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Neuromuscular Physiotherapy Management for Paraplegia due to Non-traumatic Spinal Cord Injury: A Case Report

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Abstract
Introduction: Non-traumatic spinal cord injury (SCI) refers to damage of the spinal cord without direct trauma, commonly caused by infection, tumor, vascular disorders, or degenerative conditions. Lesions at the thoracolumbar junction (Th12–L1) may result in paraplegia characterized by motor and sensory impairment below the level of injury, including lower limb weakness, impaired bladder and bowel control, reduced balance, and functional limitations. Patients are also at risk of secondary complications such as muscle weakness, spasms, restricted range of motion, contractures, and pressure ulcers. Physiotherapy plays a central role in rehabilitation through interventions aimed at preserving and improving body function, preventing complications, and promoting independence. Multimodal interventions may include infrared radiation (IRR), neuromuscular electrical stimulation (NMES), manual therapy, exercise therapy, and breathing exercises.
Objective: To describe the early clinical response to a multimodal neuromuscular physiotherapy program in a patient with paraplegia due to non-traumatic spinal cord injury at the Th12–L1 level.
Methods: This case report describes a 45-year-old female patient diagnosed with paraplegia due to non-traumatic SCI at the Th12–L1 vertebrae, treated at the Physio Sakti Clinic, Makassar.
Results: After two physiotherapy sessions, pain intensity decreased substantially, anxiety levels improved, and initial lower-limb muscle activation was observed (MMT: 0→1 in selected muscle groups). These findings highlight the early positive effects of multimodal physiotherapy on pain control and functional recovery.
Conclusion: Early neuromuscular physiotherapy using a multimodal approach can provide meaningful benefits in restoring initial function and enhancing mobility in patients with paraplegia caused by non-traumatic SCI.

Keywords
Physiotherapy; Spinal Cord Injuries; Paraplegia; Rehabilitation; Neuromuscular Electrical Stimulation; Infrared Rays

Introduction

The lumbar spine (L1–L5) serves to support the upper body while enabling a wide range of movements, including flexion, extension, rotation, and lateral flexion. The large vertebral bodies, together with lumbar lordosis, contribute to stability and load distribution, while the vertebral canal protects the spinal cord up to the L1–L2 level before continuing as the cauda equina. Intervertebral discs between the vertebrae function as shock absorbers and stabilizers.[1] Non-traumatic spinal cord injury (SCI) is commonly caused by tumors, infections, vascular disorders, or degenerative changes, particularly at the thoracolumbar junction (Th12–L1), and may result in paraplegia characterized by bilateral lower-limb paralysis, sensory deficits, spasticity, and bladder or bowel dysfunction. This condition carries important clinical implications because non-traumatic SCI at this segment is relatively uncommon but has a profound impact on daily functional activities.[2]

Epidemiologically, non-traumatic SCI occurs at a rate of approximately 17.9 cases per million population per year and shows an increasing trend. Most patients present with paraplegia, yet they retain considerable potential for functional recovery when managed with intensive rehabilitation.[3] Physiotherapists play a critical role in this process by restoring muscle strength and control, maintaining joint range of motion, and preventing complications such as pressure ulcers and contractures. Interventions may include infrared radiation (IRR) and neuromuscular electrical stimulation (NMES), in combination with manual therapy, exercise therapy, and breathing exercises. A multimodal approach is aimed at preserving and enhancing body function, preventing secondary complications, and optimizing patient independence, making it highly relevant in the rehabilitation of non-traumatic SCI at Th12–L1 from the early phase onward.[4] Although physiotherapy is widely applied in SCI management, evidence regarding the effectiveness of neuromuscular interventions for paraplegia due to non-traumatic SCI at Th12–L1 remains limited.

This case report describes a 45-year-old female entrepreneur who presented to the clinic with the primary complaint of bilateral lower-limb paralysis accompanied by difficulty standing and walking. She had previously been physically active and had no history of neurological disorders. In August 2024, the patient experienced thoracolumbar pain after participating in a tug-of-war activity. Initially, she was diagnosed with suspected herniated nucleus pulposus (HNP); however, magnetic resonance imaging (MRI) revealed a tumor at Th12–L1 compressing the spinal cord. She underwent tumor excision surgery in December 2024. Prior to surgery, she was still able to walk, but postoperatively she developed severe motor impairment in the lower limbs, progressing to paralysis. The patient received postoperative physiotherapy at a hospital in Makassar without functional improvement. The current visit represents her first assessment at Physio Sakti Clinic, Makassar.

Retrospective studies have shown that patients with SCI caused by tumors may achieve significant functional improvements through intensive rehabilitation programs, with greater gains in motor Functional Independence Measure (FIM) scores observed between admission and discharge for primary compared with secondary tumors ($p = 0.006$). Previous case reports have also described recovery of walking ability in paraplegic patients with spinal tumors following individualized rehabilitation programs.[5] Reported effective interventions include lower-limb strengthening exercises, balance and transfer training, gait training with or without assistive devices, neuromuscular electrotherapy, and occupational therapy to support independence in activities of daily living. These findings support the rationale that systematic and multimodal neuromuscular physiotherapy initiated in the early postoperative phase may provide meaningful benefits, as planned for the patient described in this study.[6] The aim of this case report is therefore to evaluate the role and effectiveness of neuromuscular physiotherapy in improving motor function and mobility in a patient with paraplegia due to non-traumatic SCI at the Th12–L1 vertebral level.

Methods

This study employed a case report design and was conducted in a physiotherapy clinic in Makassar, South Sulawesi. The patient was selected using a purposive sampling approach: a 45-year-old female diagnosed with paraplegia secondary to non-traumatic spinal cord injury (SCI) at the Th12–L1 vertebrae.

Inclusion criteria included patients aged >18 years, diagnosed with non-traumatic SCI, without systemic comorbidities affecting neuromuscular function, and willing to undergo therapy. Data were collected through interviews regarding subjective complaints and medical history, static and dynamic observation, as well as physiotherapy assessments. The physiotherapy examination included: range of motion (ROM), muscle strength measured with Manual Muscle Testing (MMT), muscle tone assessed with the Modified Ashworth Scale (MAS), pain intensity using the Visual Analogue Scale (VAS), sensory and reflex testing (physiological and pathological), coordination, activities of daily living (Spinal Cord Independence Measure/SCIM), and anxiety level assessed by the Hamilton Rating Scale for Anxiety (HRS-A). Additional diagnostic confirmation was obtained using magnetic resonance imaging (MRI) to identify the lesion site.[7]

Initial assessment revealed resting pain (VAS: 4), movement-related pain (VAS: 6), severe bilateral lower limb weakness (MMT: 0–1), normal muscle tone (MAS: 0), and limitations in daily activities (ADL). The patient's complaints began in August 2024, when she developed localized vertebral pain following sports activity. In December 2024, she underwent tumor resection surgery at the Th12–L1 level, after which she experienced lower limb weakness. In February 2025, she initiated physiotherapy at the clinic and, at the time of reporting, had completed two multimodal physiotherapy sessions.

The physiotherapy diagnosis was established according to the International Classification of Functioning, Disability and Health (ICF) framework, encompassing body functions, body structures, activity limitations, and participation restrictions. Data analysis was conducted descriptively by comparing the patient's condition before and after intervention.

Interventions were tailored to the patient's clinical findings and included infrared radiation (IRR) applied locally to the lower back region for 10 minutes prior to active therapy. Neuromuscular electrical stimulation (NMES) was administered to the bilateral quadriceps muscles using a stimulation frequency of 40 Hz, with intensity adjusted to patient tolerance, for 10 minutes to facilitate muscle activation. In addition, interferential therapy was applied for pain management using a carrier frequency of 4000 Hz, delivered via cross-pad electrode placement over the L4–L5 region and the common peroneal nerve sulcus for 15 minutes. The physiotherapy program also comprised breathing exercises, muscle strengthening exercises (8 sets × 5 repetitions), trunk stability training, manual therapy, and functional training focusing on transfers and balance activities. All interventions were delivered twice weekly to support early functional recovery.[8] The distinction between stimulation frequency for NMES and carrier frequency for interferential therapy was maintained to ensure clarity and clinical accuracy. Data were analyzed descriptively by comparing clinical findings before and after the intervention period.

Results

On 22 February 2025, during a therapy session, a basic motor-function assessment of the hip, knee, and ankle regions was performed. The patient was unable to perform active movements of the hip, knee, and ankle. Passive range of motion (ROM) was within normal limits for all assessed movements in each region.

The initial physiotherapy assessment included a comprehensive physical examination to identify impairments in posture, movement, sensory function, and neuromuscular control. The findings from static and dynamic inspection, palpation, basic motor-function assessment, and orientation to motor commands are summarized in Table 1, providing an overview of the patient's general physical condition and movement limitations at baseline.

Table 1. Physical examination and findings

No.	Physical Examination	Findings
1	Static inspection	Bilateral drop foot; bilateral lower-limb muscle atrophy; indwelling urinary catheter in situ; patient appeared anxious; postoperative surgical incision scar present at the operative site
2	Dynamic inspection	Patient arrived using a wheelchair; active use of upper limbs observed
3	Palpation	Skin contour normal; no edema; normal skin temperature; tenderness and pain elicited in the L4–L5 region
4	Orientation / motor command	Patient was unable to voluntarily move both lower limbs
5	Basic motor function examination (PFGD)	Patient was unable to perform active movements of the hip, knee, and ankle joints; passive range of motion was preserved and within normal limits in all assessed joints

Overall, the physical examination findings indicated severe motor impairment of the lower limbs accompanied by preserved passive joint mobility and the presence of both sensory and reflex abnormalities. These baseline findings provided the clinical basis for further neuromuscular and functional assessments presented in the subsequent tables.

Specific tests and results

To further characterize the patient's neuromuscular and functional status, specific clinical tests were conducted to evaluate pain intensity, muscle tone, muscle strength, range of motion, sensory function, reflex activity, coordination, activities of daily living, psychological status, and imaging findings. The results of these assessments are presented in Table 2, detailing the severity and extent of impairments associated with the non-traumatic spinal cord injury.

Table 2. Specific tests and findings

Parameter	Finding
Pain — Visual Analogue Scale (VAS)	Resting pain: 4 (mild); Pressure pain (palpation): 4 (mild); Movement-related pain: 6 (moderate)
Muscle Tone — Modified Ashworth Scale (MAS)	Lower limbs (right and left): No increase in muscle tone (MAS = 0)
Muscle Strength — Manual Muscle Testing (MMT)	Iliopsoas: 0; Gluteal muscles: 0; Adductor (groin) group: 0; Quadriceps: 0; Hamstrings: 0; Tibialis anterior: 0; Tibialis posterior: 0; Gastrocnemius: 0; Peroneal muscles: 0; Extensor digitorum longus: 0
	Overall result: No detectable voluntary muscle contraction in either lower limb
Range of Motion (ROM)	Hip (R–L): Sagittal plane 15°–0°–125°; Frontal plane 45°–0°–15°; Transverse plane 45°–0°–45°. Knee (R–L): Sagittal plane 0°–0°–130°; Transverse plane 40°–0°–35°
Sensory Examination	Temperature sensation: Absent (bilateral); Light touch: Absent (bilateral); Two-point discrimination: Unable to distinguish (bilateral)
Physiological Reflexes	Patellar reflex: Absent (areflexia, bilateral); Achilles tendon reflex: Absent (areflexia, bilateral)
Pathological Reflexes	Babinski sign: Positive; Chaddock sign: Positive; Gonda sign: Positive
Coordination Test	Heel-to-knee test: Unable to perform
Activities of Daily Living	Spinal Cord Independence Measure (SCIM): 20/100 (dependent)
Anxiety	Hamilton Rating Scale for Anxiety (HRS-A): 30 (severe anxiety)
Imaging (MRI)	Tumor lesion identified at the Th12–L1 spinal level

Physiotherapy diagnosis (ICF-based)

Based on the International Classification of Functioning, Disability and Health (ICF) framework, the patient presented with impairments in body functions, body structures, and activities. Impairments in body functions included paraplegia (b798), marked muscle weakness affecting the lower half of the body (b7303), pain (b2809/b289), and complete sensory loss involving touch, proprioception, and temperature sensation (b265, b260, b270). Psychological impairment was also evident, as reflected by significant anxiety (b198). In terms of body structures, the patient demonstrated spinal cord injury at the thoracolumbar level (s120), accompanied by muscle atrophy of the lower extremities (s750). These impairments resulted in substantial activity limitations, particularly in walking (d4500), toileting (d5300), self-care (d598), and work-related activities (d859).

Clinical summary, problems, and goals

Based on the clinical findings, the patient was diagnosed with movement and motor-function impairment of the lower limbs secondary to paraplegia caused by non-traumatic spinal cord injury at the Th12–L1 level since December 2024. The primary clinical problem identified was pain, while secondary problems included lumbar pain, bilateral lower-limb muscle weakness and atrophy, sensory loss (anesthesia), bowel and bladder dysfunction, and anxiety. These impairments collectively resulted in complex limitations in activities of daily living, particularly walking, toileting, self-care, and work participation.

The short-term physiotherapy goals focused on optimizing lower-limb movement, reducing pain, initiating muscle activation, preventing further atrophy, maintaining sensory stimulation, reducing anxiety, and preventing secondary complications such as contractures and pressure ulcers. The long-term physiotherapy goals aimed to progressively restore functional independence in activities of daily living, including toileting, walking, and self-care, through sustained and structured rehabilitation.[9]

Baseline Clinical Assessment and Physiotherapy Intervention

Based on the initial assessment findings and the established physiotherapy diagnosis, an individualized and problem-oriented physiotherapy intervention program was designed and implemented. The detailed components, modalities, and parameters of the multimodal physiotherapy intervention are presented in Table 3.

Table 3. Physiotherapy intervention program

No.	Problem	Physiotherapy modality	Parameters / Dose
1	Anxiety	Therapeutic communication	Frequency: once daily during therapy sessions; Focus: patient-centered interpersonal approach
2	Preliminary exercise	Infrared radiation (IRR)	Frequency: each therapy session; Distance: 30 cm from skin surface; Location: local lower back; Duration: 10 min
3	Pain	Interferential therapy (IFT)	Carrier frequency: 4000 Hz; Intensity: 47 mA; Electrode placement: cross-pad at L4–L5 and common peroneal nerve sulcus; Duration: 15 min
4	Paralysis (paraplegia) + atrophy	Neuromuscular electrical stimulation (NMES)	Stimulation frequency: 40 Hz; Intensity: 47 mA; Electrode placement: bilateral quadriceps and peroneus longus; Duration: 10 min
		Manual therapy (overflow muscle facilitation)	Each session: 8 strikes × 5 repetitions; Duration: 3 min
		Manual therapy (MMBTS)	Each session: 8 repetitions; Duration: 2 min
5	Anesthesia (sensory loss)	Manual therapy (tactile stimulation)	Each session; parameters adjusted to patient tolerance; Duration: 2 min
6	Muscle weakness / contracture prevention	Exercise therapy (PROM and strengthening)	Each session: 8 repetitions × 5 sets; Duration: 3 min
		Passive stretching (lower-limb muscles)	Target muscles: iliopsoas, gluteal group, groin/adductors, quadriceps, hamstrings, tibialis anterior/posterior, gastrocnemius, peroneal group; Each session: 8 repetitions × 5 sets; Duration: 3 min
7	Postural correction	Exercise therapy (Bugnet exercise)	Each session: 8 repetitions × 5 sets; Duration: 2 min
8	ADL limitation	Functional movement facilitation	Each session: 8 repetitions; facilitation of pathological reflexes (e.g., Gonda reflex) as needed; Duration: 2 min
9	Pressure-ulcer prevention / respiratory support	Positioning Breathing exercise (diaphragmatic breathing)	Repositioning every 1.5–3 h; sleep-to-sit transfers per session Each session: 8 repetitions × 3 sets; Duration: 3 min

Note: Interventions were individualized to address the patient's main problems (pain, muscle weakness), to optimize lower-limb movement, and to prevent secondary complications such as ongoing atrophy, contracture, pressure ulcers, and anxiety. The patient was instructed on a home exercise program and attended all scheduled sessions.

Short-Term Outcomes Following Physiotherapy Intervention

To examine the short-term effects of the physiotherapy intervention, selected clinical outcomes were reassessed after two treatment sessions. A comparison of baseline and post-intervention findings, including pain intensity, neuromuscular activation, anxiety level, and functional status, is summarized in Table 4.

Table 4. Intervention program evaluation (pre vs. post two sessions)

No.	Problem	Parameter	Before (22/02/2025)	After (25/02/2025)	Comment
1	Pain	Visual Analogue Scale (VAS)	Resting pain: 4; Movement pain: 6; Pressure pain: 6	Resting pain: 0; Movement pain: 2; Pressure pain: 2	Improvement observed
2	Muscle weakness	Manual Muscle Testing (MMT)	All assessed lower-limb muscles: grade 0	Selected muscles improved to grade 1 (iliopsoas, groin/adductors, quadriceps, hamstrings, gastrocnemius); other muscles remained at grade 0	Small but positive change
3	Muscle tone / atrophy	Modified Ashworth Scale (MAS)	0	0	No change detected
4	ADL limitation	Spinal Cord Independence Measure (SCIM)	20 (dependent)	20 (dependent)	No change detected
5	Anxiety	Hamilton Rating Scale for Anxiety (HRS-A)	30 (severe anxiety)	13 (mild anxiety)	Significant reduction

The patient adhered to all scheduled sessions and performed the recommended home exercises. After two intervention sessions, there was a marked reduction in pain intensity and anxiety, and and early neuromuscular activation, indicated by trace muscle contractions (MMT grade 1) in selected lower-limb muscles, while improvements in muscle atrophy and ADL independence were not yet observed. No significant adverse effects were reported during the interventions.

Discussion

Paraplegia resulting from non-traumatic spinal cord injury (SCI), such as that caused by a tumor at the Th12–L1 level, produces severe motor and sensory impairment of the lower extremities.[10] This condition arises from compression or infiltration of the spinal cord by a tumor mass rather than external physical trauma, and it can cause permanent damage to neural tissue.[11] Although the etiology is non-traumatic, the functional deficits closely resemble those observed after traumatic SCI; consequently, physiotherapy rehabilitation remains a cornerstone of patient recovery.[12]

Non-traumatic SCI more commonly affects older adults and is frequently accompanied by comorbid medical conditions that complicate recovery. However, several studies indicate that consistently delivered, intensive rehabilitation programs can produce meaningful functional improvements. One study reported that patients with partial paraplegia due to metastatic spinal tumors who received individualized physiotherapy achieved significant gains in mobility, muscle strength, and independence in activities of daily living.[13] Another study demonstrated improved motor Functional Independence Measure (FIM) scores among patients with spinal tumors undergoing inpatient rehabilitation, although these gains were somewhat lower than those seen in patients with traumatic SCI.[14,15]

The role of physiotherapy in tumor-related paraplegia is critical because it addresses not only physical restoration but also the prevention of immobility-related complications such as pressure ulcers, contractures, and reduced pulmonary capacity. Interventions such as core and upper-limb strengthening, seated and standing balance training, and transfer training (bed-to-wheelchair and wheelchair-to-toilet) are essential to rebuild patient independence. Functional electrical stimulation (FES) is increasingly used to elicit muscle contractions and limit disuse atrophy, although its effectiveness specifically in spinal tumor cases requires further investigation.[16]

Multiple factors influence rehabilitation outcomes, including pain severity, tumor location and histology, the patient's psychological state, and the availability of family and social support. Patients with tumor-related non-traumatic SCI often have shorter rehabilitation courses because of the complex prognosis of the underlying disease, yet they may still attain significant improvements—particularly in transfers, balance, and basic mobility. Recent innovations in rehabilitation technology, such as Arc-Ex (a non-invasive neural stimulation device originally developed for individuals with tetraplegia), are being explored for application in paraplegia.[17] Early clinical trials suggest that external electrical stimulation can facilitate partial recovery of previously lost neural function, offering new therapeutic possibilities for chronic SCI patients.[18]

With an individualized physiotherapy program, tailored exercise prescription, and coordinated care from a multidisciplinary rehabilitation team, patients with paraplegia due to spinal tumors can achieve clinically meaningful functional gains and greater independence. Patient and caregiver education is essential because long-term adherence to home exercise and preventive strategies substantially influences rehabilitation outcomes.[19,20]

Conclusion

This case report describes the early clinical response to a multimodal neuromuscular physiotherapy program in a patient with paraplegia secondary to non-traumatic spinal cord injury at the Th12–L1 level. The findings emphasize the importance of physiotherapy as part of early clinical management aimed at symptom control, neuromuscular facilitation, and prevention of secondary complications rather than immediate functional recovery.

Following two physiotherapy sessions, the patient demonstrated favorable early responses, including a marked reduction in pain intensity, a substantial decrease in anxiety levels, and initial neuromuscular activation in selected lower-limb muscle groups, as indicated by trace muscle contractions on Manual Muscle Testing. These changes suggest that early physiotherapy intervention may positively influence both physical and psychological aspects of recovery, even within a very short intervention period. However, no improvements were observed in muscle atrophy or independence in activities of daily living, highlighting the limited impact of short-term intervention on functional outcomes in severe neurological impairment.

These results should be interpreted as preliminary physiological and psychological responses rather than indicators of sustained functional improvement or long-term recovery. Given the severity of the spinal cord injury and the short duration of intervention, continued and structured physiotherapy over a longer period is essential to determine whether early neuromuscular activation can translate into meaningful functional gains, improved mobility, and greater independence in daily activities.

Overall, this case report contributes to the clinical understanding of early neuromuscular physiotherapy management in non-traumatic spinal cord injury and underscores the need for individualized, ongoing rehabilitation programs supported by long-term follow-up to optimize patient outcomes.

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Conflict of Interest Statement

The authors declare no conflict of interest.

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Ethics Statement

This case report did not require formal ethical approval as it involved the retrospective description of a single patient and did not include experimental intervention. Written informed consent was obtained from the patient prior to publication.

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