

Effectiveness of Combined Prolonged Muscle Stretching and Weight-Bearing Exercises for the Management of Ankle Clonus in Chronic T9 Complete Spinal Cord Injury: A Case Study

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Abstract

Background: Ankle clonus is a frequent upper motor neuron sign in persons with chronic spinal cord injury (SCI) and may interfere with standing balance, mobility and overall functional performance. Although long stretches of the muscles and exercises with weight bearing are commonly used in physiotherapy, the combined effect on ankle clonus in chronic complete SCI is not known.

Case Description: A 28-year-old male with chronic complete T9 spinal cord injury (ASIA Grade A) secondary to a road traffic accident presented with bilateral ankle clonus, plantar flexor spasticity, impaired standing balance and difficulty in functional mobility. He had spinal fixation surgery and was in a wheelchair for approximately four years.

Intervention: The patient was undergone through a 4-week physiotherapy program (4–5 sessions/week), including prolonged passive stretching of the lower limb muscles, supported weight-bearing with a customized thoraco-hip-knee-ankle-foot orthosis (THKAFO) with a walker, passive range of motion exercises, and correct positioning of the ankles in a neutral position during rest.

Results: The ankle clonus was reduced from 40–50 beats to 10–20 beats and the Modified Ashworth Scale score decreased from Grade 2 to Grade 1+ to 1 post intervention. Standing tolerance increased from about 2 hours to over 4 hours with support. The patient also had improved standing balance, less involuntary movement, less fatigue when standing and improved comfort. No treatment-related adverse events were reported.

Conclusion: This case report indicates that a combination of prolonged muscle stretching, supported weight-bearing and proper positioning may be a feasible and effective physiotherapy method to reduce ankle clonus and improve standing ability in patients with chronic complete T9 spinal cord injury. “Larger, longer follow-up studies are needed to confirm these findings.”

Keywords: Spinal cord injury, paraplegia, ankle clonus, spasticity, physiotherapy, prolonged stretching, weight-bearing, rehabilitation, case study.

Background

Spinal cord injury (SCI) is a devastating disorder that disrupts information flow between brain and body resulting in loss of motor, sensory and autonomic functions below the level of injury. Traumatic SCI is most commonly due to road traffic accidents, falls, sports injuries or violence, with road accidents being the most common cause in India. Paraplegia caused by a complete T9 spinal cord injury, resulting in complete loss of

movement and sensation in both lower limbs. Rehabilitation is a long-term process focused on improving functional independence and overall quality of life.

Many chronic SCI patients will demonstrate signs of upper motor neuron involvement such as spasticity and ankle clonus. Ankle clonus consists of a series of involuntary relaxations and contractions of the calf muscles. Persistent clonus may affect standing balance, mobility, transfers, orthotic use and general functional independence. Management of clonus is an important part of physiotherapy.

Static stretching and supported weight bearing are often used as conservative physiotherapy approaches to manage muscle hypertonicity and facilitate functional activities. Stretching helps to maintain the muscle length and may reduce reflex excitability. Supported standing provides sensory input, improves postural alignment, and increases standing tolerance.

These interventions are widely used in clinical practice but there is limited evidence concerning the combined effect of these interventions in people with ankle clonus in chronic complete T9 paraplegia. This case study reports on the outcome of a 4 week physiotherapy program of sustained stretching and supported weight bearing in a 28 year old male with chronic T9 paraplegia and ankle clonus.

Spinal cord injury (SCI) may be traumatic or non-traumatic. Traumatic SCI commonly results from falls, road traffic accidents (RTAs), sports-related injuries, violence, and occupational trauma, while non-traumatic causes include tumors, infections, vascular disorders, and degenerative conditions.

In India, traumatic SCI is predominantly associated with falls and road traffic accidents. Indian studies have reported falls as the leading cause, followed by RTAs; for example, one tertiary-care study reported 45.6% injuries due to falls and 44.9% due to RTAs. Another Indian study reported falls and RTAs as the two major causes of traumatic spinal injuries.

Spinal cord injury (SCI) is an important cause of long-term disability in India, with traumatic injuries accounting for a major proportion of cases. In the absence of a comprehensive national spinal cord injury registry, the exact incidence of SCI in India is not clearly established. Indian health-care guidelines estimate the annual incidence of spinal injury at approximately 30 cases per million population, with around 40% of these injuries resulting in complete lesions, including paraplegia and tetraplegia. Road traffic accidents and falls from height are among the major causes of traumatic SCI in India. Approximately 85% of affected individuals are males, with a substantial proportion occurring among young adults, particularly those in the 15–35-year age group.

The epidemiological pattern of SCI in India differs from that of many high-income countries, where an increasing proportion of injuries occurs among older adults. In India, road traffic injuries, occupational accidents and falls continue to contribute substantially to traumatic SCI, resulting in considerable physical, social and economic consequences for affected individuals and their families. Regional Indian studies also demonstrate a predominance of young adult males among patients with traumatic SCI.

The prevalence of spinal cord injury (SCI) varies considerably across different countries and regions because of differences in healthcare systems, injury prevention strategies, and methods used to collect data. A systematic review of global epidemiological studies reported that the prevalence of traumatic SCI ranges from 236 to 1,009 cases per million population worldwide. In India, traumatic spinal cord injury shows a marked male predominance, with reported male-to-female ratios ranging from approximately 4:1 to 6:1. A large Indian study reported a male-to-female ratio of 5.9:1. The ratio corresponds approximately to 85.5% males and 14.5% females.

The anatomy of spinal cord is a cylindrical structure of the central nervous system that extends from the lower end of the brainstem (medulla oblongata) to the vertebral canal at the level of the first or second lumbar vertebra (L1–L2) in adults. It is the main pathway for transmitting motor commands from the brain to the body and sensory information from the body to the brain. The spinal cord also coordinates reflex activity without direct involvement of the brain.

The spinal cord is segmented into 31 segments: 8 cervical, 12 thoracic, 5 lumbar, 5 sacral, and 1 coccygeal. Each segment gives rise to two spinal nerves which innervate definite parts of the body. The spinal cord internally contains a central gray matter of neuronal cell bodies in a butterfly-like pattern, surrounded by white matter of ascending sensory and descending motor nerve tracts.

The vertebral column, three connective tissue membranes known as the dura mater, arachnoid mater, and pia mater, and cerebrospinal fluid (CSF), which shields the spinal cord from mechanical injury, all surround and protect the spinal cord. These protective structures are critical for preservation of normal spinal cord function and minimization of injury in trauma.

The patient underwent a structured physiotherapy program focused on reducing ankle clonus and improving lower limb muscle tone. Treatment included prolonged passive stretching of the plantar flexor muscles, supported weight-bearing in standing using a standing frame, and proper positioning of the ankle in a neutral position during rest using pillow support/night splints to maintain muscle length. The program was carried out under supervision with regular monitoring of the patient's response and tolerance. The intervention was continued consistently over the treatment period, with gradual progression based on the patient's clinical condition.

Aim

To evaluate the effectiveness of combined prolonged muscle stretching and weight-bearing exercises in reducing ankle clonus in a patient with chronic complete T9 spinal cord injury.

Objectives

- To evaluate the reduction in the severity of ankle clonus.
- To evaluate the reduction in spasticity of the plantar flexor muscles.
- To evaluate the improvement in standing tolerance.
- To enhance postural stability during supported standing.
- To evaluate the effectiveness of combined prolonged muscle stretching and weight-bearing exercises in the management of ankle clonus.

Case Description and Assessment

A 28-year-old man struggling with spasticity in both legs, and frustrating involuntary ankle clonus. These issues made it incredibly hard for him to keep his balance while standing, exhausted him quickly, and complicated his attempts to move from his bed to his chair. On top of the physical hurdles, he was living with severe nerve pain in his legs, which he described as a constant, uncomfortable mix of burning, tingling, sudden electric shocks, and a deep feeling of heaviness.

His condition traces back to a severe RTA on October 22, 2021. Scans taken after the accident revealed a devastating injury: a spondylolisthesis at the T9 level and completely severed his spinal cord. Under the standard ASIA impairment scale, his injury is classified as a "Grade A," meaning it is a complete injury with absolutely no sensations or voluntary movement preserved below the point of damage.

Right after the accident, surgeons had to go in and use rods and screws to stabilize his spine (ORIF) and relieve the immediate pressure. Since that time, he has relied entirely on a wheelchair to get around. Like many people with this specific level of injury, his body can no longer regulate basic functions on its own; he manages a neurogenic bladder using a condom catheter and requires daily assistance from a caregiver for his bowel routine.

Despite these setbacks, a look at his current physical abilities showed a lot of upper body strength and resilience. He can completely independently roll over in bed, sit up from lying down, and push his own wheelchair. The main functional roadblock he faces right now is safely shifting himself from his bed to his wheelchair without someone else's help. However, he is able to get up and maintain a standing position—provided he uses a walker and a heavy-duty, custom THKAFO orthotic brace that supports his body from his chest all the way down to his feet.

Initial Investigations

- X-Ray
- MRI

Both revealed the vertebral damage and spondylolisthesis with complete spinal cord injury at thoracic 9 level.

Observation

- General observation revealed a conscious, cooperative, and well-oriented individual. Disuse muscle atrophy was noted in both lower limbs. Mild scoliosis was present in the lower thoracic and lumbar region, accompanied by slight postural deformity. No pressure sores or joint contractures were observed during examination.
- The patient reported neuropathic symptoms including burning sensation, tingling, electric shock-like sensations, and heaviness in both lower limbs.
- Passive range of motion of both lower limbs are as follows

Joint	Movements	Degree of Movement
Hip	1. Flexion 2. Extension 3. Abduction 4. Adduction 5. Internal Rotation 6. External Rotation	1. 130° 2. 30° 3. 45° 4. 30° 5. 45° 6. 45°
Knee	1. Flexion 2. Extension	1. 140° 2. 0°
Ankle	1. Dorsiflexion 2. Plantarflexion 3. Inversion 4. Eversion	1. 20° 2. 50° 3. 35° 4. 15°

- The MMT shows no voluntary motor activity in either lower limb.

Muscle Group	MMT Grade
Hip Muscle	0/5
Knee Muscle	0/5
Ankle Muscle	0/5

- Sensory examination revealed complete absence of sensation below the T9 dermatome level, consistent with complete spinal cord injury.
- Muscle tone was assessed using the Modified Ashworth Scale (MAS)
Ankle dorsiflexors – Grade 2 on both side.
- Bilateral ankle clonus was present on examination.
Clonus beats : 40-50 beats on both ankles

Reflex examination shows

- Babinski Sign: Positive bilaterally
- Knee Jerk: Absent
- Ankle Jerk: Absent

The patient was able to maintain standing using a customized thoraco-hip-knee-ankle-foot orthotic (THKAFO) brace with walker support for prolonged durations. Standing tolerance was reported to be about two hours with adequate support.

Clinical Impression

Based on the history and examination findings, the patient was diagnosed with chronic complete T9 spinal cord injury (ASIA Grade A) with spastic paraplegia, bilateral ankle clonus, neurogenic bladder, severe low back pain, and functional limitations affecting balance, transfers, and mobility. The presence of persistent ankle clonus and spasticity significantly influenced the patient's functional performance and formed the primary focus of physiotherapy management.

Uniqueness of Study

- I chose this case because persistent ankle clonus was a major problem in a patient with chronic, complete T9 spinal cord injury.
- The case is unique because it focuses specifically on management of ankle clonus, rather than only addressing general complications of paraplegia.
- The study combines prolonged muscle stretching and weight-bearing exercises, providing a simple and practical physiotherapy approach.
- There is limited case-based evidence on this specific combination of interventions for managing clonus in chronic complete SCI.
- This case was selected to determine whether these interventions could reduce clonus and improve standing tolerance, thereby contributing to better functional rehabilitation.

Physiotherapy Intervention Protocol

Intervention	Description	Dosage
Positioning	In supine lying, both feet were kept in a neutral position. Pillows or night splints were used when required to prevent the ankles from resting in excessive plantarflexion and to maintain proper alignment.	During rest periods and at night.
Passive ROM exercises	Passive movements of the hip, knee, and ankle joints were performed slowly through the	10–15 repetitions for each movement.

	available range. Special attention was given to ankle dorsiflexion and plantarflexion movements.	
Sustained stretching	Gentle prolonged stretching of the gastrocnemius, soleus, hamstrings, and other tight lower limb muscles. The patient was kept in supine lying position.	Hold for 45–60 seconds, repeated 4–5 times.
Weight-bearing training	Supported standing using a customized THKAFO and walker with equal weight distribution through both lower limbs.	Performed according to the patient's tolerance.
Standing Practice	The patient was encouraged to maintain an upright standing posture with proper alignment and symmetrical loading of both lower limbs.	In each treatment session
Frequency of treatment	Combined physiotherapy program	4-5 sessions per week for 4 weeks

At the beginning of treatment, the patient demonstrated approximately 50 beats of ankle clonus along with a Modified Ashworth Scale score of Grade 2. Following four weeks of intervention, the clonus reduced to approximately 10-20 beats, while muscle tone improved to Grade 1+ to Grade 1 on the Modified Ashworth Scale.

The improvement observed in this case is clinically meaningful because the patient was in the chronic stage of spinal cord injury, where changes are often slower and more difficult to achieve. The reduction in clonus and muscle tone suggests that consistent use of positioning, stretching, and weight-bearing activities may help in managing ankle clonus in individuals with long-standing paraplegia.

This case may be useful for physiotherapists working with similar patients, as the treatment methods used were simple, practical, and easily applicable in routine clinical practice without the need for specialized equipment.

Outcome Measures

- Modified Ashworth Scale (MAS)
- Ankle Clonus Assessment (number of beats)
- Range of Motion (ROM)
- Balance during standing activities

Precautions

- Monitor the patient for signs of autonomic dysreflexia during treatment.
- Check blood pressure and observe for symptoms of orthostatic hypotension before and during standing.
- Ensure proper alignment and support of the lower limbs during stretching and weight-bearing.

- Perform stretching slowly and avoid forceful movements that may trigger clonus or cause soft tissue injury.
- Inspect the skin regularly for pressure areas, especially over bony prominences, before and after standing.
- Monitor the patient's fatigue level and discontinue the session if excessive discomfort or adverse symptoms develop.
- Ensure all standing equipment is secure and provide adequate supervision throughout the intervention.

Result

Outcome Measures	Before Treatment	After Treatment
Ankle clonus	Approximately 40-50 beats	Approximately 10-20 beats
Modified Ashworth Scale (MAS)	Grade 2	Grade 1+ to 1
Standing Tolerance	About 2 hours	About 4 hours
Balance during standing	Somewhat weak	Improved

After 4 weeks of physiotherapy intervention (5 sessions per week), the patient showed noticeable improvement in ankle clonus and functional standing ability. The ankle clonus decreased from 40–50 beats before treatment to 10–20 beats after treatment. The Modified Ashworth Scale (MAS) score also improved from Grade 2 to Grade 1+–1, indicating a reduction in muscle tone.

The patient's standing tolerance increased from approximately 2 hours to more than 4 hours with support. As the severity of ankle clonus reduced, the patient demonstrated better balance during supported standing and reported greater comfort while maintaining the standing position. Involuntary movements became less frequent, and the patient experienced reduced fatigue during standing activities.

The range of motion of all joints remained within normal limits throughout the treatment period, while muscle strength did not show any significant improvement, which was expected considering the chronic complete T9 spinal cord injury. No adverse effects were reported during the intervention, and the treatment was well tolerated by the patient.

Discussion

Spasticity and ankle clonus are frequently seen after spinal cord injury, especially in patients who have been living with the condition for a long time. These problems can interfere with proper positioning, movement and daily functional activities (Adams and Hicks, 2005). Prolonged stretching is commonly used during SCI rehabilitation to maintain muscle length and reduce tightness, although its exact effect on spasticity and clonus still needs further investigation (Williams et al., 2024). Similarly, standing and supported weight-bearing may help influence muscle tone by providing continuous sensory and mechanical input to the lower limbs (Sadeghi et al., 2016). Previous studies have also explored interventions such as tilt-table standing and body-weight-supported training for managing spasticity in people with chronic SCI, which supports the use of supported standing in rehabilitation (Adams and Hicks, 2011). Keeping these findings in mind, the present case used a combination of prolonged stretching, positioning, passive ROM and supported weight-bearing. Following the intervention, the patient showed a reduction in ankle clonus and muscle tone along with better tolerance to standing (Barbosa et al., 2021).

Conclusion

This case study proposes that a physiotherapy approach combining sustained muscle stretching, supported weight bearing exercises and suitable positioning may be an effective management strategy for ankle clonus in a patient with chronic complete spinal cord injury at T9. Following 4 weeks of treatment the patient showed a significant decrease of ankle clonus and spasticity, increased standing tolerance and balance, fewer involuntary movements and less fatigue while standing. The intervention was well tolerated and the patient was advised to continue with the same exercise program including stretching, supported standing and proper positioning at home to help maintain the gains achieved.

This case exemplifies the potential value of combining these simple, inexpensive interventions as part of routine rehabilitation for persons with chronic spinal cord injury. However, this is a single-case study and further research is recommended with larger sample sizes, longer follow up periods, randomized controlled trials, comparisons with other physiotherapy interventions, use of advanced rehabilitation technology (such as FES, robotic gait training and body-weight supported treadmill training) and standardized outcome measures to strengthen evidence and improve clinical practice.

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