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Tethered Cord Syndrome and Scoliosis: An Evidence-Based Clinical Overview

Clinical Reference Document — Compiled for Clinical Education

Overview: What Is Tethered Cord Syndrome?

Tethered cord syndrome (TCS) is a broad clinical entity encompassing both congenital (primary) and acquired (secondary) pathologies that anchor, elongate, and place abnormal tension on the spinal cord. Spinal cord fixation results in chronic mechanical tension, impaired neural excursion, vascular compromise, and progressive metabolic dysfunction during normal growth and movement. This prevents the spinal cord from freely moving within the spinal canal, increasing mechanical stress with flexion and extension movements of the spine.

In its simplest form, the cord is tethered by a thickened filum terminale (>2 mm in cross-sectional diameter) with a low-lying conus medullaris (at or below L2–L3). However, the spinal cord can also be tethered by a filum with normal MRI appearance and a normally positioned conus — a critical point for diagnosis.

Etiologies

- Thickened or tight filum terminale (most common isolated form)
- Lipomas (intradural lipoma, lipomyelomeningocele)
- Myelomeningocele / spina bifida repair (secondary/acquired tethering — the underlying myelomeningocele is congenital; it is the tethering that develops after surgical repair that is acquired)
- Dermal sinus tract
- Diastematomyelia (split spinal cord malformation)
- Intradural scar formation post-surgery or trauma
- Meningoceles and other spinal dysraphisms

Epidemiology

Tethered cord syndrome is considered an uncommon neurological disorder, although the true prevalence is likely underestimated because many individuals remain undiagnosed until adolescence or adulthood. It predominantly presents in childhood and adolescence with a male predilection in some series, though this varies by etiology.

Classic Clinical Presentation

- Lower back pain worsening with activity
- Lower extremity motor weakness, spasticity, or gait disturbance
- Sensory deficits in the lower extremities
- Neurogenic bladder or bowel dysfunction (often first presenting symptom in children)
- Foot deformities (high-arched feet, hammertoes, pes cavus)
- Scoliosis or exaggerated lordosis
- Cutaneous stigmata: midline tufts of hair, skin tags, dimples, hemangiomas, subcutaneous lipomas in the lumbosacral region

Cutaneous (Skin) Signs That May Suggest Tethered Cord Syndrome

Certain skin findings over the lower back may be an external clue that the spinal cord did not develop normally. These findings are called cutaneous stigmata and are present at birth, although they may become more noticeable as a child grows.

Most birthmarks and skin variations are completely harmless. However, when skin changes occur over the midline of the lower back, particularly when more than one is present, they may indicate an underlying spinal abnormality such as tethered cord syndrome or another form of spinal dysraphism.

Skin findings that may warrant further evaluation include:

- A patch of excessive hair (sometimes called a "faun tail")
- A raised red birthmark or hemangioma over the lower back
- A fatty lump or soft tissue mass beneath the skin
- An unusual skin tag or small tail-like appendage
- A deep or atypical sacral dimple (especially if it is large, located higher on the back, off the midline, or associated with other skin findings)
- A small opening or pit that may drain fluid (dermal sinus tract)

A simple sacral dimple — one that is small, located within the crease between the buttocks, close to the anus, and not associated with any other skin changes — is common and usually does not indicate tethered cord syndrome or require imaging.

When one or more atypical skin findings are present, particularly in combination with neurological symptoms, bladder or bowel problems, foot deformities, or scoliosis, healthcare providers may recommend further evaluation with MRI or referral to a pediatric neurosurgeon.

Clinical Pearl

Most birthmarks on the lower back are benign. It is the combination of an atypical skin finding with neurological symptoms, bladder or bowel dysfunction, foot deformities, or scoliosis that increases concern for tethered cord syndrome and warrants further medical evaluation.

Pathophysiology: Why Does TCS Cause Scoliosis?

The fundamental injury mechanism in TCS involves chronic mechanical tension on the caudal spinal cord as the vertebral column grows. During childhood, the spine elongates faster than the cord ascends, placing cumulative traction on a tethered cord. This mechanical stretch produces:

- Impaired oxidative metabolism in the lumbosacral cord (reduced cytochrome oxidase activity), effectively shifting the cord toward anaerobic metabolism
- Spinal cord ischemia from vascular compromise — thought to be a major early injury mechanism contributing to metabolic dysfunction
- Apoptosis of neuroglial cells (oligodendrocytes and neurons), particularly sensitive to oxidative stress, as a secondary and potentially dominant long-term injury pathway
- Structural damage to neural perikarya and axons with prolonged or repetitive stretching

The relationship between tethering and scoliosis is thought to arise from asymmetric neural tension acting on the developing spine. Abnormal cord tension alters the neuromuscular inputs to the paraspinal musculature and disrupts normal vertebral column growth in a laterally asymmetric manner, producing a progressive lateral curve. Scoliosis may be the earliest and sometimes the only presenting manifestation of TCS — particularly in cases where the filum terminale appears normal on standard MRI.

Prevalence of the TCS–Scoliosis Relationship

Tethered cord syndrome is identified in a minority of patients undergoing evaluation for scoliosis, with reported prevalence varying considerably depending on patient age, curve characteristics, neurological findings, and the population studied. Rates are substantially higher in patients with atypical scoliosis or associated neurological abnormalities than in patients with typical adolescent idiopathic scoliosis. In specific populations:

- Among children with tight filum terminale undergoing untethering, 31% (14 of 45) had coronal spinal malalignment (scoliosis) prior to the procedure (Chern et al., 2011).
- In myelomeningocele (MMC): all patients with MMC are radiographically tethered; a significant proportion develop progressive scoliosis as a direct consequence.
- Approximately 80–90% of scoliosis is classified as idiopathic because no single underlying cause has been identified. Occult neurological conditions, including tethered cord syndrome, represent one of several important diagnoses that should be considered when atypical features are present.

Tethered cord syndrome represents an important, potentially treatable neurological cause of scoliosis that should be considered when atypical clinical features are present. This highlights the clinical necessity of screening for TCS before labeling a scoliosis as idiopathic.

Curve Characteristics: TCS vs. Adolescent Idiopathic Scoliosis

Understanding the curve pattern is essential for identifying TCS-associated scoliosis versus AIS. The following table compares key features:

Feature	TCS-Associated Scoliosis	Adolescent Idiopathic Scoliosis (AIS)
Curve direction	Often left-sided (levoscoliosis) or atypical; may be thoracolumbar	90% right-sided thoracic (dextroscoliosis) in main thoracic curves
Curve location	Frequently thoracolumbar or lumbar; may involve kyphosis component	Predominantly right thoracic; lumbar curves are typically compensatory
Age of onset	Variable; may present in infancy, childhood, or adolescence depending on etiology	Typically 10–16 years; correlates with pubertal growth spurt
Associated neurological findings	Common: bladder/bowel dysfunction, lower limb weakness, gait abnormality, foot deformity	Absent by definition; presence of neurological signs is a red flag against AIS
Skin stigmata	May have midline sacral/lumbar hair tufts, dimples, hemangiomas, subcutaneous lipomas	Absent
Curve flexibility	May be rigid due to neuromuscular contribution; or flexible in early/mild cases	Generally flexible, particularly in younger patients
Sagittal profile	Often hypokyphotic or with added kyphotic component; lordosis may be exaggerated	Typically hypokyphotic (flat back) thoracically in classic AIS
MRI findings	Low-lying conus (≤L2–L3), thickened filum (>2 mm); may be normal-appearing filum	MRI typically normal; no intraspinal pathology
Progression risk	Progressive while cord remains tethered; untethering may arrest progression in small curves	Correlated with skeletal immaturity (Risser grade, Sanders scale, triradiate cartilage)

Red flags suggesting underlying pathology (including TCS) in a scoliosis patient:

- Left-sided (atypical) main thoracic curve
- Rapid progression disproportionate to skeletal maturity
- Significant pain — scoliosis is rarely painful in AIS
- Neurological signs or symptoms (weakness, numbness, gait change, bladder/bowel dysfunction)
- Cutaneous lumbosacral stigmata
- Onset in very young children (infantile or juvenile)
- Abnormal reflexes (hyperreflexia, asymmetric reflexes, positive Babinski)
- Foot deformities (cavovarus, hammertoes)

Diagnosis and Imaging

MRI of the entire spine, with and without contrast when clinically indicated, is the imaging study of choice for evaluating suspected tethered cord syndrome and associated spinal dysraphism. Key MRI findings include:

- Conus medullaris positioned at or below L2–L3 (normal: terminates above L1–L2)
- Thickened filum terminale (>2 mm in axial cross section)
- Fatty infiltration of the filum (high T1 signal)
- Traction lesions, associated lipomas, or diastematomyelia

Critical Caveat

A normal-appearing filum terminale on standard MRI does NOT rule out tethered cord. Histopathological studies confirm that filum with normal MRI appearance is frequently not histologically normal — 97.6% of surgically resected fila in one series of 288 TCS patients contained peripheral nerves, and 41% showed fatty infiltration not visible on routine imaging. Several surgical series have demonstrated symptomatic tethered cord syndrome despite a normally positioned conus medullaris and an otherwise unremarkable appearing filum terminale on routine MRI.

MRI findings must always be interpreted in conjunction with the clinical presentation because imaging abnormalities alone do not establish the diagnosis, and normal imaging does not completely exclude symptomatic tethered cord syndrome.

Clinical Pearl

A normal MRI should not override a compelling clinical history and neurological examination. Imaging findings should always be interpreted within the broader clinical context.

Diagnosis ultimately remains a clinical diagnosis supported by imaging and ancillary testing rather than an imaging diagnosis alone.

Additional Diagnostic Tools

- Prone MRI: Assessing anteroposterior movement of the conus when switching from supine to prone is a useful adjunct. Movement of >10% of the canal width is considered normal (i.e., mobile cord). Absence of movement suggests tethering.
- Somatosensory Evoked Potentials (SSEP): Abnormal SSEPs may support surgical intervention in patients with normal MRI and urodynamic findings. SSEP is particularly valuable in differentiating idiopathic scoliosis from TCS-associated scoliosis when imaging is equivocal.
- Urodynamic studies (UDS): Neurogenic bladder dysfunction — even subclinical — supports TCS diagnosis and guides surgical timing.

- Ultrasound: Useful in neonates and young infants prior to posterior vertebral ossification; can identify abnormal cord position and movement.

Management of TCS-Associated Scoliosis: Key Differences from AIS

Scoliosis associated with tethered cord syndrome is among the most challenging spinal deformities to manage. The fundamental management difference is this: in TCS-associated scoliosis, the underlying neurological cause must be addressed before, or in conjunction with, deformity correction — unlike AIS, where deformity correction alone is the surgical goal.

Initial Management: Address the Underlying Neurological Pathology

The traditional management sequence for TCS-associated scoliosis is untethering first, followed by observation for 3–6 months, then deformity correction if required. The rationale is that untethering removes the neurological driver of curve progression, may arrest further worsening, and reduces the neurological risk of subsequent spinal distraction.

Outcomes of untethering on scoliosis (across etiologies):

- In MMC patients with curves ≤45°: untethering produced stabilization or improvement at 1 year in approximately 63–95% depending on age and lesion level.
- In tight filum terminale without other dysraphism: all 14 children with pre-existing scoliosis in one retrospective series were followed after untethering; curve stabilization was most likely in younger children with smaller curves, whereas larger curves frequently continued to progress despite untethering.
- In non-MMC TCS: McGirt et al. (2009) found that level of neurological involvement and age at untethering significantly influenced outcomes, with lumbar curves showing more favorable responses.
- Large curves (>50°) at the time of untethering rarely improve and almost always require fusion.

Staged vs. Concurrent Surgery

Traditional practice: staged untethering followed by deformity correction 3–6 months later. This interval allows neurological stabilization and helps determine whether the curve will progress.

Emerging evidence for concurrent (single stage) surgery: Several series have reported that simultaneous untethering and scoliosis correction is feasible and may reduce overall complication burden by avoiding the morbidity of a second operation (CSF leak risk, infection, excessive bleeding).

- Mehta et al. (2011, Johns Hopkins): concurrent untethering and deformity correction was comparable in safety and efficacy to staged approach in a pediatric series.
- Pediatric Spine Study Group: reduced complication rates with simultaneous detethering and spinal deformity correction in early-onset scoliosis compared to staged surgery.

However, concurrent surgery requires careful intraoperative neuromonitoring (IONM). Signal loss is possible at any phase of the combined procedure, and the surgical team must be prepared to modify the plan based on IONM changes intraoperatively.

Role of Intraoperative Neuromonitoring (IONM)

IONM is mandatory in TCS-associated scoliosis surgery regardless of approach. This differs from AIS, where IONM is standard of care but the neurological risk profile is substantially lower. In TCS:

- The cord is already under tension; deformity correction with distraction forces carries an elevated risk of cord injury
- SSEP and motor evoked potentials (MEPs) must be obtained at baseline before any positioning or instrumentation
- Signal changes during deformity correction may require immediate release of correction, a wake-up test, or abandonment of the fusion component

Is Prophylactic Untethering Always Necessary Before Fusion?

This remains a clinical controversy. Two key positions:

For prophylactic untethering: Traditional neurosurgical practice holds that tethering increases neurological risk during scoliosis correction. Untethering removes this risk and may arrest curve progression independently.

Against routine prophylactic untethering: Samdani et al. (2010) found that untethering may be unnecessary in radiographically tethered MMC patients undergoing fusion who have no clinical TCS symptoms. Untethering carries its own morbidity (wound infection, worsened bladder function, CSF leak). Increased complications without neurologic benefit have been reported in prophylactic untethering prior to scoliosis surgery in MMC.

Flexibility as a surrogate: Zhou et al. (2017) proposed that more preoperative flexibility implies adequate neural pliability, supporting curve correction without prophylactic untethering in asymptomatic TCS.

Bracing in TCS-Associated Scoliosis

Unlike AIS, where bracing is evidence-based for skeletally immature patients with curves in the 25–45° range, bracing has no established role in TCS-associated scoliosis. The neurological driver of curve progression is not affected by external orthosis. Bracing may be used temporarily for comfort or postural support while awaiting untethering but should not replace or delay surgical management. Bracing should never delay neurosurgical evaluation when tethered cord syndrome is suspected.

Exercise and Conservative Approaches

Scoliosis-specific exercises (e.g., Schroth, SEAS) are well-supported in AIS management. There is currently insufficient evidence to recommend scoliosis-specific exercise as a primary treatment for TCS-associated scoliosis. When tethered cord syndrome is suspected or confirmed, conservative management should occur in coordination with the treating neurosurgical team and should never delay appropriate surgical evaluation.

Management Comparison Summary Table

Management Aspect	AIS	TCS-Associated Scoliosis
Primary treatment goal	Halt curve progression; restore alignment	Address tethering FIRST; deformity correction second
Initial management	Cobb <25° in skeletally immature; monitor 6–12 months	Untethering recommended at diagnosis in symptomatic patients regardless of curve magnitude
Bracing	Evidence-based; recommended 25–45° in skeletally immature patients	No established role; does not address neurological driver; should never delay neurosurgical evaluation
Surgical approach	Posterior spinal fusion (PSF) standard; vertebral body tethering (VBT) emerging option	Untethering → observe → fusion if needed; or concurrent single-stage in selected cases
Neurological risk at surgery	Low with IONM; risk of iatrogenic neurological deficit very low in AIS	Elevated; cord under tension; distraction forces risky; IONM mandatory
IONM	Standard of care; primarily sentinel monitoring	Mandatory; must be prepared to abandon or modify correction based on signal changes
Exercise / PSSE	Well-supported (Schroth, SEAS); first-line conservative option	Insufficient evidence to recommend as primary treatment; untethering must be prioritized; adjunct use only
MRI requirement	Required when atypical features present; not routine in typical AIS	Required; interpret in clinical context. Normal MRI does not exclude TCS.
Multidisciplinary team	Orthopedic spine surgery; PT; psychology if needed	Neurosurgery + orthopedic spine surgery + urology + neuro-urology + PT

Key Clinical Takeaways

- Scoliosis can be the FIRST presenting sign of TCS — before neurological or urological symptoms emerge.
- Do not assume idiopathic: left-sided curves, rapid progression, pain, neurological findings, or lumbosacral cutaneous stigmata should trigger MRI and TCS workup.
- Normal MRI does NOT rule out TCS. Prone MRI, SSEP, and urodynamic studies are important adjuncts when clinical suspicion is high.
- Untethering is the primary intervention in TCS-associated scoliosis — not bracing, not fusion first.
- Smaller curves (<30–35°) in younger children appear more likely to stabilize following untethering, although progression can still occur and continued follow-up is essential.
- Large curves (>50°) rarely improve with untethering alone and require staged or concurrent fusion.
- Concurrent untethering and fusion is increasingly supported but requires expert IONM and neurosurgical collaboration.
- The neurological risk of scoliosis correction surgery is substantially higher in TCS than in AIS: distraction forces on an already-tensioned cord can cause ischemic cord injury.
- Prophylactic untethering before fusion in asymptomatic radiographically tethered MMC patients is controversial: recent evidence suggests it may not be necessary and adds surgical morbidity.

TCS Can Present as Back Pain Alone — Without Scoliosis

Scoliosis is not a required feature of TCS. In fact, the clinical picture differs substantially by age:

- In adults, back or leg pain — not scoliosis — is the dominant presenting complaint. Pain is the most common presenting symptom in adults, reported in up to 80% of published series, and is typically nondermatomal, shocklike or burning, and often refers to the anorectal region. Scoliosis and foot deformities are far less common in adults than in children with TCS.
- A documented case describes a 63-year-old man presenting with sudden severe chest and upper back pain (no scoliosis) as the initial and dominant symptom of adult TCS, followed by urinary retention — illustrating that TCS-related pain is not confined to the lumbosacral region or to patients with spinal deformity.
- In late teenagers and adults generally, back pain aggravated immediately by lumbosacral flexion (which elongates the spinal canal and stretches the tethered cord) is considered one of the most reliable clinical signs of TCS — independent of whether scoliosis is present.
- Pain in TCS is frequently exacerbated by specific positions: bending forward, prolonged sitting with crossed legs, or activities like ballet/high-kick sports that place additional flexion-extension tension on the cord.

Symptoms in adults frequently progress slowly over many years and may worsen or first become clinically apparent following trauma, pregnancy, spinal surgery, repetitive spinal loading, rapid growth, or degenerative spinal changes that increase tension on an already tethered cord.

> **Clinical Implication**
>
> *Back pain that worsens specifically with flexion, is accompanied by nondermatomal leg pain, bladder/bowel changes, or saddle-region referral — even in a patient with a straight spine — should prompt consideration of TCS, not just mechanical or discogenic causes.*

Positioning and Movement Strategies to Reduce Cord Tension and Pain

Because flexion-provoked pain is one of the most reliable clinical signs of TCS — reflecting elongation of the spinal canal and increased traction on the tethered cord — positioning and movement modification are a logical, practical extension of the mechanism described above. These strategies do not treat the underlying tether and are not a substitute for appropriate neurosurgical evaluation, but they can meaningfully reduce day-to-day mechanical strain and symptom burden and are appropriate to discuss with patients as part of a conservative or adjunctive care plan.

Rationale

Sustained lumbosacral flexion lengthens the spinal canal and increases traction on a tethered cord; sustained or repeated end-range flexion is therefore a modifiable contributor to symptom provocation. Positioning strategies aim to minimize time spent in sustained flexion, avoid abrupt or repetitive flexion-extension loading, and encourage regular postural variation, rather than prescribing a single "correct" posture.

Sitting

- Favor a supported, relatively neutral lumbar spine over a deep slump — a chair with adequate lower back support, feet flat on the floor, and hips at or slightly above knee height reduces sustained lumbar flexion.
- Avoid prolonged deep hip flexion or cross-legged sitting for extended periods, as these positions increase lumbosacral flexion and canal elongation.
- Take a brief movement break approximately every 20–30 minutes — standing, walking a short distance, or gently extending the spine — to offset cumulative flexion load from prolonged sitting.
- For desk or device use, raise screens to reduce forward head and trunk flexion rather than allowing prolonged slumped posture over a laptop or phone.

Sleeping

- Side-lying with a pillow between the knees, or back-lying (supine) with a pillow under the knees, tends to maintain a more neutral lumbar spine position overnight compared with positions that sustain flexion.
- Prolonged fetal positioning (tightly curled, hips and knees drawn to chest for extended periods) sustains lumbosacral flexion through the night and may provoke or worsen symptoms in some patients.
- Prone (stomach) sleeping with the neck rotated may create asymmetric tension through the cervical and thoracic spine and is generally less favorable for patients with flexion-provoked symptoms.
- Positional tolerance is individual; patients should be encouraged to experiment within these general principles and identify what reduces their own symptoms, in consultation with their physical therapist or care team.

Activity and Movement Considerations

- Activities involving repetitive or sustained lumbar flexion-extension (e.g., ballet, gymnastics, high-kick sports) may provoke symptoms and warrant activity modification or pacing in symptomatic patients.
- Pacing — alternating between positions and activities rather than sustaining any single posture or movement pattern for extended periods — reduces cumulative mechanical strain over the course of a day.
- Core and postural muscle support can help offset compensatory guarding that develops around a tethered cord, complementing (not replacing) positional strategies.

Clinical Pearl

Positioning and movement modification address the mechanical contribution to symptoms and can meaningfully improve day-to-day comfort, but they do not resolve the underlying tether. These strategies are best framed to patients as symptom-management tools to use alongside — never in place of — appropriate diagnostic workup and neurosurgical consultation when indicated.

Back Pain in Patients Without Scoliosis: Differential Diagnosis and Treatment

Most pediatric and adolescent back pain has nothing to do with tethered cord syndrome. This section grounds the talk in the far more common, non-TCS causes of back pain - so the audience can calibrate when TCS workup is warranted versus when conservative management is appropriate.

Epidemiology

- Low back pain in children and adolescents is common: a meta-analysis across international studies estimated substantial point, period, and lifetime prevalence rates that approach adult levels by late adolescence.
- Despite the "pediatric dogma" that back pain in children suggests serious pathology (tumor, infection), the majority of pediatric back pain is non-specific and self-limited. In a prospective study of children with back pain lasting >3 months, only 21% had a positive diagnostic finding after full workup and ≥2 years of follow-up - and of those, spondylolysis (with or without spondylolisthesis) was the most common specific diagnosis.

Red Flags Warranting Further Workup (Non-TCS Differential Included)

Per consolidated pediatric back pain red-flag criteria:

- Age younger than 10 years
- Significant trauma
- Current or prior glucocorticoid therapy
- Motor or sensory deficits
- Radicular pain
- Bladder or bowel dysfunction
- Fever or lymphadenopathy (raising concern for infection/malignancy)
- Structural deformity
- Focal compression tenderness (raising concern for spondylolysis or fracture)

Yellow flags (predicting a chronic, non-specific course rather than serious pathology): increasing age in adolescence, female sex, high sports participation load, prior pain episodes, and psychosocial factors such as low life satisfaction, anxiety, and depression.

Note the overlap with the Curve Characteristics section's red flags for TCS-associated scoliosis — bladder/bowel dysfunction, motor/sensory deficits, and structural deformity appear on both lists. The distinguishing step is imaging and neurological exam, not symptom presence alone.

Common Non-TCS Causes of Back Pain (Without Scoliosis)

- Non-specific mechanical/muscular back pain — the most common category by far; related to posture, deconditioning, or activity load rather than structural pathology.
- Spondylolysis / spondylolisthesis — the most common specific diagnosis in adolescent athletes with persistent back pain, particularly in sports involving repetitive hyperextension (gymnastics, diving, football linemen, dance).
- Disc-related pathology — comparatively rare in the pediatric population versus posterior element (bony) pathology.
- Scheuermann's kyphosis, apophysitis, and overuse injury in young athletes.
- Sacroiliac joint dysfunction — extremely common clinically and frequently confused with tethered cord syndrome on the basis of symptom overlap alone.

- Hip pathology (including femoroacetabular impingement) — another common mimic, particularly in adolescents with activity-related low back and buttock pain.

Recommended Evaluation

- Thorough history and physical exam remain the primary diagnostic tools; imaging should be guided by red flags rather than ordered reflexively.
- Clinical tests: Adams forward bending test, straight leg raise, FABER test, and assessment of lumbar flexion/extension/rotation for pain reproduction and range-of-motion limitation.
- Core stability (paraspinal and lateral abdominal muscle) assessment should be part of the standard exam, as weakness/incoordination here is common in non-specific pediatric LBP and directly informs the treatment plan.

Recommended Treatment for Non-Specific and Mechanical Back Pain (No Scoliosis, No TCS)

- First-line conservative measures: relative rest (not strict bed rest), acetaminophen or NSAIDs for symptom control, and short-term use of cold/heat and massage as adjuncts.
- Core stabilization exercise is the best-supported active treatment: specific stabilizing exercise programs have shown benefit even in patients with a radiologic diagnosis of spondylolysis/spondylolisthesis, outperforming other commonly prescribed conservative treatment programs in randomized comparison.
- Exercise therapy - with or without spinal manipulation - is supported by randomized controlled trial evidence specifically in the adolescent population (ages 12–18) with chronic or recurrent low back pain, representing the best current evidence base for conservative adolescent LBP management.
- For confirmed spondylolysis/spondylolisthesis specifically: conservative management (relative rest, structured physical therapy, and bracing in select cases) remains standard first-line practice. However, the systematic review evidence on comparative effectiveness of these nonoperative options is limited and mixed — the authors of the leading systematic review found no consensus could be reached on nonoperative versus surgical care due to limited investigation and heterogeneity of studies, with many included studies lacking blinding, control groups, and reliable measures of patient compliance. More recent evidence specifically supports early/immediate PT referral over prolonged rest: in a retrospective cohort of adolescent athletes with acute spondylolysis, earlier PT referral led to full return to activity roughly 25 days sooner than delayed referral, with no increase in adverse events.
- Psychosocial factors should be addressed concurrently, not as an afterthought — anxiety, depression, and low life satisfaction are independently associated with chronicity, and improvement in psychosocial status is considered a supportive/adjunct therapeutic target, not a substitute for physical treatment.

Physical therapy plays an important role in optimizing movement, strength, pain, and function, but it cannot eliminate pathological spinal cord tethering when present.

When to Still Suspect TCS in a Back-Pain Patient Without Scoliosis

Return to TCS in the differential when back pain:

- Is reproducibly worsened by lumbosacral flexion specifically (not just general movement)
- Is accompanied by bladder/bowel changes, saddle-region symptoms, or nondermatomal leg pain
- Persists or progresses despite appropriate conservative management
- Occurs alongside cutaneous lumbosacral stigmata, even without spinal deformity

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