Cartilage In Health and Disease (Degeneration): 2013

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Terminology

Degenerative Joint Disease

DJD

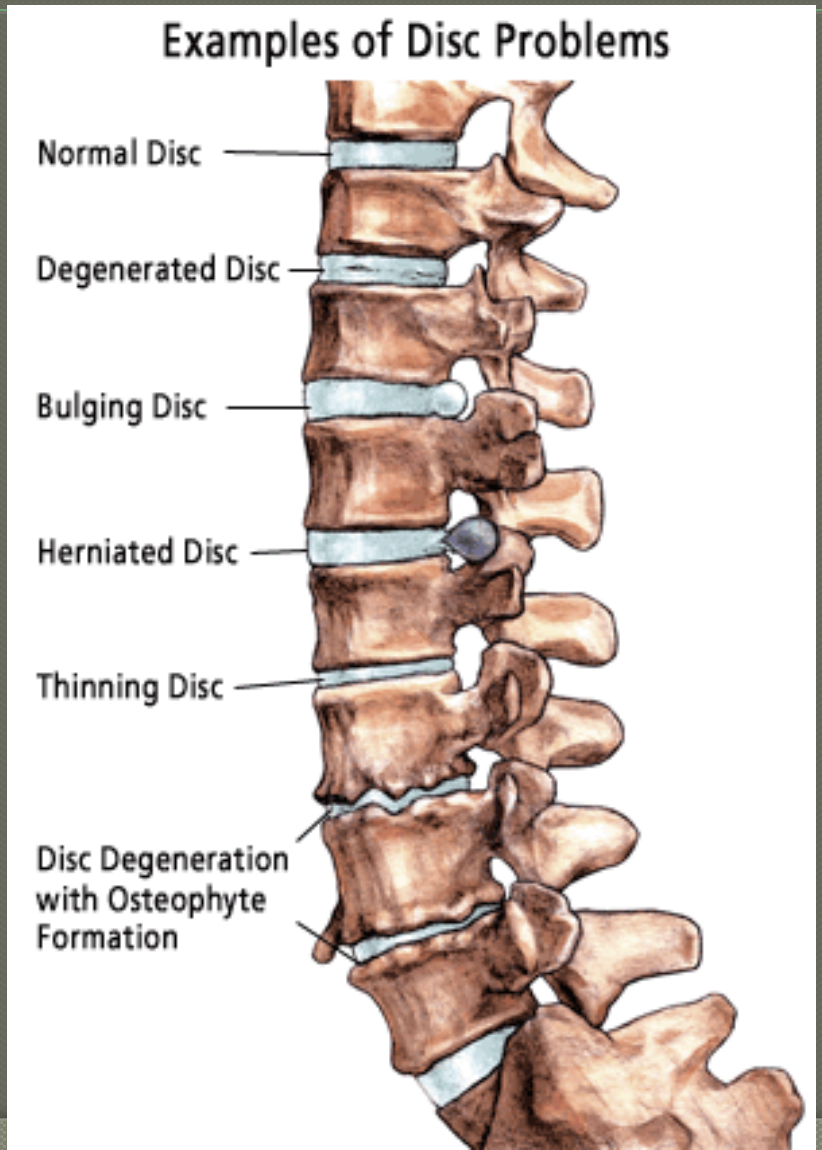
Osteoarthritis

OA

Spine

- Disc/Body
- Uncovertebral joints
- Facet joints

Spectrum of DDD



Disc/Body

- Degenerative Disc Disease/DDD
  - End-plate
  - Disc

End-plate

- Spondylosis
  - Osteophytes/spondylophytes
    - Traction spur: early change
    - Claw osteophyte: late change

Disc

- Intervertebral osteochondrosis
  - Loss of disc height
  - Vacuum phenomenon
  - Disc calcification
  - Posterior spur/osteocartilagenous ridge

Complications

- Degenerative spondylolisthesis
- Degenerative retrolisthesis
- Spinal stenosis

DJD Facts

- Scientific studies suggest that spondylosis deformans is the consequence of normal aging, whereas intervertebral osteochondrosis (AKA deteriorated disc), results from a clearly pathologic process with (or without) symptoms.
  - J Bone Jnt Surg 1962; 44: 243-68
  - Acta Ortop Scan 1985; 56: 496-99
  - Cin Orthop Rl Res 1987; 224: 97-104
  - Spine 2004; 4(6suppl): 167s-72s

Uncinates and facets

- Osteoarthritis or arthrosis

Causes of DDD: Disc Nutrition

- Morphologic changes in the endplate which occur with advancing age or degeneration can interfere with normal disc nutrition and further the degenerative process (cont. next slide)

Causes of DDD: Disc Nutrition

- These changes then alter the integrity of the proteoglycans and water concentration, reducing the number of viable cells with subsequent alteration in the movement of solutes into and out of the disc.
  - Pain 2004; 112: 225-8

Glucosamine Protects the End-plate

- This study shows that Glucosamine protects against subchondral bone change during the development of OA.
  - Arth & Rhuem 2007; 56: 1537-48

Glucosamine Shown effective

- Glucosamine sulfate at oral doses of 1500 mg daily is more effective than placebo in treating symptoms of knee OA.
  - Arth & Rheum 2007; 56: 555-67

Chondroitin Sulfate/Glucosamine More Effective Together

- CS/Glu mixtures act synergistically in reversing damage and promoting repair to cartilage
  - Osteoarthritis Cartilage 2006 Aug;14(8):793-806

Methylsulfonylmethane (MSM)

- MSM improved symptoms of pain and physical function in OA without major adverse affects
  - Osteoarthritis Cartilage 2006 Mar;14(3):286-94
  - Osteoarthritis Cartilage 2008 Nov;16(11):1277-88

Glucosamine/MSM Together

- Glu/MSM and their combination produced an analgesics and anti-inflammatory effect in OA.
  - Clin Drug Invets 2004;24(6):353-63

Estrogen Protects Cartilage

- Results suggest that estrogen has a protective effect on cartilage by direct inhibition of the catabolic (breakdown) function of chondrocytes.
  - Arth & Rheum 2006; 54: 2441-51

Causes of DDD: Atherosclerosis?

- The importance of normal blood flow to the IVD complex has been suggested to explain the association of atherosclerosis and aortic calcification with increased disc degeneration and subjective low back pain.
  - Spine 1997; 22: 1642-47

Causes of DDD: Genetic Predisposition?

- In addition to mechanical and nutritional causes, a genetic predisposition has been suggested by animal models that consistently develop DDD at an early age, as well as by reports of familial OA and lumbar canal stenosis in humans.
  - Arth Rheum 1986; 29: 863-71

Causes of DDD: Genetic Predisposition?

- A study of 115 male identical twins suggested that the development of DDD was strongly influenced by genetics. The authors concluded that DDD may be explained primarily by genetic influences and by unidentified factors.
  - Spine 1995; 20: 26001-12

Causes of DDD: Genetic Predisposition?

- A Danish twin study showed that as the twins grew older the effect of a NON-SHARED environment increased and non-additive genetic effects became more evident suggesting the substantial genetic influence on the susceptibility to DDD.
  - Twin Res 2004; 7: 16-26

Causes of DDD: Genetic Predisposition?

- Type II collagen is the most abundant in cartilage. Two genetic allele substitutions have been associated with DDD. In the case of the Trp3 allele, it is a genetic factor associated with a THREEFOLD INCREASE IN THE RISK OF SYMPTOMATIC DDD.
  - Science 1999; 285: 409-12
  - JAMA 2001; 285: 1886-8
  - JAMA 2001; 285: 1843-9

Patients' Belief of Cause of DJD

- (May have chosen from more than 1 category)
  - Hereditary 38%
  - Wear/Tear 31%
  - Occupation 27%
  - Sport 27%
  - Weather/Environment 24%
  - Age 17%
  - Falls 14%
  - Excess weight 7%
  - Previous accidents 7%
    - Arth Care & Rsrch 2007; 57: 267-71

DJD Facts

- Whatever the etiology, by the age of 50 years, 85%-90% of adults show evidence of DDD at autopsy.
  - Arth Rheum 1979; 8: 261-87

PGs and DDD

- Disc degeneration →
- Decrease in Type II collagen →
- Change in PG composition →
- Decreased water in disc →
- Results in ***ABNORMAL*** disc nutrition

Importance of Water in Cartilage

- Although the tensile strength of the collagen is that of steel wire, it cannot support compressive load since it would fold or crumble. It is the hydrostatic pressure of water bound to proteoglycans, retained and restrained by the collagen meshwork, that gives cartilage its resilience and load bearing properties.
  - Sem In Arth & Rheum 1984; 14(2): 110

PGs and DDD

- The degenerated PG has a higher keratin sulfate to chondroitin sulfate ratio reducing the tensile strength and the disc becomes progressively more fibrous and disorganized.
  - Rehabil 1977; 16: 22-9
  - Orthop Clin N Am 1971; 2: 59-70
  - Arth Rheum 1981; 24: 12-21

GAGs and DDD

- In cadaveric spines, decreased T2 signal in degenerated discs was closely associated with glucoseaminoglycan (GAG) concentration rather than absolute water content.
  - New Orleans Ortho Rsrch Soc; 1994; 166-20

Positive Effects of Motion on DJD

- Subjects (OA and RA) participating in aerobic conditioning exercise showed significant improvement over control subjects who participated in only ROM exercise.
  - Arth Rheum 1984; 32: 1403

Effects of Motion on DJD

- Subjects (OA and RA) participating in conditioning exercise showed significant improvement in exercise endurance, grip strength, flexibility, and number of clinically active joints.
  - Arth Rheum 1984; 32: 1403

Effects of Motion on DJD

- Both aerobic and non-aerobic (ROM) exercise resulted in a decrease in the number of clinically active joints.
  - Arth Rheum 1984; 32: 1403

Vibration and Cartilage

- Vibration allows the HA to be directed evenly among chondrocytes and the extracellular matrix thus improving delivery of nutrients to chondrocytes in deeper layers and improving transportation of waste products.
  - Arth & Rheum 2006; 54: 1897-1905

Adverse Affects of Friction

- Lubrican is a glycoprotein secreted by surface cartilage cells and reduces friction. This study showed that small increases in friction caused decreased lubrican and concludes that minor trauma predisposes to early cartilage degeneration.
  - Arth & Rheum 2007; 57: 3662-9

Chondroitin Sulfate and Friction

- Chondroitin sulfate significantly reduces the friction coefficient of articular cartilage
  - J Biomech 2007;40(8):1847-54

Pre-whiplash Posture Affects Capsular Injury

- Abnormal pre-injury curves enhance the likelyhood of whiplash injury to the facet capsules and predispose to accelerated post traumatic degenerative changes
  - J Biomech June 2005, 38(6):1313-1323

When was X-ray Discovered?

a. 1890
b. 1895
c. 1899
d. 1901

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- A. Hounsefield
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- C. Resnick
- D. Stoller

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- A. Hounsefield (1971)
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- D. Stoller

Lack of Motion Can Cause DJD

- Ely and Mensor showed in 1933 that an immobilized joint will develop cartilage changes similar to those of OA.
  - Surg Gyn Obst 1933; 57: 212-15

Lack of Motion Can Cause DJD

- Immobilization arthropathies are most probably a consequence of nutritional failure. Avascular cartilage, behaving like a water filled sponge, gives off fluid on compression and takes it up on release of pressure. Alternate compression and re-expansion allows supply of nutrients and removal of metabolic waste.
  - Arth Rheum 1984; 14: 122

Lack of Motion and Degeneration

- Cartilage that is not mechanically stimulated will atrophy and even passive motion is beneficial to cartilage regeneration.
  - Arth Care & Rsrch 2006; 55: 493-500
  - J Rheum 1995; 22: 1714-21
  - Structure and Function of Articular Cartilage 2003. pp 73-95

X-ray in Soft Tissue Injury

- Restricted motion.
  - This finding has shown a high incidence of OA within 5 years
  - Am J Med 2001;110(8):651

Cartilage Viable at Any Age

- Tissue cultures of 3 month old rabbits did not differ in any way from chondrocytes from 3 year old rabbits, suggesting retention of chondrogenetic expression despite age.
  - J Rheum 1976; 19: 9-16

Cartilage Viable at Any Age

- A pilot study of human chondrocytes in tissue culture disclosed no differences in morphology in DNA-RNA turnover, proline hydroxylation of collagen, or proteoglycan synthesis in chondrocytes from subjects 65 and older and children under 15.
  - Clin Orth 1971; 75: 248-60

Endplate Changes

- Modic Type I
  - Decreased T1
  - Increased T2
  - Sign of acute degeneration
  - Invariably associated with PAINFUL DISCS
    - Spine 2003; 28: 715-20
    - Radiology 2001; 218: 420-7
    - Eur Spine J 1998; 7: 363-8
    - J Spine Discord 2000; 15: 438-43

Endplate Changes

- Modic Type II
  - Increased T1
  - Isointense T2
  - Represents the endplate changing but is not yet visible on X-ray.
  - IT IS INVOLVED WITH CHANGE IN THE NUTRTION TO THE DISC.

Endplate Changes

- Modic Type III
  - Decreased T1
  - Decreased T2
  - Sclerosis visible on X-ray
  - No active marrow
  - End-stage endplate change

Facet OA

- Synovial villii may become entrapped w/in the joint with resulting joint effusions. The mechanism of pain may be related to nerve root compression from degenerative changes of the facets or by direct irritation of pain fibers from the innervated synovial linings and joint capsule.
  - Radiographics 1987; 7: 923-44

Disc Displacement

- Localized 0-25% of circumference
- Broad based 26%-50% of circumference
- Circumferential 51%-100%

Disc Displacement

- **PROTRUSION**
  - Present if the width of the base is wider than the length of the posterior extension

Disc Displacement

- **EXTRUSION**
  - Present if the width of the base is narrower than the length of the posterior extension

Disc Displacement

- **SEQUSTRATION**
  - Present if the displaced disc material has lost completely any continuity with the parent disc. The sequestered disc may migrate.

Biochemical Changes From Disc Herniation

- Nucleus material in the epidural space caused acute and chronic inflammatory reactions with an influx of histiocytes and fibroblasts.
  - Spine 1987; 12: 760-4

Biochemical Changes From Disc Herniation

- Nucleus applied to a spinal nerve induces a wide variety of functional, vascular, and morphologic abnormalities often followed by intraradicular fibrosis and neural atrophy.
  - Spine 1996; 21: 2539-43
  - Spine 1996; 21: 411-14

Biochemical Changes From Disc Herniation

- Nucleus pulposis against a nerve can cause an inflammatory reaction with leukotaxis and increased vascular permeability.
  - Spine 1995; 20: 665-9

Disc Displacement

- **SCHMORLS NODES**
  - Represent herniations through the endplate and can also be referred to as intravertebral herniations. BONE MARROW EDEMA MAY BE SEEN IN ACUTE INTRAVERTEBRAL HERNIATIONS.

Disc Displacement and F/E

- Extension worsens the degree of central and foraminal stenosis by 11%, while flexion appears to improve it by an average of 11%.
  - Spine 1996; 21: 2412-20

Cause of Pain in Spinal DJD

- Instability with associated disc degeneration, facet or uncovertebral arthropathy
- Mechanical compression of nerve by bone, ligament, or disc
- Biochemical mediators of inflammation and/or pain

Cause of Pain in Spinal DJD

- Mechanical nerve compression results in venous stasis, edema, and eventually fibrosis. The intraneural edema can occur even at low compression pressure levels.
  - Spine 1989; 14: 569-73

Cause of Pain in Spinal DJD

- Mechanical compression itself may also be capable of producing changes in nerve impulses, which could be interpreted by the CNS as pain.
  - Pain 1977; 3: 25-41

Causes of Peripheral Disc Pain

- All AKA's
  - Annular tear
  - Chronic internal disc disruption syndrome
  - Discogenic pain
  - Black disc disease

Causes of Peripheral Disc Pain

- In normal discs the sinuvertebral nerve is only on the periphery. In very degenerated discs, nerves may even penetrate into the nucleus.
  - Lancet 1997; 350: 178-81

Significance of Annular Tears

- Simply an incision of the annulus can produce morphologic and functional changes in the adjacent nerves, such as increased capillaries and reduced nerve conduction velocities.
  - Spine 1996; 21: 2539-43

Consecutive games played by Cal Ripkin

- A. 1132
- B. 1865
- C. 2231
- D. 2632

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Who is Second to Nolan Ryan (5714) for Most Strikeouts?

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Most Hits in MLB History?

- A. Pete Rose
- B. Ty Cobb
- C. Hank Aaron
- D. Willie Mays

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