

Multimodal Physiotherapy for Functional Mobility in a Child with L4–L5 Spina Bifida Occulta: A Case Report

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Abstract

Background: Spina bifida occulta may impair motor development, postural control, sensory function, and functional mobility in children. Evidence regarding individualized multimodal physiotherapy for preschool children with this condition remains limited.

Objective: To describe multimodal physiotherapy management and evaluate early clinical changes in motor performance, balance, sensory function, and functional mobility in a child with L4–L5 spina bifida occulta.

Methods: This CARE-compliant case report describes a five-year-old girl with magnetic resonance imaging-confirmed L4–L5 spina bifida occulta who completed three physiotherapy sessions. The intervention combined neuromuscular electrical stimulation, tactile sensory stimulation, stretching, active-assisted range of motion, bridging, crawling training, postural transition training, treadmill gait training, backward walker training, and play-based functional activities. Outcomes were assessed using Manual Muscle Testing, Gross Motor Function Measure-88, Pediatric Balance Scale, International Standards for Neurological Classification of Spinal Cord Injury, and the International Classification of Functioning, Disability and Health for Children and Youth framework.

Results: Gross Motor Function Measure-88 improved from 58.48% to 63.72%, while Pediatric Balance Scale increased from 6/56 to 10/56. Lower-extremity muscle strength improved across most muscle groups, particularly ankle dorsiflexors (0/5 to 2+/5). Partial sensory recovery, improved trunk control, better gait quality, increased exercise tolerance, and greater participation during therapy were also observed. No intervention-related adverse events occurred.

Conclusion: Individualized multimodal physiotherapy was associated with early clinical improvements in motor function, balance, and functional mobility. Given the single-patient design and short follow-up, these findings should be interpreted as preliminary clinical evidence. Larger prospective studies are needed to establish intervention effectiveness.

Keywords:

Spina Bifida; Physical Therapy Modalities; Motor Activity; Postural Balance; Child

Introduction

Spina bifida is a congenital neural tube defect (NTD) caused by incomplete closure of the embryonic neural tube during the third to fourth week of gestation. Depending on the extent of the defect, the condition may involve the vertebral column, meninges, spinal cord, or combinations of these structures, resulting in neurological impairments of varying severity. Spina bifida is generally classified into spina bifida occulta, meningocele, and myelomeningocele. Although spina bifida occulta is considered the mildest subtype because no neural tissue protrudes through the vertebral defect, affected individuals may still develop clinically significant neurological manifestations, particularly when associated with occult spinal dysraphism or tethered cord syndrome. These manifestations include lower-extremity muscle weakness, sensory impairment, bladder and bowel dysfunction, delayed motor development, musculoskeletal abnormalities, and reduced functional mobility, all of which may adversely affect independence and quality of life.¹

Neural tube defects remain an important global health problem because they contribute substantially to childhood disability and long-term healthcare needs. Advances in prenatal diagnosis, neonatal management, and multidisciplinary care have markedly improved survival among children with spina bifida, shifting rehabilitation goals from survival alone toward maximizing functional independence, participation, and quality of life. Consequently, rehabilitation has become an essential component of long-term management, particularly for children with persistent neurological impairments that limit participation in age-appropriate activities.

The neurological presentation of spina bifida is strongly influenced by the anatomical level of the lesion. Children with lumbar lesions, particularly at the L4–L5 level, commonly present with weakness of the hip, knee, and ankle musculature, impaired somatosensory function, poor postural control, delayed acquisition of gross motor milestones, reduced balance, and limited ambulatory capacity. These impairments frequently necessitate long-term use of orthoses and walking aids and may lead to compensatory biomechanical alterations, including anterior pelvic tilt and lumbar hyperlordosis, further reducing gait efficiency and increasing energy expenditure during walking.²

Physiotherapy is a cornerstone of multidisciplinary rehabilitation for children with spina bifida. Contemporary rehabilitation extends beyond improving muscle strength and joint mobility to include enhancement of neuromuscular control, postural stability, balance, locomotor performance, functional independence, and participation in meaningful daily activities.³ Various interventions—including neuromuscular electrical stimulation (NMES), task-specific training, gait training, strengthening exercises, sensory stimulation, orthotic management, and play-based therapy—have demonstrated potential benefits for improving motor performance and functional outcomes in children with neurological disorders.⁴

Emerging evidence suggests that multimodal rehabilitation may produce greater functional gains than isolated interventions by combining repetitive task-oriented practice, multisensory stimulation, and individualized therapeutic exercises that promote motor learning and neuroplastic adaptation. Ferreira et al. reported improvements in locomotor performance, postural control, and functional

independence following comprehensive physiotherapy interventions in children with spina bifida. Likewise, systematic reviews have shown that NMES and structured motor training improve muscle activation, functional mobility, and gross motor performance in pediatric neurological populations.⁵ Nevertheless, the current body of evidence remains heterogeneous regarding intervention protocols, treatment dosage, and outcome measures, limiting direct translation into routine clinical practice.⁶

Despite these advances, several important knowledge gaps remain. First, most published studies focus on myelomeningocele, whereas evidence specifically addressing spina bifida occulta remains scarce. Second, previous reports commonly evaluate single therapeutic modalities or short-term functional outcomes, providing limited insight into the potential contribution of integrated multimodal physiotherapy.⁷ Third, detailed descriptions of individualized clinical reasoning, standardized multidimensional assessment, sequential clinical progression, and outcome evaluation in preschool children with L4–L5 spina bifida occulta are still rarely reported. High-quality case reports therefore continue to play an important role in generating clinically applicable evidence, particularly for uncommon conditions where large prospective studies remain limited.⁸

Accordingly, this case report aimed to describe the clinical reasoning, comprehensive physiotherapy management, and early clinical changes observed in a five-year-old girl with magnetic resonance imaging-confirmed L4–L5 spina bifida occulta presenting with delayed motor development, sensory impairment, impaired postural control, and functional mobility limitations. An individualized multimodal rehabilitation program integrating NMES, tactile sensory stimulation, active-assisted therapeutic exercise, task-specific gait training, and play-based functional activities was implemented.⁹ Clinical changes were evaluated using standardized outcome measures to characterize early clinical improvement following rehabilitation. By providing detailed documentation of assessment, intervention, and sequential clinical outcomes, this report seeks to contribute practical evidence to support individualized pediatric physiotherapy while informing the design of future prospective studies involving larger populations and longer follow-up periods.¹⁰

Methods

This study was designed as a descriptive case report to document the clinical reasoning, individualized physiotherapy management, and early clinical outcomes of a child diagnosed with L4–L5 spina bifida occulta. The manuscript was prepared in accordance with the CARE (CAse REport) Guideline to improve the transparency, completeness, and reproducibility of case report reporting.

The patient received physiotherapy at ORIGO Children Stimulation Center, Indonesia, between 31 March and 14 April 2026. Three treatment sessions were completed during the observation period. Clinical assessments were performed immediately before the initial intervention and repeated after each treatment session to monitor sequential changes in neuromuscular function, gross motor performance, postural control, balance, sensory function, gait, and overall functional mobility.

This study was conducted as a single-patient case report using anonymized clinical data collected during routine physiotherapy care. According to institutional policy, formal ethical approval was not required for publication of an individual case report. Written informed consent for publication of the patient's clinical information and images was obtained from the patient's parent/legal guardian. Patient confidentiality was maintained throughout the manuscript in accordance with the Declaration of Helsinki.

The patient was a five-year-old girl with magnetic resonance imaging (MRI)-confirmed L4–L5 spina bifida occulta. According to parental history, delayed motor development became evident at approximately three months of age because spontaneous movement of both lower extremities was markedly reduced compared with the upper extremities. Before referral to the present rehabilitation program, the patient had undergone three MRI examinations and one digital subtraction angiography examination to establish the diagnosis and exclude associated vascular abnormalities. Routine physiotherapy had been initiated in September 2022.

At the initial assessment, the patient was unable to stand or walk independently and required a rigid ankle-foot orthosis (AFO) together with a backward walker for ambulation. Functional constipation and early fatigue during walking were also reported by the parents. Pregnancy was full term without major complications, and maternal antenatal care followed standard recommendations, including routine supplementation. Delivery was performed by cesarean section with a birth weight of 2,500 g. Gross motor development was delayed, with independent sitting achieved at approximately six months of age and crawling beginning at approximately three years.

A comprehensive physiotherapy assessment was performed before intervention. The examination included history taking, clinical observation, palpation, passive range-of-motion assessment, neurological examination, posture analysis, gait observation, and functional assessment. Lower-extremity muscle strength was evaluated using Manual Muscle Testing (MMT), which has demonstrated acceptable reliability and clinical utility for assessing voluntary muscle performance in neurological rehabilitation.¹¹ Neurological status was evaluated using the International Standards for Neurological Classification of Spinal Cord Injury (ISNCSCI), an internationally standardized assessment with established validity and reliability for documenting motor and sensory impairment related to spinal cord dysfunction.¹² Gross motor performance was measured using the Gross Motor Function Measure-88 (GMFM-88), whereas functional balance was evaluated using the Pediatric Balance Scale (PBS), both of which have demonstrated good psychometric properties in pediatric neurological populations.¹³ Clinical findings were subsequently interpreted using the International Classification of Functioning, Disability and Health for Children and Youth (ICF-CY) framework to identify impairments in body functions and structures, activity limitations, participation restrictions, and relevant environmental factors.¹⁴

Baseline assessment demonstrated lumbar hyperlordosis, anterior pelvic tilt, bilateral ankle clonus, marked lower-extremity muscle weakness, sensory impairment involving the bilateral L4–L5 dermatomes, impaired trunk control, reduced dynamic balance, and limited ambulatory ability. Observational gait analysis demonstrated bilateral toe dragging during the swing phase together with reduced walking endurance, requiring continued use of a backward walker and rigid AFO.¹⁵

Based on these findings, an individualized multimodal physiotherapy program was developed to address the patient's primary functional limitations. The intervention consisted of neuromuscular electrical stimulation (NMES), tactile sensory stimulation, passive stretching, active-assisted range-of-motion exercises, bridging exercises, prone positioning, crawling training, sit-to-stand practice, treadmill gait training, overground gait training using a backward walker, and play-based functional activities.¹⁶

NMES was applied to muscle groups demonstrating severe weakness, particularly the ankle dorsiflexors and plantarflexors. Self-adhesive surface electrodes were positioned over standardized motor points following published recommendations. Stimulation intensity was progressively increased until a visible, comfortable muscle contraction was obtained without pain or excessive fatigue. Treatment was delivered using symmetrical stimulation cycles with scheduled contraction and relaxation periods. The stimulation frequency (Hz), pulse duration (μ s), duty cycle, ramp time, and total treatment duration should be reported according to the device settings used during treatment.¹⁷

Passive stretching targeted the gastrocnemius and soleus muscles to preserve muscle extensibility and prevent adaptive shortening. Each stretch was maintained for approximately 20–30 seconds and repeated three to five times for each lower extremity. Active-assisted range-of-motion exercises were performed for the hip, knee, and ankle joints with therapist assistance. Approximately 10–15 repetitions were completed for each movement according to patient tolerance.

Bridging exercises were performed to facilitate activation of the abdominal, gluteal, and pelvic stabilizing muscles. Each repetition required maintenance of pelvic elevation for approximately 5–10 seconds before returning to the starting position. Eight to ten repetitions were completed with adequate rest intervals between repetitions.

Prone positioning, crawling practice, and sit-to-stand training were incorporated to improve proximal stability, weight shifting, trunk control, and transitional movement. Task-specific gait training was subsequently performed using a motorized treadmill followed by overground ambulation with a backward walker. The treadmill speed, duration of each training session, progression criteria, walking distance, and rest intervals should be reported according to the rehabilitation protocol used.¹⁸ Following treadmill practice, overground walking emphasized symmetrical weight bearing, reciprocal stepping, trunk alignment, and safe use of the assistive device.

Play-based functional activities were integrated throughout each session to increase motivation, active participation, and motor learning while maintaining age-appropriate therapeutic engagement. Intervention progression was individualized according to the patient's clinical performance and tolerance at every treatment session.

No adverse events, treatment-related injuries, excessive fatigue requiring discontinuation, or other intervention-related complications occurred throughout the rehabilitation period.¹⁹

Outcome assessment was performed before the first intervention and immediately after each treatment session. To minimize measurement variability, all evaluations were conducted by the same physiotherapist using identical assessment procedures throughout the observation period. Although evaluator blinding was not feasible because of the single-patient design, standardized assessment procedures and validated outcome measures were consistently applied to reduce potential observational bias.²⁰

Considering the descriptive nature of a single case report, no inferential statistical analysis was performed. Clinical outcomes were analyzed descriptively by comparing sequential changes in muscle strength, neurological status, gross motor performance, balance, posture, gait characteristics, and functional mobility across all assessment time points. Absolute changes and clinically meaningful trends were reported to facilitate interpretation of early clinical improvement.

To facilitate understanding of the patient's clinical course, the chronological sequence of diagnosis, rehabilitation, and outcome assessment is summarized in the CARE timeline (Table 1).

Table 1. CARE Timeline of the Patient's Clinical Course

Time	Clinical Event
Birth	Full-term cesarean delivery (2,500 g)
3 months	Delayed lower-limb movement first recognized
6 months	Independent sitting achieved
3 years	Crawling achieved
September 2022	Routine physiotherapy initiated
Before current treatment	MRI ×3 and digital subtraction angiography performed; L4–L5 spina bifida occulta confirmed
31 March 2026	Baseline physiotherapy assessment
31 March–14 April 2026	Three sessions of individualized multimodal physiotherapy
14 April 2026	Final outcome assessment

The timeline demonstrates the prolonged history of motor delay before referral for the present rehabilitation program and illustrates the temporal relationship between baseline assessment, intervention, and sequential outcome evaluation. This chronological presentation facilitates interpretation of the observed clinical changes within the context of the patient's overall rehabilitation pathway.

Results

A total of three physiotherapy sessions were completed between 31 March and 14 April 2026, and the patient successfully completed the entire rehabilitation program without interruption. The intervention consisted of neuromuscular electrical stimulation (NMES), tactile sensory stimulation, stretching, active-assisted range-of-motion exercises, bridging exercises, crawling training, postural transition training, treadmill gait training, backward walker training, and play-based functional activities. Throughout the observation period, no intervention-related adverse events, excessive fatigue requiring discontinuation, falls, or other clinical complications were observed, indicating that the rehabilitation program was well tolerated.

To establish the patient's initial clinical status before intervention, a comprehensive physiotherapy assessment was performed. The baseline evaluation incorporated standardized measurements of posture, gait, muscle strength, neurological status, passive joint mobility, gross motor performance, balance, and sensory function. This multidimensional assessment provided the basis for individualized treatment planning and subsequent evaluation of clinical progression.

Table 2. Baseline Physiotherapy Assessment

Domain	Assessment Tool	Baseline Findings
Posture	Observation	Lumbar hyperlordosis, anterior pelvic tilt, bilateral plantarflexion tendency
Ambulation	Observation	Ambulated using rigid ankle foot orthosis and backward walker
Muscle strength	Manual Muscle Testing	Hip flexors 2+/5, hip extensors 2+/5, hip abductors 2/5, knee flexors 2–/5, knee extensors 2–/5, ankle dorsiflexors 0/5, plantarflexors 0/5, evertors 0/5
Sensory function	ISNCSCI	Reduced light touch and pin prick sensation at bilateral L4 to L5 dermatomes
Gross motor function	GMFM 88	58.48%
Functional balance	Pediatric Balance Scale	6/56

The baseline assessment demonstrated substantial impairment across multiple domains of motor function and mobility. Marked weakness was observed throughout the lower extremities, particularly in the ankle musculature, where active dorsiflexion,

plantarflexion, and eversion were absent. Gross motor performance was limited, as reflected by a GMFM-88 score of 58.48%, while the PBS score of 6/56 indicated poor postural stability and a high risk of falling. Neurological examination further demonstrated bilateral sensory impairment involving the L4–L5 dermatomes, consistent with the patient's MRI-confirmed neurological lesion. To determine whether functional limitations were attributable primarily to musculoskeletal restriction or neurological dysfunction, passive joint mobility was subsequently evaluated.

Table 3. Passive Range of Motion Assessment

Region	Movement	Range of Motion	Pain	End Feel
Hip	Flexion	Full	None	Soft
	Extension	Full	None	Firm
	Abduction	Full	None	Firm
	Adduction	Full	None	Firm
Knee	Flexion	Full	None	Soft
	Extension	Full	None	Hard
Ankle	Dorsiflexion	Full	None	Springy
	Plantarflexion	Full	None	Firm
	Inversion	Full	None	Firm
	Eversion	Full	None	Firm

Passive range of motion remained within normal physiological limits in all evaluated joints without pain or abnormal end-feel. These findings indicate that structural joint restriction was unlikely to be the principal contributor to the patient's mobility limitations. Instead, functional deficits were more consistent with neurological impairment, muscle weakness, impaired postural control, and altered motor coordination.

Because sensory dysfunction represented one of the patient's principal neurological impairments, sensory integration was assessed across the major sensory systems to characterize the pattern of sensory involvement.

Table 4. Primary Sensory Assessment

Sensory System	Finding
Tactile	Impaired
Proprioceptive	Impaired
Vestibular	Normal
Visual	Normal
Auditory	Normal
Olfactory	Normal
Gustatory	Normal

The sensory assessment demonstrated impairment of tactile and proprioceptive processing, whereas vestibular, visual, auditory, olfactory, and gustatory functions remained intact. The preservation of vestibular function is clinically important because it suggests that postural instability was primarily associated with impaired somatosensory input and reduced motor control rather than vestibular dysfunction. This finding is also consistent with the neurological involvement identified at the L4–L5 spinal level. To further characterize neurological impairment, standardized sensory examination was performed using the International Standards for Neurological Classification of Spinal Cord Injury.

Table 5. ISNCSCI Findings

Nerve Root	Motor Function	Right Light Touch	Right Pin Prick	Left Light Touch	Left Pin Prick
L4	Ankle dorsiflexion	1	1	1	1
L5	Great toe extension	1	1	1	1

The ISNCSCI examination confirmed bilateral sensory impairment corresponding to the L4 and L5 dermatomes. Motor findings also demonstrated severe weakness involving muscles primarily innervated by these spinal segments, supporting the observed deficits in standing balance, gait performance, and lower-extremity motor control. Together with the baseline functional assessment, these findings established an objective reference for evaluating clinical progression during rehabilitation. Following completion of the individualized physiotherapy program, serial outcome assessments were performed after each treatment session to monitor changes across the principal clinical outcomes.

Table 6. Clinical Outcomes Across Three Physiotherapy Sessions

Outcome	Baseline (T1)	Session 2 (T2)	Session 3 (T3)	Absolute Change
Hip flexors	2+/5	3–/5	3/5	+0.5 grade
Hip extensors	2+/5	3–/5	3/5	+0.5 grade
Hip abductors	2/5	3–/5	3/5	+1 grade
Knee flexors	2–/5	2+/5	3–/5	+1 grade
Knee extensors	2–/5	2+/5	3–/5	+1 grade
Ankle dorsiflexors	0/5	2–/5	2+/5	+2.5 grades
Plantarflexors	0/5	1/5	2/5	+2 grades
Evertors	0/5	1/5	2/5	+2 grades
GMFM 88	58.48%	61.40%	63.72%	+5.24 percentage points
Pediatric Balance Scale	6/56	8/56	10/56	+4 points
ISNCSCI sensory function	Impaired	Impaired	Partial improvement	Clinical improvement

Serial assessment demonstrated progressive improvement across all primary outcome measures throughout the rehabilitation period. Gross motor performance increased from 58.48% at baseline to 63.72% after the third treatment session, representing an absolute improvement of 5.24 percentage points. Functional balance also improved, with the PBS score increasing from 6/56 to 10/56, corresponding to an absolute improvement of 4 points. Although these changes do not indicate restoration of independent mobility, they demonstrate measurable improvement in functional performance during the observation period.

The greatest relative improvement was observed in the ankle musculature. Muscle strength of the ankle dorsiflexors improved from 0/5 at baseline to 2+/5 following the third session, whereas plantarflexors and evertors improved from 0/5 to 2/5. Moderate improvements were likewise observed in the hip and knee muscle groups, suggesting progressive enhancement of voluntary neuromuscular activation during rehabilitation.

Beyond the quantitative outcomes, clinically meaningful functional improvements were observed throughout treatment. During the second session, crawling became more coordinated, accompanied by improved reciprocal limb movement and greater trunk stability. By the final evaluation, the patient demonstrated improved sitting alignment, reduced lumbar hyperlordosis, more efficient weight transfer during standing practice, increased tolerance to therapeutic activities, and smoother gait using the backward walker.

Sensory responsiveness also improved during the intervention period. Increased responsiveness to tactile stimulation was observed, particularly in the left lower extremity, although residual sensory deficits remained evident at the final assessment. Consistent with these findings, ISNCSCI reassessment indicated partial sensory improvement rather than complete neurological recovery.

Walking performance demonstrated gradual improvement throughout rehabilitation. Better trunk stability, reduced toe dragging during the swing phase, improved reciprocal stepping, and greater walking endurance were observed while using the backward walker. Nevertheless, the patient continued to require both a rigid ankle-foot orthosis and a backward walker for ambulation at the conclusion of the observation period, indicating that meaningful functional limitations persisted despite measurable clinical improvement.

Overall, the serial assessments consistently demonstrated **early clinical improvement** following individualized multimodal physiotherapy. Improvements were observed across muscle strength, gross motor performance, balance, sensory responsiveness, trunk control, gait quality, exercise tolerance, and participation during therapy. However, because observations were limited to a single patient and a short intervention period, these findings should be interpreted as descriptive clinical outcomes rather than evidence of intervention effectiveness.

Discussion

This case report describes the early clinical changes observed following an individualized multimodal physiotherapy program in a five-year-old child with MRI-confirmed L4–L5 spina bifida occulta. Improvements were documented across several clinically relevant domains, including lower-extremity muscle strength, gross motor performance, balance, trunk control, gait quality, sensory responsiveness, exercise tolerance, and participation during therapeutic activities. Although the patient continued to require a rigid ankle-foot orthosis (AFO) and backward walker for ambulation, the consistent pattern of improvement across multiple standardized outcome measures suggests that the rehabilitation program was associated with meaningful short-term functional gains. Nevertheless, because this report describes a single patient observed over a brief treatment period, the findings should be interpreted as preliminary clinical observations rather than evidence of treatment effectiveness.⁴

The improvement in lower-extremity muscle strength may reflect enhanced voluntary motor unit recruitment rather than structural muscular adaptation. Neural adaptations generally occur earlier than muscle hypertrophy during rehabilitation and include improved motor unit synchronization, increased firing frequency, reduced antagonist co-contraction, and more efficient corticospinal activation. In children with neurological disorders, repeated task-oriented practice combined with neuromuscular electrical stimulation (NMES) may facilitate activation of partially preserved motor pathways while increasing afferent sensory input to the central nervous system, thereby promoting motor learning and functional movement patterns.^{1,9} Although direct neurophysiological mechanisms were not evaluated in this case, the observed increase in ankle dorsiflexor strength from 0/5 to 2+/5 is consistent with these proposed mechanisms.⁶

Improvement in gross motor performance, demonstrated by the increase in GMFM-88 from 58.48% to 63.72%, likely reflects the cumulative effect of repetitive functional practice rather than improvement in isolated muscle strength alone. Gross motor development depends on the coordinated integration of postural control, muscle activation, sensory feedback, and motor planning. The intervention incorporated bridging, crawling, sit-to-stand training, treadmill walking, and play-based activities, all of which required repetitive execution of meaningful motor tasks. Such task-specific training is considered a fundamental principle of pediatric neurorehabilitation because repeated practice under functional conditions facilitates motor learning and improves the transfer of therapeutic gains into daily activities.^{2,8}

Functional balance also demonstrated measurable improvement, with the Pediatric Balance Scale (PBS) score increasing from 6/56 to 10/56. Although this absolute change remained below the threshold for independent balance, it indicates enhanced postural stability during sitting, standing, and transitional movements. Balance control requires continuous integration of visual, vestibular, and somatosensory information to generate appropriate postural responses. In the present case, vestibular and visual function were preserved, whereas somatosensory impairment represented the principal neurological deficit. Consequently, repeated balance activities and functional mobility training may have enhanced the patient's ability to utilize remaining sensory information more efficiently, partially compensating for impaired proprioceptive input through adaptive motor control strategies.^{3,9}

The gradual improvement in gait quality observed throughout rehabilitation is clinically meaningful because independent mobility represents one of the primary long-term rehabilitation goals for children with spina bifida. Reduced toe dragging, smoother reciprocal stepping, improved trunk alignment, and greater walking endurance were observed while using the backward walker. These findings likely resulted from the combined effects of improved proximal stability, increased lower-extremity muscle activation, repetitive gait practice, and greater postural control. However, continued dependence on assistive devices at the end of treatment indicates that neurological impairment remained substantial. Therefore, the intervention should be viewed as facilitating early functional progression rather than restoring independent ambulation.

Partial improvement in sensory responsiveness was also observed during serial assessment. Although complete sensory recovery was not achieved, increased responsiveness to tactile stimulation suggests improved sensory processing or greater awareness of preserved sensory input. Because neurological regeneration within the spinal cord is generally limited, especially over a short observation period, these findings should not be interpreted as evidence of anatomical neural recovery. Instead, they more plausibly reflect functional adaptation, increased attentional engagement during sensory stimulation, or improved utilization of residual neural pathways.²¹

An additional observation was the reduction in parental reports of constipation during the intervention period. Children with spina bifida frequently experience neurogenic bowel dysfunction secondary to impaired autonomic regulation and reduced physical activity. Increased mobility and regular physical exercise may contribute to improved gastrointestinal motility and bowel function.

Nevertheless, bowel function was not assessed using standardized outcome measures in this study; therefore, this observation should be interpreted cautiously as an incidental clinical finding rather than a confirmed treatment effect.²²

The findings of this case are generally consistent with previous reports describing beneficial effects of comprehensive physiotherapy in children with spina bifida and other pediatric neurological disorders. Previous studies have demonstrated that structured rehabilitation programs incorporating strengthening exercises, NMES, gait training, and task-specific functional practice may improve muscle activation, balance, gross motor function, and mobility.^{1,5} However, comparison across studies remains challenging because intervention protocols, treatment intensity, participant characteristics, and outcome measures vary considerably. This heterogeneity underscores the importance of detailed intervention reporting to improve reproducibility and facilitate future evidence synthesis.¹⁶

One important contribution of the present report is the integration of standardized multidimensional outcome assessment with individualized clinical reasoning. Muscle strength, neurological status, gross motor performance, balance, sensory function, and ICF-CY domains were evaluated using validated instruments, allowing comprehensive documentation of functional progression rather than reliance on a single outcome measure. Such multidimensional assessment aligns with contemporary recommendations for pediatric neurorehabilitation, where intervention success extends beyond impairment-level changes to include improvements in activity performance and participation.²²

Despite these encouraging observations, several limitations should be considered when interpreting the findings. First, this report describes only a single patient, limiting generalizability to the broader population of children with spina bifida occulta. Second, the intervention period consisted of only three treatment sessions, preventing evaluation of medium- and long-term functional outcomes. Third, no control condition was available; consequently, causal relationships between the intervention and observed improvements cannot be established. Fourth, some clinically relevant domains, including quality of life, participation, caregiver burden, bowel function, and long-term gait independence, were not assessed using standardized instruments. Finally, detailed technical parameters of several therapeutic modalities should be reported more comprehensively in future studies to improve reproducibility and facilitate comparison across rehabilitation protocols.

Future research should evaluate individualized multimodal physiotherapy using prospective cohort studies or randomized controlled trials with larger sample sizes, longer follow-up periods, standardized intervention protocols, and multidimensional outcome measures encompassing impairment, activity, participation, and health-related quality of life. Such studies are needed to clarify which components of multimodal rehabilitation provide the greatest contribution to functional recovery and to establish evidence-based recommendations for children with spina bifida occulta.

Conclusion

This case report describes the early clinical course of a five-year-old girl with MRI-confirmed L4–L5 spina bifida occulta who underwent an individualized multimodal physiotherapy program consisting of neuromuscular electrical stimulation, sensory stimulation, therapeutic exercise, task-specific gait training, and play-based functional activities. Sequential assessment demonstrated improvements in lower-extremity muscle strength, gross motor performance, balance, trunk control, gait quality, sensory responsiveness, exercise tolerance, and participation during therapy.

Although meaningful clinical improvement was observed over the three treatment sessions, the patient continued to require a rigid ankle-foot orthosis and backward walker for ambulation, indicating persistent functional limitations. Therefore, the findings should be interpreted as evidence of early clinical improvement rather than confirmation of treatment effectiveness.

This report highlights the potential value of individualized multimodal physiotherapy supported by standardized multidimensional assessment for documenting functional progression in children with spina bifida occulta. Future prospective studies involving larger sample sizes, standardized intervention protocols, longer follow-up periods, and controlled study designs are required to determine the effectiveness and long-term clinical impact of multimodal rehabilitation.

Patient Perspective

The patient's parents reported that the child appeared more confident during standing and walking practice after completing the rehabilitation sessions. They observed smoother lower-limb movements, greater willingness to participate in therapeutic activities, and improved endurance during daily mobility using the backward walker. Although independent walking had not yet been achieved, the parents expressed satisfaction with the observed functional progress and were motivated to continue the prescribed home exercise program and regular physiotherapy sessions.

Author Contribution

Ni Luh Made Reny Wahyu Sari: Conceptualization, Methodology, Supervision, Validation, Writing – Review & Editing.
Putu Ayu Meka Raini: Methodology, Investigation, Data Curation, Formal Analysis, Writing – Review & Editing.
Ni Putu Devi S. Kardha: Investigation, Validation, Resources, Writing – Review & Editing.
Ni Wayan Ari Susanthi: Investigation, Data Curation, Visualization.
I Made Dedy Bagus Astika: Investigation, Data Curation, Writing – Original Draft, Visualization, Correspondence.
Putu Tata Pradnya Dewi: Investigation, Resources, Data Curation.

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Conflict of Interest Statement

The authors declare that there are no conflicts of interest regarding the publication of this manuscript.

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Ethics Statement

This manuscript is a single-patient case report describing routine physiotherapy management using anonymized clinical information. According to institutional policy, formal ethical approval was not required for publication of this case report. Written informed consent for publication of the patient's clinical information and images was obtained from the patient's parent/legal guardian. All procedures were conducted in accordance with the ethical principles of the Declaration of Helsinki, and patient confidentiality was maintained throughout the study.

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