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Multimodal Physiotherapy for Spasticity and Motor Function in Diplegic Cerebral Palsy: A Case Report

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Abstract
Background: Spastic diplegic cerebral palsy is a neurodevelopmental disorder characterized by lower limb spasticity and impaired gross motor function. Although physiotherapy is widely applied, evidence regarding the clinical effectiveness of multimodal interventions remains limited, particularly in individual case contexts. This case highlights the short-term effects of a structured multimodal physiotherapy approach in a real-world clinical setting with limited resources.
Objective: To evaluate the clinical outcomes of a multimodal physiotherapy program on spasticity and gross motor function in a child with spastic diplegic cerebral palsy.
Methods: This study employed a single-case report design. A 3-year-8-month-old male with spastic diplegic cerebral palsy received a 4-week multimodal physiotherapy intervention consisting of passive range of motion, neurosensory stimulation, stability and proprioception training, and gait training. Spasticity was assessed using the Modified Ashworth Scale (MAS), and functional ability was measured using the Gross Motor Function Measure (GMFM-88). Outcomes were recorded across five time points (T1–T5) and analyzed descriptively.
Results: Spasticity decreased from grade 3 to 2 in the knee and ankle joints, while remaining stable at grade 2 in the hip. No changes were observed in muscle strength, which remained dominated by reflex and passive tone patterns. The GMFM total score increased from 34.3% to 36.6%, with improvements across all dimensions, particularly in standing and mobility-related activities.
Conclusion: Multimodal physiotherapy demonstrated gradual improvements in spasticity and gross motor function; however, no transition from reflexive to voluntary motor control was observed. These findings should be interpreted cautiously due to the single-case design and limited generalizability.

Keywords
Cerebral Palsy; Spastic Diplegia; Physical Therapy Modalities; Spasticity; Gross Motor Function Measure

Introduction

Cerebral palsy (CP) comprises a group of permanent, non-progressive neurodevelopmental disorders that affect movement and posture, leading to activity limitations and long-term disability.[1] These motor impairments are frequently accompanied by a range of comorbid conditions, including sensory deficits, cognitive impairment, epilepsy, and musculoskeletal deformities, which further compromise functional independence and quality of life.[1] Among the clinical subtypes, spastic diplegia is one of the most prevalent forms, primarily affecting the lower extremities and resulting in gait abnormalities, impaired postural control, and reduced participation in daily activities.[2,3]

Globally, the prevalence of CP ranges from 1.5 to 3 per 1,000 live births in high-income countries, while higher rates are reported in low- and middle-income countries due to disparities in prenatal and perinatal care.[4,5] The burden of CP is particularly significant in resource-limited settings, where delayed diagnosis, limited access to rehabilitation services, and sociocultural barriers contribute to suboptimal outcomes.[6] In Indonesia, epidemiological data remain scarce; however, existing evidence indicates that diagnosis is often delayed beyond the critical period for neuroplasticity, thereby limiting the effectiveness of early intervention strategies.[7,8]

Physiotherapy plays a central role in the management of CP, with the primary goals of reducing spasticity, improving motor function, and enhancing participation.[9] Contemporary evidence emphasizes the importance of task-specific, intensive, and goal-directed interventions to optimize neuroplastic adaptations.[10] Interventions such as gait training, strength training, and activity-based therapy have demonstrated varying levels of effectiveness, whereas the benefits of traditional approaches, including neurodevelopmental therapy, remain inconsistent.[11,12] This variability highlights the need for integrated or multimodal approaches that combine multiple therapeutic components to address the complex and multidimensional impairments observed in children with CP.

Despite growing interest in multimodal physiotherapy, current evidence remains limited and heterogeneous, particularly regarding its clinical application in children with spastic diplegic CP.[9,13] Most studies focus on single-modality interventions or controlled experimental settings, which may not fully reflect real-world clinical practice. Furthermore, there is a lack of detailed case-based evidence illustrating how multimodal interventions influence spasticity, motor control, and functional outcomes in individual patients.[14,15] This gap is especially relevant in low-resource clinical contexts, where individualized and adaptable treatment strategies are essential.

Therefore, this case report aims to describe the clinical outcomes of a multimodal physiotherapy program on spasticity and gross motor function in a child with spastic diplegic cerebral palsy. This report seeks to contribute to the existing literature by providing a clinically grounded perspective on the application and potential benefits of multimodal rehabilitation in a real-world setting.

Methods

This study was conducted as a single-case report in accordance with the CARE (CAse REport) guidelines to ensure comprehensive and transparent clinical reporting. The study was carried out over a 4-week period, from September 15 to October 9, 2025, at the Pediatric Physiotherapy Unit of a secondary-level hospital in Semarang, Indonesia. The clinical setting consisted of an outpatient rehabilitation facility equipped with standard pediatric physiotherapy equipment, including therapy mats, balance boards, and assistive devices for gait training.

The subject was a 3-year-8-month-old male diagnosed with spastic diplegic cerebral palsy by a pediatric neurologist based on clinical examination and developmental history. The patient presented with delayed motor development, particularly in transitions from sitting to standing, inability to stand independently, and impaired gait pattern. Birth history indicated delayed crying after delivery, suggesting possible perinatal hypoxic events. The patient experienced seizures at the age of 7 months, predominantly affecting the left side. There was no reported family history of similar neurological conditions. Gross motor development had been delayed since infancy, particularly in lower extremity function due to spasticity.

The Gross Motor Function Classification System (GMFCS) level was not formally assessed at baseline due to incomplete clinical documentation; however, based on observed functional limitations, the patient demonstrated characteristics consistent with moderate motor impairment affecting standing and walking abilities. This limitation should be considered when interpreting the findings. Differential diagnoses such as neuromuscular disorders, genetic syndromes, and progressive neurological conditions were considered unlikely based on the non-progressive clinical presentation and neurological evaluation.

Anthropometric data and Gross Motor Function Classification System (GMFCS) level were not formally documented at baseline, which represents a limitation in clinical characterization. The Gross Motor Function Classification System (GMFCS) is widely used to classify functional mobility in children with cerebral palsy into five levels based on self-initiated movement, particularly sitting and walking abilities.[16,17]

Data collection involved both primary and secondary sources. Primary data were obtained through direct physiotherapy assessment, while secondary data were collected from medical records and caregiver reports. Spasticity was evaluated using the Modified Ashworth Scale (MAS), a commonly used clinical scale for grading muscle tone, although its sensitivity and inter-rater reliability have known limitations.[18] Functional ability was assessed using the Gross Motor Function Measure (GMFM-88), a validated and reliable instrument specifically developed for children with cerebral palsy to quantify changes in gross motor function.[19] Muscle strength was assessed qualitatively based on observed movement patterns and categorized as reflex-dominant (R) or tone-dominant (T), indicating the absence of controlled voluntary movement.

The intervention program consisted of a multimodal physiotherapy approach designed to address the multifactorial impairments associated with cerebral palsy. The primary objectives included reducing spasticity, maintaining joint mobility, enhancing sensory integration, and improving functional motor performance. The intervention protocol comprised passive range of motion (ROM), neurosensory stimulation, stability and proprioception training, and gait training. All interventions were delivered by a licensed physiotherapist with clinical experience in pediatric neurorehabilitation.

Passive ROM exercises involved gentle flexion and extension movements at the hip, knee, and ankle joints within a pain-free range, administered for approximately 15 minutes per session, twice weekly. Neurosensory stimulation included tactile and proprioceptive inputs such as light stroking, joint compression, and patterned sensory stimulation applied to the trunk and extremities for approximately 30 minutes per session. Stability and proprioception training involved assisted sitting and standing balance exercises, weight-bearing activities, and the use of a balance board to facilitate postural control. Gait training was conducted daily for approximately 10 minutes, focusing on assisted ambulation over short distances (5–10 meters) with manual facilitation to improve step pattern and weight shifting.

The rationale for combining these modalities is based on the understanding that motor dysfunction in cerebral palsy arises from both neural and musculoskeletal impairments. Passive ROM is intended to maintain joint mobility and modulate stretch reflex activity, while neurosensory stimulation enhances sensory processing and motor integration. Stability and proprioception training target postural control mechanisms, and gait training provides task-specific practice to improve functional mobility.[20]

No adverse events were reported during the intervention period. The patient completed all scheduled sessions, indicating good adherence; however, adherence to home-based exercises was not objectively measured. Outcomes were recorded at five time points (T1–T5) to capture short-term changes over the intervention period. The clinical workflow of the study is summarized in Table 1.

Table 1. Clinical Procedure Flow of the Case Report

Step	Description
1	Patient presentation with motor delay complaints
2	Clinical assessment using MAS, GMFM-88, and muscle strength observation
3	Diagnosis confirmation by pediatric neurologist
4	Baseline measurement (T1)
5	Multimodal physiotherapy intervention (4 weeks)
6	Serial assessments at T2–T5
7	Outcome evaluation

Data analysis was conducted descriptively by comparing changes in outcome measures across the five time points. Given the single-case design and absence of a control group, no inferential statistical analysis was performed. Instead, trends in spasticity and functional outcomes were interpreted within a clinical context. Informed consent was obtained from the patient's parents prior to participation and publication of this case report. Caregiver involvement was reported as consistent; however, adherence to home-based exercises was not quantitatively monitored.

Results

Clinical outcomes were recorded at five time points (T1–T5) to capture short-term changes in spasticity, muscle strength, and gross motor function following the multimodal physiotherapy intervention. The data are presented to describe temporal patterns across the intervention period. Spasticity of the lower extremities was assessed using the Modified Ashworth Scale (MAS), where higher scores indicate increased resistance to passive movement. The distribution of spasticity scores across joints is presented in Table 2.

Table 2. Spasticity Assessment Using Modified Ashworth Scale (MAS)

Joint	T1	T2	T3	T4	T5
Hip	2	2	2	2	2
Knee	3	3	2	2	2
Ankle	3	3	3	3	2

MAS: 0 = no increase in muscle tone; 1–4 = increasing levels of spasticity.

The hip joint maintained a constant spasticity score across all time points. In contrast, the knee joint showed a reduction beginning at T3, while the ankle joint demonstrated a decrease at the final measurement point (T5). Muscle strength was assessed qualitatively based on movement patterns, categorized as reflex-dominant (R) or tone-dominant (T), indicating the absence of controlled voluntary movement. The findings are summarized in Table 3.

Table 3. Muscle Strength Assessment

Muscle Group	T1	T2	T3	T4	T5
Hip Flexors	R	R	R	R	R
Hip Extensors	T	T	T	T	T
Knee Flexors	R	R	R	R	R
Knee Extensors	T	T	T	T	T
Ankle Flexors	T	T	T	T	T
Ankle Extensors	T	T	T	T	T

R = reflex-dominant movement; T = tone without voluntary movement.

Across all measurement points, no variation was observed in muscle strength patterns. Flexor muscle groups consistently exhibited reflex-dominant responses, while extensor groups and ankle musculature demonstrated tone-dominant characteristics. Gross motor function was evaluated using the GMFM-88, which assesses five functional dimensions. The distribution of scores across dimensions and time points is presented in Table 4.

Table 4. Gross Motor Function Measure (GMFM-88) Scores (%)

Dimension	T1	T2	T3	T4	T5
Lying and Rolling	64.3	64.3	64.3	66.7	66.7
Sitting	55.8	55.8	55.8	58.1	58.1
Crawling and Kneeling	32.6	32.6	32.6	35.4	35.4
Standing	15.4	15.4	15.4	17.9	17.9
Walking, Running, Jumping	3.2	3.2	3.2	4.8	4.8
Total Score	34.3	34.3	34.3	36.6	36.6

GMFM-88 assesses five dimensions of gross motor function expressed as percentage scores.

GMFM scores remained unchanged during the initial phase (T1–T3) and increased at T4, with values maintained at T5 across all dimensions. The total score increased from 34.3% at baseline to 36.6% at the final assessment. Overall, the recorded outcomes demonstrate temporal changes in spasticity and gross motor function across the intervention period, while muscle strength patterns remained stable throughout all measurement points. To enhance the visualization of outcome trends, changes in GMFM scores and spasticity levels across time points are illustrated in Figure 1 and Figure 2.

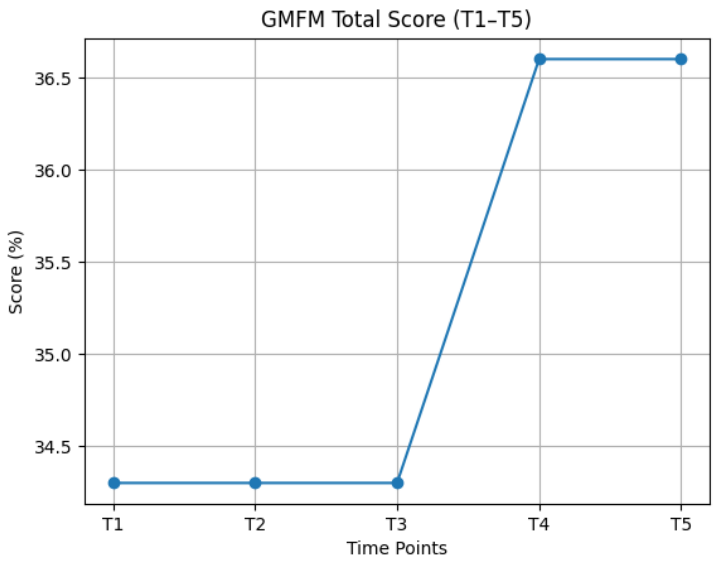

Figure 1. Trend of GMFM Total Score Across Time Points (T1–T5)

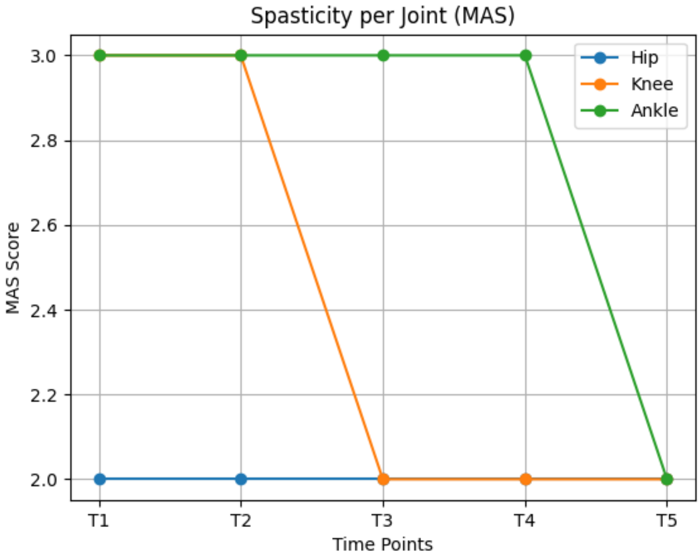

Figure 2. Changes in Spasticity Levels (Modified Ashworth Scale) Across Hip, Knee, and Ankle Joints

Discussion

This case report examined the short-term effects of a multimodal physiotherapy program on spasticity, muscle strength, and gross motor function in a child with spastic diplegic cerebral palsy. The findings indicate a reduction in spasticity in the knee and ankle joints, accompanied by modest improvements in gross motor function, while no observable changes occurred in muscle strength patterns. These results suggest that the applied intervention may influence neural and functional components of motor impairment, although its impact on voluntary motor control remains limited.

The reduction in spasticity observed in the knee and ankle joints is consistent with previous evidence indicating that repeated passive movement and sensory input can modulate stretch reflex excitability.[9,10,21] Passive range of motion (ROM) exercises are known to improve joint mobility primarily through increased stretch tolerance rather than structural changes in muscle architecture.[3,21] This mechanism may explain the observed decrease in resistance to passive movement without concurrent changes in muscle strength. Additionally, neurosensory stimulation, including tactile and proprioceptive input, may contribute to modulation of muscle tone by influencing sensorimotor integration processes.[11,21] The combination of these modalities likely produced a cumulative effect on neural regulation of spasticity, particularly in distal joints where reflex hyperexcitability is often more pronounced.

Despite these improvements, spasticity in the hip joint remained unchanged throughout the intervention period. This finding may reflect differences in biomechanical demands, muscle group involvement, and baseline severity across joints. Larger proximal muscles may require higher intensity or longer duration interventions to achieve measurable changes. Furthermore, the absence of progressive loading or active engagement strategies may have limited the potential for broader neuromuscular adaptation. This observation highlights the importance of tailoring intervention intensity and specificity according to joint characteristics and functional demands.

In contrast to spasticity outcomes, no changes were observed in muscle strength. This finding aligns with existing literature demonstrating that improvements in muscle strength in children with cerebral palsy require active, repetitive, and progressively loaded resistance training.[13,21] The persistence of reflex-dominant and tone-dominant movement patterns in this case indicates that the intervention did not sufficiently stimulate voluntary motor activation. Without targeted strength training protocols that incorporate overload and task-specific resistance, neuromuscular adaptations are unlikely to occur. This distinction underscores the need to differentiate between interventions aimed at tone modulation and those designed to enhance force production capacity.

The observed increase in GMFM scores suggests a gradual improvement in gross motor function, particularly in dimensions related to postural control and mobility. Previous studies have demonstrated that multimodal and task-oriented physiotherapy approaches can enhance functional performance by promoting neuroplasticity and motor learning.[3,13] Interventions such as gait training and balance exercises provide repetitive, goal-directed practice that reinforces motor patterns and improves coordination.[13,17] In this case, the integration of stability training and assisted gait practice may have contributed to improvements in functional domains, despite the absence of measurable changes in muscle strength. Recent randomized controlled trials also support the effectiveness of intensive, task-specific interventions in improving functional outcomes in children with cerebral palsy.[13,17]

The observed increase in GMFM score (2.3%) should be interpreted cautiously, as the minimal clinically important difference (MCID) for GMFM varies depending on GMFCS level and intervention context. In this case, the magnitude of change may represent a small functional improvement, but its clinical relevance remains uncertain.

However, the magnitude of change in GMFM score was relatively small, and its clinical significance remains uncertain. The lack of reported minimal clinically important difference (MCID) for this specific context limits the ability to determine whether the observed improvement represents a meaningful functional gain. This highlights an important limitation in interpreting outcomes in single-case designs, where statistical inference and clinical thresholds are often unavailable.

Individual factors likely played a critical role in shaping the observed outcomes. [7,8], yet the presence of early neurological insult and persistent spasticity may have constrained motor development. Additionally, the absence of detailed classification, such as GMFCS level, limits the ability to contextualize the severity of impairment and compare findings with existing literature. Variability in adherence to home-based exercises, although not formally measured, may also have influenced the effectiveness of the intervention.

Several methodological limitations should be acknowledged. As a single-case report, this study lacks a control condition, making it difficult to attribute observed changes solely to the intervention. Potential sources of bias include observer bias in outcome assessment and measurement limitations associated with clinical scales such as MAS.[18] The short duration of intervention and absence of long-term follow-up further restrict the interpretation of sustained effects. Additionally, the lack of patient-reported outcomes or caregiver perspectives limits insight into functional changes in daily life.

Despite these limitations, this case provides clinically relevant insights into the application of multimodal physiotherapy in a real-world setting. The findings suggest that combining passive, sensory, and task-oriented interventions may produce incremental improvements in spasticity and functional performance. However, to achieve more substantial gains, particularly in voluntary motor control and muscle strength, future interventions should incorporate higher intensity, progressive resistance training, and longer treatment duration.

Future research should focus on controlled studies with larger samples to evaluate the effectiveness of multimodal physiotherapy and to establish clinically meaningful outcome thresholds. Additionally, integrating standardized classifications such as GMFCS and including patient-centered outcomes would enhance the interpretability and applicability of findings in clinical practice. A key clinical takeaway from this case is that multimodal physiotherapy may be effective for short-term modulation of spasticity and gradual functional improvement, but it is insufficient to induce voluntary motor control without incorporating progressive, task-specific strengthening. Clinicians should therefore prioritize combining multimodal approaches with active resistance training to achieve more comprehensive motor outcomes.

Conclusion

This case report demonstrates that a 4-week multimodal physiotherapy program may contribute to reductions in spasticity and modest improvements in gross motor function in a child with spastic diplegic cerebral palsy. However, no changes were observed in muscle strength or voluntary motor control, indicating that the intervention was insufficient to induce neuromuscular adaptation.

Given the single-case design, these findings represent low-level evidence and should be interpreted with caution, with limited generalizability. Clinically, the results suggest that multimodal physiotherapy may be useful as an initial strategy to address spasticity and support functional gains, but should be complemented with progressive, task-specific strengthening interventions to achieve more substantial motor improvements. In clinical practice, early integration of structured strengthening and task-specific training is recommended to complement multimodal physiotherapy programs.

Future research should involve controlled studies with larger sample sizes, standardized functional classification (e.g., GMFCS), and longer follow-up periods to determine the effectiveness and clinical significance of multimodal physiotherapy in children with cerebral palsy.

Author Contribution

Tri Novaliano Rechtsi Medistianto: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Writing original draft.
W. Wahyuni: Supervision, Validation, Methodology, Writing review & editing, Project administration.
Ika Hayati: Resources, Investigation, Data curation, Writing review & editing.

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Conflict of Interest Statement

The author declares no conflict of interest.

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Ethics Statement

Written informed consent was obtained from the patient's parents prior to the intervention and publication of this case report.

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