

## ***FUNCTIONAL ANATOMY OF THE LUMBAR SPINE AND SACROILIAC JOINT***

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### ***SUMMARY***

The anatomy of the lumbar spine, pelvis and hip region will be detailed. In addition to describing the muscle fascia networks of the trunk and their role in movement and stability of the spine and pelvis, the central core of the spine, namely the vertebral elements, intervertebral discs, and content of the spinal canal will be discussed. With an in-depth understanding of the three dimensional anatomy of the lumbopelvic region, the anatomical basis of syndromes related to the low back can then be discussed, and implications for the important roles that muscular system plays in the management of patients with low back pain better understood.

### ***OBJECTIVES***

(1) Gain an appreciation of the three dimensional anatomical relationships of the lumbar spine, pelvis, and hips, (2) understand the role that the fascia lata, abdominal, and thoracolumbar fascial networks play in stability and motion of the lumbopelvic region, (3) understand the spatial relationships of the contents of the spinal canal and lumbopelvic articulations and the relationship between clinical syndromes and changes in these relationships.

### ***GENERAL OUTLINE***

Muscles associated with the thoracolumbar fascia system with implications for exercise

Articulations of the lumbopelvic region and contents of the spinal canal with implications for low back pain syndromes

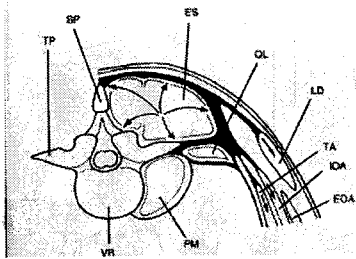
Muscles associated with the fascia lata system with implications for exercise

The abdominal mechanism with implications for exercise

## Muscles Associated with the Thoracolumbar Fascia System

### Thoracolumbar Fascia Attachments:

Bone: Transverse and spinous processes, iliac crest



Muscles attached to thoracolumbar fascia: Latissimus Dorsi, Internal Abdominal Oblique, Transversus Abdominus, Gluteus Maximus



Muscles encased within the thoracolumbar fascia

- a. Superficial Erector Spinae
- b. Deep Erector Spinae
- c. Multifidus

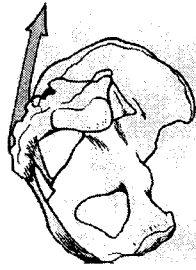
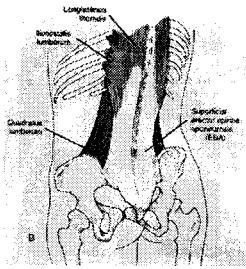
### Superficial Erector Spinae Muscle Attachments

1. Erector Spinae Aponeurosis (ESA)
2. Ribs

### Functional Implications

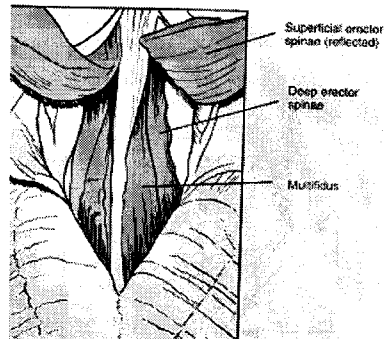
1. Extensive connective tissue of ESA and lack of actual "muscle belly" of this muscle over dorsal surface of the sacrum and lower lumbar spine

2. **Secondarily acts over lumbar spine via thorax attachment, locking mechanism of sacroiliac jt.**



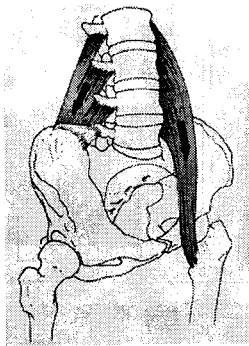
### Deep Erector Spinae Attachments

1. **Iliac crest superior and lateral to posterior superior iliac spine (PSIS)**
2. **Courses superiorly and anteriorly to reach lumbar transverse processes**



### Functional Implications

1. **Only muscle belly lateral to the PSIS**
2. **Aligned to exert dynamic posterior shear force to lumbar vertebrae - guy wires in the sagittal plane**



### Multifidus Attachments

1. Dorsal surface of sacrum, iliac crest medial to PSIS
2. Mammillary processes of superior facet, facet joint capsule
3. Spinous processes



### Functional Implications

1. Only muscle belly medial to PSIS
2. Optimal lever arm for lumbar extension (posterior sagittal rotation of lumbar vertebrae)
3. Multifidus muscle changes in chronic low back pain
  - a. Structure and morphometry
    1. Selective type II fiber atrophy
    2. Internal structural changes in type I fibers
    3. Increased adipose tissue within muscle
  - b. Potential causes
    1. Disuse atrophy - inactivity
    2. Axonal injury - neuropraxia

### Quadratus Lumborum and Iliolumbar ligament

Course of quadratus lumborum to lumbar transverse processes identical to path of deep erector spinae muscle

Absence of quadratus lumborum at L5-S1 level and occasionally L4-L5 level and iliolumbar ligament found in its place (metaplasia) Iliolumbar ligament - strong restraint to anterior shear occurring as a result of lumbar lordosis.



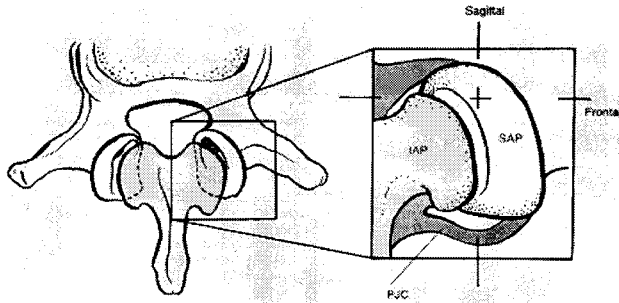
From Frymoyer, *Adult Spine*, Raven Press 1991, with permission

### ***THE APOPHYSEAL JOINTS OF THE LUMBAR SPINE***

The apophyseal joints are the only synovial joints of the lumbar spine. They are formed by the articulation between the superior articulating process (1) of the subjacent vertebrae, and the inferior articulating process (2) of the cranially adjacent vertebrae.

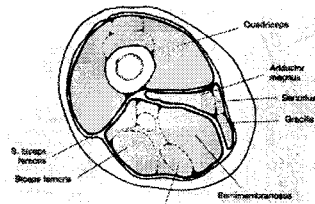
The apophyseal joints have a joint capsule that is fairly thin and redundant posteriorly, but is very thick anteriorly. In reality, the anterior aspect of the apophyseal joint capsule is the ligamentum flavum, which is the reason that it is so thick. When one views a horizontal section of a lumbar vertebral segment, it is easy to see that the inferior articulating process (2) "rides" on the posterior aspect of the ligamentum flavum. Often times in degenerative conditions, the posterior aspect of the ligamentum flavum has fibrocartilage imbedded in the ligament probably in response to the loads placed upon it by the inferior articulating process.

The spatial relationship of the facets in the lumbar spine is important to note. The inferior articulating process is relatively convex and sits medial to the relatively concave superior articulating facet. The joints are primarily oriented in the sagittal plane, which suggests that the motion that the lumbar spine is most "geared" toward is sagittal plane motion, i.e. flexion and extension. Note for example that the range of total flexion and extension at the lumbosacral joint is 25 degrees, and the total range of flexion and extension at L4-L5 is 20 degrees. Compare this segmental flexion and extension with rotation capabilities. Each segment has about 2 - 3 degrees of movement in rotation to one side. Note that with rotation, compressive loading between two facets occurs on one side while distraction of the two facets occurs on the opposite side. Furthermore, when a rotary force is "continued" despite compressive loading of the facets, the axis of motion for lumbar rotation is shifted to the center of the joints resulting in a strong shear of the lumbar spine at the bone-disc interface.



A convex - concave surface can be broken down to component planes, in this case a frontal and sagittal plane. The sagittal plane of the joint is a check to rotary forces of the lumbar spine, and the frontal plane is a check to anterior shear of the superior vertebrae on its subjacent partner.

The degenerative process seen in facets of the lumbar spine suggests the importance of recognizing the effects of anterior shear stress to the lumbar spine. The frontal plane aspect of the joint degenerates from compressive forces. This compressive force is largely a result of unchecked anterior shear - a loss of the cyclic compression and decompression that is necessary to maintain cartilage health. The sagittal plane aspect of the joint shows degeneration from friction between the two surfaces (interfacial wear), which results in templates of cartilage (like bacon strips) peeling away from the facet surfaces. This is often given as one reason for the success of a mobilization or manipulation of the facet joints, which "frees" the template of cartilage from its trapped position between the joint surfaces.

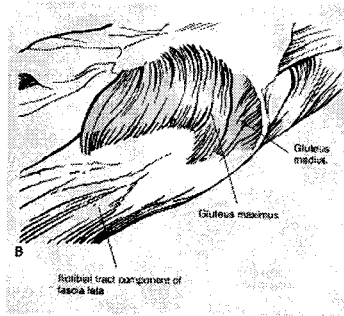


**FASCIA LATA SYSTEM**

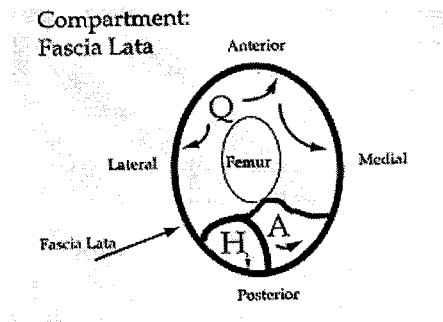
The fascia lata is the fascial system that "envelopes the muscles of the thigh, with the quadriceps taking up a great portion of this compartment.

Note that the lateral aspect of the fascia lata is much thicker than the medial aspect of the fascia lata. The thicker lateral aspect of the fascia lata is referred to as the iliotibial tract, which serves as the major point of attachment for the gluteus maximus muscle. The

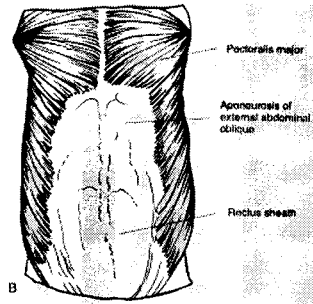
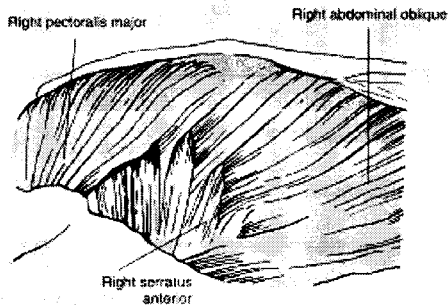
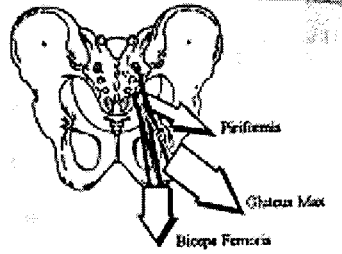
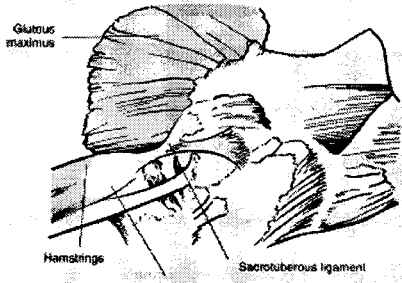
gluteus maximus thus mechanically links the thoracolumbar fascia and the fascia lata systems.



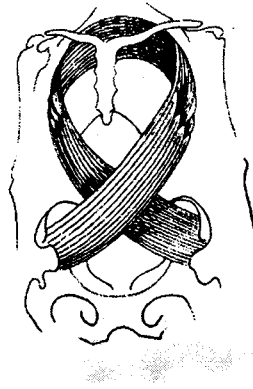
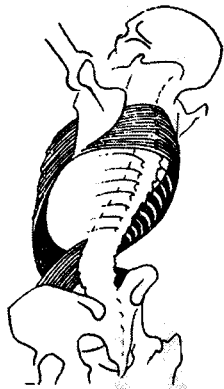
Muscles encased within the fascia lata include the quadriceps, adductor group, and the hamstrings.



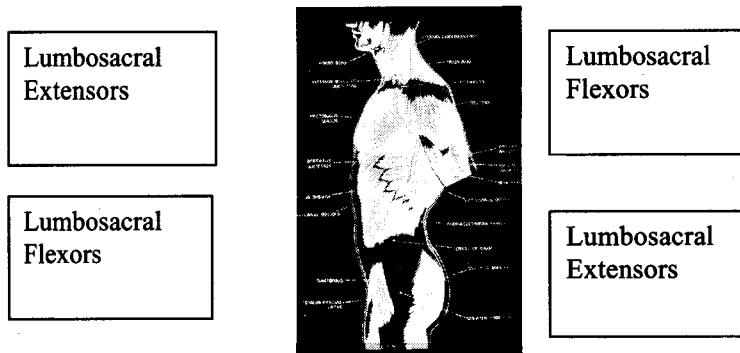
Note also the relationship that the hamstring muscles have to the sacrotuberous and sacrospinous ligamentous complex. Increased tension to the sacrotuberous and sacrospinous ligaments contributes to stability over the sacroiliac joint.



Mechanical linkage of the serratus anterior, pectoralis major, to the abdominal fascia system should then be considered in relationship to the shoulder girdle and pelvis and potential role that the muscles of the shoulder girdle, abdominal mechanism, spinal extensors, and lower extremity musculature contribute to lumbopelvic stability.



From Porterfield, DeRosa: Mechanical Shoulder Pain: Perspectives in Functional Anatomy, In Press



All pictures from Porterfield JA, DeRosa C.: Mechanical Low Back Pain: Perspectives in Functional Anatomy.

W.B. Saunders, Philadelphia, 1998, ISBN 0-7216-6837-2. Materials may not be duplicated without permission.

### REFERENCES

1. Bednar DA, Orr FW, Simon GT: Observations on the pathomorphology of the thoracolumbar fascia in chronic mechanical back pain. *Spine* 20:1161-1164, 1995.
2. Bogduk N, Macintosh JE: The applied anatomy of the thoracolumbar fascia. *Spine* 9:164, 1984.
3. Dolan P, Mannion AF, Adams MA: Passive tissues help the back muscles to generate extensor moments during lifting. *J Biomech* 27:1077-1085, 1994.
4. Macintosh J, Bogduk N: The biomechanics of the lumbar multifidus. *Clin Biomech* 1:205-213, 1986.
5. Rantanen J, Hurme M, Falck B et al: The lumbar multifidus muscle five years after surgery for a lumbar intervertebral disc herniation. *Spine* 18:568-574, 1993.
6. van Wingerden JP, Vleeming A, Snijders CJ, Stoeckart R: A functional-anatomical approach to the spine-pelvis mechanism: interaction between the biceps femoris muscle and the sacrotuberous ligament. *Eur Spine J* 2:140-144, 1993.
7. Vleeming A, Pool-Goudzwaard AL, Stoeckart R, van Wingerden JP, Snider CJ: The posterior layer of the thoracolumbar fascia: its function in load transfer from spine to legs. *Spine* 20:753-758, 1995.
8. Vleeming A, Stoeckart R, Snijders CJ, Stoeckart R, Stijnen T: Load application to the sacrotuberous ligament: influences on sacroiliac joint mechanics. *Clin Biomech* 4:204-209, 1989b.
9. Vleeming A, Stoeckart R, Snijders CJ: The sacrotuberous ligament: a conceptual approach to its dynamic role in stabilizing the sacroiliac joint. *Clin Biomech* 4:201-203, 1989a.
10. DeRosa C, Porterfield JA: A physical therapy model for the treatment of low back pain. *Physical Therapy* 72:261-269, 1992.
11. DeRosa C: Physical Therapy in the Management of Mechanical Spinal Disorders. *J of Musculoskeletal Medicine*, 60-69, July 1994.

12. Hides JA, Stokes MJ, Saide M, Jull GA, Cooper DH: Evidence of lumbar multifidus muscle wasting ipsilateral to symptoms in patients with acute/subacute low back pain. *Spine* 19:165-172, 1994.
13. Porterfield JA, DeRosa C: *Mechanical Low Back Pain: Perspectives in Functional Anatomy*. W.B. Saunders, Philadelphia, 1998.