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**CASE REPORT**

# The Rehabilitative Management of Adult Scoliosis with Radicular Neuropathy and Lateral Spondylolisthesis of Lumbar Vertebrae: A Case Report

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## ABSTRACT

**Introduction**: Adult scoliosis is a progressive spinal deformity that can be further complicated by neurological symptoms and structural instability due to the asymmetric degenerative changes in the vertebral column. Radicular neuropathy and lateral rotational listhesis caused by curve progression may lead to significant functional impairment, chronic pain, and reduced quality of life.

***Case presentation*:** A 53-year-old female patient presenting with severe scoliosis complained of 6-months continuous radicular pain to our spine rehabilitation clinic. Scoliogram showed right thoracic curve (T4-T11) Cobb's angle 70$^{o}$, left lumbar curve (T11-L4) Cobb's angle 65$^{o}$, rotational lateral listhesis of L2-L3 grade I. Patient was prescribed with scoliosis-specific therapeutic exercise and physical modalities for 3 months. A rigid 3D adult scoliosis brace was custom-made and used part-time (4-5 hours daily) for 6 months. Our data demonstrated immediate and continuous improvement of pain and spinal stability.

**Discussion:** Implementing individualized rehabilitative strategies targeting both mechanical and neurogenic disorders were able to help maintain symptoms and progression of adult scoliosis, as recommended by literature.

**Conclusion**: Comprehensive rehabilitative approach to adult scoliosis patient with spondylolisthesis and radiculopathy is important to reduce symptoms and enhance function by emphasizing the integration of physical therapy, pain management, and bracing.

**Keywords**: *Adult scoliosis, Spondylolisthesis, Radiculopathy, Rehabilitative management, Spinal Orthoses*

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# INTRODUCTION

Adult scoliosis represents a complex three-dimensional deformity of the skeletally mature spine, that could results in spinal curvature and irregular alignment.[1] The prevalence of adult scoliosis was reported around 1-10%[2] and expected to be increasing as the aging generation continues to grow.[3] Unlike the juvenile and adolescent forms, the adult presentation is often compounded by degenerative changes, pain, and functional decline, underscoring the importance of accurate characterization for guiding management strategies.[4]

The classification of adult scoliosis was initially Aebi et al. based on the etiology of the spinal deformity. Type 1 is known as the primary degenerative or "de novo" scoliosis that occurs due to degeneration process on the intervertebral disc and facet joints causing asymmetrical forces. Type 2 adult scoliosis refers to the progressive idiopathic scoliosis of the lumbar and/or thoracolumbar spine in adulthood. Lastly, secondary adult scoliosis is classified as type 3. This deformity is due to known origin such as preexisting idiopathic curves on other spine segments, neuromuscular and congenital disorders, osteoporosis, and other metabolic bone disease.[5]

The SRS-Schwab adult spine deformity classification further highlights the importance of three-dimensional evaluation of scoliosis from coronal and sagittal profiles. This classification also integrate the spinopelvic parameters[3,6] which strongly corelates with functional outcomes of conservative and surgical treatment of spinal deformity.[7]

The impacts of spinal deformities in adult and elderly people are completely different compared with growing patients and is more notable for curves exceeding the 30°.[8,9] The clinical impact of adult scoliosis was reported to be influenced by curve pattern and location, with lumbar and thoracolumbar deformities generally producing more severe pain than thoracic curves. Pain presentation in this population is often distinctive, characterized by asymmetry and the presence of cruralgia, which are regarded as hallmark features. Adult scoliosis with moderate to severe symptoms often caused limitation and impacting functional and reducing quality of life. Nonetheless, current evidence does not clearly establish whether the intensity or chronicity of pain can reliably differentiate scoliosis-related symptoms from non-scoliosis spinal pain in adults.[4,9]

The degenerative condition of spine is a complex process that could also be complicated by spinal instability. The outcome of adult scoliosis when managed non-surgically has been investigated. The conventional rehabilitative efforts include physiotherapeutic scoliosis- specific exercises (PSSE)[4,10], special inpatient rehabilitation (SIR), bracing, soft bracing, and part time rigid bracing.[8,10] In the area where spinal stability is compromised, rehabilitation measures need to be more careful but rigorous. However, comprehensive rehabilitation guideline for complex scoliosis condition is still limited. This report aims to report conservative rehabilitation efforts for a type 2 adult scoliosis patient presenting with radiculopathy and signs of spinal instability managed with multimodal therapy combining bracing and PSSE.

# CASE PRESENTATION

Reported in this study is the case of a 53-year-old female patient with adult scoliosis presenting with chief complain of radicular pain. The case was followed for 6 months (10 November 2024 - 30 May 2025). The reporting of this case study followed the CARE Guidelines for case reports.[11]

The chief complaint of pain on lower back radiating to both lower legs was felt in the last six months ago and worsening in the past two weeks. The sensation of pain was described as continuous, lancelating, and radiating from dermatome L1-2 with pain scale 5-6. The pain worsened when she went up and down the stairs and during performing religious activities that requires prolonged sitting and bearing offerings. When the pain is worsened, she had to stop her activity and lay in supine position to rest. Occasionally, she took over-the-counter pain killer to reduce the pain. She did not have any complain of weakness, sensory deficits, nor autonomic disorders. There was no history of trauma, tumor, and other comorbidities.

Upon a consultation with an orthopedic surgeon, she was given pain medication and recommended for surgery. However, the patient was hesitant and wanted to pursue conservative treatment first, before committing to surgery. Therefore, the patient was self-referred to Physical Medicine and Rehabilitation (PM&R) Specialist in Prospine Clinic, Surabaya. In our clinic, we informed the patient about the indications for surgery in adult scoliosis and the limitations of conservative treatment for her case.

Nonetheless, the patient understood and still would like to proceed with rehabilitation programs.

During physical examination, patient was cooperative. Vital signs and general screening of system organs were within normal limits. Scoliotic posture was apparent, with description (Figure 1):

A: Anterior view: Head, neck, and trunk are deviated to left side. Right shoulder and Left breast are more prominent. Body-arm distance is smaller on the left side. Pelvic translation is accompanied with leg asymmetry.

B: Left lateral view: Forward head posture. Left shoulder is more retracted. Flat back, protruded abdomen.

C: Posterior view: Head, neck, and trunk are deviated to left side. Shoulders are asymmetrical. Right mid-thoracic and left lumbar areas are prominent. Body-arm distance is smaller on the left side. Pelvic translation is accompanied with leg asymmetry.

D: Right lateral: Forward head posture. Right shoulder is more protracted. Flat back, protruded abdomen

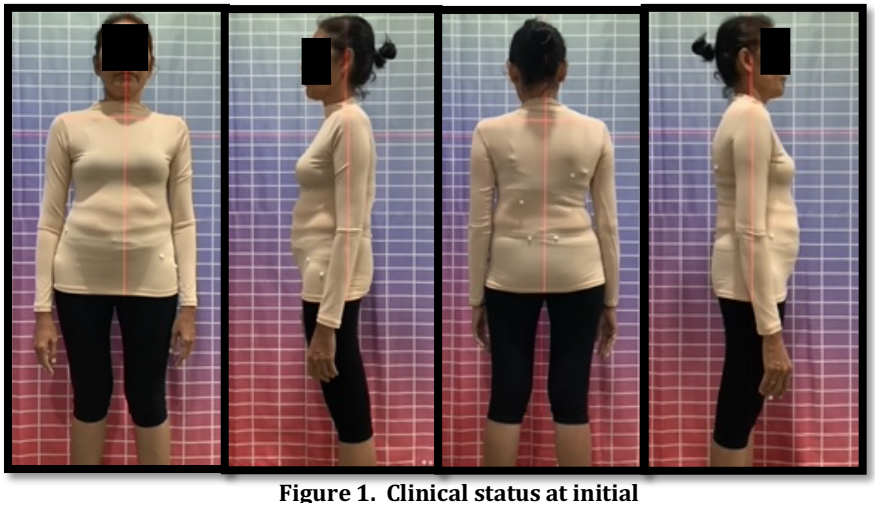


**Figure 1. Clinical status at initial**

Adam's Forward Flexion Test (Figure 2) showed humps on right thoracic and left lumbar areas with scoliometer measurement of 12° and 10°, respectively. Lateral trunk deviation was also apparent during the movement of trunk flexion and extension. The Ott's and modified Schober's measurements were within normal limits, indicating that overall spine flexibility was preserved. Tender points were present on paravertebral area around the thoracic and lumbar prominence with visual analogue scale (VAS) 5-6.

**Figure 2. Adam's Forward Bending**

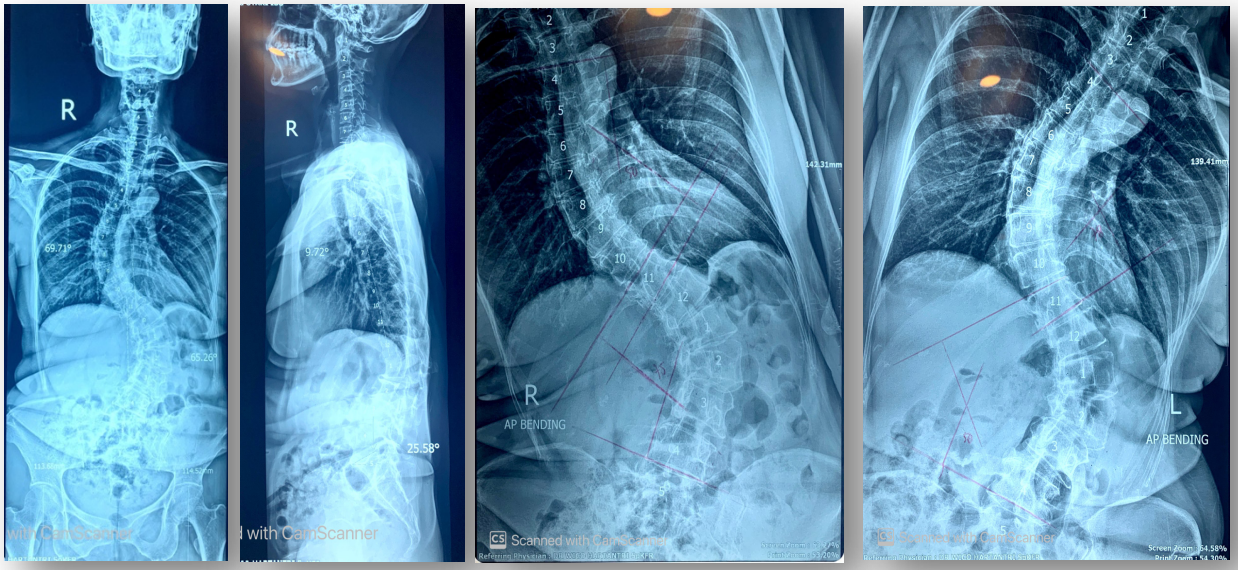



**Figure 3. Whole Spine Radiography (Scoliosis Standard) Pre-intervention**

Scoliogram pre-intervention (**Figure 3**) showed right thoracic convexity (T4-T11) Cobb's angle 70º apex at T7 Nash-Moe grade 2 and left lumbar convexity (T11-L4) Cobb's angle 65º apex at L2 Nash-Moe grade 4. Other radiologic findings include rotational lateral listhesis of L2-L3 grade I, 2 cm distance of CSVL with C7PL to the left side, no leg length discrepancy, and Risser grade 5. Rigo classification is B type.

The treatment goals for this patient were to manage pain, to improve posture and trunk flexibility, to reduce risk of curve progression, and to increase quality of life. PMR programs focused on pain and trunk control, trunk flexibility, ROM and muscle strength training, integration of active 3D self-correction to activity daily living (ADL) activities, and prevention of scoliosis curve progression and further vertebrae instability.

Patient was prescribed with Physiotherapy Scoliosis Specific Exercise (PSSE) and home exercise program daily. Pain modalities that were prescribed are Low-LASER therapy and ultrasound diathermy twice weekly for 3 months. A rigid low-profile adult scoliosis brace was custom-made with Rigo-Cheneau System (RSC). The dosage of brace usage was recommended part-time (4-5 hours daily) for 6 months with regular follow-up. Assessment of pain at every therapy session and performed serial radiologic assessments after 1 month and 6 months of part-time rigid bracing.

We also gave health education about her condition and the importance of home exercise program and to avoid overloading trunk during weight bearing and excessive twisting movement.

## RESULTS

Initial pain management using multiple physical modalities and PSSE as tolerated showed improvement in pain scale (reduce 2 level of pain). The patient's VAS score was reduced since the first treatment and remained controlled around VAS 1-2 until the sixth month's evaluation. She also reported to have better mobility and able to continue her daily activity with no debilitating pain.

Figure 4 depict the posture evaluation while using brace on the 1st month after fabrication (Figure 4). The sagittal and coronal alignments showed better symmetry and posture. The in-brace radiology (Figure 5) showed a reduction of 4º (5,7%) of the main thoracic curve and 1º (1,4%) increase of the lumbar curve. The sagittal profile showed an increase of 1º (10%) of the thoracic kyphosis angle and a reduction of 10º (38,4%) on sacral slope / Ferguson's angle.

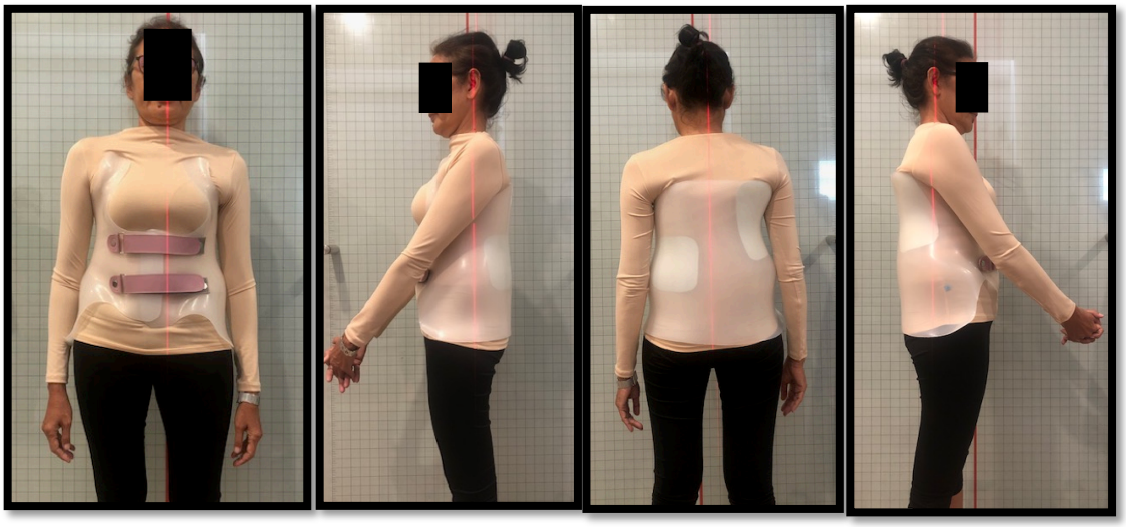


**Figure 4. Clinical Picture of Patient During Initial Fitting of RSC Brace**

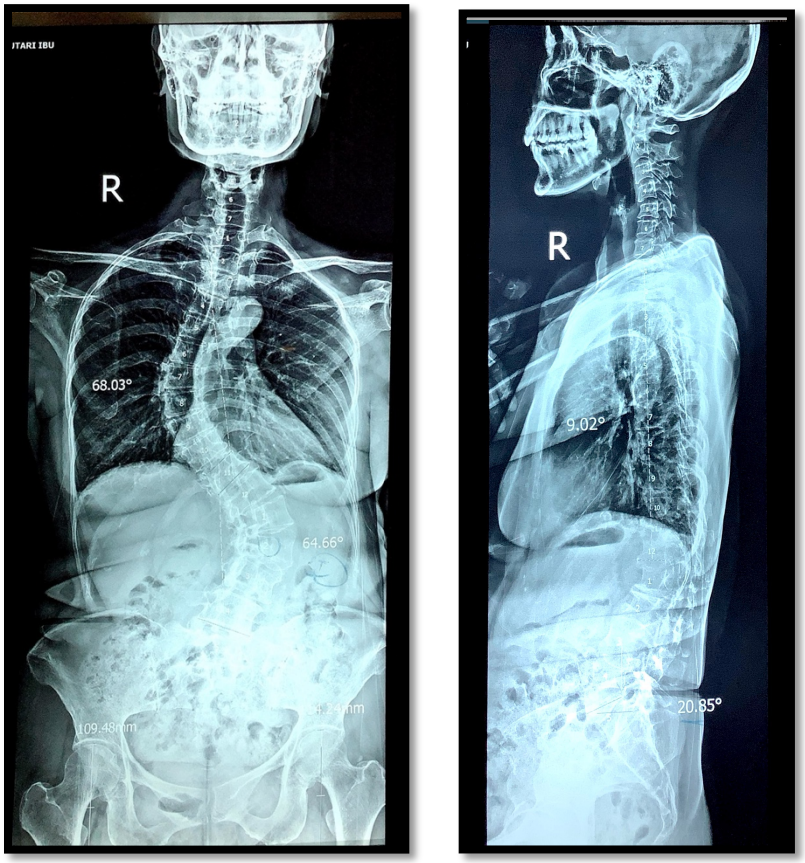
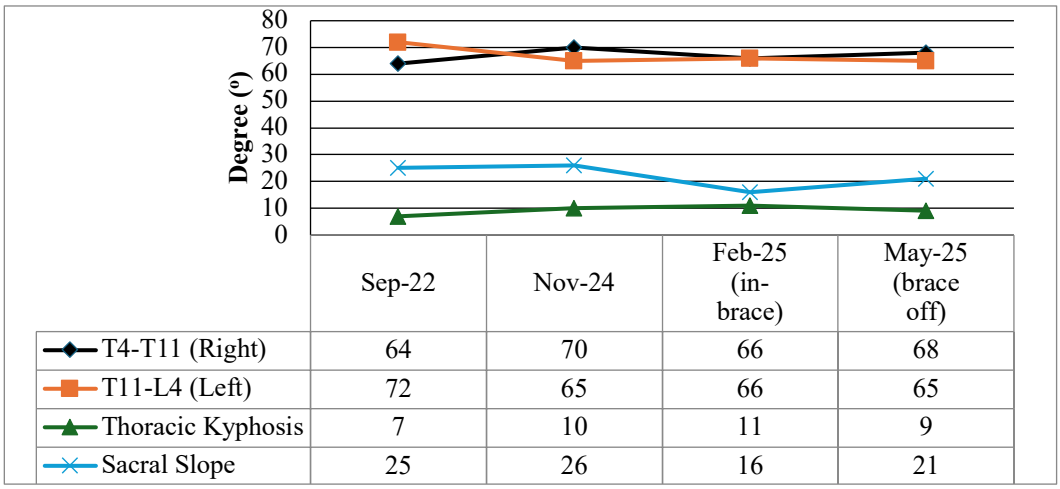



**Figure 5. Whole Spine Radiography (Scoliosis Standard) in RSC Brace**

The changing of sagittal and coronal profiles based on radiologic findings (right thoracic and left lumbar scoliosis curvatures, thoracic kyphosis, and sacral slope angles) is recorded in **Figure 6**. Over the course of 6 months evaluation, there was no signs of further instability of the displaced lumbar vertebrae. Upon the latest x-ray in May 2025, the scoliosis curve remained relatively stable with no progression, with 2º (2,8%) improvement of the major thoracic curve on 6-month evaluation compared with the degree on convexity on the first visit to our clinic. If compared with the earliest available record (September 2022), the improvement on thoracic curve was doubled (4º (6,2%)) and lumbar curve was improved 7º (9,7%).




| | Sep-22 | Nov-24 | Feb-25 (in-brace) | May-25 (brace off) |
|---|---|---|---|---|
| T4-T11 (Right) | 64 | 70 | 66 | 68 |
| T11-L4 (Left) | 72 | 65 | 66 | 65 |
| Thoracic Kyphosis | 7 | 10 | 11 | 9 |
| Sacral Slope | 25 | 26 | 16 | 21 |

**Figure 6. Sagittal and Coronal Profiles Based on Radiologic Findings (Right Thoracic and Left Lumbar Scoliosis Curvatures, Thoracic Kyphosis and Sacral Slope Angles)**

## DISCUSSION

The natural history of adolescent scoliosis to adulthood implicates as gradual curve progression due to the asymmetrical axial loading. The asymmetrical forces accelerates asymmetrical spinal degeneration. Previous studies showed that patients with adult spinal deformity experienced a gradual worsening of the coronal curve, averaging 0.83 ± 1.1° per year, which ultimately resulted in a 3.6° increase in Cobb angle compared to their initial presentation.[1,12] Our patient experienced similar progression pattern during the two years of no scoliosis treatment (2022-2024).

The clinical presentation of pain in adult spinal deformity was reported to be more strongly associated with sagittal malalignment than with the absolute magnitude of the coronal deformity.[10] Current evidence emphasizes the importance of three-dimensional evaluation of both regional and global sagittal and coronal alignment parameters, including pelvic orientation, through full-length standing radiographs in anteroposterior and lateral views.[2,10] These factors have been consistently linked to pain severity and functional disability, which was also reflected in our patient who experienced severe pain with the progressing spinal deformity.[4] Therefore, following the broad consensus that optimal scoliosis treatment, we addressed not only coronal curve correction but also the preservation or restoration of physiological sagittal spinal alignment, pain, and functional outcome.[10]

The SOSORT guidelines stipulated that both PSSE and braces be prescribed for adult scoliosis with chronic pain and progressive curve. Further study also recommend analysis of clinical and radiological condition to prescribe "Corrective" and "Accommodative" brace can be worn when either daily or as required.[13,14] We incorporated both 3D rigid brace with "Accommodative" design and application of PSSE with the principles, i.e.: three-dimensional self-correction of posture, stabilization of corrected posture, patient education, and the integration of corrective positions into daily activities)[10]. The chosen design for rigid brace for this patient was not to correct spinal alignment, but to provide external support and load-sharing for the deformed spine to lower the risk of progression. This highlights the complex interplay of structural distortion and neurological compromise

in scoliosis. From a rehabilitative perspective, bracing has traditionally been employed with the aim of unloading the growth plates at the concave aspect of the curve, thereby promoting growth and mitigating curve progression.[15]

Furthermore, radicular pain in patients with spinal deformity, which may arise from multiple biomechanical mechanisms. The degenerative changes, such as three-dimensional listhesis, L3–L4 endplate obliquity, reduction of lumbar lordosis, and development of thoracolumbar kyphosis are significantly correlated with symptom burden. Nerve root compression is more likely to occur on the concave side of the curve, whereas traction-related irritation may develop along the convex side.[8] Such insights underscore the necessity of a comprehensive radiological assessment and a multidisciplinary rehabilitation approach. We found that combination of PSSE, bracing, and multimodal physical modalities helps with to relieve pain and symptoms of neuropathy.

To the authors knowledge, there is still limited guidelines of the evaluation and management of adult scoliosis. This report highlights the role of conservative rehabilitation to help the patient maintain her symptoms and postpone surgery. However, we would like to comment that all these efforts were made with the acknowledgement of the indications and urgency of surgery. The yellow and red flags of spinal problems were monitored regularly, and the patient were informed that if conservative efforts fail, then intervention medicine or surgery might be unavoidable.

## CONCLUSION

A comprehensive rehabilitative strategy is crucial in managing adult scoliosis complicated by spondylolisthesis and radiculopathy. By integrating scoliosis-specific physical therapy, structured pain management, and individualized spinal bracing, symptoms can be effectively alleviated while spinal stability and overall function are enhanced. Such a multimodal approach not only addresses mechanical deformity and neurogenic pain but also supports long-term functional outcomes and quality of life, consistent with current evidence-based recommendations.

## CONFLICT OF INTEREST

The authors declared no conflict of interest.

## ACKNOWLEDGEMENT

The authors have nothing to declare.

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