Lumbar Spine Imaging: When to Order and What the Results Mean

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PM&R 2/15/18

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- **Physiosonix**: ultrasound company, Founder/stockholder
- **Healthhelp**: utilization review, consultant
- **UpToDate:** Section Editor
- **Evidence Based Neuroimaging Diagnosis and Treatment:** Springer, Co-Editor

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DEPARTMENT OF RADIOLOGY

NIH Collaboratory

Rethinking Clinical Trials®

Health Care Systems Research Collaboratory

Talk Outline

- When to image: guideline review
- What we say:
  - Nomenclature: Classifying Findings
  - Degeneration: The Spectrum of Normal
- Summary

Talk Outline

- When to image: guideline review
-
  - Nomenclature: Classifying Findings
  - Degeneration: The Spectrum of Normal
-

AHCPR Guidelines

- 1991
- Addressed acute LBP
- Established red flag concept
  - –No imaging before 4 wks unless red flag was present

Red Flags for Early Imaging

- Sig trauma
- Mild trauma age>50
- h/o cancer
- Unexplained wt loss/ fever
- Immunocompromised
- IVDA/steroids
- Osteoporosis
- Cauda equina
  - Bilat leg symptoms
  - Bowel/bladder symptoms
- Age <20 or >70

Re-affirmation of Guidelines in 2009 Review

Articles

Lancet Chou et al 2009: 373: 463

Imaging strategies for low-back pain: systematic review and meta-analysis

Roger Chou, Rongwei Fu, John A Carrino, Richard A Deyo

Summary

Background Some clinicians do lumbar imaging routinely or in the absence of historical or clinical features suggestive of serious low-back problems. We investigated the effects of routine, immediate lumbar imaging versus usual clinical

Lancet 2009; 373: 463–72

See Comment page 436

Why Not Image Early?

- Multiple studies have failed to show benefit
- Increased cost
- Potential for worse outcomes

Lack of Benefit of Early MR

JAMA 2003: 289; 2810

Rapid Magnetic Resonance Imaging vs Radiographs for Patients With Low Back Pain

A Randomized Controlled Trial

Jeffrey G. Jarvik, MD, MPH
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Context Faster magnetic resonance imaging (MRI) scanning has made MRI a potential cost-effective replacement for radiographs for patients with low back pain. However, whether rapid MRI scanning results in better patient outcomes than radiographic evaluation or a cost-effective alternative is unknown.

Objective To determine the clinical and economic consequences of replacing spine radiographs with rapid MRI for primary care patients.

Design, Setting, and Patients Randomized controlled trial of 380 patients aged 18 years or older whose primary physicians had ordered that their low back pain be evaluated by radiographs. The patients were recruited between November 1998 and June 2000 from 1 of 4 imaging centers in the Seattle, Wash, area: a university-based teaching program, a nonuniversity-based teaching program, and 2 private clinics.

Intervention Patients were randomly assigned to receive lumbar spine evaluation by rapid MRI or by radiograph.

Main Outcome Measures Back-related disability measured by the modified Roland questionnaire. Secondary outcomes included Medical Outcomes Study 36-Item Short Form Health Survey (SF-36), pain, preference scores, satisfaction, and costs.

Lack of Benefit of Early MR vs. Xray

- No difference disability/pain
- Increased surgeries & cost
- Concern about cascade of interventions triggered by imaging

Why not image early?

Spine

SPINE Volume 37, Number 18, pp 1617–1627

OCCUPATIONAL HEALTH/ERGONOMICS

Early Imaging for Acute Low Back Pain

One-Year Health and Disability Outcomes Among Washington State Workers

Janessa M. Graves, MPH, PhD,* Deborah Fulton-Kehoe, MPH, PhD,† Jeffrey G. Jarvik, MD, MPH,‡ and Gary M. Franklin, MD, MPH§

Lack of Benefit of Early MR

- WA State injured workers
- Compared those with vs. w/out early imaging
- 20% had early imaging without red flag

Lack of Benefit of Early MR

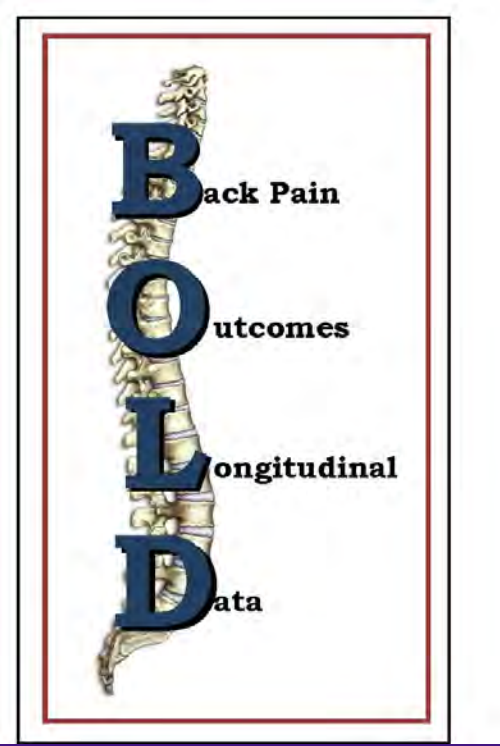
- Similar 1-yr pt reported outcomes
- 2-fold likelihood of being on disability at 1 year
- Longer duration of disability
  - –121 days more for LBP only
  - –94 days more for radiculopathy

What About Older Adults?

"I recommend using your third wish to prevent joint pain in later years."

Back pain
Outcomes using
Longitudinal
Data

BOLD



BOLD Registry

- 5,239 patients ≥ 65 with new primary care visits for back pain
- 3 integrated systems: Kaiser Perm N. CA, Henry Ford Health System, Harvard Vanguard/Harvard Pilgrim
- Identify patients using Health Care Information Systems
- Contacted at 3, 6, 12 months
- Asked about pain, disability, depression, anxiety

Early Imaging Study- Key Aspects

- Design:
  - Prospective observational cohort study
  - Propensity score matching of demographic and clinical characteristics
- Exposure: Diagnostic imaging (plain films, CT or MR of lumbar or thoracic spine within 42 days of a new primary care visit for back pain.
- Primary Outcome: Roland-Morris Disability Questionnaire

Early Imaging and Outcomes

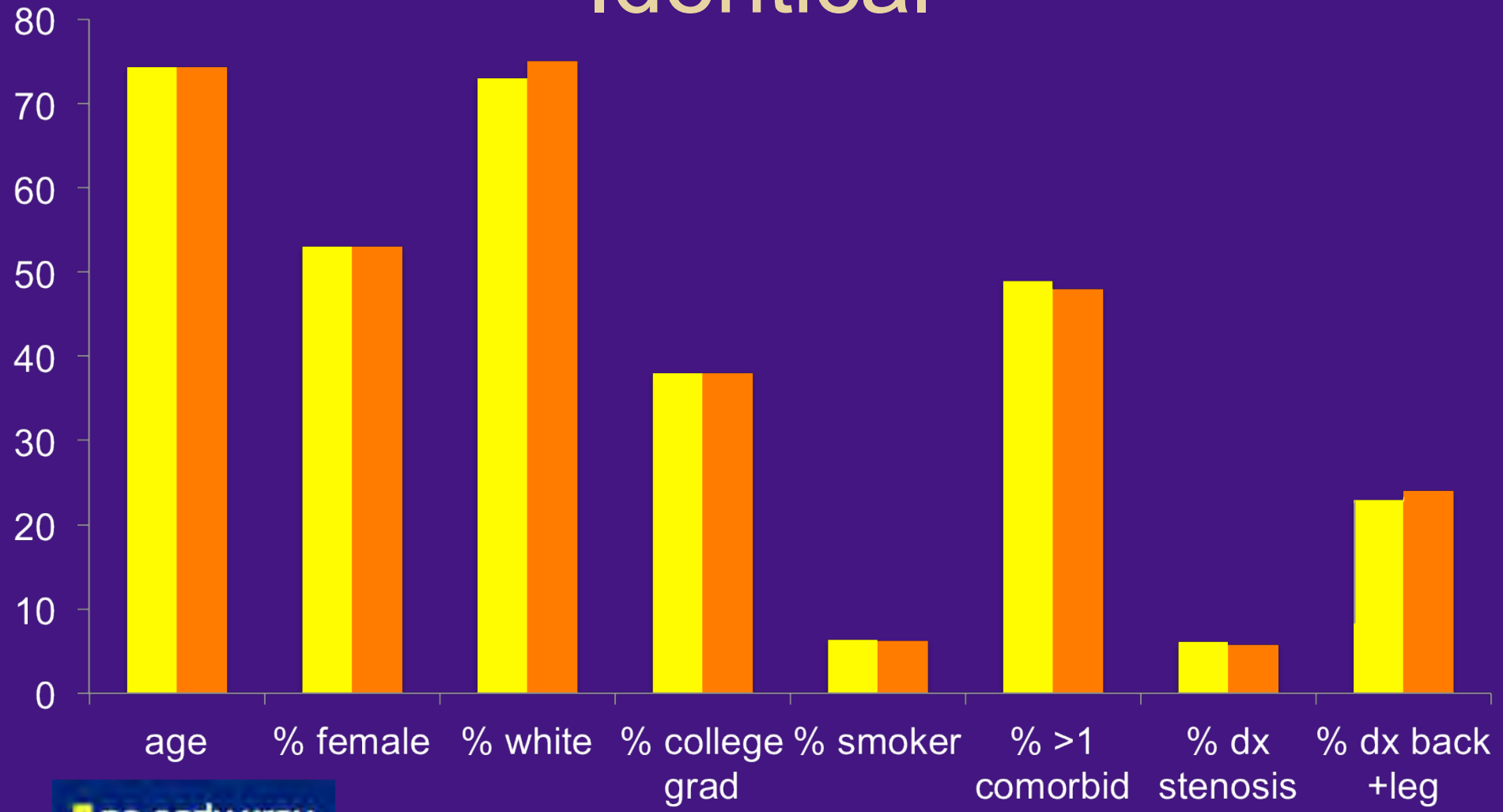
Research

Original Investigation

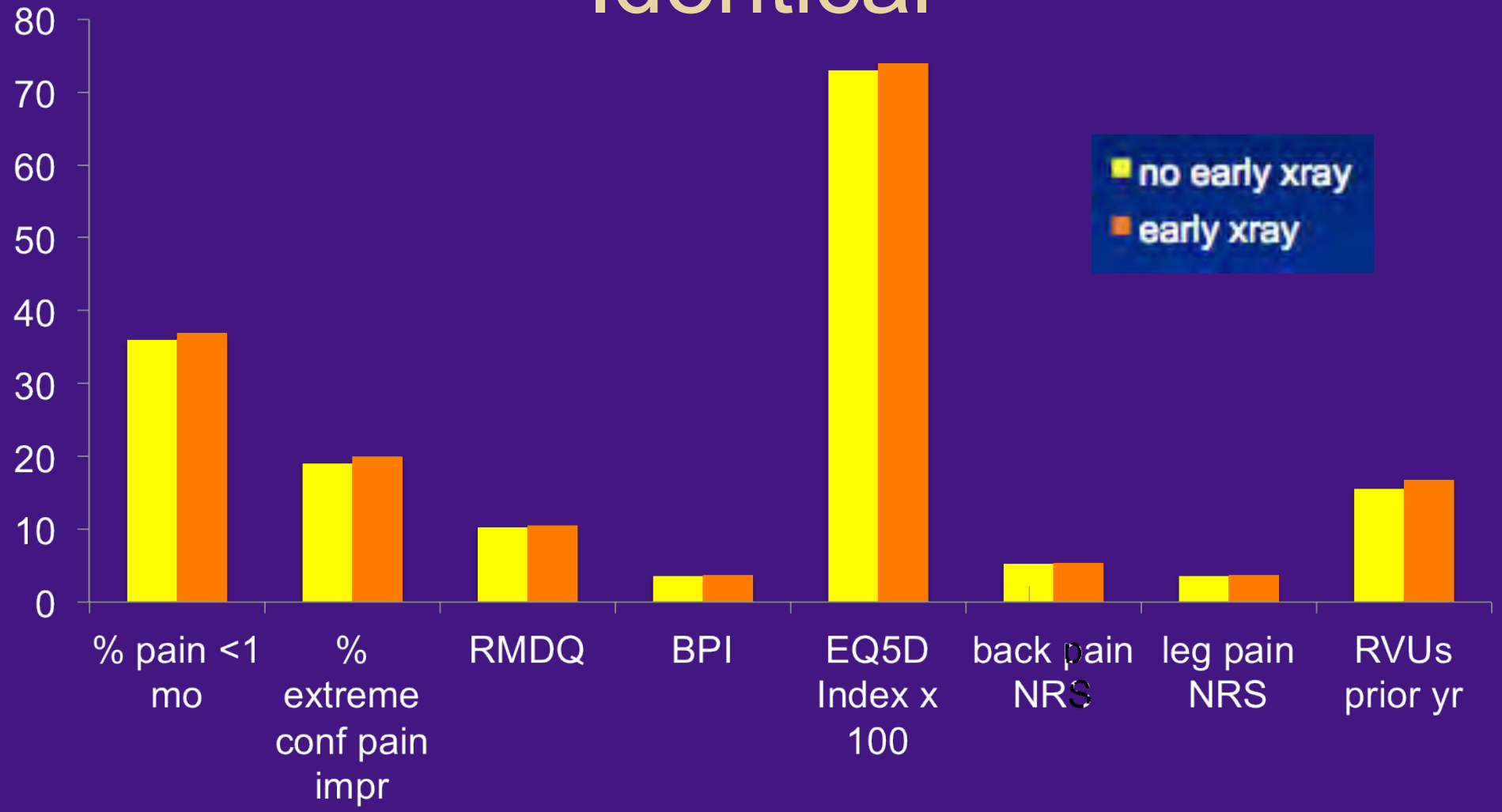
Association of Early Imaging for Back Pain With Clinical Outcomes in Older Adults

JAMA. 2015;313(11):1143-1153. doi:10.1001/jama.2015.1871

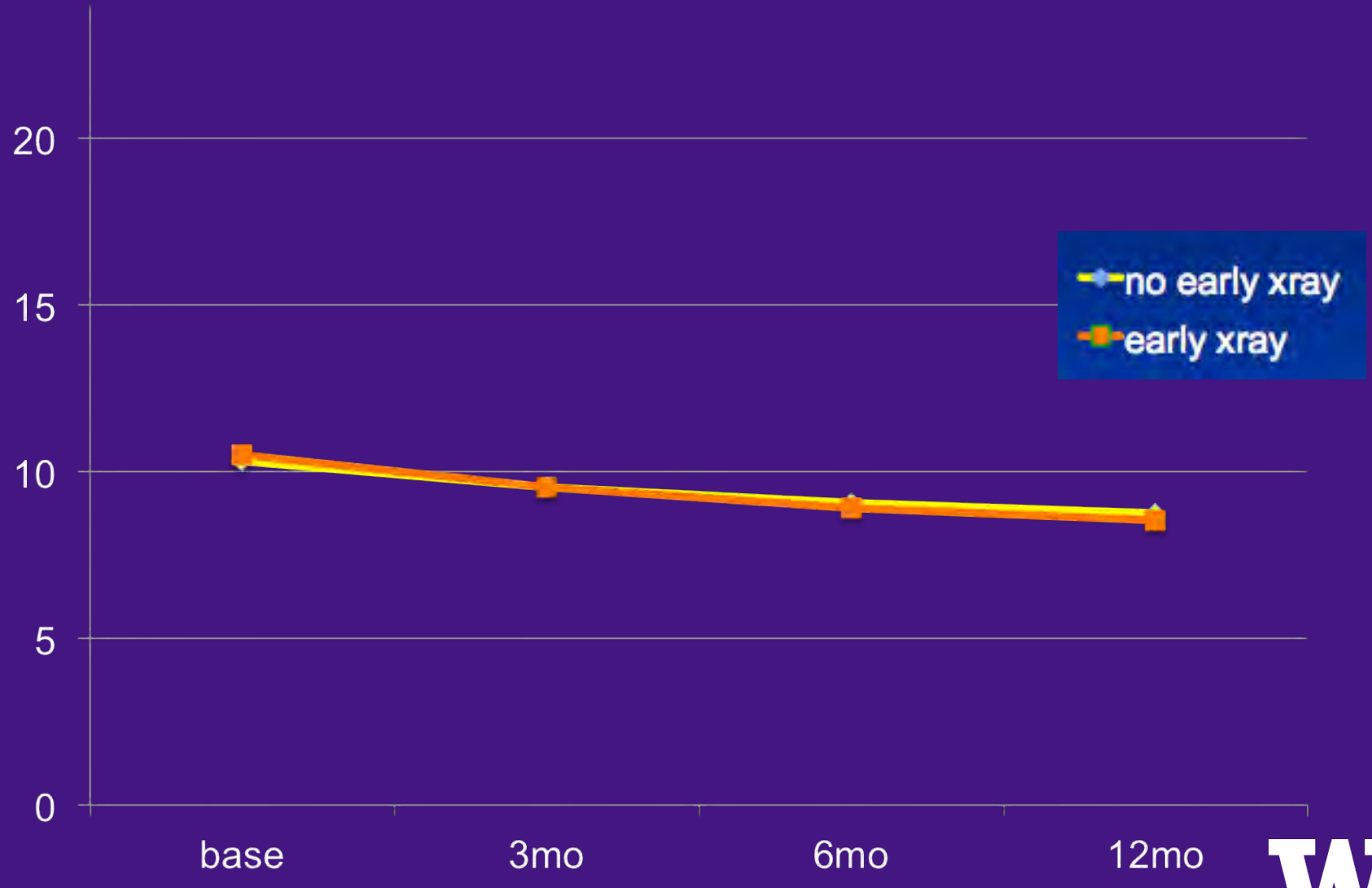
Baseline Demographics Virtually Identical



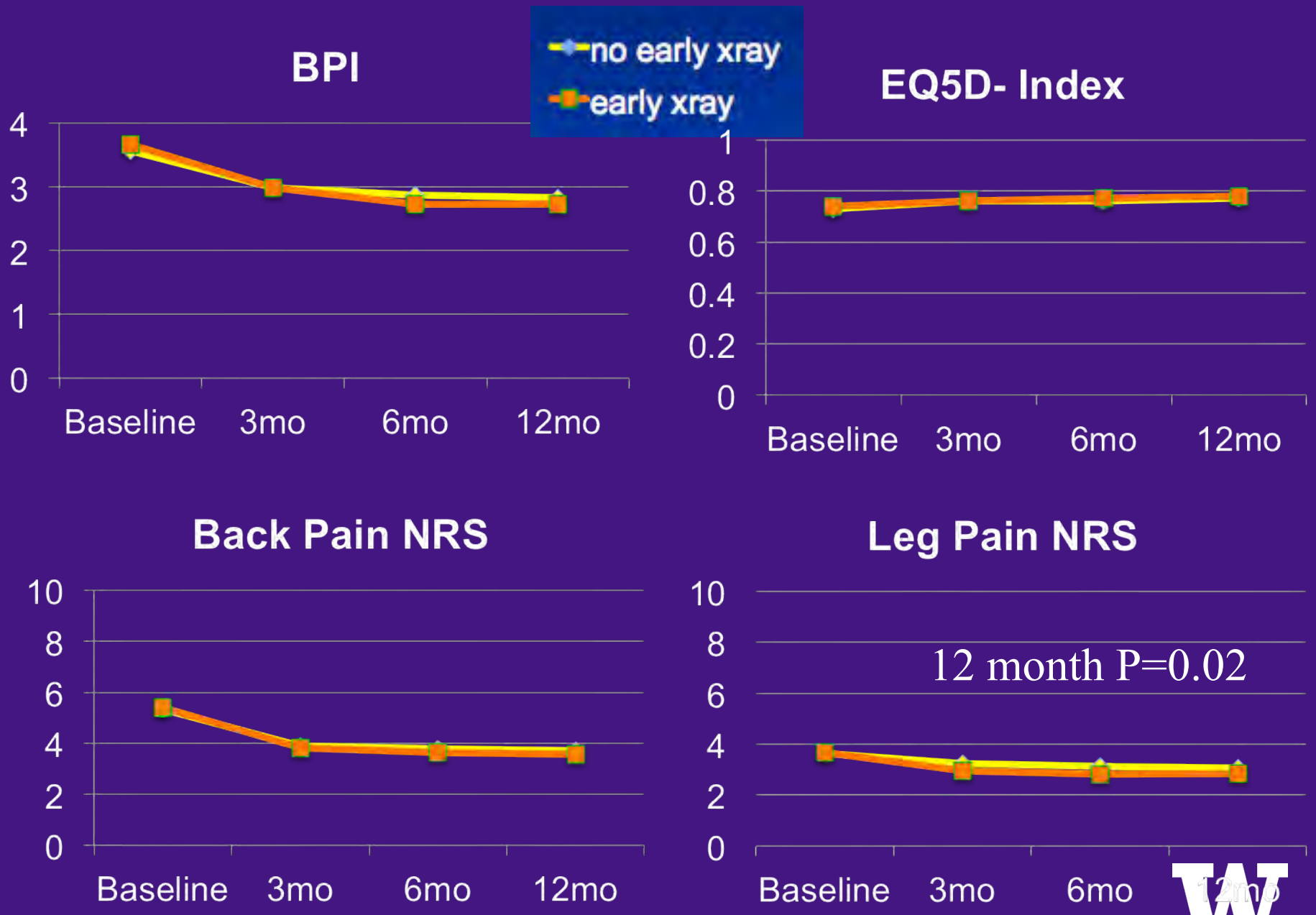
Baseline Characteristics Virtually Identical



No Difference in Primary Outcome (RMDQ) Over Time

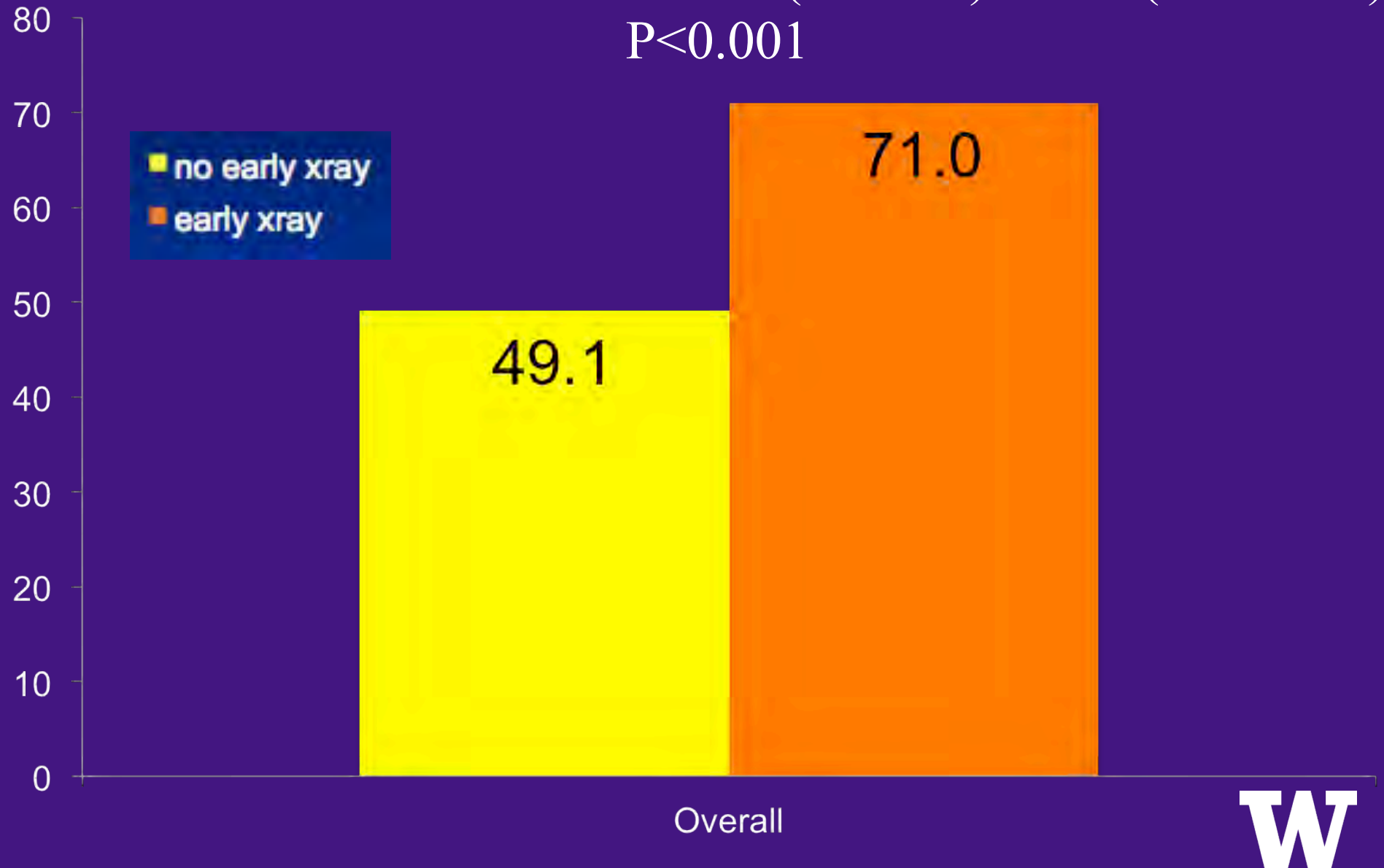


Secondary Measures Over Time

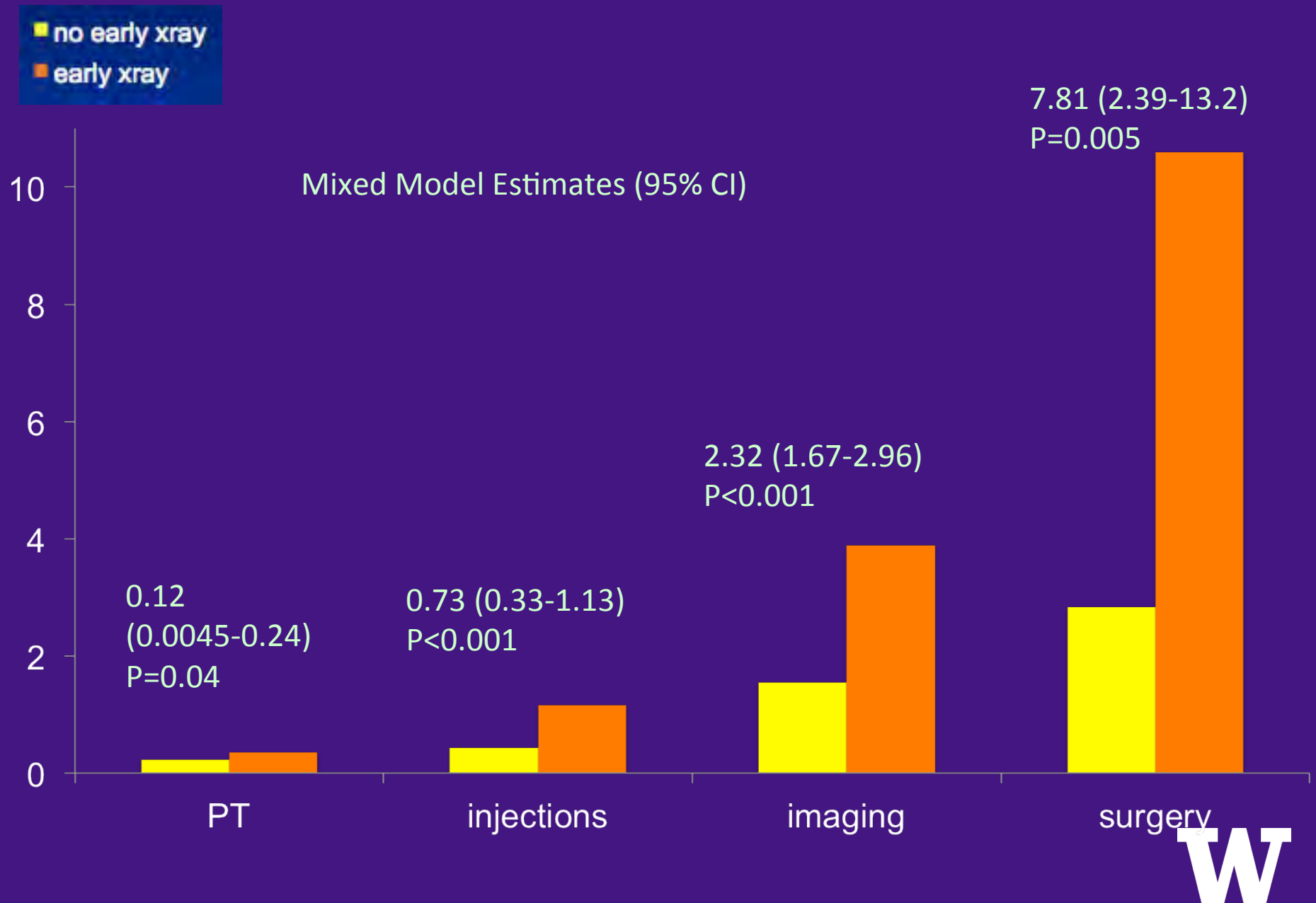


Large Differences in 12 Month RVUs

Mixed model difference estimate (95% CI)= 22.3 (12.3-32.3)
P<0.001



Large Differences in 12 Month RVUs/Pt



RVU Differences Translated into $$

- Additional cost/pt
  - –Early radiographs: $953
  - –Early MR/CT: $1,395
- 44 million Medicare beneficiaries would result in an additional $2 billion/yr

BOLD Early Imaging Results

- Early imaging group no better outcomes than similar older adults who do not get early imaging.
- Early imaging group had greater use of healthcare services, such as visits, injections, etc.

Summary Guideline from ACP and APS

CLINICAL GUIDELINES | *Annals of Int Med 2007: 147:478*

Diagnosis and Treatment of Low Back Pain: A Joint Clinical Practice Guideline from the American College of Physicians and the American Pain Society

Roger Chou, MD; Amir Qaseem, MD, PhD, MHA; Vincenza Snow, MD; Donald Casey, MD, MPH, MBA; J. Thomas Cross Jr., MD, MPH; Paul Shekelle, MD, PhD; and Douglas K. Owens, MD, MS, for the Clinical Efficacy Assessment Subcommittee of the American College of Physicians and the American College of Physicians/American Pain Society Low Back Pain Guidelines Panel*

ACP and APS Recommendations

1. Use H&P to place pts into 3 categories
   a) Non-specific LBP
   b) Radiculopathy/spinal stenosis
   c) Other specific causes

   (strong recommendation, moderate evidence quality)

ACP and APS Recommendations

2. No routine imaging or diagnostic tests in patients with non-specific LBP

(strong recommendation, moderate evidence quality)

ACP and APS Recommendations

3. Perform diagnostic testing when patient has:
   a) Progressive or severe neuro deficits
   b) Has serious underlying condition

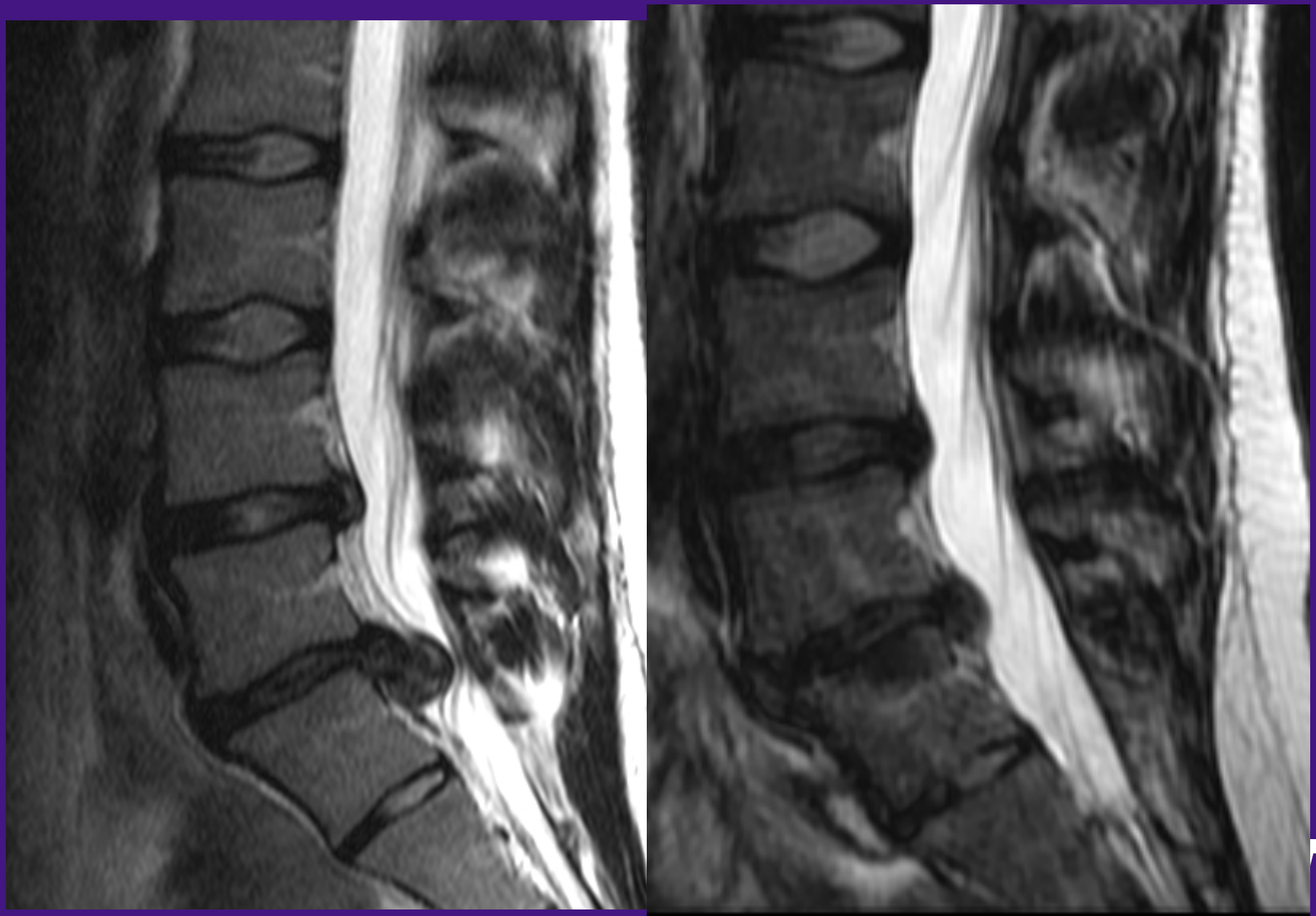
(strong recommendation, moderate evidence quality)

ACP and APS Recommendations

4. Diagnostic testing for spinal stenosis or radiculopathy
   a) For pre-surgical eval
   b) For pre-inj eval (for radic)
   c) MR preferred over CT

   (strong recommendation, moderate evidence quality)

10 Month F/U Disc Extrusion



Talk Outline

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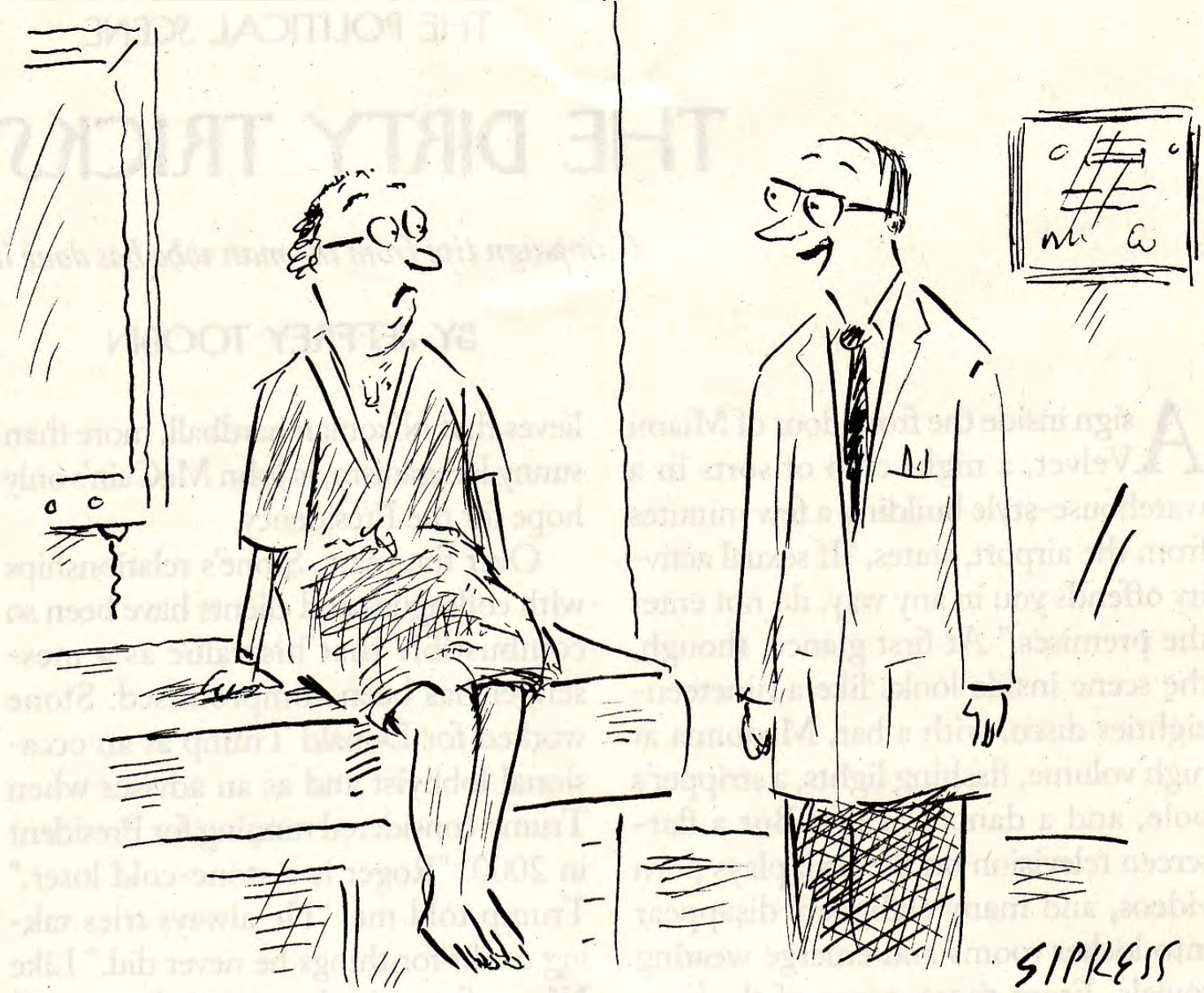
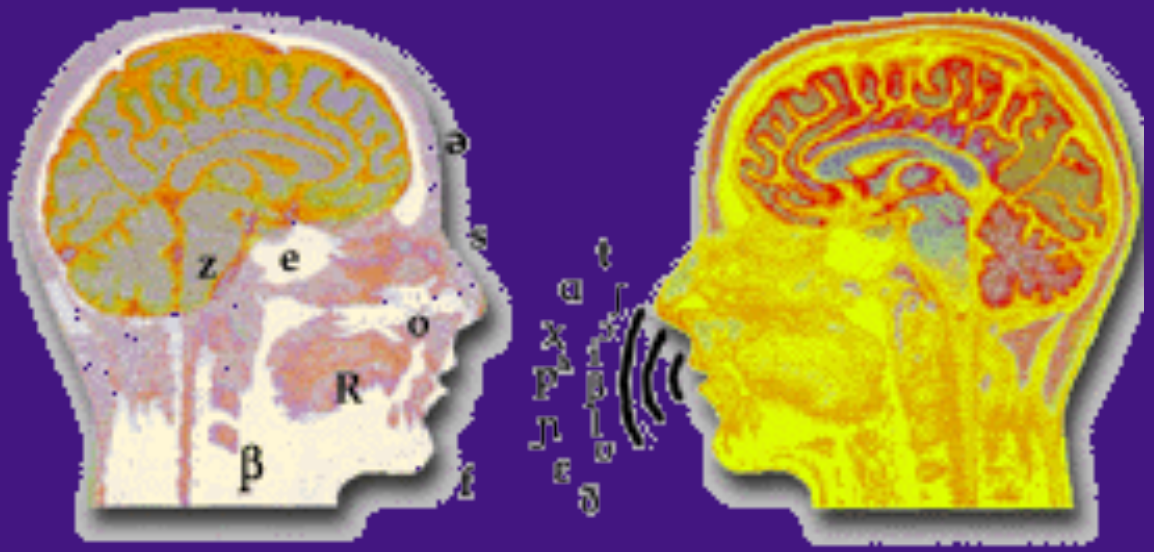
  - Degeneration: The Spectrum of Normal
-



"I can cure your back problem, but there's a risk that you'll be left with nothing to talk about."

Speaking the Same Language

Nomenclature for disc findings



Consensus Nomenclature

Milette PC et al: Am J Neuroradiol 22: 429-430; 2001
Fardon DF et al The Spine J: 14; 2525-2545; 2014

http://www.asnr.org/spine_nomenclature/

American Academy of Orthopaedic Surgeons (AAOS)
American Academy of Physical Medicine and Rehabilitation (AAPM&R)
American College of Radiology (ACR)
American Society of Neuroradiology (ASNR)
American Society of Spine Radiology (ASSR)
Joint Section on Disorders of the Spine and Peripheral Nerves of the American Association of Neurological Surgeons (AANS)
Congress of Neurological Surgeons (CNS)
European Society of Neuroradiology (ESNR)
North American Spine Society (NASS)
Physiatric Association of Spine, Sports and Occupational Rehabilitation (PASSOR)

Goals of Nomenclature

Milette, AJNR; 26 2005

- Practical
- High interobserver agreement
- Simple

Leah

An insurmountable Amount of homeworck.

(I would hate to have this mound)

Nomenclature

- normal
- degeneration
- anular fissure
- herniation

Consensus Nomenclature

- normal
  - –well hydrated disc
  - –central dark band= central fibrosus

age-related changes=NOT normal

Intranuclear Cleft

Normal

Consensus Nomenclature

- normal
- degeneration
  - –desiccation
  - –narrowing
  - –bulging
  - –endplate changes
  - –osteophytes

Disc Degeneration

Desiccation

Narrowing

Consensus Nomenclature

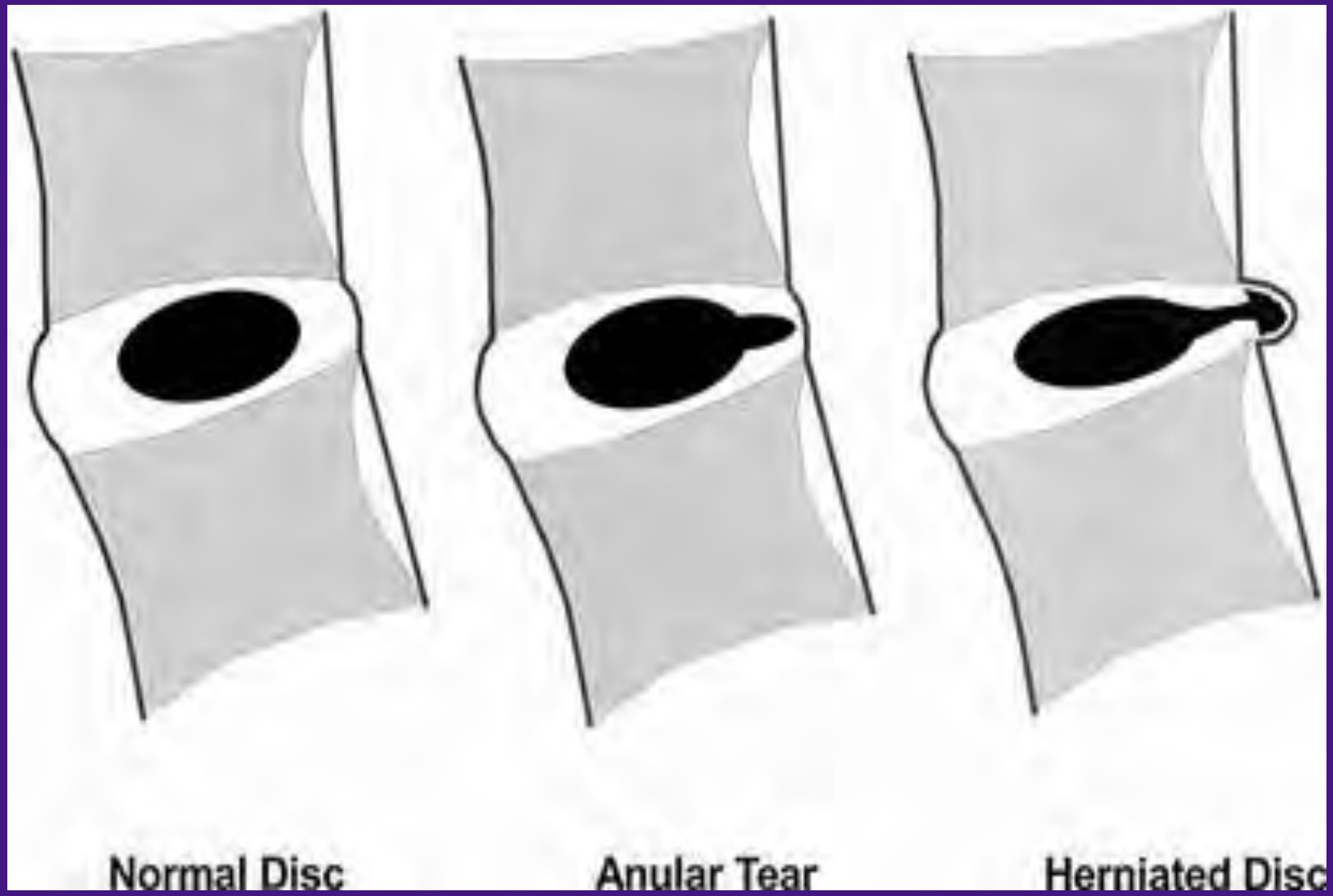
- normal
- degeneration
- anular tear=anular fissure (high intensity zones=HIZ)
- herniation

Anular Fissures

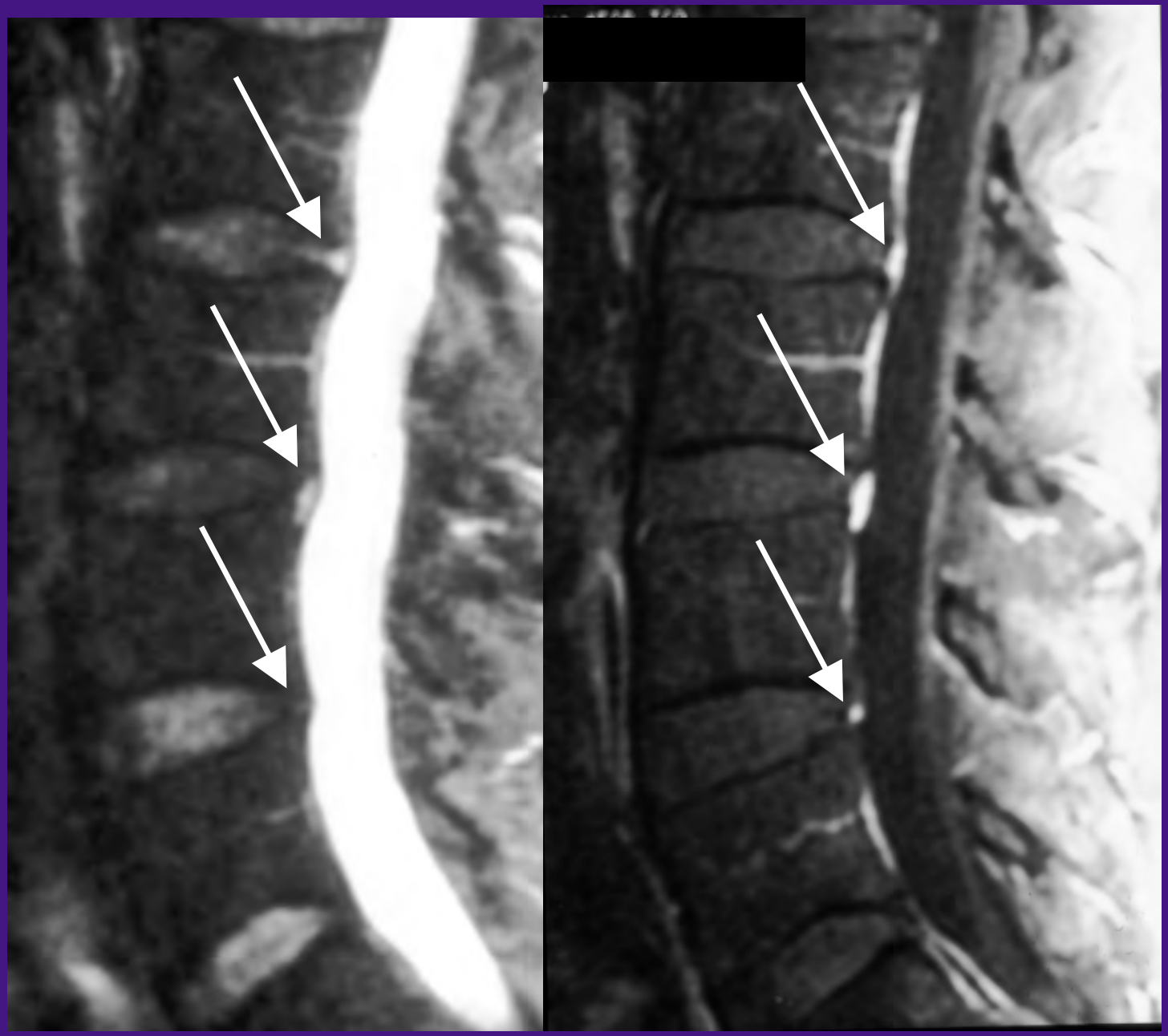
- Localized disruption of anulus without displacement of disc material beyond interspace

Anular Fissures vs. Disc Herniation

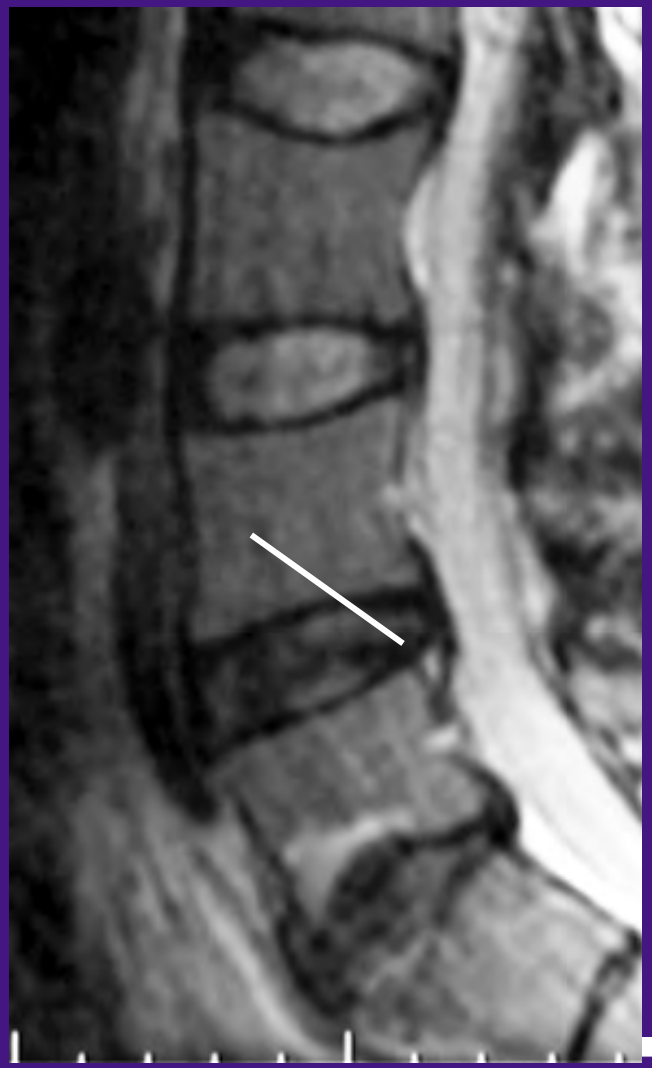
(Fardon DF and Milette PC. Spine: 26 (5); E93-113; 2001)



Degeneration and Fissures



Anular Fissure
(High Intensity Zone/HIZ)



Consensus Nomenclature

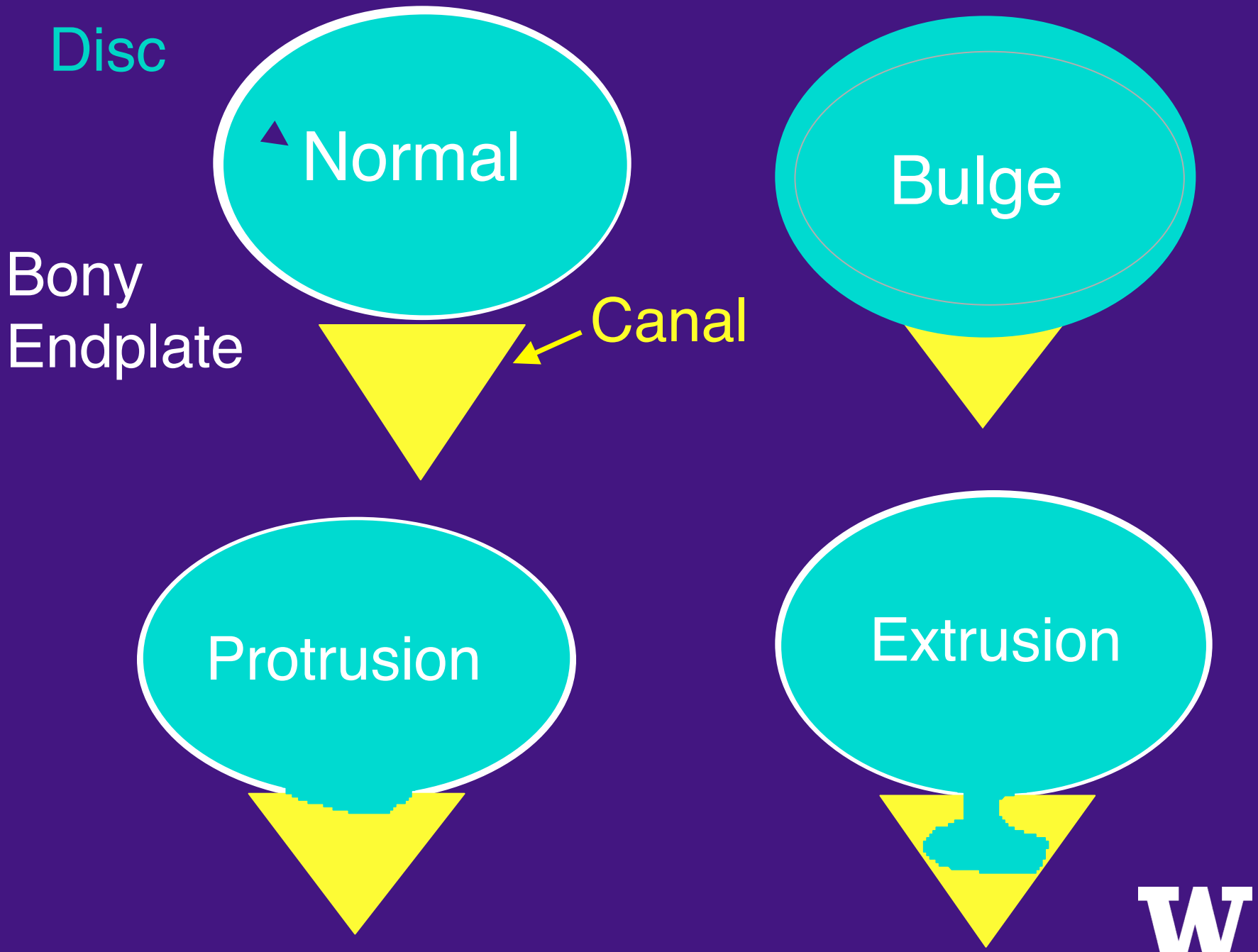
- normal
- degeneration
- herniation
  - –protrusion
  - –extrusion

Consensus Nomenclature

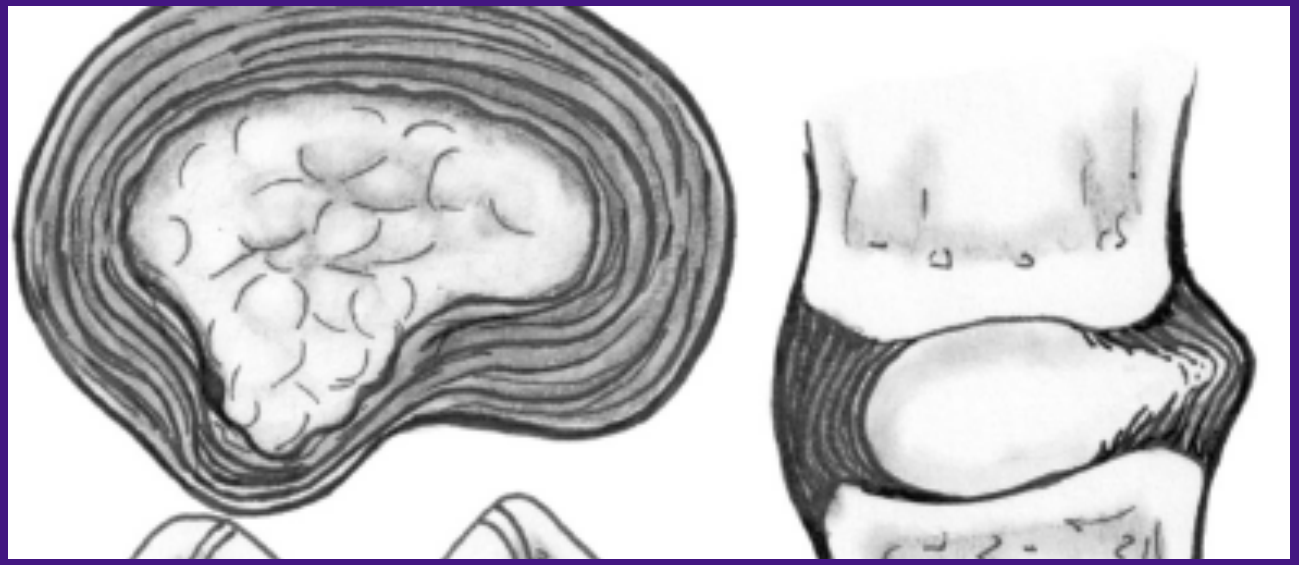
- Herniation
  - **localized** displacement of disc

    ≥25% (90°) = bulge

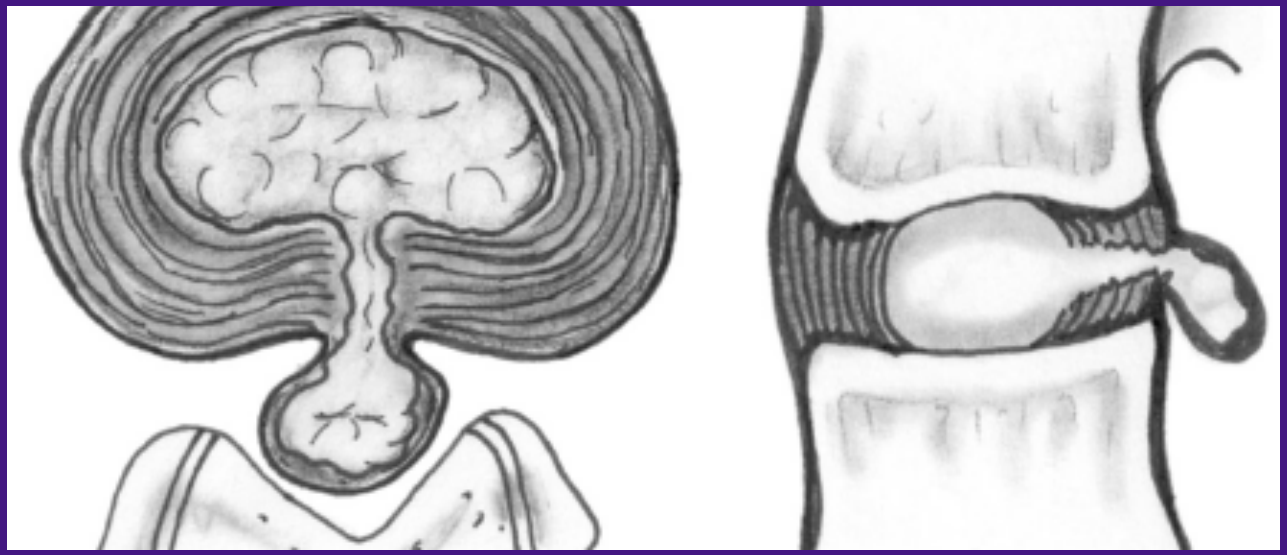
    <25% = herniation


Disc
Normal
Bulge
Bony
Endplate
Canal
Protrusion
Extrusion

Consensus Nomenclature

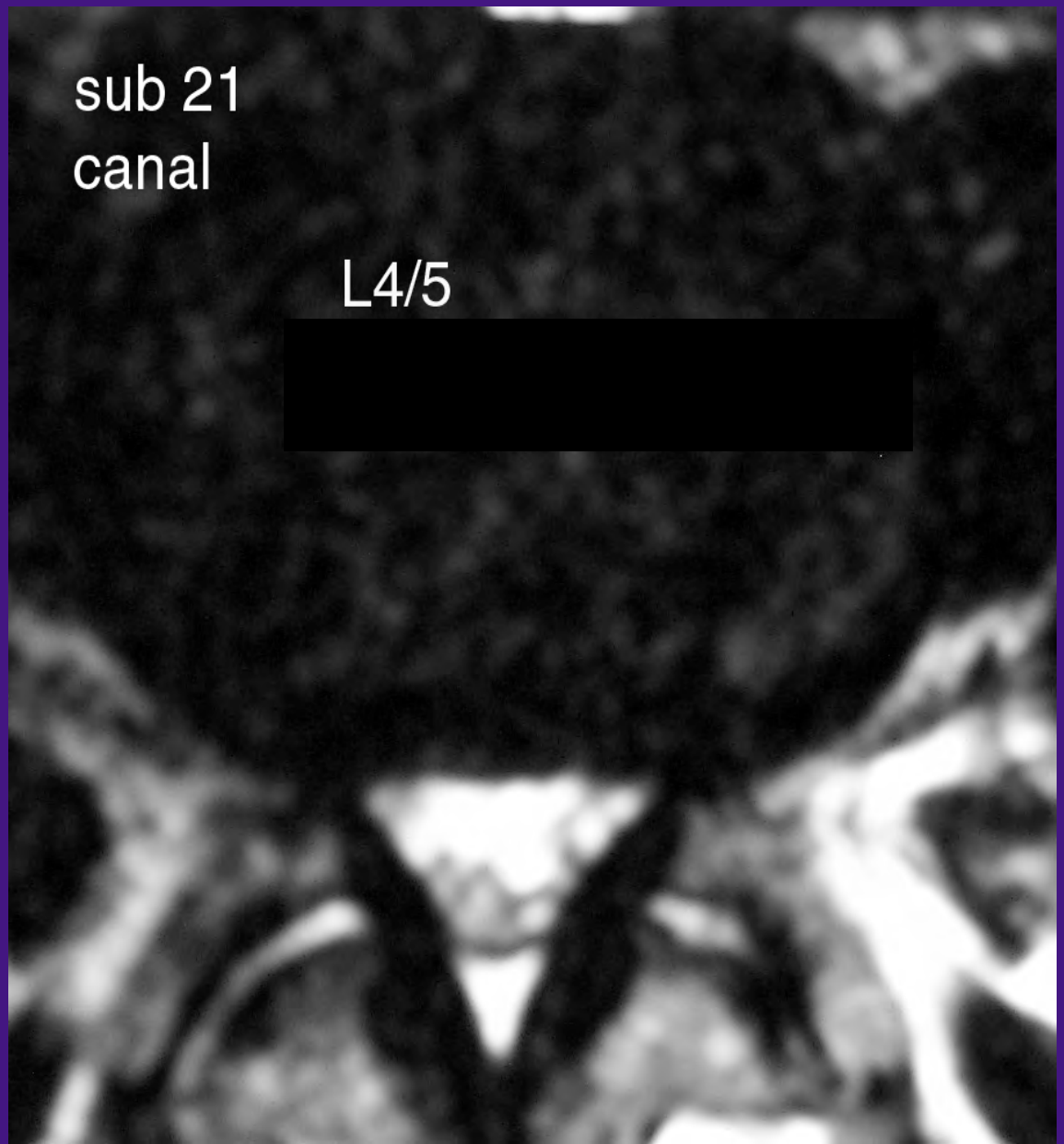


Protrusion

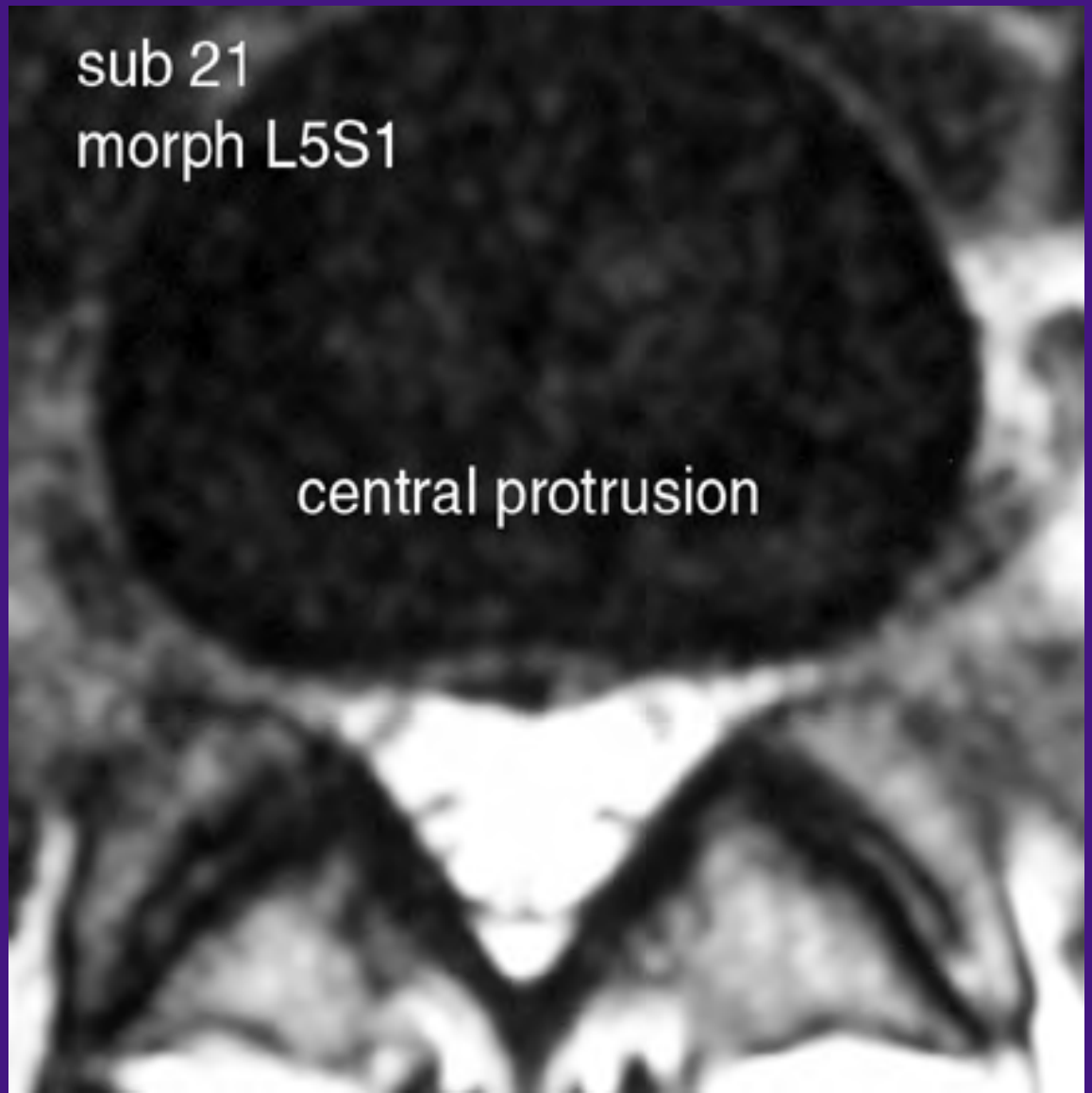


Extrusion

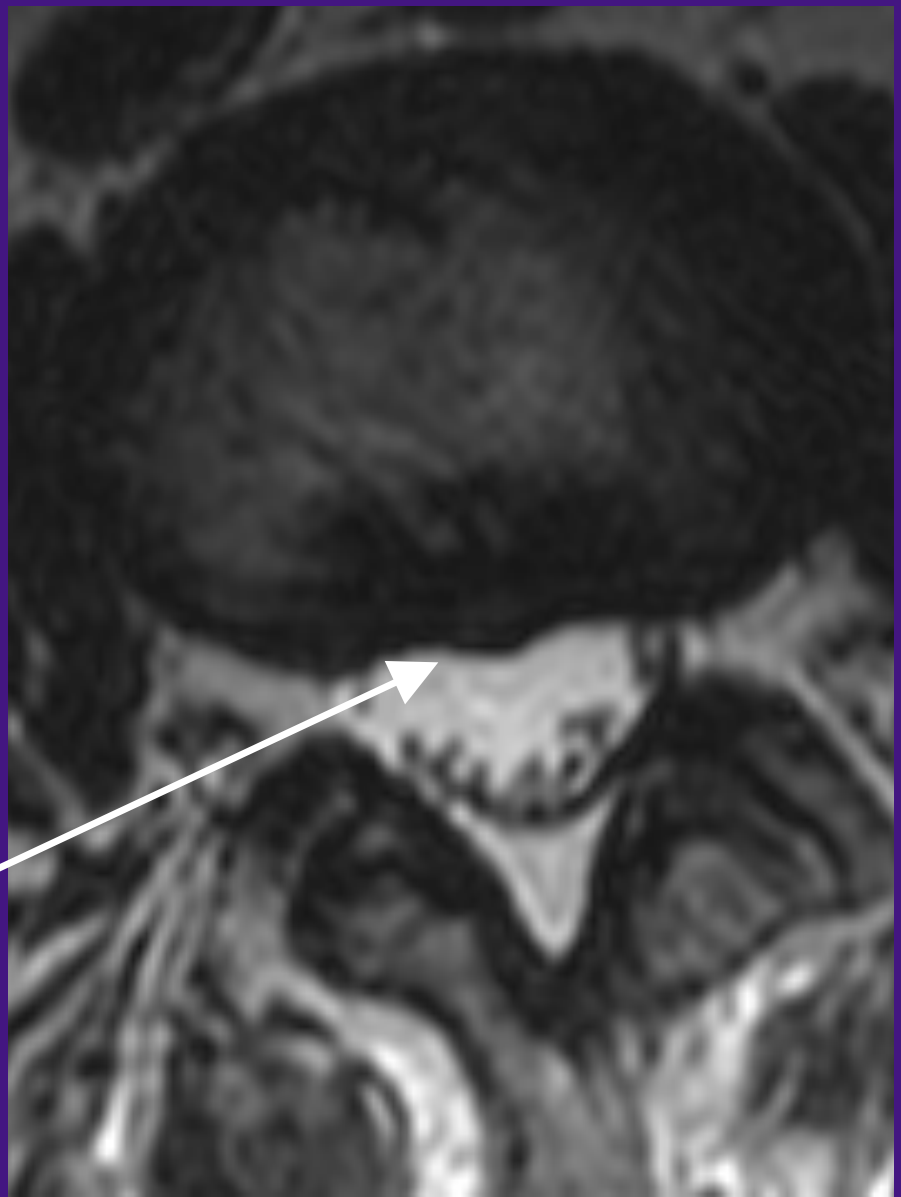
Bulging



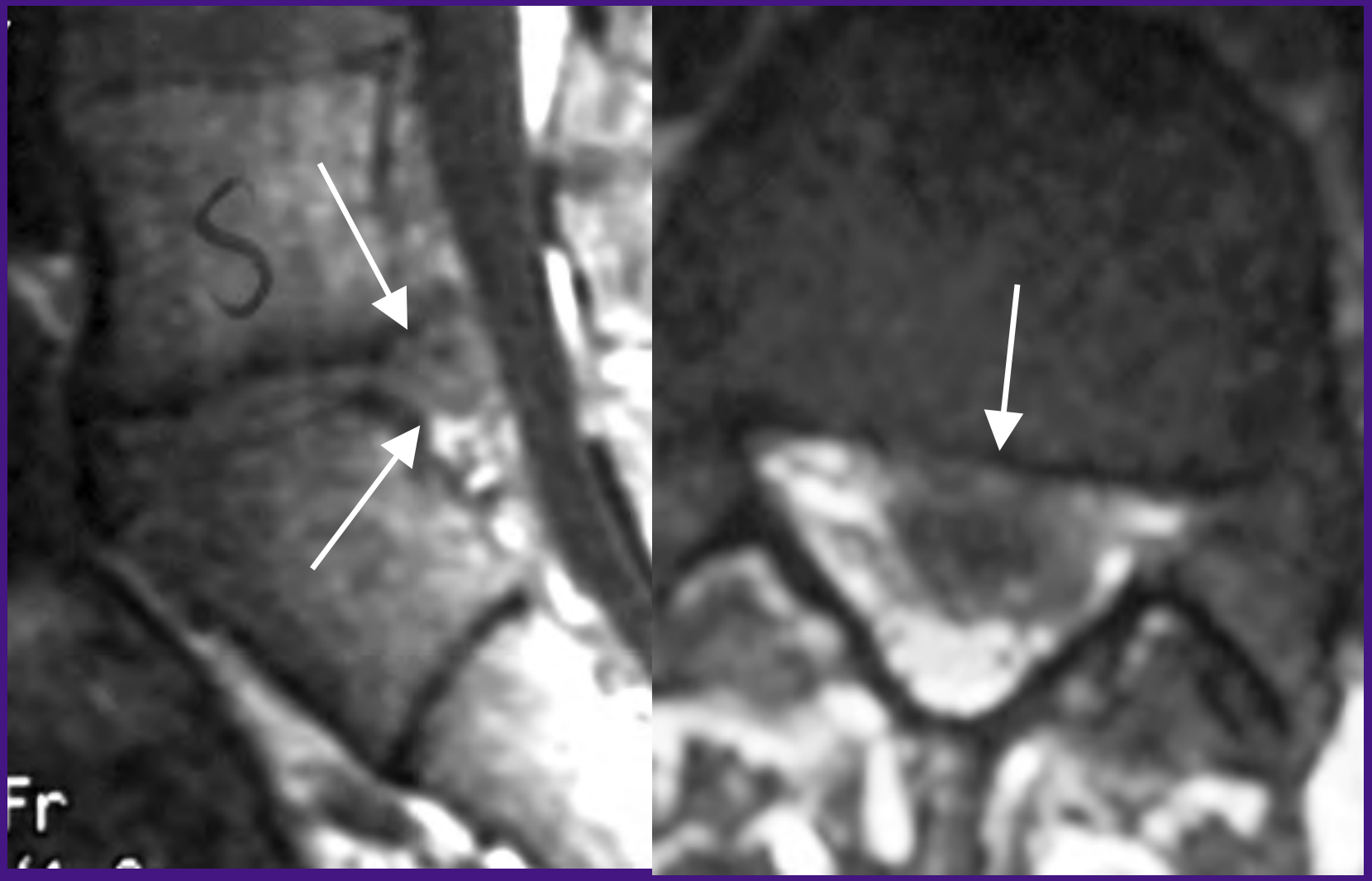
Protrusion



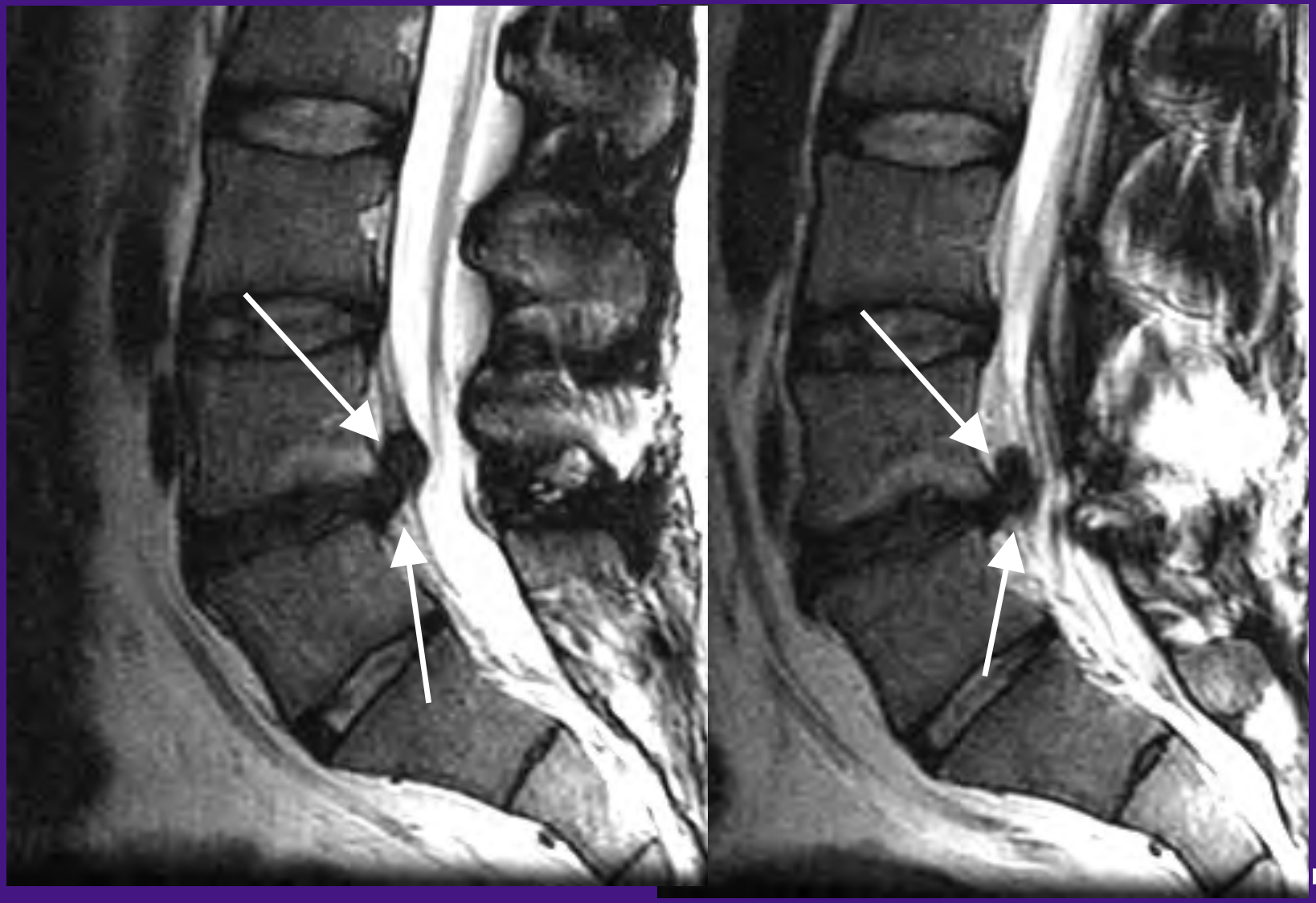
Protrusion



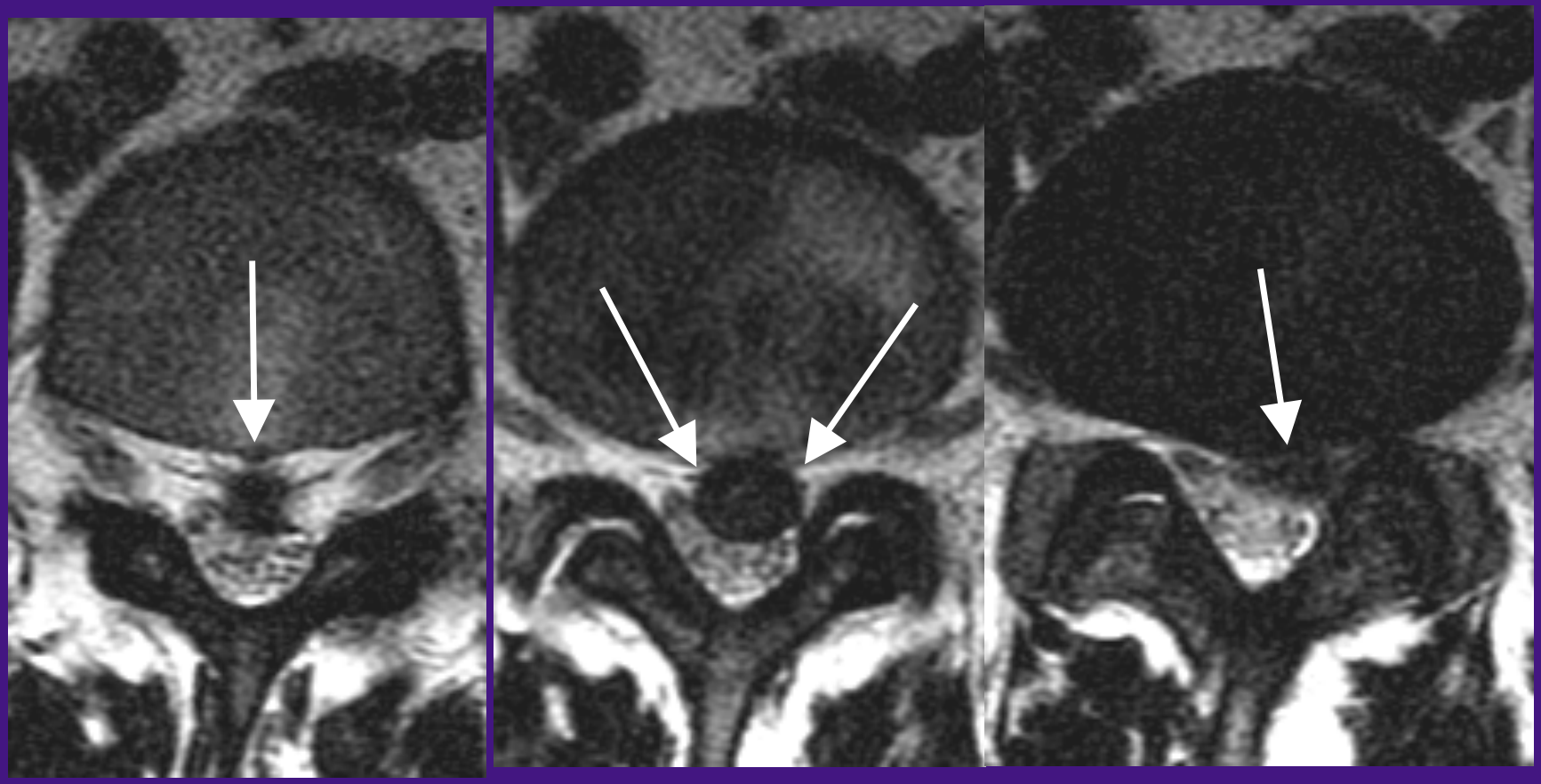
Extrusion



Extrusion



Extrusion



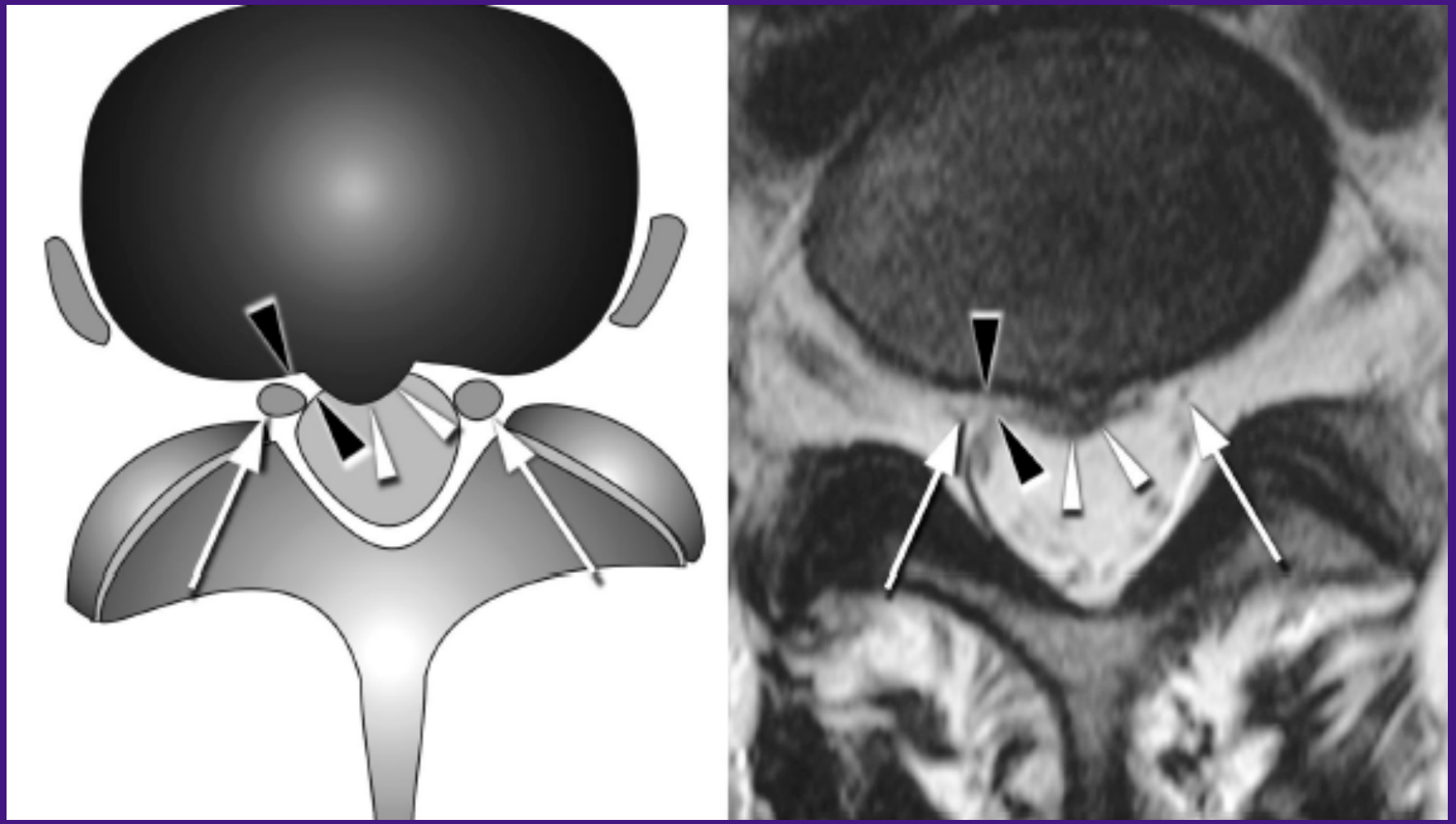
Reliability of Pro/Ex Classification

- Intrareader kappa=.69-.72
- Interreader kappa=.57-.59

Kappa value	Degree of agreement
0-.2	Poor
.2-.4	Fair
.4-.6	Moderate
.6-.8	Substantial
.8-1.0	Near Perfect

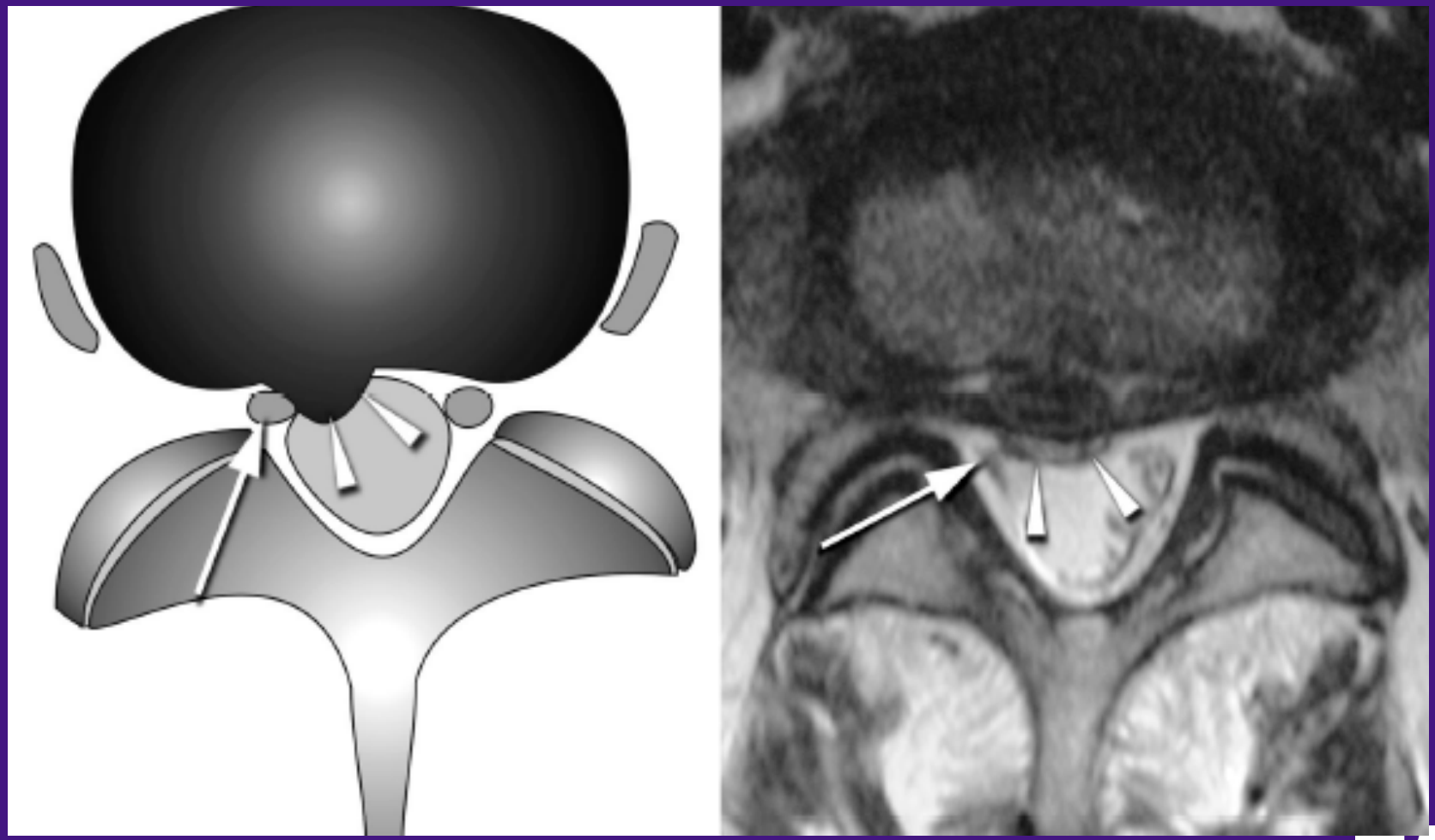
Normal Nerve Roots

(Pfirrmann et al, Radiology 2004)

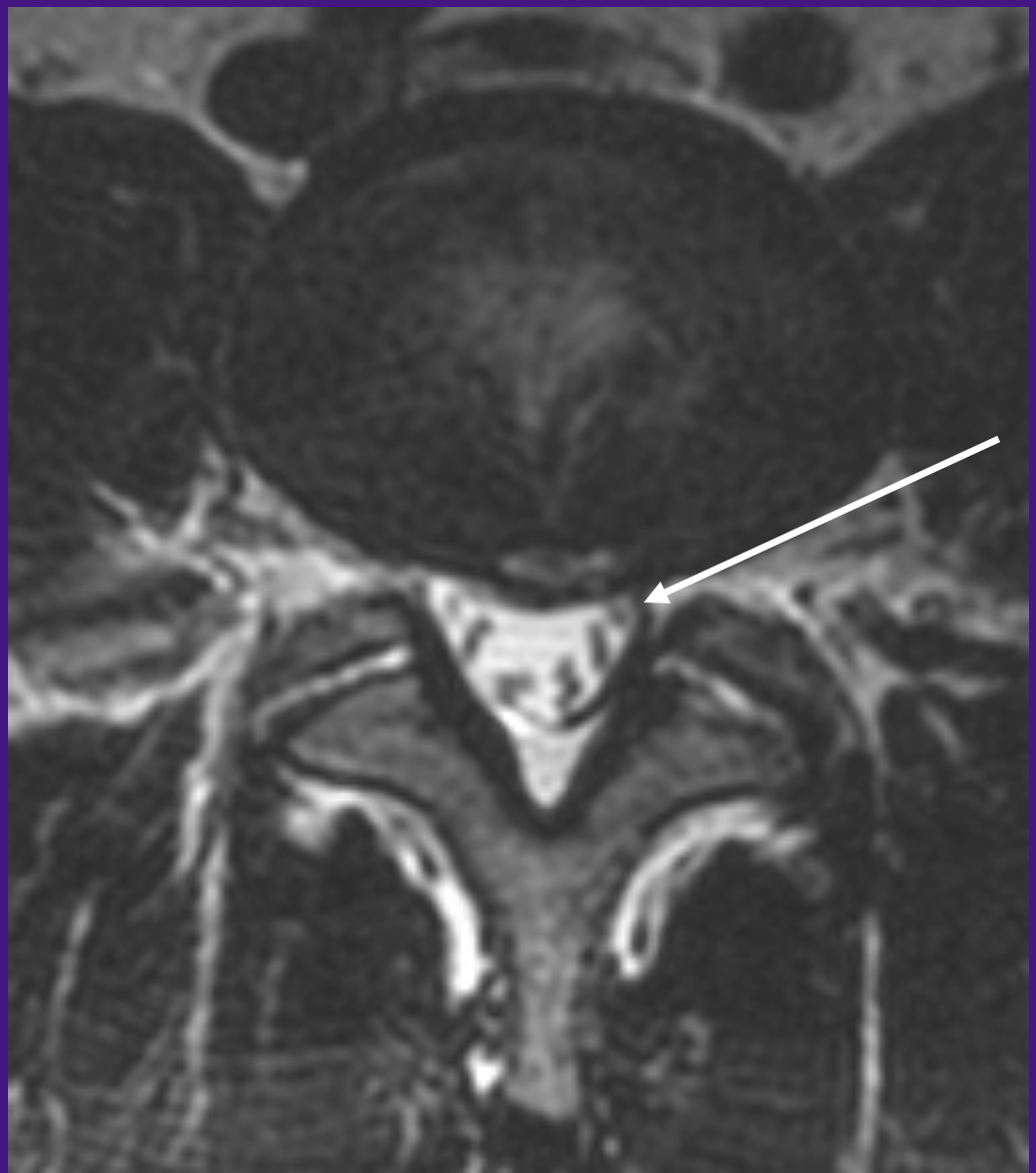


Contacted Nerve Root

(Pfirrmann et al, Radiology 2004)

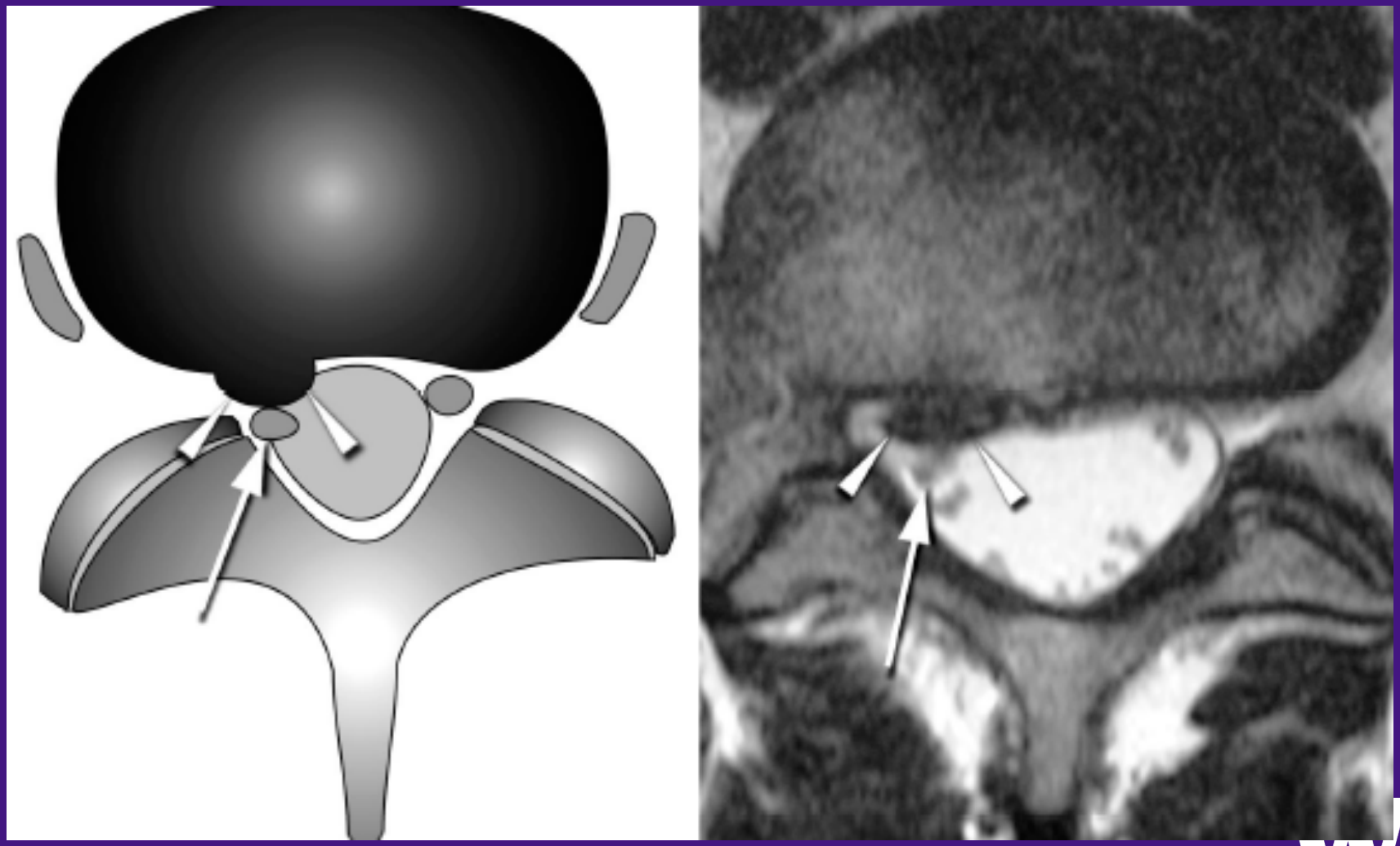


Contacted Nerve Root



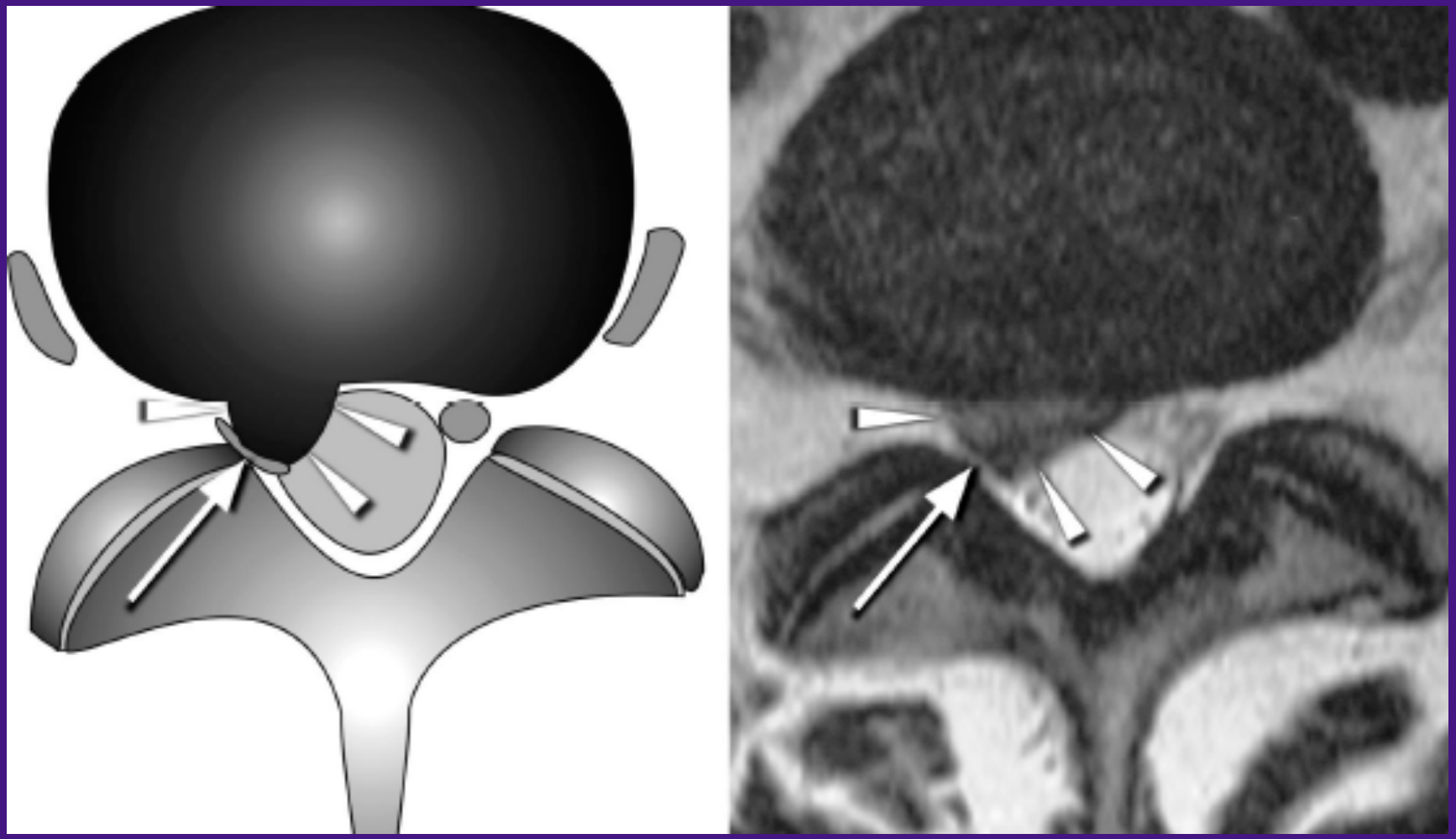
Displaced Nerve Root

(Pfirrmann et al, Radiology 2004)

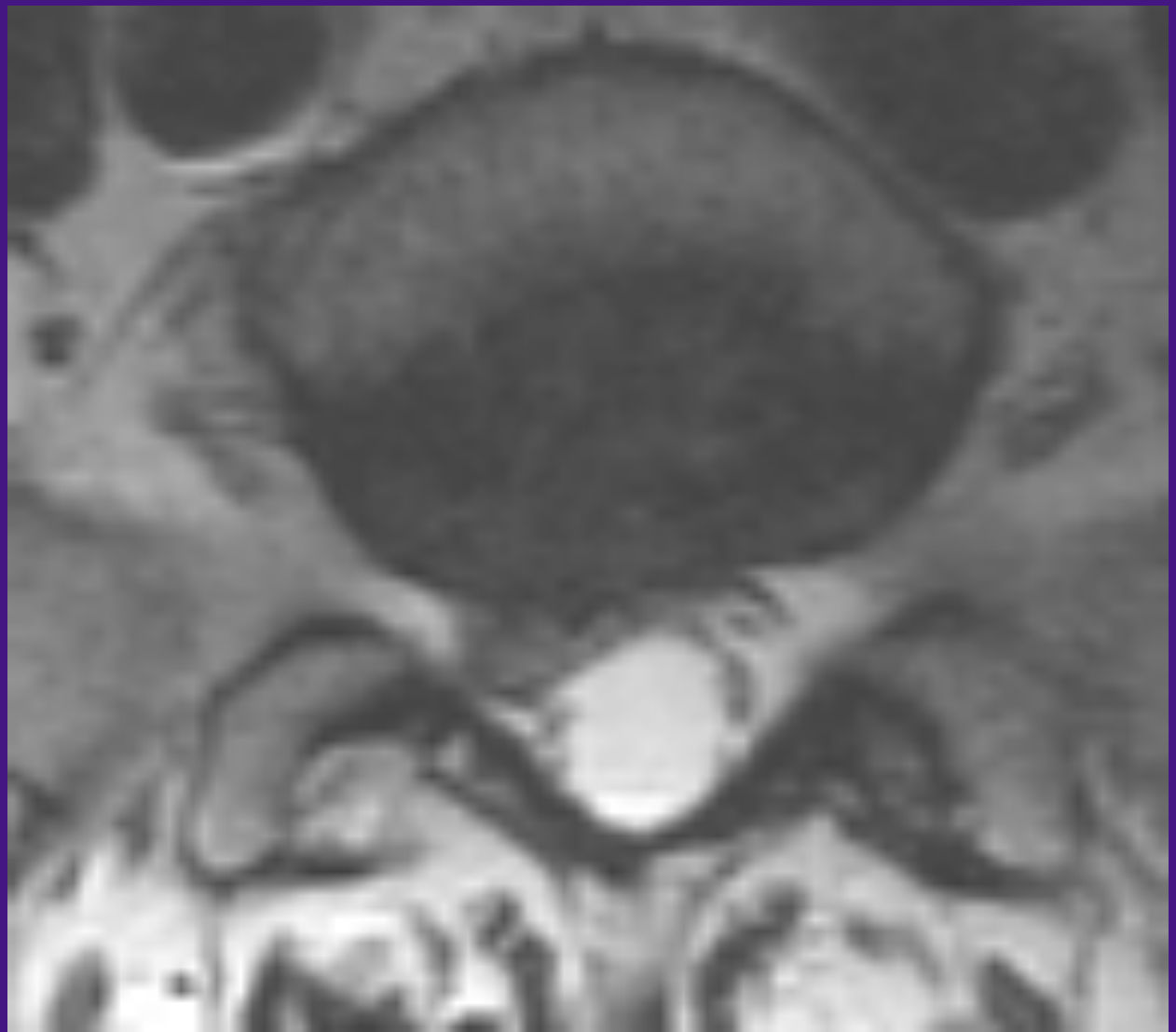


Compressed Nerve Root

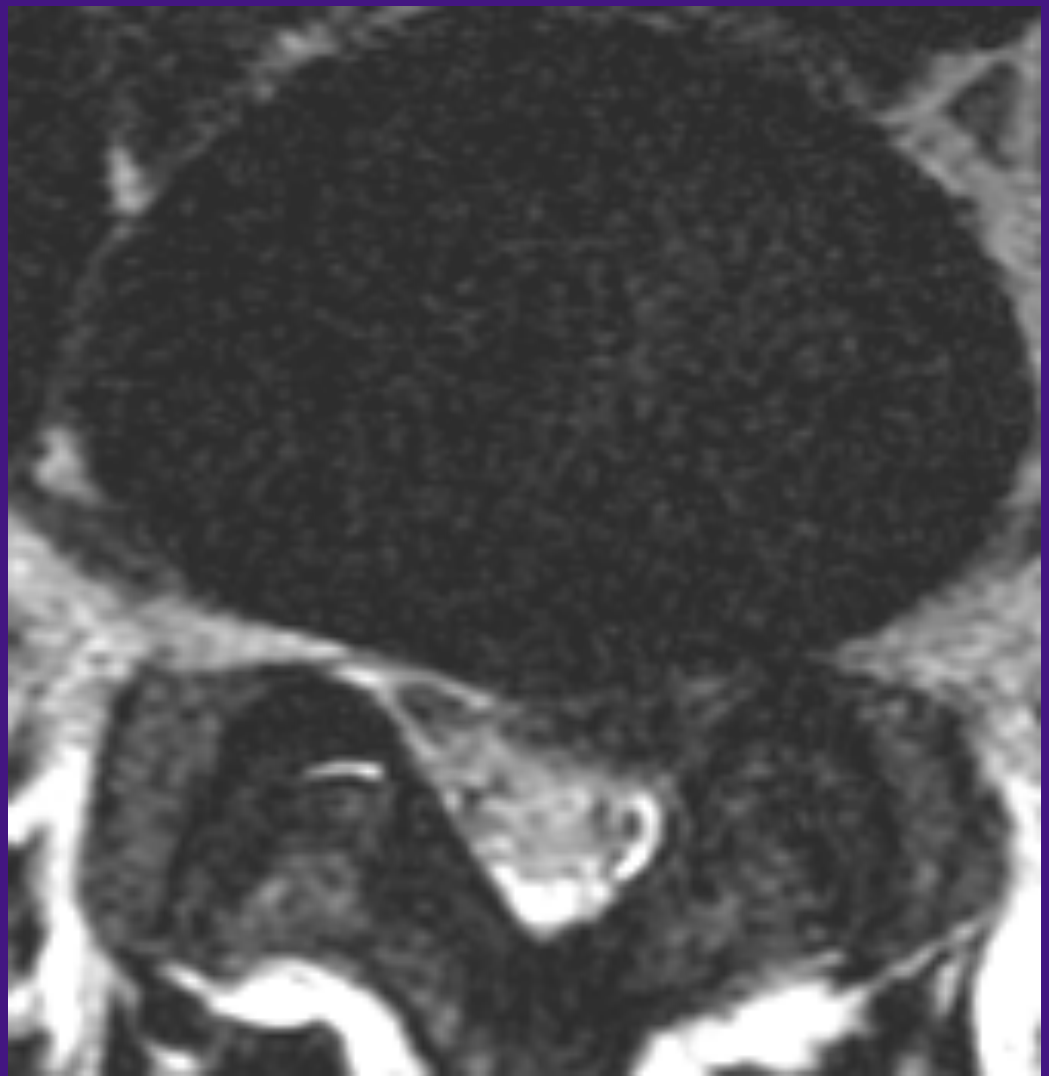
(Pfirrmann et al, Radiology 2004)



Displaced and Compressed Nerve Root



Displaced and Compressed Nerve Root

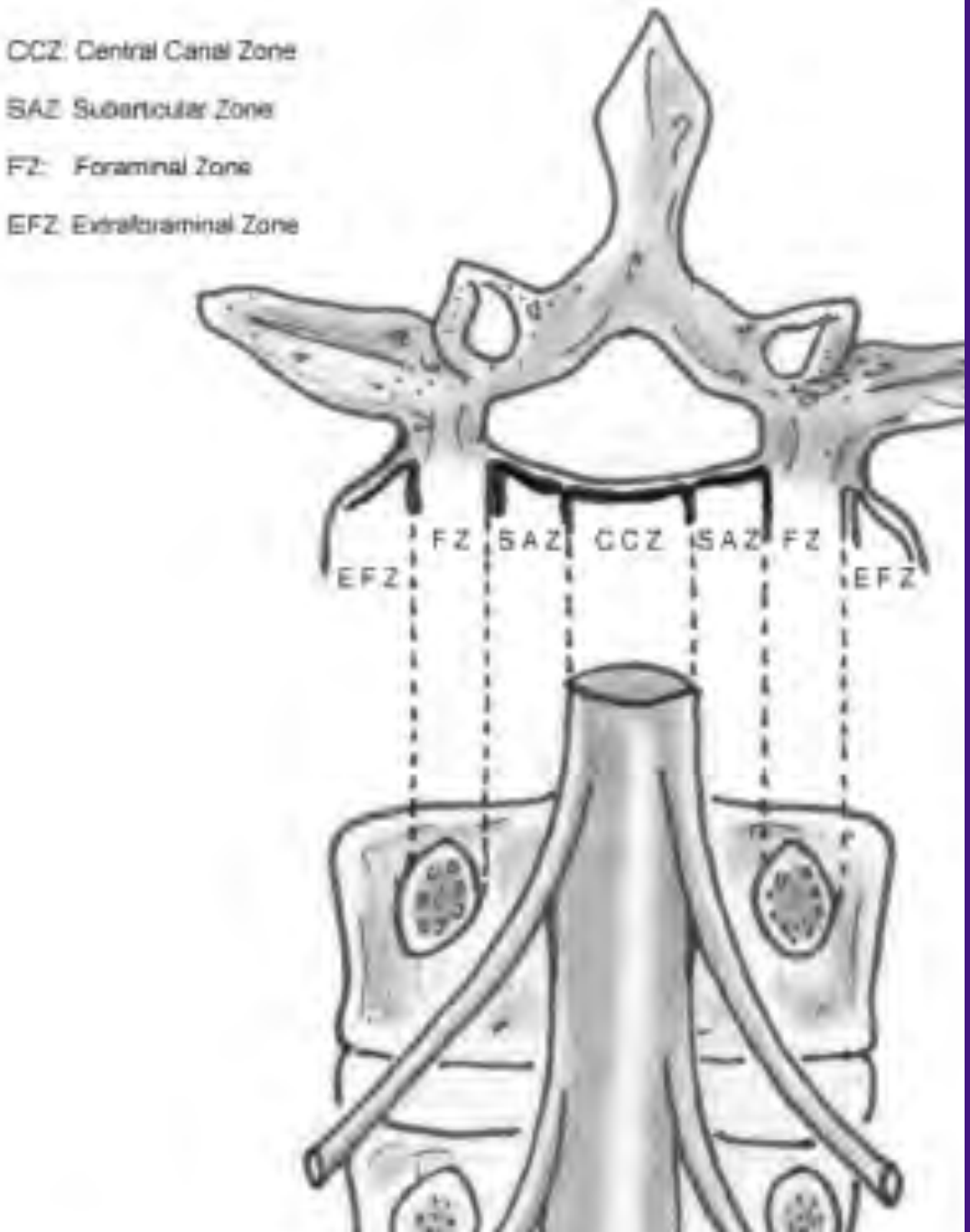


Reliability of Pfirrmann Nerve Root Grade

- Intrareader κ 0.72-0.77
- Interreader κ 0.62-0.67

Kappa value	Degree of agreement
0-.2	Poor
.2-.4	Fair
.4-.6	Moderate
.6-.8	Substantial
.8-1.0	Near Perfect

Anatomic Zones



Anatomic Levels

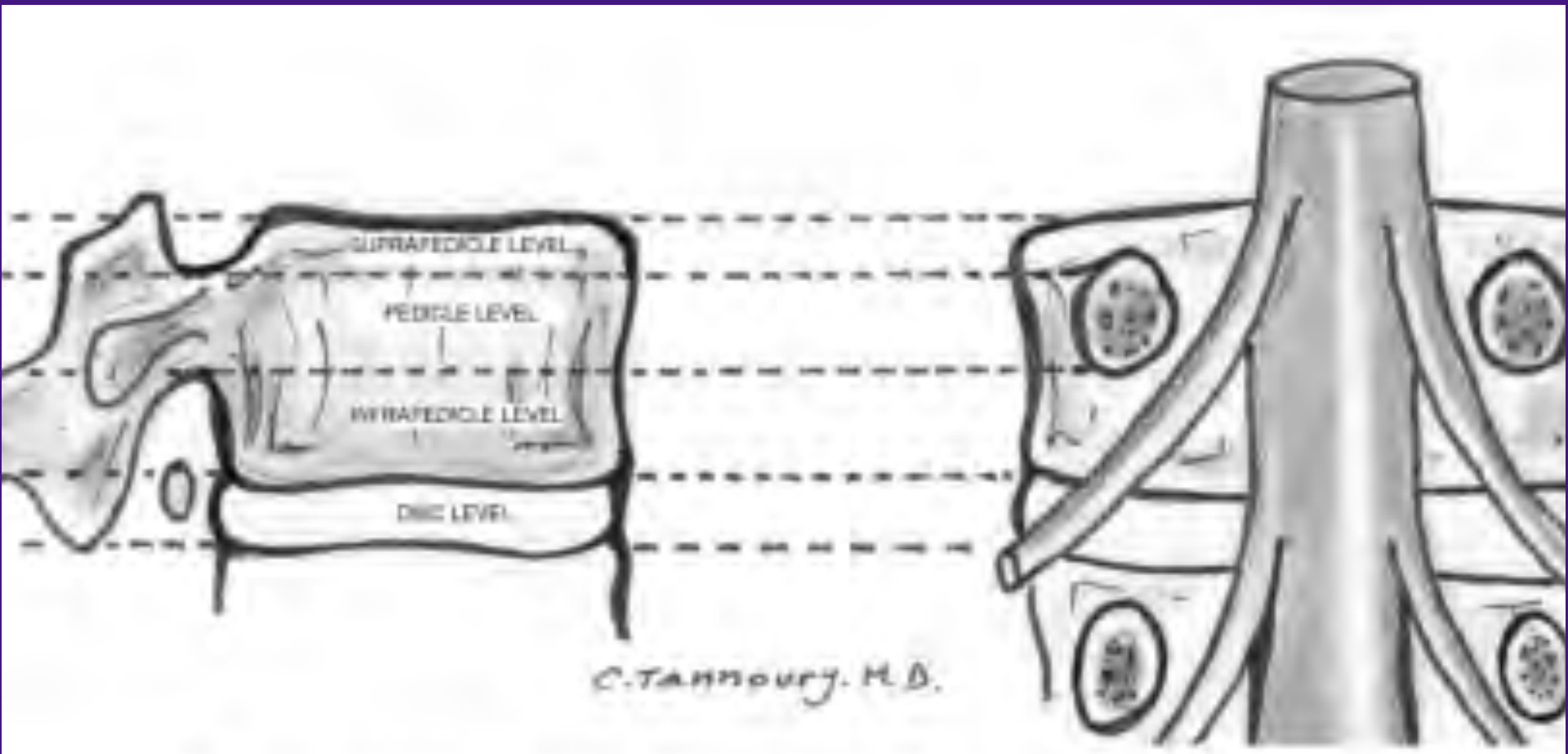


Fig. 12. Anatomic levels depicted in sagittal and coronal projections.

Reporting of Radiologic Parameters in Patients with Central Lumbar Spinal Stenosis

Consensus Meeting Zurich, October 2012

Eur Radiol (2014) 24:3224–3232
DOI 10.1007/s00330-014-3346-z

MUSCULOSKELETAL

Consensus conference on core radiological parameters to describe lumbar stenosis - an initiative for structured reporting

Gustav Andreisek · Richard A. Deyo · Jeffrey G. Jarvik · Francois Porchet · Sebastian F. X. Winklhofer · Johann Steurer · On behalf of the LSOS working group

Imaging Parameters

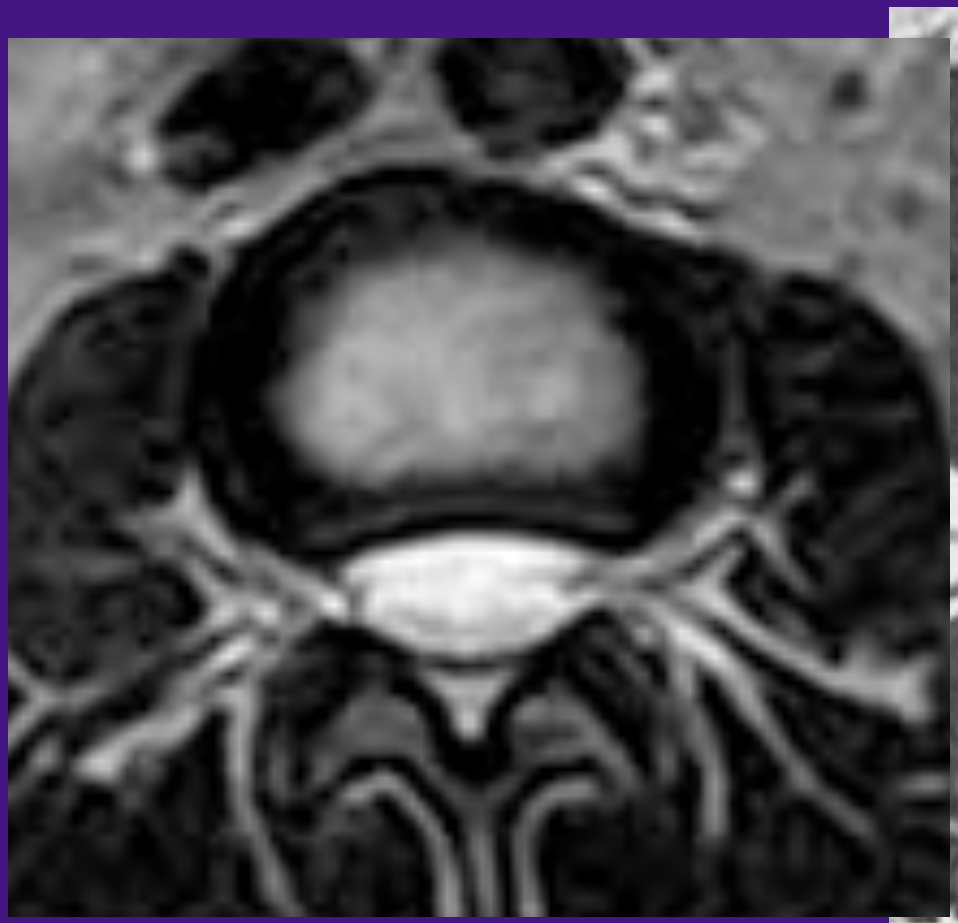
- Qualitative
  1. Compromise of central zone
  2. Fluid around cauda equina
  3. Root compression in lat recess
- Quantitative
  - AP diameter of thecal sac

Imaging Parameters

- Qualitative
  1. Compromise of central zone relative to normal size
     - Mild <1/3
     - Moderate 1/3-2/3
     - Severe >2/3

  (Lurie Spine 2008)

Spinal Stenosis



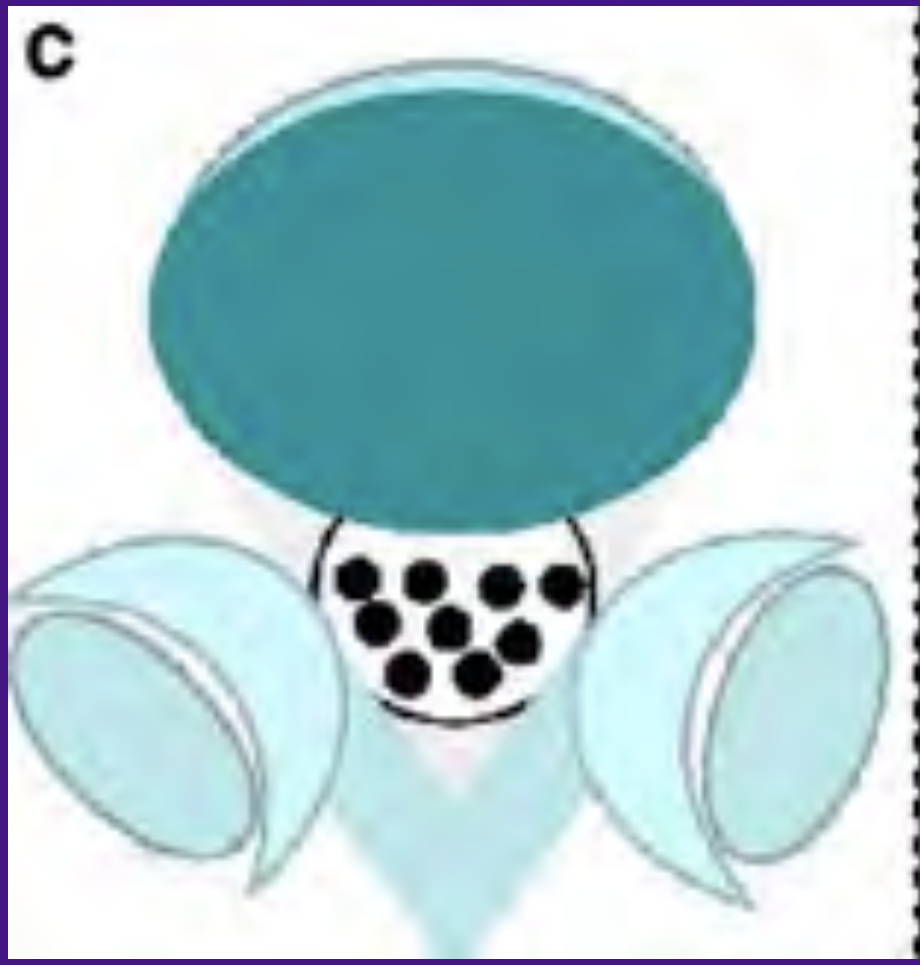
Imaging Parameters

- Qualitative
  2. Fluid around cauda equina
     - Grade 0: no stenosis
     - Grade 1: mild stenosis- can see individual roots
     - Grade 2: some root aggregation
     - Grade 3: no differentiation

     (Guen Skel Radiol 2011)

Stenosis Grade 1

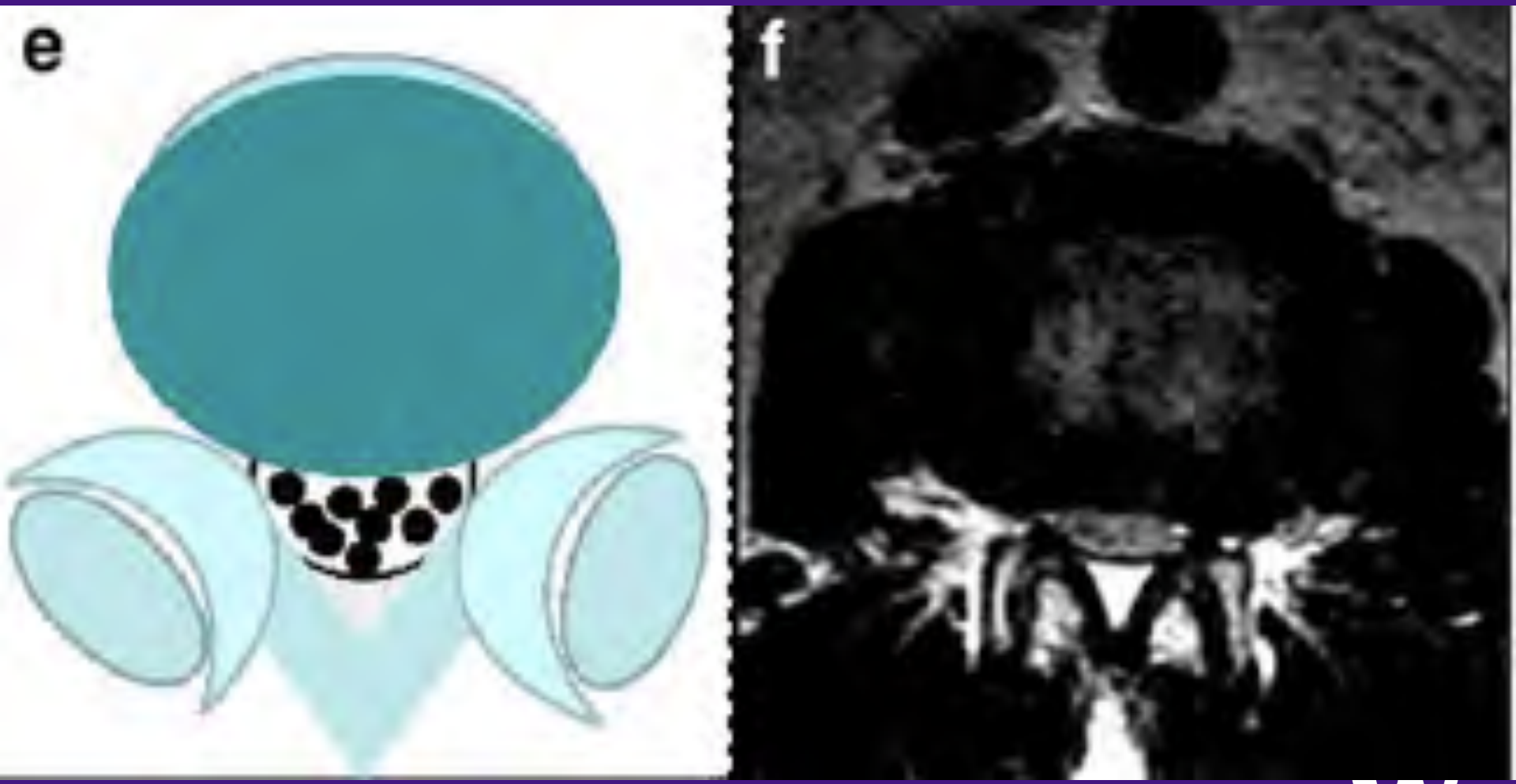
Still can see individual roots



(Guen Skel Radiol 2011)

Stenosis Grade 2

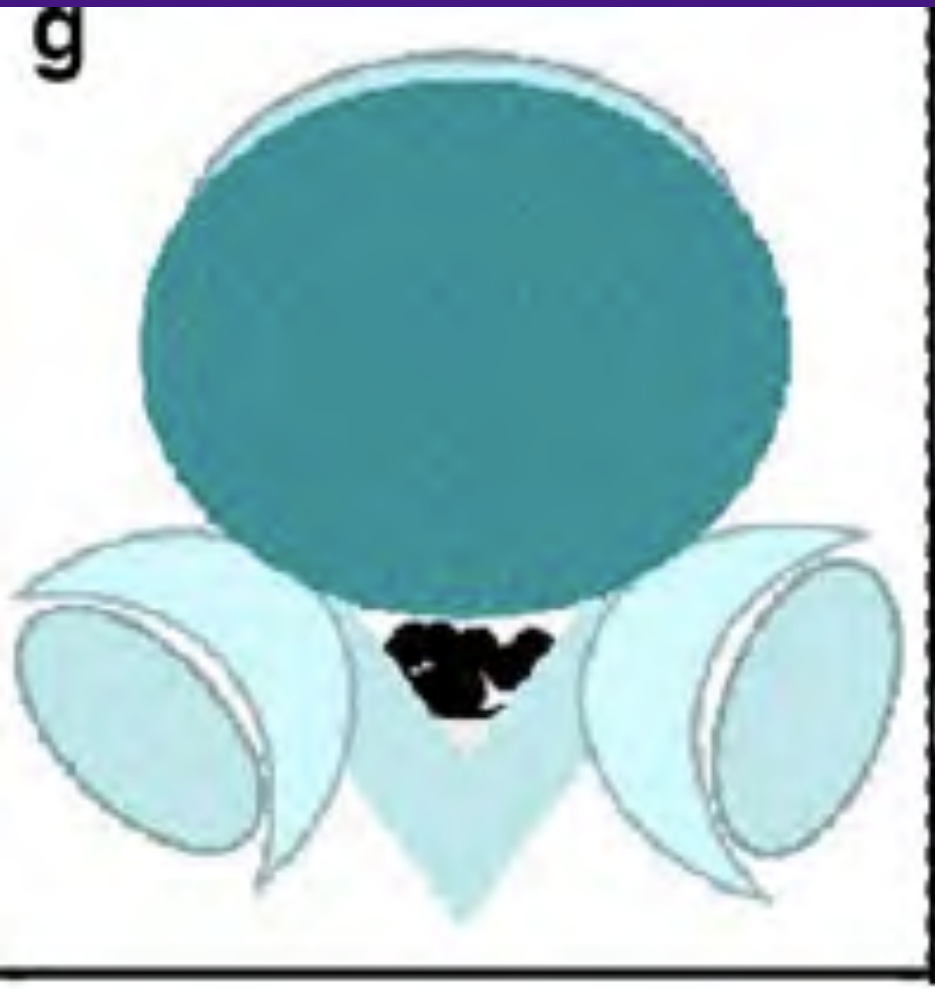
Some root aggregation

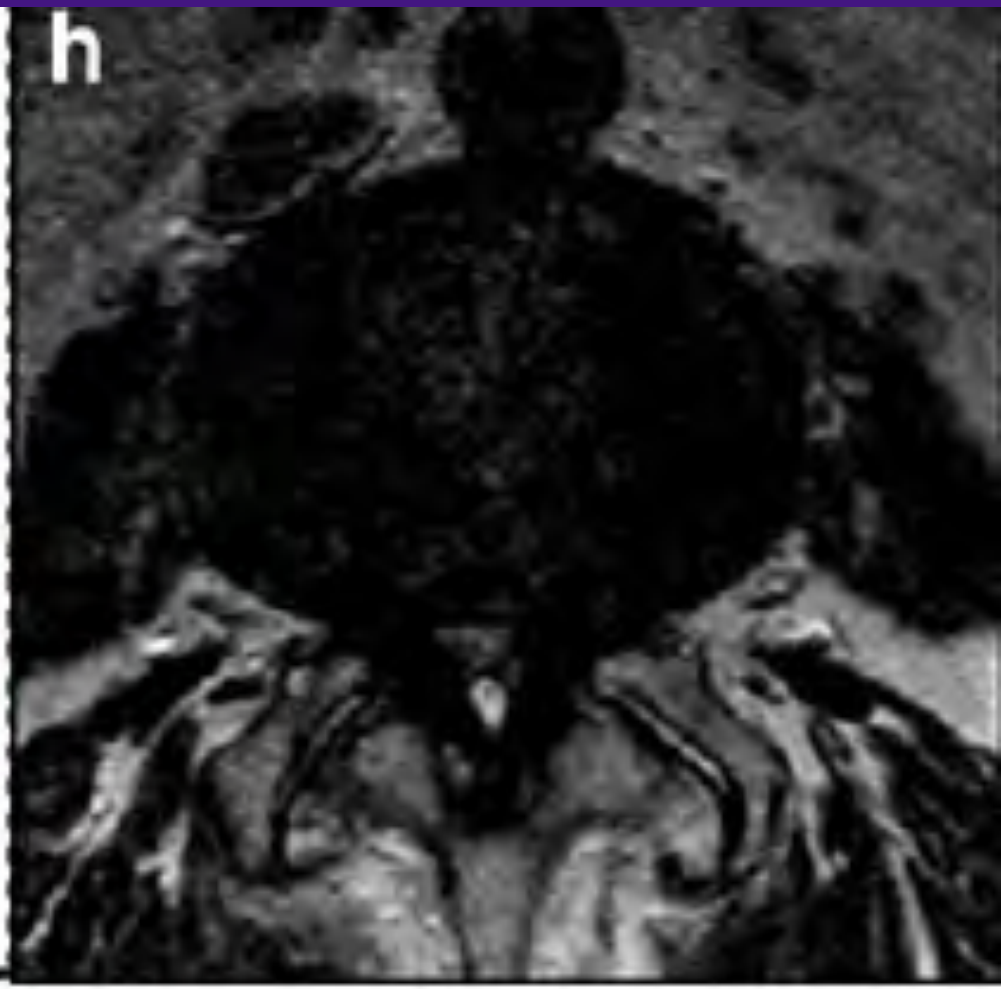


(Guen Skel Radiol 2011)

Stenosis Grade 3

Entire cauda equina in a bundle





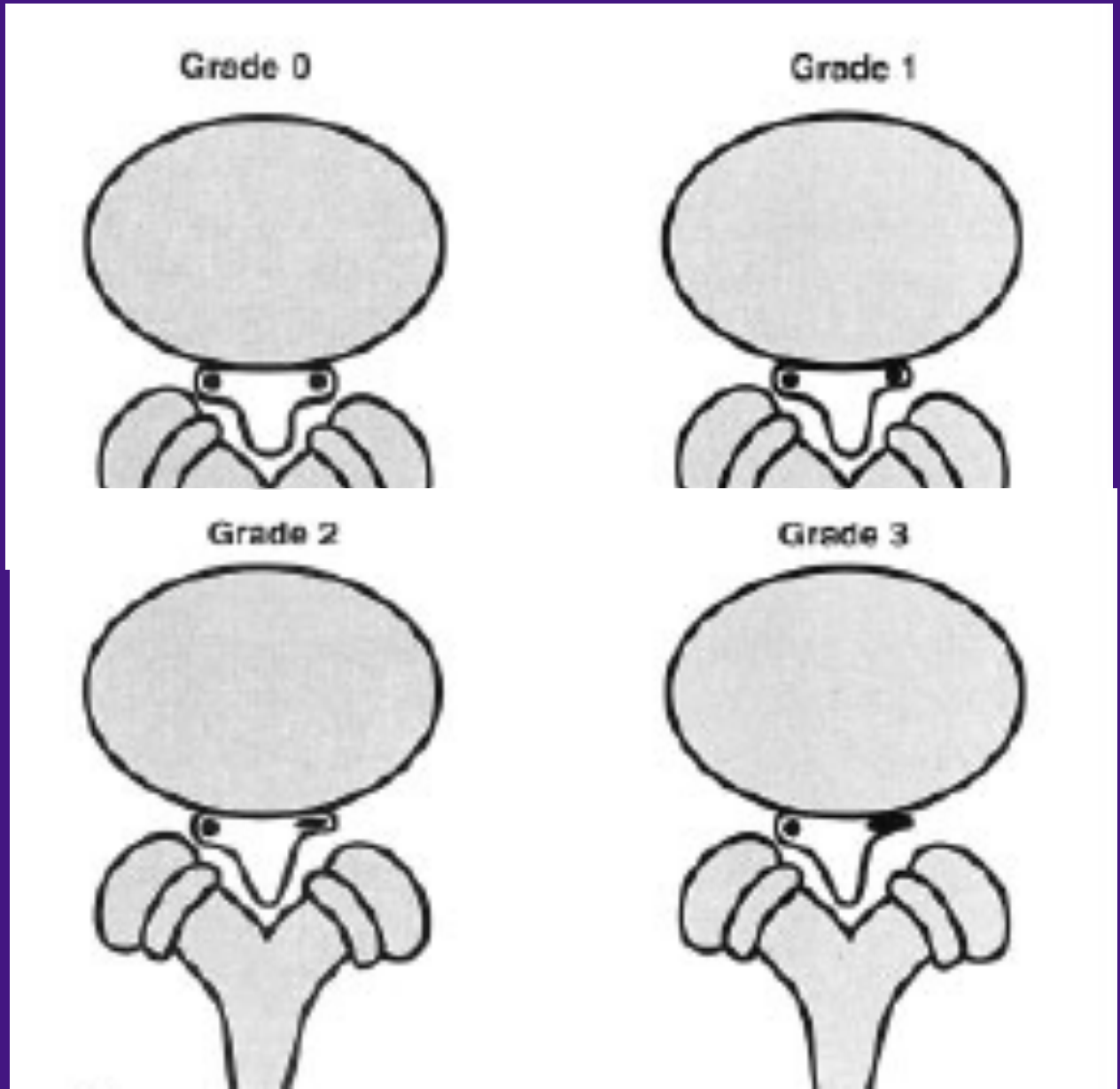
(Guen Skel Radiol 2011)

Imaging Parameters

- Qualitative
  3. Root compression in lat recess
     - Grade 1: narrow LR w/o root comp
     - Grade 2: narrow LR w/root flat but preserved CSF
     - Grade 3: CSF oblit in LR and sev root compression

(Bartynski AJNR 2003)

Bartynski Grading



Talk Outline

- When to image: guideline review
- What to say:
  - Nomenclature: Classifying Disc Findings
  - Degeneration: The Spectrum of Normal
- Summary

Fundamental Problem

- Many findings
- Poor association with pain

Prevalence of Anular Fissures in Normals

Modality	Author/ Year	Age Range	Prev
MR	Jensen/ 1994	20-80	14%
MR	Stadnik/ 1998	17-60 61-71	48% 100%
MR	Weishaupt/ 1998	20-50	33%
MR	Carragee/ 2000	22-57	24%
MR	Jarvik/ 2001	35-70	38%

-

Carragee Spine 2001

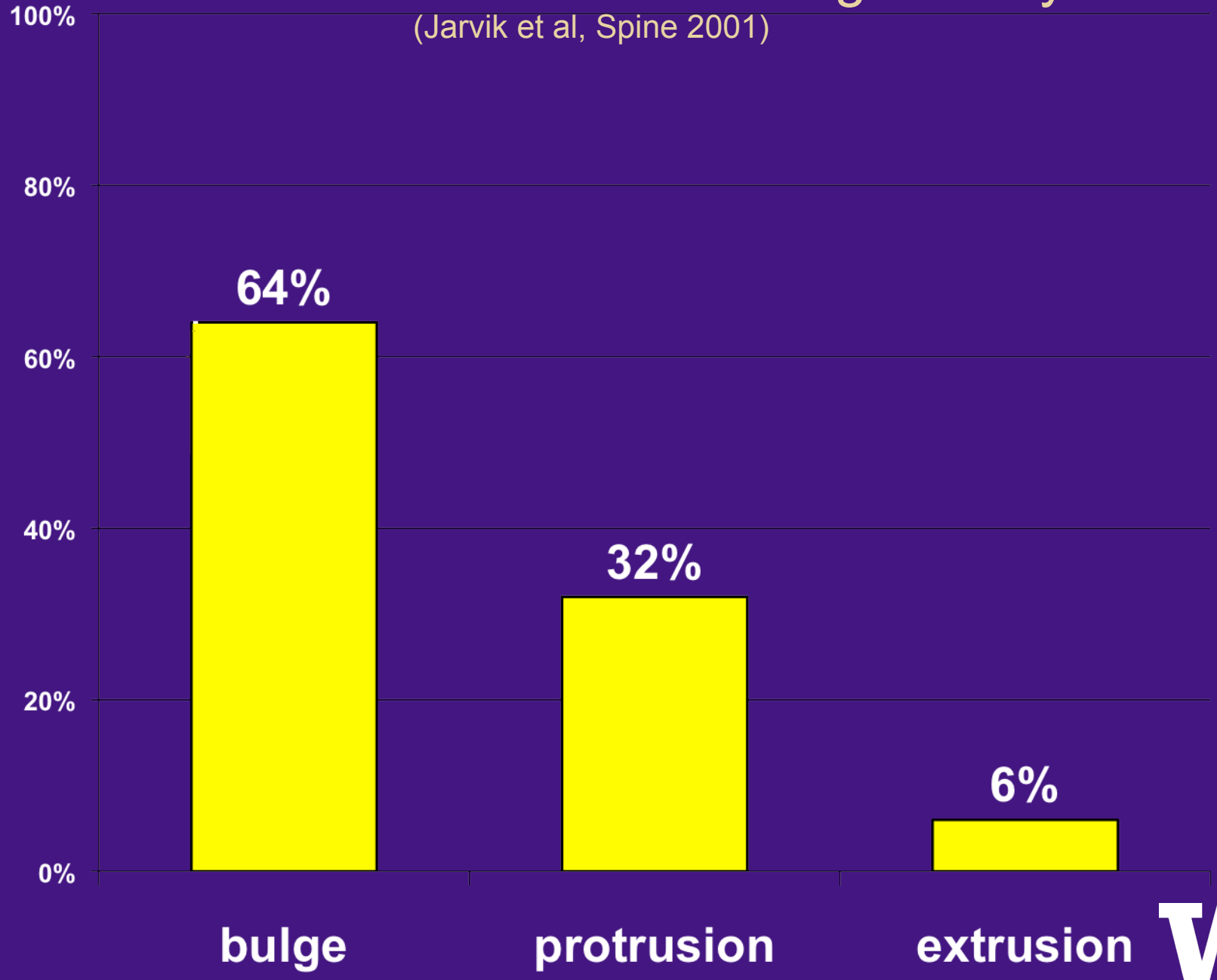
- HIZ does not reliably indicate presence of symptomatic internal disc disruption
- prevalence of HIZ in asx's too high (25%) for meaningful clinical use
- at discography, same % of asx and sx discs with an HIZ were painful

Prevalence of Disc Herniations in Normals

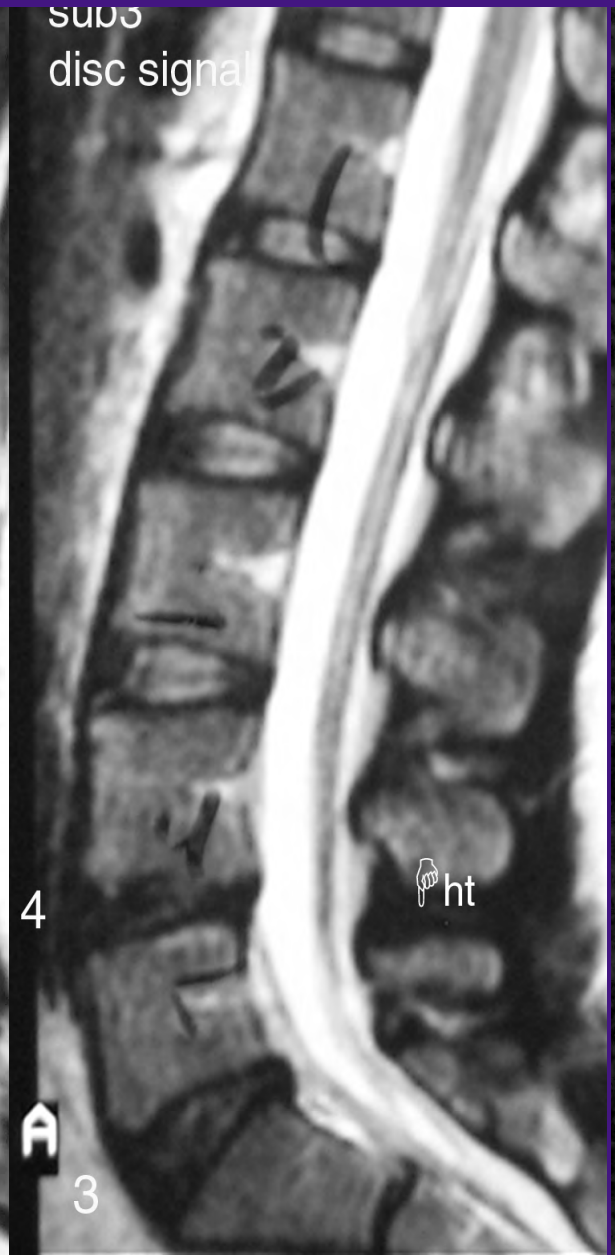
Modality	Author/Yr	Finding	Prev
Myelo	**Hitselberger/ 1968**	**Any**	**24%**
CT	**Wiesel/ 1983**	**HNP**	**20-27%**
MR	**Boden/ 1990**	**HNP**	**22-36%**
MR	**Jensen/ 1994**	**Protrusion** **Extrusion**	**20-60%** **1%**
MR	**Stadnik/ 1998**	**Protrusion** **Extrusion**	**26-80%** **0%**

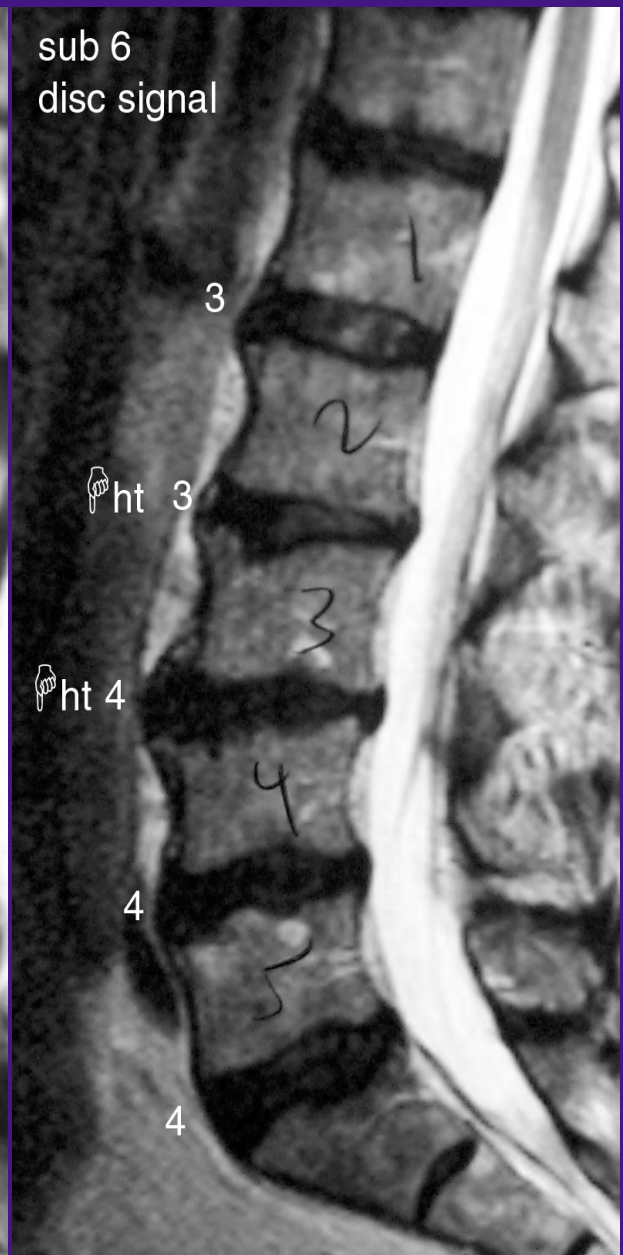
Baseline Prevalence of Disc Findings at Any Level

(Jarvik et al, Spine 2001)



Disc Degeneration





Prevalence of Disc Degeneration in Normals

Modality	Author/ Year	Age Range	Prev
MR	Boden/ 1990	20-60 60-80	44% 93%
MR	Stadnik/ 1998	17-60 61-71	52% 80%
MR	Weishaupt/ 1998	20-50	72-100%
MR	Jarvik/ 2001	35-70	91%

Viewpoint

THE LANCET

Should radiologists change the way they report plain radiography of the spine?

The Lancet; Jul 18, 1998; 352, 9123;
pg. 229

Martin Roland, Maurits van Tulder

Roland and van Tulder Recommended Reports

Disc degeneration:

Approximately 80%-100% of people without back pain have this, so finding may not be related to patient's pain

Lumbar Spine Macro

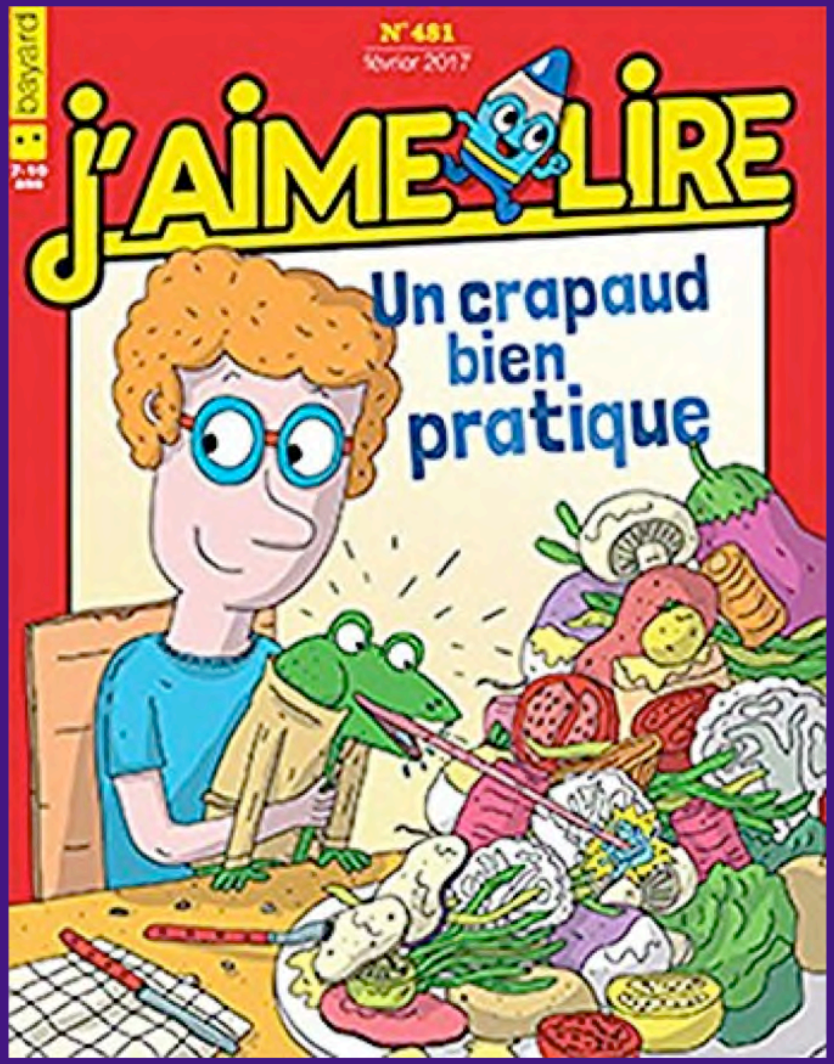
The following findings are so common in people without low back pain that while we report their presence, they may have nothing to do with a patient's low back pain (Reference-Jarvik et al, Spine 2001):

Finding (prevalence in pts without low back pain)

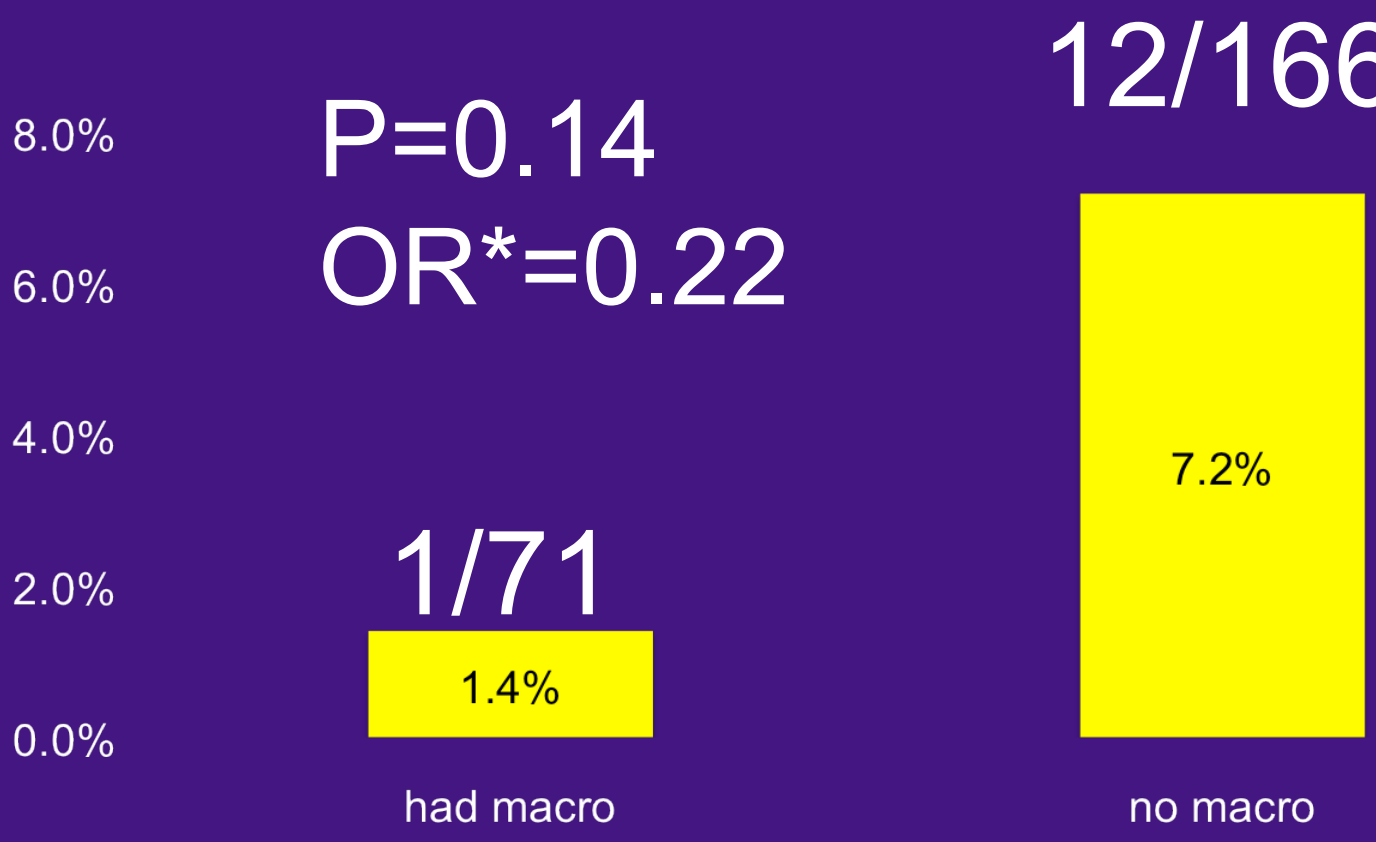
- Disc degeneration (91%)
- Disc signal Loss (83%)
- Disc height loss (56%)
- Disc bulge(64%)
- Disc protrusion (32%)
- Annular fissure (38%)

Lumbar Imaging with Reporting of Epidemiology (LIRE)

LIRE (pronounced *leer*) from the French verb, ‘to read’.

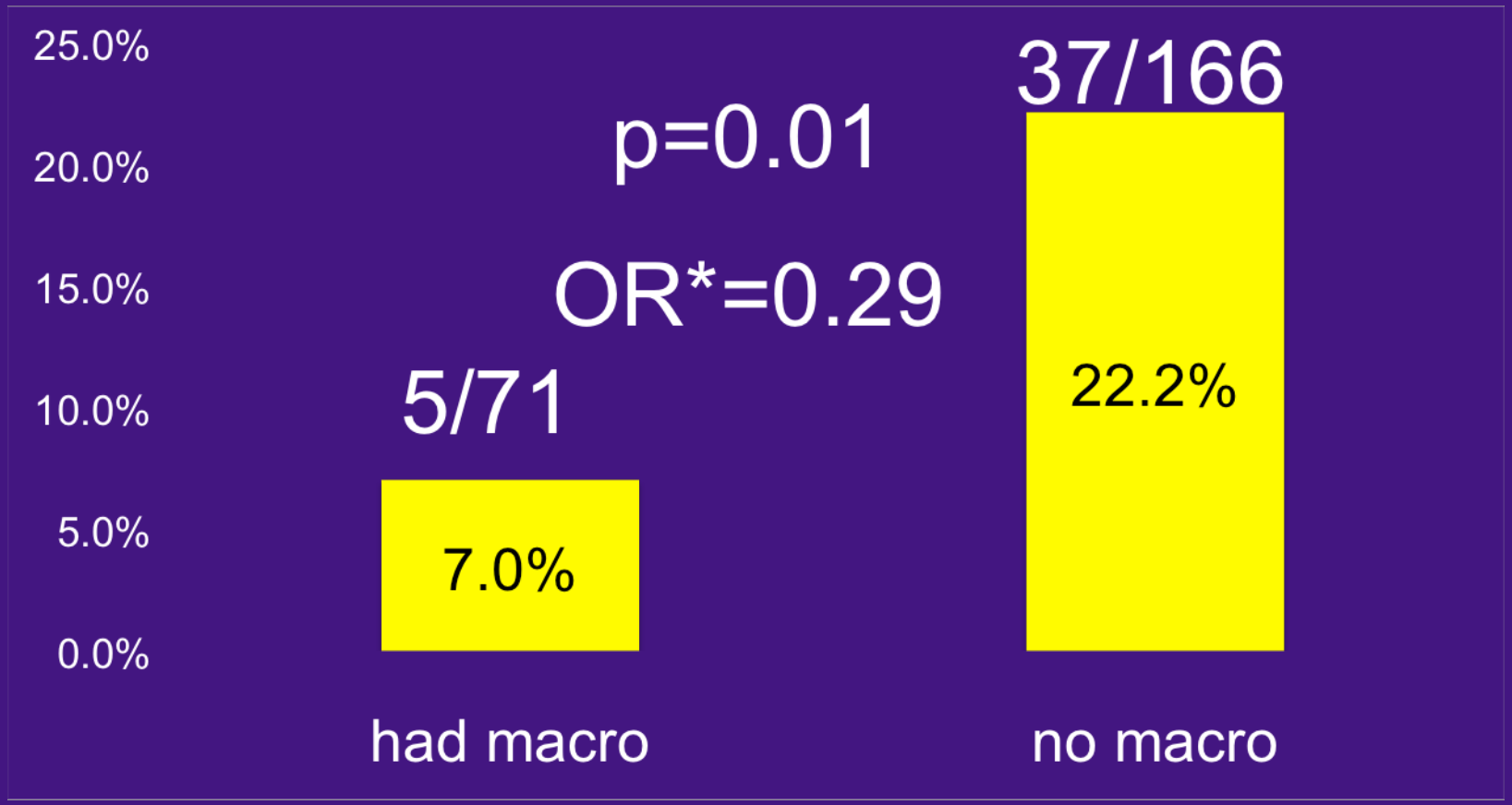


Retrospective Pilot Results: Subsequent Imaging Within 1 Yr



* Adjusted for imaging severity

Results: Subsequent Narcotic Rx Within 1 Yr



Published last month…

Radiology

Jessica G. Fried, MD
Angeline S. Andrew, PhD
Natalie Y. Ring, BS
David A. Pastel, MD

Changes in Primary Care Health Care Utilization after Inclusion of Epidemiologic Data in Lumbar Spine MR Imaging Reports for Uncomplicated Low Back Pain[1]

Results: Patients in the statement group were 12% less likely to be referred to a spine specialist (137 of 187 [73%] vs 159 of 188 [85%]; $P = .007$) and were 7% less likely to undergo repeat imaging (seven of 187 [4%] vs 20 of 188 [11%]; $P = .01$) compared with patients in the nonstatement group. The intervention was not associated with any change in narcotic prescription (53 of 188 [28%] vs 54 of 187 [29%]; $P = .88$) or with the rate of low back surgery (24 of 188 [13%] vs 16 of 187 [9%]; $P = .19$).

Conclusion: In this study, inclusion of a simple epidemiologic statement in lumbar MR imaging reports was associated with decreased utilization in high-cost domains of low back pain management.

Intervention Text

The following findings are so common in normal, pain-free volunteers, that while we report their presence, they must be interpreted with caution and in the context of the clinical situation. Among people between the age of 40 and 60 years, who do not have back pain, a plain film x-ray will find that about:

- 8 in 10 have disk degeneration
- 6 in 10 have disk height loss

Note that even 3 in 10 means that the finding is quite common in people without back pain.

Talk Outline

- When to image: guideline review
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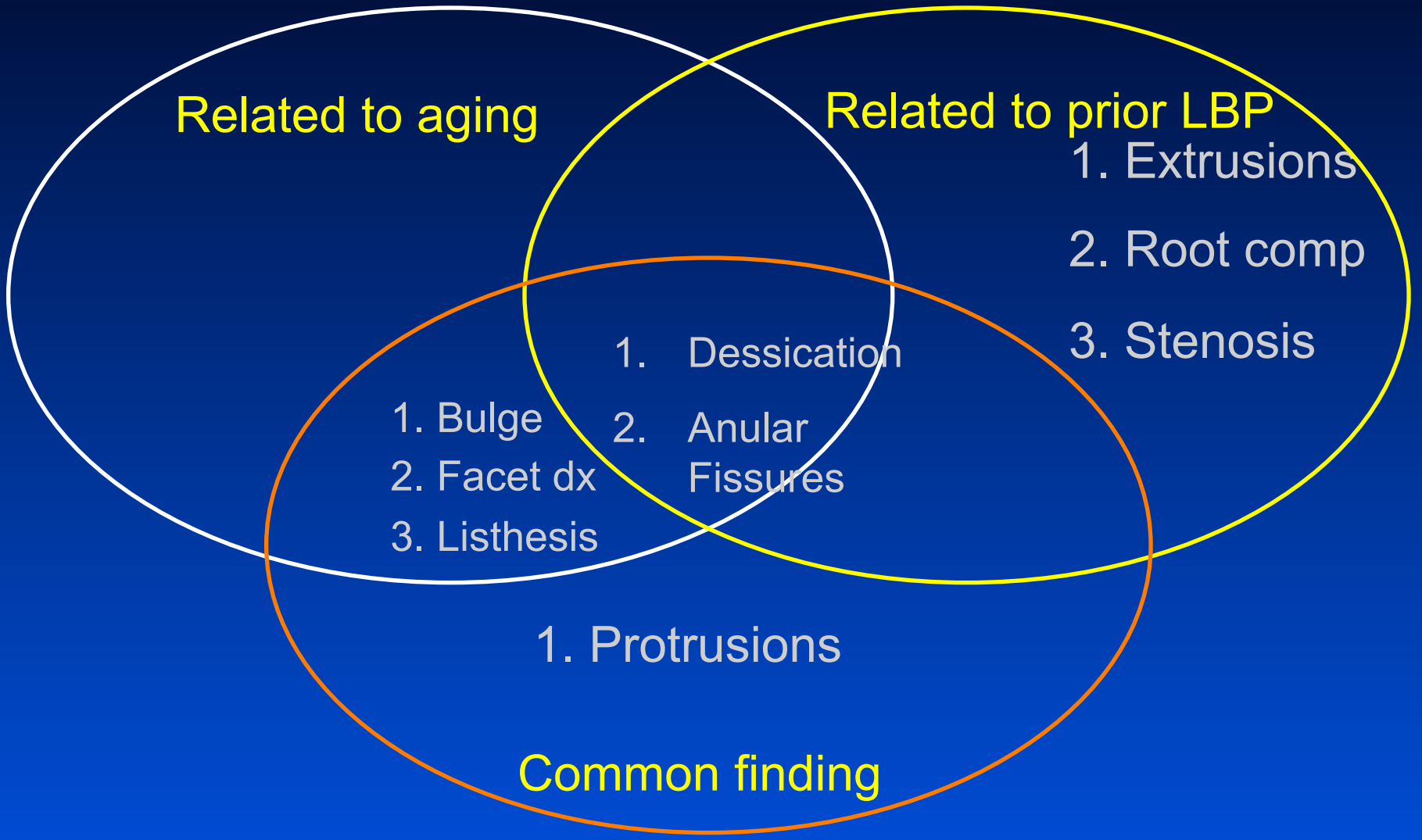
- Summary

Classification of Imaging Findings



Take Home Points

- Don’t image without a good clinical reason
- Don’t image older adults early just because of their age

Take Home Points: What We Say

- Standardized nomenclature whenever possible
  - Good for learning healthcare system
  - Good for training
  - Good for patients
- Many findings common in asx's
- 3 findings more likely to be clinically important
  - disc extrusions
  - root compression
  - central stenosis

www.thecleancenter.org

UW Clinical Learning, Evidence And Research (CLEAR) Center for Musculoskeletal Disorders

- New UW NIH/NIAMS P30 Center
- Focused on transforming clinical → research data
- Data sets available for UW researchers
  - Claims (Marketscan, CMS)
  - Observational cohort (BOLD)
  - RCT (not yet…) LESS, LIRE
- Pilot $$ for faculty ($20k/project)

"Where's that damn 'escape' key?"

• •