Low Back Pain: Pathophysiology, Diagnosis, and Therapeutic Considerations

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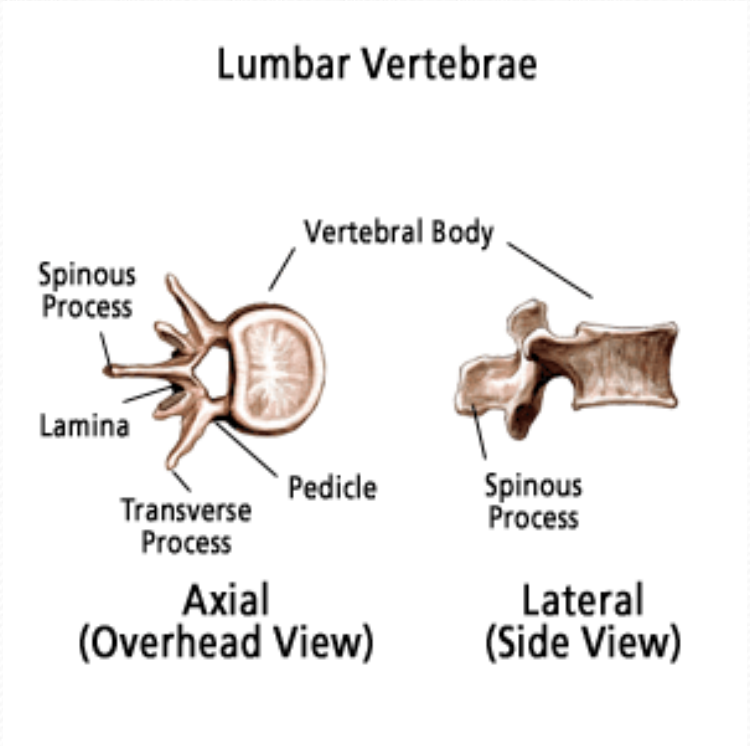
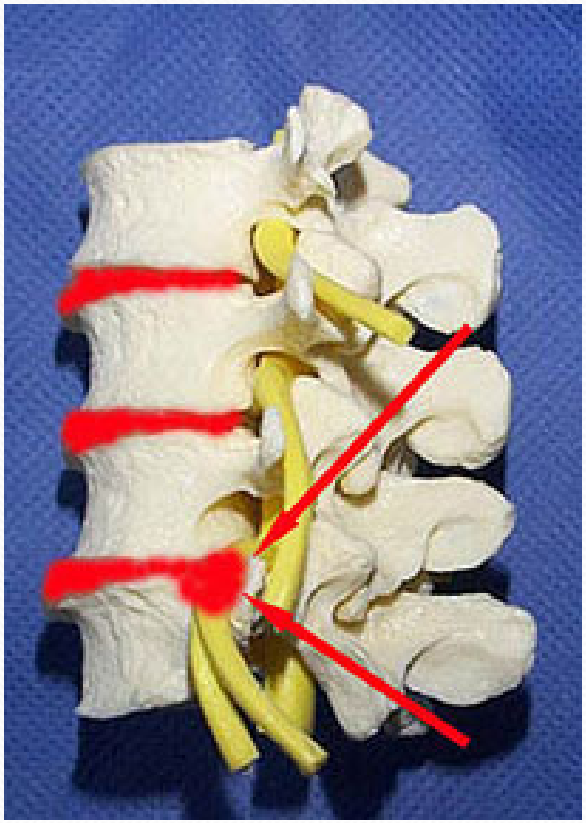
Symptoms of Low Back Pain: Epidemiology

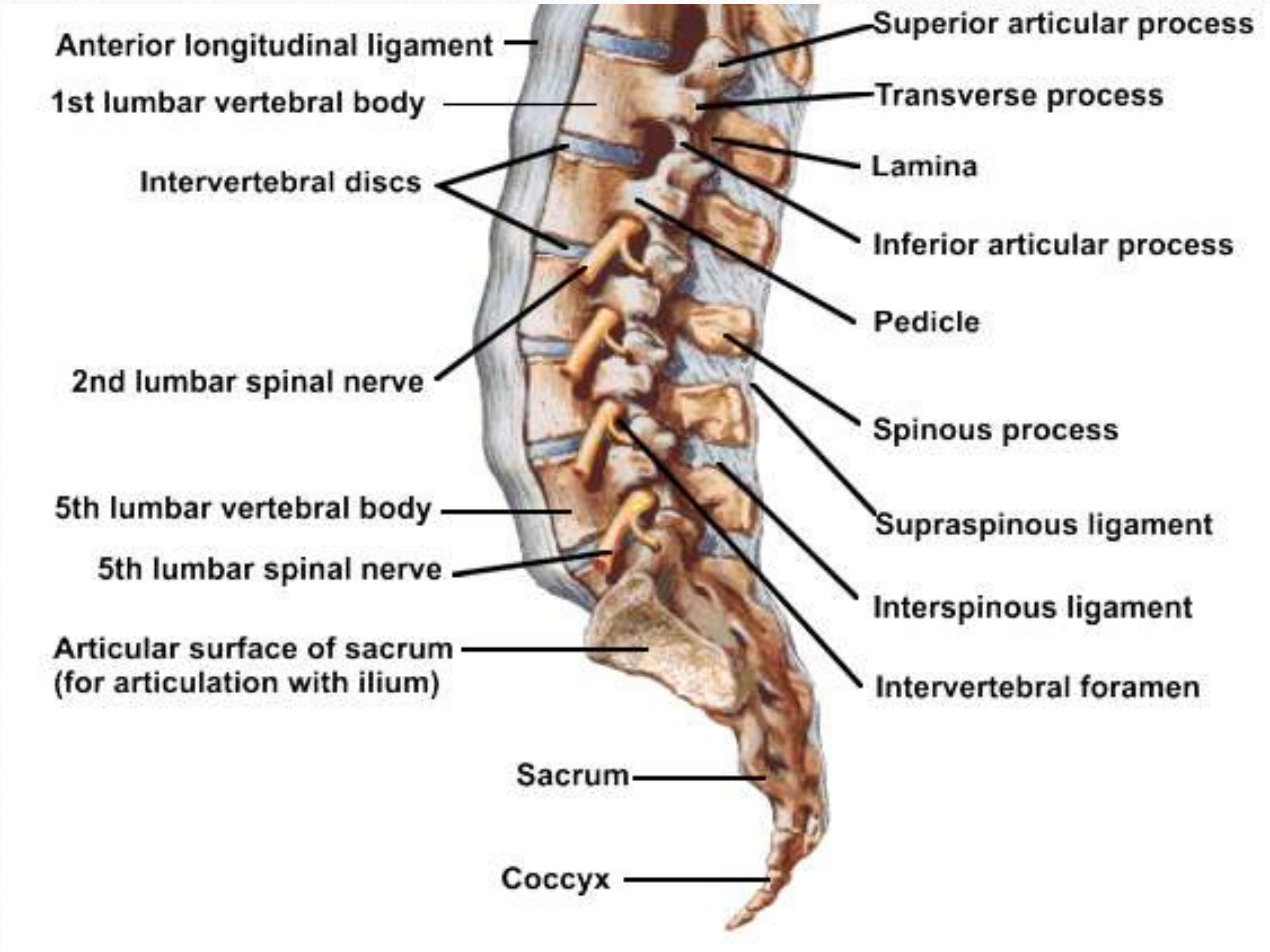
- 40% of people have had low back pain within the past 6 months
- Lifetime prevalence may be as high as 84%
- Median time off work for a back injury is 7 days
- About half the amount of sick days used for back pain are accounted for by the 15% of people who are home for more than a month
- The percentage of patients disabled by back pain has steadily increased over the past 25 years

Lumbar Vertebrae

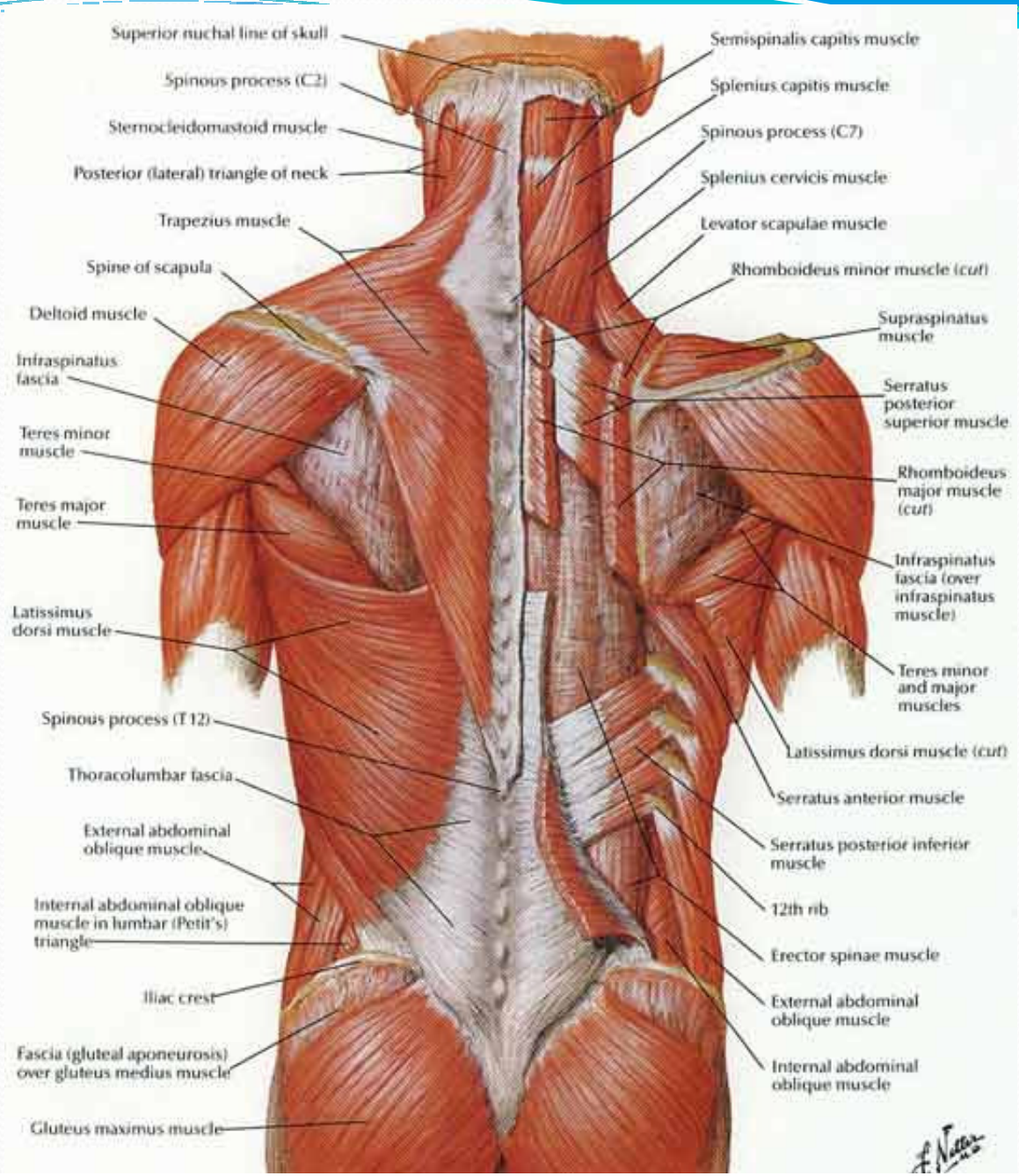




Ligamentous Support



Spine Musculature



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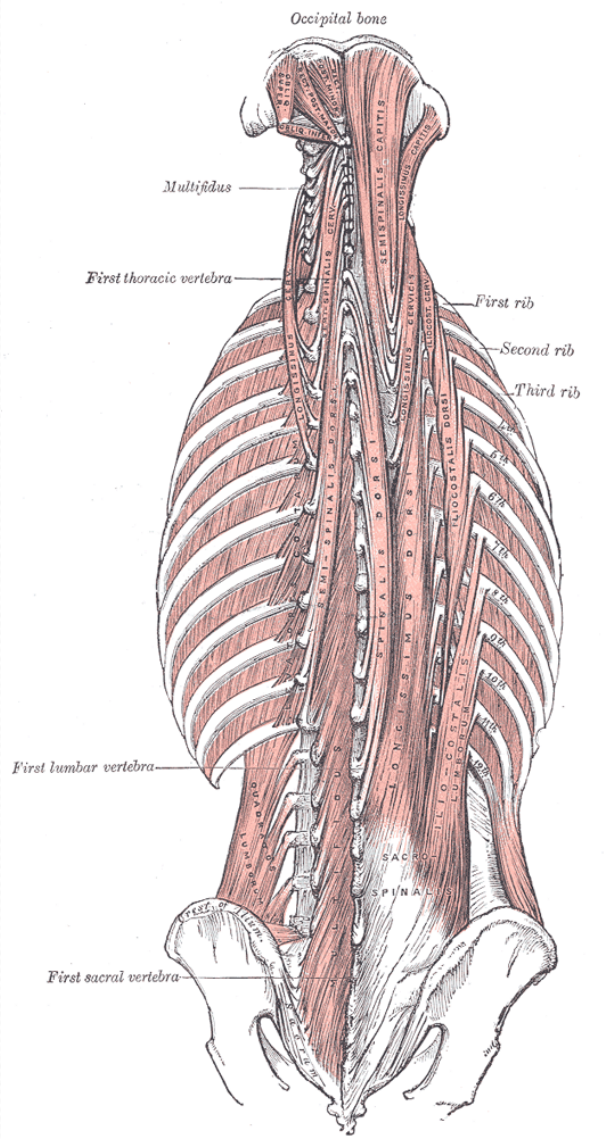
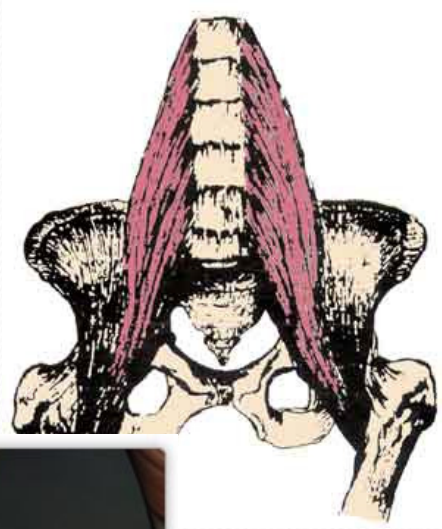
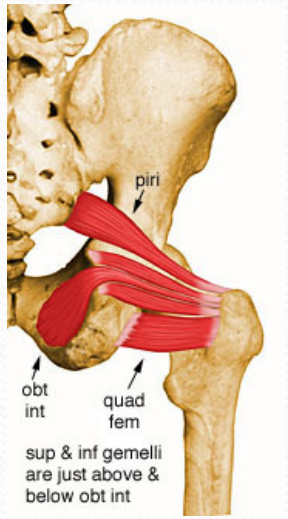
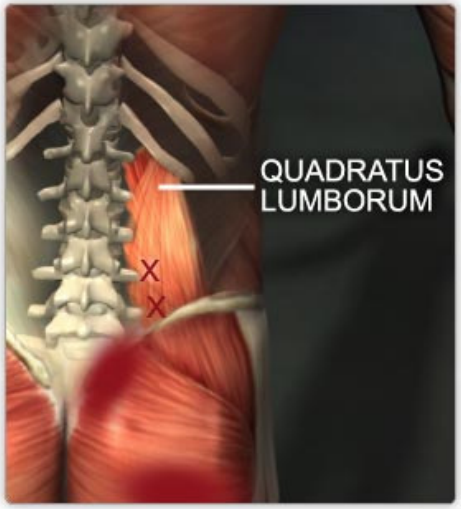
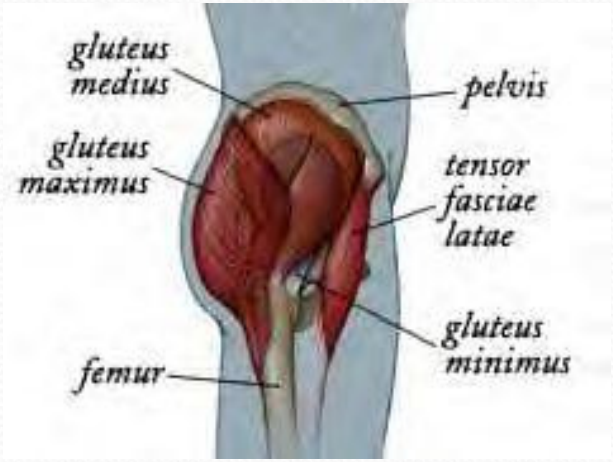


Anterior Muscle Group & Supporting Musculature









Joints

- Intervertebral Disc
  - Nucleus pulposus (90% water at birth)
  - Annulus fibrosus
    - Shock absorber
- Zygapophyseal Joints
  - Synovial joints (synovium + capsule)
  - Lie in sagittal plane, allowing primarily flexion & extension

Neural Considerations

- Conus medullaris ends at L2
- Cauda equina consists of dorsal and ventral rootlets which join in the intervertebral foramen to become the spinal nerves
- Spinal nerves gives off the ventral primary rami, which form plexus
- Dorsal primary rami innervate posterior half of vertebral bodies, paraspinal muscles, zygaphophyseal joints (medial branch), lumbar multifidi (medial branch), sensation to back

Definitions

- Facet arthropathy
- Spondylosis
- Discogenic pain
- Radiculitis
- Radiculopathy
- Instability
- Spinal stenosis
- Mechanical Low Back Pain
- Failed Back Syndrome
- Myofascial Pain

Facet Arthropathy & Degenerative Spondylosis

- These conditions often co-exist
- Facet degenerative changes can be shown on oblique plain radiographs
- Both can cause axial back pain, and both can refer pain into the buttocks & legs
- Only diagnostic maneuvers for z-joint pain are fluoroscopically-guided z-joint injections and medial branch blocks

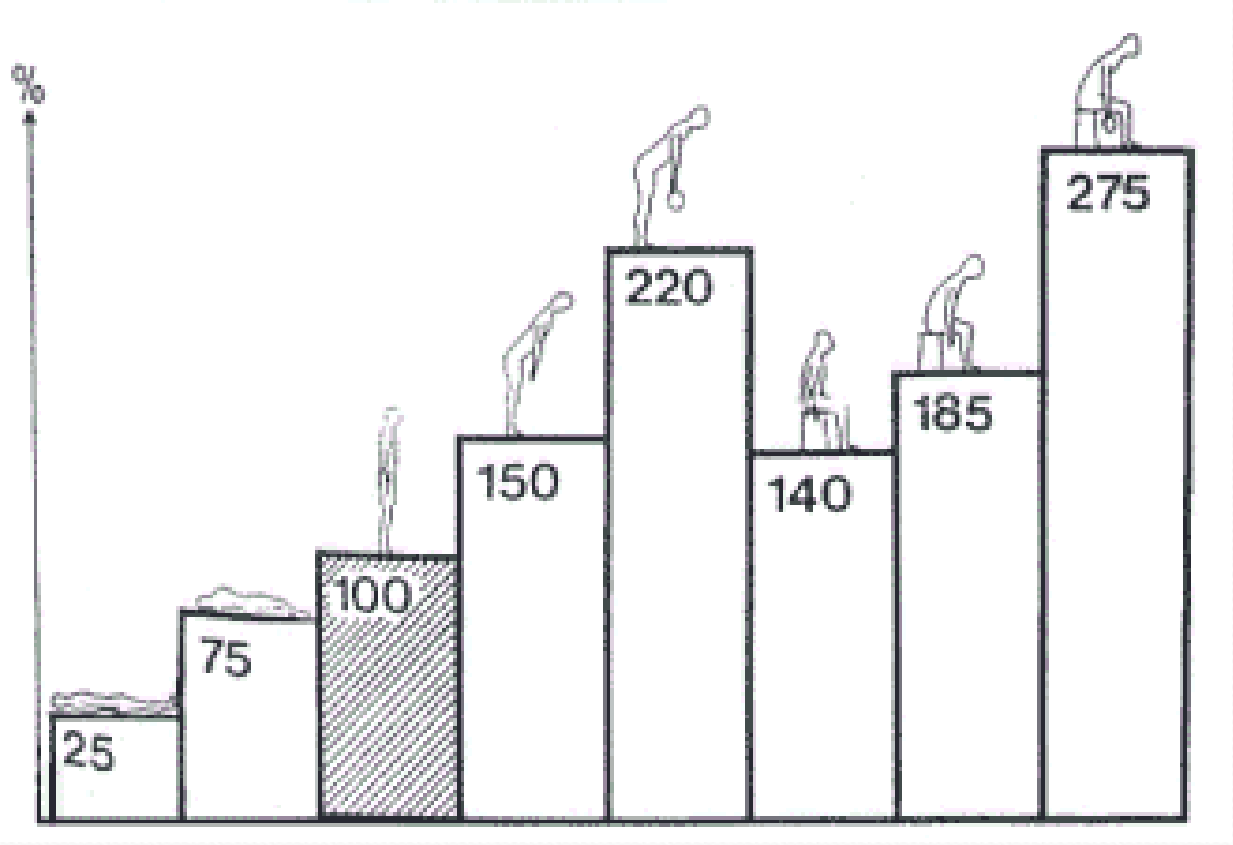
Discogenic Pain

- Can be from degenerative disc disease (DDD), internal disc disruption, and disc herniation
- Classically described as bandlike and exacerbated by lumbar flexion
- If a disc herniation crowds the intervertebral foramen, radicular symptoms may prevail

Radiculitis & Radiculopathy

- Chemical radiculitis of a spinal nerve is caused by any acute disc herniation
- Inflammatory response, mediated by phospholipase A2, cyclooxygenase-2, prostaglandin E2, NO, cytokines, interleukins, and immunoglobulins
- If the disc compresses the nerve, radiculopathy occurs

Pathophysiology: Intradiscal Pressures



Nachemson, AL. Disc pressure measurements. Spine 1981; 6(1):93-97)

Instability

- Often-used term – 2 definitions
- Mechanical Instability, or Gross Instability, is relative motion of one vertebrae on another, seen on flexion/extension films
  - Requires evaluation by spinal surgeon
- Micro-instability refers to very small movement, caused by tissue damage, poor muscular endurance, or poor muscular control
  - Contributes to Mechanical Low Back Pain

Spinal Stenosis

- Gives symptoms of monoradiculopathy, polyradiculopathy, or classic neurogenic claudication
- Neurogenic claudication – bilateral leg pain initiated by walking, prolonged standing, and walking downhill
  - Relieved by sitting or bending forward
- Surgical consideration is given only to patients with intractable pain, profound or progressive neurologic deficit, or lifestyle impairment

Failed Back Syndrome

- Chronic back and/or leg pain that occurs after back surgery. Contributing factors include residual or recurrent disc herniation, persistent post-op pressure on a spinal nerve, altered joint mobility, scar tissue, depression/anxiety, sleeplessness

Myofascial Low Back Pain

- In the face of a normal plain film, a normal MRI, and continued low back pain, a diagnosis of myofascial pain must be considered
- Treatment – antidepressants, trigger point injections, stretching, strengthening, ROM, **aerobic exercise**

What Causes Low Back Pain?

Triggered by an acute event, with contributing factors of the degenerative cascade

Pathophysiology:
Kirkaldy-Willis degenerative cascade

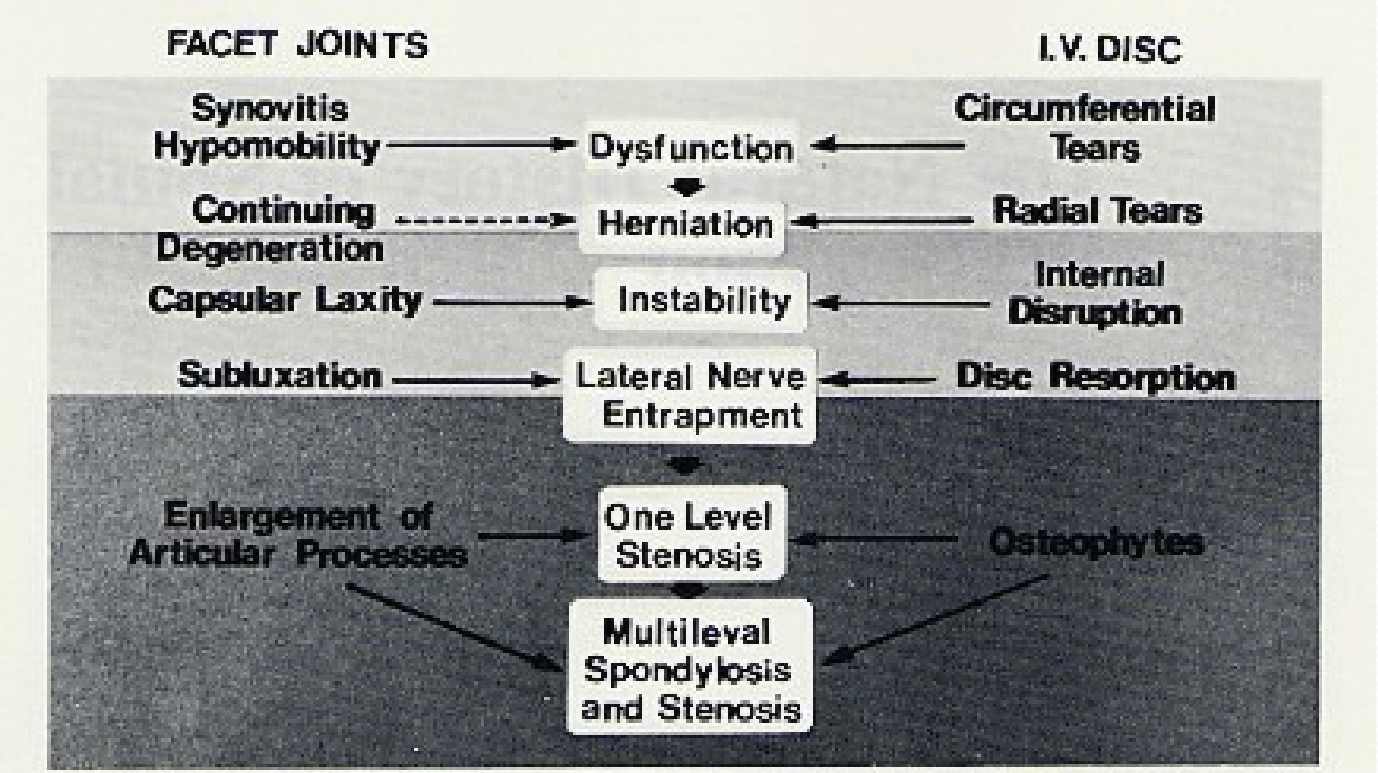


Fig. 1-1. The spectrum of pathological changes in facet joints and disk and the interaction of these changes. The upper light horizontal bar represents dysfunction, the middle darker bar instability, and the lower dark bar stabilization.

Pathophysiology: Segmental Stability

- A cadaver spine in which the bones and ligaments are intact but the muscles have been removed will buckle under only 20 lbs of compressive load
- In normal situations, about 10% of maximal muscular contraction is needed to provide segmental stability
- Muscular endurance is more important than absolute muscle strength for performing ADLs

Pathophysiology: Neural Processing

- Group of pt w/o back pain contract transversus abdominis prior to contraction of peripheral musculature
- In pts w/ low back pain, firing of the transversus abdominis was delayed, often after the limb movement was complete
  - Richardson, Jull, et al. General considerations in motor control and joint stabilization: the basis of assessment and exercise techniques. Theraputic exercise for spinal segmental stabilization in low back pain: scientific basis and clinical approach. 1999:79-91.

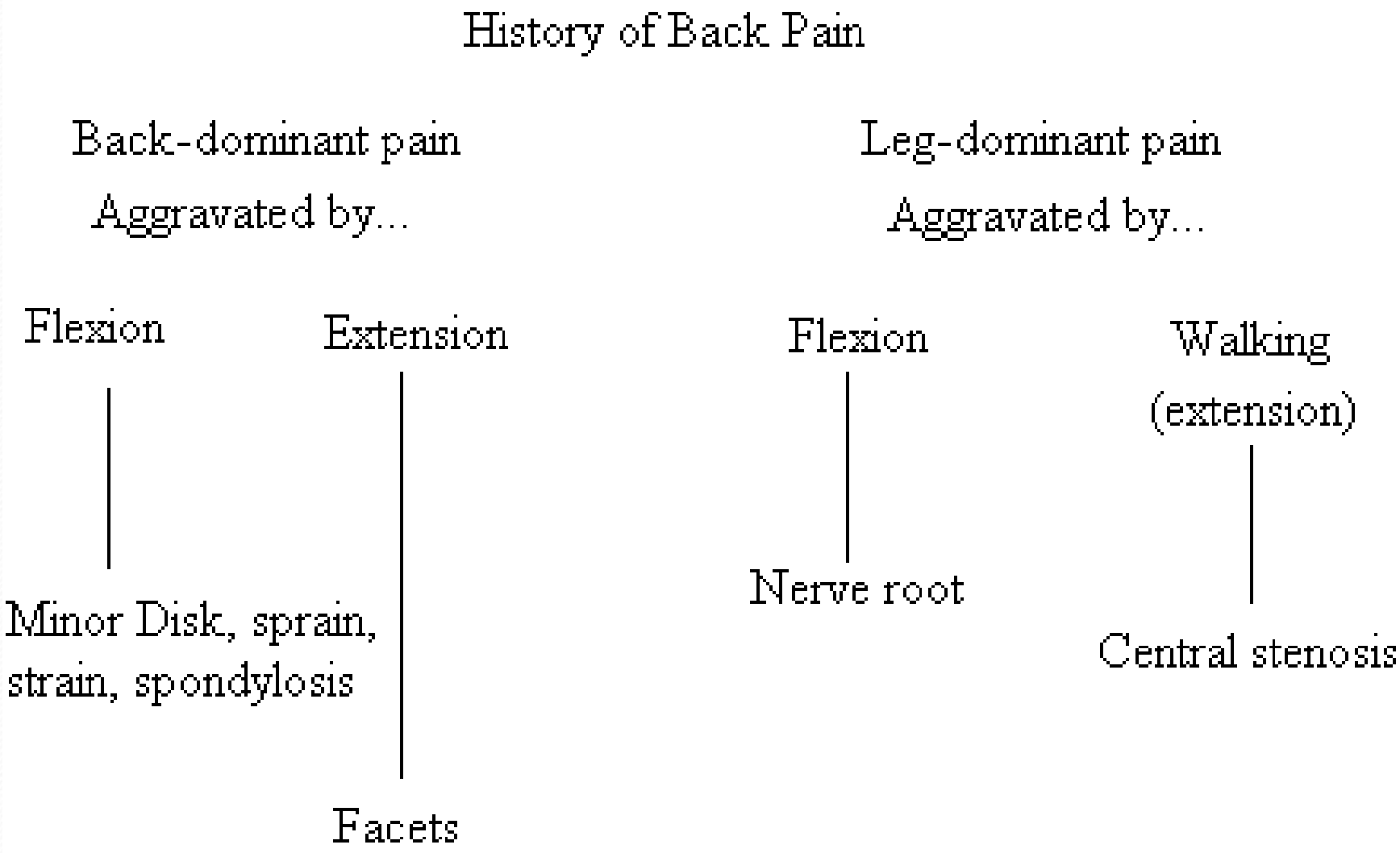
Pathophysiology: Altered paraspinals

- Biopsies of multifidi in pts with LBP demonstrate atrophy of Type 2 muscle fibers w/ internal structural changes of type 1 fibers
- 5 years postoperatively, Type 2 fiber atrophy was still found. However, percentage of Type 1 fibers w/ abnormal structures decreased in positive outcome group; had increased in negative outcome group
  - Rantanen J, Hurme M, Falck B, et. Al. The lumbar multifidus muscle five years after surgery for a lumbar intervertebral disc herniation. Spine 1993; 18(5):568-574

History

- Location, character, severity, onset, duration, frequency, alleviating/aggravating factors, associated signs and symptoms

History


History of Back Pain
Back-dominant pain
Aggravated by…
Flexion
Minor Disk, sprain, strain, spondylosis
Extension
Facets
Leg-dominant pain
Aggravated by…
Flexion
Nerve root
Walking (extension)
Central stenosis

History – Red Flags

Recent significant trauma, or milder trauma age >50
Unexplained weight loss
Unexplained fever
Immunosuppression
History of cancer
Intravenous (IV) drug use
Osteoporosis, prolonged use of corticosteroids
Age >70
Focal neurologic deficit progressive or disabling symptoms
Duration greater than 6 weeks

Psychosocial Factors

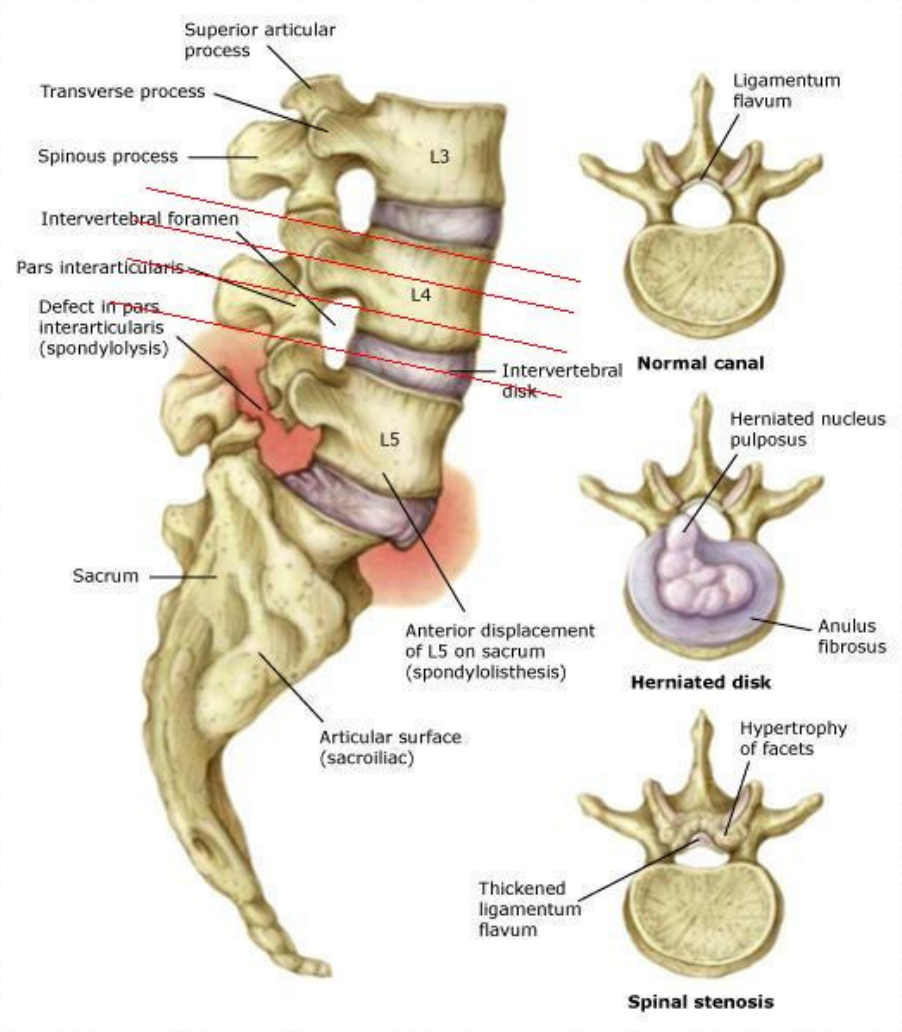
- Presence of catastrophic thinking
- Expectations that the pain will only worsen with work or activity
- Poor sleep
- Compensation issues
- Stress/anxiety
- Work issues
- Extended time off work

Physical

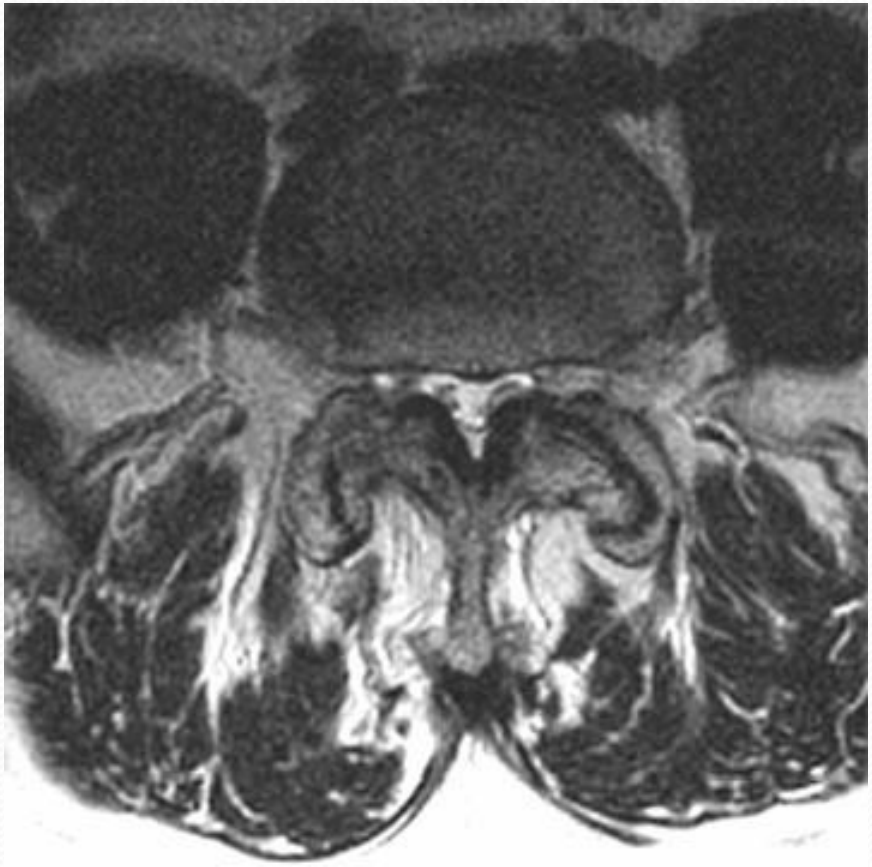
- Observation
- Palpation
- ROM
- Neurologic examination
- Additional areas to examine
  - Abdominal muscle strength
  - Pelvis musculature ROM, strength

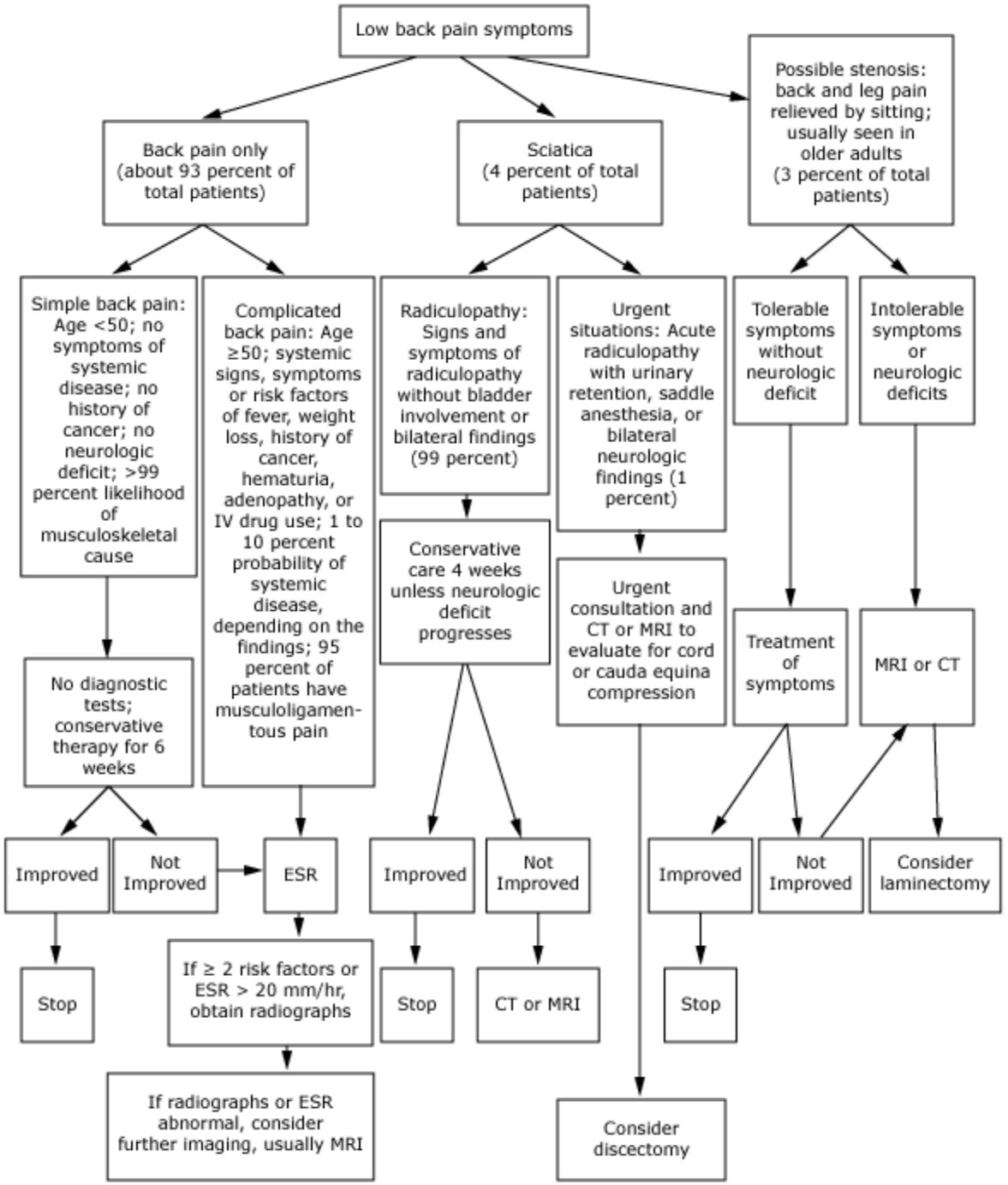
Spine Anatomy: Imaging

Spine Anatomy: Imaging



Spine Anatomy: Imaging




Low back pain symptoms
Back pain only (about 93 percent of total patients)
Sciatica (4 percent of total patients)
Possible stenosis: back and leg pain relieved by sitting; usually seen in older adults (3 percent of total patients)
Simple back pain: Age <50; no symptoms of systemic disease; no history of cancer; no neurologic deficit; >99 percent likelihood of musculoskeletal cause
Complicated back pain: Age ≥50; systemic signs, symptoms or risk factors of fever, weight loss, history of cancer, hematuria, adenopathy, or IV drug use; 1 to 10 percent probability of systemic disease, depending on the findings; 95 percent of patients have musculoligamen-tous pain
Radiculopathy: Signs and symptoms of radiculopathy without bladder involvement or bilateral findings (99 percent)
Urgent situations: Acute radiculopathy with urinary retention, saddle anesthesia, or bilateral neurologic findings (1 percent)
Tolerable symptoms without neurologic deficit
Intolerable symptoms or neurologic deficits
No diagnostic tests; conservative therapy for 6 weeks
Conservative care 4 weeks unless neurologic deficit progresses
Urgent consultation and CT or MRI to evaluate for cord or cauda equina compression
Treatment of symptoms
MRI or CT
Improved
Not Improved
ESR
Improved
Not Improved
Improved
Not Improved
Consider laminectomy
Stop
If ≥ 2 risk factors or ESR > 20 mm/hr, obtain radiographs
Stop
CT or MRI
Stop
If radiographs or ESR abnormal, consider further imaging, usually MRI
Consider discectomy

Treatment: Reassurance & Education

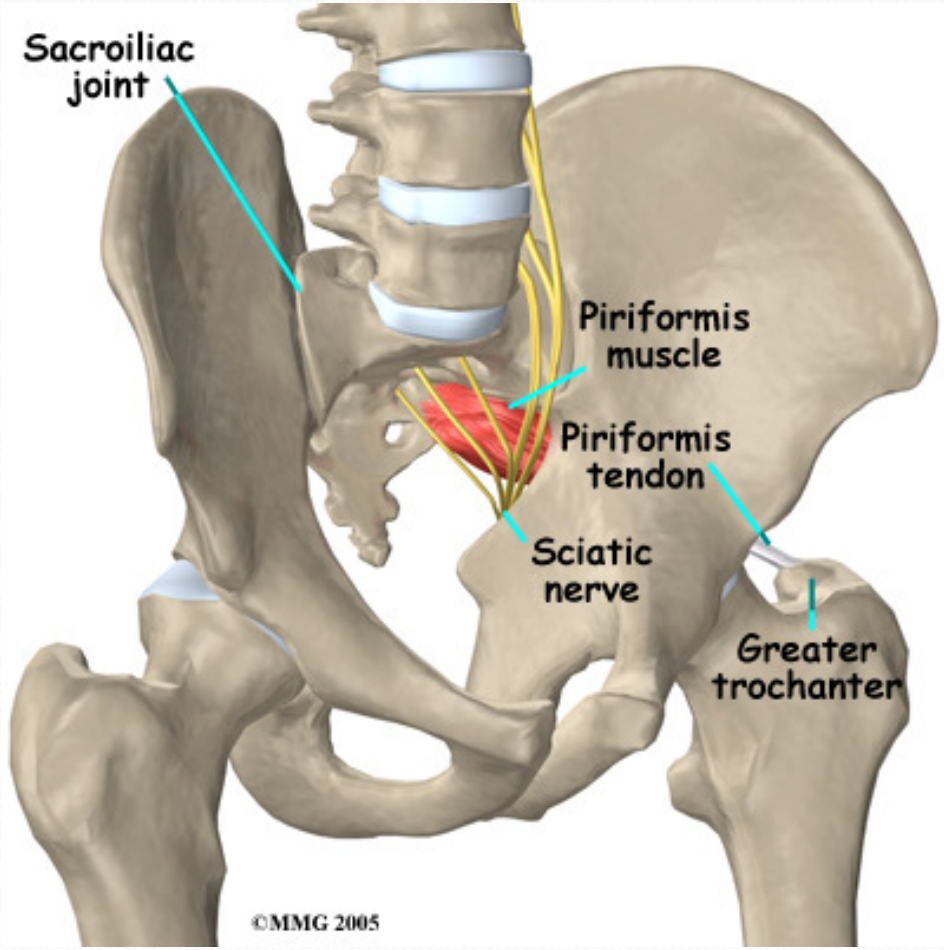
- Reassurance should include information about the underlying pathology, the fact that the prognosis is good, and that they should return to regular activity

- Occasionally, this is all that a patient may need

Treatment: Biomechanics

- Postural retraining is important for two primary reasons
  - Exercises are more effective if they are done from a position of proper alignment
  - Virtually all patients will spend much more time in habitual postures such as sitting and standing than will ever be spent exercising

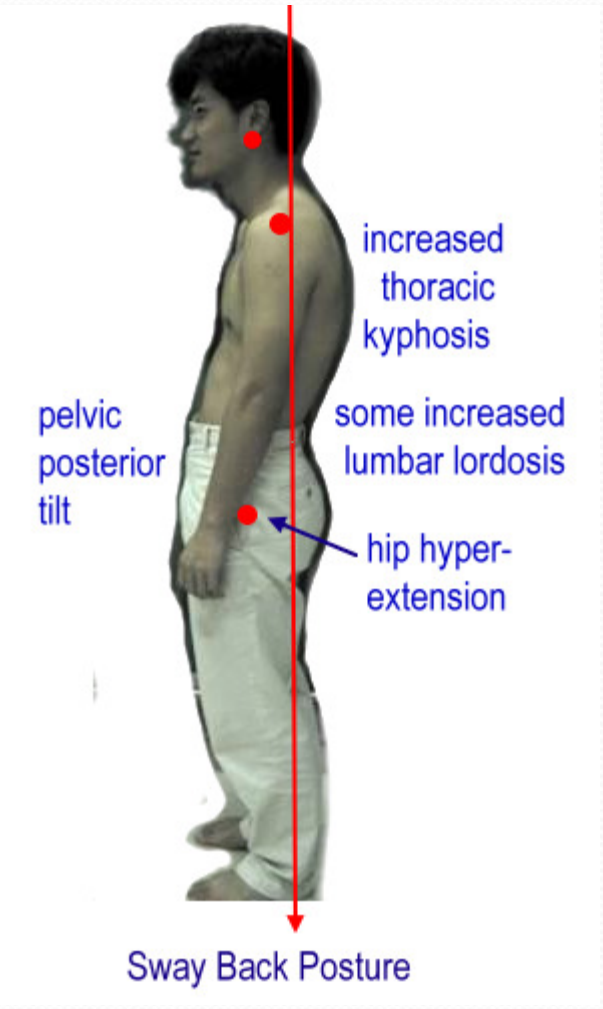
Biomechanics: Posture



Biomechanics: Anterior Pelvic Tilt

- Weak anterior abdominals
- Tight one-joint hip flexors
- Tight two-joint hip flexors
- Tight paraspinals
- Weak hip extensors

Biomechanics: Posterior Pelvic Tilt



- Weak iliopsoas
- Weak external obliques
- Tight hamstrings

Biomechanics: Lateral Pelvic Tilt

- Weak gluteus medius
- Tight unilateral trunk muscles
- Slight heel lift may correct by allowing the tight muscles to relax

Treatment:

Aerobic Activity

- Studies have found that group classes that combine low-impact aerobics with strengthening and stretching floor exercises can be as effective in reducing pain and decreasing disability as individualized PT and strengthening with weight machines
- No particular type of aerobic activity has been found to be more effective for gaining fitness or decreasing pain than another for pts w/ back pain
- Slow walking reduces spine motion and causes overall higher spine loading, and therefore more pain than faster walking with arm swings

Treatment:
Aquatic exercise

- Buoyancy effects
- Decreased pain via gate theory
  - Sensory input from water temperature, hydrostatic pressure and turbulence

Treatment: Manipulation

- Types of manipulation
  - High Velocity, Low Amplitude (HVLA)
  - Soft tissue techniques
  - Muscle Energy Techniques
  - Strain/Counterstrain

Treatment: Manipulation

- Most countries recommend spinal manipulation for treatment of acute low back pain
- Metaanalysis reveals manipulation to be as effective as other treatments (analgesics, exercise, physical therapy), but not more effective

Treatment: Traction

- Studies have varied in weight, frequency, and length of treatment
- Multiple randomized controlled trials using different doses of traction have not found traction to be effective for treatment of back pain

Treatment:
Lumbar supports

- One study showed that patients who wore a lumbar support plus rigid insert had more subjective improvement than those who wore a brace without support
- No evidence that lumbar supports actually increase intraabdominal pressure, decrease muscle forces and fatigue, or limit ROM

Treatment:
Heel lifts

- Must differentiate if leg length discrepancy is anatomic or functional
- Correct foot biomechanics prior to using lift
- Small unblinded studies have found that correction of leg length discrepancy decreases low back pain
- No large controlled trials

Treatment:

Transcutaneus electrical nerve stimulation

- Metaanalyses of TENS outcomes show trends toward better pain reduction, better function, and satisfaction with treatment as compared with placebo, but these trends do not reach statistical significance

Treatment: Massage

- Mechanism of action thought to include relaxation and stress reduction; theraputic benefits of touch, and beneficial effects on the structure of function of tissues and pain sensation
- High-quality studies have found massage to be effective for improving symptoms and functions in subacute and chronic low back pain

Treatment: Yoga/Pilates

- Have been found helpful in case series but have not been subjected to stringent randomized controlled trials

Treatment: Medication

- NSAIDs
- Muscle Relaxants
- Antidepressants
- Anticonvulsants
- Topical treatments
  - Lidoderm
  - Capsacin
- Opioids

Treatment:
Trigger Point Injections

- Useful for myofascial component of mechanical low back pain
- Cochrane review of injection therapy found trigger point injections to be effective in treatment of low back pain

Treatment: Acupuncture

- The general consensus in multiple reviews is that evidence for acupuncture in relieving low back pain is either positive or inconclusive.
  - In Britain, the BMA analysis found it to be effective
  - In Canada, the Canadian/Alberta Health Authorities found the results inconclusive
- Most studies are poorly designed or controlled

Treatment:
Botulinum toxin

- Increasingly being used to treat low back pain.
- Mechanism of action could be through changes in sympathetic tone, reduction of muscle spasms
- Studies at this point are small, and results are inconclusive

Treatment: Prolotherapy

- Consists of series of injections into spinal ligaments to cause inflammation and thickening of ligaments
- Still controversial, with inconclusive results at this point

Interventional Techniques

- Epidural injections
- Facet Joint Injections/Medial Branch Blocks/RFA
- SI joint injections
- Selective Nerve Root Blocks

Interventional Techniques

- Hip Injections
- Spinal Cord Stimulator Trials
- Pump Trials
  - Pain pump; Baclofen pump
- Provocative Discography
  - IDET; Percutaneous Disc Decompression

My Prescription

- Medications
- Therapy
- Imaging
- Injections
- Electrodiagnostics
- DME
- Labs (UDS)
- Activity/Work Status
- Follow-up

Treatment: General Approach

- September 2007 Archives of PM&R Article
- Set in Switzerland
- Compared Function-Centered vs Pain-Centered Rehabiliation Program
  - FCT emphasized activity despite pain by using work simulation, strength, endurance, and cardiovascular training
  - PCT emphasized pain reduction and included passive and active mobilization, stretching, strength training
- Compared with PCT, FCT significantly increased average number of work days during the follow-up year (primary outcome)
  - Did not affect unemployment rate or number of patients receiving permanent disability allowance

Sources

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