

Sources of Low Back Pain

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Disclosures

None to declare

Objectives



Distinguish between End-Organ Dysfunction and Altered Nervous System Processing Models of low back pain



List common anatomical causes of low back pain



List and report the prevalence of serious pathology and associated red flags

Conceptual Models of Low Back Pain

End Organ Dysfunction Model (EODM)

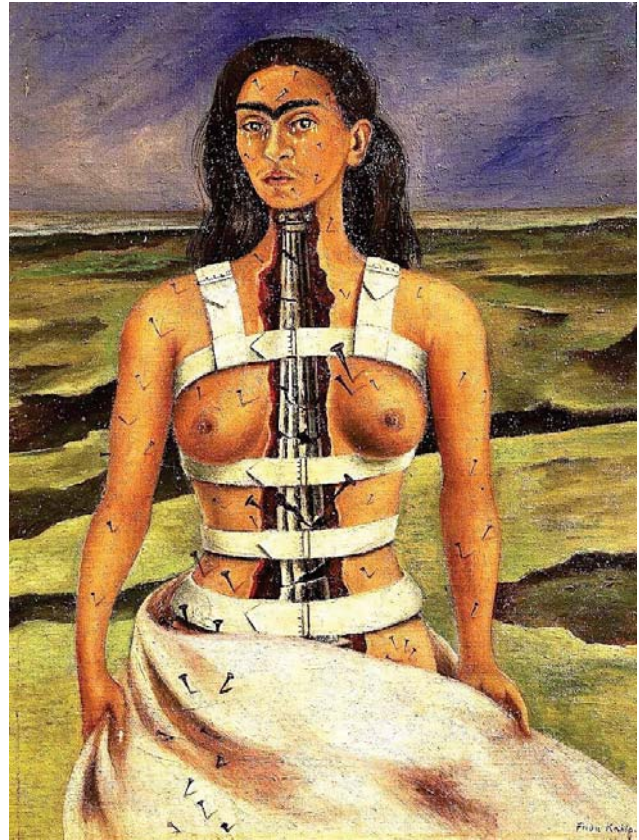
- Pain reflects structural abnormalities
- Injury or degeneration
- Patients feel back pain due to nociceptive focus of the spine
- Pain represents normal functioning of the nervous system



Conceptual Models of Low Back Pain

Altered Nervous System Processing Models (ANSPM)

- Patients suffer from alterations in nervous system processing of sensory information
- Rejects the notion of a direct link between tissue injury and pain
- Heightened susceptibility to pain (genetic, depression/anxiety, psychological traits)



Model Relevance

A Distinct Event Causing the Symptoms

EODM

- Plausible when symptoms can be traced to a distinct injury

ANSPM

- Low back pain often begins in the absence of a definable mechanical event

Model Relevance

Symptoms Correlate with a Well-Defined Abnorm.

EODM

- Provocation and palliation techniques
- May reveal structural basis for LBP in patients

ANSPM

- Difficult to find correlation between symptoms reported and biological pathology in the spine
- Spine changes in discs and facet joints are prevalent in individuals with and without LBP

- Apkarian, A. and Robinson, J., 2010. *Low Back Pain - IASP*. [online] iasp-pain.org. Available at: <<https://www.iasp-pain.org/PublicationsNews/NewsletterIssue.aspx?ItemNumber=2084>> [Accessed 10 March 2020].
- Boden SD, Davis DO, Dina TS, Patronas NJ, Wiesel SW. Abnormal magnetic resonance scans of the lumbar spine in asymptomatic subjects. *J Bone Joint Surg Am* 1990;72:403–8.
- Borenstein DG, O'Mara JW Jr, Boden SD, Lauerman WC, Jacobson A, Platenberg C, Schellinger D, Wiesel SW. The value of magnetic resonance imaging of the lumbar spine to predict low-back pain in asymptomatic subjects: a seven-year follow-up study. *J Bone Joint Surg Am* 2001;83:1306–11.

Model Relevance

Co-Occurrence with Mood Disturbance

EODM

- Prior to onset of pain, LBP patients should be indistinguishable from others

ANSPM

- Premorbid psychological dysfunction or distress increase risk of LBP

- Apkarian, A. and Robinson, J., 2010. *Low Back Pain - IASP*. [online] iasp-pain.org. Available at: <<https://www.iasp-pain.org/PublicationsNews/NewsletterIssue.aspx?ItemNumber=2084>> [Accessed 10 March 2020].
- Carragee E, Alamin T, Cheng I, Franklin T, Hurwitz E. Does minor trauma cause serious low back illness? *Spine* 2006;31:2942–9.
- Ghaffari M, Alipour A, Farshad AA, Jensen I, Josephson M, Vingard E. Effect of psychosocial factors on low back pain in industrial workers. *Occup Med (Lond)* 2008;58:341–7.

Discogenic Pain

- 39% of low back pain may be attributed to disc pathology
- Discogenic back pain can be attributable to any cause that stimulates the sensory nerve endings of the disc

- Comer C, Conaghan PG. Tackling persistent low back pain in primary care. *Practitioner*. 2009;253:32–43.
- Park WM, Kim K, Kim YH. Effects of degenerated intervertebral discs on intersegmental rotations, intradiscal pressures, and facet joint forces of the whole lumbar spine. *Comput Biol Med*. 2013;43:1234–40.

Discogenic Pain

Clinical Presentation

- Pain in the center of low back described as a deep, dull ache
- Referred pain can extend into the lower extremity and can extend distally below the knee

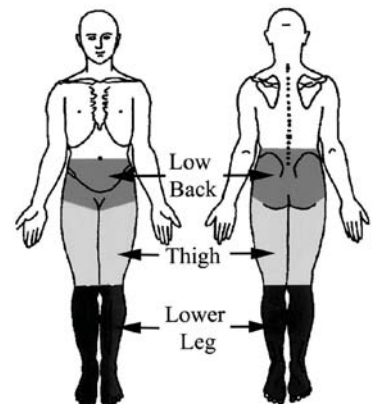


Figure 2. Primary pain zones: low back (including hip/buttock), proximal leg (thigh), and lower leg (below the knee).

- O'Neill CW, et al. Disc stimulation and patterns of referred pain. *Spine* 2002;27:2776–81.

Discogenic Pain

- Raj PP. Intervertebral Disc: Anatomy-Physiology-Pathophysiology-Treatment. Pain Practice 2008; 8 (1): 18-44.

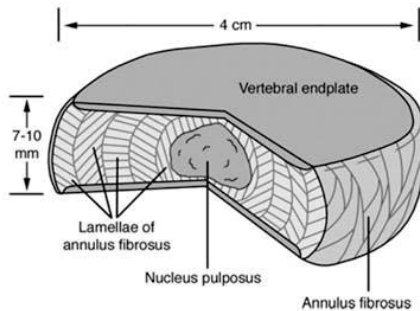


Figure 2. A cut out portion of a normal disc. Note the location of the Nucleus Pulposus, the vertebral end plate and the architecture of Annulus Fibrosus. The intervertebral disc is 4 cm wide and 7-10 mm thick.

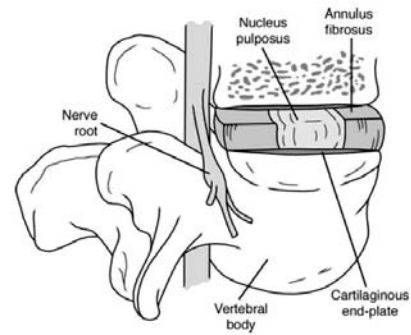
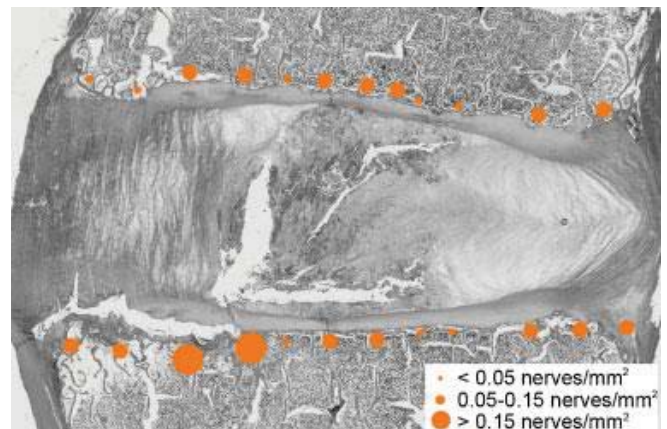
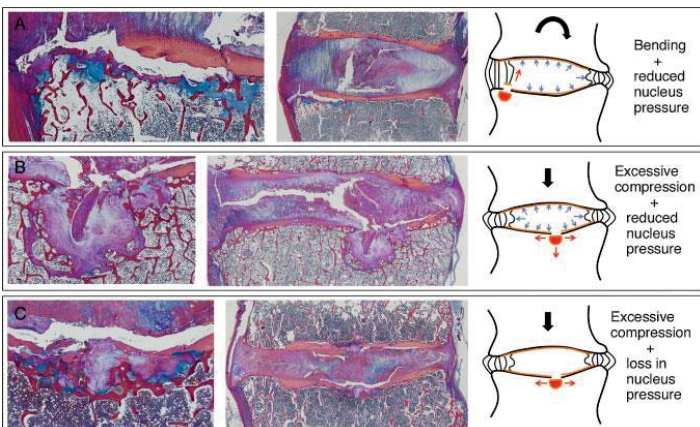


Figure 1. A line drawing of the spinal segment consisting of two vertebral bodies and a normal intervertebral disc sandwiched between them.

Discogenic Pain

Hypothesis:

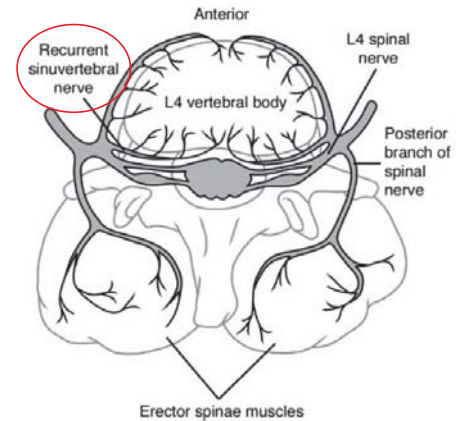
- Discogenic low back pain can evolve from either annular disruption and/or internal endplate disruption



- Peng BG. Pathophysiology, diagnosis, and treatment of discogenic low back pain. World J Orthop 2013; 4(2): 42-52.
- Lotz JC, Fields AJ, and Liebenberg EC. The Role of the Vertebral End Plate in Low Back Pain. Global Spine J 2013; 3: 153-164.

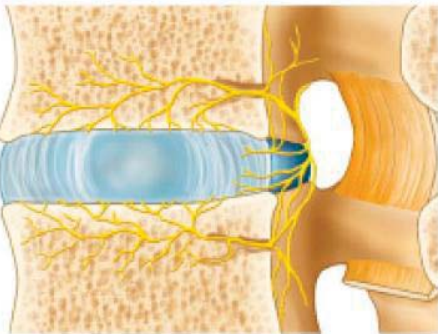
Discogenic Pain

- Deyo RA and Weinstein JN. Low Back Pain. N Engl J Med 2001; 344(5): 363-370.
- Shayota B et al. A Comprehensive review of the sinuvertebral nerve with clinical applications. Anat Call Biol 2019; 52: 128-133.

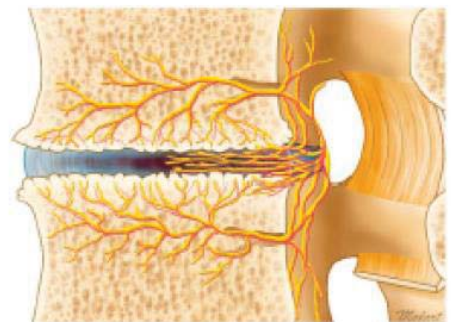


Discogenic Pain

A



B



- Kim HS, Wu PH, and Jang IT. Lumbar Degenerative Disease Part 1: Anatomy and Pathophysiology of Intervertebral Discogenic Pain and Radiofrequency Ablation of Basivertebral and Sinuvertebral Nerve Treatment for Chronic Discogenic Back Pain: A Prospective Case Series and Review of Literature. Int J Mol Sci 2020; 21: 1483.

Sacroiliac Joint Pain

- Using control diagnostic blocks, SI joint represents 13% to 30% of chronic low back pain

- Foley BS, Buschbacher RM. Sacroiliac joint pain. Am J Phys Med Rehabil. 2006;85:997–1006.
- Dreyfuss P, Michaelsen M, Pauza K, McLarty J, Bogduk N. The value of medical history and physical examination in diagnosing sacroiliac joint pain. Spine 1996;21:2594-2602.
- Schwarzer AC, Aprill CN, Bogduk N: The sacroiliac joint in chronic low back pain. Spine 1995;20:31–7.

Clinical Presentation

Sacroiliac Joint Pain

- Pain perceived in the region of the SI joint with or without referred pain into the lower limb girdle or lower limb itself
- Low back or upper buttock over the joint

Sacroiliac Joint Pain

Clinical Presentation

Table 2: Frequency of Pain Referral to the Lower Extremity

Anatomic Region	Percentage of Patients With Pain
Thigh	48
Posterior	30
Lateral	20
Anterior	10
Medial	0
Lower leg	28
Posterior	18
Lateral	12
Anterior	10
Medial	0
Ankle	14
Foot	12
Lateral	8
Plantar	4
Dorsal	4
Medial	0

Table 3: Eighteen Observed Patterns of Sacroiliac Pain Referral in Order of Decreasing Frequency

Pattern of Pain Referral	Percent of Patients
Lower lumbar and buttock	30
Buttock alone	12
Lower lumbar, buttock, and thigh	10
Lower lumbar, buttock, thigh, and leg	10
Lower lumbar alone	6
Buttock and thigh	4
Buttock, groin, and thigh	4
Buttock, thigh, leg, ankle, and foot	4
Buttock and leg	2
Lower lumbar, buttock, and groin	2
Buttock, groin, thigh, leg, ankle, and foot	2
Lower lumbar, buttock, thigh, leg, and ankle	2
Lower lumbar, buttock, abdomen, and thigh	2
Lower lumbar, buttock, thigh, leg, ankle, and foot	2
Lower lumbar, buttock, groin, thigh, leg, and foot	2
Upper lumbar, lower lumbar, buttock, thigh, and leg	2
Upper lumbar, lower lumbar, buttock, groin, and thigh	2
Upper lumbar, lower lumbar, buttock, groin, thigh, leg, ankle, and foot	2

- o Slipman CW, Jackson HB, Lipetz JS, Chan KT, Lenrow D, Vresilovic EJ. Sacroiliac joint pain referral zones. Arch Phys Med Rehabil. 2000;81:334-8.

Sacroiliac Joint Pain

Clinical Presentation

- o Dreyfuss P, Michaelsen M, Pauza K, McLarty J, Bogduk N. The value of medical history and physical examination in diagnosing sacroiliac joint pain. Spine 1996;21:2594-2602.

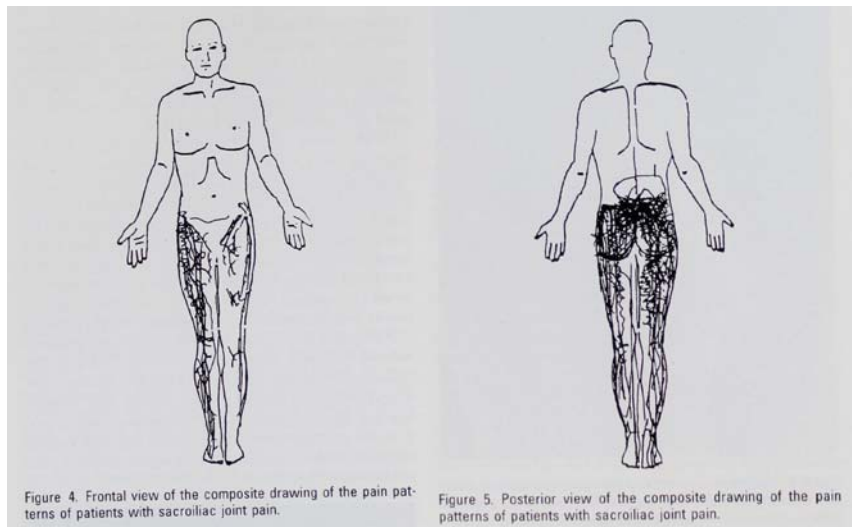


Figure 5. Posterior view of the composite drawing of the pain patterns of patients with sacroiliac joint pain.

Sacroiliac Joint Pain

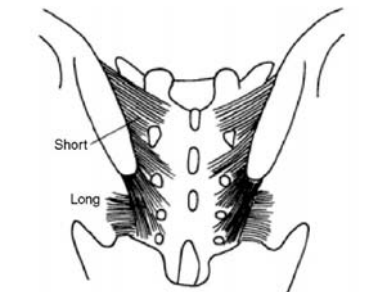
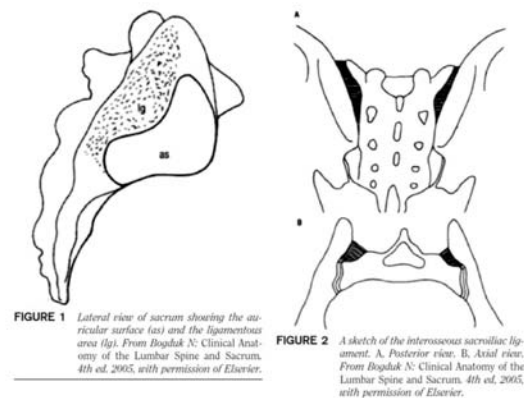
Possible Intra Articular Pain Generators

- Osteoarthritic change

Possible Extra Articular Pain Generators

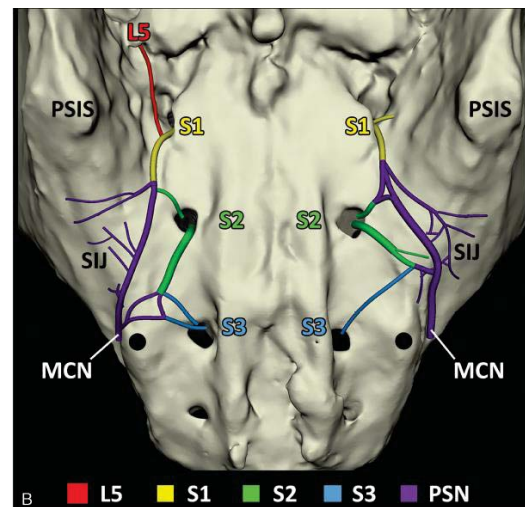
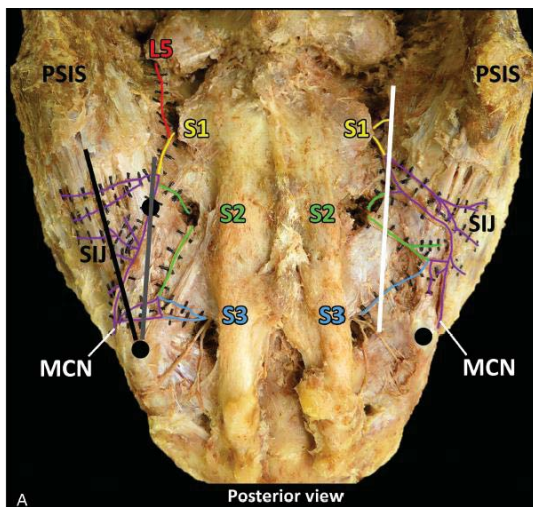
- Enthesis/ligamentous sprain
- Ligamentous, tendinous, or fascial attachment or soft tissue injuries that occur on the dorsal aspect of the SI joint
- Altered joint mechanics: hypermobility or hypomobility
- Altered muscle firing patterns

○ Foley BS, Buschbacher RM. Sacroiliac joint pain: anatomy, biomechanics, diagnosis, and treatment. Am J Phys Med Rehabil 2006;85:997–1006.



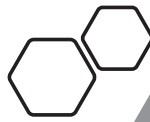
Sacroiliac Joint Pain

Joint Innervation



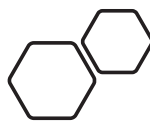
○ Roberts SL, Burnham RS, Ravichandiran K, Agur AM, and Loh EY. Cadaveric Study of Sacroiliac Joint Innervation: Implications for Diagnostic Blocks and Radiofrequency Ablation. Reg Anesth Pain Med 2014; 39: 456-464.

Facet Joint Pain



- Facet joint pain has been estimated to be responsible for 30% of chronic low back pain

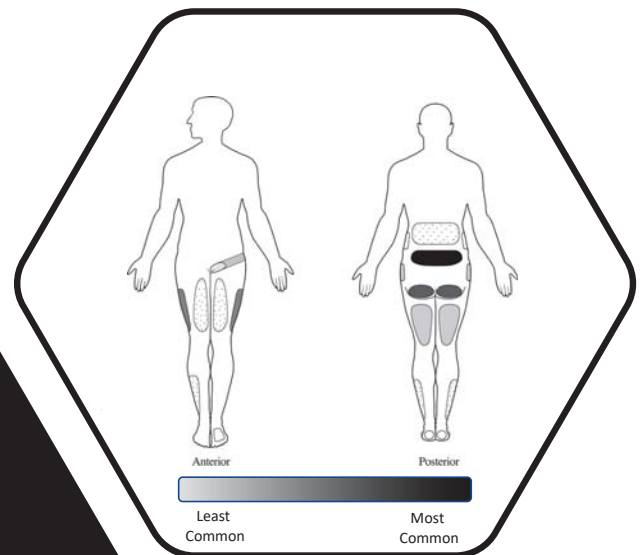
- o van Kleef M, Vanelderen P, Cohen SP, *et al.*: **12. Pain originating from the lumbar facet joints.** *Pain Pract.* 2010; **10**(5): 459–69.
- o Cohen SP, Raja SN: Pathogenesis, diagnosis, and treatment of lumbar zygapophysial (facet) joint pain. *Anesthesiology.* 2007; **106**(3): 591–614.
- o Kalichman L, Hunter DJ. Lumbar facet joint osteoarthritis: a review. *Semin Arthritis Rheum.* 2007;37:69–80.



Facet Joint Pain

Clinical Presentation

- Described as a deep aching sensation, unilateral or bilateral
- Radiation to buttocks, thighs, or groins can be described

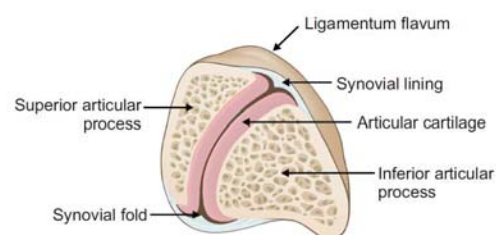
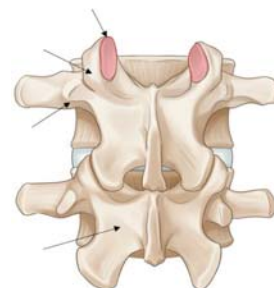


- o Cohen SP, Raja SN: Pathogenesis, diagnosis, and treatment of lumbar zygapophysial (facet) joint pain. *Anesthesiology.* 2007; **106**(3): 591–614.

Facet Joint Pain

- Pain can be caused by osteoarthritis of the facet or strain of the facet joint capsule
- May be linked disc degeneration
- Pain can arise from the synovial membrane, hyaline cartilage, bone or fibrous capsule

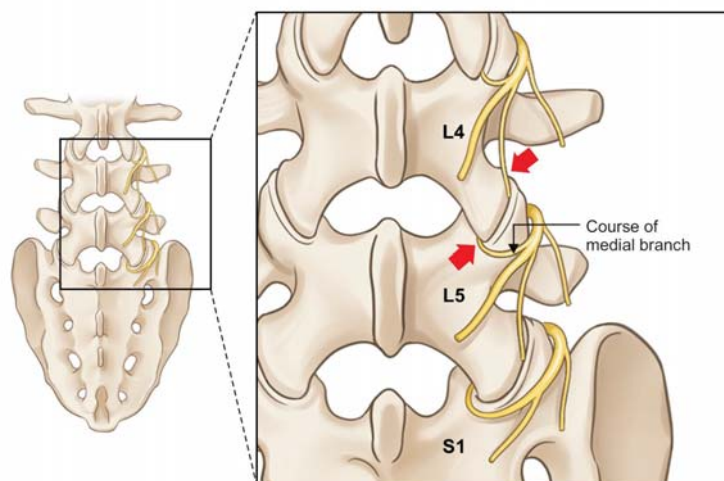
- Cohen SP, Raja SN: Pathogenesis, diagnosis, and treatment of lumbar zygapophysial (facet) joint pain. *Anesthesiology*. 2007; 106(3): 591–614.
- Kalichman L, Hunter DJ. Lumbar facet joint osteoarthritis: a review. *Semin Arthritis Rheum*. 2007;37:69–80.
- Won HS, Yang M, and Kim YD. Facet joint injections for management of low back pain: a clinically focused review. *Anesth Pain Med* 2020; 15: 8-18.



Facet Joint Pain

- Pain generating structures are innervated by the medial branches of the dorsal rami and modulated by sympathetic efferent fibers

- van Kleef M, Vanelderen P, Cohen SP, et al.: 12. Pain originating from the lumbar facet joints. *Pain Pract*. 2010; 10(5): 459–69.
- Won HS, Yang M, and Kim YD. Facet joint injections for management of low back pain: a clinically focused review. *Anesth Pain Med* 2020; 15: 8-18.



Spinal Stenosis



13-14% of patients with low back problems who see a specialist



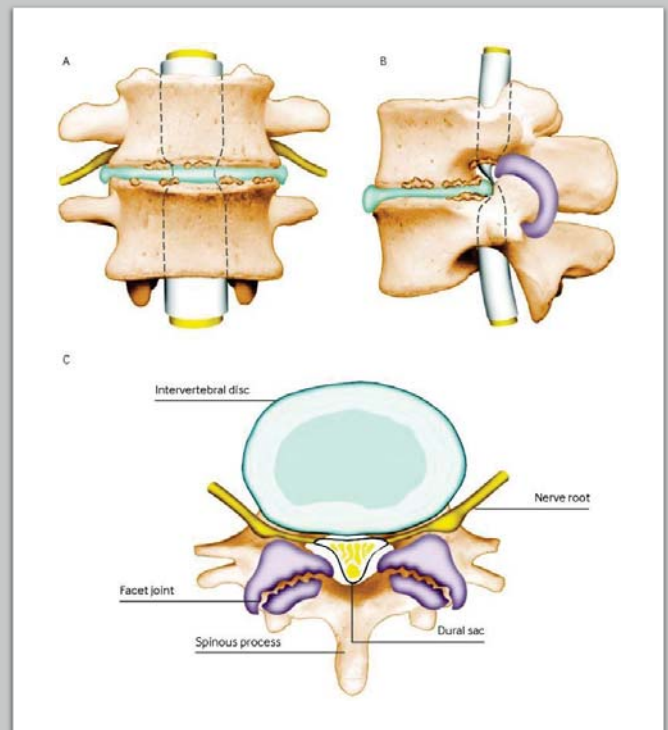
3-4% of patients with low back problems who see a general practitioner

○ ECRI Health Technology Assessment Group. Treatment of degenerative lumbar spinal stenosis: summary. 2001.

Spinal Stenosis

- Defined as narrowing of the spinal canal or intervertebral foramina
- Etiology can be congenital (2.6-4.7%)
- Acquired etiology more common from degeneration of facet joint, loss of disc height, disc bulging, osteophyte formation, ligamentum flavum hypertrophy

- Kalichman L, Cole R, Kim DH, et al. Spinal stenosis prevalence and association with symptoms: the Framingham Study. *Spine J* 2009;9:545-50.
- Lurie J and Tomkins-Lane C. Management of lumbar spinal stenosis. *BMJ* 2016; 352: h6234.
- Deer T et al. A Review of Lumbar Spinal Stenosis with Intermittent Neurogenic Claudication: Disease and Diagnosis. *Pain Med* 2019 Dec; 20(Suppl 2): S32-44.



Spinal Stenosis

Clinical Presentation

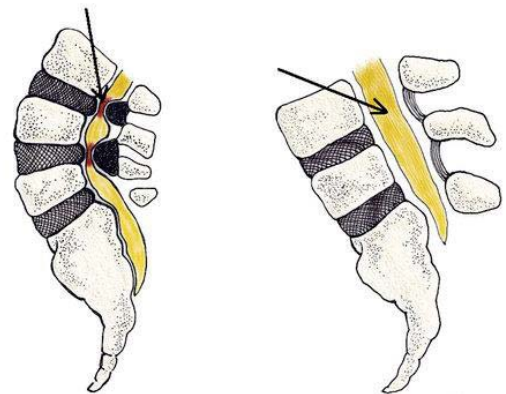
- Common sites of pain are low back, buttocks, thighs, and legs
- Described as cramping or burning feeling
- Gradual onset of dull aching in the low back and posterolateral thighs to sharp radicular pain

o Lurie J and Tomkins-Lane C. Management of lumbar spinal stenosis. BMJ 2016; 352: h6234.

Spinal Stenosis

Clinical Presentation

- Neurogenic claudication is a characteristic manifestation
- Progressive onset of pain, numbness, weakness, and tingling in low back, buttocks, and legs with walking or extension
- Symptoms are posture dependent



o Lurie J and Tomkins-Lane C. Management of lumbar spinal stenosis. BMJ 2016; 352: h6234.

Spinal Stenosis

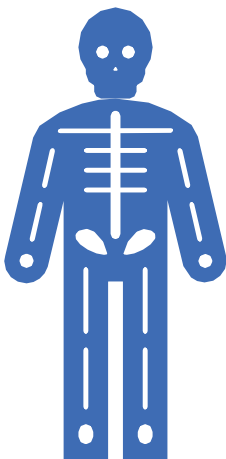
Ischemic Theory

- Compression of microvasculature causes nerve root ischemia
- Leads to paresthesia, pain, weakness

Venous Stasis Theory

- Inadequate oxygenation and accumulation of metabolites in the cauda equina

- Chad DA. Lumbar spinal stenosis. *Neurol Clin* 2007;25:407-18.
- Lurie J and Tomkins-Lane C. Management of lumbar spinal stenosis. *BMJ* 2016; 352: h6234.



Spondylolysis and Spondylolisthesis

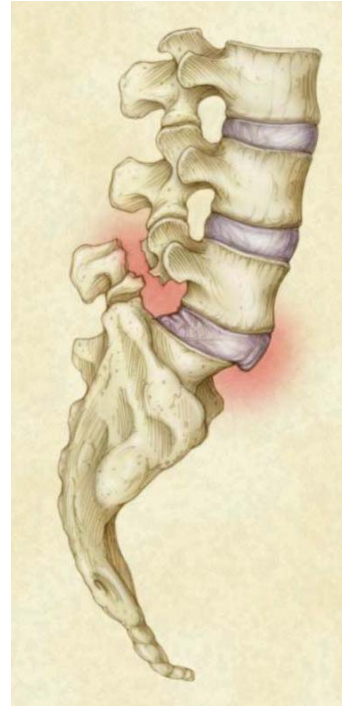
- **Spondylolysis:** a defect or fracture of the pars interarticularis of the vertebral arch
- **Spondylolisthesis:** anterior displacement of the vertebral body in reference to bordering vertebral bodies

- Wang YXJ, Zolta'n K, Deng M, et al. Lumbar degenerative spondylolisthesis epidemiology: a systematic review with a focus on gender-specific and age-specific prevalence. *J Orthop Translat* 2017; 11:39-52.
- Gagnet P et al. Spondylolysis and spondylolisthesis: A review of the literature. *Journal of Orthopaedics* 2018; 15: 404-407.

Spondylolisthesis

- Reported prevalence ranges from 19.1% to 43.1%
- Mean age ranging from 71.5 to 75.7 years

- Wang YXJ, Zolta'n K, Deng M, et al. Lumbar degenerative spondylolisthesis epidemiology: a systematic review with a focus on gender-specific and age-specific prevalence. J Orthop Translat 2017; 11:39–52.
- Deyo RA and Weinstein JN. Low Back Pain. N Engl J Med 2001; 344(5): 363-370.



+ • Other Sources of Low Back Pain

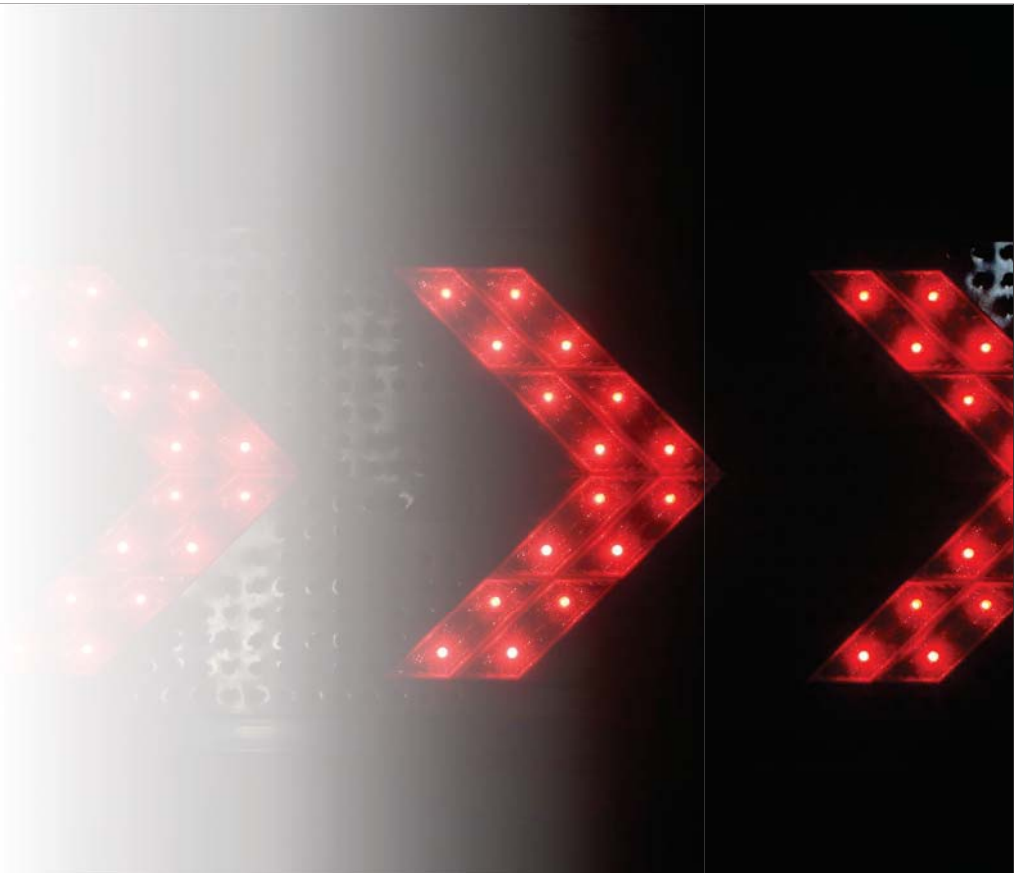
- Muscular pain or Fibromyalgia
- Piriformis syndrome
- Hip osteoarthritis

- Urits I et al. Low Back Pain, a Comprehensive Review: Pathophysiology, Diagnosis, and Treatment. Current Pain and Headache Reports 2019; 23: 23.

Red Flags

- Wide variety of red flags are provided in literature/guidelines for low back pain
- Typically lists are based on consensus rather than evidence based studies

o Verhagen AP, Downie A, Popal C, Maher, and Koes BW. Red flags presented in current low back pain guidelines: A review. Eur Spine J 2016; 25: 2788-2802.



Red Flags

- Cauda Equina Syndrome
- Severe Unremitting Worsening of Pain
- Significant Trauma
- Weight Loss, Fever, History of Cancer or HIV
- Use of IV Drugs or Steroids
- Patient > 50 years of age (esp. > 65 years of age) -> First Episode of Severe Low Back Pain
- Widespread Neurological Signs

o Accelerating Change Transformation Team, 2017. *Evidence-Informed Primary Care of Management of Low Back Pain. Clinical Practice Guideline 3rd Edition*. [online] actt.albertadoctors.org/CPGs/Lists/CPGDocumentList/LBP-guideline.pdf [accessed March 27, 2021].

Red Flags

A review of guidelines found 46 discrete red flags related to 4 main categories of serious pathology

- Malignancy
- Fracture
- Cauda Equina Syndrome
- Infection

o Verhagen AP, Downie A, Popal C, Maher, and Koes BW. Red flags presented in current low back pain guidelines: A review. Eur Spine J 2016; 25: 2788-2802.

Serious Pathology in Primary Care

Table 2. Prevalence of serious spinal pathology among the 1,172 patients with acute low back pain presenting to a primary care setting

Pathology	No. of cases of confirmed pathology	Prevalence (95% CI)*
Spinal fracture	8	0.7 (0.4–1.3)
Cancer	0	0.0 (0.0–0.3)
Infection	0	0.0 (0.0–0.3)
Cauda equina syndrome	1	0.1 (0.0–0.5)
Inflammatory disorder	2	0.2 (0.1–0.6)
Total	11	0.9 (0.5–1.7)

* 95% CI = 95% confidence interval.

o Henschke N et al. Prevalence of and Screening for Serious Spinal Pathology in Patients Presenting to Primary Care Settings with Acute Low Back Pain. Arthritis & Rheumatism 2009; 60 (10): 3072-3080.

Serious Pathology in Primary Care

Table 3. Diagnostic accuracy of recommended “red flag” questions for detecting spinal fracture in the 1,172 patients with acute low back pain*

Red flag question	No. (%) red flag positive	Sensitivity, %	Specificity, %	Positive LR (95% CI)	Negative LR (95% CI)
Age >70 years	56 (4.8)	50	96	11.19 (4.65–19.48)	0.52 (0.23–0.82)
Significant trauma (major in young, minor in elderly)	31 (2.6)	25	98	10.03 (2.76–26.36)	0.77 (0.42–0.95)
Prolonged use of corticosteroids	8 (0.7)	25	100	48.50 (11.62–165.22)	0.75 (0.41–0.93)
Sensory level (altered sensation from trunk down)	19 (1.6)	0	98	0.00 (0.00–21.01)	1.02 (1.02–1.03)
Clinician diagnosis of fracture	7 (0.6)	50	100	194.00 (52.10–653.61)	0.50 (0.22–0.79)

* LR = likelihood ratio; 95% CI = 95% confidence interval.

- Henschke N et al. Prevalence of and Screening for Serious Spinal Pathology in Patients Presenting to Primary Care Settings with Acute Low Back Pain. *Arthritis & Rheumatism* 2009; 60 (10): 3072-3080.



Serious Pathology in the Emergency Department

- Vertebral Fractures: 0.0-4.2%, in retrospective studies up to 7.4%
- Cancer: 0.5-4.2%
- Infectious disorders: 0.0-0.6%, in retrospective studies up to 1.9%
- Spinal cord pathology or cauda equina compression: 1.9%
- Vascular pathologies: 0.0-0.9%

- Galliker G et al. Low Back Pain in the Emergency Department: Prevalence of Serious Spinal Pathologies and Diagnostic Accuracy of Red Flags. *The American Journal of Medicine* 2020; 133: 60-72.



Serious Pathology in the Emergency Department

84 potential red flags for diagnosis of 12 serious pathologies investigated

Red flags with good diagnostic accuracy (LR+>10):

- Spinal Cancer: Suspicion and/or history of cancer
- Epidural Abscess: IV drug use, indwelling vascular catheter, other infection site
- Any Serious Outcome: Bladder/suprapubic fullness on physical exam, anemia
- Vertebral Fracture: History of trauma + neurological signs

o Galliker G et al. Low Back Pain in the Emergency Department: Prevalence of Serious Spinal Pathologies and Diagnostic Accuracy of Red Flags. The American Journal of Medicine 2020; 133: 60-72.



Thank You