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Core Stabilization and Stretching Improve Functional Mobility in Lumbar Spondylolisthesis: A Case Report

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Abstract

Background: Lumbar spondylolisthesis may cause low back pain, impaired balance, and reduced functional mobility. Conservative physiotherapy is commonly recommended for low-grade spondylolisthesis; however, evidence regarding combined core stabilization and stretching exercises in older adults remains limited.

Objective: To describe the potential effects of combined core stabilization and stretching exercises on pain and functional mobility in a patient with Grade I lumbar spondylolisthesis.

Methods: This single-patient case report involved a 68-year-old woman diagnosed with Grade I L3–L4 lumbar spondylolisthesis. The patient received core stabilization and stretching exercises twice weekly for 3 weeks (6 sessions). Outcomes were assessed using the Numeric Rating Scale (NRS), Timed Up and Go test (TUG), Romberg test, 2-Minute Walk Test (2MWT), and Oswestry Disability Index (ODI). Percentage changes were calculated descriptively. Differential diagnoses, including lumbar spinal stenosis and discogenic low back pain, were clinically excluded.

Results: After intervention, pain intensity decreased from 6/10 to 3/10 on the NRS. TUG performance improved from 22 s to 19 s, while 2MWT distance increased from 90 m to 115 m. Improvements were also observed in Romberg test performance. ODI decreased from 58% to 50%, indicating reduced disability. No adverse events were reported during the intervention period.

Conclusion: Combined core stabilization and stretching exercises may provide potential benefits in reducing pain and improving functional mobility in Grade I lumbar spondylolisthesis. However, interpretation should remain cautious because the findings were derived from a single-case report with limited follow-up duration.

Keywords
Spondylolisthesis; Core Stability Exercise; Stretching Exercise; Functional Mobility; Aged

Introduction

Lumbar spondylolisthesis is a spinal disorder characterized by anterior displacement of one vertebral body relative to the adjacent vertebra, resulting in segmental instability, altered spinal biomechanics, and functional impairment. The condition commonly affects the lumbosacral region and is frequently associated with chronic low back pain, impaired balance, muscular weakness, and reduced mobility, particularly in older adults. Degenerative changes in the intervertebral discs, facet joints, and supporting ligamentous structures contribute substantially to the development of low-grade lumbar spondylolisthesis in the aging population.[1]
The prevalence of degenerative lumbar spondylolisthesis increases with age and is reported more frequently in women because of age-related spinal degeneration and biomechanical alterations. Previous epidemiological studies have reported prevalence rates ranging from approximately 6% to 25% depending on population characteristics and diagnostic criteria.[2] Although lower lumbar involvement is more common, upper lumbar levels such as L3–L4 may also demonstrate clinically significant instability and altered trunk mechanics.[3] Degenerative changes at the L3–L4 segment may contribute to impaired postural control, reduced walking tolerance, and compensatory movement patterns that negatively affect functional independence in older adults.[4]

Conservative rehabilitation remains the primary management approach for patients with Grade I lumbar spondylolisthesis because surgical intervention is generally reserved for severe instability, neurological deficits, or refractory symptoms. Current conservative management guidelines emphasize exercise-based rehabilitation focusing on spinal stabilization, mobility restoration, and functional improvement.[5] Among the available physiotherapy approaches, core stabilization exercise has received increasing attention because of its role in improving neuromuscular control and segmental spinal stability. Core stabilization exercises target deep trunk musculature, including the transversus abdominis and multifidus muscles, which contribute substantially to lumbopelvic stability and postural regulation.[6] Previous randomized controlled trials have demonstrated that stabilization-oriented exercise programs may improve pain intensity, balance performance, and disability in patients with chronic low back disorders.[7]

In addition to stabilization training, stretching exercise is frequently incorporated into rehabilitation programs to address soft tissue tightness and movement restriction. Reduced flexibility of the hamstring, piriformis, and lumbar-associated musculature may increase mechanical stress on the lumbar spine and further compromise movement efficiency in patients with lumbar instability.[8] Stretching interventions may therefore contribute to improved mobility, reduced muscular tension, and enhanced tolerance to functional activities. Furthermore, combining stabilization and flexibility-oriented exercises may provide complementary biomechanical benefits by simultaneously improving spinal control and reducing abnormal musculoskeletal loading.[9]

Despite growing evidence supporting exercise-based rehabilitation in chronic low back disorders, evidence specifically investigating the combined application of core stabilization and stretching exercises in patients with lumbar spondylolisthesis remains limited. Most previous studies have focused on nonspecific low back pain populations or isolated stabilization interventions without integrating flexibility-based approaches.[7,10] In addition, reports specifically describing conservative physiotherapy management in

older adults with degenerative Grade I L3–L4 spondylolisthesis remain scarce. This limitation is clinically important because upper lumbar involvement may demonstrate different biomechanical characteristics compared with lower lumbar instability. Therefore, documenting clinically relevant rehabilitation outcomes in this population may contribute additional insight into conservative physiotherapy management strategies.

This case was considered clinically relevant because the patient demonstrated persistent pain, impaired mobility, and postural instability despite previous conservative management. The present case report aimed to describe the potential effects of combined core stabilization and stretching exercises on pain intensity, balance performance, walking capacity, and functional mobility in an older adult with Grade I lumbar spondylolisthesis. It was hypothesized that the combined intervention would contribute to clinically meaningful improvement in mobility-related outcomes following a structured physiotherapy program.

Methods

This study was designed as a single-patient clinical case report to describe the potential effects of combined core stabilization and stretching exercises on functional mobility in a patient with Grade I lumbar spondylolisthesis. The report was prepared according to the CARE (CAse REport) guideline to improve transparency and reproducibility of clinical reporting.[1] The case report design was selected because the study aimed to provide detailed clinical documentation of a conservative physiotherapy intervention in a patient presenting with persistent functional limitation and lumbar instability.

The patient was a 68-year-old woman diagnosed with Grade I L3–L4 degenerative lumbar spondylolisthesis based on clinical examination and magnetic resonance imaging (MRI) findings. The patient worked as a gas seller and reported chronic low back pain persisting for approximately 2 years following a bicycle fall. Symptoms were aggravated by prolonged sitting, prolonged walking, squatting, and sit-to-stand activities. The patient had a history of controlled hypertension managed with antihypertensive medication and reported intermittent analgesic consumption before physiotherapy treatment. Anthropometric assessment showed a body height of 156 cm, body weight of 61 kg, and body mass index (BMI) of 25.1 kg/m². Prior to symptom onset, the patient remained physically active because of occupational demands involving repetitive lifting and prolonged standing. No family history of major spinal deformity or inflammatory musculoskeletal disease was reported.

Initial physiotherapy assessment demonstrated pain during lumbar movement, impaired balance, reduced walking tolerance, and decreased functional mobility. Lumbar flexion was approximately 45°, extension 15°, lateral flexion 20° bilaterally, and rotation 25° bilaterally based on standard goniometric measurement. Manual muscle testing identified mild weakness of trunk stabilizing muscles and hip abductors graded 4/5 according to the Medical Research Council scale. The Straight Leg Raise test was negative for radicular symptoms. Clinical findings also demonstrated impaired postural stability during unsupported standing and transitional movement tasks. MRI examination confirmed Grade I anterior slippage at the L3–L4 segment with degenerative disc changes and segmental instability. Differential diagnostic considerations included lumbar spinal stenosis, discogenic low back pain, and facet joint syndrome; however, the absence of severe neurological symptoms and the presence of radiological instability findings supported the diagnosis of degenerative lumbar spondylolisthesis.

The patient had previously undergone conservative physiotherapy management for approximately 2 months with limited improvement in symptoms and functional mobility. No additional structured rehabilitation program was performed during the present intervention period. Analgesic use was minimized during treatment to reduce potential co-intervention bias. Written informed consent for physiotherapy intervention and publication of anonymized clinical information was obtained from the patient before data collection. According to institutional policy, formal ethical clearance was not required because this study was limited to a single-case clinical report without experimental intervention or identifiable patient information.

The rehabilitation program consisted of combined core stabilization and stretching exercises administered twice weekly for 3 weeks, resulting in six supervised physiotherapy sessions. All interventions were delivered by a licensed physiotherapist experienced in musculoskeletal rehabilitation. Each session lasted approximately 45–60 minutes, including warm-up activities, supervised exercise intervention, rest intervals, and reassessment of patient tolerance. Exercise intensity was maintained at low-to-moderate intensity using the Borg Rating of Perceived Exertion scale, targeting an RPE level of 11–13.

Core stabilization exercises aimed to improve neuromuscular control and lumbopelvic stability. The intervention program included pelvic tilt exercise, bridging exercise, diagonal curl-up exercise, and straight leg raise exercise. Initial dosage consisted of 2 sets of 8 repetitions for each exercise**.** Bridging exercise was initially maintained for 8 seconds and progressively increased to 10 seconds according to patient tolerance. Progression was performed gradually based on movement quality, symptom response, and postural control capacity.

Stretching exercises were incorporated to reduce muscle tightness and improve movement efficiency. Interventions targeted the hamstring, piriformis, and lumbar-associated musculature using hamstring stretching, piriformis stretching, and single-knee-to-chest stretching techniques. Static stretching was maintained for approximately 10–15 seconds for each repetition and performed for two sets. Adequate recovery intervals were provided between exercise sets to minimize fatigue and symptom aggravation. The combination of stabilization and stretching exercises was selected based on the rationale that improved trunk control and soft tissue flexibility may simultaneously reduce abnormal biomechanical loading on unstable lumbar segments.

Before presenting the intervention protocol in tabular form, Table 1 summarizes exercise frequency, dosage, intensity, and progression principles implemented throughout the intervention period.

Table 1. Structured Physiotherapy Intervention Program

Exercise	Frequency	Intensity	Dosage	Intervention Type
Pelvic tilt	2×/week	RPE 11–13	2 × 8 repetitions	Core stabilization
Bridging	2×/week	RPE 11–13	2 × 8 repetitions, hold 8–10 s	Core stabilization
Diagonal curl-up	2×/week	RPE 11–13	2 × 8 repetitions	Core stabilization
Straight leg raise	2×/week	RPE 11–13	2 × 8 repetitions	Core stabilization
Single-knee-to-chest stretch	2×/week	Low intensity	2 × 8 repetitions	Stretching
Piriformis stretching	2×/week	Low intensity	Hold 10–15 s × 2 sets	Stretching
Hamstring stretching	2×/week	Low intensity	Hold 10–15 s × 2 sets	Stretching

Outcome assessment was performed before the first intervention session and after completion of the sixth treatment session. Pain intensity was evaluated using the Numeric Rating Scale (NRS). Functional mobility and dynamic balance were assessed using the Timed Up and Go test (TUG), a valid and reliable instrument commonly used in geriatric and musculoskeletal populations.[2] Static balance performance was evaluated using the Romberg test under eyes-open and eyes-closed conditions. Walking capacity and

functional endurance were assessed using the 2-Minute Walk Test (2MWT).[3] Disability associated with low back pain was evaluated using the Oswestry Disability Index (ODI).[4]

To improve clinical interpretation, percentage change was calculated descriptively for each outcome parameter between baseline and post-intervention assessments. Minimal clinically important difference (MCID) values reported in previous literature were considered during interpretation of TUG and ODI outcomes. However, inferential statistical analysis was not performed because the present study involved a single-case design without repeated baseline measurements. Adverse events, symptom aggravation, and patient tolerance were monitored throughout the intervention period, and no serious adverse events were identified.

To improve clarity regarding the sequence of clinical assessment, intervention delivery, and outcome evaluation, the overall management process implemented in this case report is summarized in Figure 1. The timeline illustrates the progression from symptom onset and diagnostic confirmation to physiotherapy intervention and post-intervention reassessment.

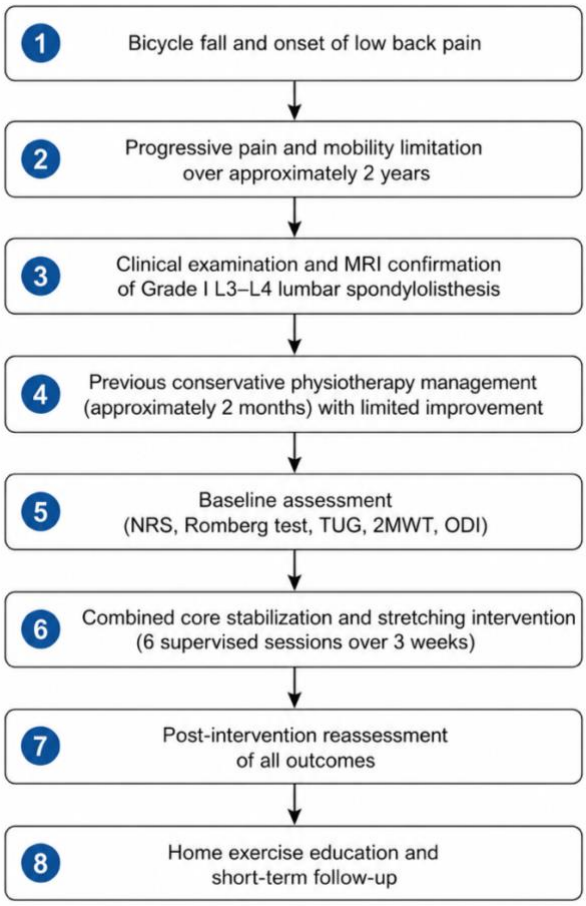

Figure 1. Timeline of Clinical Management in a Patient with Grade I Lumbar Spondylolisthesis

Discussion

This case report described the potential effects of combined core stabilization and stretching exercises on pain intensity, balance performance, walking capacity, and functional mobility in an older adult with Grade I lumbar spondylolisthesis. Following completion of the 3-week physiotherapy program, improvements were observed across multiple clinical outcomes, including the Numeric Rating Scale, Timed Up and Go test, Romberg test, 2-Minute Walk Test, and Oswestry Disability Index. Although the findings should be interpreted cautiously because of the inherent limitations of a single-case design, the overall clinical trend suggests that the combined rehabilitation approach may contribute to short-term functional improvement in patients with low-grade degenerative lumbar instability.

The reduction in pain intensity observed in this case may be associated with improved lumbopelvic stabilization and reduced mechanical stress on lumbar structures following exercise intervention. Patients with degenerative lumbar spondylolisthesis frequently experience pain because of segmental instability, altered load distribution, muscular dysfunction, and compensatory movement patterns.[11] Core stabilization exercise has been reported to improve activation of deep trunk musculature, particularly the transversus abdominis and multifidus muscles, which contribute substantially to segmental spinal stability and motor control.[12] Improved neuromuscular coordination may reduce excessive micro-movement within unstable lumbar segments and consequently reduce nociceptive stimulation during functional activity. Similar findings have been reported in randomized controlled trials demonstrating that stabilization-oriented rehabilitation programs may improve pain intensity and disability in individuals with chronic lumbar disorders.[13]

Improvement in functional mobility observed through the Timed Up and Go test may reflect enhanced postural control and movement efficiency following intervention. Functional mobility impairment in older adults with lumbar spondylolisthesis is frequently associated with pain-related movement limitation, trunk muscle weakness, and fear of movement during transitional tasks.[14] In the present case, TUG performance improved from 22 seconds to 19 seconds following intervention. Although improvement was identified, the post-intervention value remained above normative values commonly reported in healthy older adults. Therefore, the observed improvement should not be interpreted as complete restoration of functional mobility. This clarification is important to avoid overestimation of treatment effectiveness given the low level of evidence associated with a single-case report design.

The improvement observed in Romberg test performance may indicate enhanced postural regulation and proprioceptive control following rehabilitation. Segmental lumbar instability may compromise sensorimotor integration and alter balance

performance, particularly during tasks requiring reduced visual input or narrow base of support.[15] Core stabilization exercises may contribute to improved trunk coordination and postural control by enhancing activation of deep stabilizing musculature and improving afferent feedback mechanisms.[16] In this case, greater improvement was observed during eyes-closed conditions, which may suggest increased reliance on somatosensory control following intervention. However, interpretation of Romberg findings should remain cautious because the assessment remains partly dependent on examiner observation and demonstrates lower objectivity compared with instrumented balance analysis.

Walking capacity assessed using the 2-Minute Walk Test also improved following intervention. Functional walking endurance represents an important indicator of integrated musculoskeletal and neuromuscular performance in older adults.[17] The increase in walking distance observed in this case may have resulted from reduced pain intensity, improved trunk stability, and greater movement confidence during ambulation. Previous studies have similarly reported that combined stabilization and flexibility-oriented rehabilitation programs may improve walking tolerance and functional performance in patients with chronic low back disorders.[18] Nevertheless, because repeated baseline measurements and long-term follow-up assessments were not performed, it remains unclear whether the observed improvement represented sustained physiological adaptation or short-term symptomatic response.

Disability measured using the Oswestry Disability Index demonstrated an 8% reduction following the intervention. Although this finding suggested an improvement in self-reported functional limitation, the magnitude of change was modest and remained below commonly proposed thresholds for clinically meaningful improvement, which have been estimated at approximately 10 ODI points or a 30% reduction from baseline.[19] Therefore, the ODI findings should be interpreted conservatively. This observation highlights the importance of distinguishing numerical improvement from clinically meaningful recovery, particularly in elderly patients with chronic musculoskeletal disorders. Persistent disability despite symptom reduction may also reflect the multifactorial nature of functional limitation in older adults, including age-related deconditioning, behavioral adaptation, and chronic movement avoidance.

The combination of core stabilization and stretching exercises was selected based on the rationale that lumbar stability and soft tissue flexibility represent complementary components of movement control. Core stabilization primarily targets neuromuscular control and spinal segmental stability, whereas stretching intervention aims to reduce excessive muscular tension and improve movement efficiency.[20] Tightness of the hamstring, piriformis, and lumbar-associated musculature may increase abnormal biomechanical loading on unstable lumbar segments and contribute to compensatory movement patterns.[21] Consequently, integrating flexibility-oriented exercise with stabilization training may facilitate more efficient lumbopelvic mechanics during functional activity. This rationale is consistent with current conservative rehabilitation recommendations for lumbar instability conditions emphasizing multimodal exercise-based management.[22]

The present findings should also be interpreted within the context of current conservative management guidelines for lumbar spondylolisthesis. Contemporary rehabilitation recommendations emphasize exercise-based intervention focusing on spinal stabilization, mobility restoration, symptom reduction, and functional improvement before consideration of surgical treatment in low-grade cases.[23] The intervention program implemented in this report was aligned with these principles by combining stabilization-oriented exercise and flexibility training while maintaining low-to-moderate exercise intensity appropriate for an older adult population.

Several methodological limitations should be acknowledged. First, the study involved only one patient, thereby substantially limiting generalizability and external validity. Second, the absence of a control condition, repeated baseline measurement, and blinding procedure increases susceptibility to observer bias, placebo response, and natural symptom fluctuation over time. Third, follow-up duration remained relatively short, limiting interpretation regarding long-term sustainability of treatment outcomes. Fourth, coexisting factors such as daily activity modification, patient motivation, adherence to home exercise, and intermittent analgesic use may also have contributed to the observed improvement. Finally, some outcome measures, particularly the Romberg test, remain partly subjective and may demonstrate measurement variability.

Another important issue identified during the review process involved inconsistency in Timed Up and Go data between the original abstract and results section. This discrepancy has been corrected in the revised manuscript to ensure consistency across all sections. Accurate reporting is essential in case report methodology because small numerical inconsistencies may substantially influence interpretation of clinical effectiveness.

From a clinical perspective, the intervention appeared feasible, well tolerated, and potentially beneficial for older adults presenting with low-grade lumbar instability and mobility limitation. The patient completed all supervised sessions without adverse events and demonstrated good adherence throughout the rehabilitation process. However, clinicians should avoid assuming causal effectiveness because the present evidence remains preliminary and derived from a single-case design. Future studies involving larger sample sizes, standardized progression protocols, controlled comparative designs, and longer follow-up periods are required to clarify the long-term effectiveness and clinical relevance of combined core stabilization and stretching interventions in patients with lumbar spondylolisthesis.

Conclusion

Combined core stabilization and stretching exercises may provide potential benefits in reducing pain and improving functional mobility in an older adult with Grade I lumbar spondylolisthesis. Improvements were observed in pain intensity, balance performance, walking capacity, and disability outcomes following six supervised physiotherapy sessions.

Nevertheless, interpretation of the findings should remain cautious because the present study was based on a single-case report without repeated baseline measurements, a control condition, or long-term follow-up evaluation. Therefore, the findings should not be generalized as definitive evidence of treatment effectiveness.

From a clinical perspective, the intervention program appeared feasible, well tolerated, and applicable for older adults presenting with low-grade lumbar instability and mobility limitation. The findings also support the potential role of multimodal exercise-based rehabilitation emphasizing spinal stabilization and flexibility-oriented intervention in conservative physiotherapy management.

Future studies involving larger sample sizes, controlled comparative designs, standardized progression protocols, and longer follow-up duration are recommended to clarify the long-term effectiveness and clinical relevance of combined core stabilization and stretching exercises in patients with lumbar spondylolisthesis.

Author Contribution

Rosalia Putri Hidayat: Conceptualization, Methodology, Investigation, Data curation, Formal analysis, Writing original draft.
Dwi Rosella Komalasari: Conceptualization, Methodology, Formal analysis, Writing review and editing, Supervision.
Sri Yunanto: Writing review and editing, Supervision.

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Conflict of Interest Statement

The authors declare no conflict of interest.

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Ethics Statement

This case report was conducted in accordance with institutional ethical principles for clinical practice and publication. Written informed consent for physiotherapy intervention and publication of anonymized clinical information was obtained from the patient prior to manuscript preparation. According to institutional policy, formal ethical clearance was not required because this study was limited to a single-case clinical report without experimental intervention or identifiable patient information.

Patient Consent

Written informed consent was obtained from the patient for publication of this case report and accompanying clinical data.

Patient Perspective

The patient reported reduced pain during prolonged standing and walking activities after completion of the intervention program. The patient also described improved confidence during daily movement and expressed satisfaction with the rehabilitation outcome, rating the intervention 8/10 on a self-reported satisfaction scale.

Data Availability Statement

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

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