Majalah Ilmiah Fisioterapi Indonesia
Indonesian Scientific Journal of Physiotherapy

Case Reports / Case Studies
ISSN (Print): 2303-1921
ISSN (Online): 2722-2026
Volume 14, Number 2, Pages 539-543 (2026)
DOI: https://doi.org/10.24843/mifi.000001824

Physiotherapy Management of Quadriplegic Cerebral Palsy Following Tuberculous Meningitis: A Case Report

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Received 15 April 2026; Revised 21 April 2026; Accepted 23 April 2026; Published 15 May 2026

Abstract

Background: Cerebral palsy (CP) is a non-progressive motor disorder resulting from early brain injury. Tuberculous meningitis (TBM) is a severe central nervous system infection that can lead to permanent neurological impairment, including spastic quadriplegic CP. Early physiotherapy is essential to optimize functional outcomes in affected infants.

Objective: To describe the clinical outcomes of a structured physiotherapy program in an infant with quadriplegic cerebral palsy following tuberculous meningitis.

Methods: A case report was conducted on a 7-month-old male infant diagnosed with quadriplegic CP secondary to TBM. Baseline assessment included Modified Ashworth Scale (MAS), Hammersmith Infant Neurological Examination (HINE), Gross Motor Function Classification System (GMFCS), Manual Ability Classification System (MACS), Communication Function Classification System (CFCS), and Eating and Drinking Ability Classification System (EDACS). The patient received physiotherapy based on Neurodevelopmental Treatment (NDT), including positioning, sensory stimulation, head and trunk control exercises, hand function training, and spasticity inhibition. The intervention was delivered three times per week for four weeks.

Results: Spasticity decreased across multiple joints, particularly in finger flexors (MAS 3 to 2) and knee extensors (MAS 3 to 2). The HINE score improved from 33 to 42, indicating enhanced neurological function. Functional classifications remained unchanged (GMFCS IV, MACS IV, CFCS IV, EDACS I), reflecting persistent severe functional limitations.

Conclusion: A structured physiotherapy program based on NDT may improve neuromotor outcomes in infants with quadriplegic CP following TBM. However, findings should be interpreted cautiously due to the single-case design.

Keywords
Cerebral Palsy; Tuberculous Meningitis; Physical Therapy Modalities; Muscle Spasticity; Neurodevelopmental Treatment

Introduction

Cerebral palsy (CP) is a group of permanent disorders affecting movement and posture, caused by non-progressive disturbances in the developing fetal or infant brain.[1] Although the primary neurological injury is static, the clinical manifestations evolve over time, often leading to significant limitations in motor function, activity, and participation.[2] Globally, the prevalence of CP is estimated at 2–3 per 1,000 live births, with higher rates reported in low- and middle-income countries due to disparities in maternal and neonatal healthcare.[3] In these settings, preventable conditions such as central nervous system infections remain a major contributor to neurological disability in infants.[2,3]

Tuberculous meningitis (TBM) represents the most severe form of extrapulmonary tuberculosis, accounting for approximately 1–2% of all tuberculosis cases but contributing disproportionately to neurological morbidity and mortality.[4] The pathophysiology of TBM involves a complex inflammatory process affecting the meninges, leading to increased intracranial pressure, cerebral edema, vasculitis, and ischemic injury.[4] These pathological mechanisms frequently result in permanent damage to motor and sensory pathways, predisposing affected infants to severe neurological sequelae, including spastic quadriplegic CP.[4,5] Infants who survive TBM are therefore at high risk of long-term developmental impairment, characterized by increased muscle tone, poor postural control, and delayed motor milestones.[4,5]

Quadriplegic CP is among the most severe forms of the condition, involving all four limbs and often accompanied by impairments in communication, feeding, and sensory processing.[6] The extent of functional limitation in these patients is typically classified using standardized systems such as the Gross Motor Function Classification System (GMFCS) and Manual Ability Classification System (MACS), which provide insight into the severity of motor impairment and guide clinical management.[7] Early identification and intervention are critical, as the first years of life represent a period of heightened neuroplasticity, during which targeted rehabilitation may influence functional outcomes.[8]

Physiotherapy plays a central role in the management of infants with CP, particularly through early intervention strategies aimed at optimizing motor development and preventing secondary complications.[9] Contemporary rehabilitation approaches emphasize task-specific training, neurosensory stimulation, and family-centered care to enhance motor learning and participation.[9,10] Among these approaches, Neurodevelopmental Treatment (NDT) is widely used to facilitate normal movement patterns, inhibit abnormal tone, and promote postural control through guided handling and environmental adaptation.[11] In addition, increasing evidence supports the importance of intensive, repetitive, and context-specific practice in driving neuroplastic changes and improving motor outcomes in infants at risk of CP.[12]

Despite the growing body of evidence on early intervention in CP, there remains limited literature specifically addressing physiotherapy management in infants with CP secondary to TBM. Most existing studies focus on CP of perinatal origin, such as hypoxic–ischemic encephalopathy, with comparatively little attention given to infection-related etiologies.[12–14] Furthermore, detailed

case reports describing structured physiotherapy interventions in infants with severe quadriplegic CP, particularly those integrating Neurodevelopmental Treatment with family-based home programs, are still scarce.[15,16] This gap highlights the need for clinically detailed reports that can inform practice in complex cases with multifactorial neurological impairment.

This case report describes the physiotherapy management of a 7-month-old infant with quadriplegic cerebral palsy following tuberculous meningitis. The intervention focused on a structured program incorporating Neurodevelopmental Treatment, sensorimotor stimulation, and family involvement. The objective of this study was to describe the clinical outcomes of this intervention in terms of spasticity, neurological function, and functional classification.

Methods

This study was designed as a single-patient case report and prepared in accordance with the CARE (CAse REport) guidelines to ensure comprehensive and transparent reporting. The report describes the physiotherapy management of an infant diagnosed with quadriplegic cerebral palsy (CP) following tuberculous meningitis (TBM), focusing on neuromotor outcomes and functional status. The diagnosis of tuberculous meningitis was established based on clinical findings supported by hospital-based evaluation, including neurological examination and relevant laboratory or imaging investigations.

The patient was a 7-month-old male infant who presented to the outpatient physiotherapy unit at RSD KRMT Wongsonegoro Semarang. Based on parental reports and medical records, the patient had a history of tuberculous meningitis diagnosed during early infancy and managed through hospital-based medical treatment. Following the illness, the patient demonstrated regression of developmental milestones, including loss of emerging motor abilities. No significant complications during pregnancy or delivery were reported. The patient was born at term through normal delivery, with no reported complications during pregnancy or childbirth.

At baseline assessment, the patient presented with generalized spasticity, dominant extensor posture, absence of head control, limited voluntary movement, and reduced responsiveness to environmental stimuli. Functional classification indicated severe impairment, with Gross Motor Function Classification System (GMFCS) level IV, Manual Ability Classification System (MACS) level IV, Communication Function Classification System (CFCS) level IV, and Eating and Drinking Ability Classification System (EDACS) level I.

Clinical outcomes were assessed using standardized instruments. Spasticity was evaluated using the Modified Ashworth Scale (MAS), a widely used tool for assessing resistance to passive movement in neurological conditions.[17] Neurological function was assessed using the Hammersmith Infant Neurological Examination (HINE), which has demonstrated validity and reliability in identifying early neurological impairment and predicting motor outcomes in infants at risk of CP.[18] Functional classification was determined using GMFCS, MACS, CFCS, and EDACS, which are established classification systems for describing functional abilities in children with CP.[19,20] To enhance clarity and reproducibility, the clinical course and follow-up schedule are summarized in Table 1.

Table 1. Clinical Timeline and Follow-up Schedule

Phase	Description
Initial condition	Diagnosis of tuberculous meningitis and hospital-based treatment
Post-illness phase	Developmental regression observed
Baseline (T1)	Initial physiotherapy assessment
Mid-intervention (T2)	Evaluation after two weeks of intervention
Post-intervention (T3)	Final evaluation after four weeks of intervention

The physiotherapy intervention was conducted over a four-week period with a frequency of three sessions per week, totaling 12 supervised sessions. Each session lasted approximately 45–60 minutes. The intervention was based on Neurodevelopmental Treatment (NDT), which aims to facilitate normal movement patterns, improve postural control, and inhibit abnormal muscle tone through guided handling and task-specific activities.

The intervention program included positioning (prone, supine, side-lying), sensorimotor stimulation, head and trunk control exercises, hand function training, spasticity inhibition techniques, and myofascial release. In addition, a structured home program was provided to caregivers to ensure continuity of therapy, with adherence monitored through caregiver reports. Outcome evaluation was performed at three time points (T1–T3) to monitor clinical progression. The types of outcome measures and their application are summarized in Table 2.

Table 2. Outcome Measures and Evaluation Schedule

Outcome Domain	Instrument	Description	Time Points
Spasticity	Modified Ashworth Scale (MAS)	Measures resistance to passive movement	T1, T2, T3
Neurological function	HINE	Assesses neurological development in infants	T1, T2, T3
Gross motor function	GMFCS	Classifies gross motor ability	T1, T3
Manual ability	MACS	Classifies hand function	T1, T3
Communication	CFCS	Assesses communication function	T1, T3
Feeding ability	EDACS	Assesses eating and drinking ability	T1, T3

Data analysis was conducted descriptively by comparing changes in clinical outcomes across evaluation time points. No inferential statistical analysis was performed due to the single-case design.

Written informed consent was obtained from the patient's parents for participation and publication of this case report.

Results

Clinical outcomes were evaluated across three time points (T1–T3) to describe changes in spasticity, neurological function, and functional classification following the physiotherapy intervention. The results are presented to provide a structured overview of the patient's clinical progression over the intervention period. To illustrate changes in muscle tone across multiple joints, the progression of spasticity measured using the Modified Ashworth Scale (MAS) is summarized in Table 3.

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Table 3. Spasticity Assessment Across Time Points (MAS)

Movement	T1 (D/S)	T2 (D/S)	T3 (D/S)
Elbow flexion	2/2	2/2	1+/1+
Elbow extension	2/2	2/2	1+/1+
Wrist flexion	2/2	2/2	1+/1+
Wrist extension	1+/1+	1+/1+	1/1
Finger flexion	3/3	3/3	2/2
Finger extension	1+/1+	1+/1+	1/1
Knee flexion	2/2	2/2	1+/1+
Knee extension	3/3	3/3	2/2
Ankle plantarflexion	3/3	3/3	2/2
Ankle dorsiflexion	1+/1+	1+/1+	1/1

Note: D = dextra; S = sinistra; MAS = Modified Ashworth Scale

As presented in Table 3, spasticity levels decreased across several muscle groups over the intervention period. Reductions were most evident in finger flexors, knee extensors, and ankle plantarflexors, where MAS scores decreased from 3 to 2 at T3. Neurological function was further assessed using the Hammersmith Infant Neurological Examination (HINE). The progression of HINE scores across time points is presented in Table 4.

Table 4. Neurological Assessment Across Time Points (HINE)

Domain	T1	T2	T3
Cranial nerve function	11	12	13
Movement	3	3	4
Tone	6	7	8
Reflexes and reactions	4	5	6
Posture	9	10	11
Total score	33	37	42

Note: HINE = Hammersmith Infant Neurological Examination

As shown in Table 4, the total HINE score increased from 33 at baseline (T1) to 42 at the final evaluation (T3), reflecting changes across multiple domains, including tone, reflexes, posture, and movement. Functional classification remained unchanged throughout the intervention period. At both baseline and post-intervention assessments, the patient was classified as GMFCS level IV, MACS level IV, CFCS level IV, and EDACS level I, indicating persistent severe limitations in gross motor function, manual ability, and communication, with preserved feeding ability. To provide a concise overview of overall clinical progression, the direction of change across outcome domains is summarized in Table 5.

Table 5. Summary of Clinical Progression

Outcome Domain	Trend	Description
Spasticity (MAS)	Decreasing	Reduction observed across multiple joints
Neurological function (HINE)	Increasing	Total score improved from 33 to 42
Functional classification	Stable	No change in GMFCS, MACS, CFCS, EDACS levels

No adverse events or complications were reported during the intervention period.

Discussion

This case report describes the clinical course of an infant with quadriplegic cerebral palsy (CP) following tuberculous meningitis (TBM) who underwent a structured physiotherapy program based on Neurodevelopmental Treatment (NDT). The findings demonstrate improvements in spasticity and neurological function over a four-week intervention period, while functional classification remained unchanged. These results reflect the complexity of neurological recovery in infants with severe CP and highlight the role of early, structured physiotherapy in supporting neuromotor development.[7,11]

The reduction in spasticity observed across multiple muscle groups may be attributed to the combined effects of positioning, slow stretching, and reflex-inhibiting postures implemented within the NDT framework.[21] These interventions are designed to modulate abnormal muscle tone through sustained proprioceptive input and facilitation of more normalized movement patterns. Previous studies have reported that repetitive sensorimotor stimulation and guided handling can reduce hypertonicity by influencing spinal reflex excitability and improving central motor control.[6,8] In infants with CP, early intervention targeting tone regulation is essential to prevent secondary complications such as contractures and musculoskeletal deformities.[1,11] The gradual decrease in Modified Ashworth Scale (MAS) scores observed in this case is therefore consistent with the expected physiological response to structured neuromotor intervention.

The improvement in Hammersmith Infant Neurological Examination (HINE) score from 33 to 42 suggests a positive change in neurological function across multiple domains, including tone, posture, reflexes, and movement. The HINE is widely recognized as a valid and reliable tool for early detection of neurological impairment and for predicting motor outcomes in infants at risk of CP.[18] A higher HINE score over time is generally associated with improved neuromotor organization and better developmental trajectories. However, it is important to interpret this improvement within the context of early infancy, where neurological maturation and spontaneous developmental progression may also contribute to changes in clinical presentation.[9,11] Therefore, while the observed increase in HINE score may reflect the effect of physiotherapy, the potential influence of natural maturation cannot be excluded. The improvement in HINE score from 33 to 42 suggests clinically meaningful neurological progress, reflecting enhanced neuromotor organization across multiple domains.

Despite improvements in spasticity and neurological function, functional classification levels (GMFCS IV, MACS IV, CFCS IV) remained unchanged throughout the intervention period. This finding is not unexpected, as functional classification systems are designed to reflect relatively stable levels of ability and are less sensitive to short-term changes, particularly over a four-week period.[19,20 1,11]. The absence of change in functional classification therefore does not necessarily indicate a lack of clinical progress but rather reflects the limitations of these tools in detecting short-term improvements.

From a pathophysiological perspective, the neurological impairments observed in this case are consistent with the sequelae of TBM, which include inflammation-induced damage to cortical and subcortical structures, disruption of corticospinal pathways, and impaired sensory integration.[4,5] These mechanisms contribute to the development of spasticity, abnormal postural control, and delayed motor development. Early physiotherapy intervention aims to mitigate these effects by promoting adaptive neuroplasticity

through repetitive, task-specific stimulation. [4,5] Evidence suggests that the developing brain retains a high degree of plasticity, particularly in the first year of life, allowing targeted interventions to influence neural reorganization and functional outcomes.[8,9,13]

The use of NDT in this case reflects a commonly applied clinical approach in pediatric neurorehabilitation. Although the evidence supporting NDT remains mixed, it continues to be widely used due to its emphasis on individualized handling, facilitation of functional movement, and integration into daily activities.[2,16] In this case, the addition of a structured home program and caregiver involvement likely contributed to increased therapy intensity and consistency, which are key factors in promoting motor learning. Family-centered approaches have been shown to enhance adherence, increase opportunities for practice, and improve overall functional outcomes in children with CP.[7,11,12]

Several limitations should be considered when interpreting the findings of this report. First, as a single-case study, the results cannot be generalized to a broader population. Second, the short duration of the intervention limits the ability to assess long-term outcomes and functional changes. Third, the absence of a control condition makes it difficult to distinguish between intervention effects and natural developmental progression. Additionally, potential sources of bias, including observer bias and caregiver-reported adherence, may have influenced the findings. These limitations are inherent to the case report design and should be acknowledged in the interpretation of results. These findings are consistent with previous studies demonstrating that early physiotherapy intervention can support neuromotor improvement in infants with cerebral palsy, although most evidence is derived from perinatal etiologies rather than infection-related cases.[7,11,12]

This case highlights the clinical importance of early physiotherapy intervention in infants with CP secondary to TBM, a population that remains underrepresented in the literature. While most studies focus on CP of perinatal origin, infection-related cases such as TBM present unique challenges due to the severity and distribution of neurological damage. The findings suggest that structured physiotherapy, combined with caregiver involvement, may support improvements in neuromotor function, even in cases with severe baseline impairment.

Future research should focus on longitudinal studies and controlled trials to evaluate the effectiveness of physiotherapy interventions in infants with CP secondary to infectious etiologies. The inclusion of objective outcome measures, longer follow-up periods, and standardized intervention protocols would provide a more robust evidence base to guide clinical practice.

Conclusion

This case report describes the clinical outcomes of a structured physiotherapy program in an infant with quadriplegic cerebral palsy following tuberculous meningitis. The intervention was associated with reductions in spasticity and improvements in neurological function, as indicated by changes in Modified Ashworth Scale and Hammersmith Infant Neurological Examination scores. Functional classification levels remained unchanged over the intervention period.

These findings suggest that early physiotherapy incorporating Neurodevelopmental Treatment and family-based home programs may support neuromotor development in infants with severe neurological impairment. However, given the single-case design and short follow-up duration, the results should be interpreted as preliminary evidence. From a clinical perspective, physiotherapists may consider implementing structured, repetitive, and family-centered interventions to optimize early motor outcomes in similar cases. Future research involving larger samples, longer follow-up periods, and standardized outcome measures is required to establish the effectiveness and generalizability of such interventions.

Author Contribution

Ifa Aulia Musyarifah Putri: Conceptualization, Investigation, Data curation, Formal analysis, Writing original draft.
Wahyuni: Supervision, Methodology, Validation, Writing review and editing, Project administration.
Ika Hayati: Clinical investigation, Resources, Data collection, Writing review and editing.

Acknowledgments

The author would like to thank the patient's family for their cooperation and participation in this study, as well as the clinical staff at RSD KRMT Wongsonegoro Semarang for their support during the intervention process.

Conflict of Interest Statement

The author declares no conflict of interest.

Funding Sources

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. Ethical approval was not required for this study according to institutional policy for single-case reports.

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