The Effect of Rood's Ontogenic Motor Patterns on Trunk Control and Balance in Spastic Diplegic Cerebral Palsy Children

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ABSTRACT

Background: Cerebral palsy (CP) is a non-progressive neuromotor disorder affecting movement, muscle tone, and posture due to brain injury during early development. Effective interventions are essential for improving functional outcomes in children with spastic diplegic CP.

Objective: This study aimed to evaluate the effects of Rood's Ontogenic Motor Patterns (ROMP) on trunk control and balance in children with spastic diplegic cerebral palsy.

Methods: A single-blinded randomized clinical trial was conducted with 22 children aged 3-10 years, diagnosed with spastic diplegic CP. Participants were randomly assigned to two groups: Group A received Functional Electrical Stimulation with ROMP, and Group B received conventional physical therapy. The intervention lasted five weeks, with three sessions per week. Outcomes were assessed using the Modified Ashworth Scale, Gross Motor Function Measurement Scale (GMFM-88), and Pediatric Berg Balance Scale. Data were analyzed using SPSS 27.

Results: Group A showed significant improvement in balance (PBBS: pre 13.81 ± 1.64, post 24.18 ± 4.67; p=0.017) and GMFM-88 scores (pre 9.95 ± 109.50, post 15.73 ± 173.0; p<0.001). Spasticity reduced significantly in the ROMP group (MAS: pre 11.50 ± 126.50, post 7.30 ± 73.00; p=0.010).

Conclusion: ROMP significantly improved balance and reduced spasticity in children with spastic diplegic CP compared to conventional therapy, suggesting its potential integration into rehabilitation programs.

INTRODUCTION

Cerebral palsy (CP) is a prevalent neuromotor disorder characterized by a range of movement and posture abnormalities due to non-progressive damage to the developing brain, typically occurring during the prenatal to neonatal stages. This condition, first described by William Little over 170 years ago, is not a specific disease but rather a spectrum of motor disabilities resulting from various etiologies, including prenatal, perinatal, and postnatal factors such as hypoxic-ischemic events, infections, and trauma (1, 2). Despite the non-progressive nature of the initial brain injury, children with CP often develop secondary conditions over time that can significantly impact their functional abilities, such as muscle tone abnormalities, coordination deficits, and other musculoskeletal complications (3). These secondary conditions underscore the importance of effective therapeutic interventions to enhance motor control and overall functional outcomes in this population.

The classification of CP is multifaceted, involving considerations of motor type, anatomical distribution, and functional capabilities. The Gross Motor Function Classification System (GMFCS) and the Gross Motor Function Measurement Scale (GMFM-88) are commonly employed to assess and categorize motor function in children with CP, aiding in the development of tailored rehabilitation strategies (12). Among the various types of CP, spastic diplegia is distinguished by increased muscle tone primarily affecting the lower extremities, often resulting in significant challenges with trunk control and balance (4, 5). Effective management of these motor impairments is crucial for improving mobility and quality of life in affected children.

Rood's Ontogenic Motor Patterns (ROMP) represent a therapeutic approach that emphasizes the use of sensory inputs to facilitate motor responses and the sequential development of motor skills. This method, pioneered by Margaret Rood in the 1940s, incorporates facilitation and inhibition techniques to modulate muscle activity and promote functional movement patterns through a progression of stability and mobility exercises (16, 17). The approach is based on the principle that motor control develops in a cephalocaudal and proximodistal direction, with interventions tailored to the individual's developmental stage and motor abilities (18). Rood's techniques have been used alongside other neurodevelopmental therapies, such as the Bobath approach, to enhance motor function in children with CP, although the efficacy of these combined methods remains a subject of ongoing research (19, 20).

The therapeutic potential of Rood's Ontogenic Motor Patterns for improving trunk control and balance in children with spastic diplegic CP has garnered interest, given the critical role of trunk stability in functional mobility and

balance (21). Previous studies have demonstrated that targeted interventions focusing on core stability and proprioceptive feedback can lead to significant improvements in postural control and motor performance (22). However, the effectiveness of Rood's specific motor patterns in this context has not been extensively explored. This study aims to evaluate the impact of Rood's Ontogenic Motor Patterns on trunk control and balance in children with spastic diplegic CP, comparing outcomes with those achieved through conventional physical therapy interventions. By assessing changes in muscle tone, gross motor function, and balance using established measures such as the Modified Ashworth Scale, GMFM-88, and the Pediatric Berg Balance Scale, this research seeks to elucidate the potential benefits of ROMP in enhancing motor function in this population (23, 24).

The significance of this study lies in its potential to inform clinical practice by providing evidence on the efficacy of ROMP as a rehabilitative strategy for children with spastic diplegic CP. Enhancing trunk control and balance is paramount for improving overall functional abilities and independence, which are critical goals in the management of CP (25). By exploring the comparative effects of ROMP and conventional therapy, this study aims to contribute to the growing body of literature supporting multimodal rehabilitation approaches for children with CP, ultimately guiding clinicians in optimizing therapeutic interventions to meet the unique needs of this diverse patient population (26).

MATERIAL AND METHODS

The study employed an experimental design following a single-blinded randomized clinical trial approach to investigate the effects of Rood's Ontogenic Motor Patterns on trunk control and balance in children with spastic diplegic cerebral palsy. A total of 22 children were recruited using a consecutive sampling method based on predefined inclusion and exclusion criteria. Eligible participants were children aged 3 to 10 years, of either gender, who were diagnosed with spastic diplegic cerebral palsy, classified within Gross Motor Function Classification System (GMFCS) levels II to IV, and had Modified Ashworth Scale scores ranging from 0 to 2. Participants were required to have a Pediatric Berg Balance Scale (PBBS) score of more than 20 and the ability to follow verbal commands. Children were excluded if they were uncooperative, had visual or intellectual impairments, were using anti-epileptic or anti-spasticity medications, had other types of cerebral palsy (e.g., hemiplegic, quadriplegic, ataxic), or had conditions such as severe mental abnormalities, cardiac anomalies affecting exercise tolerance, recent orthopedic surgery within the past four months, bony malalignments, or contractures.

The sample size of 22 participants was determined to be sufficient using Epitool, ensuring adequate power to detect significant differences between the intervention groups. Participants were randomly allocated into two groups using the chit-and-draw method: Group A received Functional Electrical Stimulation (FES) combined with Rood's Ontogenic Motor Patterns using an inhibitory approach, while Group B received conventional physical therapy. The interventions were administered over a period of five weeks, with sessions held three days a week. Ethical approval for the study was obtained from the Ethical Review Committee of The University of Faisalabad, and the study was registered with the Iranian Registry of Clinical Trials (IRCT) under the trial ID IRCT20240306061198N3, ensuring adherence to ethical standards, including the Declaration of Helsinki, in all aspects of the research.

Data collection took place at the Children's Hospital & Institute of Child Health Care in Faisalabad, specifically within the Outpatient Department of the Physical Therapy Department. Baseline assessments were conducted before the intervention, and follow-up assessments were performed immediately after the five-week intervention period. Outcome measures included muscle tone assessed by the Modified Ashworth Scale, trunk control and balance evaluated using the Pediatric Berg Balance Scale, and gross motor function measured with the GMFM-88. These measures provided comprehensive insights into the impact of the interventions on the participants' motor abilities.

Statistical analysis was conducted using SPSS version 27. The Shapiro-Wilk test was initially applied to assess the normality of the data. For normally distributed data, paired t-tests were used for within-group comparisons, and independent t-tests were employed for between-group analyses. Non-parametric tests, specifically the Mann-Whitney test, were utilized for non-normally distributed data to compare the effectiveness of the interventions between the two groups. All statistical tests were conducted with a significance level set at $p < 0.05$, ensuring robust analysis of the data to determine the efficacy of the interventions.

The rigorous methodological approach, including the random allocation of participants, standardized intervention protocols, and use of validated outcome measures, was designed to minimize bias and enhance the reliability of the findings. The study's design and analytical methods aimed to provide clear evidence on the effectiveness of Rood's Ontogenic Motor Patterns in improving trunk control and balance in children with spastic diplegic cerebral palsy, with potential implications for clinical practice and the development of targeted rehabilitation programs for this population.

RESULTS

The results of the study, including the statistical analysis and tables, are presented below to provide a clear and comprehensive understanding of the findings. The study involved 22 children with spastic diplegic cerebral palsy, divided equally into two groups: one receiving Functional Electrical Stimulation with Rood's Ontogenic Motor Patterns (ROMP) The other receiving conventional physical therapy. Descriptive statistics for age and gender distribution are summarized in Table 1. The mean age of participants in the conventional treatment group was 5.54 years (±2.42), while the ROMP group had a mean age of 6.91 years (±2.21). Gender distribution was balanced with 50% male and 50% female participants across both groups.

Table 1: Descriptive Statistics of Age & Gender

Group	N	Mean Age	Std. Deviation Age
Conventional Treatment	11	5.54	2.42
Rood's Motor Ontogenic Patterns	11	6.91	2.21

Table 2: Gender Distribution

Gender	Frequency	Percentage
Female	11	50.0
Male	11	50.0

Table 3: GMFM-88 Level Classification

GMFM-88 Level	Frequency	Percentage	Mean
II	6	27.3	1.86
III	13	59.1	1.86
IV	3	13.6	1.86

Table 4: Pediatric Berg Balance Scale and Gross Motor Function - Between Group Analysis

Variable	Assessment	Conventional Mean ± SD	ROMP Mean ± SD
Pediatric Berg Balance Scale	PRE	13.81 ± 1.64	13.45 ± 3.49
Pediatric Berg Balance Scale	POST	20.18 ± 2.40	24.18 ± 4.67
Gross Motor Function Measurement Scale	PRE	9.95 ± 109.50	10.05 ± 113.5
Gross Motor Function Measurement Scale	POST	10.27 ± 80.0	15.73 ± 173.0

The mean age of children participating in conventional treatment was 5.54 ± 2.42 years, while in the Rood's Ontogenic Motor Patterns group, it was 6.91 ± 2.21 years.

Gender distribution was equal, with 11 males and 11 females, representing 50% each. The GMFM-88 levels among participants showed 27.3% in Level II, 59.1% in Level III, and 13.6% in Level IV, with a mean score of 1.86 (±0.64).

The Pediatric Berg Balance Scale scores showed no significant difference between groups before the intervention ($p = 0.761$). However, post-intervention results indicated a significant improvement in balance in the ROMP group compared to the conventional group, with a t-value of -2.59 and a p-value of 0.017.

Gross Motor Function Measurement Scale (GMFM-88) scores indicated a significant difference post-intervention between the ROMP and conventional groups ($p < 0.001$), demonstrating greater improvements in the ROMP group.

The Modified Ashworth Scale results did not show a significant difference in pre-intervention scores between groups ($p = 1.000$). However, a significant reduction in spasticity was observed in the ROMP group post-intervention ($p = 0.010$).

The results highlight that Rood's Ontogenic Motor Patterns significantly improve balance and trunk control in children with spastic diplegic cerebral palsy compared to conventional therapy. The ROMP group's higher post-intervention scores on the Pediatric Berg Balance Scale and GMFM-88 indicate enhanced motor performance and functional outcomes. The reduction in Modified Ashworth Scale scores further suggests a positive impact on muscle tone and spasticity, underscoring the therapeutic potential of ROMP in this population. These findings support the integration of ROMP into rehabilitation programs for children with CP to optimize balance and motor function.

Overall, the study demonstrates that Rood's Ontogenic Motor Patterns provide superior benefits in improving balance and reducing spasticity compared to conventional therapy, with significant implications for clinical practice in the management of spastic diplegic cerebral palsy. Further research with larger sample sizes and longer follow-up periods is recommended to validate these findings and explore the long-term effects of ROMP in this patient population.

DISCUSSION

The findings of this study indicated that Rood's Ontogenic Motor Patterns (ROMP) were significantly more effective than conventional physical therapy in improving balance and trunk control in children with spastic diplegic cerebral palsy. This aligns with previous research that has highlighted the benefits of sensory-motor approaches in enhancing motor functions in children with neuromotor disorders (22).

The ROMP intervention, which combines facilitation and inhibition techniques to stimulate motor development, appeared to target critical aspects of balance and postural stability, supporting the observed improvements in the Pediatric Berg Balance Scale and Gross Motor Function Measurement Scale scores. These outcomes are consistent with earlier studies that have demonstrated the efficacy of neurodevelopmental treatments in enhancing motor skills and functional independence in children with cerebral palsy (23, 24).

The significant improvement in balance observed in the ROMP group suggests that the approach effectively addressed core stability and proprioceptive feedback, fundamental components of motor control and balance. This finding is particularly relevant given the documented challenges in trunk control and balance among children with spastic diplegic cerebral palsy, which often impede their functional mobility and quality of life (21). By emphasizing the sequential development of motor patterns and utilizing sensory inputs to modulate muscle activity,

ROMP may provide a robust framework for addressing these deficits, potentially offering a more targeted and effective therapeutic option than conventional therapy alone.

The reduction in spasticity as measured by the Modified Ashworth Scale further supports the utility of ROMP in managing neuromotor impairments in this population. Spasticity is a common and challenging feature of cerebral palsy that contributes to functional limitations and hinders rehabilitation progress. The observed decrease in muscle tone following ROMP intervention is consistent with the proposed mechanisms of sensory-motor approaches, which aim to modulate neural circuits and reduce abnormal muscle contractions (26). These results echo findings from previous studies that have shown neuroplastic changes in the central nervous system as a response to targeted therapeutic interventions, suggesting that ROMP may facilitate motor learning and adaptation through repeated sensorimotor engagement (25).

Despite the promising results, the study had several limitations that should be considered. The small sample size of 22 participants limits the generalizability of the findings, and the short intervention period may not fully capture the long-term effects of ROMP. Furthermore, individual differences in baseline motor abilities and response to treatment were not extensively explored, which could influence the observed outcomes. Future studies with larger sample sizes and extended follow-up periods are recommended to validate the efficacy of ROMP and examine its sustainability over time. Additionally, subgroup analyses based on age, severity of impairment, and other relevant factors could provide insights into which populations might benefit most from this intervention, thereby facilitating personalized treatment approaches (27).

Another limitation was the single-blinded design, which may introduce bias in the assessment of outcomes. Although efforts were made to standardize the intervention protocols and minimize variability, the potential influence of subjective factors cannot be entirely ruled out. Moreover, the study did not account for external factors such as family support and environmental modifications, which are known to impact rehabilitation outcomes in children with cerebral palsy (28). Addressing these variables in future research could enhance the understanding of how contextual factors interact with therapeutic interventions like ROMP.

The strengths of this study include its randomized clinical trial design, which provided a rigorous framework for comparing the effects of ROMP with conventional therapy. The use of validated outcome measures such as the Pediatric Berg Balance Scale and GMFM-88 ensured that the assessments were reliable and clinically meaningful. Additionally, the study's focus on a specific subgroup of cerebral palsy, spastic diplegia, allowed for a targeted investigation of therapeutic effects, which is crucial for developing tailored interventions in this heterogeneous condition.

CONCLUSION

In conclusion, the study provides evidence that Rood's Ontogenic Motor Patterns are more effective than conventional therapy in improving balance and reducing spasticity in children with spastic diplegic cerebral palsy. These findings suggest that incorporating ROMP into rehabilitation programs could offer enhanced benefits for motor function and overall quality of life in this population. Future research should explore the integration of ROMP with other therapeutic modalities and investigate the long-term impacts of this approach to optimize clinical outcomes in children with cerebral palsy.

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