioral-cognitive therapy approach and the purposes identified before treatment do not involve these components, the improvement in goal-directed motor functions has led to an improvement in the role limitations due to behavioral or emotional-behavioral reasons and contributed to the improvement in the self-esteem and mental health of the child. Determination of positive changes in quality of life measurement results that are subjective may be a result of the positive feedback following the more careful and systematic approach to the disabled children by their families during treatment, considering the fact that the quality of life scale was completed by the mothers. One may think that the lack of a change in the cognitive area of WeeFIM, the functional independence scale used in our study, is normal as WeeFIM does not evaluate the participation dimension and does not reflect the change and improvement perceived by the family.

The focus of the applied therapy involves goals related more to daily living activities than gross motor skills and increase in gross motor function may therefore be seen as an unexpected result; however, daily living activities are known to be largely based on gross motor functions[29]. It can be suggested that the therapy we used improved the daily living activities and therefore also gross motor functions.

No change was found in the body functions of the children in our study. Although intensive therapy approaches were found to affect spasticity negatively in earlier studies, the lack of any change in spasticity in this study supports the view that intensive therapy with GD-NDT will not increase spasticity. The lack of any change in ankle selective dorsiflexion motor control in the children is an expected result as the applied therapy approach does not focus specifically on this function. This study is consistent with the study of Lowing et al [30]. We found that 76.9% of the goals were achieved after treatment. Although consistent with the results of Löwing, our rate was lower. The presence of such a relative difference between the studies stems from the low number of GMFCS level IV patients in the Löwing study and the relatively higher level IV and V patients higher (38.4%) and the absence of level V patients in our study. The motor function improvement of level I and II children have been found to be faster in various studies[30].

The main limitation of this study was the lack of hypotonic, dyskinetic, ataxic or mixed types of cerebral palsy beside spastic type. The second limitation was the number of participations. Also we have not control group but control group design is very difficult for these style study because all children with CP must be given therapy and no therapy group is not ethical issue.

CONCLUSION

The quality of life and gross motor functions of children increased after GD-NDT, especially regarding independence in daily living activities such as self-care, transfers and locomotion and the levels of quality of life. The biggest advantage of our study was the implementation of the training for the selected goal- directed activities by the physiotherapists who took 8 weeks of basic Bobath training. The greatest limitation of our study was the lack of long-term follow-up. Although there was an increase in GAS and this increase was reflected in the child's daily life, the maintenance of the acquired skills and the effect on motor learning is uncertain. Future studies aiming to determine the effectiveness of GDT should therefore be planned with larger series and as a randomized controlled study including follow-up periods.

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