Spine Pain

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KEY POINTS FROM THIS ARTICLE:

1) "Spinal pain, and especially low back pain (LBP), represent the second leading cause for a medical consultation in a primary care setting and is a leading cause of disability worldwide."

2) Low back pain (LBP) is the 2nd leading cause of disability worldwide. About 1% of the world population is disabled with low back pain.

3) The resolution of chronic LBP can occur in less than 5–10% of cases.

4) Acute nonspecific back pain is *NOT* a benign, transient and self-limiting condition. Its rate of one-year recurrence is 20–44%, and a lifetime recurrence of up to 72%.

5) The most frequent cause of LBP is "internal disc disruption (IDD) and is referred to as discogenic pain." **[Key Point]** "Internal disc disruption refers to annular fissures, disc collapse and mechanical failure, with no significant modification of external disc shape, with or without endplates changes."

6) Discogenic pain is "considered as the most frequent cause of chronic low back pain." Discogenic pain secondary to internal disc disruption is the main cause of chronic LBP and disability.

7) Both discogenic and radicular pain have either a mechanical and/or inflammatory genesis.

8) Advanced spinal imaging is "not sufficient for a definitive diagnosis because similar findings could be present in either asymptomatic and symptomatic subjects."

9) The posterior disc annulus and cartilaginous end plates are innervated by the sinuvertebral nerves. The sinuvertebral nerve is formed by the union of the grey ramus communicans [post ganglionic sympathetic efferents] and a small branch from the anterior primary ramus of the spinal nerve. **[Sympathetic Innervation]**

10) "Sympathetic trunks and ganglia directly innervate the anterior longitudinal ligament (ALL), the anterior periostium and vertebral body, the paravertebral muscles and fascia as well as the anterolateral disc." **[Sympathetic Innervation]**

11) Sympathetic nerves "directly or indirectly supply all of the anterior spine" structures. **[Sympathetic Innervation]**

12) Facet Pain

- The richly innervated facet joints can be a direct source of pain, and facet degenerative changes cause compression of nerve roots in lateral recesses and in the neural foramina.

- The facets joints have a double innervation, somatic and autonomic.

- Facets are innervated by the medial branches of the posterior primary rami of the spinal nerves.

- Each medial branch innervates the facet joints at its own level and at the level below.

- Facet pain is well-localized local pain.

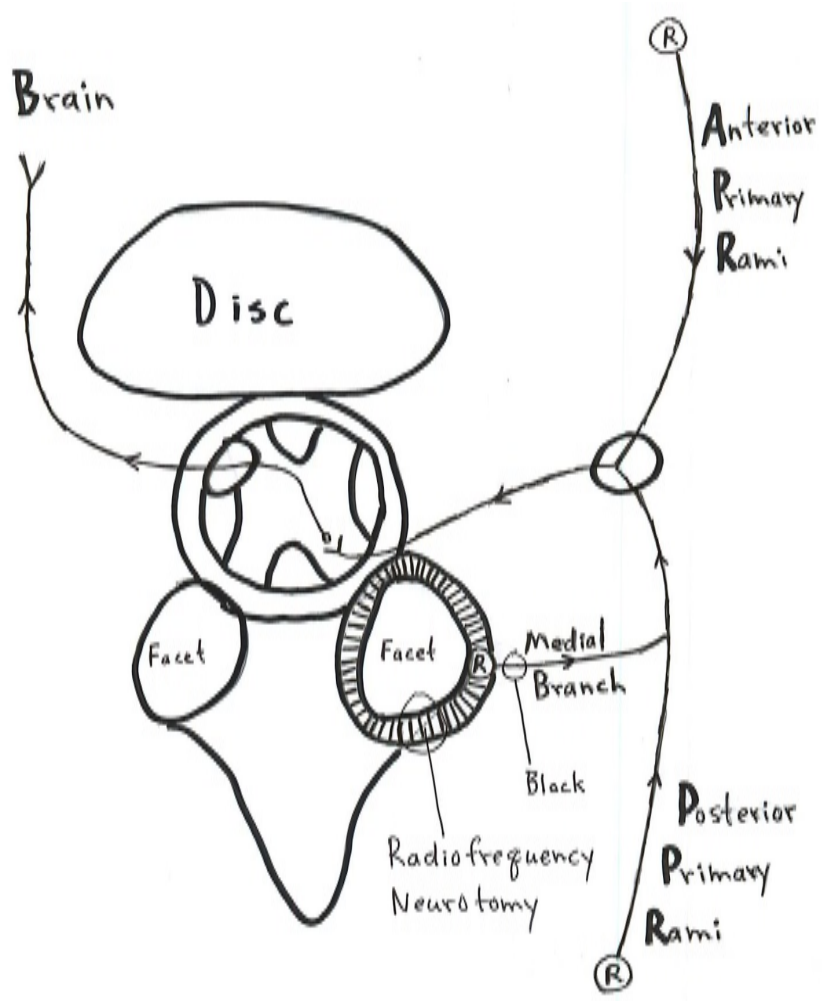
- The autonomic innervation of the facets is responsible for referred pain. This referred pain is diffuse and poorly localized into deep tissues of a somatome [sclerotome]. "A somatome [sclerotome] includes all tissues having the same embryological origin that also share common neural circuits and can also share pathways of sensory referral."

- "A possible cause of back and referred pain is pain emanating from the zygapophysial joints." Z-joints are the second most important spinal pain generators. "The origin of pain from the facets has had a prevalence of 15–52% among subjects complaining of chronic lumbar pain."

- "The facet joint degeneration is also a frequent cause of radicular pain by compression of the nerve roots in lateral recesses and in the foramina secondary to hypertrophic and osteophytic remodeling of the facets, subluxation, joint effusion with capsular tension, and synovial cysts."

- "There are no features, on history or clinical examination, whereby lumbar zygapophysial joint pain can be diagnosed clinically, nor specific symptoms correlating with the positive responses to diagnostic joint injections, but a patient who experiences pain during standing and walking, relieved by sitting and worsened by ipsilateral extension and palpation is suspect."

- "Controlled diagnostic blocks [of the medial branch of the posterior primary rami] are the only means of making a diagnosis of zygapophysial joint pain".



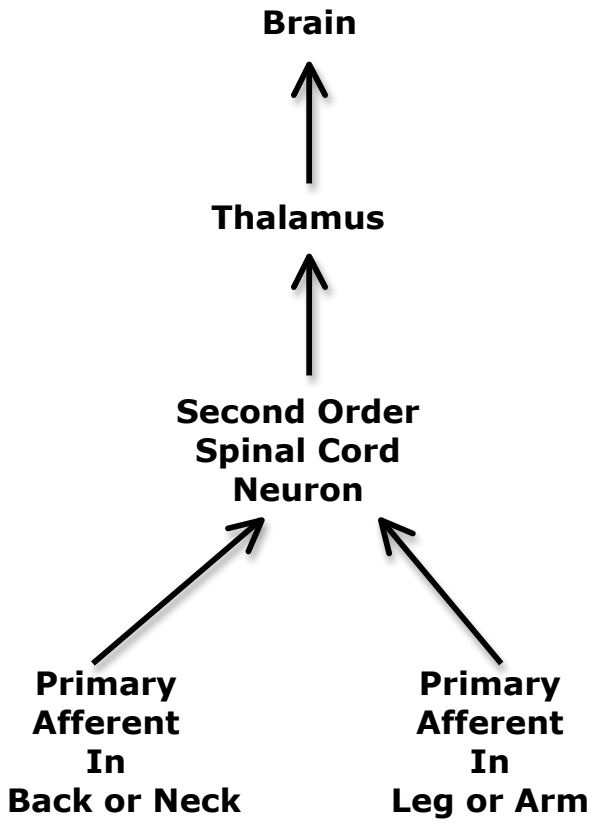
13) "The syndrome of acute locked back is thought to be due to entrapment of fibroadipose meniscoid or their fragment within the facet joint."

14) Sympathetic ***a****fferents* innervate the lumbar discs L2-3-4-5 and transmit pain via the sympathetic chain to the L2 spinal level. Consequently, referred pain from all lumbar spinal levels concentrate within the somatomes of the L2 nerve root. "Local anesthetic blocks of the L2 nerve root can relieve a [lower lumbar] discogenic LBP."

15) Referred pain is triggered by stimulation of the nociceptive receptors.

- Referred pain occurs with the convergence of peripheral neurons from different sites onto a common 2nd-order neuron within the dorsal horn of the spinal cord. "The brain can be incapable of distinguishing the exact source of a sensory input arriving onto the common neuron."

- Referred lumbar pain generally does not extend below the knee. Referred cervical facet pain generally does not extend below to the elbow.



These tissues had a shared neuromere during embryological development

16) Pain starts in peripheral receptors and is transferred along nociceptive neurons or along wide dynamic range (WDR) neurons (which can transmit either nociceptive or non-nociceptive information).

17) Wind-Up Pain

- Chronic stimulation of pain neurons promotes an excessive release of substance-P and glutamate into synaptic spaces of the dorsal horns of the spinal cord.

- Glutamate attaches to the N-methyl-d-aspartate (NMDA) receptors of postsynaptic membranes, promoting an influx of Ca++ ions.

- Ca++ ions activate the production of nitric oxide.

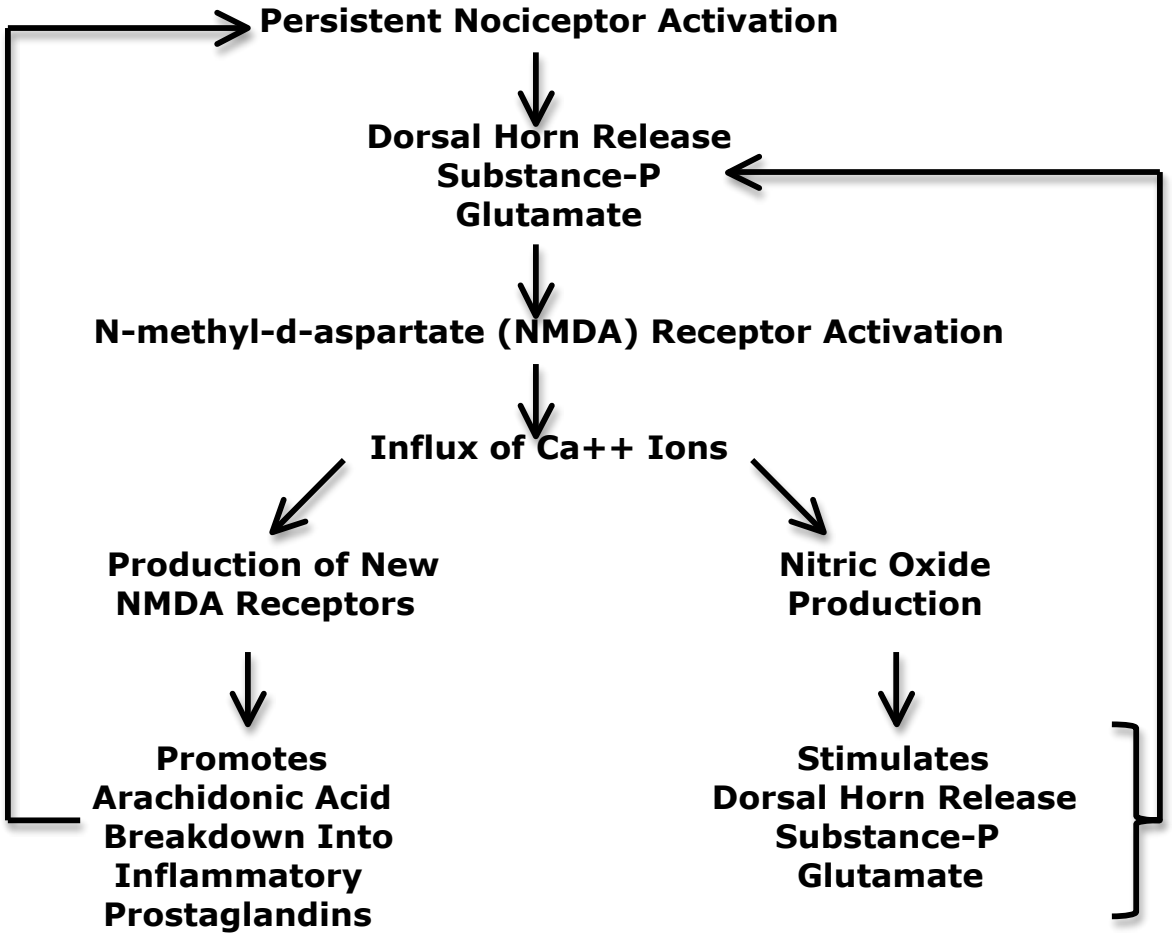
- Nitric oxide stimulates the further presynaptic release of substance-P (SP) and glutamate creating a self-maintaining feedback circle.

- At the same time, activation of the NMDA receptors induces a production of new NMDA membrane receptors.

- NMDA receptor activation also promotes the breakdown of arachidonic acid to inflammatory prostaglandins.

- Inflammatory prostaglandins activate the peripheral nociceptors.

Wind-Up Pain



18) Chronic LBP patients have
- Impaired motion
- Spinal repositioning errors
- Postural imbalance
- Early muscle fatigue
- The absence of muscle relaxation at full lumbar flexion

19) Patients with psychological distress can develop an abnormal spinal motion control that can elicit progressive chronic pain in absence of spinal injury.

20) Stability is required for correct function of the spine. "Degenerative instability is a common cause of axial and radicular pain and disability." Degenerative instability is often misdiagnosed, and is a frequent indication for surgery.

21) "Mechanical receptors located within discs, ligaments and joint capsules convey to CNS proprioceptive inputs on the spatial position, the loading status and the movement of each motion segment." Damage to any spinal structures and receptors generate altered inputs for the CNS that promote an inappropriate muscle

action and elicit an abnormal peripheral feedback response, creating a vicious circle of muscle and joint stress, chronic dysfunction and pain.
[Key Concept]

22) Spinal degeneration evolves in three phases:

- Dysfunction phase
  Intermittent nonspecific low back pain appears at the initial changes in the discs and facet joints.

- Instability phase
  Facet cartilage degeneration and disc space narrowing leads to ligament impairment and abnormal vertebral movement and alignment: "at this stage the pain can become more persistent."

- Re-Stabilization phase
  Re-stabilization phase is associated with significant disc collapse, claw osteophytes, facet and end plate sclerosis and arthrosis between the spinous processes.

23) Movement disorders usually begin in the disc, then extend to the facets of the same motion segment, and then extend to adjacent segments, creating a regional pathological segmental dysfunction.

24) Traction spurs are the consequence of increased tensile stresses exerted by the anterior longitudinal ligaments and Sharpey's fibers provoked by increased abnormal movements.

25) "Conventional static imaging cannot be reliable in assessing spinal instability."

26) "Open MR systems allow positional-dynamic studies in either standing or seated positions to detect increased and abnormal intersegmental movements."

27) "Dynamic radiographs remain the most commonly used reference before surgery because of the feasibility and lower cost."

28) Discogenic pain

- "Only in a limited percentage of cases is back pain due to a disc herniation." "As few as 1% of the cases of LBP are due to nerve root compression."

- "The most frequent cause of nonspecific lumbar axial spinal pain is believed to be the discogenic pain due to internal disruption of the disc (IDD)."

- In a normal disc, nociceptive and proprioceptive nerves are found in the outermost few millimeters, the 2–3 most external lamellae of the annulus fibrosus.

- In a very degenerated disc, nerves may reach the nucleus. "Neural ingrowth into the disc is an important factor contributing to discogenic pain." "Neoinnervation is significantly greater in painful discs than in degenerated asymptomatic discs."

- Because the disc is innervated with post-ganglionic sympathetic efferents and sympathetic afferent nerve fibers, "discogenic pain is a kind a visceral pain."

29) Early internal disc derangement is a radial tear of the annulus. The repair and healing of this injury includes the development of a "densely vascularized and innervated granulation tissue." This focal damage and inflammation of the annulus leads to a progressive inflammatory degradation of the entire disc matrix.

30) "Vertebral endplates are subject to fatigue failures under repeated loads during normal daily work activities." "The end-plate fracture can initiate the biophysical and biochemical changes of internal disc disruption," including the inflammatory degradation of disc matrix, and antigenic responses with the disc nucleus. "Whatever the cause of the internal disc disruption is, the disc becomes and remains painful for mechanical and chemical sensitization mechanisms."

31) "More than from mechanical factors, pain sensitization mainly depends on inflammatory mechanisms." **[Important, balance omega-6/omega-3 ratio]**

32) "There is no way to definitely clinically diagnose internal disc disruption: the diagnosis can be based on the reproduction of the typical patient's pain by discography."

33) "The endplates have a similar density of innervation to the annulus and are another important source of lumbar discogenic pain."

34) "Current evidence considers MRI as a valuable diagnostic tool for assessing disc morphology that avoids the expense and invasiveness of discography; it can be considered the study of choice for the evaluation of patients with LBP."

35) "Discography remains a presurgical invasive technique reserved for patients with persistent presumed discogenic pain, unresponsive to conservative management."

36) Radicular pain is evoked by an inflamed dorsal root or dorsal root ganglion. "Radicular pain is generated by ectopic discharges within an irritated spinal nerve or in its dorsal root or ganglion."

- The most frequent cause of radicular pain is disc herniation and/or canal stenosis.

- "Radicular pain is a pain radiating from the spine into the dermatome of a nerve root and can be associated or not with radiculopathy. Radiculopathy consists

in a block of conduction in sensory axons, causing numbness, or in motor axons, causing weakness: it does not provoke pain."

- Radicular pain's most frequent causes the disc herniation and canal stenosis. "Disc herniation is the single most common cause of radicular pain." Radicular pain can occur as a consequence of disc inflammation, such as PGE2 and/or IL-6.

- "Axial spinal pain and referred pain are common, but radicular pain is not. Although overestimated in the past, the real prevalence of radicular pain is only 12% or less of cases."

- "Radicular pain is lancinating, shooting down along a narrow well localized band, whereas the somatic referred pain starts in the back and spreads into the buttock and thigh within a larger and ill-localized, deep area, where it is usually less intense than the axial component."

- "The other main cause of radicular pain is central and lateral canal stenosis and foramenal stenosis."

37) In patients with disc herniation and radiculopathy, high levels of disc phospholipase A2 is found. Phospholipase A2 is "involved in the production of arachidonic acid, leukotrienes and prostaglandins."

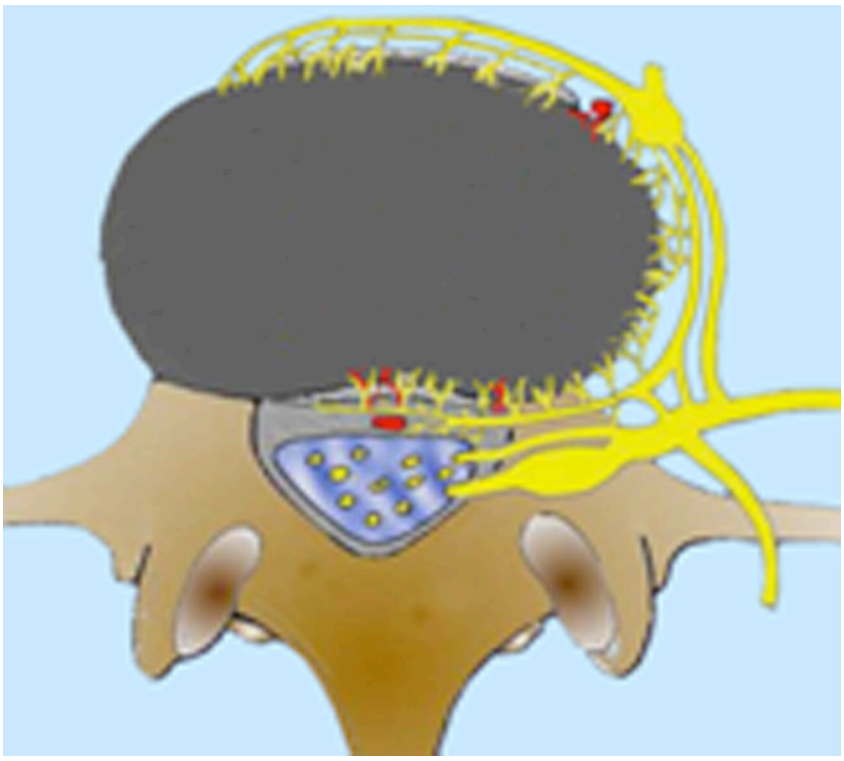
38) "Herniated discs attract macrophages, lymphocytes and fibroblasts which produce a variety of chemical mediators including phospholipase A2, prostaglandins, nitric oxide, interleukins, TNF-alpha."

39) "Axial loaded MRIs can detect changes in the dural sac cross- sectional area which conventional studies cannot demonstrate. Upright MRIs allow patients to reproduce the positions that elicit their symptoms and also may uncover MRI findings that were not visible with routine supine imaging."

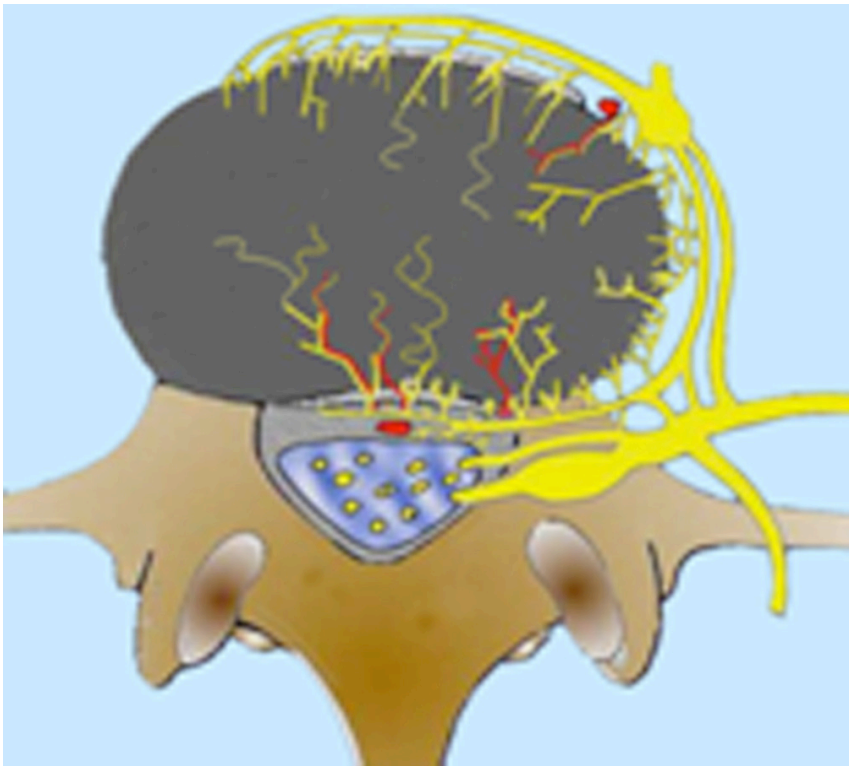
40) Degenerative changes and abnormal movements are very often present in asymptomatic individuals.

41) No imaging modality is considered to be a gold standard to diagnose the pain source in chronic low back pain.

COMMENTS FROM DAN MURPHY: key concepts from this article include:
- Compressive neuropathology is quite rare in clinical practice
- Most chronic low back pain is discogenic from internal disc disruption
- Degenerated discs have pain nerves that migrate deeper into the annulus/nuc
- Disc pain thresholds are altered by inflammatory molecules
- An inflamed disc is more likely to generate pain when mechanically stressed
- In makes sense to manage these chronic patients with improved mechanics and anti-inflammatory protocols



Normal Disc With Peripheral Innervation



Degenerated Disc With Neoneuralization