

# The normal disc

## **Nucleus pulposus and the cartilaginous vertebral endplate:**

Chondrocyte-like cells  
Synthesise type II collagen,  
Proteoglycans

## **Annulus fibrosus**

Fibroblast-like cells  
Synthesise type I and type II collagen for the.

## **Proteoglycans**

A core protein from which radiate chains of glycosaminoglycans containing keratan sulphate and chondroitin sulphate.  
Multiple proteoglycans are joined to a hyaluronic acid chain to form aggregates.

Aggregates are held together by type II collagen, which is cross-linked by type IX collagen.<sup>1</sup>

The hydroscopic properties of the proteoglycan matrix endow the nucleus with hydrostatic properties,<sup>2</sup> allowing it to accommodate compression loads and to brace the annulus.

However, the constituents of the matrix are not static.

Continually degraded by enzymes, the matrix metalloproteinases (MMPs), which are secreted by the chondrocytes. 3-5 Degradation of the matrix allows it to be refreshed by newly-synthesised components.

Growth factors:

Fibroblast growth factor (bFGF),  
Transforming growth factor (TGF)  
Insulin-like growth factor (IGF),

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# Ageing Disc

- The concentration of cells in the disc declines with age, especially in the annulus.
- The rate of synthesis of proteoglycans decreases. The Pg's produced are **smaller and less aggregated**
- The concentration of C S04 falls, Hence **a rise in the ratio of keratan sulphate** to chondroitin sulphate.
- The **collagen content of the nucleus** increases and changes from type II to type I, Hence NP is more fibrous.
- Fewer polar groups of the proteoglycans available to bind water. The nucleus becomes solid & dry
- **Herniated discs are associated with an increased degree of senescence :apoptosis.**

# MRI on first episode of injury: The Spine Journal

6 (2006) 624–635

- MRI : Common degenerative findings are often interpreted as recent developments and the probable anatomic cause of the new symptoms
- To date no prospective study has established a baseline MR status of the lumbar spine in subjects without significant LBP problems and prospectively surveyed these subjects for acute changes shortly after new and serious LBP episodes.
- LBP intensity (visual analogue scale), Oswestry Disability Index, and work loss. MRI outcomes: disc degeneration, herniation, annular fissures, end plate changes, facet arthrosis, canal stenosis, spondylolisthesis, and root impingement.
- 200 subjects with a lifetime history of no significant LBP problems, and a high risk
- for new LBP; Subjects were followed every 6 months for 5 years

Subjects with a new severe LBP episode were assessed for new diagnostic tests.

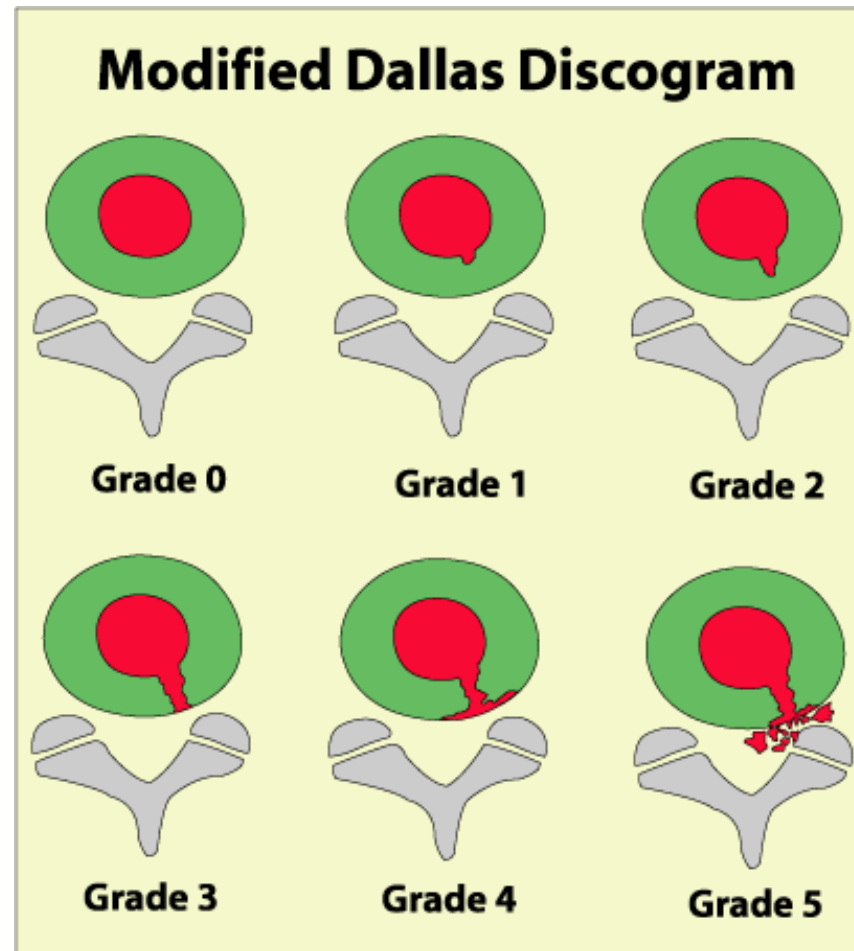
# Conclusions

- 84% had either unchanged MR or showed regression of baseline changes.
- The most common progressive findings were disc signal loss (10%), progressive facet arthrosis (10%), or increased end plate changes (4%).
- 2/200 with primary radicular complaints, had new findings of probable clinical significance
- **New findings were not more frequent in subjects with LBP episodes developing after minor trauma than when LBP developed spontaneously.**
- Findings on MR imaging within **12 weeks of serious LBP inception** are highly unlikely to represent any new structural change. Primary radicular syndromes may have new root compression findings associated with root irritation.
- Support an alternative hypothesis: degeneration begin very early in life- the basis of nutritional, developmental, and genetic factors. Later minor traumatic or repetitive occupational events play a minor role, if any, in eventual structural changes and serious disability

# Discography: Orthop Clin N Am 35 (2004) 7 – 16

- Highly individualized.
- Determine whether degeneration within a disc seen on imaging studies is the primary clinically significant source of a patient's LBP illness.
- First, anatomically normal discs at discography are not painful
- Second, discs that prove to be intensely painful and clinically concordant when injected are more likely to have annular fissures into or through the outer third of the disc annulus

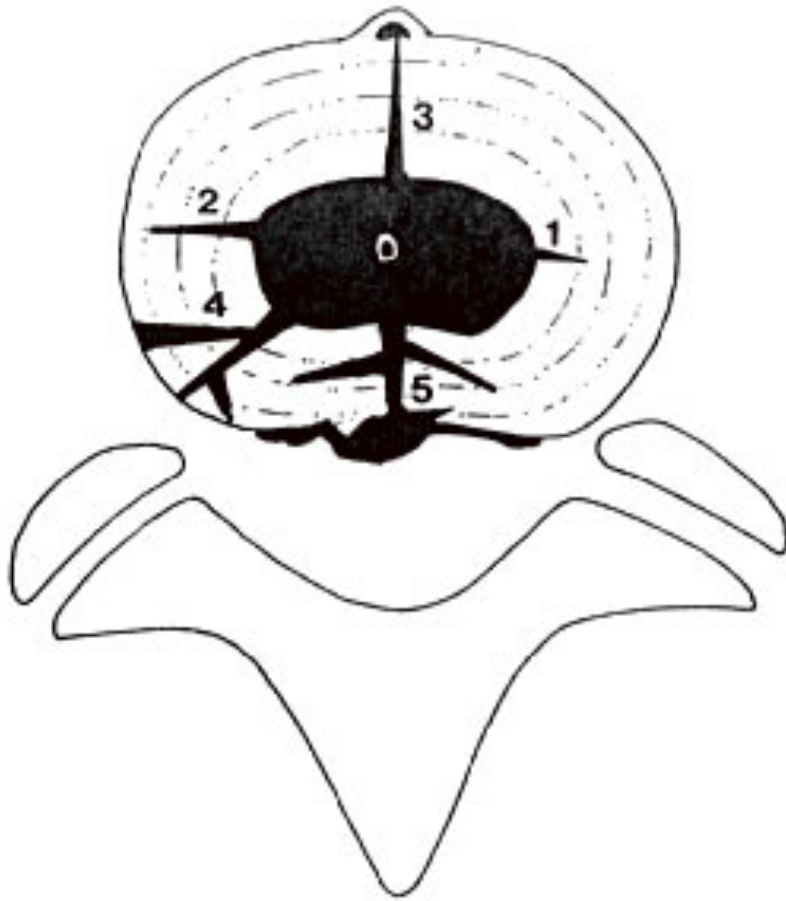
# Modified Dallas Discogram



- Provocation discography is perhaps one of the rare techniques which is helpful in indicating the need for lumbar spinal fusion in patients with degenerative discs.
- It is, however, invasive, and a small amount of antibiotics should be added to the dye to protect against iatrogenic discitis.
- Provocation discography should be combined with psychometric testing. The painful disc should be fused and a 360° fusion is perhaps better than a posterior fusion in patients with positive provocation discography.

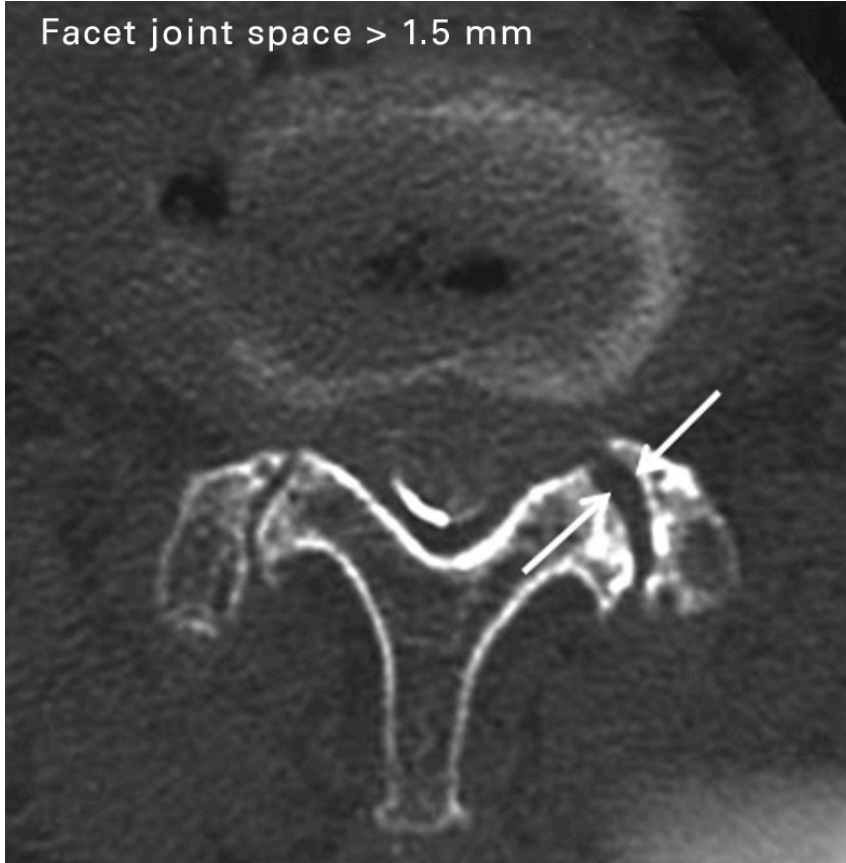


# Types of Annular tear



- 1. incomplete
- 2. incomplete
- 3. anterior
- 4. Radial posterolateral
- 5. Posterior

Facet joint space > 1.5 mm



- The width of the facet joint space was measured perpendicular to the joint at its widest portion, and the facet-opening was defined as a width greater than 1.5 mm

- If the neutral zone of the segment was  $< 2$  mm/N, the segment was considered to be stable and laminoplasty was carried out.
- If the neutral zone was  $\geq 2$  mm/N, the segment was considered to be unstable and decompression and transforaminal interbody fusion were performed.
- The facet joint is a crucial component in stability of the lumbar spine. The facet joints prevent excessive movement from damaging the discs and the posterior annulus is protected during torsion by the facet surfaces and during flexion by the capsular ligaments.<sup>24-26</sup>
- The compliance of the joint for torsion in a normal segment, however, is quite low. The physiological range of rotational movement is approximately  $10^\circ$  for the entire lumbar spine, or approximately  $1^\circ$  on each side for each joint.<sup>27</sup>
- Joint failure can occur after approximately  $10^\circ$  to  $30^\circ$  of torsion and irreversible damage to the joints will occur when torsion exceeds  $3^\circ$ .<sup>28</sup> Therefore, radiological abnormalities of the facet joints contribute to the diagnosis of segmental instability.

# MRI for spinal instability

- Recent MRI studies of the degenerative lumbar spine have shown that the presence of a large fluid-filled joint, giving a high signal change on T2-weighted axial images, especially in the upright position, is related to instability.

- They concluded that large ( $> 1.5$  mm) facet joint effusions are highly predictive of degenerative spondylolisthesis at L4-5 in the absence of a measurable anterolisthesis on supine MRI
- In our study, facet type (Fig. 3) was not a predictor of stability, but comparison of the neutral zone among the facet types revealed that the sagittally-orientated type tended to be unstable, while the wrapped type tended to be stable.
- In our study the segments with MRI grade 3 or 4, which corresponds to mild disc degeneration, were more prone to being 'unstable' than those with MRI grade 5.

- Increased range of movement on flexion-extension radiographs was not a significant predictor of instability and neither was degenerative spondylolisthesis as a single factor.
- The natural history suggested that degenerative spondylolisthesis did not always lead to instability in elderly patients who had probably reached a stabilisation phase corresponding to MRI grade 5.
- Segmental instability is merely the biomechanical failure of a lumbar segment and does not necessarily correlate with the degree of pain.

# Discography

The Spine Journal 3 (2003) 11S–27S

- Indications
- 1. correlation of the abnormality with the clinical symptoms. Such symptoms may include recurrent pain from a previously operated disc and lateral disc herniation.
- 2. Persistent, severe symptoms in whom other diagnostic tests have failed to reveal clear confirmation of a suspected disc as the source of pain.
- 3. Assessment of patients who have failed to respond to surgical intervention to determine if there is painful pseudarthrosis or a symptomatic disc in a posteriorly fused segment and to help evaluate possible recurrent disc herniation.
- 4. Assessment of discs before fusion to determine if the discs within the proposed fusion segment are symptomatic and to determine if discs adjacent to this segment are normal.
- 5. Assessment of candidates for minimally invasive surgical intervention to confirm a contained disc herniation or

# Age related disc changes *J Bone Joint Surg [Am]*

1990;72-A:403-8.

**Table II.** Incidence of MRI findings in individuals who had never had LBP according to Boden et al<sup>62</sup>

<b>Age (yrs)</b>	<b>Number</b>	<b>Herniated disc (%)</b>	<b>Spinal stenosis (%)</b>	<b>Bulging disc (%)</b>	<b>Disc degeneration (%)</b>
20 to 39	35	21	1	56	34
40 to 59	18	22	0	50	59
60 to 80	14	36	21	79	93



- Boos et al 66 have shown in 46 asymptomatic individuals followed for a mean of five years that herniations of the disc and neural compromise did not become significantly worse at follow-up, whereas degeneration of progressed in 19 individuals (41%), six of whom had to seek medical treatment with another five having to stop work temporarily.
- Nevertheless, medical consultation for LBP was predicted with higher accuracy by listlessness, job satisfaction, and working in shifts.
- Work incapacity was best predicted by physical job characteristics, job disaffection, and working in shifts.
- There is no strong correlation between MRI changes in the intervertebral disc and LBP.

# *High-intensity zone (HIZ)*

- It is surrounded by a low-intensity black signal of the annulus, and is appreciably brighter than that of the nucleus.
- Provocative discography revealed that the HIZ represented painful internal disruption of the disc with a positive predictive value of 86%.
- However, the HIZ is not necessarily associated with a painful disc.
- The nature of the HIZ is unclear. It may represent an area of secondary inflammation as a result of a tear in the annulus.
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