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Core Stability Training for Balance Improvement in a Post-Operative Spinal Tuberculosis Patient: A Case Report

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Abstract

Introduction: Spinal tuberculosis (TB spondylitis) is a severe manifestation of Mycobacterium tuberculosis infection, characterized by chronic spinal inflammation. Surgical management is often required for debridement and stabilization but may compromise postural control and balance.

Methods: This case report describes a 36-year-old male who underwent spinal tuberculosis surgery and subsequently received physiotherapy with a focus on core stability training. The intervention consisted of six physiotherapy sessions conducted twice weekly, emphasizing pelvic tilting exercises to improve trunk stability. Balance outcomes were assessed using the Berg Balance Scale (BBS). Additionally, a literature review was performed using Google Scholar, PubMed, and ProQuest with the keywords “spondylitis tuberculosis” AND “core stability,” limited to full-text articles published between 2018 and 2023.

Results: The patient’s BBS score increased from 6 at baseline to 21 after six sessions, suggesting improved balance performance. This improvement is likely associated with enhanced trunk stability and activation of local stabilizing muscles. Core stability exercises are known to stimulate sensory and motor receptors, thereby improving neuromuscular control and postural balance.

Conclusion: Core stability training demonstrated short-term effectiveness in improving balance in a post-operative spinal tuberculosis patient. While these results are promising, the short duration of intervention limits long-term evaluation. Further studies are needed to confirm the sustained benefits of core training in this population.

Keywords

Spinal tuberculosis, Spondylitis, Core stability, Balance, Exercise therapy

Introduction

Tuberculosis (TB) is an infectious disease caused by *Mycobacterium tuberculosis*, a gram-positive, intracellular bacterium belonging to the order *Actinomycetales*.[1] It primarily infects the lungs via aerosol transmission and is characterized by slow growth.[2] Infected individuals can spread the bacteria through airborne droplet nuclei, which, when inhaled, reach the alveoli, where the bacteria accumulate and replicate. Initial infection typically develops within 2–10 weeks after exposure.[3]

Although pulmonary TB is the most common presentation, *M. tuberculosis* can disseminate to extrapulmonary sites, including the bones and joints. One of the most serious forms of extrapulmonary TB is spinal tuberculosis, also known as Pott’s disease. This condition arises when the bacilli spread hematogenously from a primary focus, usually the lungs, to the vertebral column. The bacteria commonly localize in the highly vascularized anterior portion of the vertebral body, resulting in caseating granulomatous inflammation, progressive bone destruction, and vertebral collapse. These changes can lead to kyphotic deformity, spinal instability, spinal cord compression, neurological deficits, and significant functional impairment.[4] The thoracic and lumbar regions are most frequently affected, and diagnosis may be delayed due to nonspecific symptoms such as back pain, stiffness, and fatigue.[3,4] Early diagnosis and multidisciplinary management—comprising anti-tuberculosis pharmacotherapy and physiotherapy—are essential for preventing complications and restoring function.

Although alveolar macrophages usually eliminate inhaled bacilli, in some cases the bacteria survive intracellularly, replicate, and disseminate via lymphatic or hematogenous routes. Hematogenous spread enables the bacteria to reach distant sites, such as the spine, leading to tuberculous spondylitis.[5]

Indonesia is among the countries with the highest TB burden globally, with an estimated 647 cases per 100,000 population.[3] Approximately 10% of TB cases in Indonesia are extrapulmonary, and of those, nearly half affect the osteoarticular system.[6] Within this subset, tuberculous spondylitis accounts for roughly 50% of cases, making it the most prevalent form of skeletal TB. The condition is most commonly diagnosed in individuals aged 40–50, although it may also affect younger adults and adolescents. Epidemiological data suggest a higher incidence in males compared to

females.[6] Limited access to early diagnosis, particularly in rural areas, poses significant barriers to the timely management of extrapulmonary TB in Indonesia.

Spinal TB predominantly affects the thoracic and lumbosacral vertebrae. Treatment often includes surgical intervention, such as debridement with or without spinal stabilization using implants like plates and screws. Post-operative complications may include muscle weakness, spasticity, muscle spasms, and balance disorders, which impair mobility and often require the use of assistive devices such as walkers. These patients frequently experience decreased functional ability due to pain, discomfort, and neuromuscular deficits. Postural abnormalities caused by spinal damage further compromise core stability, placing additional strain on the musculoskeletal system. Physical rehabilitation is critical in restoring function and preventing further complications.[7]

Physiotherapy plays a key role in the management of post-operative TB spondylitis.[8] One of the main rehabilitation goals is to address balance impairments through core stability training. Core stability is essential for maintaining posture, supporting limb movement, and enabling efficient motion of the upper and lower extremities. Studies have demonstrated that core stability exercises improve muscular strength, particularly in the abdominal and lumbar regions, which is vital for trunk control and overall balance in individuals with spinal pathology.[9] These exercises also reduce pain and improve physical function in affected individuals. Additional physiotherapy strategies may include breathing exercises for muscle relaxation and bridging exercises for core strengthening.[9] To manage spasticity, intrinsic foot muscle activation exercises are used to improve foot coordination and control.[10]

Given the prevalence and impact of post-operative TB spondylitis, this study aims to evaluate the effectiveness of core stability exercises in improving postural control and balance, as measured by the Berg Balance Scale (BBS).

Methods

This study is a single-case report involving a 36-year-old male patient diagnosed with post-operative tuberculous spondylitis. Inclusion criteria included impaired ambulation requiring assistive devices, lower limb stiffness, reduced muscle strength, limited range of motion (ROM), and balance disorders. The patient was selected through purposive sampling based on clinical presentation and availability during the treatment period at Hermina Hospital, Sukabumi.

The intervention consisted of core stability exercises, specifically pelvic tilting, performed twice a week, combined with a prescribed home program. The patient received six physiotherapy sessions during hospitalization, with each session lasting approximately 60 minutes.

This case report utilized quantitative outcome measures, namely the Berg Balance Scale (BBS)—a reliable and valid tool (ICC > 0.9) for assessing fall risk and balance impairments. The results were analyzed using descriptive-comparative methods by comparing pre- and post-intervention scores. Muscle strength was assessed using Manual Muscle Testing (MMT) with a scoring scale of 0–5. Progress was tracked through changes in BBS and MMT scores and reduction in clinical symptoms across the intervention period.[9]

To support this case analysis, a literature review was conducted using books, peer-reviewed journals, and online databases including Google Scholar, ScienceDirect, and PubMed. The main keywords used were “core stability exercise” AND “TB spondylitis”. Articles unrelated to spinal tuberculosis rehabilitation or lacking empirical data were excluded.

A 36-year-old male presented with complaints of inability to walk without assistive devices and poor standing balance. In 2019, he experienced recurrent chest tightness upon waking, which gradually resolved after reducing smoking. In December 2021, he developed severe back pain that did not improve with medication, leading to significant functional impairment. Radiographic findings confirmed pulmonary and spinal TB. On November 23, 2022, he underwent spinal surgery with internal fixation at Cipto Mangunkusumo Hospital (RSCM). Postoperatively, he was prescribed physiotherapy twice weekly.

Static postural inspection revealed posterior pelvic tilt. Dynamically, the patient required a walker for transfers and ambulation. Clinical findings included bilateral lower limb spasticity, paraspinal muscle spasms, reduced ROM in the trunk, hips, knees, and ankles, and decreased muscle strength without pain. Abnormal gait and balance disturbances were observed.

To minimize observer bias, all assessments were performed by independent, trained physiotherapists. Article selection for literature review was conducted independently by two researchers to reduce selection bias. However, this study did not assess external supporting or confounding variables. The single-case design allowed for in-depth exploration of rehabilitation outcomes and challenges in post-operative spinal TB management.

Patients with post-operative tuberculous spondylitis may present with various musculoskeletal impairments, including spasticity, muscle spasms, reduced muscle strength, limited ROM, balance disturbances, and abnormal gait patterns. Appropriate physiotherapeutic intervention tailored to these problems can help alleviate symptoms. Based on these issues, the clinical question was formulated: "What is the effectiveness of core stability exercises in improving postural control and balance in post-operative tuberculous spondylitis?"

The physiotherapy program aimed to reduce the patient's functional complaints through targeted interventions. The main intervention applied was core stability training, supported by complementary exercises to address other clinical issues (see Table 1). The primary exercise was pelvic tilting**,** which was performed both actively and passively.

In the active method, the patient lay supine with a towel placed under the pelvis and was instructed to press down on the towel, engaging the core muscles. In the passive method, the physiotherapist mobilized the patient's pelvis through anterior, posterior, and rotational movements. This core exercise was administered twice per week over a three-week period.

Figure 1. Pelvic Tilting Exercise

In addition to core exercises, balance training was also incorporated. This involved two methods:

1. The patient stood while holding onto a walker for support and was instructed to lift one leg alternately.
2. Progressive balance tasks were introduced based on the patient's improvement.

Based on the literature reviewed, balance training protocols typically span four weeks with a frequency of three sessions per week.

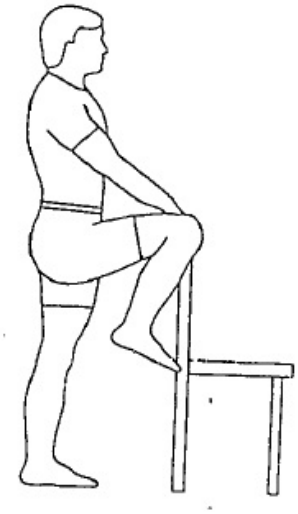

Figure 2. Balance Exercise

Results

This single-subject case study involved a 36-year-old male patient diagnosed with post-operative spinal tuberculosis (spondylitis TB), who received six physiotherapy sessions at Hermina Hospital Sukabumi. The patient presented with notable clinical impairments, including lower extremity weakness, paraspinal muscle spasms, impaired postural control, and significant balance deficits. The primary physiotherapy intervention consisted of core stability exercises, particularly pelvic tilting and bridging, aimed at improving postural alignment and functional mobility.

Quantitative outcomes were measured at each session using standardized tools. The Berg Balance Scale (BBS), a validated instrument for assessing balance and fall risk, demonstrated a marked improvement. The patient's BBS score increased from 6 at the initial evaluation to 21 by the sixth session, as shown in Figure 3**.** This progression reflects a functional improvement from non-ambulatory status toward assisted ambulation, as defined by BBS interpretation criteria.

Muscle tone was evaluated using the Modified Ashworth Scale (MAS)**,** focusing on the lower extremities. Initial scores of 2 on both sides indicated moderate spasticity, which decreased to 1+ by the final session, suggesting a reduction in hypertonicity in response to therapeutic intervention. Improvements in Range of Motion (ROM) were also observed in the trunk, hip, knee, and ankle joints, supporting increased mobility and joint function. Muscle strength, assessed using Manual Muscle Testing (MMT) (scale 0–5), showed consistent gains across trunk and lower limb regions, indicating enhanced neuromuscular control and postural support.

Table 1. Patient Demographics

Variable	Information
Initials	Mr. A.K.
Sex	Male
Age	36 years
Medical Diagnosis	Post-Op Spondylitis TB
Smoking Status	Former active smoker

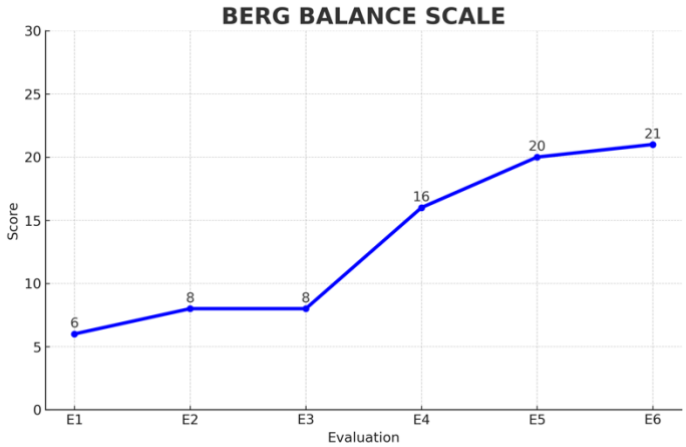

Figure 3. Changes in Berg Balance Scale Score Across Sessions

The graphical representation above illustrates a substantial increase in BBS scores beginning from the third session. During the first three sessions, the patient struggled with performing pelvic tilting exercises due to unfamiliarity with the movement. This prompted the physiotherapist to modify the exercise into a simpler form to facilitate patient engagement.

In addition to numerical data**,** qualitative clinical observations contributed valuable insights into the patient's progress. Static and dynamic postural evaluations initially revealed posterior pelvic tilting and an incomplete gait cycle, characterized by the absence of key gait phases. These abnormalities gradually diminished as core strength and neuromuscular coordination improved.

Muscle spasms were initially evident in the paraspinal muscles, particularly the upper trapezius and quadratus **l**umborum**,** and were significantly reduced through targeted stretching and postural training. Early sessions also revealed weak activation of the rectus abdominis and oblique muscles, which improved over time through consistent bridging and pelvic tilting exercises.

Notably, during the first half of the intervention period, the patient exhibited difficulty recognizing and performing core exercises. Simplified instructions and tactile feedback enhanced motor learning, resulting in better movement execution and improved engagement during later sessions.

Overall, both quantitative metrics and qualitative clinical findings highlight the positive impact of core stability exercises on balance and postural control in a patient with post-operative tuberculous spondylitis. Improvements in ambulation, reduced spasticity, increased joint mobility, and strengthened musculature support the clinical effectiveness of this physiotherapeutic intervention strategy.

Discussion

Core Stability Exercise to Improve Postural Control

Postural control is a critical component in executing functional activities and maintaining balance, as it enables individuals to interact with their environment efficiently. Deficient postural control may result in poor muscle recruitment, co-contraction of antagonistic muscles, and difficulty integrating sensory feedback for balance regulation.[11]

Achieving effective postural control requires the integrated activation of neuromuscular systems and the coordination of visual, vestibular, and somatosensory inputs. This complex motor function is fundamental to maintaining upright posture and orientation in space. Enhancement of muscle activity is one strategy to promote postural control by maximizing spinal stability.[12]

This case study investigated the impact of core stability exercises—specifically pelvic tilting—on postural control and balance in a post-operative spinal tuberculosis (TB) patient. The Berg Balance Scale (BBS) score improved from 6 to 21 over six sessions, indicating a transition from total dependence to partial independence in mobility-related tasks. Concurrently, the patient demonstrated increased trunk and lower extremity strength, as evidenced by Manual Muscle Testing (MMT), and reduced spasticity measured by the Modified Ashworth Scale. Qualitative improvements were also observed in posture, gait mechanics, and pelvic alignment.

These findings are consistent with those reported by Yildirim et al., who found that core stability training enhances postural alignment, trunk strength, and gait coordination in spinal TB patients. Similarly, Akuthota et al. emphasized the importance of the transversus abdominis and multifidus in lumbar stabilization, aligning with the targeted muscles in this study. Kibler et al. supported the effectiveness of core stability in improving dynamic balance and injury prevention across various populations.

Unlike broader core training protocols, this case emphasized pelvic tilting—a targeted intervention aimed at correcting pelvic alignment, which is foundational for trunk and postural stability in spinal TB. The incorporation of bridging and foot muscle activation exercises further supported proximal-to-distal control, enhancing balance and motor coordination.

Core stability involves the coordination and strength of the trunk, pelvic, and abdominal muscles to ensure vertebral stability during movement.[13] It reflects the neuromuscular system's ability to maintain posture and support extremity movements.[14,15] Posterior pelvic tilting reduces tension in the erector spinae, iliopsoas, and rectus abdominis, while anterior tilting affects the gluteus maximus and hamstrings—each promoting better equilibrium.[16]

Weak trunk control and non-mobile pelvis contribute to postural misalignment. Pelvic tilting, particularly in the anterior-posterior direction, activates hip abductors and trunk stabilizers to achieve dynamic pelvic stability and alignment. Standing balance depends heavily on pelvic orientation, governed by coordinated activity of the hip and lower trunk muscles.[17]

The core is anatomically described as a box consisting of the abdominal wall anteriorly, paraspinal and gluteal muscles posteriorly, the diaphragm superiorly, and the pelvic floor muscles inferiorly. These active and passive structures stabilize the spine through localized muscle activity, enhancing trunk function and reducing joint loading.

Balance is maintained through coordinated reflexive and voluntary muscle actions, integrating sensory inputs that inform motor responses. Trunk positioning relative to gravity provides critical feedback for maintaining upright alignment.[18]

Pelvic tilting aligns with the kinetic chain concept involving the erector spinae, iliopsoas, rectus femoris, gluteus maximus, and hamstrings. These muscles coordinate trunk-limb movement and static-dynamic balance. Improvements were noted from the third week of intervention, as adaptations in energy systems and neuromuscular coordination took effect.[19]

Core activation begins contralaterally, facilitating rotational movements and enhancing lower limb range of motion and weight-bearing capacity. The contraction of stabilizing muscles such as the transversus abdominis, multifidus, and gluteus maximus promotes trunk rigidity and functional independence.

These findings have significant implications for post-operative rehabilitation in spinal TB. Core stability training, particularly focusing on pelvic alignment and postural strategies, should be integrated into physiotherapy programs to enhance functional recovery. Improved coordination of the core, hip, and lower trunk muscles contributes to balance restoration and mobility gains.

However, this case study has limitations. As a single-subject design, it restricts generalizability. Subjective assessment tools like MMT and the Ashworth Scale are prone to evaluator bias. Moreover, confounding factors such as prior physical fitness and psychosocial variables were not controlled. Objective tools like force platforms or electromyography (EMG) could provide more precise data. Future studies should incorporate long-term follow-up to determine the sustainability of outcomes and include larger sample sizes to enhance external validity.

Conclusion

Following six evaluation sessions conducted over a three-week period (twice weekly), the implementation of core stability exercises—specifically pelvic tilting—resulted in substantial improvements in postural control and balance in a patient recovering from post-operative spinal tuberculosis. The patient's Berg Balance Scale (BBS) score increased from 6 to 21, indicating a progression from severe balance impairment necessitating assistive devices to partial independence in standing and ambulation. This improvement reflects enhanced static and dynamic balance capacity.

Beyond the BBS score enhancement, the core stability intervention, including pelvic tilting and bridging exercises, contributed to greater trunk muscle strength and reduced spasticity, thereby improving neuromuscular coordination and spinal stabilization. These outcomes support the role of core stability training as a critical element in physiotherapeutic rehabilitation targeting postural control and functional mobility.

Accordingly, core stability exercises can be recommended as an essential component of physiotherapy programs for patients experiencing neurological or post-surgical impairments affecting trunk function. However, the conclusions drawn from this single-case design are inherently limited in generalizability. Further research, particularly randomized controlled trials with larger sample sizes and long-term follow-up, is warranted to validate these findings and extend their applicability to broader clinical populations.

Author Contribution

Riza Pahlawi contributed to the conception, study design, data collection, data analysis, and drafting of the manuscript. Putri Savana Andriani contributed to literature review, data interpretation, critical revision of the manuscript, and supervision of the study process.

All authors have read and approved the final version of the manuscript and agree to be accountable for all aspects of the work.

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Conflict of Interest Statement

The authors declare that there are no conflicts of interest related to this study.

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Ethics Statement

This study was conducted in accordance with the ethical principles of the Declaration of Helsinki. Ethical approval was not required as the study involved only non-invasive procedures (blood pressure measurement and questionnaire surveys) and posed minimal risk to participants. Informed consent was obtained from all participants prior to their inclusion in the study, and confidentiality was strictly maintained.

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