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Chronic Low Back Pain with Early-Onset Spinal Intervertebral Disc Degeneration in Adolescence: A Case of Pain Management Using Sling-Based Rehabilitation

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ABSTRACT

Low back pain (LBP) is a leading cause of global disability. Although LBP from intervertebral disc degeneration (IDD) is typically age-related, early-onset IDD is increasingly seen in young adults. Sling-based rehabilitation enhances neuromuscular control and core stability, offering a non-invasive option to reduce pain and improve function in LBP. This case highlights unrecognized early structural degeneration in young adults and demonstrates sling therapy's effectiveness as a movement-centered intervention for chronic LBP. A 26-year-old female presented with a 13-year history of intermittent LBP, worsened by prolonged sitting, poor posture, and high-level exercise (Muay Thai, gym training). Prior treatments (oral analgesics, passive modalities) failed. Examination revealed anterior pelvic tilt, hyperlordosis, gluteal/hip flexor weakness, and left sacroiliac dysfunction. MRI showed degenerative disc disease at L4–5/L5–S1, Schmorl's nodes at L2–3/L5–S1, and central protrusions without nerve compression. Initial management included pharmacotherapy, TENS, ultrasound, and infrared. A sling-based program targeted core stabilization and posture correction. Pain reduced and trunk control improved within 2–3 weeks; significant functional gains occurred by 4–6 weeks.

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Introduction

Low back pain (LBP) is one of the causes of disability worldwide, with approximately 70–80% of adults experiencing at least one episode in their lifetime (Jensen et al., 2020; Lorio et al., 2016). LBP is often associated with aging, but degenerative changes in the intervertebral disc (IDD) now are increasingly found in adolescents and young adults, this condition known as early-onset IDD. Intervertebral discs are structures that made up of a nucleus pulposus and a fibrous annulus fibrosus. These structures functioning as shock absorbers and facilitators of spinal flexibility (Foster et al., 2018). Degeneration begins with loss of hydration and structural integrity, progressing to disc protrusion and neural compression. This process can manifest even in younger individuals due to genetic predisposition or biomechanical stressors (Drummond et al., 2024: Fiani et al., 2021).

Although true disc herniation remains rare in adolescence, with cases less than 0.2%, disc degeneration has been detected increasingly in asymptomatic and symptomatic young adults, particularly among athletes or individuals with poor postural control Imaging findings such as Schmorl's nodes, decreased disc height, and early foraminal narrowing are commonly observed and correlate with persistent mechanical LBP (Farley et al., 2024).

First-line management of early-onset disc degeneration traditionally involves conservative approaches such as education, postural correction, pharmacologic support, and physical therapy Sling-based rehabilitation are one of the modalities that can be used by gaining traction due to their ability to enhance neuromuscular coordination and core activation (Maeo et al., 2017; Oostdam et al., 2020). Sling exercise uses suspension devices to stabilizing the support surface, prompting reflexive engagement of stabilizing muscles such as the transversus abdominis and multifidus as a deeper activation than mat-based core training (Calatayud et al., 2014; Kim et al., 2018). Recent clinical trials and meta-analyses demonstrate that sling exercise significantly reduces pain by improving VAS (Visual Analogue Scale), improves trunk strength, and restores anticipatory muscle control in patients with chronic non-specific LBP and muscle control in patients with chronic non-specific LBP (Oichi et al., 2020).

This case report presents a 26-year-old female with early-onset spinal IDD and chronic LBP who demonstrated marked improvement following a structured sling-based rehabilitation program. The aim is to highlight the underrecognized early structural degeneration in young adults and show the effect of sling therapy as an effective, movement-centered, non-invasive intervention for chronic LBP.

Case Presentation

A 26-year-old female presented with a history of chronic low back pain (LBP) since 13 years ago, this pain characterized by intermittent dull aches that worsened with prolonged sitting, poor posture, and later physical exertion. Over time, the pain became more persistent and disabling. This patient is also engaged in high-intensity sports activities, including Muay Thai and gym workouts, which have worsened her symptoms. She said the pain increased during standing, walking and after gym movements like back squats. There were no other symptoms such as bowel/bladder dysfunction, morning stiffness or any radiating pain to the posterior thigh. She had previously tried oral analgesics and passive modalities, but her symptoms still persisted

During the physical examination, the patient's vital signs were found to be within normal ranges. Look examination showed anterior pelvic tilt and compensatory lumbar hyperlordosis during standing posture. Gait analysis showed slight asymmetry, particularly during the heel-off phase, with reduced push-off strength on the left lower limb. Feel examination showed tenderness in the left sacroiliac (SI) joint, gluteus medius, and lower thoracic paraspinal regions, including the m. quadratus lumborum. There was no local warmth or swelling, and muscle tone was increased located in the thoracolumbar paraspinals. Movement examination showed that active lumbar extension in standing was painful and limited, reproducing the patient's complaint. Manual muscle testing showed weakness in the left hip flexors, hip abductors, and m. gluteus maximus. Neurological examination was normal, with no sensory deficits, preserved reflexes, and no signs of radiculopathy.

Several special tests were performed to support the clinical diagnosis. FABER and Gaenslen's tests were positive on the left, indicated SI joint dysfunction. The straight leg raise test was positive. The Thomas test showed tightness in the left hip flexors. A positive Trendelenburg test on the left confirmed weakness in the gluteus medius. The patient has undergone a non contrast lumbosacral MRI, which revealed early degenerative disc disease at the L4-L5 and L5-S1 levels, accompanied by central disc protrusion, Schmorl's nodes located

at L2-3 and L5-S1, as well as narrowing of the neural foramina without any nerve root compression.

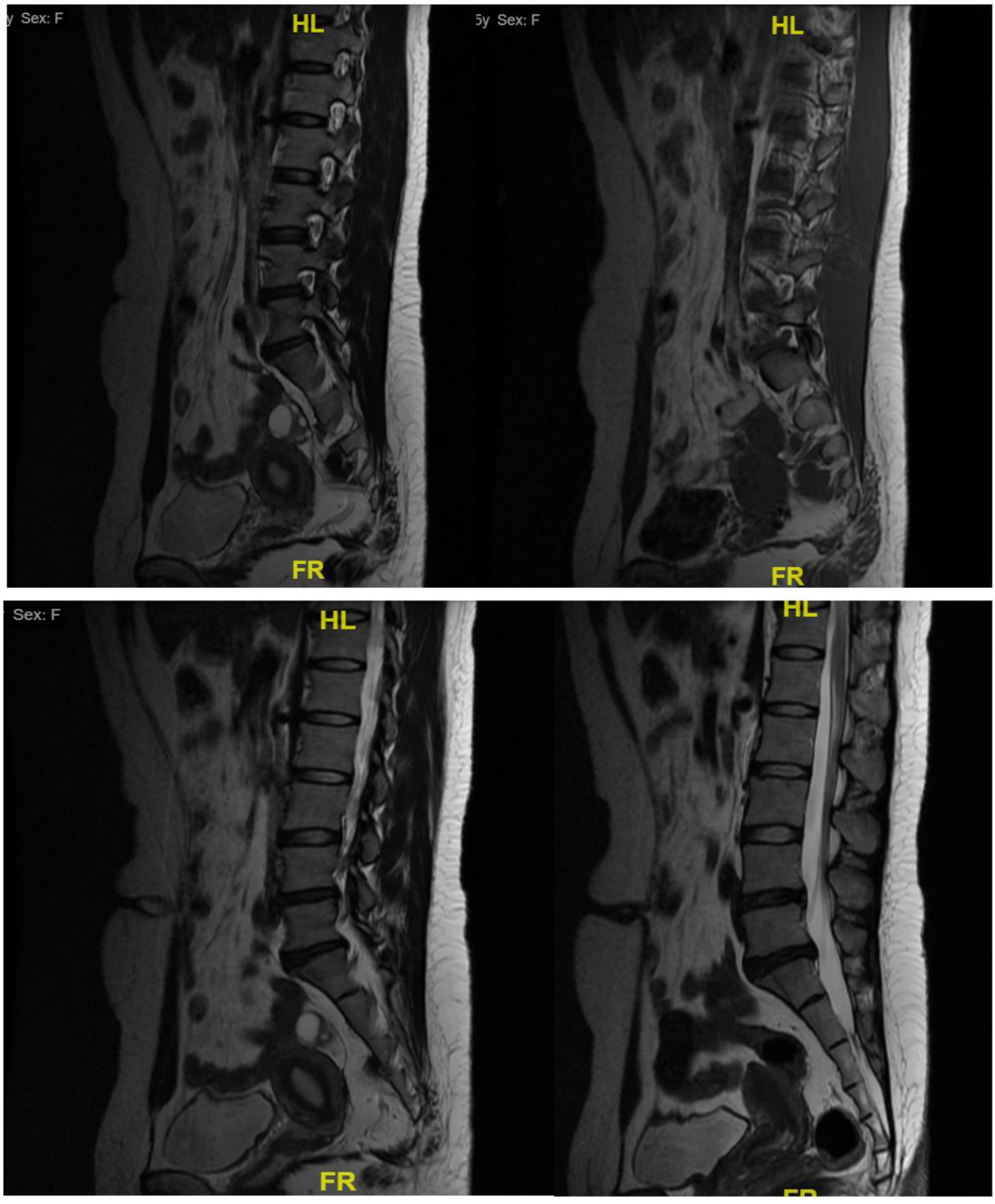

Figure 1. Non contrast lumbosacral MRI of the patient

MRI of the lumbar spine without contrast was performed using T1 and T2-weighted imaging sequences, sagittal and axial slices, and MR myelography, with the following results:

a. Degeneration of the intervertebral discs at L4–5 and L5–S1 is observed.
b. Schmorl's nodes are seen at L2–3 and L5–S1.

c. L4–5: Central disc bulging slightly narrows the spinal canal, with extension into the paracentral and bilateral foraminal regions, but without nerve root compression.
d. L5–S1: Central disc protrusion narrows the spinal canal and extends bilaterally into the paracentral regions, irritating both traversing S1 nerve roots. There is also a bulging disc toward the right foraminal side, causing no nerve root compression.
e. The spinal cord appears normal. Lumbar lordosis is straightened. Alignment is good, with no evidence of spondylolisthesis.
f. The conus medullaris terminates at the T12–L1 level. No abnormalities in the paravertebral soft tissues.
g. MR Myelogram: Mild spinal canal stenosis at the L5–S1 level

Initial management for this patient, she has been prescribed etoricoxib for pain and inflammation, B-complex vitamins for neuromuscular support and topical diclofenac sodium, she also participated in a sling-based rehabilitation program. Additionally, modalities such as TENS, ultrasound, and infrared therapy were also given. After several weeks, progressive improvement was observed, the patient feel that pain intensity decreased, improved trunk stability, and enhanced movement quality. Pain has been decreased that within 2 to 3 weeks after the sling-based rehabilitation, with significant functional advancements occurring within 4 to 6 weeks.

Results and discussion

Chronic low back pain (CLBP) is a significant factor that leads to global burden of disease, cause among 354 diseases for years lived with disability from 1990 to 2017. CLBP is typically described as persistent lumbar pain that lasts for more than 3 months (stated by the French agency for healthcare evaluations, Agence NAtionale d'Évaluation en Santé, ANAES) to low back pain with a duration more than 6 months (the American Society of Interventional Pain Physicians, ASIPP). Non degenerative CLBP meaning pain caused by pathology such as trauma, spondylolysis, tumors, infections, or inflammatory processes. The second classification is degenerative cLBP that has replaced the term "nonspecific low back pain" . This refers to pain that contribute from age-related or mechanical degeneration of spinal structures, such as intervertebral discs, facet joints, ligaments, or changes in spinal alignment (Donnally et al., 2025).

Intervertebral disc degeneration (IDD) is condition that characterized by damaging of the intervertebral discs (Binch et al., 2021; Kadow et al., 2015). An intervertebral disc is a fibrocartilaginous structure which function is to transmit compressive loads between vertebral bodies. It consists of three main parts: the cartilaginous endplates, nucleus pulposus at the center, and the anulus fibrosus which surrounds the nucleus. Disc degeneration is associated with numerous clinical conditions including herniation of the nucleus purposing, mechanical back pain, spinal stenosis, and spondylosis. Intervertebral disc degeneration starts with dehydration of the nucleus pulposus, reduction in disc height, annular tears, disc bulging or herniation, and results in loss of mechanical function (Sulima et al., 2020).

Though commonly associated with aging, studies showed that IDD can occur much earlier in life, particularly in individuals with genetic predisposition, mechanical stress, trauma, and smoking habit (Battié et al., 2019; Samartzis et al., 2015). Genetic predisposition has shown to be one of the factors that affect intervertebral disc degeneration (IDD) in young

individuals, in addition to mechanical and environmental factors. Several genes have been implicated, including ACAN (aggrecan), which maintains disc hydration and structure, and collagen genes such as COL1A1, COL9A2, COL9A3, and COL11A1, which contribute to extracellular matrix integrity. Variations of these genes may disrupt collagen formation and accelerate degeneration. Other significant genes that contribute including inflammatory genes like IL1A, which increase cytokine activity and matrix degradation, and MMP2, a metalloproteinase that promotes extracellular matrix breakdown. Polymorphisms in the VDR (vitamin D receptor) gene have also been associated with altered disc metabolism and degeneration. This shown that genetic factors also play a role in intervertebral disc degeneration found in young individuals (Park et al., 2017).

MRI scan of a person with intervertebral disc degeneration will normally show a number of characteristic features. One of the first indicators is a decrease in T2-weighted signal intensity due to disc dehydration. This is seen most commonly in the lower lumbar spine, especially at the L4/L5 and L5/S1 levels. Structural loss may also lead to decreased disc height. Schmorl's nodes, which are herniations of disc material into the vertebral endplate, are common in younger patients and are associated with endplate degeneration. These findings, along with altered endplate signal changes, are seen to have greater association with chronic low back pain.

Sling-based rehabilitation (sling exercise therapy, SET) is a therapeutic approach using suspension systems to support the body or its parts while exercising and moving (Belavy et al., 2017; Kjaer et al., 2016). This will reduce gravitational load and create an unstable environment that challenges postural control and muscle coordination by facilitating partial bodyweight unloading and using closed kinetic chain movements (Li et al., 2022). SET also enhances the activation of deep stabilizing muscles such as the transversus abdominis and multifidus, which are crucial for spinal stability . This trunk muscle supports will improve in strength and endurance, balance and propioception, flexibility and Range of Motion (ROM), and pain reduction (Vergroesen et al., 2015).

SET is indicated for patients with chronic mechanical low back pain (especially those with core instability or segmental dysfunction), as well as for early disc degeneration, scoliosis, and postural imbalance. It is contraindicated in cases of acute fractures, uncontrolled systemic diseases, cognitive impairments, and severe skin conditions that prevent cooperation or sling application (Hlaing et al., 2021). Study from a 2024 systematic review and meta-analysis by Drummond et al. 2024 demonstrated that SET significantly reduced pain and disability scores compared to motor control or no intervention, while also improving muscle activation and strength. Another study in 2022 by Li, et al. found that after just two weeks of specific exercise training (SET), there was a changes of the cortical motor for the m. transversus abdominis and multifidus, bringing them more in line. These findings showed that using SET as an early and functionally progressive will decrease pain, restore spinal stability, and encourage neuroplastic recovery in those suffering from chronic low back pain.

Degenerative disc disease is typically associated with older age, but intervertebral disc degeneration (IDD) can manifest in young adults and even adolescents with other conditions. In out case, a 26-year-old patient's MRI showing early degeneration at L4–L5 and L5–S1, along with Schmorl's nodes that is consistent with premature disc changes in youth. Many factors contribute to such early onset IDD, including genetic predisposition, chronic mechanical stress, high-impact sports, and genetic predisposition can affect the disc integrity. In this case, a 13-

year history of low back pain aggravated by poor posture suggests that poor biomechanical strain (for example anterior pelvic tilt and hyperlordosis increasing lumbar load) played a role for the disc wear. Early disc degeneration in a young patient shows that degenerative changes are not exclusive to the elderly and can arise from a lifestyle and genetic predisposition.

Genetic predisposition may contribute to IDD in this patient. The patient said that the intermittent low back pain since childhood and worsened during adolescence, particularly when she did the high-impact activities. There is also a family history of back pain, showing a possible hereditary factor. This shows that genetic factors may play a role for IDD in young individuals. Several genes such as ACAN, which encodes aggrecan responsible for disc hydration, and collagen-related genes like COL1A1, COL9A2, COL9A3, and COL11A1 play roles in maintaining extracellular matrix integrity. Variants in these genes can impair collagen synthesis and accelerate disc degeneration. Considering this patient's early symptoms, imaging findings, and family history, it is possible to consider genetic predisposition as one of the contributing factors to her disc degeneration.

Despite the MRI evidence of disc degeneration, the source of this patient's pain was not attributable to the discs alone. There was no nerve root compression identified on imaging, indicating that her chronic low back pain was from other structures. The physical examination showed sacroiliac joint (SIJ) dysfunction (positive FABER and Gaenslen's tests) and significant postural imbalance, which are one of the caused for the chronic low back pain. This patient has an anterior pelvic tilt posture with exaggerated lumbar lordosis which can add more stress on the SI joints and lumbar facets, leading to pain and instability. Moreover, we found that this patient has weakness in the gluteal and hip muscles and tendernes or spasm in the thoracolumbar paraspinals which lead to poor core stability and muscular imbalance as the aggravating factors.

These findings showed the multifactorial causes for her condition such as malalignment, joint dysfunction, and muscle imbalance were all her symptoms alongside the disc changes. In managing such a complex condition, it is important to perform a comprehensive evaluation and make a comprehensive treatment for this patient's conditions. This case want to highlight that must treat the whole patient's condition, not just the MRI. This can be done by recognizing factors such as the SIJ dysfunction, postural problem, and weak stabilizing muscle, and we can make a more effective, individualized rehabilitation plan. Treating the patient as a whole — and not just treating the scan findings — ensures that therapy targets the actual causes of pain and functional limitation in this young woman.

Given the patient's early IDD in combination with core instability and SIJ dysfunction, a conservative rehabilitative approach was indicated.We used sling-based rehabilitation, for her treatment. SET used suspended slings to assist and challenge the body during movement. This unloading is especially advantageous for a degenerative disc case, as it avoids excessive axial pressure on vulnerable disc segments during rehabilitation. At the same time, the unstable support of the slings compels the engagement of deep core stabilizers; in other words, it elicits robust core muscle activation (particularly the transversus abdominis and multifidus) to maintain control. This training enhances neuromuscular control because the patient must coordinate muscles to stabilize the lumbar-pelvic region during sling exercises. The benefits of Sling Exercise Therapy for this patient were a lot.

First, by decreasing mechanical load on the spine, SET enabled reduction of pain and strengthen the muscle. The patient could perform movements without exacerbating her symptoms and can decrease the pain . Second, to increase core and pelvic muscle strength contributed to gradual postural correction. As her deep abdominals and gluteal muscles became stronger and more coordinated, the anterior pelvic tilt and lumbar hyperlordosis could be reduced towards a more neutral alignment, alleviating abnormal stresses on the lower back and SI joints. Third, improved neuromuscular coordination translated into better motor control of the lumbopelvic region. This is particularly important for SIJ dysfunction, as enhanced stability and muscle around the pelvis to help protect the SI joint from mechanical stress and recurrent misalignment. SET provided a targeted low-impact rehabilitation strategy that suited for a young patient with early disc degeneration, associated core instability, and SIJ dysfunction.

After starting sling-based rehabilitation, the patient also got other treatments like transcutaneous electrical nerve stimulation (TENS), ultrasound, and infrared therapy to help decrease the pain. Over several weeks, the patient feel a significant reduction of her pain levels, with better posture stability. Within just two to three weeks of beginning the program, she reported a decrease in pain, which allowed for more active engagement in daily activities. By the four to six-week, the patient showed clinical progress, especially in areas like postural control, core endurance, and less discomfort during standing, walking, and training. These improvements show the effectiveness of a personalized rehabilitation strategy. The most important of this case is to looking for chronic low back pain in a holistic way this will take into mechanical, neuromuscular, and postural factors, rather than just relying on imaging results. A personalized clinical approach is important, as we need to treat patients as individuals, not just their MRI.

Conclusion

Chronic low back pain (CLBP) in young adults with early-onset intervertebral disc degeneration often stems from multifactorial causes beyond MRI findings, such as core instability, postural imbalances, and sacroiliac joint dysfunction, as observed in this case report. Sling-based rehabilitation proved effective in reducing pain, strengthening muscles, stabilizing the trunk, and improving overall function. A comprehensive, personalized management approach is essential, considering the patient's full clinical presentation rather than relying solely on imaging results. For future research, randomized controlled trials comparing sling-based rehabilitation with other conservative therapies in adolescents and young adults with early-onset disc degeneration could validate its efficacy, optimal protocols, and long-term outcomes across diverse populations.

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