

Biomechanical Basis of Lumbar Pain

Prepared by S. Pollak

Introduction:

The lumbar area of the back is made up of five movable L1-L5 vertebrae which have intervertebral discs in between them¹. The intervertebral discs provide segmental stability of the spine and are the major load bearing structures of the spine. Additionally, these discs protect the spinal cord and prevent the vertebrae from rubbing against one another. Stability of the spine is also aided by ligaments, and facet joints known as zygapophysial joints². Ligaments help with resisting flexion rotation and posterior shear while the facet joints are responsible for preventing large extension rotation and anterior displacement³. Directly underneath each vertebral body is a neural foramen through which nerves from the spinal cord pass to innervate various muscles with sensation and motor information¹.

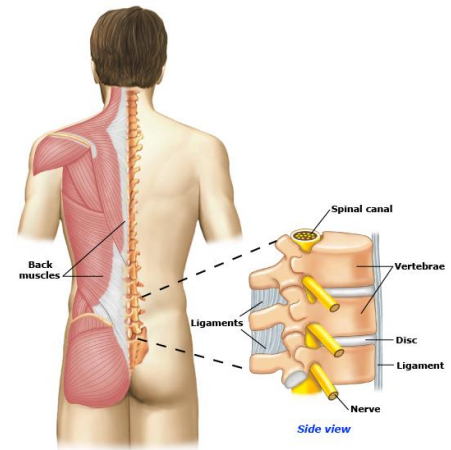


Figure 1: Anatomy of Back
Reference: www.uptodate.com

Lumbar pain is highly prevalent and affects up to eighty percent of individuals at some point in their lives. In general any of the structures mentioned above could be a source of pain⁵. However, even though back pain could arise from any of the ligaments, muscles, fasciae, joints or discs of the lumbar spine the majority of pain comes from benign musculoskeletal problems. These benign musculoskeletal problems are known as non-specific low back pain and can be due to muscle/soft tissues sprain or strain. Almost all instances of back pain fall within this category⁵.

Risk Factors:

Various risk factors predispose individuals to lumbar pain. These include genetic factors such as weak tissues, disc degeneration, and osteoarthritis of facet joints. Twin studies by Battie and Videman, 2006 showed that genetic factors are associated with development of degenerative changes on imaging further supporting that genetic factors play a role⁶. Individual factors are also important in risk stratification for patients with low back pain. Patients who are obese, female and older in age are at an increased risk. Also height has shown to matter, with taller people being at an increased risk. Psychosocial factors also can play a role such as depression, anxiety and somatization. Somatization is the belief there is a problem with no underlying organic cause detected.

Environment and physical factors such as occupation and daily physical activity are also important

risk factors. A population-based, prospective study in England found that jobs involving lifting, pulling, or pushing objects of at least 25 pounds, and jobs involving psychosocial strain and prolonged periods of standing or walking, were associated with a higher incidence of low back pain, especially among women⁴. Also, studies have shown that incidence of lumbar pain is elevated in individuals with low socioeconomic status and low educational attainment⁵. Lastly, smoking has shown to accelerate the onset of low back pain by interfering with delivery of nutrients to the central part of the intervertebral discs and therefore increasing the risk of disc degeneration and disc herniation.

Etiology of Lumbar Pain:

Benign Musculoskeletal problems: This includes ligament sprain, muscle spasm, and muscle strain. These are usually have no specific test for diagnosis and will be tender on palpation.

Disogenic pain: This is pain that arises from degenerative disc disease. The degeneration is from wear and tear, breakdown of the spinal discs, where there is small cracks and tears and possible loss of fluid in the discs⁷. Disogenic pain can also arise from a herniated disc. Too much wear and tear can lead to the outer covering of the disk being weakened and the soft inner tissue protrudes out. A herniated disc can pinch a nerve root and cause leg pain or weakness. A bulging disc protrudes less than a herniated disc. It is more common than a herniated disc and is seen in half of people who have no back pain.

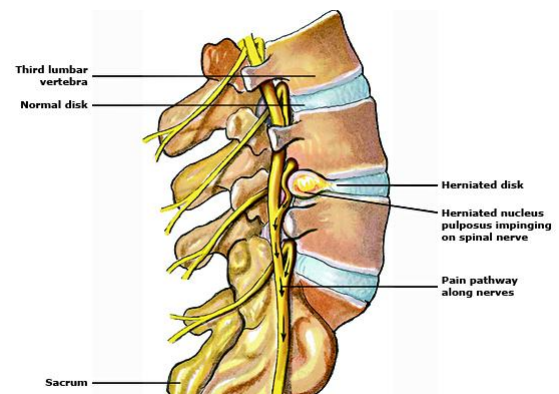


Figure 2: Herniation and Pain in Disk Injury
Reference: www.uptodate.com

Facet joint arthropathy: Arthritis in the zygapophysial joints connecting the vertebrae to one another. This can lead to bone spurs around the joint and may cause low back pain. Facet joint arthropathy is very common with aging.

Spondylolisthesis: One of the vertebrae of the lower spine slips forward in relation to another. This is usually caused by stress on the joints of the lower back and may be associated with facet joint arthropathy.

Lumbar spinal stenosis: Spinal stenosis is a condition in which the vertebral canal is narrowed. This is often caused by inflammation due to one or more damaged discs, and is common in older patients.

Sacroiliac joint pain: Twenty percent of patients with chronic low back pain below L5-S1 are suffering from sacroiliac joint pain. The most likely pathology of the SJP is sprain or rupture of the anterior sacroiliac ligament, and the possible causes for that are classified into four groups (traumatic, mechanical, hormonal, and inflammatory):

Traumatic: Activities that involve twisting, bending, or heavy lifting (for example, swinging a golf club or shoveling).

Hormonal changes: Menstruation, pregnancy (common), lactation (breastfeeding).

Inflammatory joint disease: Ankylosing Spondylitis (most common), reiter's reactive arthritis, psoriatic arthritis.

Symptoms:

Radiculopathy: Occurs when nerve root is irritated by a protruding disc or arthritis of the spine. The patient will experience radiating pain, numbness, tingling, or muscle weakness in the specific areas related to the affected nerve root, usually the lower leg. Most people with these conditions improve with limited or no treatment.

Sciatica: Sciatica refers to the most common symptom of radiculopathy. It is a sharp or burning pain that extends down the back or side of the thigh to the foot. There may also be numbness or tingling. If a disc is herniated, sciatic pain often increases with coughing, sneezing, or bearing down⁸.

Neurogenic claudication: Pain that runs down the back to the buttocks, thighs, and lower legs involving both sides of the body. The patient may have limping and weakness in the legs. Pain usually gets worse when extending the lower spine (eg, when standing or walking), and gets better when flexing the spine by sitting, stooping, or leaning forward⁸.

Diagnosis:

To diagnose lumbar pain, one must combine the patient's history and physical examination. Also it is important to get diagnostic studies. The following diagnostic studies are important in evaluating lumbar back pain:

X-Rays: If clinical improvement has not occurred after four to six weeks, plain A-P and lateral x-rays of the lumbosacral spine may be useful (two views total). The goal of radiography is to rule out tumor, infection, instability, spondyloarthropathy, and spondylolisthesis.

CT and MRI scanning — Computed tomography (CT) and magnetic resonance imaging (MRI) are more sensitive than plain radiographs for detecting infection and cancer, and can show herniated discs and spinal stenosis. MRI is most helpful in diagnostic herniated disks⁷.

Early or frequent use of scanning is not recommended for most patients. CT or MRI is indicated for progressive neurologic deficits, high suspicion of cancer or infection, and should be considered for those with more than 12 weeks of persistent low back pain. When available, MRI is preferred over CT scan for better visualization of soft tissue and absence of radiation exposure⁷.

Prevention and Management:

Primary Prevention:

- Physical Exercise (most important).
- Information and Education (second most important).
- Biomechanics of back pain, lifting should always be done with the knees bent and the abdominal muscles tightened to avoid straining the weaker muscles in the lower back.
- Lumbar support: lifting belt, mattresses (harder mattress is generally better for alignment), chairs (sitting posture, quality of chairs), and correction of leg length discrepancy.
- Modify lifestyle risk factors: obesity/overweight, smoking and alcohol consumption cessation.



Secondary and Tertiary Prevention:

- Remaining active: prolonged bed rest is not recommended. Studies have shown that people with low back pain recover faster when they remain active. Movement helps to relieve muscle spasms and prevents loss of muscle strength. Back exercises or stretching routines should not be used immediately after a new episode of low back pain because this could worsen or prolong pain. However, as symptoms begin to resolve, a program of exercises can help to increase back flexibility and strengthen the muscles that support the back
- Heat: Using a heating pad can help with low back pain during the first few weeks. It is not clear if cold packs help as well.
- Work: Most experts recommend that people with low back pain continue to work so long as it is possible to avoid prolonged standing or sitting, heavy lifting, and twisting.
- Pain medications: Take a pain medication such as aspirin, acetaminophen or ibuprofen.
- Physical therapy: If back pain has been present for more than 4 to 6 weeks a physical therapist may directly supervise exercise sessions, or can teach the person to perform the exercise program at home.

- Manipulation: Manipulation involves moving a joint (spinal column) beyond the normal range of voluntary movement.
- Acupuncture: Acupuncture involves inserting very fine needles into specific points, based on traditional Chinese maps of the body's flow of energy.
- Massage and yoga: The benefit of massage or yoga was found to be greatest in people with chronic back pain who expected to improve with one of these treatment.
- Spinal Decompression and Traction: Putting the joints of the spine under traction (use of weights to realign or pull the spinal column into alignment) to create negative pressure, allowing nutrients and blood to enter and relieve pain and symptoms.
 - Indications: Herniated or bulging disc, disc degeneration, sciatica - any type of radicular back or leg pain.
 - Facet Syndrome - Degeneration or arthritis in the joint between two vertebrae.
 - Foraminal Stenosis - Narrowing of the passageway spinal nerves pass through.
 - Central Stenosis - Narrowing of the channel the spinal cord passes through.

References:

1. Hay MC. Anatomy of the lumbar spine. *Med J Aust* 1976; 1:874.
2. Panjabi MM, Goe1 V, Oxland T, et al. Human lumbar vertebrae. Quantitative three-dimensional anatomy. *Spine* 1992;17:299 –306.
3. Sharma M, Langrana NA, Rodriguez J. Role of ligaments and facets in lumbar spinal stability. *Spine* 1995;20(8):887–900.
4. Macfarlane GJ, Thomas E, Papageorgiou AC, et al. Employment and physical work activities as predictors of future low back pain. *Spine (Phila Pa 1976)* 1997; 22:1143.
5. Deyo RA, Mirza SK, Martin BI. Back pain prevalence and visit rates: estimates from U.S. national surveys, 2002. *Spine (Phila Pa 1976)* 2006; 31:2724
6. Battié MC, Videman T. Lumbar disc degeneration: epidemiology and genetics. *J Bone Joint Surg Am* 2006; 88 Suppl 2:3.
7. Chou R, Qaseem A, Snow V, et al. Diagnosis and treatment of low back pain: a joint clinical practice guideline from the American College of Physicians and the American Pain Society. *Ann Intern Med* 2007; 147:478.
8. McCombe PF, Fairbank JC, Cockersole BC, Pynsent PB. 1989 Volvo Award in clinical sciences. Reproducibility of physical signs in low-back pain. *Spine (Phila Pa 1976)* 1989; 14:908.