Degenerative Spine 1: The Aging Spine

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Outline

- How does our spine change with age?
- Natural history of axial back/neck pain
- Discogenic versus facet degeneration
- Osteoporosis
- Medical Treatment options
- Surgical Treatment options
- Surgical Approach

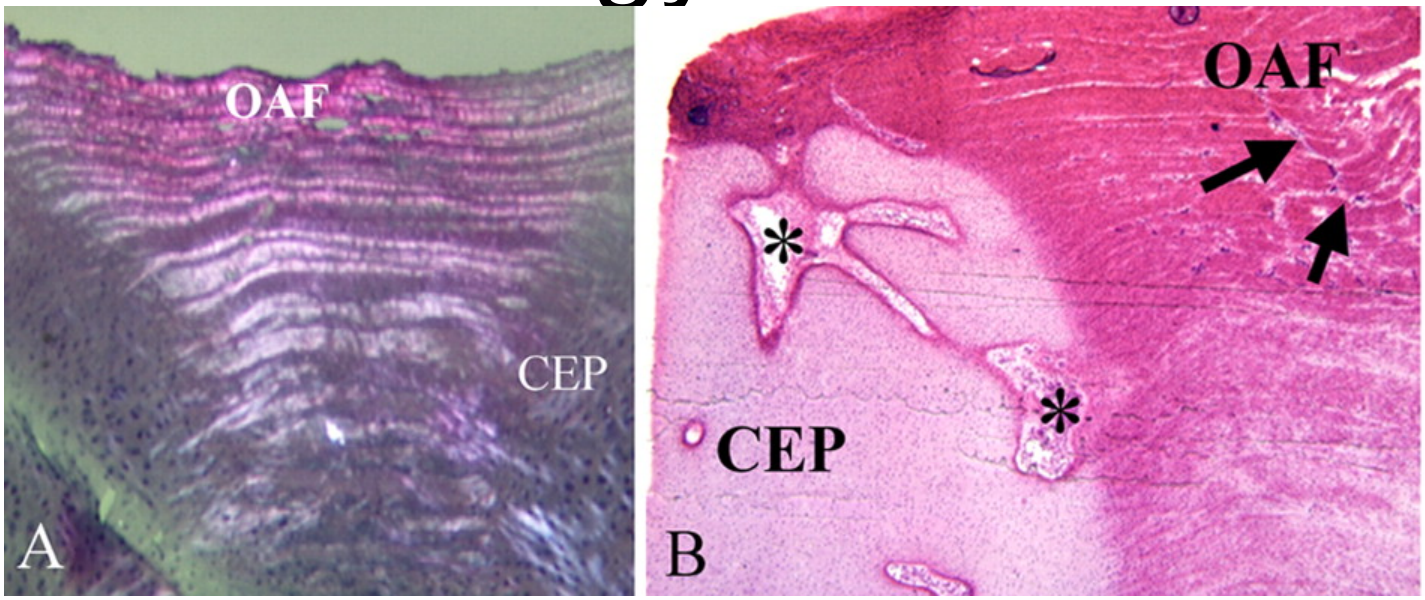
Important issues in thinking about the aging spine

- Precarious nutritional status of the intervertebral disc
- Changes in the intervertebral disc leading to change in the distribution of stresses on the spinal column
- Compensatory facet changes and development of osteoarthritic changes
- Bony spur development and osteoarthritic changes of the facet complex resulting in foraminal or spinal canal stenosis
- Degenerative changes can occur without pain

Epidemiology of disc degeneration

- Physical loading due to occupation/sports plays a **minor role**
- Heredity plays a **major role**, note that great variability in degenerative changes occur within the age groups and high degree of similarity in twins
- Degenerative changes in women lag behind those in men by 10 years
- The only chemical exposure associated with disc degeneration is **smokin**g

Histology of the Disc



The intervertebral disc is a cartilagenous articulating structure between the vertebral bodies that allows movement (flexion, extension, rotation)

Outer annulus fibrosus (OAF) surrounds the central nucelus pulposus

Collagen fibers continue from the annulus into the adjacent tissues, tying this fibrocartilaginous structure to the vertebral bodies at its rim, to the longitudinal ligaments anteriorly and posteriorly, and to the hyaline cartilage end plates superiorly and inferiorly (CEP)

The Normal Adult Disc

- Large amount of extracellular matrix with only 1% cellular component
- 2 cell populations:

Elongated fibroblast-like cells in the annulus and cartilagenous end-plate

- Produce Type I and II collagen

Rounded or oval chondrocyte like cells

in the nucleus pulposus

- Produce Type II collagen only

- Elastin comprises only 2% of dry weight but occupies specific location between lamellae of the annulus
- Nerves and blood vessels are restricted to the outer few millimeters of the annulus

The Aging Disc

- The number of vascular channels perforating the osseous vertebral end plate diminishes drastically between six and thirty months of age
- Lamellar organization becomes more complex with interdigitations and more bifurcations
- Cell proliferation, cluster formation, and a greater level of cell death also occur
- Loss of demarcation between the annulus and the nucleus also increasingly occurs with age, from the second decade onward
- Structural dis-organization of the cartilage end plate, including cracks, thinning of the end plate, altered cell density
- Microfracture in the adjacent subchondral bone, and bone sclerosis
- Increased number and extent of clefts and tears, the presence of granular material, and neovascularization from the outer aspect of the annulus inwards
- Nuclear fibrous transformation, anular disorganization, as well as endplate and vertebral body alterations precede the formation of tears and clefts in the intervertebral disc

Macroscopic changes in lumbar disc degeneration

Nucleus Pulposus
- fibrous transformation
- cleft formation
- brown discolouration
- calcification

Annulus Fibrosus
- annular disorganization
- rim lesions
- radial tears
- concentric tears
- brown discolouration
- calcification
- herniation

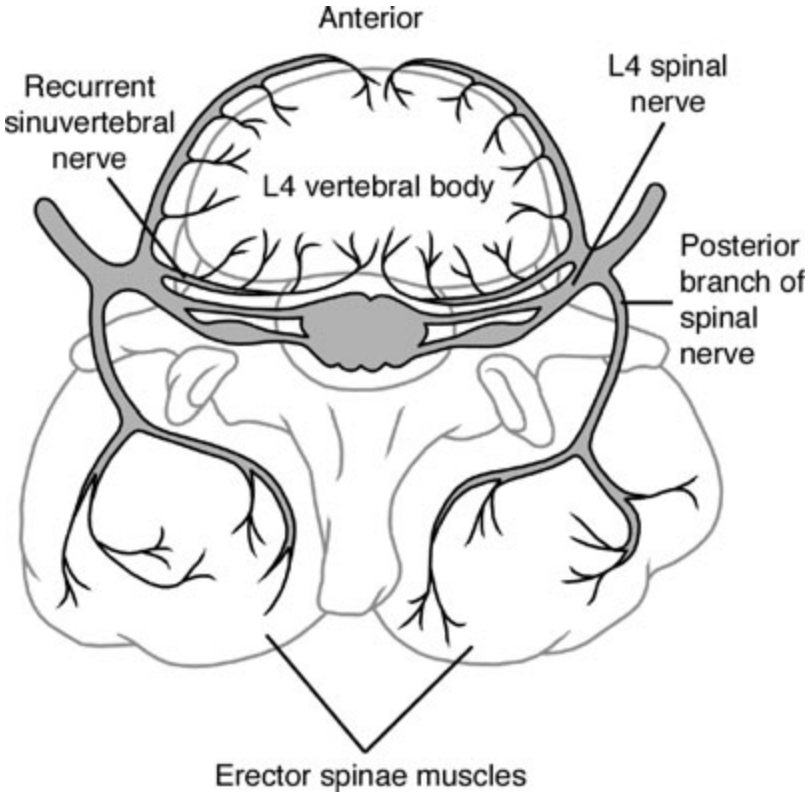
End Plate
- focal defects in cartilage to complete resorption
- fractures
- osteophyte formation
- subchondral sclerosis

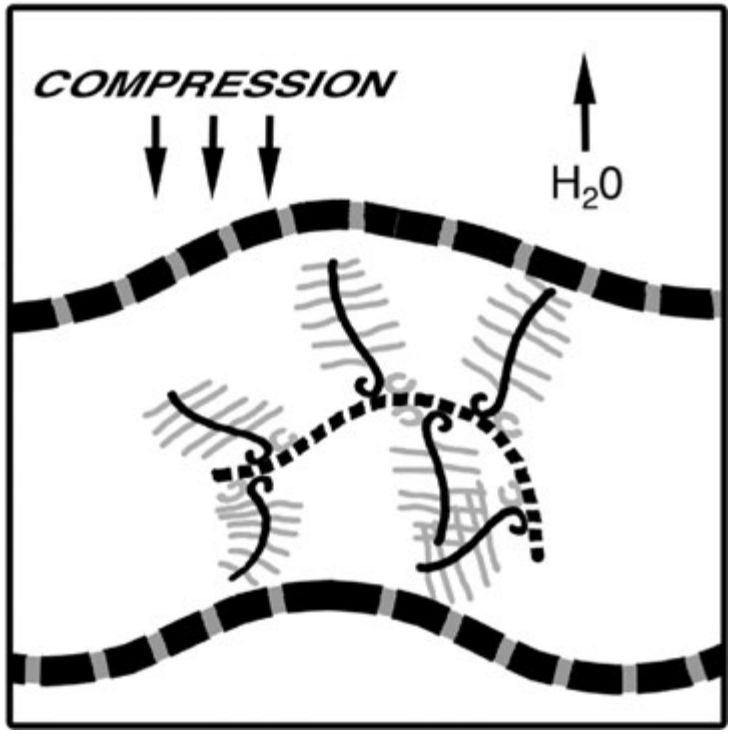
Changes with Disc Degeneration

- Most important biochemical change is **loss of glycosaminoglycans** from degradation of aggrecan molecules. This loss is responsible for a fall in osmotic pressure of the disc matrix and thus a loss in hydration

- Disc-cell proliferation and cell-cluster formation occur
- Increased cell death (possibly by both apoptosis and necrosis)
- Molecular changes are also seen, such as increased production of cytokines and matrix-degrading enzymes

How does disc degeneration result in pain?





Loss of proteoglycans leads to lower osmotic pressure in the disc, thus the disc Is less able to maintain hydration under load. Inappropriate stress concentrations along the endplate or in the annulus

Other effects of disc degeneration

Rapid loss of disc height under load in degenerate discs causes the following:

1. apophyseal joints adjacent to disc may be subject to abnormal loads and eventually develop **osteoarthritic changes**

2. reduction in the tensional forces on the ligamentum flavum and hence may cause remodeling and thickening. With consequent loss of elasticity, the ligament will tend to bulge into the spinal canal, leading to **spinal stenosis.**

Mechanical Back Pain

- 80% of the population experience low back pain in their lifetime
- Most patients improve within the first month and 90% symptom free at 3 months
- Important to rule out non-mechanical back pain (Red Flags: fever, weight loss, continuous stiffness, acute bone pain, and pain at rest)

Why are facets painful?

- Free and encapsulated nerve endings in facet joints as well as nerves containing substance P and calcitonin gene-related peptide.
- Facet-joint capsules contain low-threshold mechanoreceptors, mechanically sensitive nociceptors, and silent nociceptors.
- Excessive capsule stretch activates nociceptors, leads to prolonged neural afterdischarges, and can cause damage to the capsule and to axons in the capsule
- Inflammation leads to decreased thresholds of nerve endings in facet capsules as well as elevated baseline discharge rates.

Lumbar Facet Pain

The following in support of lumbar facet pain of capsular origin:

(1) a population of high-threshold, small-diameter sensory neurons in the capsule,

(2) sensitization and increased discharge of facet-joint neurons in the presence of inflammation

(3) demonstration of the effects of substance P on these neurons

(4) substance P-containing nerves in subchondral bone in osteoarthritic facet joints

Schwarzer et al. injected the lumbar facet joints of 176 patients who had nonspecific low-back pain and no definitive radiologic findings. Of these patients, 15% had pain relief with a shorter-acting anesthetic (lignocaine) and 50% improvement in pain with a longer-acting anesthetic (bupivacaine).

Cervical Facet Pain

- The incidence of cervical facet pain is greater than that of lumbar facet pain.
- Approximately 55% of patients with chronic, nonspecific cervical spinal pain have pain of facet origin
- In a study reported by Aprill and Bogduk, 128 patients with chronic neck pain underwent diagnostic blocks to the cervical facets; eighty-two obtained complete relief of pain.

How to distinguish facet pain from discogenic pain?

Medical Management of Degenerative Spinal Conditions

Diagnsosis	Management
Degenerative discs and facet joints	Exercises for muscle support, anti-inflammatory medications, braces. If the initial pain is severe, a short period of bed rest may be necessary to control the acute pain, with gradual return of activities as soon as possible
Spinal Stenosis	anti-inflammatory medicines, exercise, and physical therapy, local anesthesia
Herniated Lumbar disc	restriction of activity, non-steroidal anti-inflammatory medications, short periods of bed rest. If the pain is particularly severe, then exercise and physical therapy are considered

Surgical Intervention for chronic low back pain without stenosis or spondylolithesis

Lumbar fusion is recommended for disabling LBP due to one- or two-level degenerative disease

Posterolateral fusion or an interbody fusion (PLIF, TLIF, or ALIF)

An interbody graft is an option to improve fusion rates and functional outcome (marginal improvement)

Osteoporosis

- A generalized bone disorder caused by loss of bone mass that causes bone fragility
- Occurs most commonly in the elderly and postmenopausal women

A reduction in the number, thickness, and interconnectivity of vertebral trabeculae in combination with altered load transmission across the degenerated disc predisposes a vertebral body to fracture from minor trauma

Osteoporosis

- **Risk Factors:** alcohol abuse, smoking, immobilization and lack of exercise, excessive exercise with weight loss and amenorrhea, corticosteroids, thyroid hormone, anticonvulsant, Turner's syndrome and Klinefelter's syndrome

Osteoporosis

Osteoporotic Vertebral Fractures

Hx –

- Localized pain in back sometimes associated with radicular radiation
- Weightbearing aggrevates the pain
- Rest improves the pain
- Healing and continued pain may last 4-8wks

Px – Dorsal kyphosis (Widow's hump)

Height loss

Osteoporosis

Medical Management

- Oral calcium supplementation (1 – 2 grams of elemental calcium per day)
- Estrogen 0.625 micrograms/day x 3-4wks
  add Androgen therapy in elderly men
- Vitamin D 1000 IU daily
- Fosamax
- Limit modifiable risk factors
- Regular aerobic and anaerobic excercise
- TLSO/Jewett Brace to prevent further vertebral compressions

Osteoporosis

Surgical Management

Kyphoplasty (percutaneous injection of Methyl Acrylic into compression fracture)

- Pain relief
- Durable reduction of deformity

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