Rationale – Imaging of the Painful Disc

1. Links between morphologic changes and discogenic pain not well established.
2. Morphologic features of disc degeneration are common in asymptomatic individuals.
3. Ideally is should be possible to identify the symptomatic disc level before surgery non-invasively.


Outline – Imaging of the Painful Disc

1. Plain films
2. CT discography
3. MRI
4. New developments
Outline – Imaging of the Painful Disc

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Spinal Radiographic Findings and Low Back Pain
Results of a Systematic Review of Observational Studies

<table>
<thead>
<tr>
<th>Findings</th>
<th>Odds Ratios</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disc degeneration</td>
<td>1.2 - 3.3</td>
</tr>
<tr>
<td>Spondylosis</td>
<td>1.05 - 2.03</td>
</tr>
<tr>
<td>Spondylolysis/ Spondylolisthesis</td>
<td>0.33-2.12</td>
</tr>
</tbody>
</table>


Definition of Degenerative Disease and Grading

Disc height loss*
Mild (<33%), moderate (33-66%), severe (>66%)
Using normative databases**

Osteophytes*
<3mm, 3-6 mm and >6 mm

Sclerosis*


Association of low back pain and individual radiographic features

Pain definition:
- Last 4 weeks
- > 1 year

<table>
<thead>
<tr>
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<tr>
<td>Disc space narrowing</td>
<td>2.0-2.2</td>
</tr>
<tr>
<td>Osteophytes</td>
<td>1.5-1.6</td>
</tr>
</tbody>
</table>

(5 but not significant in multi-regression model with DSN)

De Schepper E et al. Spine 2010, 35(5): 531-6

Conclusion
Disc space narrowing is moderately associated with lumbar back pain, in particular if chronic and more than 2 levels are affected
Outline – Imaging of the Painful Disc

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Computed tomography-evaluated features of spinal degeneration: association with self-reported low back pain.

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<th>Odds Ratios</th>
<th>Disc space narrowing</th>
<th>1.44</th>
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<tr>
<td>Spinal stenosis</td>
<td>2.87</td>
<td>(&lt;10 mm at disc level)</td>
<td>but non significant</td>
</tr>
</tbody>
</table>

Conclusion
Degenerative CT findings are very common, only limited correlation between LBP and CT findings, spinal stenosis close to significant


CT discography
Supplemental technique, if other imaging is inconclusive

Indications:
- Surgical management
- Pain > 3 months that does not respond to treatment
- Failed back surgery

Contraindications:
- Bone fusion
- Severe spinal canal compromise (stenosis)
- Anticoagulation, allergy, skin infection

CT discography

**Technique:**
- 3 ml Omnipaque (+/- antibiotic, Ancef)
- Coaxial placement of 18 and 22 gauge needle in the center of the disc
- Injection of 1.5-3 ml of contrast
- Assessment of pathologic and control discs


**Interpretation:**
- PAIN symptoms
  - No pain
  - Pain (partially) concordant
  - Pain discordant
  - Imaging +, no pain = not significant
  - Painful disc, imaging - = inconclusive

CT discography

IMAGING FINDINGS:
Annulus degeneration: (Dallas scale*)

(1) Local <10% inner annulus
(2) Partial <50% outer annulus
(3) Total >50% beyond outer annulus

Grade 3

## Outline – Imaging of the Painful Disc

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### CT discography Controversies

**High false positive rate in prospective studies.**

In patients with chronic pain and psychiatric risk factors, specificity at most 20%.

In healthy patients with no chronic pain and a normal psychiatric profile, the specificity was found to be at most 90%.

*Carragee et al. Spine. 2006 Mar 1;31(5):505-9*


### CT discography Controversies

**Discography resulted in**

- accelerated disc degeneration,
- disc herniation,
- loss of disc height and
- the development of reactive endplate changes

compared to matched-controls after 10 years

*Carragee et al. Spine. 2009 Oct 1;34(21):2338-45*

### Pfirrmann grading

**Disc degeneration for T2-w FSE MRI**

- **I** normal
- **II** inhomogeneous signal with or without horizontal bands
- **III** inhomogeneous gray
- **IV** inhomogeneous gray to black- moderate narrowing
- **V** collapsed disc spacer

*Pfirrmann et al. Spine, 2001 Sep;26(17):1873-8*
### Modic endplate changes

**MRI**

**Modic 1**: Low on T1, bright on T2; Disruption/fissuring of endplates, vascularized fibrous tissue  
**Modic 2**: Bright on T1 and T2; yellow marrow replacement  
**Modic 3**: Low on T1 and T2; bone sclerosis


### Modic changes versus back pain

**Modic 1**  
Most frequently associated with lumbar back pain, 73% in type 1 and 11% in type 2, increase in pain with worsening type 1 changes, improvement in pain in transition from type 1 to type 2, high specificity and predictive value

Rahme et al. AJNR, 2008 May;29(5):838-42.

### Modic changes versus back pain Controversies

159 Train engineers with high pain scores vs 69 sedentary controls  
VAS LBP over the last - 2 weeks - 3 months

Modic changes not significantly different between cohorts with higher pain scores and controls, only type 1 changes significantly associated with pain scores, and only at L5/S1


### Disc degeneration in asymptomatic subjects Controversies

**Results:**  
Disc bulges 62%  
Protrusion 67%  
Extrusion 18%

**Conclusion:**  
Limitations of degenerative disc disease as a marker for back pain

Weishaupt et al. Radiology 2001; 218: 420-7
Conclusion

Imaging including discography is limited in identifying painful degenerative disc disease


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MR spectroscopy – in vitro study

Goal: Can lactic acid and proteoglycans serve as metabolic markers for discogenic back pain?

Methods:
Disc tissue removed from 9 patients with discogenic pain and 9 with scoliosis

Keshari et al. Spine. 2008 Feb 1;33(3):312-7

MR spectroscopy – in vitro study

Goal: Can lactic acid and proteoglycans serve as metabolic markers for discogenic back pain?

HR-MAS-NMR Spectroscopy

Keshari et al. Spine. 2008 Feb 1;33(3):312-7
**MR spectroscopy – in vitro study**

**Goal:** Can lactic acid and proteoglycans serve as metabolic markers for discogenic back pain?

**Results:**
Lower proteoglycan/collagen and PG/lactate
Higher lactate collagen in disc pain patients

*Keshari et al. Spine. 2008 Feb 1;33(3):312-7*

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**Research**

**Goal:** Do MRS and T1(rho) correlate with clinical scores and discography?

**Methods:**
26 patients with sympt. disc and 23 controls
MRI and MRS at 3T
Oswestry Disability, discography

**Results:**
Water/PG peak area ratio increased in patients and positive discography (p<0.05)

*MRS and T1rho may serve as biomarkers of symptomatic IVDD*

*Zuo J al. Spine. 2012 Feb 1;37(3):214-21*
**Take home points - 1**

Radiographic finding disc space narrowing is best correlated with back pain, but radiography is limited in identifying painful discs.

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**Take home points - 2**

CT discography has a number of limitations and is frequently false positive, it also may lead to accelerated degenerative disc disease.

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**Take home points - 3**

MRI degenerative findings frequent in asymptomatic subjects, disc degeneration has a low specificity for pain and endplate changes have low sensitivity.

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**Take home points - 4**

Promising but so far MRS for lactate only in vitro, long term studies required for MRS of PG content and T1(rho) no good standard of reference yet.
Thank you for your attention
tmlink@radiology.ucsf.edu

**CT discography Controversies**

Prospective study:
Positive discography was not highly predictive in identifying intradiscal lesions causing chronic serious LBP illness

Carragee et al. Spine. 2006 Aug 15;31(18):2115-23

**Modic changes versus discography Controversies**

Results:
- Negative MRI - discography
  - 28% concordant,
  - 17% discordant
- Positive MRI - discography
  - 35% concordant,
  - 17% discordant

Conclusion:
No significant relationship


50 patients with discogenic pain and
- MRI
- Discography

Discography was used as a standard of reference

Results:
- Modic I
  - Sens. 29%
  - Spec. 97%
- Modic I,II
  - Sens. 48%
  - Spec. 96%

Weishaupt et al. Radiology 2001; 218: 420-7
Does early imaging influence management and improve outcome in patients with low back pain? A pragmatic randomised controlled trial.

Early use of MRI does not appear to affect management overall but does result in a slight improvement in clinical outcome.


Structural variables on MRI and discography at baseline have only weak association with back pain episodes and no association with disability or future medical care.


Goal: Can T1(rho) and T2 be used to assess disc degeneration and function?

Methods:
16 subjects MRI at 3T
SF-36, Oswestry Disability Pfirrmann grading


**T1rho/T2 at 3T of the intervertebral disc**

**Goal:** Can T1(rho) and T2 be used to assess disc degeneration and function?

**Results:**
Significant correlations of Pfirrmann grades and clinical questionnaires with T1(rho) and T2

*Blumenkrantz et al. Magn Reson Med 2010; 63(5):1193-1200*