

# SCIENTIFIC

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## PHYSICAL THERAPY

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### Patient with severe, intermittent left side low back pain following golf

Greg Linwick, PT, Spokane Residency

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**Chief Complaint:** Patient with severe, intermittent left side low back pain following golf

**Medical Diagnosis:** Sacralized L5

**Initial Observation:** Gait symmetric, no difficulty or demonstration of pain with postural transitions.

**History:** This 17 year old male reports back pain for as long as he can remember. He experiences intermittent episodes of acute flares after playing golf, which at times, is so bad that he has difficulty walking. He is on his high school golf team, and would like to play in college. Symptoms are pain felt across his low back, typically worse on the left in the vicinity of the sacroiliac junction. Symptoms are aggravated by his golf drive, just after his club passes his left hip. Symptoms are extremely aggravated if he tries to stop his swing at this point. His last acute flare occurred approximately two weeks ago, but has largely resolved, particularly over the past two days. He was able to practice at the driving range recently with minimal symptoms.

### **In this Issue:**

**Patient with severe, intermittent left side low back pain following golf**  
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**Function of the Rib Cage** *[continuation from last issue]*

*The role of respiration, rib mechanics and neural reflexes in coordinated movement and stability of the rib cage.*

Sam Betts, PT, MOMT, FAAOMPT

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He does do some trunk strengthening, which consists primarily of abdominal exercises. He denies a history of peripheral symptoms. He denies bowel or bladder dysfunction associated with symptoms. Lumbar x-ray shows a sacralized L5, but is otherwise unremarkable.

**Inspection:** No obvious gait asymmetry or abnormality. Postural landmarks are level in static standing. Slightly exaggerated spinal curves in side view, shoulders slightly forward.

**Functional Tests/Quick tests:** Hip hiking in standing unilaterally on the left is aggravating. Trunk rotation in standing on the left unilaterally is also aggravating. The heel drop test is negative.

**Active Motion:** Trunk flexion in standing is fingertips to ankles without affect on symptoms and with reasonable lumbar curve reversal. Spinal segments L4 through T10 appear rotated right at end range. Trunk extension in standing appears normal without symptoms. Trunk

side bending in standing appears symmetric left to right, without obvious angles or flat spots and is pain free bilaterally. Trunk rotation in standing is symmetric left to right with pain at end range of left rotation. Combined trunk motions in flexion are quite aggravating to the left, much more so than to right. Combined motions into extension are painful to the left. Hip extension and rotation is symmetric, pain free and within normal limits.

**Passive Motion:** Passive left rotation is only primary trunk motion that is painful with overpressure. Overpressure of combined motions was deferred.

**Resisted Motion:** Resisted left rotation at end range of right rotation was painful. Other motions were strong and painless through all ranges.

**Palpation:** Tenderness to palpation was evident in the vicinity of the left sacro-iliac joint. Palpation about the low back and buttock were otherwise unremarkable.

**Neurological Status:** Lower extremity myotomes were intact, symmetric left to right. DTR's at knee and ankle were intact and symmetric. Straight leg raise was negative bilaterally, as was Ely's test. Sensation was intact to sharp and light touch bilaterally.

**Special Tests:** Thomas, Faber, hip scour, Ober's tests were all negative for symptom provocation. Tests for Maigne's syndrome (skin rolling, thoraco-lumbar provocation, palpation of iliac crest) were negative. Spinal compression and distraction were also negative.

**Specific Mobility Testing:** Grade 2 hypomobility was found in flexion at L2-3, from T12-L2 in extension and in left rotation at L2-3. Other segments appeared normal at Grade 3. Shear testing was negative. Testing to determine coupling of lumbar motion revealed side bending opposite to rotation in flexion and equal in extension.

**Treatment to Date:**

Day 1: Trunk rotation in standing using door pulley,



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with right rotation only, dosed at 3 sets of 30 repetitions at 60% 1 RM (3 lbs.). He was also instructed in the same for his home program.

Day 2: Patient reported feeling better, but still not functioning at level he was prior to recent acute episode. Soft tissue massage to the lumbar paraspinal muscles was given. Articulation to L2-3 was given, resulting in grade 3-mobility afterward. Left trunk rotation exercise was added to his home program, now at 2 sets of 25 reps bilaterally in standing. The patient was able to perform

rotations in semi flexion in standing without complaint, and was recommended to do this for his home program after three more days of performing rotation upright.

Day 3: The patient golfed 9 holes with some increase in symptoms afterward. He went to the driving range the next day and was quite flared up after that, having difficulty walking. However, he reports that this was not as bad as his previous flare-up. He returned to performing his pulley exercise upright. His left rotation range in stance was 80% of that on

on the right with pain at end range. Treatment of soft tissue massage was administered, along with posterior-anterior articulation to L3-4 in beginning range. Left rotation increased to 95% of right with less pain at end range. Treatment concluded with ice and interferential current therapy.

Day 4: The patient reported feeling better. He has not golfed much lately but has been compliant with his home exercise program. Pulley exercises in left rotation in upright stance were added at 60% 1 RM in maximal available range. He reported some

discomfort at end range, so the right foot was placed just forward enough to extinguish symptoms (i.e., low lumbar vertebrae protected by creating relative right rotation from below). The patient was instructed to gradually self progress by reducing foot stagger. Trunk rotation was added, standing left unilaterally, to his home exercise program, in the available pain-free range, increasing excursion as tolerated. Upper lumbar extension with lower lumbar spine braced inflexion over back of chair was also added to his home program. The patient also said he knew of techniques to incorporate more upper-trunk and less lower-trunk effort in his golf drive, which was encouraged.

Day 5: The patient had been golfing for 18 holes two days prior without complaint and shot very well. However, he has not been golfing daily, as is his usual training routine. I added standing left rotation with 20 lb bar on his shoulders to his home exercise program, 2 sets of 15 with 1 minute rest and the right foot forward as required to eliminate symptoms and to progress

by reducing stagger of his feet. Treatment of massage to lumbar paraspinals was administered prefacing articulation to L2-3 without notable change in mobility (remained grade 2).

Telephone follow-up one month later revealed that the patient had been golfing regularly with minimal complaint.

**Impression:** Atypical lumbar-coupled motion creates facet trauma at end range of follow-through with driver, which involves extension-right side bending-left rotation. Coupled motion for this patient is extension-left side bending-left rotation. Limited upper lumbar extension and limited left rotation at L2-3 puts excessive stress on L3-4 during swing.

**Literature search "sacralization":** Articles found on Medline can be broadly categorized as those relating sacralization to the occurrence of low back pain; and those relating the presence of sacralization to the occurrence of spondylolisthesis. Bonaiuti, et

al 1997 (1) conducted a literature search, which identified studies exploring the relationship of transitional vertebrae to low back pain and degenerative joint disease. Four studies found no relationship to low back pain; two found a correlation. I found no greater predisposition to disc degeneration in a sample of 20-year-old subjects with transitional vertebrae. Hald, et al 1997 (2) summarized radiographic findings of 10,922 asymptomatic applicants to the German Air Force: 4.9% were sacralized. Leboeuf, et al 1989 (3) reported no greater incidence of low back pain in individuals with sacralization examining 530 radiographs. Szot, et al 1985 (4) found low back pain unrelated to radiographic lumbar changes in elite gymnasts followed over a four-year period. Magora and Schwartz 1978 (5) found no relation between low back pain and sacralization. They did note, however, that low back pain patients with sacralization tended to experience more severe symptoms than those low back pain patients without sacralization.

Studies exploring the relationship between sacralization and spondylolisthesis include Kin and Suk 1997 (6). They compared radiographs of 21 sacralized and 12 lumbarized cases with 149 controls. Sacralized cases with isthmic defects at L4-5, showed greater anterior slippage than lumbarized cases with defects; both cases showed greater slippage than controls. Sacralized cases with defects at L5-S1 showed less slippage than lumbarized; and both showed less slippage than controls. Cinotti 1997 (7) compared flexion and extension stress x-rays between 27 cases of spondylolisthesis, and 27 cases without spondylolisthesis. Facet joint orientation (more sagittal), and movement at the affected level, was the only significant factors associated with the presence of spondylolisthesis. Sacralization, lumbar-sacral angle and intercrestal line were not significant.

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## Function of the rib cage

### *The role of respiration, rib mechanics and neural reflexes in coordinated movement and stability of the rib cage*

Sam Betts, PT, FAAOMPT

*[continuation from last issue]*

#### *Movements of the first rib*

The first rib is postulated to behave differently from other costal cartilages due to its stiffness and its connection to the sternum as a primarily cartilaginous, not synovial joint. Saumarez showed that the first ring behaves like a rigid body, rigidly attached to the manubrium. Therefore, the entire ring must rotate around the manubriosternal joint with translation at the costovertebral joint, to allow it to move at all. If, as the sternum rises, the manubriosternal joint rotates its superior surface posteriorly and the first thoracic vertebra extends relative to the second, the first rib can move as a rigid body. (This would mean that extension motion of T1 would be crucial for normal mobility of the first ring?) Mobility of the manubriosternal joint in the anterior-posterior direction allows for greater motion at the first rib without the first

thoracic vertebra having to extend. As the first rib rotates about the manubriosternal joint the costotransverse surface of the rib rises up the articular surface of the transverse process of T1 while the relative motion of the costovertebral joint is in the postero-superior direction.

#### *Interaction of the spine and ribs*

The ribs are all of different lengths and, as they rise, their tips will bear changing relationships to each other. This would cause misfit at the costosternal joints and, if they were perfect ball and socket joints, they would jam. The misfit could be overcome either by some 'play' at the chondrosternal joints allowing the misfit, or, the spine could flex or extend allowing the tip of each costal cartilage to move relative to one another. This raises the question of how the spine and rib cage interact with each other.

Saumarez [Saumarez, 1986] calculated the magnitude of misfit at the chondrosternal joints anteriorly for systematic elevations of the sternum and movements of the spine, to see if there is a path of "minimum misfit" at the chondrosternal joints with spine motion. He found that there is a path of minimum misfit in which there is progressive extension of the thoracic spine as the sternum elevates. Each vertebrae rotates at slightly different angles, the magnitude of such allows the costal cartilages to fit the chondrosternal joints perfectly. This implies that there is a large degree of interdependence between the movement of the spine and rib cage, but large degrees of misfit will occur in certain cases, e.g. full inspiration on a fully flexed spine. It is not known how the exact path of minimal misfit is induced from supraspinal activation of intercostal muscle length tension mechanisms.

Each rib is assumed to be supported by two reactions at the costovertebral joint, from the two proximal facets of the joint, of unknown magnitude, at right angles to the two joint facets. At the costotransverse joint, there are minimal stabilizing forces from the joint itself. Most forces occur in the form of shearing, rather than the component at right angles to the joint, as in the costovertebral joint. The rib tends to slide across the relatively flat surface of the costotransverse joint. These forces must be taken up by friction at the joint (which is unlikely due to its synovial nature) or externally. The lateral muscles in the deepest layer of the erector spinae (ilio-costalis thoracis, cervicis and lumborum) form a strip of muscle that runs from rib to rib, inserting into their posterior borders, just lateral to the rib angles. These muscles are ideally suited to reduce shear forces and stabilize the joint.[Saumarez, 1986 ] Because the muscle attachments that pull upward and downward act at a similar distance from the costovertebral joint, they may apply forces that effectively equal zero ( they “cancel each other out”)

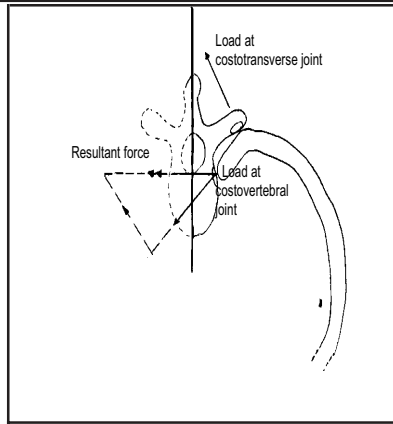


fig 3: Diagrams showing the resultant force of joint reaction forces at the costotransverse and costovertebral joints.

Upper right shows how a load producing a shear force across the intervertebral joint is resolved into an axial compression moment and a component normal to facets of intervertebral articulation.  
figure 3a

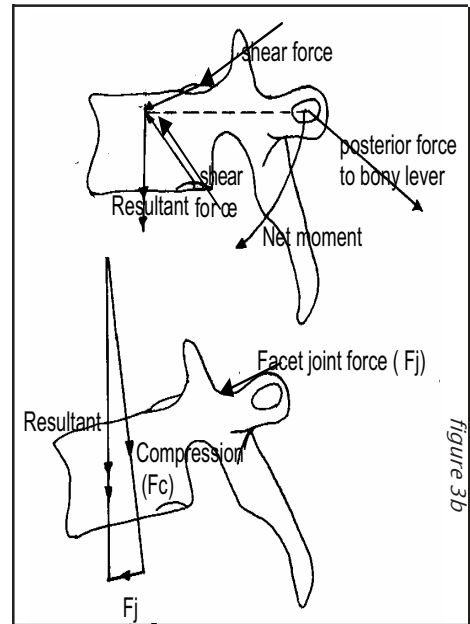


figure 3b

In addition, each rib is stabilized by the action of the erector spinae and the sheets of intercostal fibers above and below it, except for the first rib, which is supported by the scalenes.[Saumarez, 1986] Reaction at the costal cartilages assumed to be a compression effect along the ribs long axes. It is also assumed to be under a fairly constant load, which may vary with rib muscle action or pneumatic loads.

Figure 3a above shows a superior view of a thoracic vertebra. It is loaded on each side by two ribs, articulating with it at three points. The upper rib associated with the vertebral body loads it at the superior costovertebral facet and the inferior rib loads it at

the inferior costovertebral facet. The directions of these loads are such that the resultant forces applied to the vertebra are mainly resolved in compression down the spine axially. In Fig 3b it shows that the resultant force in the A-P direction is zero, eliminating shear forces between vertebrae. Saumarez points out that shearing may occur as forces at the costovertebral and costotransverse joints may not always be equal.

Figure 4 (on page 10) shows the direction of forces applied to the spine by an inspiratory pneumatic load. It shows that although the forces applied to the spine mainly result in compression, there is an anterior bending motion exerting shear force anteriorly to

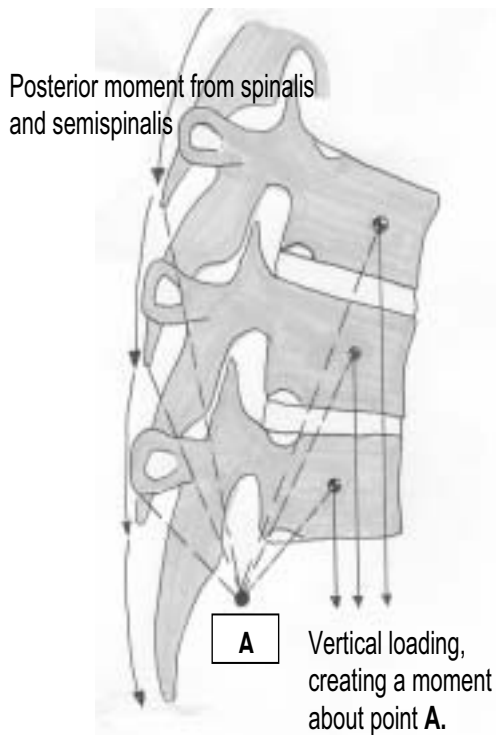


Fig 4:  
Diagram showing how individual loads are transmitted down the thoracic spine. Loads placed on the spine create a moment about a point A, whereas actions of spinalis and semispinalis create an opposite moment about point A.

the vertebral body.

The author has chosen point "A" as an arbitrary point of equilibrium where anterior bending forces ( or sagittal rotation) can meet posterior extensor forces exerted by the spinal musculature to rotate or stabilize the spine about that point. It would seem that the author's depiction of this point is an abstract point chosen to resolve moments of force. Interestingly however, this location is near the apex of the thoracic kyphosis, so one would imagine is a critical point in resolution of net anterior and posterior loading. The deep medial muscles of the erector spinae ( spinalis cervicis, thoracis and the semispinalis groups)

are theorized to provide extension moments to the spine. The author makes no mention of other muscles that could assist, such as multifidus, levator costae, latissimus, and serratus posterior inferior.

The resultant forces applied to the sternum by the costal cartilages and pneumatic loading are assumed to be taken up by the sternocleidomastoid muscles and the slips of rectus abdominus inserting into the xiphisternum.

Previous discussions of intercostal muscle activities define muscle action during quiet breathing and larger inspiratory loads. An analysis of intercostal loading under varying inspiratory loads by Saumarez shows that tension

of the intercostals acts to minimize stress to ribs to protect them at peak loads. He found that intercostal muscles were proportionally thicker in areas under greater stress and tension. He found that under peak loads, both the internal and external intercostal sheets are active and predicts that their concerted action stabilizes the rib cage. The moments exerted by both the internal and external intercostal fibers exerts a moment on the rib that moves it around an axis that is appropriate for its normal movements, but oppose each other in all other directions, thus stabilizing the costotransverse and costovertebral joints. In one space the intercostals lower the superior rib, but the intercostals in the space above raise that rib and in turn lower the rib above it and so on. This means that the intercostal mechanisms must be considered as a whole, in which the fibers are controlled to change length as to produce a particular rib cage configuration and to produce forces that stabilize it in that configuration. From previous discussion, the control is thought to occur supraspinally, with some interac-

tion via local reflexive pathways from the diaphragm, intercostal muscles and costovertebral and costotransverse joints.

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