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Effect of Neurodevelopmental Treatment on Mobility in Spastic Quadriplegic Cerebral Palsy: A Case Report

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Abstract

Background: Spastic quadriplegic cerebral palsy is a severe form of cerebral palsy characterized by marked motor impairment, postural dysfunction, and sensory processing deficits that limit functional mobility. Neurodevelopmental Treatment (NDT) is widely used in pediatric rehabilitation to improve motor control and functional abilities, although evidence in children with severe functional limitations remains limited.

Objective: This study aimed to evaluate the effectiveness of Neurodevelopmental Treatment in improving sensory processing and gross motor function in a child with spastic quadriplegic cerebral palsy.

Methods: A descriptive analytical case report was conducted in a 5 year old boy classified as GMFCS Level V. The intervention was provided for four weeks, three sessions per week, with each session lasting 45 minutes. Outcome measures included the Short Sensory Profile (SSP), Modified Ashworth Scale (MAS), and Gross Motor Function Measure 88 (GMFM 88). Data were analyzed descriptively using percentage changes.

Results: Sensory processing improved, indicated by an increase in SSP total score from 106/190. Gross motor function also improved, particularly in Dimension A (lying and rolling), with GMFM 88 scores increasing from 9.80% to 10.80%. Spasticity levels showed no significant change, with MAS scores remaining stable at a mean score of 1–2.

Conclusion: Neurodevelopmental Treatment improved sensory processing and basic gross motor function, especially in early motor activities such as lying and rolling. However, no significant effect on spasticity was observed during the short intervention period. Longer intervention duration may be needed to influence muscle tone.

Keywords

Motor Skills Disorders; Muscle Spasticity; Postural Balance; Rehabilitation; Sensory Processing; Neurodevelopmental Treatment

Introduction

Cerebral palsy (CP) is a non-progressive neurological disorder caused by injury or abnormal development of the immature brain, leading to impairments in movement, posture, and motor control. It represents the most common cause of childhood physical disability worldwide, with an estimated prevalence ranging from 1 to 4 per 1,000 live births.[1] The burden of CP is disproportionately higher in low- and middle-income countries, where limited access to maternal, neonatal, and rehabilitation services contributes to delayed diagnosis and suboptimal management.[2]

Among the various clinical subtypes, spastic cerebral palsy accounts for the majority of cases, characterized by increased muscle tone, hyperreflexia, and impaired voluntary movement.[3] Spastic quadriplegia represents the most severe form, involving all four limbs and resulting in profound functional limitations, including inability to sit, stand, or walk independently. This condition is often associated with extensive central nervous system damage, leading not only to motor deficits but also to sensory processing dysfunction and impaired postural control.[4] These combined impairments significantly restrict a child's ability to interact with the environment and perform basic functional activities.

In clinical practice, children with severe CP (Gross Motor Function Classification System [GMFCS] Level V) exhibit minimal voluntary motor control and complete dependence on caregivers. Such severe functional limitations require targeted rehabilitation strategies that address both motor and sensory components.[5] Sensory processing deficits, in particular, play a critical role in motor performance, as effective movement depends on the integration of sensory input and motor output. Therefore, interventions that simultaneously target sensorimotor integration are essential to improve functional outcomes in this population.[6]

Neurodevelopmental Treatment (NDT) is a widely applied therapeutic approach in pediatric neurorehabilitation, focusing on facilitating normal movement patterns and inhibiting abnormal reflex activity through guided sensorimotor experiences.[7] This approach emphasizes postural control, alignment, and functional movement through the use of key points of control and task-specific facilitation. Evidence from recent studies indicates that NDT can improve trunk control, balance, and motor coordination in children with cerebral palsy.[8] Furthermore, quasi-experimental and systematic evidence suggests that NDT contributes to significant improvements in gross motor function, particularly when combined with conventional therapy.[9]

However, despite its widespread clinical use, the effectiveness of NDT remains a subject of debate. Systematic evaluations have reported inconsistent findings, with some studies demonstrating significant functional improvements, while others show limited or non-significant effects depending on intervention duration, frequency, and patient characteristics.[10] In particular, most existing studies focus on children with mild to moderate functional limitations (GMFCS Levels I–III), whereas evidence in children with severe impairment (GMFCS Level V), especially those with spastic quadriplegia, remains scarce.[11]

In addition, previous research has predominantly emphasized motor outcomes, such as gross motor function and balance, while relatively few studies have explored the role of sensory processing as a contributing factor to motor improvement. This gap is

clinically important, as sensorimotor integration is fundamental to functional movement, particularly in children with severe neurological impairment.

Therefore, this case report addresses a critical gap in the literature by evaluating the effectiveness of Neurodevelopmental Treatment in a child with spastic quadriplegic cerebral palsy classified as GMFCS Level V. This study uniquely integrates both sensory (Short Sensory Profile) and motor (GMFM-88) outcomes to provide a more comprehensive understanding of intervention effects. The objective of this study is to evaluate the effectiveness of Neurodevelopmental Treatment in improving sensory processing, postural control, and gross motor function in a child with spastic quadriplegic cerebral palsy. This case is clinically significant as it represents a child with severe functional limitation (GMFCS Level V) managed in a clinical rehabilitation setting, where evidence for Neurodevelopmental Treatment remains limited, particularly in relation to sensorimotor outcomes.

Methods

This study employed a descriptive analytical case report design following the CARE guidelines. The study was conducted at PNTC Karanganyar Clinic from September 15 to October 9, 2025, including baseline assessment, intervention, and post-intervention evaluation phases. The participant was a 5-year-old boy diagnosed with spastic quadriplegic cerebral palsy classified as Gross Motor Function Classification System (GMFCS) Level V. The child demonstrated severe functional limitations and complete dependence in mobility. To ensure compliance with CARE guidelines, a clinical timeline illustrating the sequence of assessment, intervention, and evaluation is presented in Figure 1.

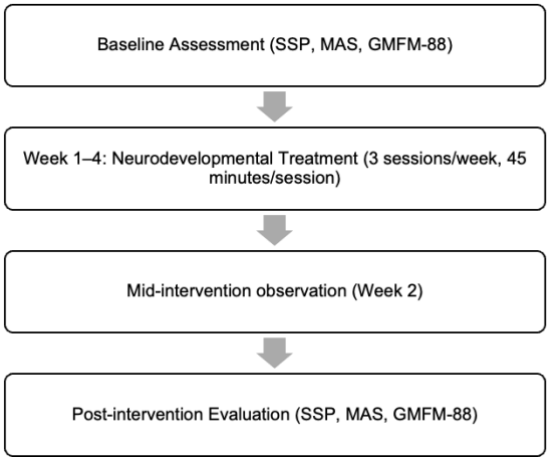

Figure 1. Clinical Timeline of Assessment, Intervention, and Evaluation

Inclusion criteria included a confirmed diagnosis of spastic quadriplegic cerebral palsy, age below 6 years, GMFCS Level V classification, and absence of intensive rehabilitation within the last three months. Exclusion criteria included uncontrolled seizures, acute medical conditions, or musculoskeletal deformities requiring surgical intervention. Purposive sampling was applied due to the single-case design. To provide a clear clinical overview, the participant's baseline characteristics are presented in Table 1.

Table 1. Baseline Characteristics of the Participant

Variable	Description
Age	5 years
Sex	Male
Diagnosis	Spastic quadriplegic cerebral palsy
GMFCS Level	Level V
Birth history	Vaginal delivery, 3.3 kg, 48 cm
Medical history	Seizures at 8 months, developmental delay
Functional status	Fully dependent for mobility

Outcome measures included the Short Sensory Profile (SSP), Modified Ashworth Scale (MAS), and Gross Motor Function Measure-88 (GMFM-88), which assess sensory processing, spasticity, and gross motor function, respectively. All instruments have demonstrated acceptable validity and reliability in pediatric neurological populations. The intervention consisted of Neurodevelopmental Treatment (NDT) administered three times per week for four weeks, with each session lasting 45 minutes. A structured protocol was applied to ensure reproducibility, as presented in Table 2.

Table 2. Neurodevelopmental Treatment (NDT) Protocol

Component	Description
Frequency	3 sessions/week
Duration	45 minutes/session
Total duration	4 weeks
Patient position	Supine, side-lying
Key points of control	Shoulder girdle and pelvis
Facilitation techniques	Guided rolling, trunk activation, head control facilitation
Inhibition techniques	Reduction of abnormal reflex patterns through slow passive movement
Sensory stimulation	Tactile (light touch), proprioceptive (joint compression)
Functional training	Rolling, supine-to-side transitions
Progression	Increased assistance → partial assistance
Session goal	Improve postural control and sensorimotor integration

The intervention was delivered progressively, beginning with full therapist assistance and gradually transitioning to partial facilitation as the patient demonstrated improved motor responses. In early sessions, emphasis was placed on postural alignment and sensory stimulation, while later sessions focused on active participation in rolling and transitional movements. Each session targeted specific functional goals, particularly improvement in trunk control and initiation of movement.

All interventions were delivered by a licensed physiotherapist specialized in pediatric neurorehabilitation. The intensity and progression were adjusted based on the patient's tolerance and response. Outcome assessments were conducted before and after the intervention period. Data were analyzed descriptively using absolute values and percentage changes. Visual trend analysis was applied to illustrate functional improvements.

Written informed consent was obtained from the patient's parents for participation and publication of this case report, including the use of clinical data and anonymized information. All identifying information has been removed to ensure patient confidentiality. This study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki. As this study represents a single case report without experimental intervention beyond standard clinical care, formal ethical clearance was not required according to institutional policy. No adverse events, such as fatigue, increased spasticity, or seizure recurrence, were reported during the intervention period.

Results

Baseline assessment demonstrated significant impairments in sensory processing, motor function, and spasticity. The Short Sensory Profile (SSP) total score was 106/190, indicating a "definite difference" classification across all sensory domains. Gross motor function, assessed using GMFM-88, showed a total score of 9.80%, with functional ability limited to Dimension A (lying and rolling). The participant was classified as GMFCS Level V, indicating severe functional limitation and complete dependence in mobility. Spasticity assessment using the Modified Ashworth Scale (MAS) revealed mild to moderate hypertonia, with most joints scoring 1, while ankle plantarflexors and dorsiflexors showed higher scores (2), indicating increased resistance to passive movement. Changes in sensory processing were evaluated using SSP across the intervention period. A progressive improvement was observed in the total score, indicating reduced sensory processing difficulties following intervention. The numerical values at each assessment point are presented to enhance the clarity and interpretability of sensory improvements over time. To illustrate this trend, Figure 2 presents the changes in SSP scores across assessment points.

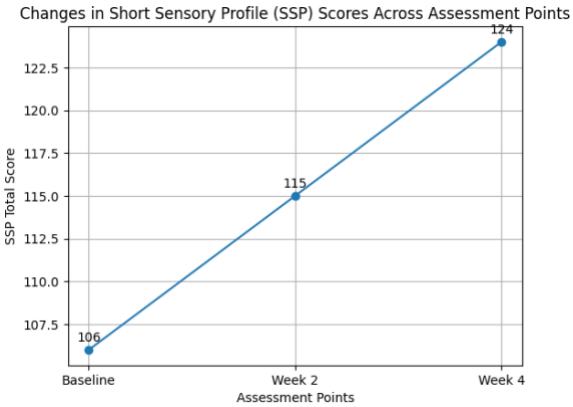

Figure 2. Changes in Short Sensory Profile (SSP) Scores Across Assessment Points

Overall, improvements were noted across multiple sensory domains, particularly in tactile sensitivity and movement sensitivity, suggesting enhanced sensory integration following the intervention. Spasticity outcomes assessed using MAS showed no observable change between pre- and post-intervention measurements. Scores remained stable across all assessed joints. For clarity, only joints demonstrating notable spasticity are presented in Table 3.

Table 3. Modified Ashworth Scale (MAS) Scores Before and After Intervention

Joint Movement	Pre-Intervention	Post-Intervention
Elbow extension	1+	1+
Knee flexion	1+	1+
Ankle plantarflexion	2	2
Ankle dorsiflexion	2	2
Ankle eversion	2	2

These findings indicate that the intervention did not produce measurable changes in muscle tone within the intervention period. Gross motor function assessed using GMFM-88 demonstrated improvement following the intervention, particularly in Dimension A (lying and rolling). The total GMFM score increased from 9.80% at baseline to 10.80% post-intervention. The GMFM-88 scores are presented with precise numerical values to illustrate the progression of gross motor function following the intervention. Figure 3 illustrates the progression of GMFM scores across the intervention period.

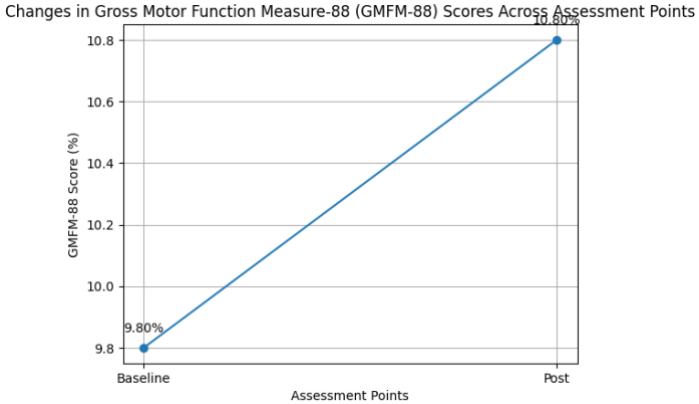

Figure 3. Changes in Gross Motor Function Measure-88 (GMFM-88) Scores Across Assessment Points

No functional changes were observed in Dimensions B (sitting), C (crawling and kneeling), D (standing), or E (walking, running, and jumping), which remained at 0% throughout the study. No adverse events, including fatigue, increased spasticity, or seizure recurrence, were reported during the intervention period.

Discussion

The findings of this case report demonstrate that Neurodevelopmental Treatment (NDT) contributed to improvements in sensory processing and gross motor function, particularly in basic motor activities such as lying and rolling. However, no changes were observed in spasticity following the short intervention period. These results highlight the selective impact of NDT on functional and sensorimotor domains rather than on muscle tone reduction.

Improvement in gross motor function, particularly in GMFM Dimension A, is consistent with previous evidence indicating that NDT facilitates early motor activities through postural alignment and guided movement patterns.[12] Furthermore, structured NDT programs have been shown to enhance functional independence and motor performance when applied consistently over time.[13]

The observed improvements can be explained through a neurophysiological framework. NDT emphasizes facilitation of normal movement patterns and inhibition of abnormal reflex activity through sensorimotor input.[14] This approach enhances postural control and motor coordination by optimizing afferent sensory feedback and motor output integration. As motor control in children with cerebral palsy relies heavily on sensory input, improvements in sensory processing may directly contribute to enhanced movement quality.[14]

This mechanism is supported by evidence indicating that sensorimotor integration plays a critical role in motor learning and functional performance in children with neurological disorders.[14] In this study, improvements in sensory processing (SSP) were observed alongside gains in motor performance, suggesting that enhanced sensory integration may have facilitated better motor planning and execution. This finding addresses an important gap in previous studies, which have largely focused on motor outcomes without adequately considering the role of sensory processing.[15]

Despite these positive findings, no change in spasticity was observed, which is consistent with the theoretical basis and existing literature on NDT. Spasticity in cerebral palsy is primarily caused by upper motor neuron lesions and altered neural excitability, making it relatively resistant to short-term therapeutic interventions. Previous studies have also reported that NDT does not consistently reduce spasticity, particularly in children with severe functional impairment.[16]

Moreover, the short duration of intervention (four weeks) may not be sufficient to induce measurable changes in muscle tone. Evidence suggests that longer intervention periods or combined therapeutic approaches may be required to achieve significant reductions in spasticity.[16] Additionally, the Modified Ashworth Scale (MAS) primarily measures resistance to passive movement and may not fully capture functional changes in motor performance.[17] Therefore, the absence of change in MAS scores does not necessarily indicate a lack of functional improvement.

It is also important to contextualize these findings within the broader literature, which presents mixed evidence regarding the effectiveness of NDT. While many studies report improvements in motor function and postural control, others suggest that NDT may not be superior to task-oriented or activity-based interventions.[18] This inconsistency may be attributed to heterogeneity in study design, intervention protocols, and patient characteristics.

Importantly, most existing studies have focused on children with mild to moderate impairment, whereas evidence in children with severe impairment (GMFCS Level V), particularly those with spastic quadriplegia, remains limited.[19] The present study contributes to this gap by demonstrating that even in severe cases, NDT may still provide clinically meaningful improvements in basic motor function and sensory integration.[20]

From a clinical perspective, these findings suggest that NDT remains a relevant therapeutic option, particularly when the goal is to enhance foundational motor abilities and sensorimotor coordination rather than to directly reduce spasticity. Clinicians may consider integrating NDT with complementary approaches to maximize rehabilitation outcomes across multiple domains.

This study has several limitations. First, as a single case report, the findings cannot be generalized to the broader population of children with cerebral palsy. Second, the short duration of intervention limits the ability to observe long-term effects, particularly on spasticity. Third, the absence of a control condition and inferential statistical analysis restricts causal interpretation.

Future research should involve larger samples, longer intervention durations, and multimodal rehabilitation approaches. Further investigation into the interaction between sensory processing and motor function may also provide important insights for optimizing interventions in children with severe cerebral palsy.

Conclusion

Neurodevelopmental Treatment (NDT) demonstrated effectiveness in improving sensory processing and gross motor function, particularly in basic motor activities such as lying and rolling, in a child with spastic quadriplegic cerebral palsy classified as GMFCS Level V. These improvements suggest that NDT contributes to enhanced postural control, motor coordination, and sensorimotor integration, which are essential for early functional mobility.

However, no changes were observed in spasticity following the four-week intervention period, indicating that short-term NDT may not be sufficient to influence muscle tone in children with severe neurological impairment. This finding reinforces the understanding that functional motor gains may occur independently of changes in spasticity.

From a clinical perspective, NDT can be considered a valuable therapeutic approach for improving foundational motor abilities in children with severe cerebral palsy. Nevertheless, longer intervention duration and integration with complementary rehabilitation strategies may be required to achieve broader functional outcomes, including potential modulation of spasticity. Further research involving larger sample sizes, longer follow-up periods, and multimodal interventions is recommended to strengthen the evidence base and optimize rehabilitation strategies for this population. Longer intervention duration (>4 weeks) is recommended to achieve potential modifications in muscle tone and optimize functional outcomes.

Author Contribution

Yudith Leo Bantara: Conceptualization, Methodology, Investigation, Data Curation, Formal Analysis, Writing Original Draft, Writing Review and Editing.
Adnan Faris Naufal: Supervision, Methodology, Validation, Writing Review and Editing.
Arif Kurniawan: Data Interpretation, Validation, Writing Review and Editing, Project Administration.

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Conflict of Interest Statement

The authors declare no conflict of interest.

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This study received no external funding.

Ethics Statement

Written informed consent was obtained from the patient's parents for participation and publication of this case report, including the use of anonymized clinical data. All procedures were conducted in accordance with the ethical principles of the Declaration of Helsinki.

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