Majalah Ilmiah Fisioterapi Indonesia
Indonesian Scientific Journal of Physiotherapy

Case Reports / Case Studies
ISSN (Print): 2303-1921
ISSN (Online): 2722-0443
Volume 14, Number 2, Pages 365-369 (2026)
DOI: https://doi.org/10.24843/mifi.000001779

Multimodal Physiotherapy for Lumbar Disc Bulging in an Adolescent Athlete: A Case Report

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Received 4 April 2026; Revised 12 April 2026; Accepted 12 April 2026; Published 4 May 2026

Abstract

Background: Lumbar disc bulging is a common cause of low back pain and functional limitation, particularly in physically active populations, yet evidence on combined physiotherapy interventions in adolescent athletes remains limited.

Objective: To evaluate the clinical effectiveness of a multimodal physiotherapy intervention in reducing pain and improving function in a patient with lumbar disc bulging.

Methods: This case report followed CARE guidelines and employed a single-subject AB design. A 14-year-old female volleyball athlete diagnosed with L4–L5 lumbar disc bulging received a multimodal physiotherapy program consisting of transcutaneous electrical nerve stimulation, ultrasound therapy, and therapeutic exercise over three weeks (three sessions). Outcomes included pain intensity measured by the Visual Analog Scale, lumbar range of motion assessed using a goniometer, muscle strength evaluated with Manual Muscle Testing, and functional performance based on sport-specific activity. Data were analyzed descriptively across time points (T0–T3).

Results: Pain decreased from VAS 5 to 2, lumbar flexion improved from 60° to 75°, and muscle strength increased from grade 4 to 5. Functional performance improved with minimal residual pain (VAS 2/10), indicating clinically meaningful improvement.

Conclusion: A multimodal physiotherapy approach may provide clinically relevant benefits in pain reduction and functional recovery in adolescent patients with lumbar disc bulging and may serve as a potential conservative management strategy.

Keywords

Low Back Pain; Intervertebral Disc Displacement; Transcutaneous Electrical Nerve Stimulation; Ultrasound Therapy; Exercise Therapy

Introduction

Lumbar disc bulging is a degenerative spinal condition characterized by the extension of the intervertebral disc beyond its normal anatomical boundaries without rupture of the annulus fibrosus.[1] This condition is one of the major contributors to low back pain, which remains a leading cause of disability worldwide. Recent global estimates indicate that more than 619 million individuals were affected by low back pain in 2020, with projections reaching approximately 843 million cases by 2050, highlighting its substantial and growing public health burden.[2]

The lower lumbar segments, particularly L4–L5 and L5–S1, are the most frequently affected due to their exposure to high mechanical stress during daily activities such as lifting, bending, and prolonged sitting.[3] In addition to degenerative changes, repetitive loading and biomechanical strain associated with sports activities may accelerate disc pathology, especially in adolescent athletes. This population is particularly vulnerable due to ongoing musculoskeletal development combined with high physical demands, which may predispose them to early onset spinal disorders and functional impairment.[4]

Clinically, lumbar disc bulging presents with localized or radiating pain, paraspinal muscle spasm, restricted range of motion, and reduced functional capacity. These impairments can significantly affect athletic performance and limit participation in sport-specific activities.[5] Furthermore, inadequate management may lead to persistent symptoms and long-term functional limitations.

Conservative management is widely recommended as the first-line approach for lumbar disc pathology in the absence of severe neurological deficits.[6] Physiotherapy interventions play a central role in this approach, aiming to reduce pain, restore mobility, and improve functional performance. Among these, transcutaneous electrical nerve stimulation (TENS), ultrasound therapy, and therapeutic exercise are commonly utilized modalities.[7] TENS is known to modulate pain through the gate control mechanism and activation of endogenous opioid pathways, while ultrasound therapy provides both thermal and non-thermal effects that may enhance tissue healing, reduce muscle spasm, and improve circulation.[8,9] In addition, core stabilization exercises contribute to improved spinal stability, neuromuscular control, and functional performance.[10]

Although previous studies have demonstrated the effectiveness of these modalities individually, evidence regarding their combined use within a structured multimodal physiotherapy protocol remains limited, particularly in adolescent athletic populations. Most available studies focus on adult populations or single-modality interventions, leaving a gap in understanding the potential synergistic effects of combined therapies in younger, physically active individuals. This gap is clinically important, as adolescent athletes require targeted interventions that address both pain reduction and functional restoration specific to sport performance.

Therefore, this case report aims to evaluate the clinical effectiveness of a multimodal physiotherapy intervention, combining TENS, ultrasound therapy, and therapeutic exercise, in reducing pain and improving functional outcomes in an adolescent athlete with lumbar disc bulging. By addressing this gap, the present study seeks to provide clinically relevant insights into conservative management strategies tailored to this specific population.

Methods

This study employed a single-subject research design using an AB approach and was reported in accordance with the CARE guidelines. The study was conducted at the physiotherapy unit of Indriati Solo Baru Hospital over a three-week period. The AB design consisted of a baseline phase (A) followed by an intervention phase (B), allowing observation of clinical changes over time within the same individual.

The participant was a 14-year-old female volleyball athlete who presented with left-sided low back pain during sport-specific activity, particularly during the smash movement. Anthropometric assessment showed a body weight of 42 kg and height of 155 cm (body mass index 17.5 kg/m²). The patient reported a history of repetitive spinal loading during training, with no prior spinal surgery and no neurological symptoms. Previous management included routine physiotherapy prior to the current episode.

The inclusion criteria were: (1) confirmed diagnosis of mild lumbar disc bulging based on magnetic resonance imaging, (2) pain associated with specific functional activity, and (3) absence of neurological deficits. The exclusion criteria included: (1) severe disc herniation, (2) radiating pain accompanied by neurological impairment, and (3) history of spinal surgery. The participant was recruited using purposive sampling from patients attending physiotherapy services at the study site.

Physical examination revealed localized tenderness and mild paraspinal muscle spasm in the left lumbar region. Lumbar range of motion was limited, particularly in flexion and left lateral flexion. Muscle strength was graded 4/5 using Manual Muscle Testing. Special tests, including Straight Leg Raise and Slump Test, were negative. These findings suggested mechanical low back pain without neural involvement.

Magnetic resonance imaging demonstrated a mild posterior disc bulging at the L4–L5 level, without evidence of nerve root compression. The bulging was centrally located with no significant spinal canal narrowing, consistent with standard radiological classification of disc pathology. Differential diagnoses, including lumbar muscle strain and disc herniation, were considered and excluded based on clinical findings and imaging results.

The intervention protocol consisted of a multimodal physiotherapy program combining transcutaneous electrical nerve stimulation, ultrasound therapy, and therapeutic exercise. To improve clarity and reproducibility, the detailed protocol is presented in Table 1.

Table 1. Multimodal Physiotherapy Intervention Protocol

Component	Parameters	Application Details
TENS	Frequency: 80–100 Hz; Pulse duration: 100 µs; Duration: 15 min	Electrodes placed over the lumbar paraspinal region; sensory-level intensity
Ultrasound Therapy	Frequency: 1 MHz; Intensity: 0.1–0.5 W/cm²; Duration: 10 min	Applied over L4–L5 region using circular motion with coupling gel
Exercise Therapy	Stretching: cat-camel, hamstring stretch, trunk rotation; Core stabilization: pelvic tilt, bridging	3 sets of 10–15 repetitions; supervised sessions with progression based on tolerance

The intervention was delivered over three sessions across three weeks. Exercise intensity and repetitions were adjusted progressively according to the patient's tolerance and clinical response. Patient adherence was monitored during supervised sessions, and no modification of the intervention protocol was required. No adverse events were reported during the intervention period.

Outcome measures included pain intensity assessed using the Visual Analog Scale, lumbar range of motion measured with a goniometer, muscle strength evaluated using Manual Muscle Testing, and functional performance assessed through sport-specific activity (volleyball smash movement). All instruments are widely used in clinical practice. Functional performance was assessed using a sport-specific functional test, namely the volleyball smash movement, evaluated based on pain response and movement tolerance during execution.

Pain intensity was assessed using the Visual Analog Scale, which has demonstrated good validity and reliability in measuring subjective pain intensity. Lumbar range of motion was measured using a goniometer, a standard clinical tool with established reliability for joint angle assessment.Muscle strength was evaluated using Manual Muscle Testing, which has shown acceptable reliability and validity in clinical settings. Measurements were conducted at baseline (T0) and after each intervention session (T1–T3). The timeline of assessment allowed evaluation of progressive changes across the intervention phase.

Data were analyzed descriptively by comparing changes in outcome measures across time points. This approach is appropriate for single-case designs, where emphasis is placed on within-subject clinical change rather than statistical inference. No statistical software was used due to the descriptive nature of the analysis. Data were analyzed using descriptive analysis with Microsoft Excel.

Ethical considerations were addressed by obtaining written informed consent from the patient and her legal guardian prior to participation and publication. All procedures were conducted in accordance with the principles of the Declaration of Helsinki. Patient confidentiality and anonymity were strictly maintained throughout the study, and no identifiable personal information is disclosed in this report.

Results

Clinical outcomes were assessed at baseline (T0) and after each intervention session (T1–T3) to evaluate changes in pain intensity, lumbar range of motion, muscle strength, and functional performance. Pain intensity showed a progressive decrease across all time points. The detailed changes are presented in Table 2.

Table 2. Changes in Pain Intensity (Visual Analog Scale)

Time Point	Pain Score (VAS)
T0	5
T1	4
T2	3
T3	2

Lumbar range of motion improved gradually during the intervention period, particularly in flexion. A summary of ROM changes is presented in Table 3.

Table 3. Lumbar Range of Motion (Degrees)

Movement	T0	T1	T2	T3
Flexion	60°	65°	70°	75°
Extension	20°	20°	25°	25°
Lateral Flexion (Left)	Limited	Improved	Improved	Normal

Muscle strength of the core and back extensor muscles also increased over time. The progression is shown in Table 4.

Table 4. Muscle Strength (Manual Muscle Testing)

Muscle Group	T0	T1	T2	T3
Core Muscles	4	4	4+	5
Back Extensors	4	4	4+	5

Functional performance improved following the intervention. The patient was able to return to volleyball activity, specifically performing a smash movement, with minimal residual pain (VAS 2/10). No adverse events or complications were reported during the intervention period. Patient adherence to the supervised intervention sessions was good, and all sessions were completed as planned. To provide a clearer overview of the intervention process and clinical progression, a structured timeline is presented in Table 5.

Table 5. Clinical Timeline of the Case

Time	Event
Day 0	Onset of low back pain
Day 7	MRI examination
Day 7–21	Physiotherapy sessions (3 sessions)
Day 21	Final evaluation
Day 35	Follow-up assessment

To further illustrate the trend of pain reduction across sessions, a graphical representation of VAS changes is presented in Figure 1.

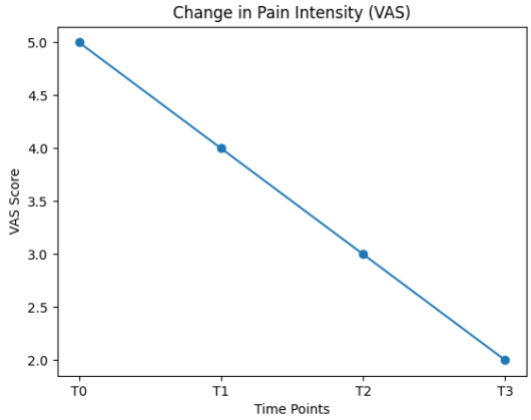

Figure 1. Trend of Pain Intensity (VAS) Across Intervention Sessions

The improvement in lumbar flexion range of motion is also presented graphically to demonstrate the progressive changes over time (Figure 2).

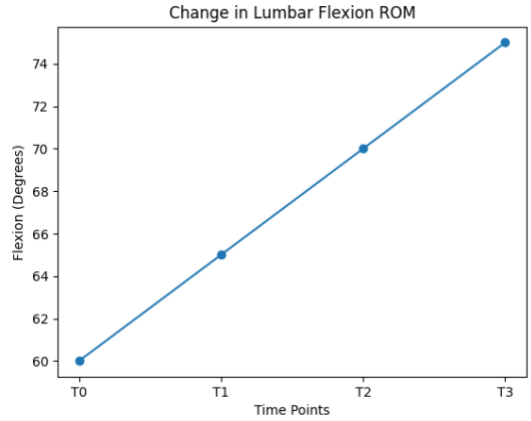

Figure 2. Trend of Lumbar Flexion Range of Motion Across Sessions

At follow-up two weeks after completion of the intervention, the patient reported sustained improvement in pain (VAS 2/10) and was able to participate in volleyball training without significant discomfort. No recurrence of symptoms was reported during this period. The patient reported a noticeable reduction in pain and improved confidence during sports activity. She expressed satisfaction with the intervention and reported being able to return to volleyball practice with minimal discomfort.

Discussion

This case report demonstrated clinically meaningful improvements in pain, lumbar range of motion, muscle strength, and functional performance following a multimodal physiotherapy intervention. The reduction in pain from VAS 5 to 2 exceeds the minimal clinically important difference (MCID) for low back pain, which is typically reported to be approximately 1.5–2 points, indicating a clinically meaningful improvement.[8,11]

The analgesic effect observed in this case can be explained, in part, by the application of transcutaneous electrical nerve stimulation (TENS), which modulates nociceptive input through the gate control mechanism and stimulates endogenous opioid release.[9] In addition, ultrasound therapy may have contributed to pain reduction by enhancing local circulation, reducing muscle spasm, and promoting tissue healing through thermal and non-thermal effects.[10] These findings are supported by previous studies demonstrating the role of electrotherapy modalities in pain modulation and tissue recovery.

Beyond pain reduction, improvements in lumbar range of motion and muscle strength are likely associated with the incorporation of therapeutic exercise, particularly core stabilization training.[12] Core stabilization exercises enhance neuromuscular control and spinal stability by activating deep trunk muscles, which are essential for maintaining functional movement and preventing excessive spinal loading.[13] Recent evidence suggests that such exercises significantly improve pain and functional outcomes in individuals with low back pain, particularly when integrated into comprehensive rehabilitation programs.[10]

Importantly, the combination of modalities used in this study may have produced a synergistic effect. Previous research has indicated that combining electrotherapy with exercise-based interventions yields greater improvements compared to single-modality approaches.[8] This synergistic interaction likely arises from addressing both symptom modulation (pain reduction) and underlying biomechanical dysfunction (stability and motor control), which are key contributors to lumbar spine disorders.[14]

From a clinical perspective, the improvement in functional performance, particularly the patient's ability to return to volleyball activity with minimal pain, highlights the practical relevance of this intervention.[15] In adolescent athletes, restoring sport-specific function is a critical outcome, as it directly affects performance and participation.[16] The integration of strengthening and stabilization exercises likely contributed to improved load distribution and movement efficiency, thereby reducing mechanical stress on the lumbar spine.

Compared with previous studies, most existing evidence has focused on adult populations or non-specific low back pain, whereas this case specifically addresses an adolescent athlete with lumbar disc pathology. This distinction is important, as younger individuals may present with different biomechanical and physiological characteristics, requiring tailored intervention strategies. Therefore, this case contributes to the limited body of evidence on multimodal physiotherapy in this specific population.

Despite these positive findings, several limitations must be acknowledged. First, the single-case design limits generalizability and precludes causal inference. Second, the absence of long-term follow-up restricts understanding of the sustainability of treatment effects. Third, the lack of a control condition prevents comparison with alternative interventions. These limitations may affect both internal and external validity and should be considered when interpreting the findings.

Future research should focus on randomized controlled trials with larger sample sizes and longer follow-up periods to confirm the effectiveness of multimodal physiotherapy interventions. Additionally, incorporating clinically meaningful thresholds, such as minimal clinically important differences, would enhance the clinical applicability of future studies.

Overall, this case highlights the potential benefits of integrating multiple physiotherapy modalities to address the multifactorial nature of lumbar disc bulging, particularly in physically active populations. The findings provide preliminary clinical insight that may inform individualized rehabilitation strategies.

Conclusion

This case report demonstrates that a multimodal physiotherapy intervention, consisting of transcutaneous electrical nerve stimulation, ultrasound therapy, and therapeutic exercise, may lead to clinically meaningful improvements in pain, lumbar range of motion, muscle strength, and functional performance in an adolescent athlete with lumbar disc bulging. The findings suggest that integrating multiple physiotherapy modalities can address both symptom reduction and functional restoration, particularly in physically active populations requiring sport-specific recovery. However, given the inherent limitations of a single-case design, these results should be interpreted with caution and not generalized to broader populations. This case highlights the potential role of multimodal physiotherapy as a conservative management strategy and underscores the need for further research using robust study designs to confirm its effectiveness and long-term outcomes.

Author Contribution

Anindya Veta Anggraheni: Conceptualization, data collection, manuscript drafting.
Wijiyanto: Methodology, supervision, critical revision of the manuscript.
Widyo Bintoro: Data analysis, interpretation of results, manuscript editing.

Acknowledgments

The authors would like to thank Indriati Solo Baru Hospital for facilitating this study and supporting the clinical process.

Conflict of Interest Statement

The authors declare no conflict of interest.

Funding Sources

This study received no external funding.

Ethics Statement

Written informed consent was obtained from the patient and her legal guardian for participation and publication. All procedures were conducted in accordance with the principles of the Declaration of Helsinki, and patient anonymity was strictly maintained.

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