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Degenerative conditions of the posterior elements of the spine: Diagnostic and therapeutic principles

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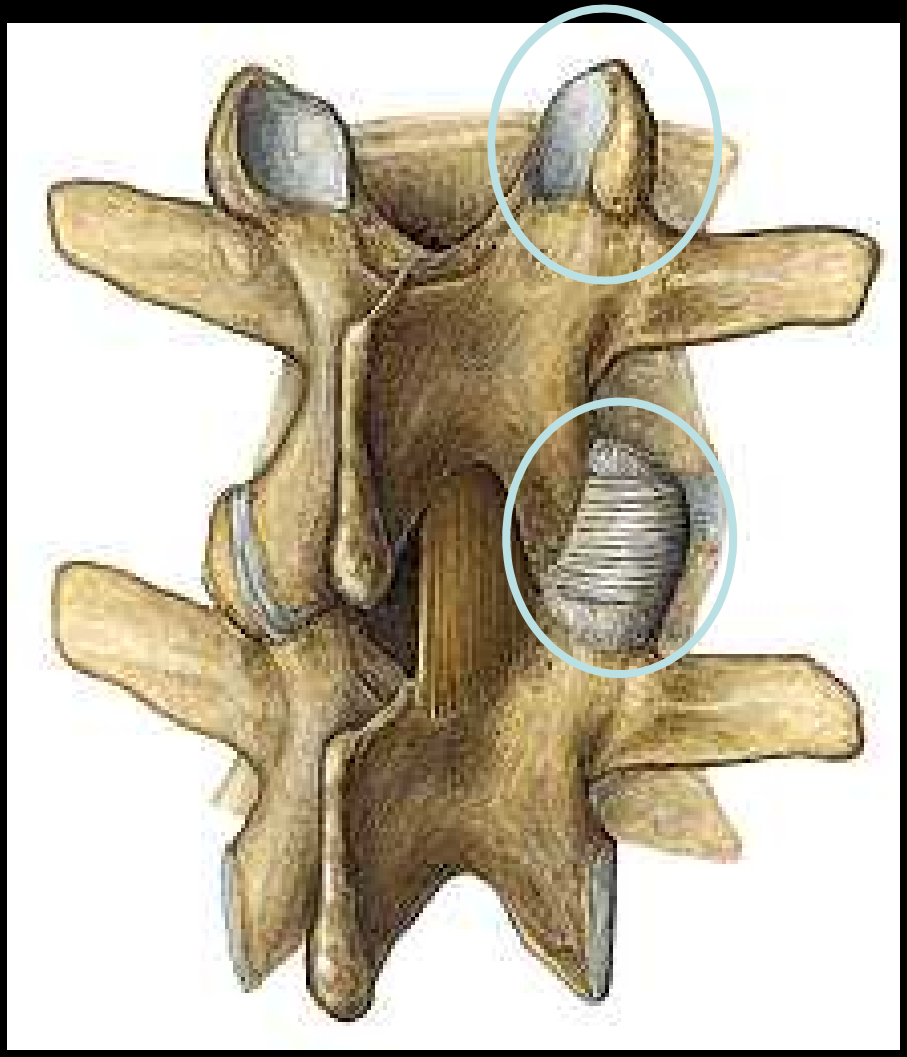
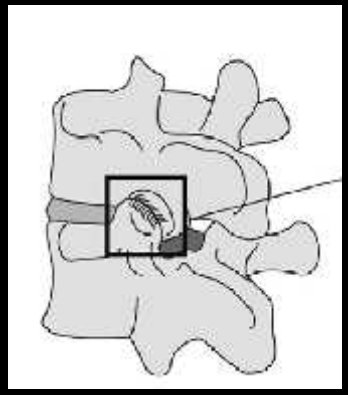
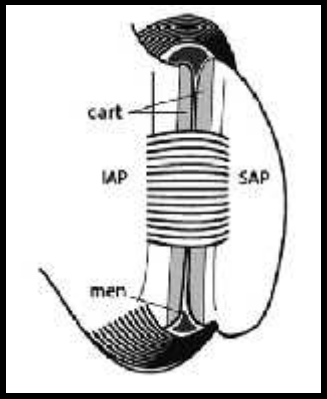
Anatomy

Zygoapophyseal Joint



- Synovial joint (diarthrial) surrounded by a capsule
- Two articular surfaces covered with cartilage



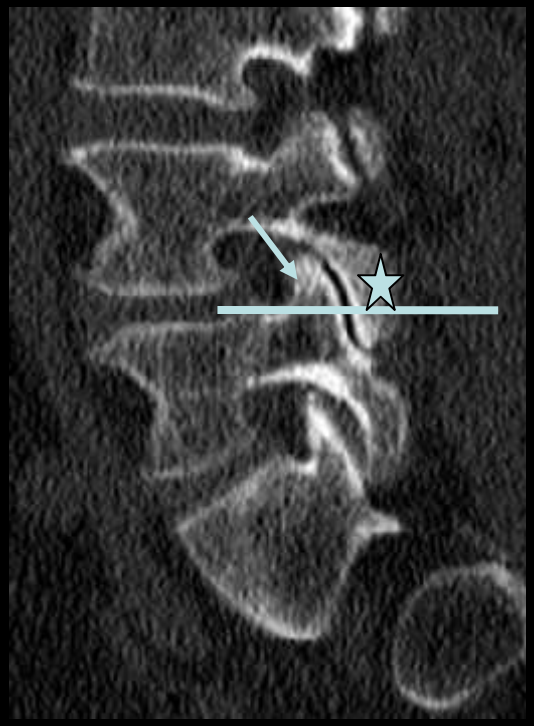


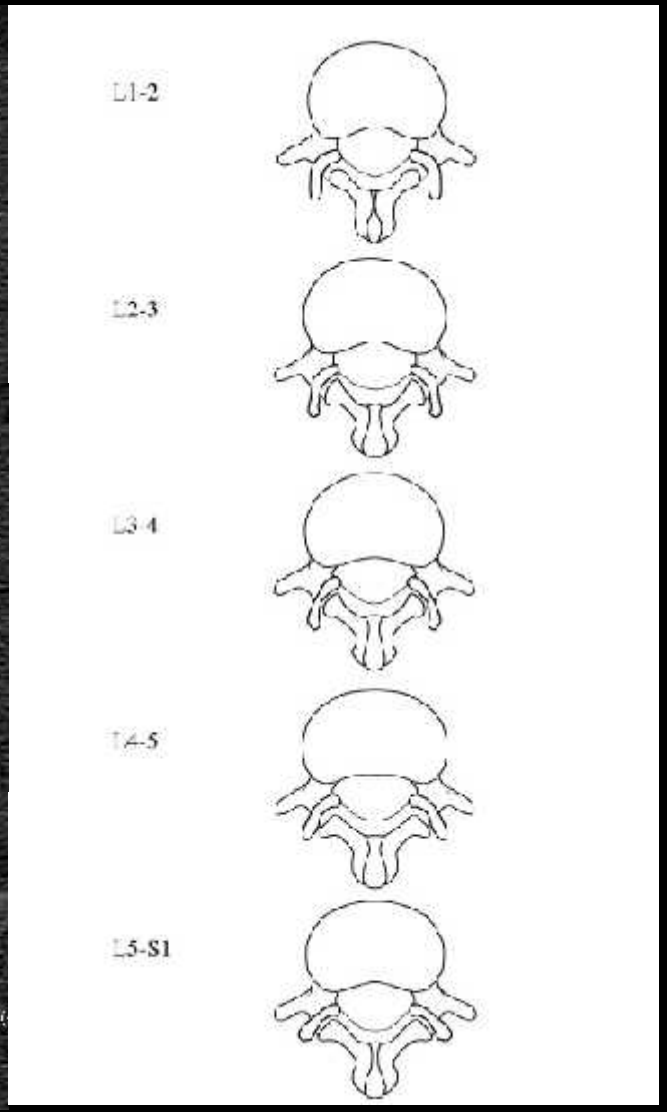
Degenerative process common to all synovial joints:

- Cartilage wear
- Subchondral sclerosis
- Osteophytosis
- Joint effusion

Anatomy

Zygoapophyseal Joint





Mechanical consequences:

- Sagittal facets = limit axial rotation
- Coronal facets = limit flexion/extension

Anatomy

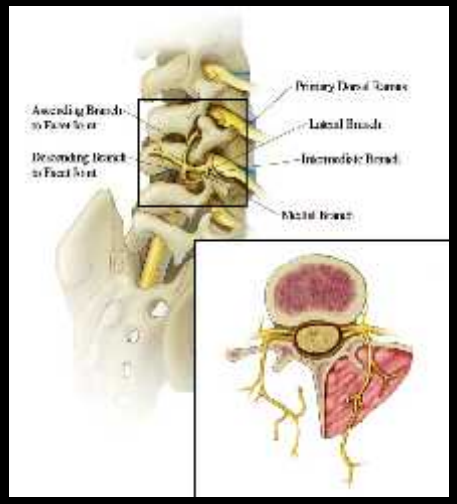
Zygoapophyseal Joint

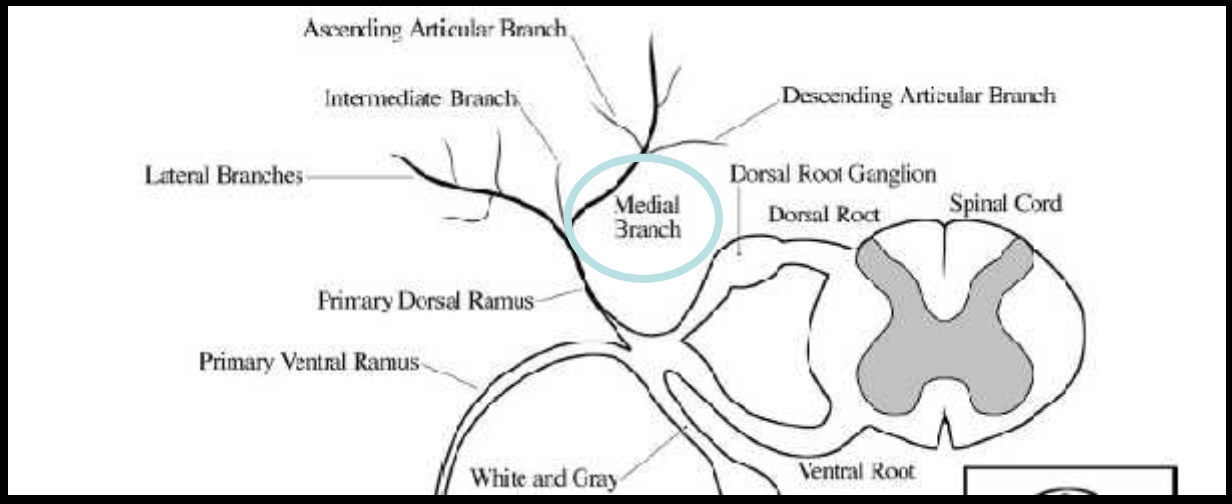
Connected to:

- Muscle structures (multifidus, interspinalis)
- Ligament structures (interspinous and supraspinous ligaments)

Richly innervated by:

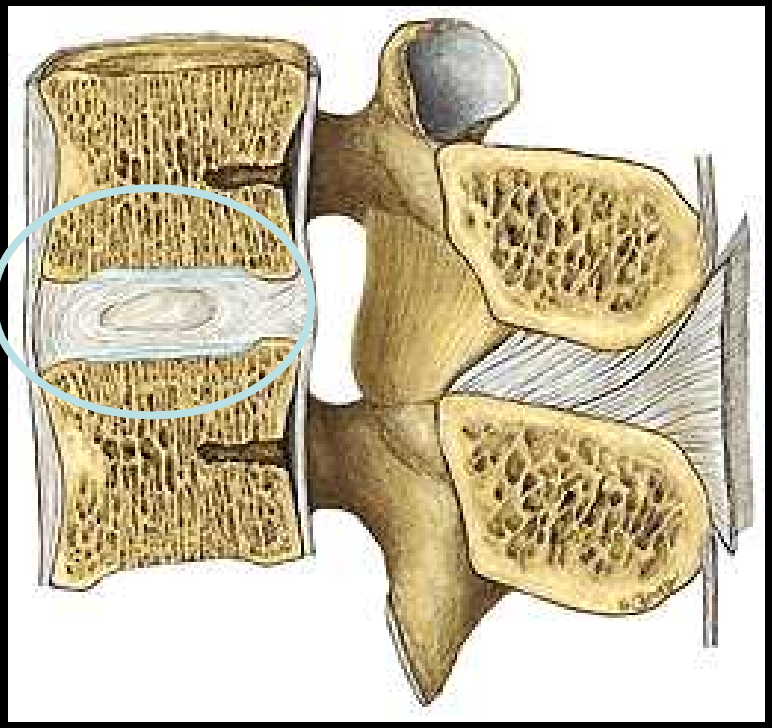
- Main trunk of the dorsal branch of the spinal nerve
- **Medial branch of the dorsal ramus**
- Lateral branch of the dorsal branch
- Large inter- and intra-patient variability

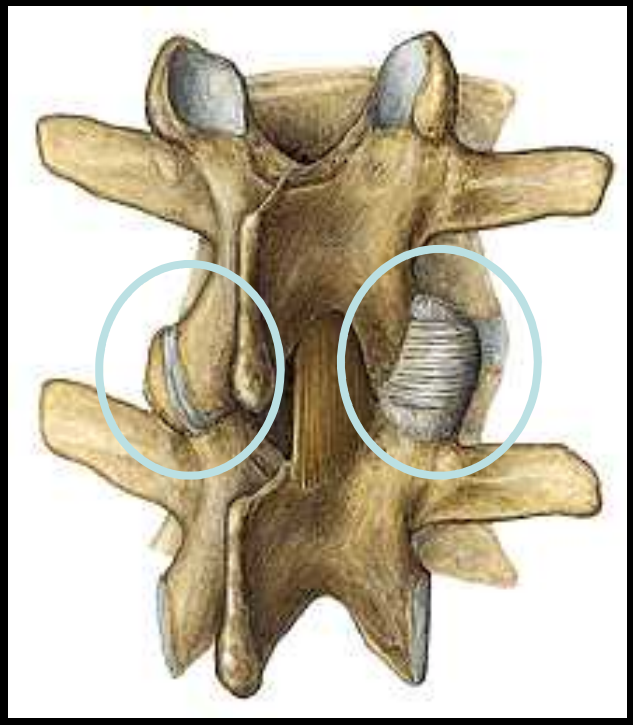




Anatomy

Notion of mobile spinal segment (disc + zygapophyseal joints)





The mobile spinal segment is a unit in which the intervertebral disc and zygapophyseal joints work together to ensure stability and absorb stresses placed on the spine.

Biomechanics

Role of zygapophyseal joints

- In axial compression, the zygapophyseal joints bear 15% of the load, the remainder the disk.

- The decrease in disc height increases stress on the joints zygapophyseal (15 → 45%) *Yang KH et al, Spine 1984*

↓

- Linear correlation between the degree of disc degeneration and the loss of zygapophyseal cartilage coating *Fujiwara A et al, Spine 2000*

↓

- Zygapophyseal degenerative (cartilaginous) involvement increases segmental mobility already increased to stages with degenerative discs

c1 Dıpend du type de dos. Probablement valable pour un type III de Roussouly
cdi; 20/09/2017

Biomechanics

Principe of Kirkaldy- Wallis

Kirkaldy-Wallis WH et al, Clin Orthop 1982

Degenerative process of the mobile spinal complex occurs in 3 stages:

- 1/ inaugural functional alteration: involvement of a joint leads to alteration of both the disc and the other facet joint at the same level
- 2/ micro and macro-instability
- 3/ stabilization

Risk Factors

Age: Prevalence increases with age (> 45 years)

Spinal level: More marked (and frequent?) involvement at the L4-L5 level.

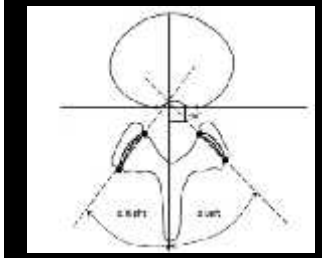
Degenerative disc disease:

Decreased disc height
Segmental instability → Increased joint stress

However, it is possible to acquire osteoarthritis of the zygoapophyseal joint without disc involvement

Facet orientation and tropism:

- Orientation: angle formed by the axis of the joint and the posterior vertebral plane-
- Tropism: asymmetry of one angle with respect to the other at the same level (low < 7°, moderate 7-15°, large >15°)



- Association between sagittal orientation and degenerative spondylolisthesis

- No link between facet tropism and osteoarthritis

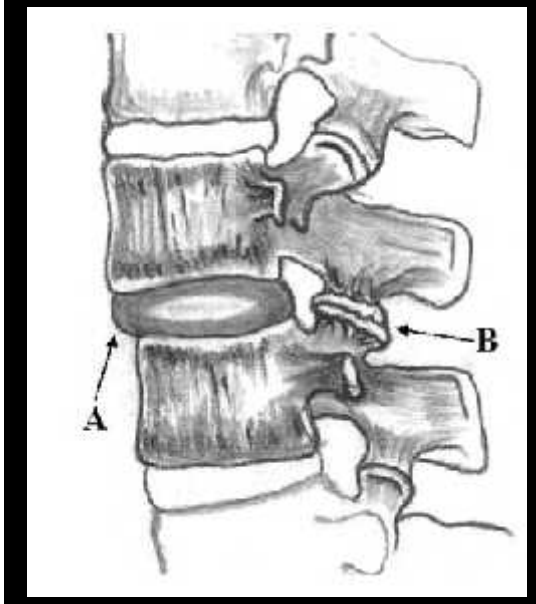
Kalichman L et al, Spine 2009

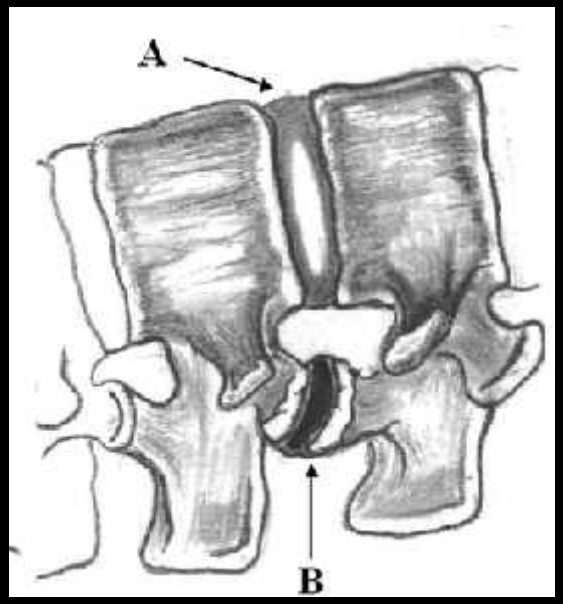
Functional consequences

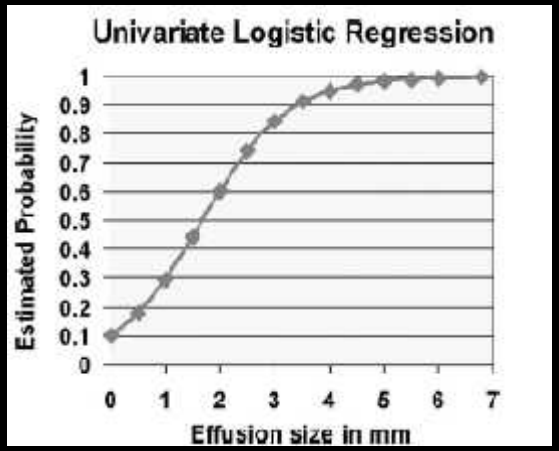
Segmental spinal instability

Functional consequences

Segmental spinal instability







<u>Degenerative Spondylolisthesis assumed when:</u>

- effusion >1.5mm
- listhesis grade 1 or 2 degenerative involvement (not stabilized)

Rihn J et al, Spine 2007
Chaput C et al, Spine 2007
Caterini R et al, J Ortho Traum 2011

Functional consequences

Segmental spinal instability

If stabilized zygapophyseal osteoarthritis (Kirkaldy-Willis principle):

15% of patients without effusion

Rihn J et al, Spine 2007

Imaging techniques

Computed Tomography

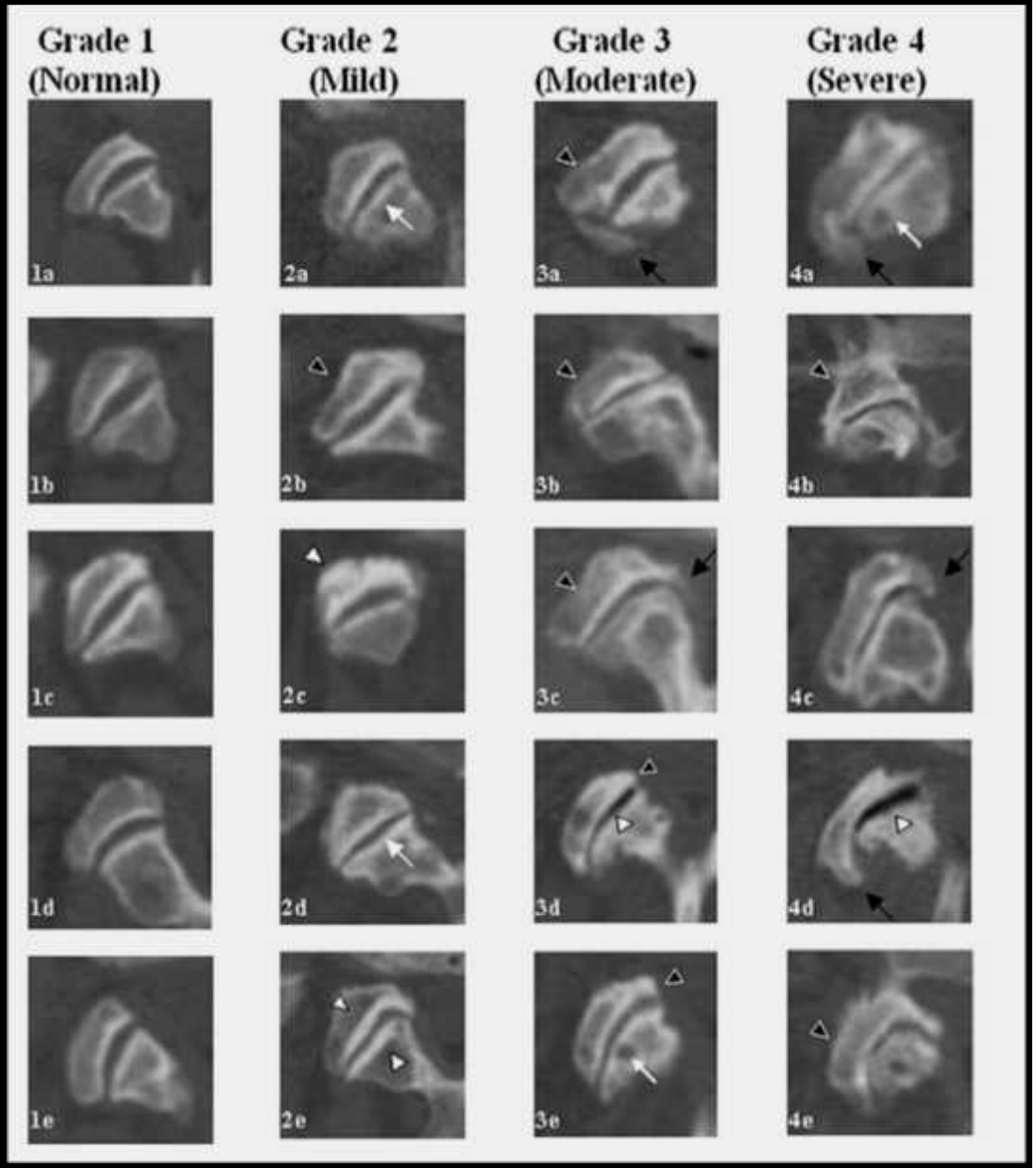
Weishaupt Classification

Grade I (Normal): No JSN (2 mm or greater); no osteophytes or possible small osteophytes; no articular process hypertrophy; no sclerosis or doubtful sclerosis; no subchondral erosions; no subchondral cysts; no joint space vacuum phenomenon.

Grade II (Mild): JSN (joint space 1–2 mm); and/or definite small osteophytes; and/or mild articular process hypertrophy; and/or definite sclerosis; no subchondral erosions; no subchondral cysts; no joint space vacuum phenomenon.

Grade III (Moderate): JSN (joint space ≤1 mm); and/or moderate osteophytes; and/or moderate articular process hypertrophy; and/or mild subchondral erosions; and/or mild subchondral cysts; and/or joint space vacuum phenomenon.

Grade IV (Severe): Severe JSN (bone to bone); large osteophytes; severe articular process hypertrophy; severe articular erosions; severe subchondral cysts; and/or joint space vacuum phenomenon.



Kalichman L et al, Spine 2009

Imaging techniques

MRI (Std T1/T2 sequences)

Grogan's Classification:

Cartilage

Normal

Surface irregularities

Focal areas of uncovering

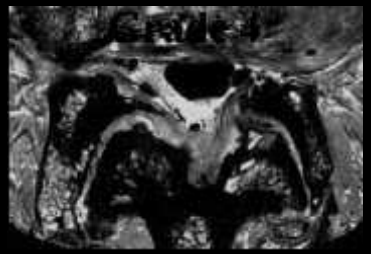
Complete loss

Subchondral Sclerosis

Normal

Focal sclerosis

Sclerosis < 50% articular surface



Sclerosis > 50% articular surface

Osteophytes

Normal

Small osteophytes

Moderate sized Osteophytes

Bulky osteophytes

Imaging techniques

CT/MRI comparison

Both techniques tend to underestimate the severity

Zhou X et al, BMC Med Imaging 2016

CT
- Easier detection of degenerative involvement
- Better appreciation of the ≠ components of the disease (sclerosis, osteophytes...)
- Accurate analysis of foraminal impact (cervical spine +++)

MRI
- Associated analysis disco-vertebral complex degenerative involvement (Modic...)
- Analysis of disc complications
- Early detection of lesions
- Highlights the inflammatory/symptomatic - components of the degenerative disease (+++)

↓

Zygapophyseal joints
All subsequent elements
(T2 FS/ T1 FS G)

Imaging techniques

CT/MRI comparison

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Zhou X et al, BMC Med Imaging 2016

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↓

Sequences with fat signal suppression should be used whenever painful symptoms are not explained by Conventional sequences

D'Aprile P et al, Eur Rad 2007

Lakadamyali H et al, AJR 2008

Imaging techniques

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- Early detection of lesions
- Highlights the inflammatory/symptomatic - components of the degenerative disease (+++)

↓

Sequences with fat signal suppression should be used systematically!

Imaging techniques

MRI: interest of sequences in fat suppression

→ Highlighting the symptomatic - inflammatory - components of degenerative impairment

Imaging techniques

MRI: interest of fat suppressed sequences

→ Highlighting the symptomatic - inflammatory - components of degenerative impairment

Systematic injection?

	Discovertebral Junction	Epidural space	Posterior Elements
Standard + T2 FS (group 1)	44 (44)	0	22 (22)
Standard + T1FSG (group 2)	66 (66)	36 (51)	131 (257)
Mc Nemar test:	P < .05	P < .05	P < .05

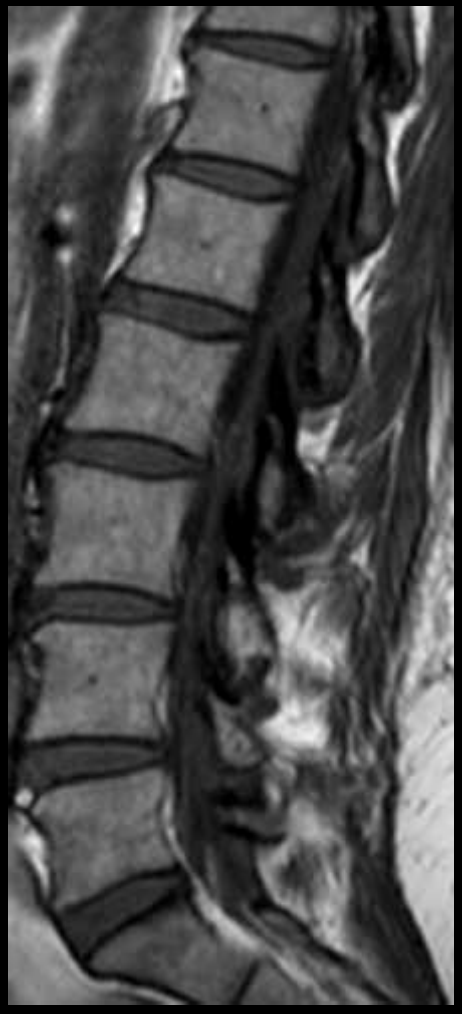
In terms of the absolute number of lesions and pathological stages,
T1 FS gad > T2FS/ STIR

Theumann N et al, JFR 2010

Imaging techniques

MRI: interest of fat suppressed sequences

→ Highlighting the symptomatic - inflammatory - components of degenerative impairment



Imaging techniques

MRI: interest of fat suppressed sequences

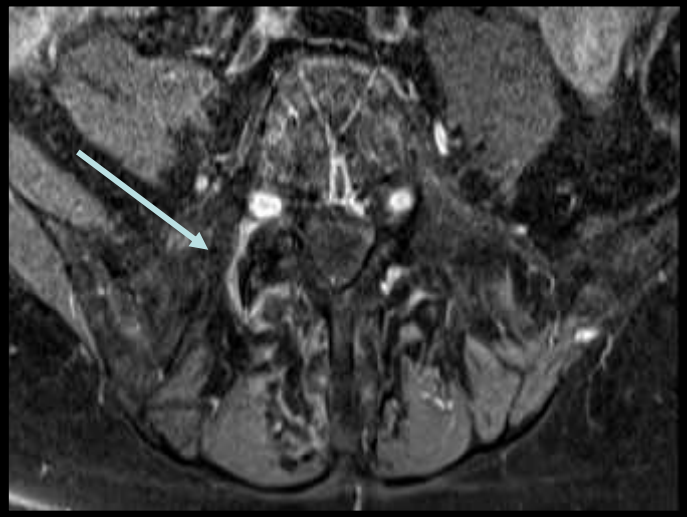
→ Highlighting the symptomatic - inflammatory - components of degenerative impairment

Imaging techniques

MRI: interest of fat suppressed sequences

→ Highlighting the symptomatic - inflammatory - components of degenerative impairment

T2FS

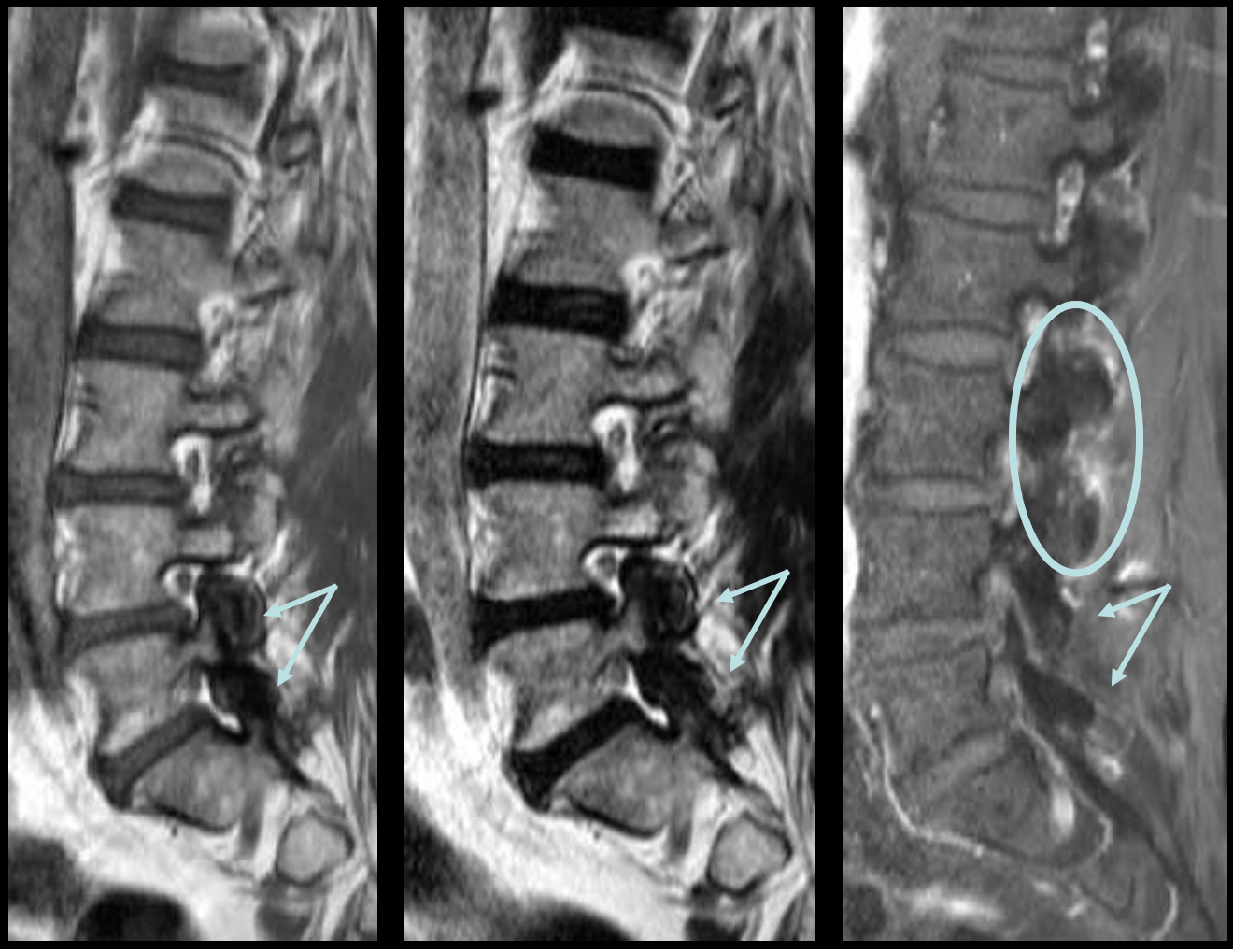


T1FSGd

Imaging techniques

MRI: interest of fat suppressed sequences

→ Highlighting the symptomatic - inflammatory - components of degenerative impairment



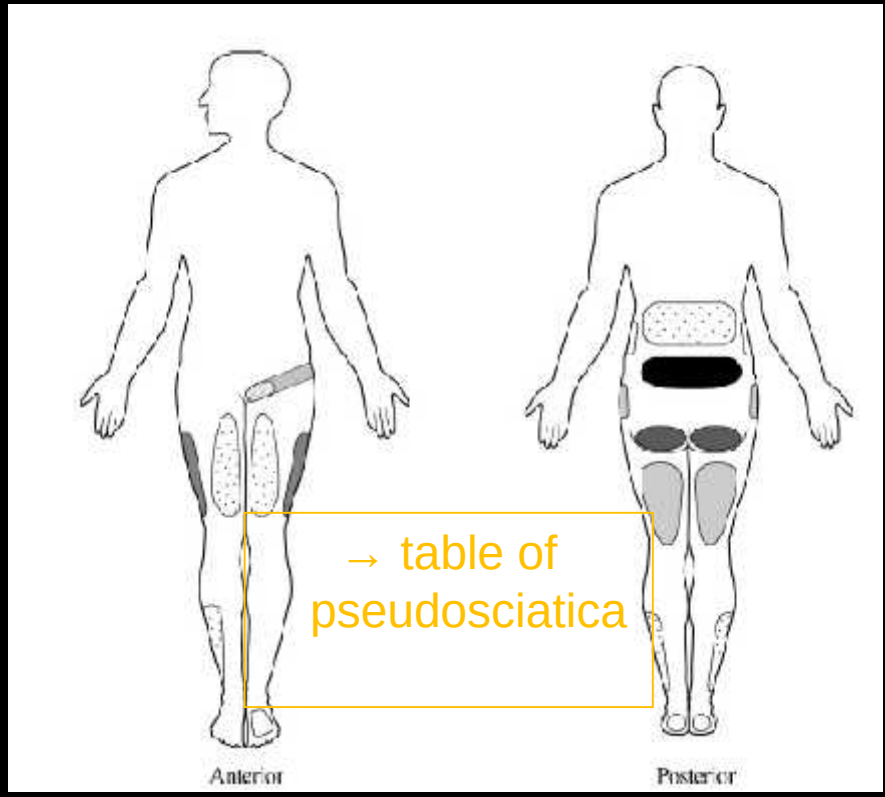
Painful symptomatology

Painful symptomatology primarily related to capsular involvement (/ synovial or cartilage) where there is a significant number of nociceptors

Referred pain

Prevalence of chronic facet spinal pain = 31%

Manchikanti L et al, BMC Muscu Skel Dis 2004



Cohen S et al, Anesthesiology 2007

Painful symptomatology

Root compression: Paraarticular cyst

- Extradural masses, located laterally/ dural sheath
- Near a degenerative zygapophyseal joint
- Levels of L4-L5 > L3-L4 > L2-L3
- Patients in their sixties

- = secondary synovial hernias effusion / hemorrhage
- MRI T2WI: Hyperintense centre, Hypointense rim
- Repeated hemorrhages → heterogeneous aspect
- Arthro-CT allows confirmation of joint communication

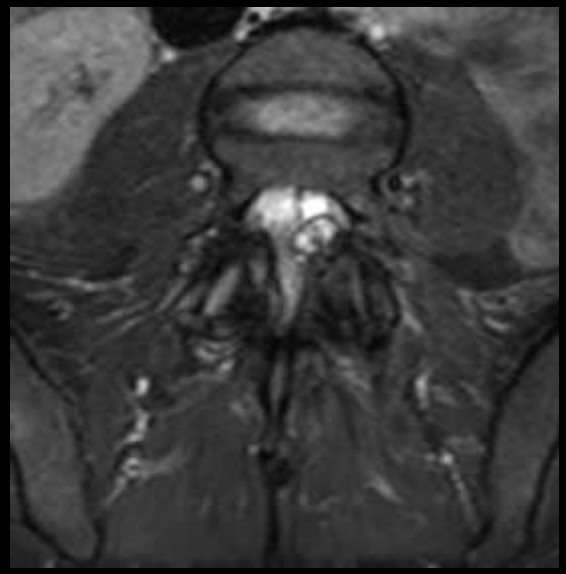
Varlotta G et al, Skeletal Radiol 2011

Painful symptomatology

Root compression: Paraarticular cyst

Painful symptomatology

Root compression: Paraarticular cyst

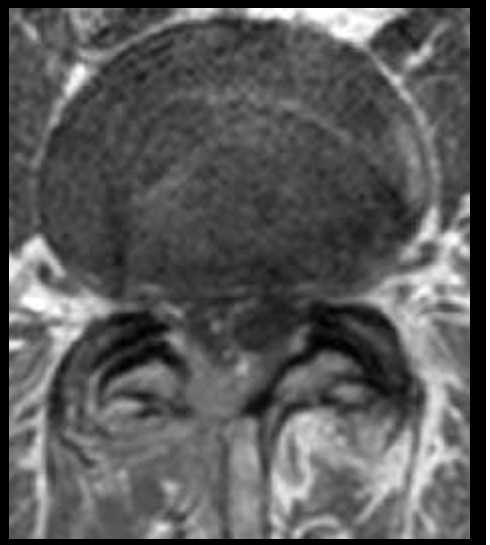


Painful symptomatology

Root compression: Paraarticular cyst

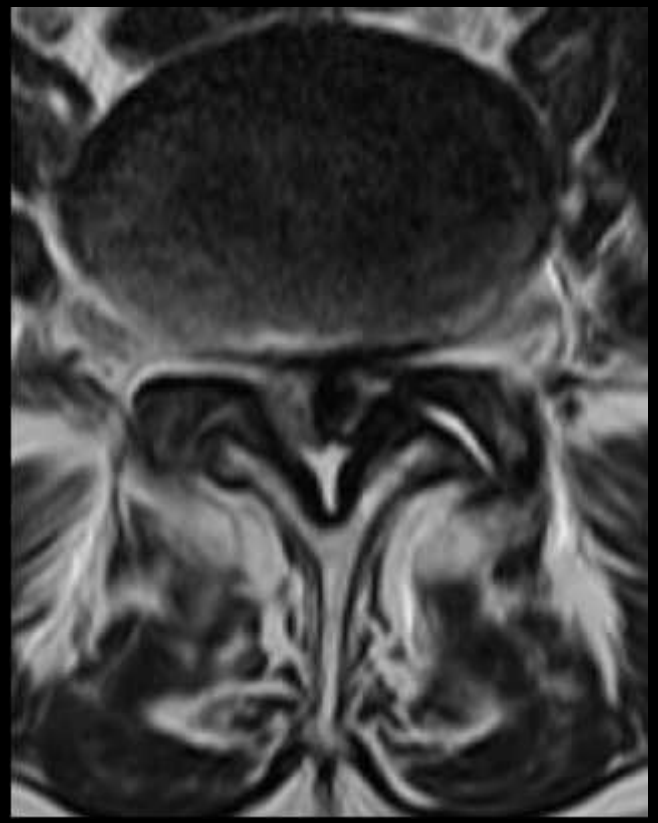






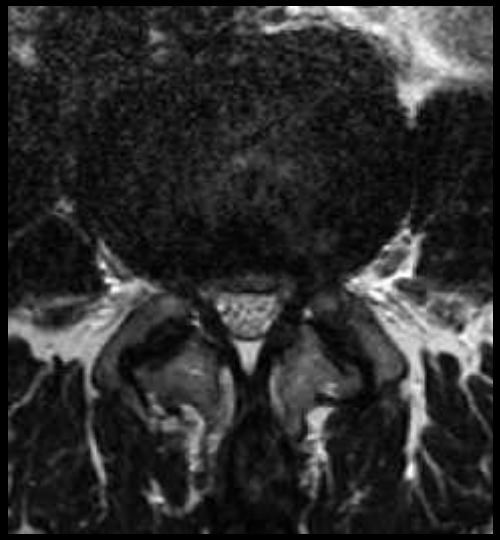
Painful symptomatology

Root compression: Paraarticular cyst



Painful symptomatology

Root compression: Foraminal/ductal stenosis

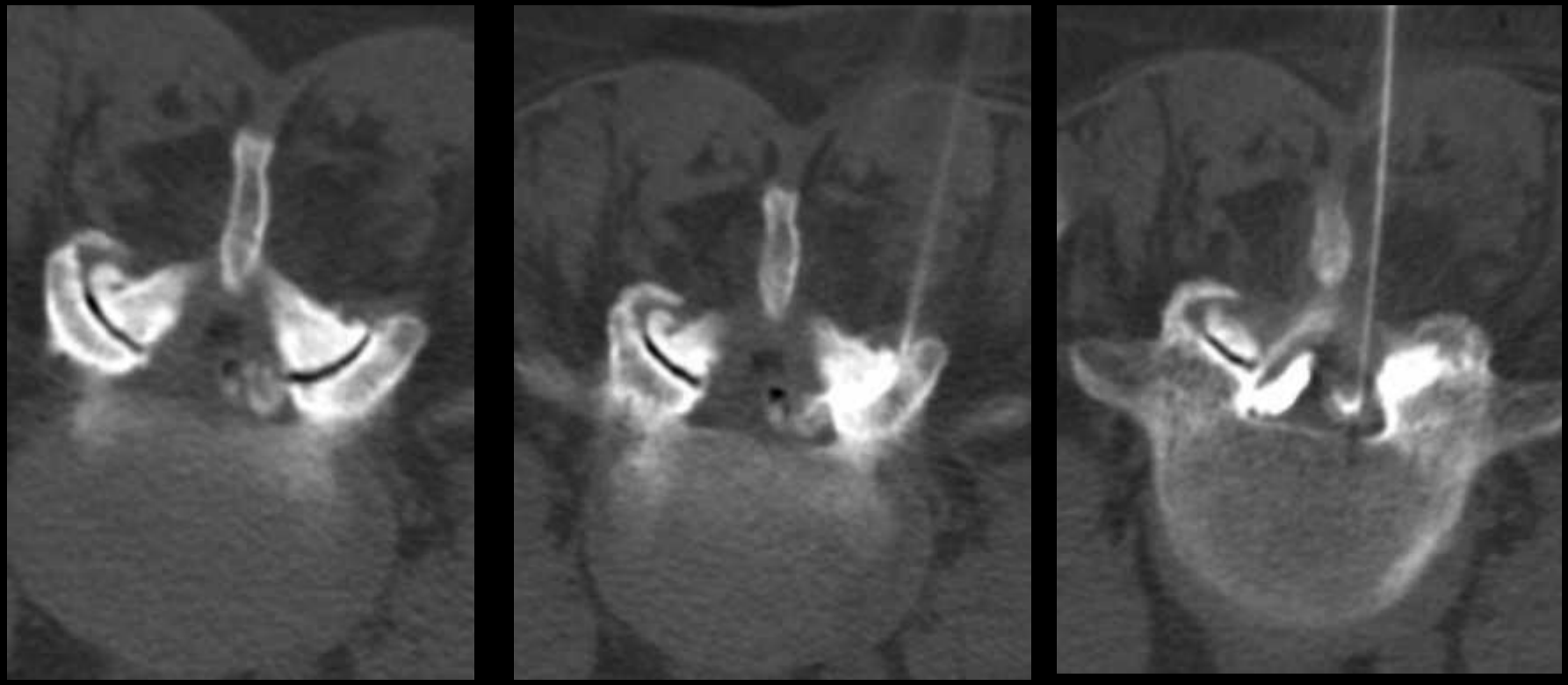


See Lausanne Classification

Therapeutic principles

Root compression: Para-articular/Synovial cyst.

Rupture / percutaneous infiltration

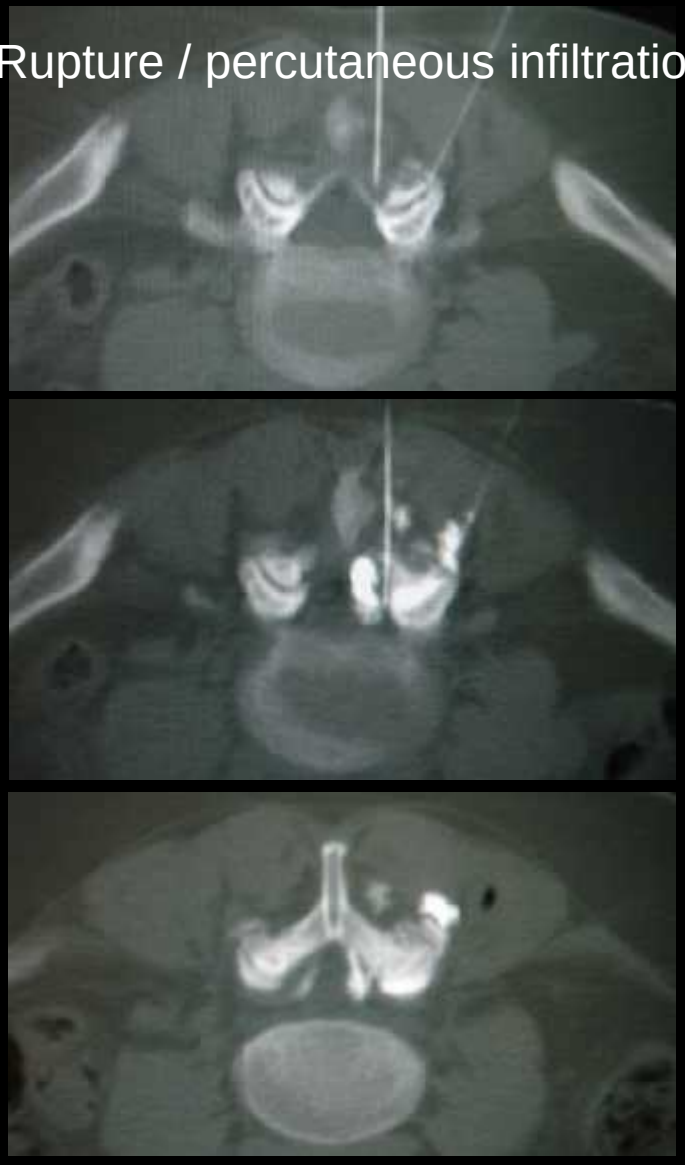


Amoretti N et al, Eur Rad 2012
Eshraghi Y et al, Pain Physician 2016

Therapeutic principles

Root compression: Para-articular/Synovial cyst.

Rupture / percutaneous infiltration

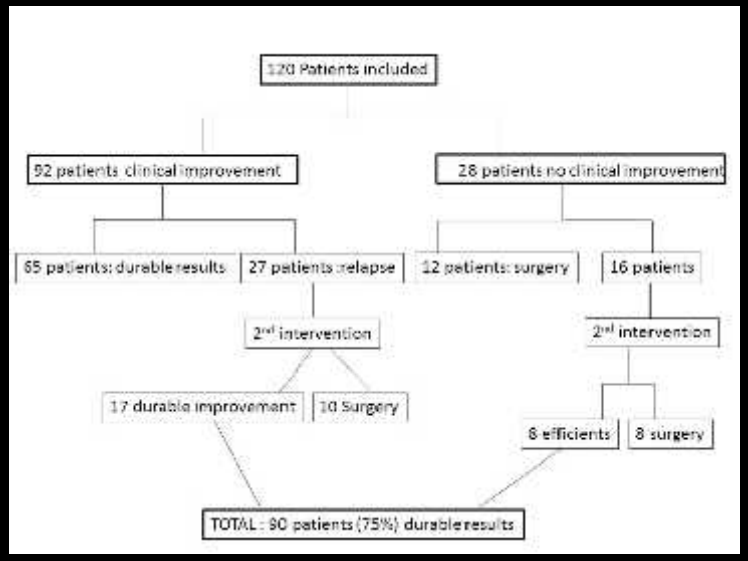


Double track first when the latero-dural route is possible

Puncture/burst cyst by alternating or simultaneous injection of PDC in the cyst and in the joint

Epidurography when cyst burst

Injection of corticosteroids slowly in intra-articular and intraductal (hydrocortancyl)



Amoretti N et al, Eur Rad 2012

Therapeutic principles

→ Antiinflammatory and Analgesics per os, physiotherapy, osteopathy:
No evaluation to date

1. Infiltration of Zygapophyseal joints

→ Intra-articular cortisone injection: a single randomized study vs placebo
- at 1 month, no significant difference
- at 3 months, no significant difference
- at 6 months, corticosteroid group > placebo (but relationship with corticosteroids unproven)

Carette S et al, New Engl J Med 1991

→ Systematic review of the literature: weak methodology preventing any meta-analysis. Effectiveness always questionable

Vekaria R et al, Eur Spine J 2016

Therapeutic principles

1. Infiltration of Zygapophyseal joints

Determine the joint(s) to be treated

→ Define the joint to be treated

- On imaging:
  - CT: impossible
  - SPECT: detection of "active lesions" *Hodler LE et al, J Nucl Med 1995*
  - MRI: fat suppression sequences (injected?)
  - → no published randomised studies
  - → the two techniques would not be interchangeable

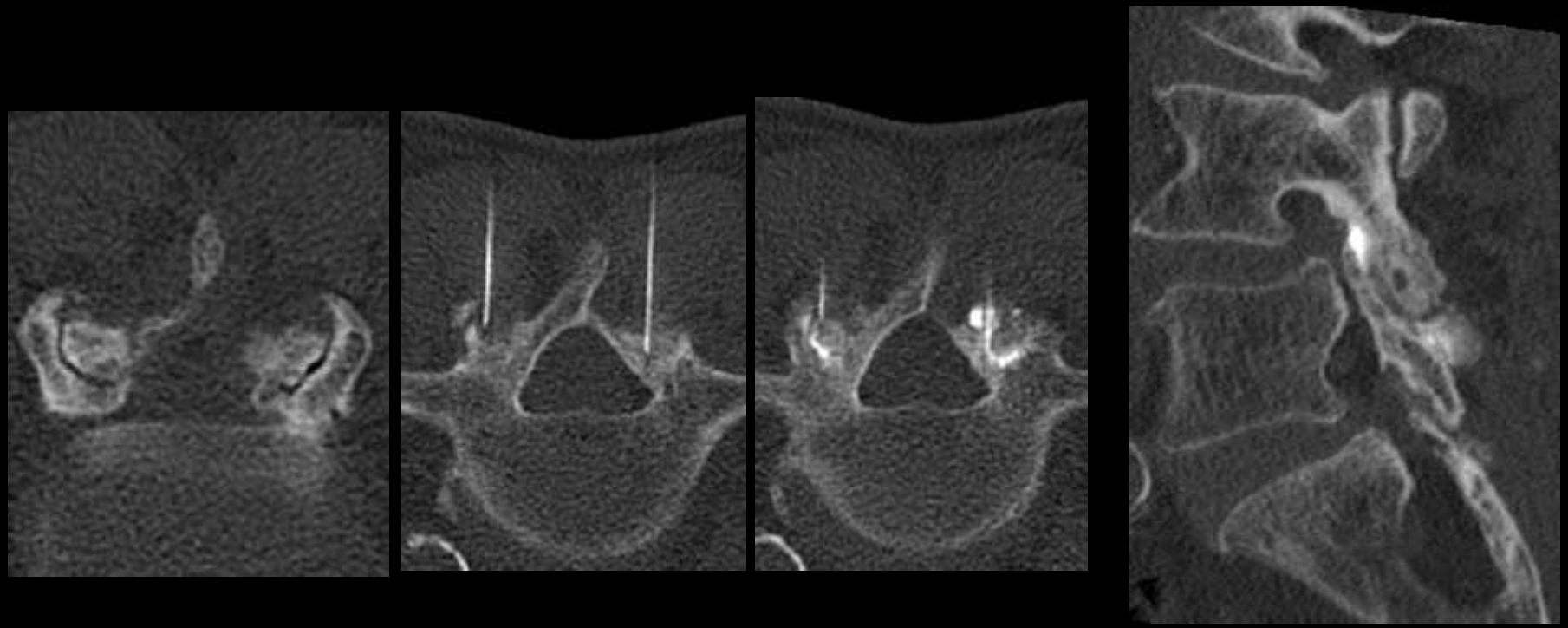
Lehman VT et al, Diagn Interv radiol 2016

- Therapeutic tests: Anesthetic injection (half-life) intra-articular

Therapeutic principles

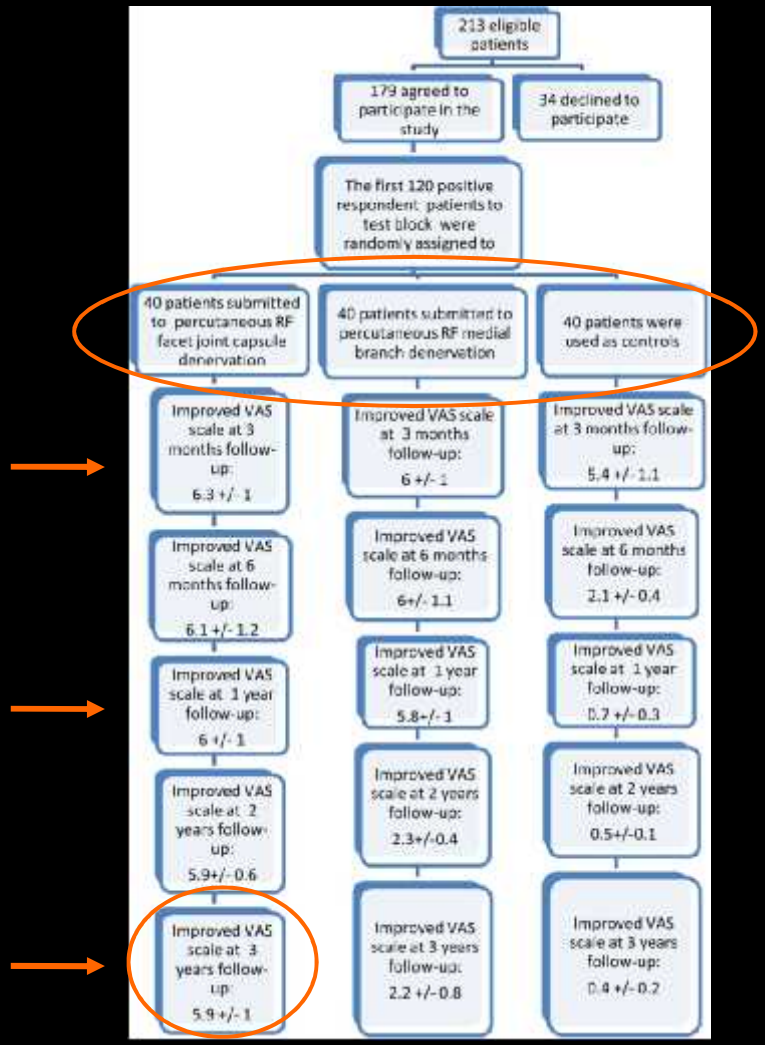
1. Infiltration of Zygapophyseal joints

Proceed with strict technique



Therapeutic principles

1. RF Zygapophyseal joints ?



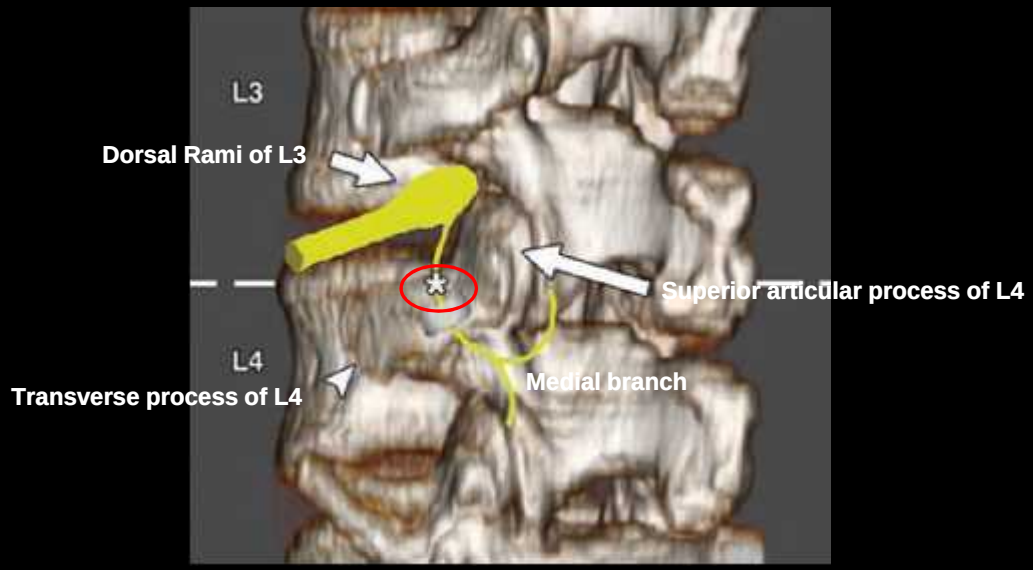
Moussa WMM et al, Clinical Neurology and Neurosurgery 2016

Therapeutic principles

2. Neurotomy of the medial branch of the dorsal branch of the spinal nerve

Determine the right levels to treat

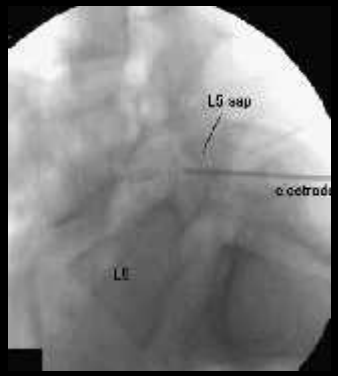
Diagnostic test utilising local anaesthesia to the medial branch of the dorsal branch of the spinal nerve (0.5 - 0.75ml bupivacaine 0.5% or lidocaine 2%)

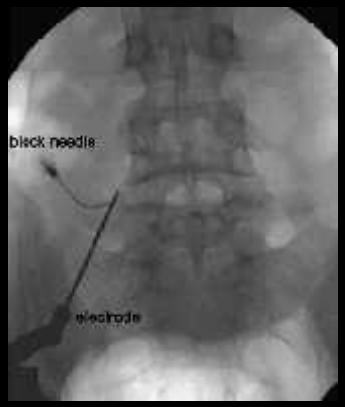


Therapeutic principles

2. Neurotomy of the medial branch of the dorsal branch of the spinal nerve

Proceed by rigorous technique (radio frequency: 80°/90 sec x2 or x3)





Han SH et al, Medicine 2017

Amrhein TJ et al, AJR 2016

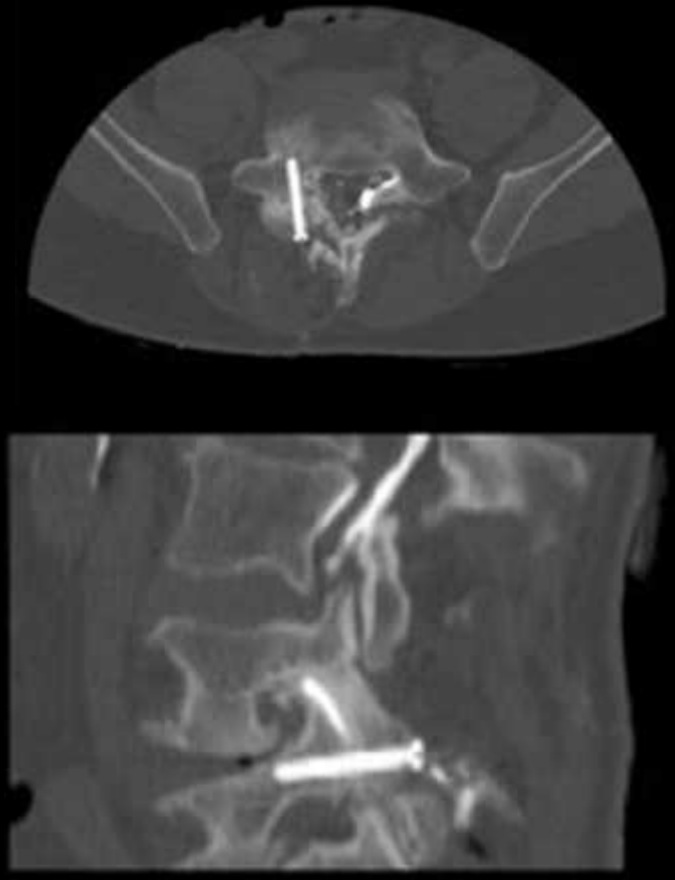
The efficacy of conventional radiofrequency denervation in patients with chronic low back pain originating from the facet joints: a meta-analysis of randomized controlled trials

CONCLUSIONS: Conventional radiofrequency denervation resulted in significant reductions in low back pain originating from the facet joints in patients showing the best response to diagnostic block over the first 12 months when compared with sham procedures or epidural nerve blocks.

Lee CH et al, The Spine Journal 2017

Therapeutic principles

3. Percutaneous screwing



Amoretti N et al, Cardiovasc Intervent Radiol 2016

Conclusion

Zygapophyseal Joints

- With the disc forms the mobile spinal complex
- Disc insufficiency → degenerative involvement by increased stress
- Degenerative impairment → dysfunction- instability- stabilization *according to Kirkaldy-Wallis*

- Consequences:
    1. Segmental instability
    2. Painful symptomatology
        - nerve root by direct compression (cyst, osteophytes)
        - referred: pseudo-radicular symptomatology

- Support
    1/ eliminate disco-vertebral pathology (Modic 1 ...)
    2/ identify the symptomatic joint (scintigraphy, FatSat MRI, diagnostic block ++)
    3/ medical treatment: infiltration, neurotomy medial branch (++)
    4/ surgery: evaluated suitability of percutaneous screwing