



FUNCTIONAL IMPAIRMENTS ASSOCIATED WITH SPONDYLOLISTHESIS: A PROSPECTIVE STUDY

Orthopaedics

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ABSTRACT

Spondylolisthesis, characterized by the anterior displacement of a vertebra, can lead to varying degrees of pain and functional impairment. This study aims to evaluate the functional impairments associated with different grades of spondylolisthesis. A prospective study was conducted with 60 participants, categorized into three groups based on the grade of spondylolisthesis: Grade I (n=20), Grade II (n=20), and Grade III (n=20). Participants underwent comprehensive assessments, including the Visual Analog Scale (VAS) for pain, Oswestry Disability Index (ODI) for disability, Sit-and-Reach Test for spinal flexibility, Timed Up and Go (TUG) Test for functional mobility, and 6-Minute Walk Test (6MWT) for overall functional capacity. Data were analyzed using ANOVA, post hoc Tukey's HSD tests, and Pearson's correlation coefficient. Significant differences were observed among the three groups ($p < 0.001$). Group 1 (Grade I) reported the lowest pain levels (VAS: 4.5 ± 1.2), disability (ODI: $25 \pm 8\%$), highest flexibility (Sit-and-Reach: 12.0 ± 3.0 cm), and best functional capacity (TUG: 10.5 ± 1.5 seconds, 6MWT: 400 ± 45 meters). Group 3 (Grade III) had the highest pain (VAS: 7.8 ± 1.5), disability (ODI: $50 \pm 10\%$), lowest flexibility (Sit-and-Reach: 5.0 ± 2.0 cm), and worst functional capacity (TUG: 15.5 ± 2.5 seconds, 6MWT: 300 ± 35 meters). Higher grades of spondylolisthesis are significantly associated with increased pain, greater disability, and reduced flexibility and functional capacity. These findings underscore the need for early diagnosis and intervention to improve patient outcomes.

KEYWORDS

Spondylolisthesis, functional impairments, pain, disability, spinal flexibility, clinical management, prospective study.

INTRODUCTION:

Spondylolisthesis is a spinal disorder characterized by the anterior displacement of a vertebra relative to the one beneath it. This condition can arise from various etiologies, including congenital defects, degenerative changes, trauma, and pathological processes such as infections or tumors (Wiltse & Rothman, 2003). Spondylolisthesis is classified into different grades based on the extent of slippage, with higher grades indicating more severe displacement (Meyerding, 1932).

The clinical manifestations of spondylolisthesis can vary widely, ranging from asymptomatic cases to severe pain and neurological deficits. The most common symptoms include lower back pain, radiculopathy, and neurogenic claudication. The degree of functional impairment is influenced by factors such as the grade of slippage, the presence of nerve compression, and individual patient characteristics (Parisini et al., 2001).

Understanding the functional impairments associated with spondylolisthesis is crucial for developing effective treatment strategies. Previous research has shown that spondylolisthesis can significantly impact spinal biomechanics, leading to decreased spinal stability, altered gait patterns, and reduced physical activity levels (Weinstein et al., 2005). These changes can result in substantial limitations in daily activities and a decrease in quality of life (Carreon et al., 2007).

This prospective study aims to comprehensively evaluate the functional impairments associated with varying grades of spondylolisthesis. By examining parameters such as pain levels, disability, spinal flexibility, and overall functional capacity, this study seeks to provide insights that can inform clinical management and improve patient outcomes. The findings will contribute to the existing body of knowledge and help in the development of tailored therapeutic approaches for individuals with spondylolisthesis.

METHODOLOGY:

This prospective study was conducted to evaluate the functional impairments associated with varying grades of spondylolisthesis. All participants provided written informed consent.

Participants

Inclusion Criteria:

- Adults aged 18-70 years.
- Diagnosed with spondylolisthesis (Grade I to III) confirmed by radiographic imaging.
- Symptom duration of at least three months.
- Willingness to participate and provide signed informed consent.

Exclusion Criteria:

- Severe spinal conditions other than spondylolisthesis (e.g., severe scoliosis, spinal tumors).
- Previous spinal surgery within the past year.
- Neurological disorders affecting gait and balance (e.g., multiple sclerosis, Parkinson's disease).
- Severe comorbidities (e.g., uncontrolled diabetes, severe cardiovascular diseases).
- Pregnancy.

Procedure

The prospective study enrolled 60 participants diagnosed with spondylolisthesis, categorized into three groups based on the severity of the condition: Grade I (n = 20), Grade II (n = 20), and Grade III (n = 20). After obtaining informed consent, each participant underwent a comprehensive baseline assessment. This assessment included a detailed medical history review, physical examination, and completion of validated questionnaires such as the Visual Analog Scale (VAS) to quantify pain levels and the Oswestry Disability Index (ODI) to assess disability. Radiographic imaging of the lumbar spine was performed to confirm the grade of spondylolisthesis and exclude other severe spinal conditions.

Functional assessments were conducted to evaluate various aspects of physical function. The Sit-and-Reach Test was employed to assess spinal flexibility, with participants instructed to sit on the floor and reach forward as far as possible while keeping their legs straight. The distance reached was measured in centimeters. Functional mobility was evaluated using the Timed Up and Go (TUG) Test, where participants were timed as they stood up from a seated position, walked three meters, turned around, walked back, and sat down again. The time taken was recorded in seconds. Overall functional capacity was assessed through the 6-Minute Walk Test (6MWT), during which participants were instructed to walk as far as possible for six minutes, and the distance covered was measured in meters.

Data analysis was conducted using the Statistical Package for the Social Sciences (SPSS) software. Analysis of Variance (ANOVA) was employed to compare continuous variables (VAS, ODI, Sit-and-Reach Test, TUG Test, 6MWT) across the three groups. Post hoc tests, such as Tukey's Honestly Significant Difference (HSD), were utilized to identify specific group differences when ANOVA yielded significant results. Additionally, Pearson's correlation coefficient was calculated to examine the relationships between the grade of spondylolisthesis and functional outcomes. A significance level of $p < 0.05$ was considered statistically significant for all analyses.

RESULTS:

The study included 60 participants divided equally into three groups based on the grade of spondylolisthesis: Group 1 (Grade I), Group 2 (Grade II), and Group 3 (Grade III). The results are summarized in the

table below:

Parameter	Group 1 (Grade I)	Group 2 (Grade II)	Group 3 (Grade III)	p-value
Number of Subjects	20	20	20	
Mean Age (years)	45 ± 9	47 ± 10	48 ± 11	0.78
VAS Pain Score	4.5 ± 1.2	6.2 ± 1.4	7.8 ± 1.5	< 0.001**
ODI (%)	25 ± 8	35 ± 9	50 ± 10	< 0.001**
Sit-and-Reach Test (cm)	12.0 ± 3.0	8.0 ± 2.5	5.0 ± 2.0	< 0.001**
TUG Test (seconds)	10.5 ± 1.5	13.0 ± 2.0	15.5 ± 2.5	< 0.001**
6MWT (meters)	400 ± 45	350 ± 40	300 ± 35	< 0.001**

Note: VAS = Visual Analog Scale, ODI = Oswestry Disability Index, TUG = Timed Up and Go, 6MWT = 6-Minute Walk Test. **p-value < 0.05 considered statistically significant.

Pain Levels

Significant differences in pain levels, as measured by the VAS, were observed between the three groups ($p < 0.001$). Group 1 (Grade I) reported the lowest pain scores (4.5 ± 1.2), followed by Group 2 (Grade II) with moderate pain scores (6.2 ± 1.4), and Group 3 (Grade III) with the highest pain scores (7.8 ± 1.5).

Disability

The ODI results indicated significant differences in disability levels across the groups ($p < 0.001$). Group 1 had the lowest disability percentage ($25 \pm 8\%$), Group 2 had a moderate disability percentage ($35 \pm 9\%$), and Group 3 exhibited the highest disability percentage ($50 \pm 10\%$).

Spinal Flexibility

The Sit-and-Reach Test results showed significant differences in spinal flexibility among the groups ($p < 0.001$). Participants in Group 1 demonstrated the greatest flexibility (12.0 ± 3.0 cm), while Group 2 had moderate flexibility (8.0 ± 2.5 cm), and Group 3 had the least flexibility (5.0 ± 2.0 cm).

Functional Mobility

The TUG Test results indicated significant differences in functional mobility ($p < 0.001$). Group 1 had the fastest times (10.5 ± 1.5 seconds), followed by Group 2 (13.0 ± 2.0 seconds), and Group 3 had the slowest times (15.5 ± 2.5 seconds).

Overall Functional Capacity

The 6MWT results demonstrated significant differences in overall functional capacity ($p < 0.001$). Group 1 covered the greatest distance (400 ± 45 meters), Group 2 covered a moderate distance (350 ± 40 meters), and Group 3 covered the least distance (300 ± 35 meters).

DISCUSSION:

This prospective study investigated the functional impairments associated with varying grades of spondylolisthesis, revealing significant differences in pain levels, disability, spinal flexibility, functional mobility, and overall functional capacity among patients with Grade I, II, and III spondylolisthesis. The findings align with previous research indicating that higher grades of spondylolisthesis are correlated with increased pain and disability (Weinstein et al., 2005).

Pain and Disability

Patients with Grade III spondylolisthesis reported significantly higher pain levels and disability compared to those with Grade I and II spondylolisthesis. These results are consistent with the literature, which suggests that the degree of vertebral slippage exacerbates nerve compression and mechanical instability, leading to increased pain and functional limitations (Carreon et al., 2007). The higher Oswestry Disability Index (ODI) scores in the Grade III group further illustrate the substantial impact of severe spondylolisthesis on daily activities and overall quality of life (Wiltse & Rothman, 2003).

Spinal Flexibility and Functional Mobility

The Sit-and-Reach Test and Timed Up and Go (TUG) Test results demonstrated that higher grades of spondylolisthesis are associated with reduced spinal flexibility and functional mobility. Patients with Grade III spondylolisthesis exhibited significantly lower flexibility and slower TUG times, indicating greater physical impairment. These findings can be attributed to the structural changes in the spine and the compensatory mechanisms adopted by patients to manage pain and

instability (Parisini et al., 2001).

Overall Functional Capacity

The 6-Minute Walk Test (6MWT) results showed a progressive decline in overall functional capacity with increasing spondylolisthesis grade. Patients with Grade III spondylolisthesis covered significantly less distance than those with Grade I and II, highlighting the impact of severe vertebral slippage on endurance and physical performance. This decline in functional capacity can lead to a more sedentary lifestyle, further compounding the negative effects on health and well-being (Meyerding, 1932).

The results of this study emphasize the importance of early diagnosis and intervention in patients with spondylolisthesis. Conservative treatments, such as physical therapy and pain management, may be effective in the early stages (Grade I and II) but may require more aggressive approaches, including surgical intervention, for patients with Grade III spondylolisthesis (Weinstein et al., 2005). Tailored rehabilitation programs focusing on pain relief, improving flexibility, and enhancing functional capacity are crucial for optimizing patient outcomes.

CONCLUSION:

This study highlights the significant functional impairments associated with higher grades of spondylolisthesis, including increased pain, greater disability, reduced spinal flexibility, slower functional mobility, and lower overall functional capacity. These findings underscore the need for targeted clinical interventions to manage symptoms and improve quality of life in patients with severe spondylolisthesis. Further research is warranted to explore the long-term effects of various treatment modalities on functional outcomes in this patient population.

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