

Case Report
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Adolescent Lumbar Spondylolisthesis and a Double Major Curve Scoliosis—are they Related? Can we Preserve Lumbar Motion

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ABSTRACT

The coexistence of idiopathic scoliosis and spondylolisthesis is well documented, yet their etiological relationship remains unclear. In some cases, scoliosis may arise secondarily due to the mechanical impact of spondylolisthesis, while in others, both conditions occur independently. We report the case of a 9-year-old girl with symptomatic grade III isthmic spondylolisthesis and mild lumbar scoliosis. Conservative management failed due to non-compliance, leading to progression of both the vertebral slip and spinal curvature. Surgical stabilization of the spondylolisthesis was performed, but scoliosis continued to worsen, ultimately requiring posterior thoracic fusion T3-T12 - preserving motion of the lumbar spine. Following this, the lumbar curve improved spontaneously. At three-year follow-up, the patient remained pain-free, with reduced asymmetry and preserved function. This case illustrates the diagnostic and therapeutic challenges in managing concomitant scoliosis and spondylolisthesis. Scoliotic curves in this context may be classified as idiopathic, spasm-related (functional), or olithetic (structural). Identifying the nature of the scoliosis is essential for selecting the appropriate treatment strategy and determining whether spinal fusion should address one or both deformities. Independent idiopathic curves should be managed per standard guidelines, whereas secondary curves may improve after addressing the underlying spondylolisthesis. In patients with coexisting scoliosis and spondylolisthesis, careful assessment is needed to distinguish between idiopathic and secondary curves. Timely surgical intervention in symptomatic spondylolisthesis may prevent or reverse associated deformity, but progressive concomitant idiopathic scoliosis may still require specific surgical management.

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Introduction

Idiopathic scoliosis is believed to have a complex genetic etiology involving the biomechanical properties of discs, ligaments, and bones, often with a positive family history [1-3]. but in fact, the term idiopathic merely reflects how little we truly understand about its causes. The treatment for adolescent idiopathic scoliosis is guided by the magnitude of the spinal curvature and the skeletal maturity. In patients with mild curves (Cobb angle <20°) and significant growth remaining, observation with regular clinical and radiographic follow-up is generally sufficient, as many of these curves do not progress [4]. For moderate curves (Cobb angle 20–40°) in skeletally immature patients, orthotic management using a spinal brace is often indicated to prevent progression during the remaining growth period [5]. Surgical intervention is considered in cases of more severe curvatures (Cobb >45°), especially in patients with substantial growth remaining or documented progression, as these deformities are more likely to worsen and may lead to future functional impairment [6].

Spondylolisthesis can develop during adolescence and lead to progressive deformity, pain, and neurological deficits [7]. Various classification systems exist to determine the severity of the condition; deformity is described by the percentage of vertebral slippage according to Meyerding's classification, and Wiltse proposed the physiopathology classification most used nowadays (Type I dysplastic; type II isthmic spondylolisthesis; type III degenerative; type IV traumatic; type V pathologic; type VI iatrogenic) [8,9]. The highest rate of spondylolisthesis slippage is found in Wiltse's type I (incidence of 32%) hence, most of the high-grade cases (slippage >50%) are dysplastic. The management of spondylolisthesis in early ages depends on the degree of vertebral slippage, the possible spino-plevic imbalance, and the presence of symptoms [10]. In low-grade slips (<50% translation) without significant symptoms or progression, conservative treatment with activity modification, physiotherapy, and periodic monitoring is usually appropriate [11]. Surgical intervention is generally reserved for high-grade slips, progressive

deformities, or cases with neurological symptoms – the goal is to achieve fusion, possibly with forehead reduction, depending on the sagittal alignment [12].

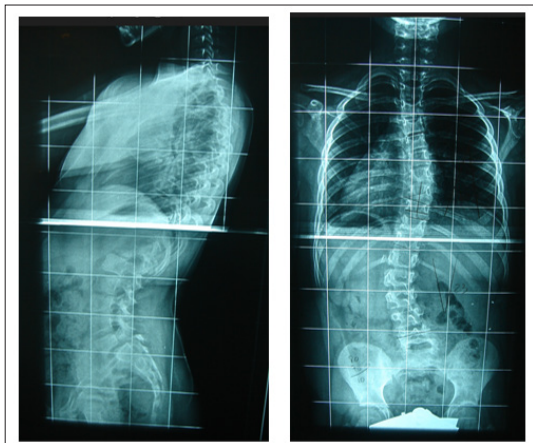


Figure 1 A: AP & Lateral Radiographs Right Sided Thoracic Curve 15° cobb angle and left sided lumbar curve 23° and a Risser 0



Meyerding L5 Grade II isthmic spondylolisthesis

1 B: – Slip angle of 25°

The coexistence of scoliosis and spondylolisthesis is well-documented, with prevalence rates ranging between 15% and 48% Fisk et al., found scoliosis of at least 5° Cobb angle in 48% of children with spondylolisthesis; Libson et al [13-15]. reports that the incidence of scoliosis was 23% in cases of asymptomatic spondylolisthesis, increasing to 43% among patients with symptomatic spondylolisthesis. Although the synchronism is certain, the correlation between the two diseases is yet to be clear, and the literature shows that even though the concomitant presence of both defects may potentiate the clinical picture, they might not be etiologically related. These patients might be divided into two groups according to the relationship of the deformities: one where there is no common ground between the spondylolisthesis and the scoliosis (hence, idiopathic) and the other where the scoliosis derives from the presence of the spondylolisthesis [16]. Realizing this relationship might help to individualize the treatment decision (the need for reduction and the fusion extension) and to correctly assess the prognosis of the scoliotic curve progression after the spondylolisthesis treatment.

Case Report

A 9-year-old girl presented with persistent, movement-induced mechanical lower back pain relieved by rest, along with lumbar deformity. There was no history of comorbidities, and she had not

reached menarche. Physical examination revealed mild lumbar asymmetry, negative Adam’s test, hamstring tightness, and no neurological deficits. Initial imaging showed grade II isthmic spondylolisthesis, no MRI abnormalities, Risser 0, a 15° right thoracic curve, and a 23° left lumbar curve (Figure 1). The initial proposed conservative treatment consisted of physiotherapy and a brace - however, the patient was noncompliant, and both pain and deformity worsened progressively. Radiological follow-up revealed an increased 28° thoracic curve and 36° lumbar curve, with unstable, Meyerding’s grade III L5 spondylolisthesis (with a 23° slip angle) (Figure 2). Posterolateral L5S1 instrumented fusion was performed based on instability, balance, and slip angle (Figure 3). Even though the lumbar pain subsided, the thoracic and lumbar

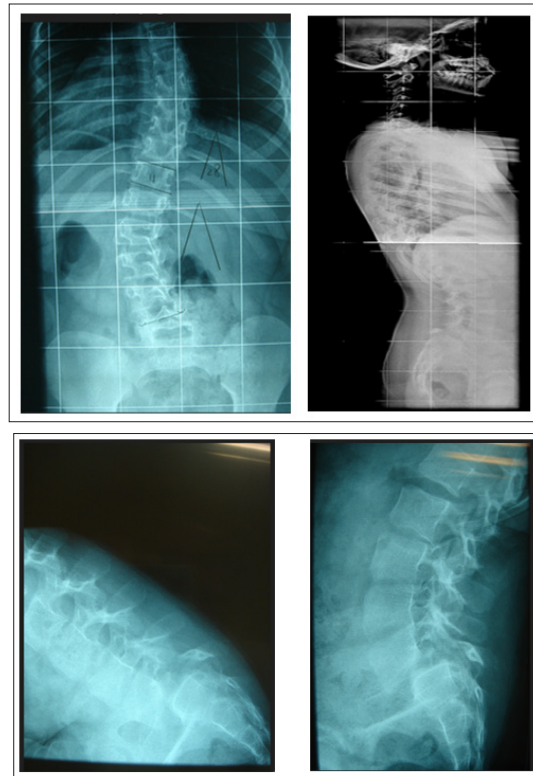


Figure 2:

A - AP and Lateral Radiographs R Sided Thoracic 28° L sided lumbar 36°

B - Lateral Dynamic Radiographs Meyerding Grade III unstable L5 spondylo

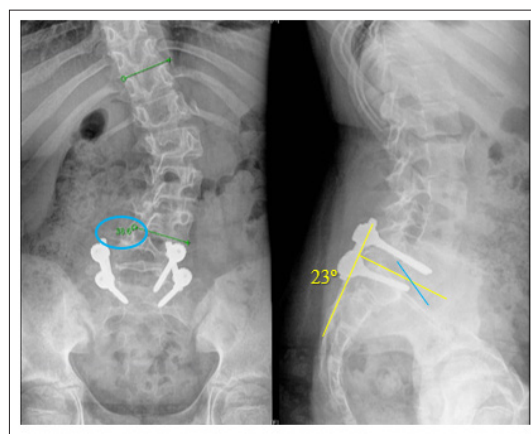


Figure 3:Post op Radiographs –L5S1 Postero-Lateral Instrumented Fusion (Lumbar Cobb angle 38° and Slip angle 23°)

curves continued to progress during follow-up. By the second year post lumbosacral fusion, the thoracic Cobb angle reached 83° , and the lumbar Cobb angle 56° (Figure 4). Acknowledging the diagnosis of idiopathic scoliosis with progressive deformity (despite appropriate treatment of spondylolisthesis) as an independent disease, posterior instrumentation and fusion from T3 to T12 was performed, leaving the lumbar spine mobile. Recovery was uneventful and no complications were observed postoperatively. In follow-up evaluations, the lumbar curve gradually improved without requiring bracing. At three years after selective thoracic fusion, the lumbar curve decreased from 57° to 31° (Figure 5). Clinical examination showed a well-balanced spine, a reduced rib hump and flank asymmetry, absence of pain, normal muscle strength (5/5), and a physiologically ergonomic range of motion (Figure 6).

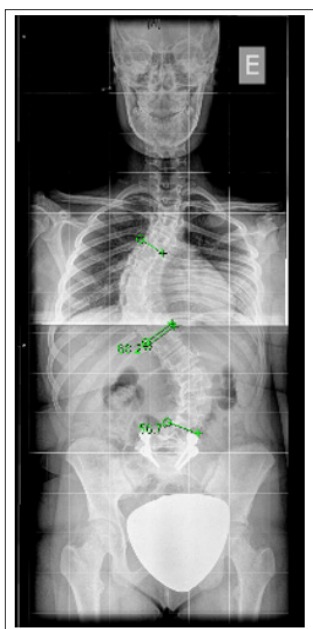


Figure 4: AP Radiograph at 2-year FU – Thoracic Cobb angle 83° and Lumbar Cobb angle 56°

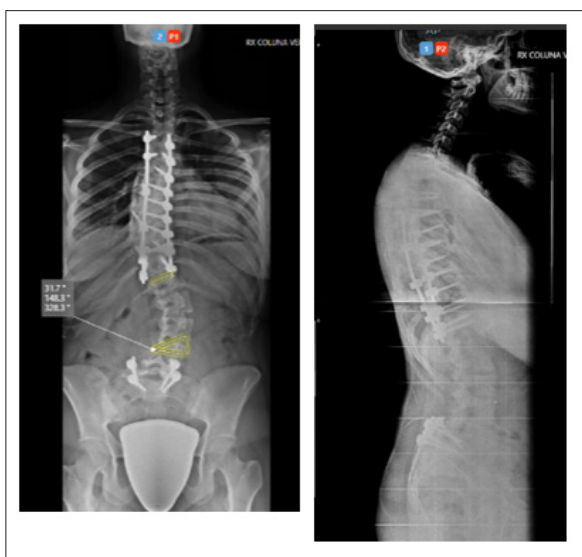


Figure 5: AP and Lateral Radiographs at 19y of age (3 years after thoracic selective fusion)

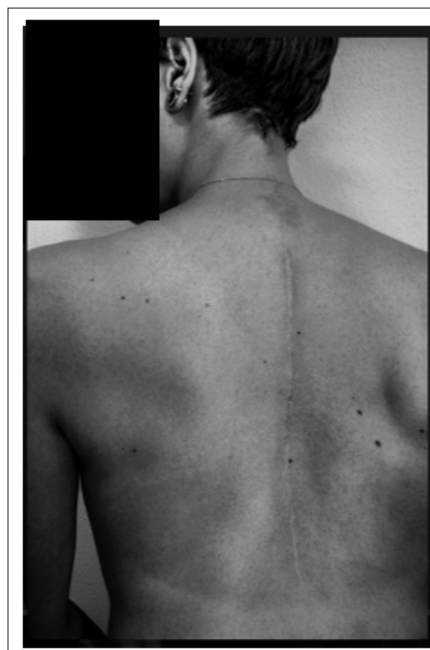


Figure 6: Clinical Photos

- A – One Year Post Thoracic Fusion at 15y
- B – Three Years Later at 19y of age

Discussion

Scoliosis associated with spondylolisthesis can arise independently or secondary to the lumbosacral deformity. Secondary scoliosis cases may be further divided into the sciatic/spasm (functional) group and the olisthetic (structural) group. In the functional group, the scoliotic posture is related to the muscle spasm that results from the spondylolisthetic defect decompensation; usually, the curves are longer, and there is no significant vertebral rotation. In these patients, if the symptomatic spondylolisthesis is treated before the spinal deformity becomes structural, it relieves the muscle spasm and can lead to partial or complete resolution of the deformity without the need to address it directly [3,13,16-18]. In the structural group, the olisthetic scoliotic deformity

arises as a consequence of the imbalance caused by the pars dysmorphism – if the pars defect is asymmetrical, the slippage of the L5 vertebra occurs in both sagittal and coronal planes resulting in an oblique/rotated lumbosacral foundation causing a compensatory scoliosis; therefore the most rotated vertebral body is the displaced L5 and not the apical curve vertebra as it usually happens in idiopathic scoliosis cases; The closer the scoliosis curve is to the area of spondylolisthesis, the more likely it is that the curve is secondary to, or influenced by, the spondylolisthesis [16-19]. In these cases, the treatment for the spondylolysis should include a reduction maneuver in order to gain a possible curve correction – if only in situ fusion is performed, the “asymmetric ring” is not amended and the cause of the deformity remains untreated [17]. In fact, some authors support early surgical intervention for lytic spondylolisthesis associated with spasmic or olisthetic-related scoliosis, aiming to close the lytic gap and thereby preventing the potential development of new scoliosis curves or the progression of existing ones. Synchronous independent spondylolisthesis is diagnosed in 6.2% of patients with idiopathic scoliosis; these primary group patients usually have a positive familiar history for scoliosis, and the scoliotic deformity behaves in the typical fashion - the majority of these patients present a more proximal curve, thoracic or thoracolumbar, (instead of lumbo-sacral) with significant rotation in the apical vertebra (not the lower end vertebra), and progress detachedly from the spondylolysis development or treatment [20]. Bracing and physiotherapy remain first-line treatments for low-grade spondylolisthesis and mild scoliosis, but patient non-compliance can lead to curve progression and necessitate surgical intervention. When symptomatic, spondylolisthesis surgical treatment may require in situ fusion (in patients with good sagittal spinopelvic and coronal balances), but reduction should be preferable in the unbalanced cases. The treatment of an associated scoliosis is only warranted if the curve shows progression over time, and in such cases, it should be managed according to the standard therapeutic principles applied to idiopathic scoliosis of comparable magnitude [14,21]. Concomitantly, it is generally accepted that, when needed, the scoliosis fusion should not involve the olisthetic level unless it falls within the segment of the scoliosis curve selected for fusion during usual treatment planning [22]. If the scoliosis is severe enough to require treatment should be considered idiopathic and managed accordingly, independently of spondylolisthesis, if the spondylolisthesis is asymptomatic. However, if the spondylolisthesis is symptomatic, scoliosis should be addressed either concurrently with or following the treatment of the spondylolisthesis [23]. Scoliosis management depends on the curve magnitude: curves $<25^\circ$ Cobb usually require no treatment, while curves $>25^\circ$ are managed according to idiopathic scoliosis guidelines [13,16-18]. Fusion surgeries may correct curves dominated by spasm even without restoring spinal symmetry [3,17]. Bracing remains standard for progressive idiopathic scoliosis in adolescents (Cobb angle $>25^\circ$), but non-compliance and progression often necessitate surgical correction to prevent deformity and morbidity. In recent years, fusionless surgical options like vertebral posterior tethering have been explored even in double curve scoliosis [24]. Ideal indications for posterior tethering include Lenke 5C curves, Cobb angles between 40° and 65° , Sanders stages 2–6 (preferably 3–4), and curve flexibility of $\geq 50\%$ [25,26].

In this particular case, the key challenge was the therapeutic decision-making for the idiopathic scoliosis, specifically regarding the extent of spinal fusion. The patient presented with a double major structural curve deformity, Lenke type 3, which would

typically require instrumentation extending distally to the last touched vertebra, which would mean fusing to L4; however, given that the patient had already undergone an L5–S1 fusion for spondylolisthesis, fusing to L4 would leave L4–L5 as the only remaining mobile segment between two fused regions. The alternative would be extending the fusion to the pelvis – but doing so at a young age has significant long-term consequences as it eliminates movement across the lumbosacral junction, severely restricting flexibility and impairing normal biomechanics; this can lead to difficulties with activities that require bending, twisting, or shock absorption, such as sports or even routine tasks like tying shoelaces. Psychosocially, the limitations imposed by such a fusion can affect body image, self-esteem, and participation in age-appropriate social and physical activities. After thorough discussion with the patient and her parents, and after explaining the risks associated with performing a “selective” fusion outside standard recommendations - particularly the potential for progression of the lumbar curve - we chose to fuse only the thoracic spine [27]. We firmly believe this was the right decision. Should complications develop in the future, a second-stage fusion extending the arthrodesis to the pelvis will remain a feasible option.

Conclusion

This case highlights the complex interplay between spondylolisthesis and scoliosis in adolescents. Determining whether the scoliotic curve is idiopathic or secondary to the lumbosacral defect is crucial to understand the possible progression and prognosis. The case underscores the importance of individualized treatment planning based on curve progression, spinal balance, and underlying pathology; and highlights that even after adequate surgical management of symptomatic spondylolisthesis, scoliosis may progress independently, reinforcing the need to assess each deformity on its own merits. Despite appropriate surgical management of spondylolisthesis, progressive idiopathic scoliosis may necessitate further intervention. Early diagnosis, patient compliance with non-surgical treatments, and timely surgical decisions are crucial for optimal outcomes, minimizing long-term morbidity, and preserving function [28].

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