Degenerative Disc Disease and Low Back Pain

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Causes of Chronic Low Back Pain
Discogenic pain affects 1-2 million between age 45 and 64

Intervertebral disc: 25-40%
Facet Joints: 10-25%
Sacroiliac Joints: 2-30%

Zhang, 2009
Manchikanti, 2001

With age, nucleus loses ability to attract water

Degeneration ≠ Pain

- Where is the pain coming from?
- What is the desired ‘disease modifying activity’?
- Circular reliance between proper diagnosis and effective treatment. Even the best treatment is ineffective in the poorly-selected patient
- Distinguish therapies aimed at prevention (degeneration) versus treatment (pain)
‘For any structure to be deemed a cause of back pain it should have a nerve supply, and be capable of causing pain similar to that seen clinically...’ Bogduk, 1997

Outer Disc Boundaries Contain Both Nociceptive and Proprioceptive Nerve Fibers

Innervation of Annulus Fibrosus

Bogduk, 1981

Innervation of the Vertebral Endplate

Crock, 1986

Bailey et al, 2010

Neo-innervation
Balance Between Repulsion and Attraction

Pressure Matrix - Impermeability, Proteoglycan

Neurotrophins (NGF, BDNF)
Peripheral disc damage plus increased inflammation can sensitize nociceptors.

During inflammation, nociceptors can fire at lower thresholds.

Ozaktay et al., 1995
Cavanaugh, 1996

Annular Pain – Internal Disc Disruption
Fissures Extend to the Outer 30% of annulus
Secondary inflammation with neovascularization appears as a HIZ

Crock, 1986
April, 1992
Peng, 2005

Endplate Defects Trigger Fibrovascular Marrow

Crock, 1986
Ohtori, 2006
Degmetich, 2011

Fibrovascular Marrow is Innervated

PGP9.5 Immunolocalization

Rahme, 2008
Degmetich, 2011
Endplates are more innervated in regions of damage

Endplate Damage is Hard to Visualize with Standard MRI

Cascade of Degeneration and Damage Leads to Neo-innervation

**Injury – Inflammation – Cytokine secretion (IL-1β, TNF-α)**

- NGF secretion – retrograde to DRG
- NGF acts on TrKA-neurons – growth + SP, CGRP
- Matrix damage + chemical sensitization – Pain

**Lotz, 2013**

Ma, 2011 Lee, 2011

Garcia-Cosamalon, 2010
Summary

- Degeneration by itself is non-painful
- Nucleus pulposus is pro-inflammatory
- Peripheral disc damage (of endplate or annulus) can:
  1) trigger neo-innervation;
  2) chemical sensitization; and
  3) mechanical irritation
- Mechanical irritation plus chemical sensitization can cause pain
Summary

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  1) trigger neo-innervation;
  2) chemical sensitization; and
  3) mechanical irritation
- Mechanical irritation plus chemical sensitization can cause pain
- Need better imaging techniques to identify areas of innervated damage

The Vertebral Endplate is also a source of pain

- Endplate is ‘weak link’ during spinal compression
  Adams, 2000; Gallagher, 2005
- Endplate innervation is increased in discogenic pain patients
  Freemont, 2002; Brown, 1997
- Endplates deflect during discography, elevated interosseus pressure can cause pain
  Heggeness, 1993; Esse, 1992
- BML is one of the most specific MRI finding for discography-confirmed discogenic pain
  Braithwaite, 1998; Weishaupt, 2001