The Degenerate Spine:

When should we intervene

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NHS
Birmingham Women's and Children's
NHS Foundation Trust

By your side

Spire Healthcare

NHS
The Royal Orthopaedic Hospital
NHS Foundation Trust

Outline of the talk:

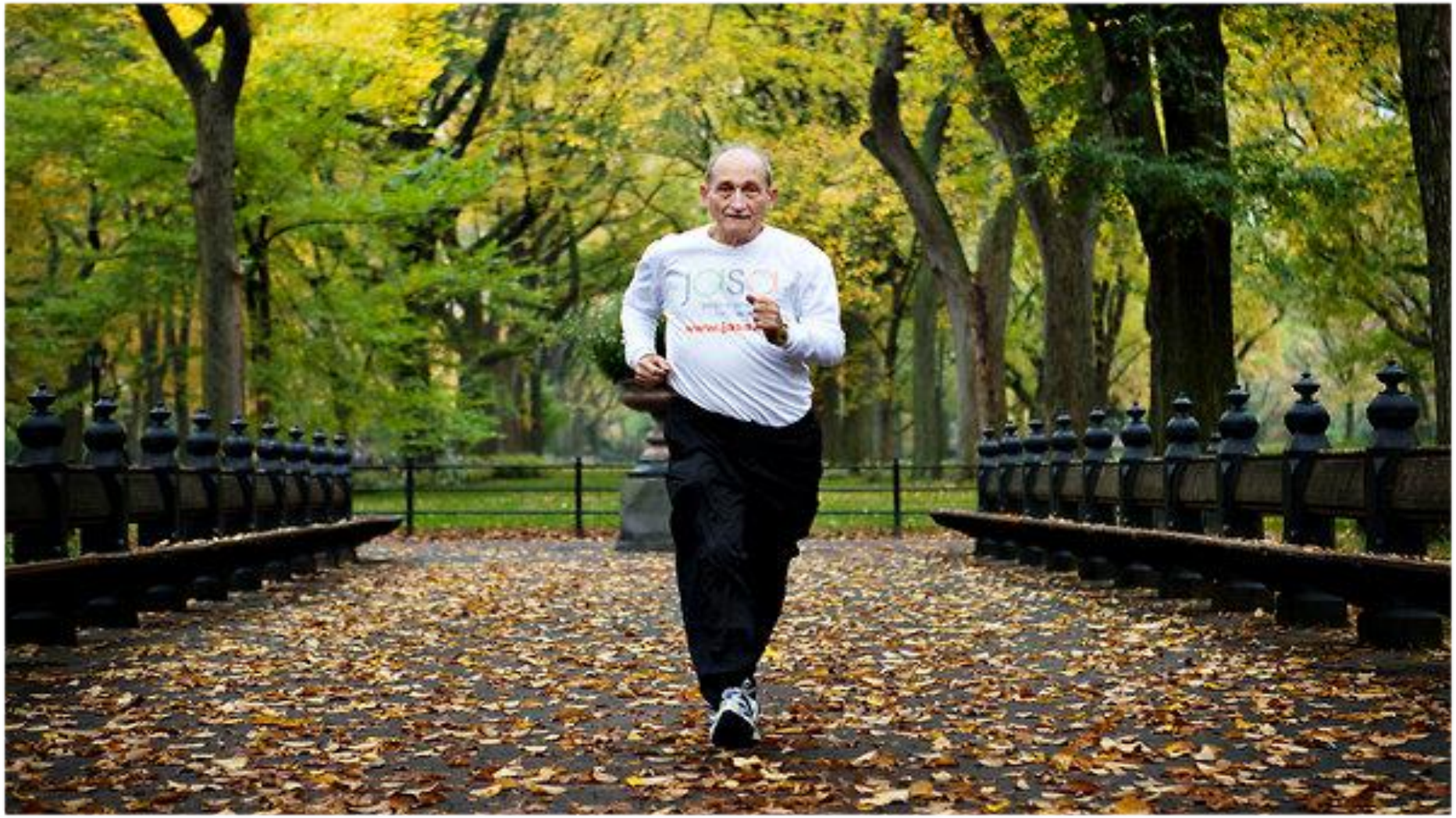
- Pathology and pain generators
- Clinical and radiological correlation
- Spectrum of spinal degeneration
- Column failure
- Intervention options and the evidence!

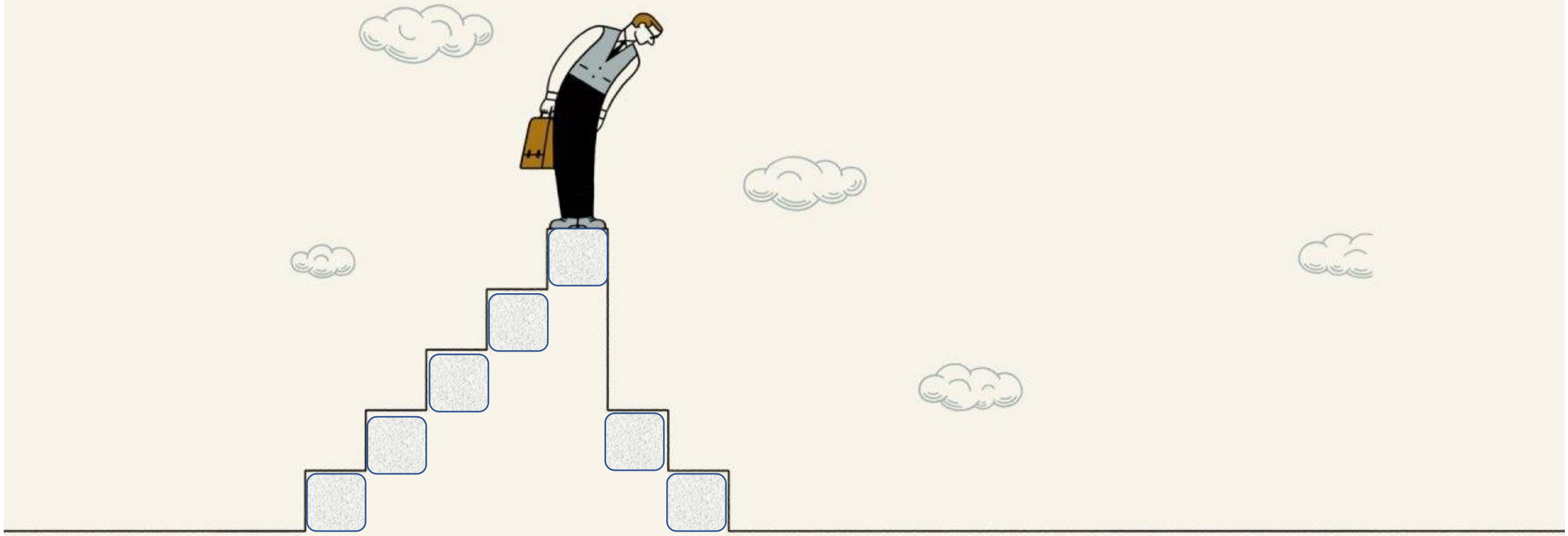
Disclaimer: Back = Neck or Lower back

Use and abuse our backs

- Sitting habits
- Body habits
- Smoking
- Diet
- Sedentary lifestyle
- Lack of exercise
- TV / Social media / Internet

Age or Mileage



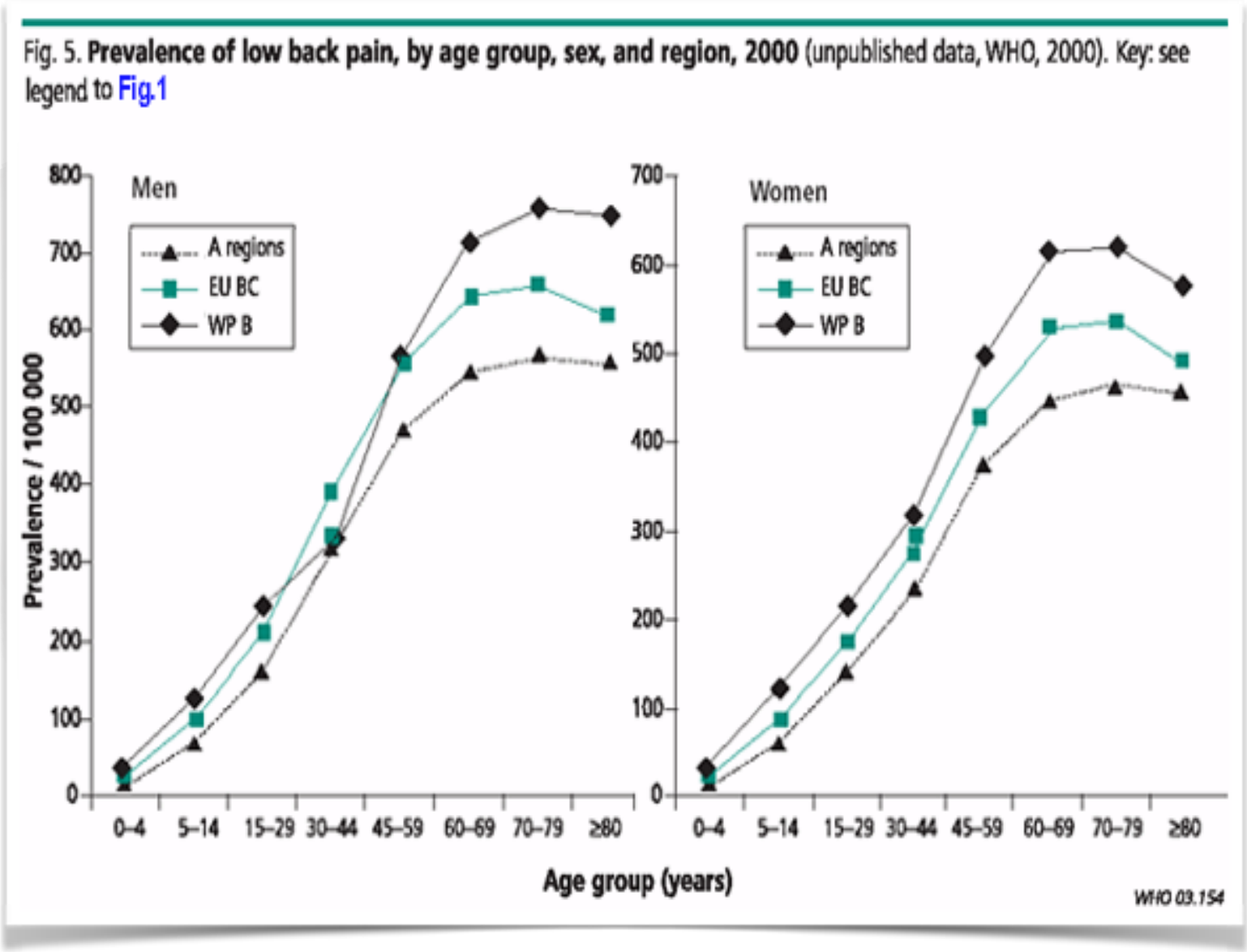


Low back pain

- **Site:**
  - Below12th rib
  - Above Gluteal fold
- **Cause:**
  - Specific (Cause suspected)
  - Non-specific (??)
- **Severity:**
  - Acute: < 6 weeks
  - Chronic: > 3 mo

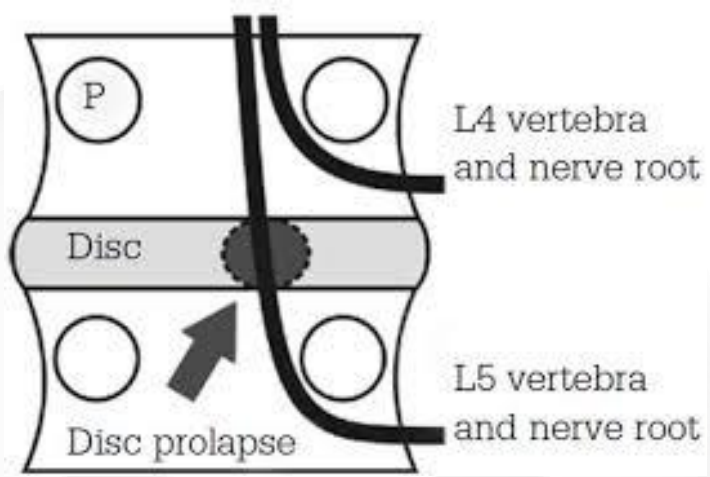
Low back pain

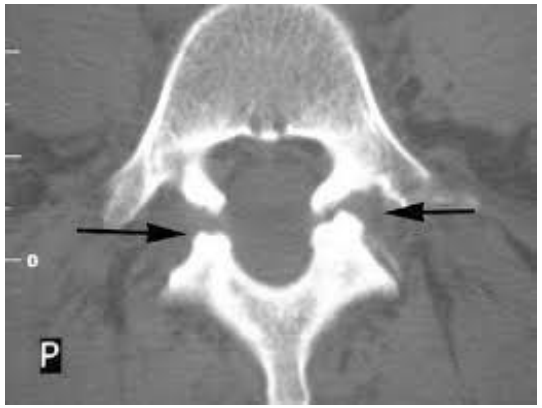
- Major Health and socio-economic issue
- Time off work in the economically active
- Point prevalence: 58 - 84%

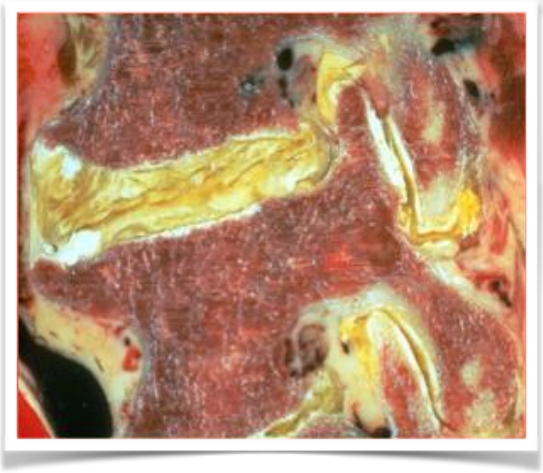


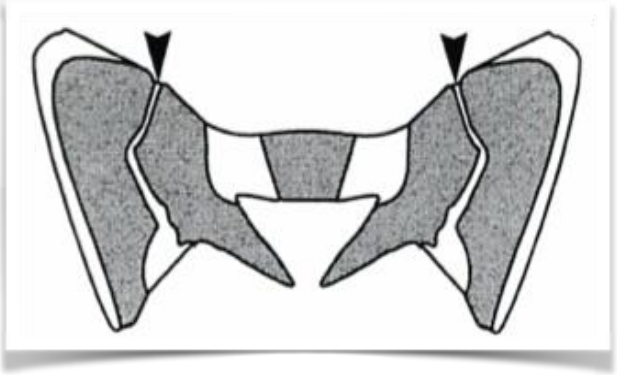
Pain generators

- Inter-vertebral discs
- Facet joints
- Vertebral body failure
- Spinal column failure

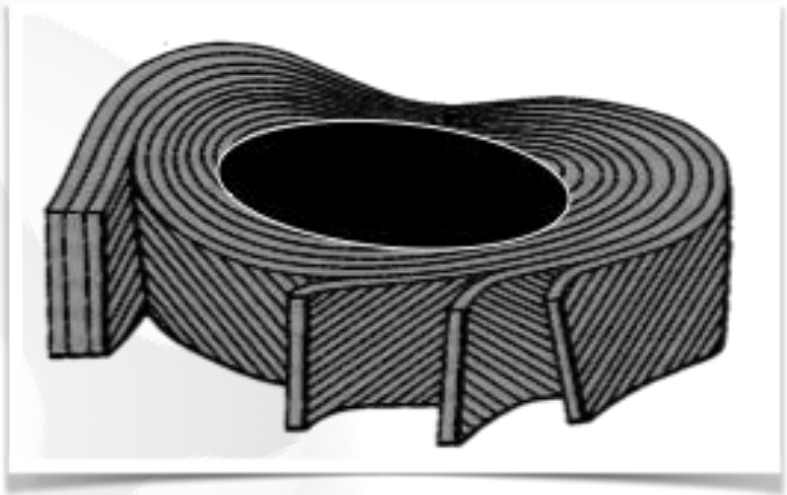


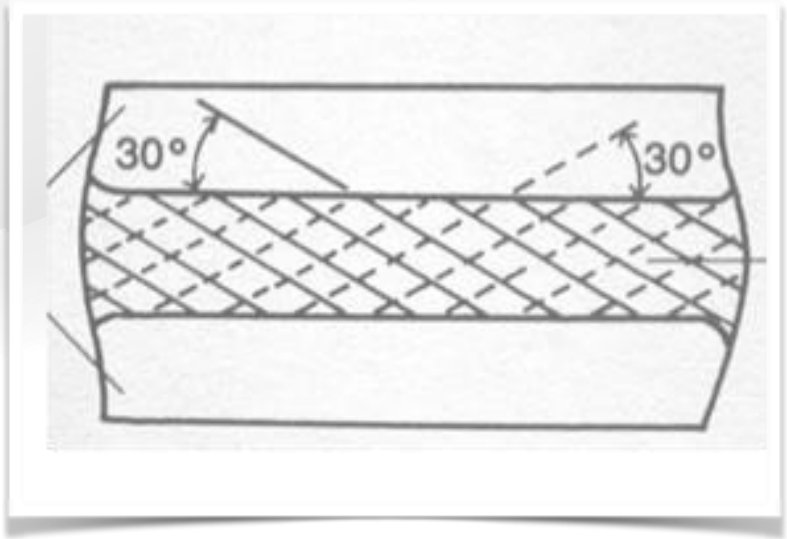


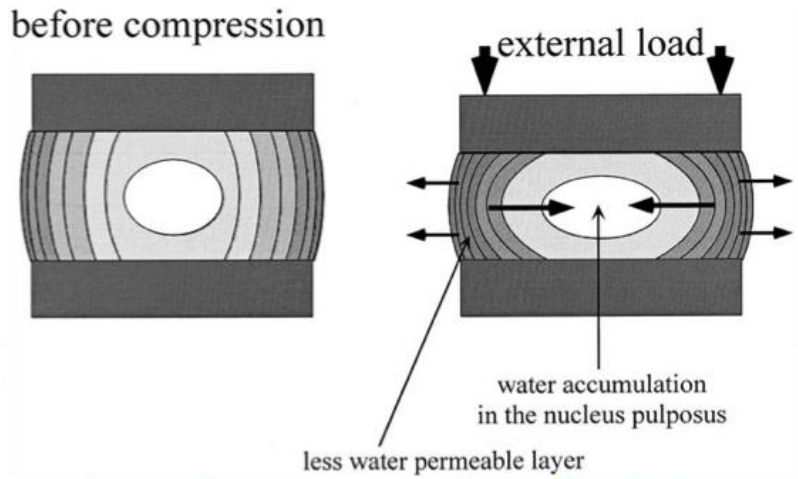


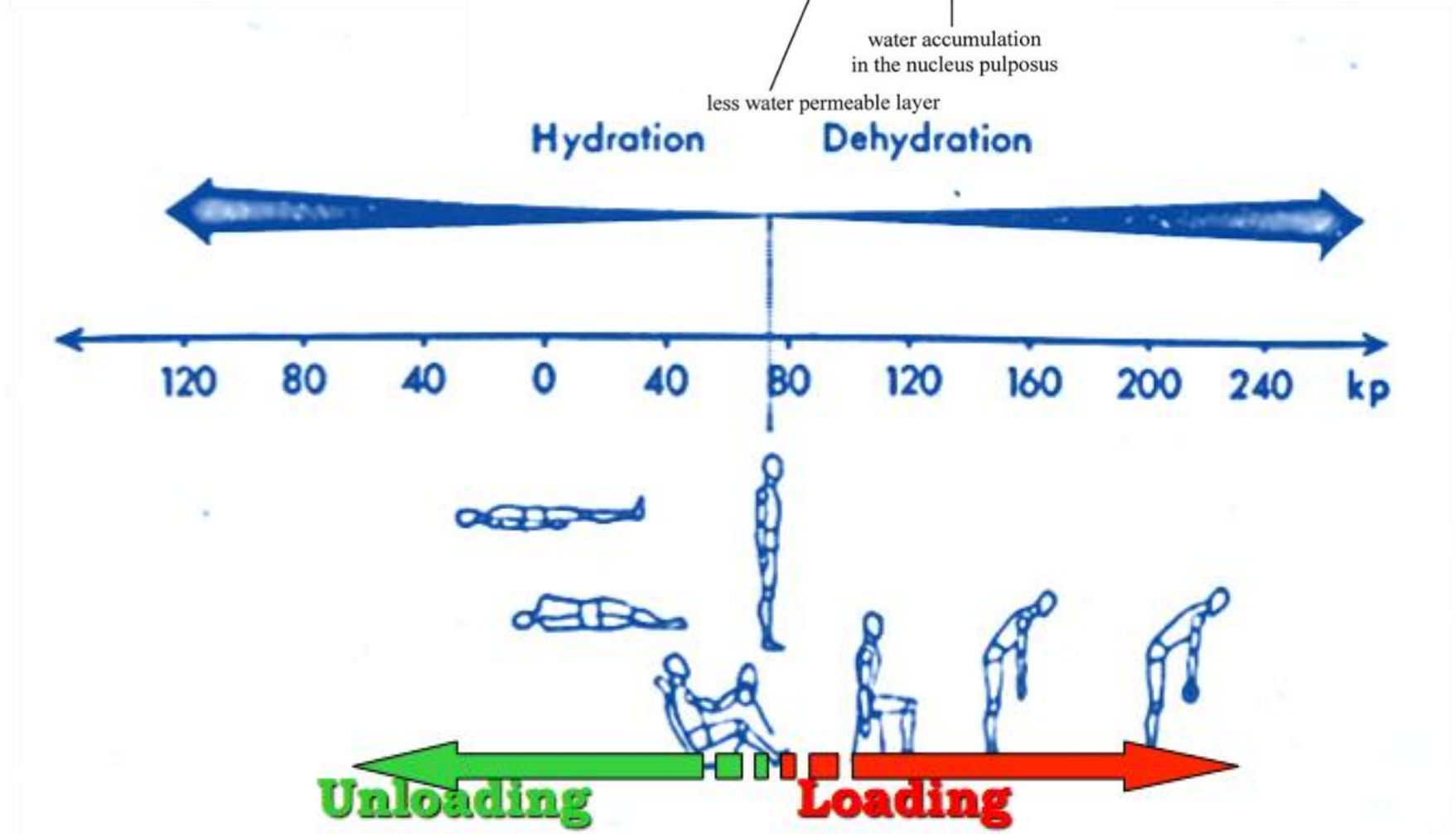


Inter-vertebral disc ‘Disc’






before compression
external load
water accumulation
in the nucleus pulposus
less water permeable layer


Hydration
Dehydration
120
80
40
0
40
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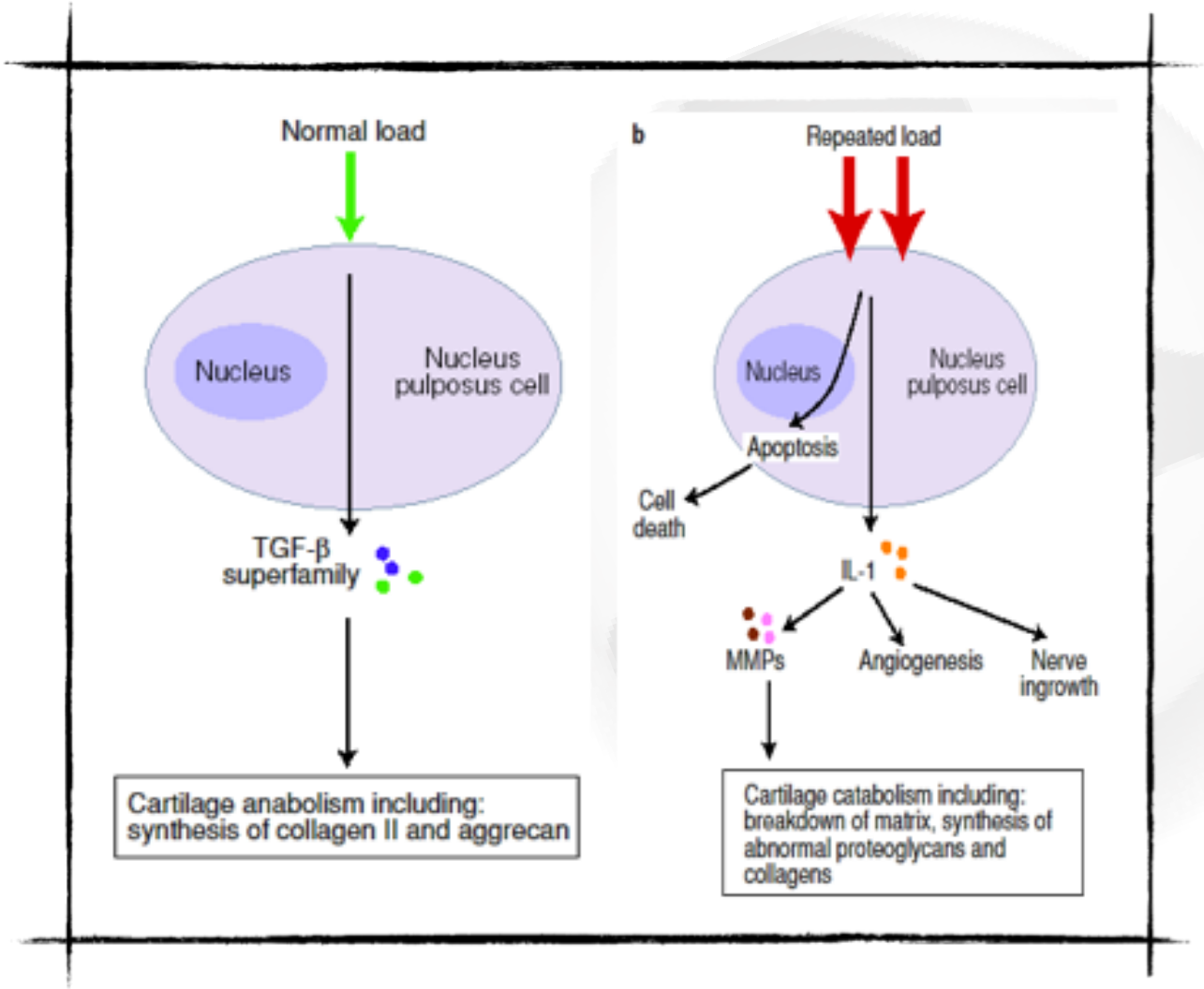
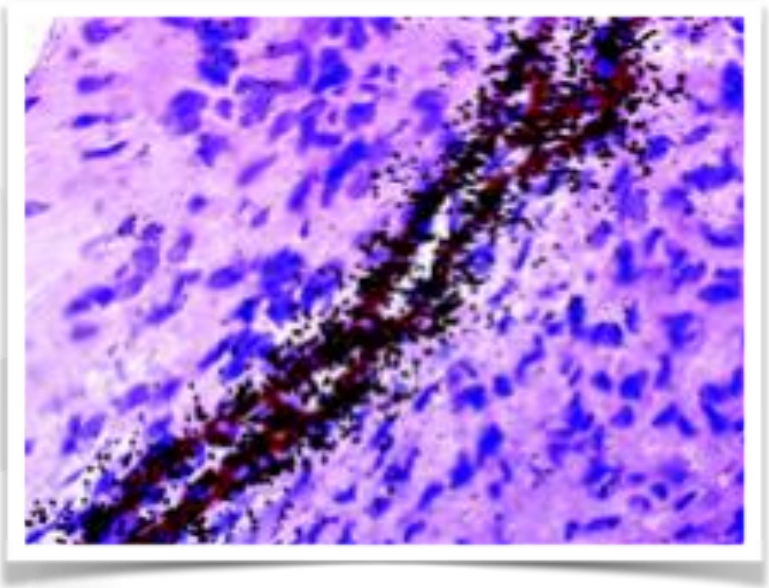
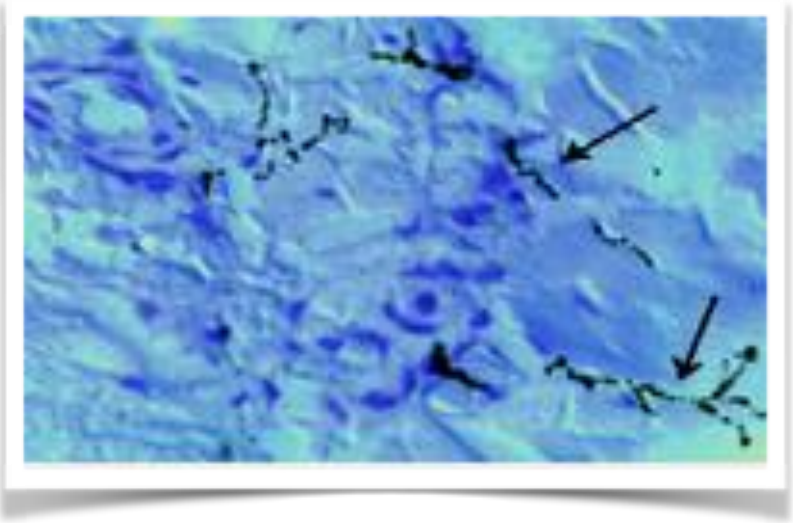
160
200
240
kp
Unloading
Loading

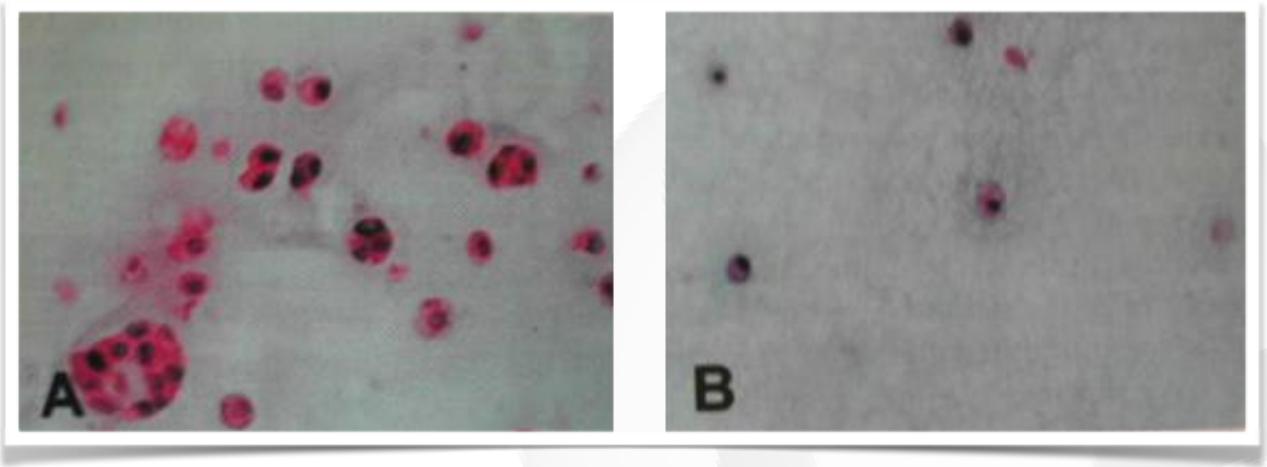
Cellular pathology leading to disc degeneration

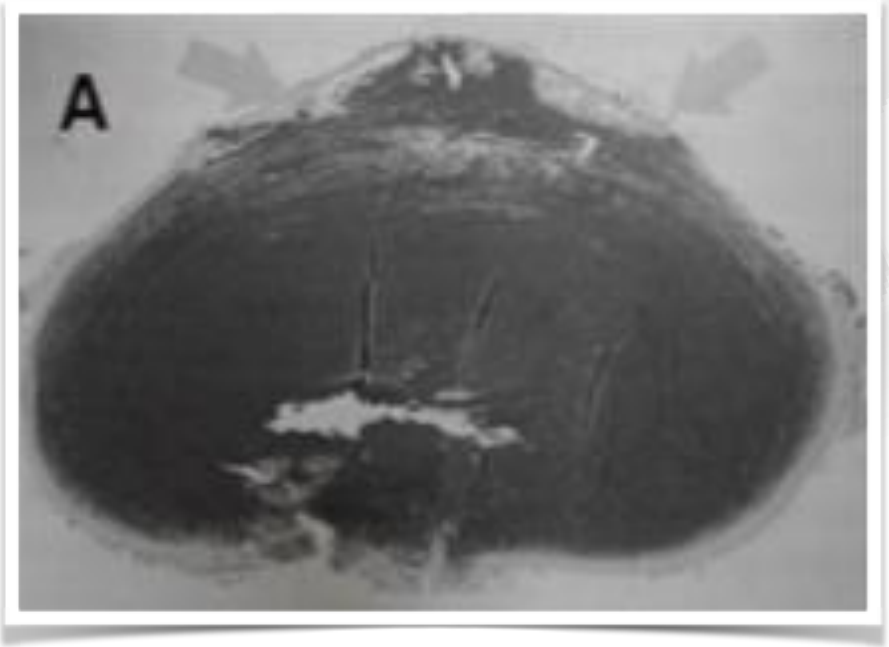




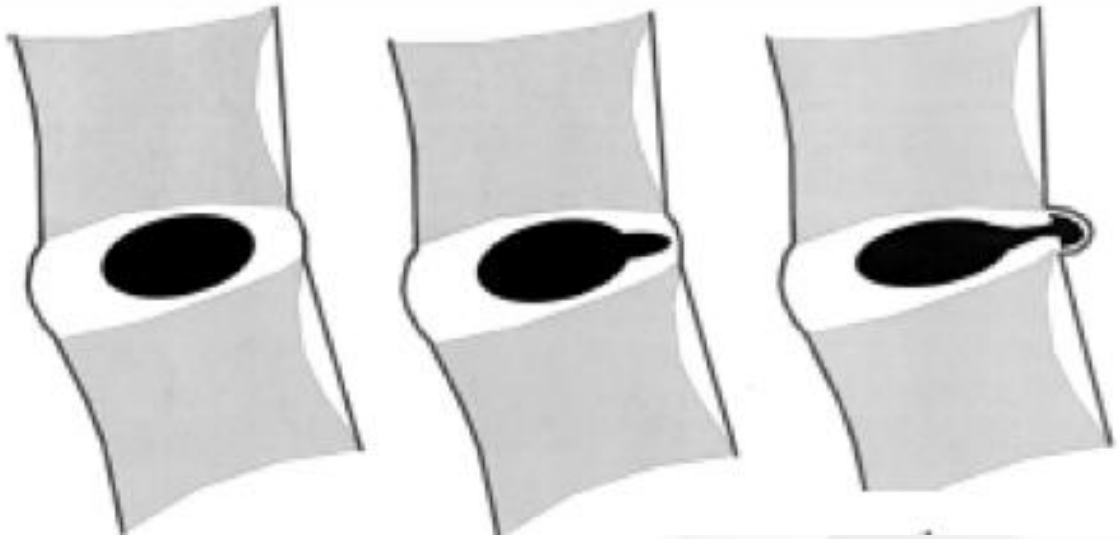


Micro & Macroscopic changes in the degenerate disc

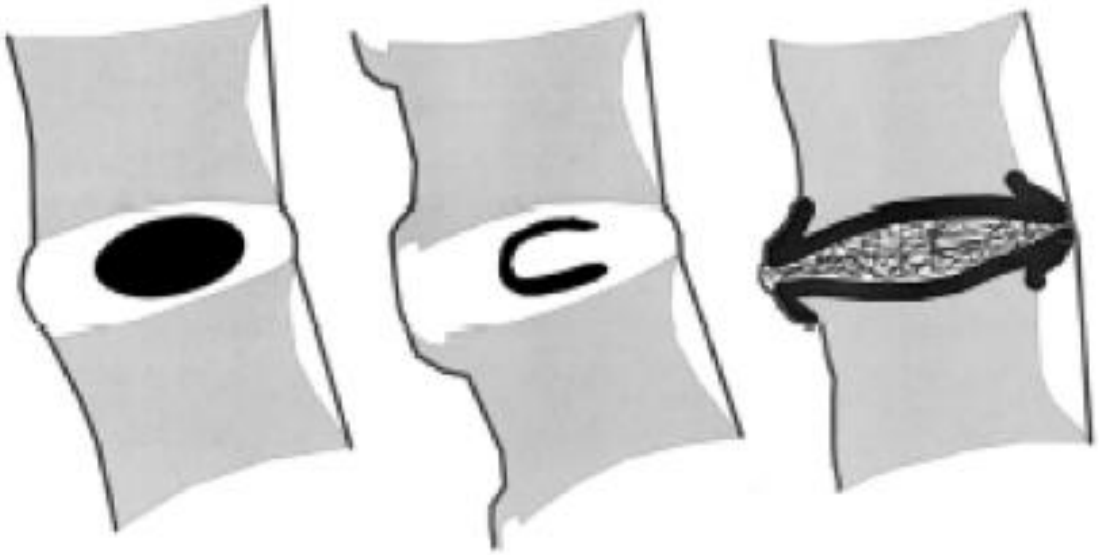




The degenerative cascade

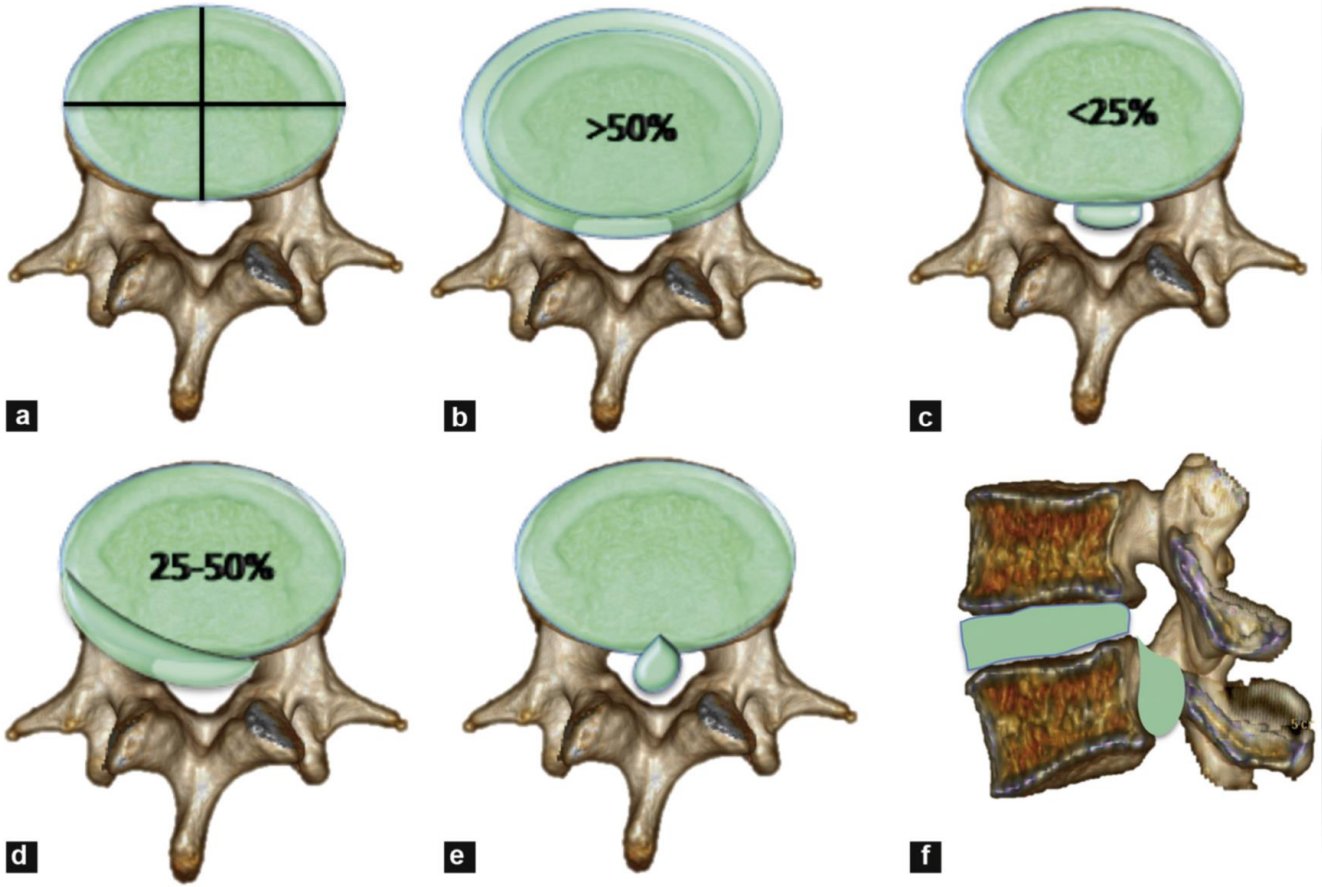


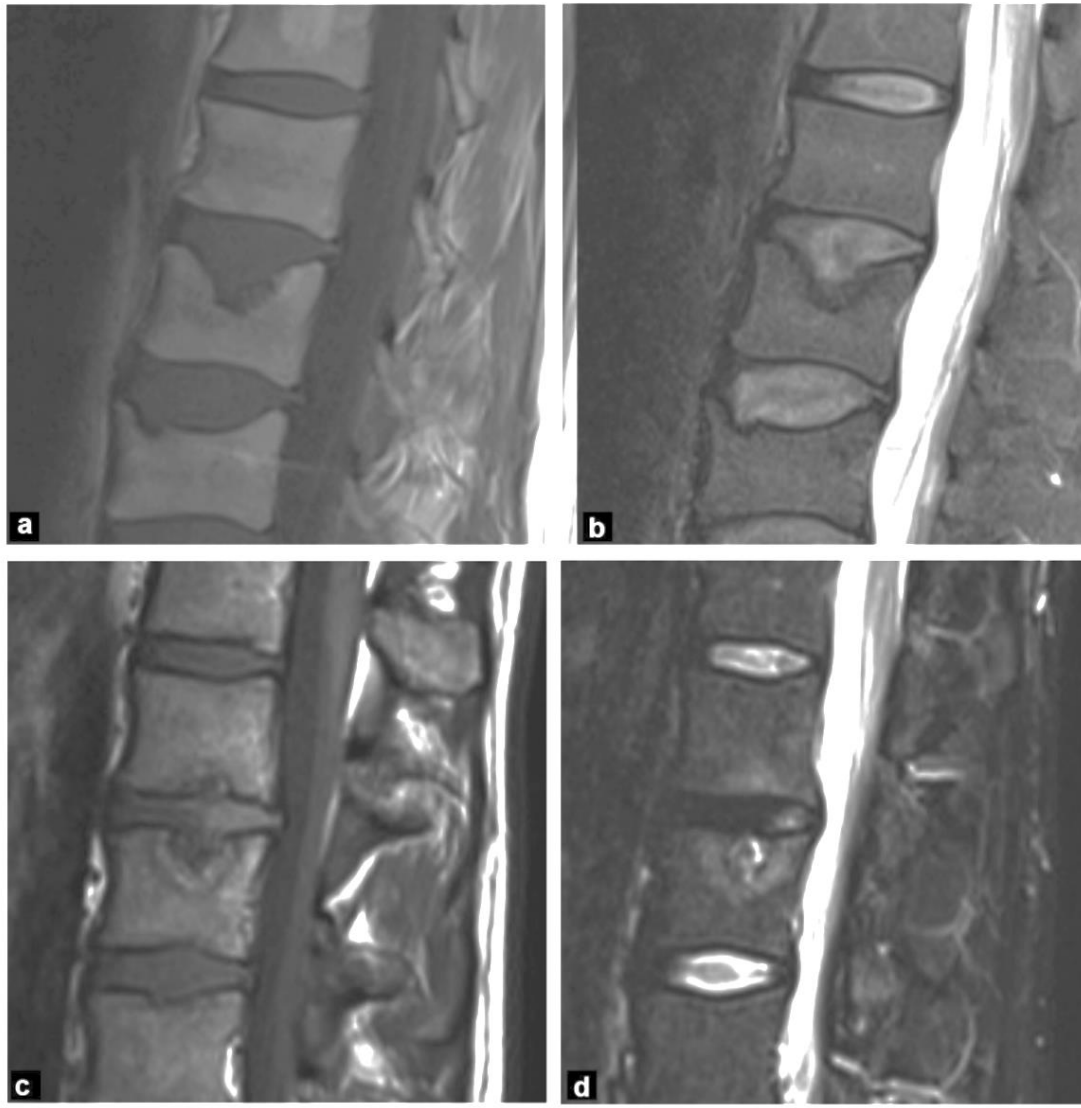
The ‘Radiculopathy’ pathway



The ‘Degeneration’ pathway

The Prolapse pathway

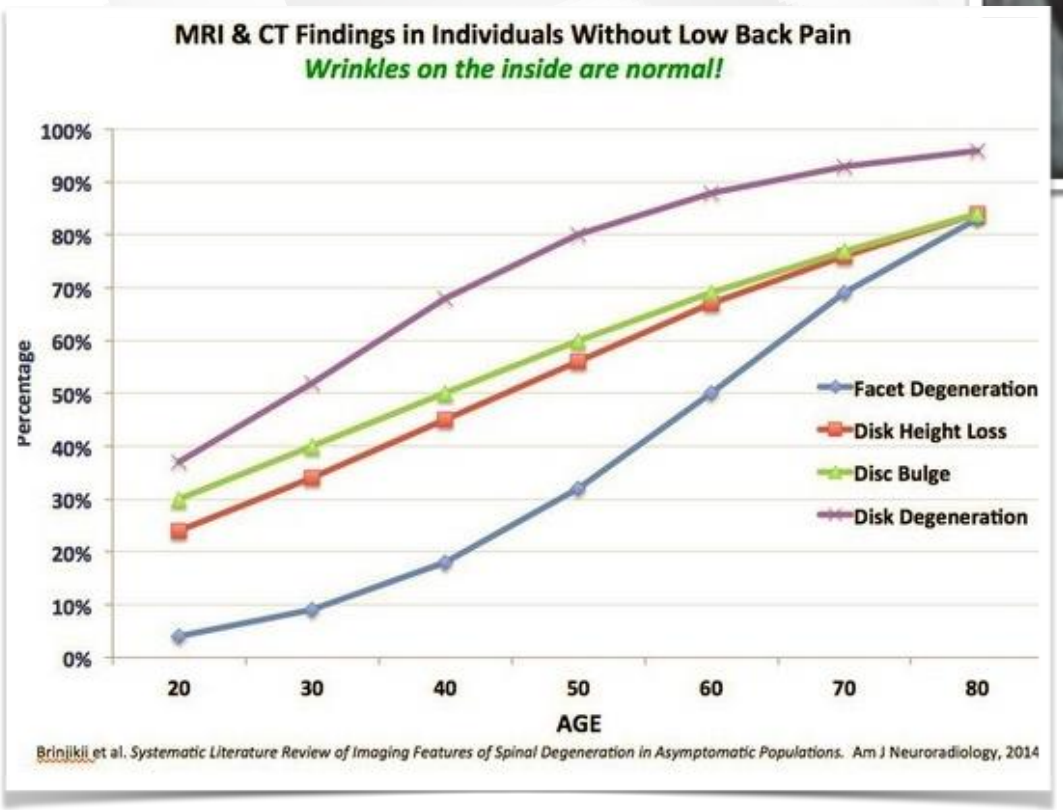




MRI

VOMIT

- **V**ictim
- **O**f
- **M**edical
- **I**maging
- **T**echnology



ORIGINAL RESEARCH
SPINE

Systematic Literature Review of Imaging Features of Spinal Degeneration in Asymptomatic Populations

W. Brinjikji, P.H. Luetmer, B. Comstock, B.W. Bresnahan, L.E. Chen, R.A. Deyo, S. Halabi, J.A. Turner, A.L. Avins, K. James, J.T. Wald, D.F. Kallmes, and J.G. Jarvik

Systematic review of 33 published papers

3110 asymptomatic patients

Table 2: Age-specific prevalence estimates of degenerative spine imaging findings in asymptomatic patients[a]

Imaging Finding	Age (yr)						
	20	30	40	50	60	70	80
Disk degeneration	37%	52%	68%	80%	88%	93%	96%
Disk signal loss	17%	33%	54%	73%	86%	94%	97%
Disk height loss	24%	34%	45%	56%	67%	76%	84%
Disk bulge	30%	40%	50%	60%	69%	77%	84%
Disk protrusion	29%	31%	33%	36%	38%	40%	43%
Annular fissure	19%	20%	22%	23%	25%	27%	29%
Facet degeneration	4%	9%	18%	32%	50%	69%	83%
Spondylolisthesis	3%	5%	8%	14%	23%	35%	50%

Radiation exposure

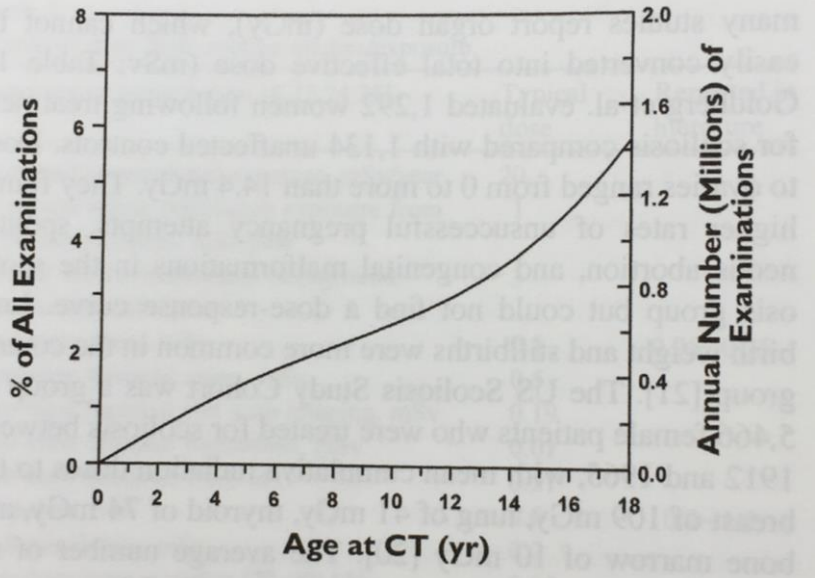


Fig. 1. Younger age at radiation exposure is associated with increased risk of fatal cancer, as estimated by the National Academy of Sciences Biologic Effects of Ionizing Radiation Committee (solid line) and the International Commission on Radiation Protection (ICRP), report 60. From Brenner et al. [4].

- Xrays (erect position)
- CT scans
- Bone scans / SPECT CT

Estimated radiation exposure.

		Estimated dose: PA			Estimated dose: lateral		
	EOS, AP	EOS, PA	Radiograph (CR)	Intraoperative T-spine	EOS, lateral	Radiograph, no filter (CR)	Intraoperative T-spine
Thyroid, mGy	0.19	0.05	0.09	0.03	0.24	0.51	0.13
Breast, mGy	0.19	0.02	0.08	0.05	0.16	0.21	1.70
Ovary, mGy	0.08	0.08	0.27	0.00	0.09	0.25	0.00
Testicles, mGy	0.25	0.04	0.02	0.00	0.05	0.02	0.00
Active bone marrow, mGy	0.05	0.10	0.32	0.15	0.09	0.29	0.39
Effective dose ICRP103, mSv	0.121	0.069	0.215	0.119	0.121	0.295	0.712

AP, anteroposterior; PA, posteroanterior.
Source: Luo et al. [22].

ELSEVIER MASSON

REVIEW / *Musculoskeletal imaging*

A review of the value of MRI signs in low back pain

I. Ract [a,*], J.-M. Meadeb [b], G. Mercy [c], F. Cueff [d], J.-L. Husson [d], R. Guillin [a]

[a] *Medical Imaging Department, Rennes University Hospital, 16, boulevard de Bulgarie, 35056 Rennes, France*
[b] *Rheumatology Department, Rennes University Hospital, 16, boulevard de Bulgarie, 35056 Rennes, France*
[c] *Medical Imaging Department, GH Pitié-Salpétrière, 43-87, boulevard de l'Hôpital, 75013 Paris, France*
[d] *Orthopedic, Reparative and Traumatic Surgery Department, Rennes University Hospital, rue Henri-Le-Guilloux, 35033 Rennes cedex 9, France*

HIZ and disc prolapse

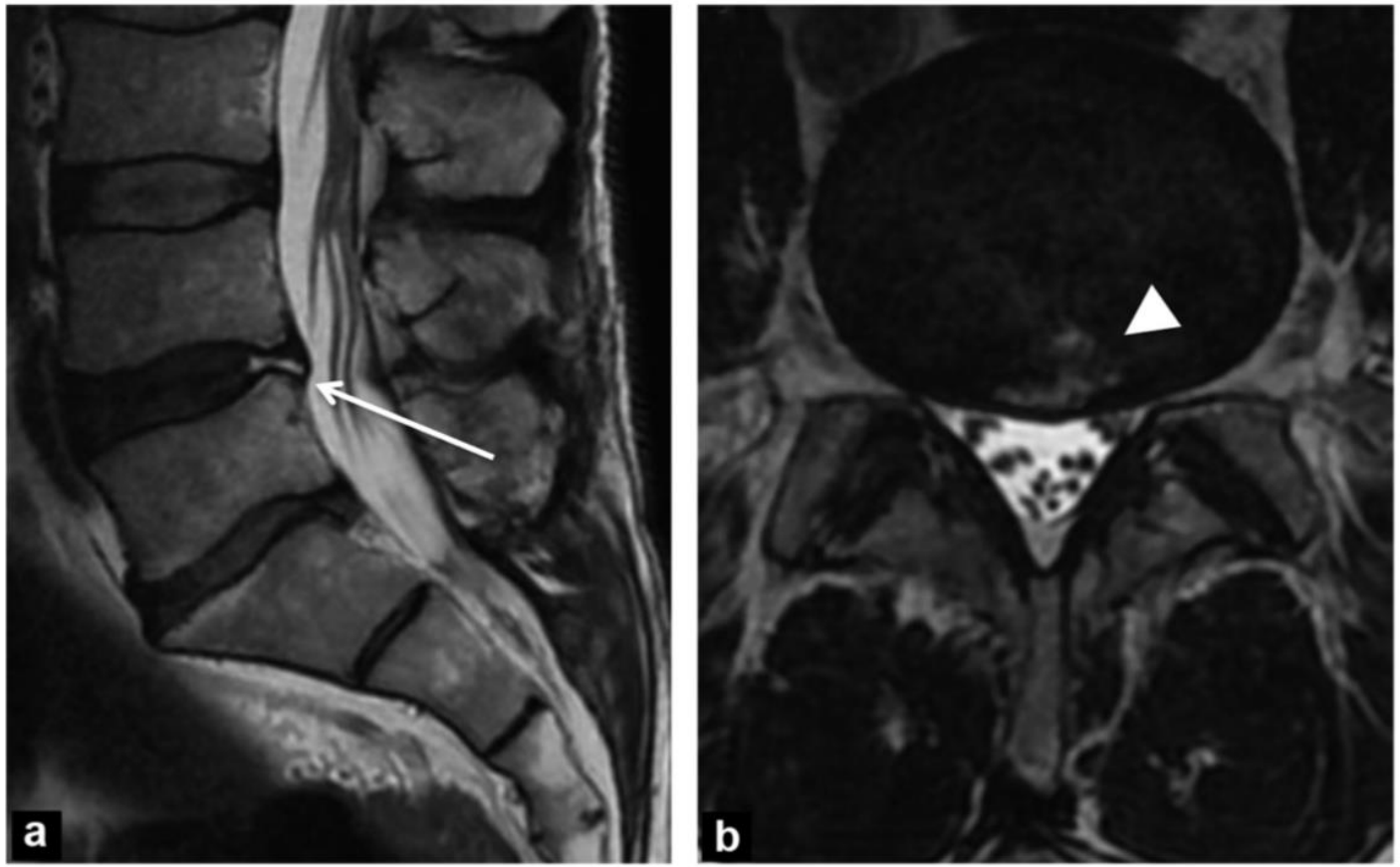
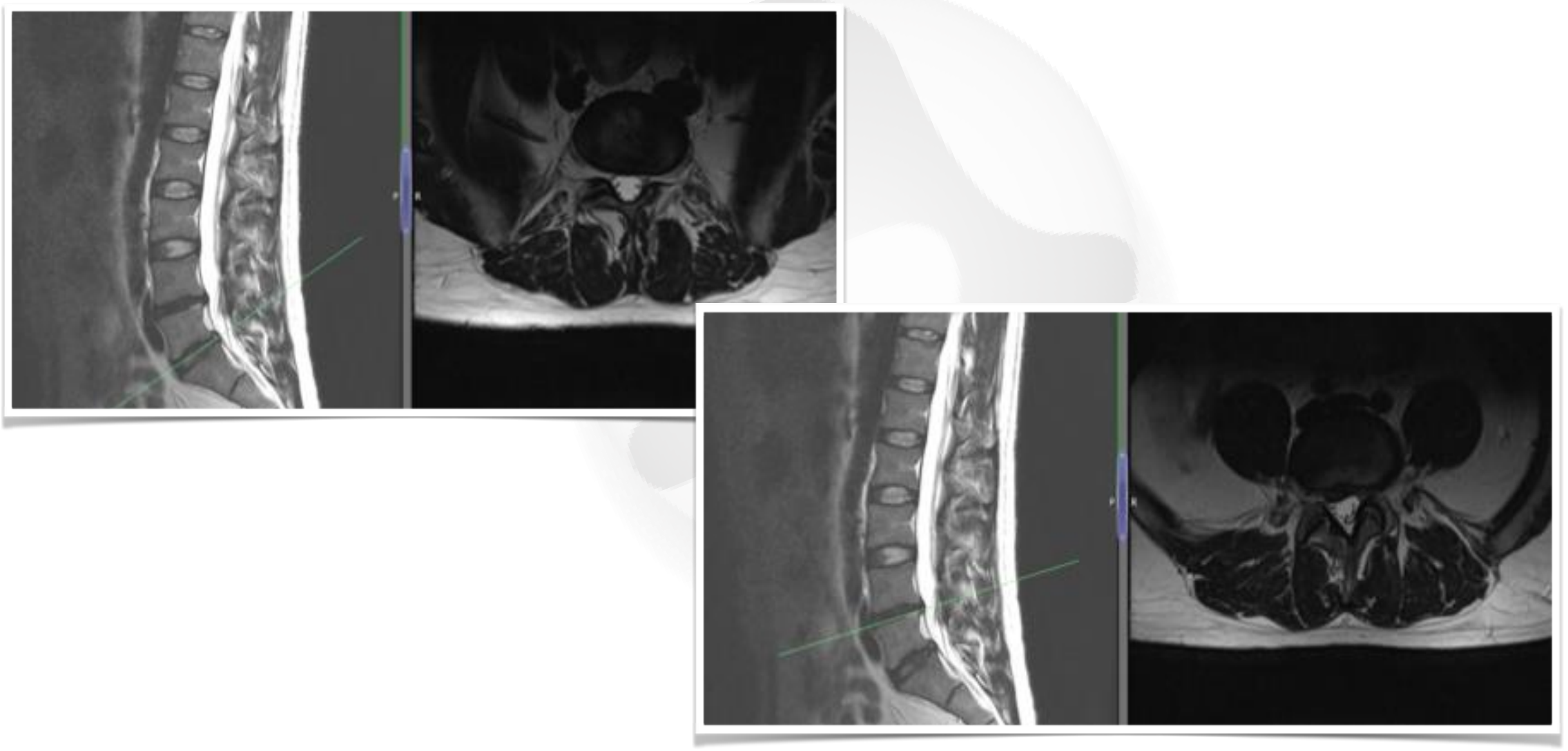
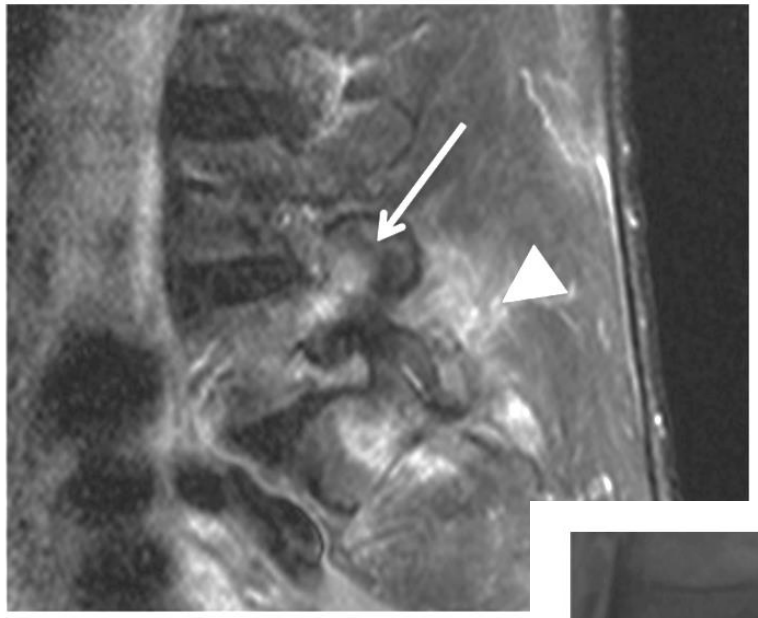


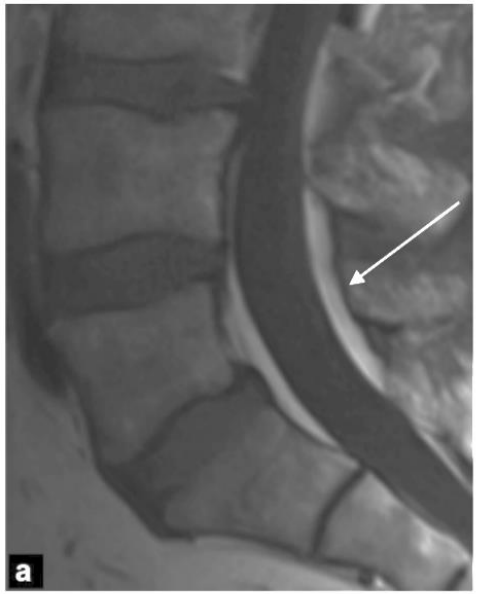
Figure 2. a: sagittal T2-weighted MR image; b: axial T2-weighted MR image of the L4-L5 disc, showing an area of high signal intensity (arrow) within the posterior annulus of the disc corresponding to radial annular disruption (arrow head).

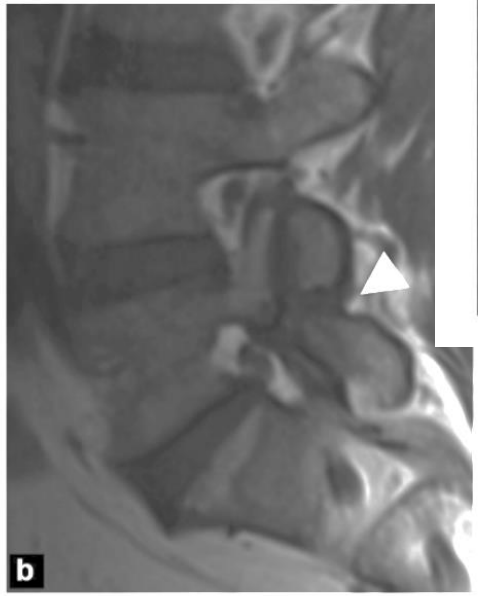
Paracentral and far lateral disc prolapse



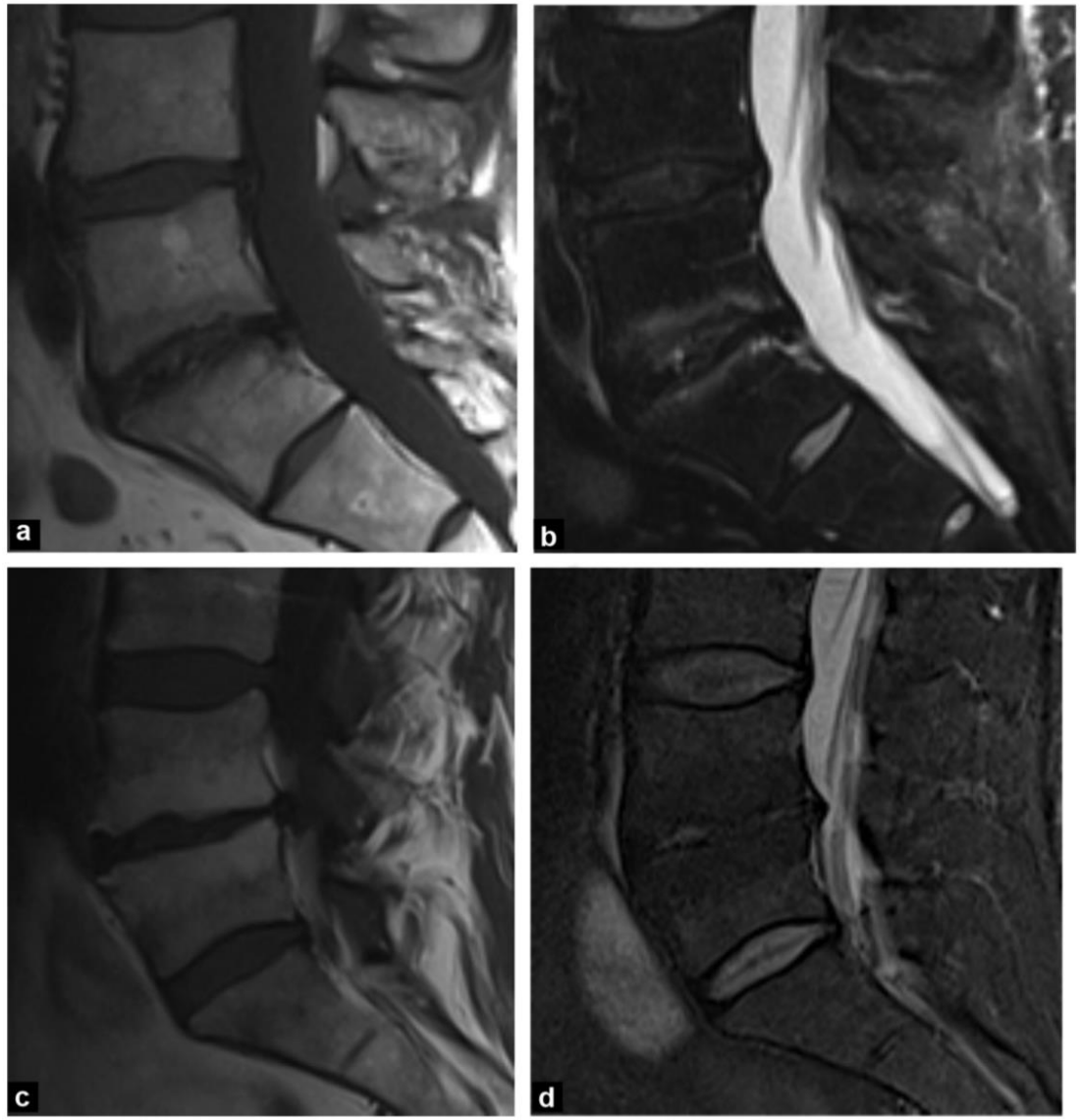
Posterior elements

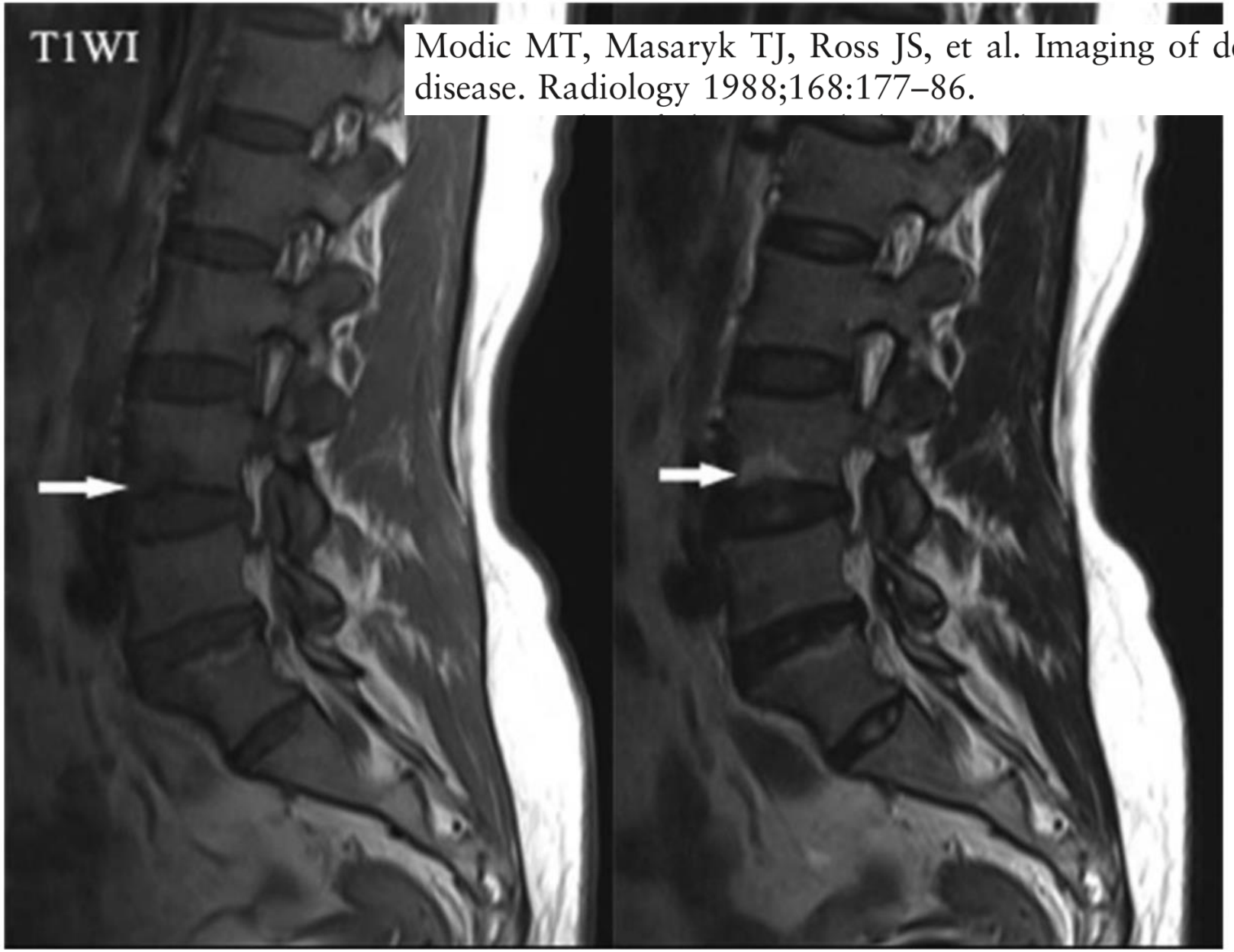






Reactive endplate changes: Modic changes





Modic MT, Masaryk TJ, Ross JS, et al. Imaging of degenertivae disk disease. Radiology 1988;168:177–86.

Figure 1. Type I Modic changes are hypointense on T1-weighted imaging and hyperintense on T2-weighted imaging and represent bone marrow edema and inflammation.

Modic MT, Masaryk TJ, Ross JS, et al. Imaging of degenertivae disk disease. Radiology 1988;168:177–86.

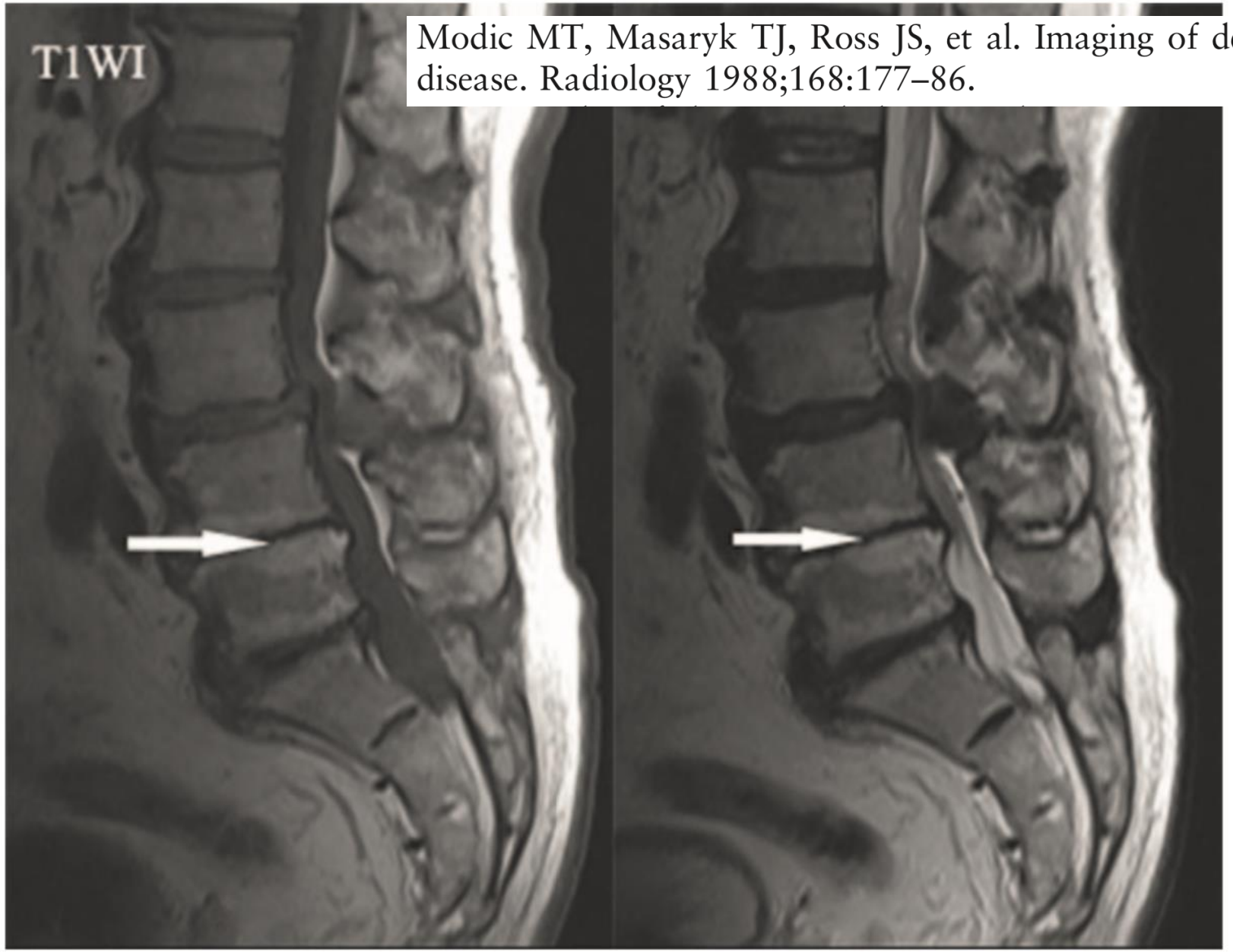
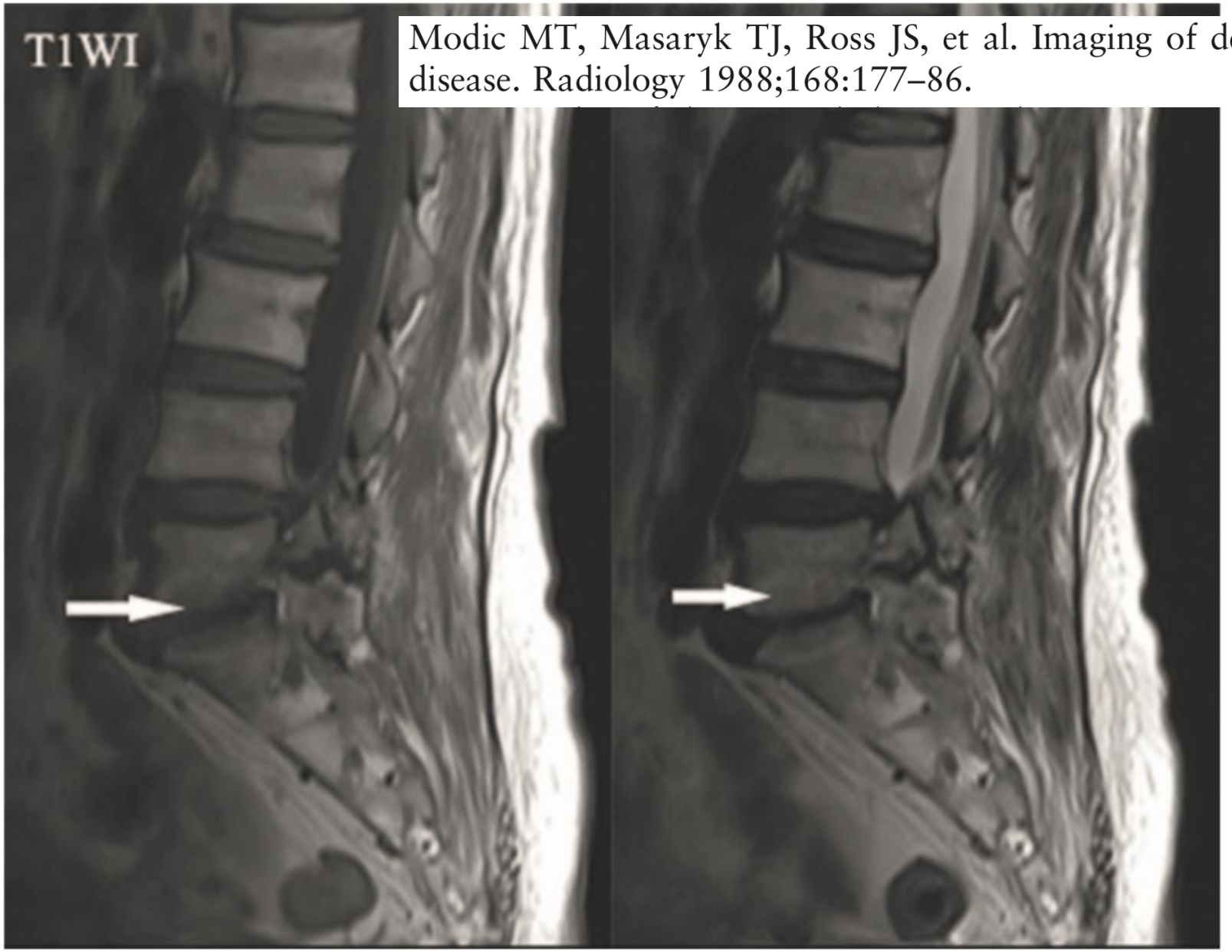


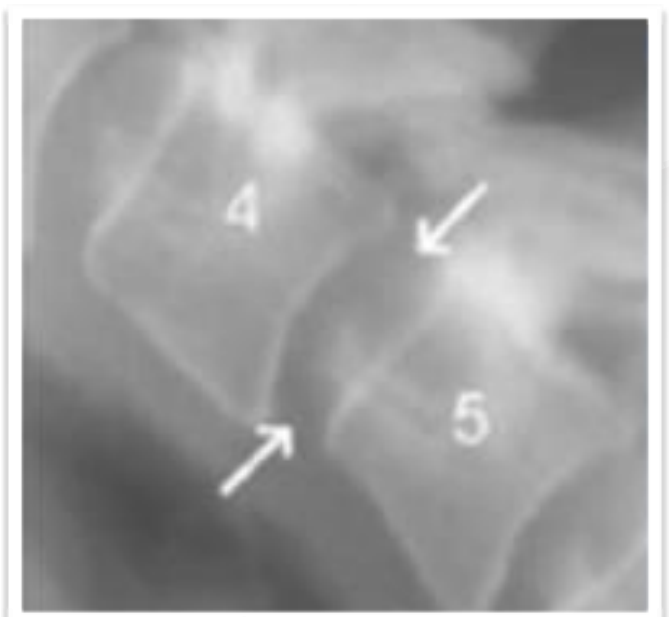
Figure 2. Type II Modic changes are hyperintense on T1-weighted imaging and isointense or slightly hyperintense on T2-weighted imaging and are associated with conversion of normal red hematopoietic bone marrow into yellow fatty marrow as a result of marrow ischemia.

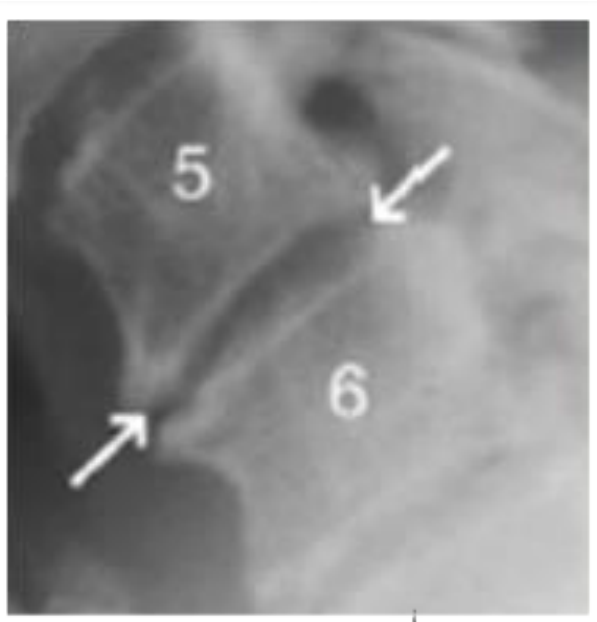


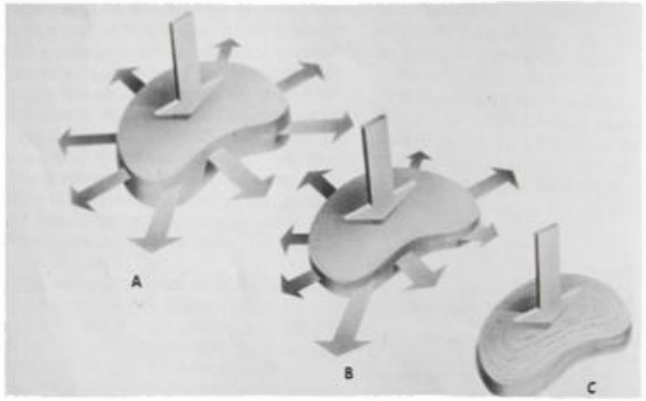
Modic MT, Masaryk TJ, Ross JS, et al. Imaging of degenertivae disk disease. Radiology 1988;168:177–86.

Figure 3. Type III Modic changes are subsequently described as hypointense on both T1- and T1-weighted imaging and are thought to represent subchondral bone sclerosis.

Disc height and degeneration

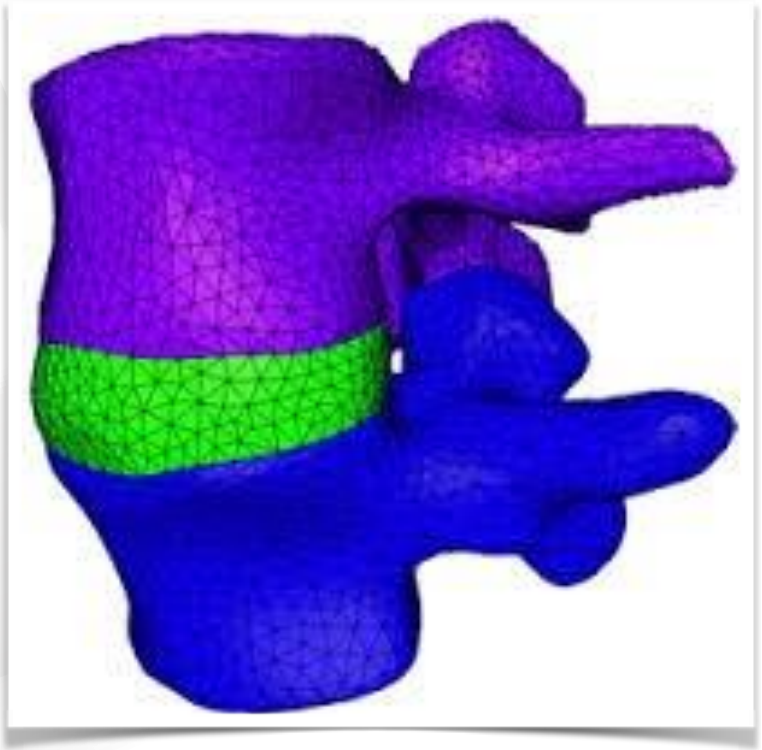




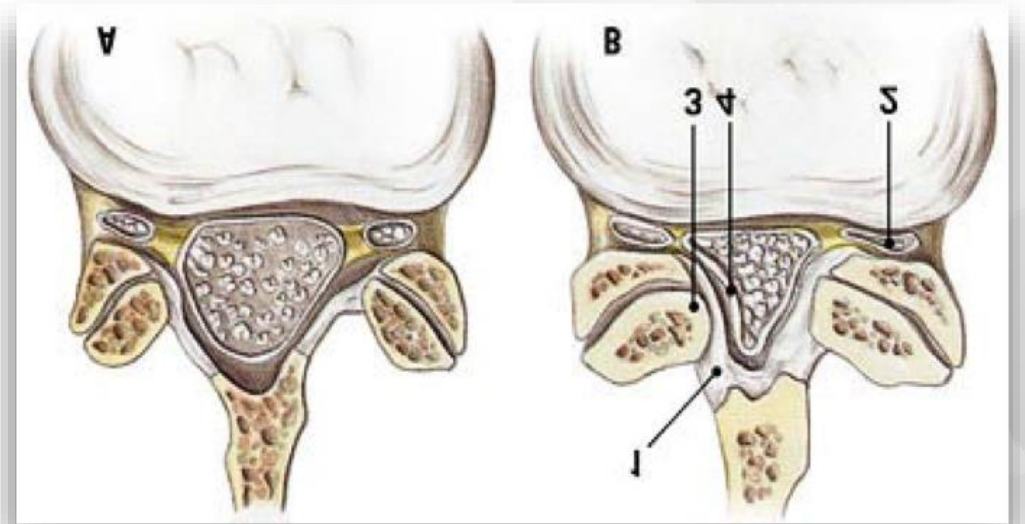


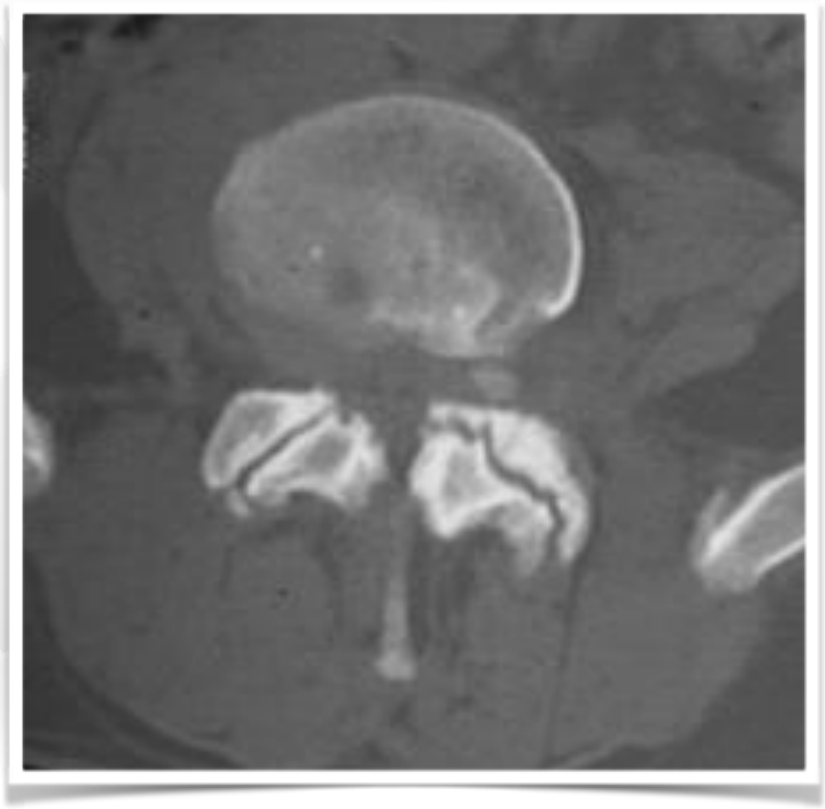
The motion segment

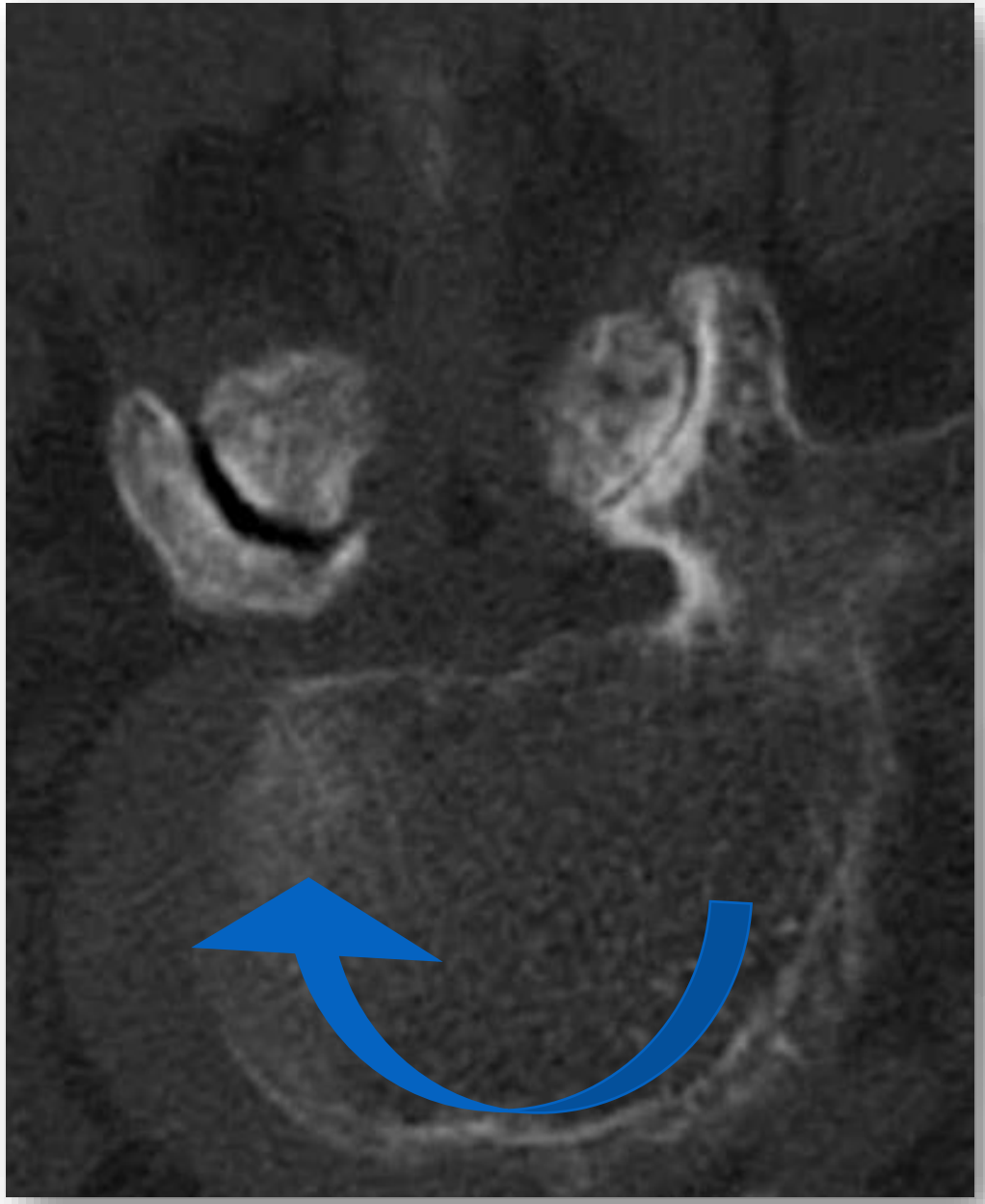
- Inter-vertebral disc
- End-plate: cartilage, bone
- Facet joints
- Passive restraints: Ligaments

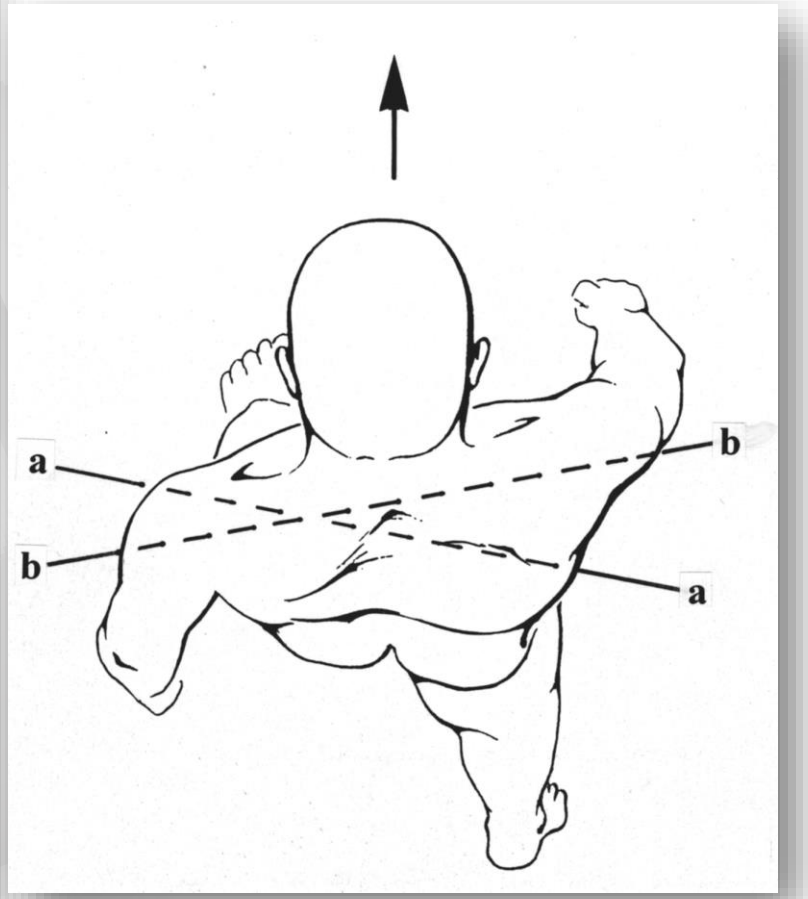


Facet arthritis



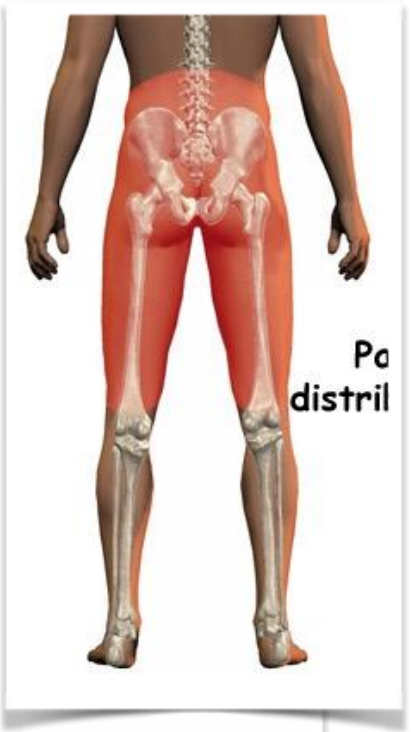


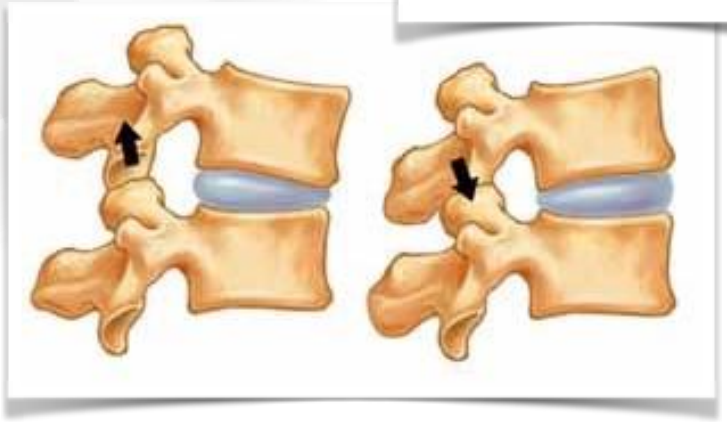



a
b
b
a

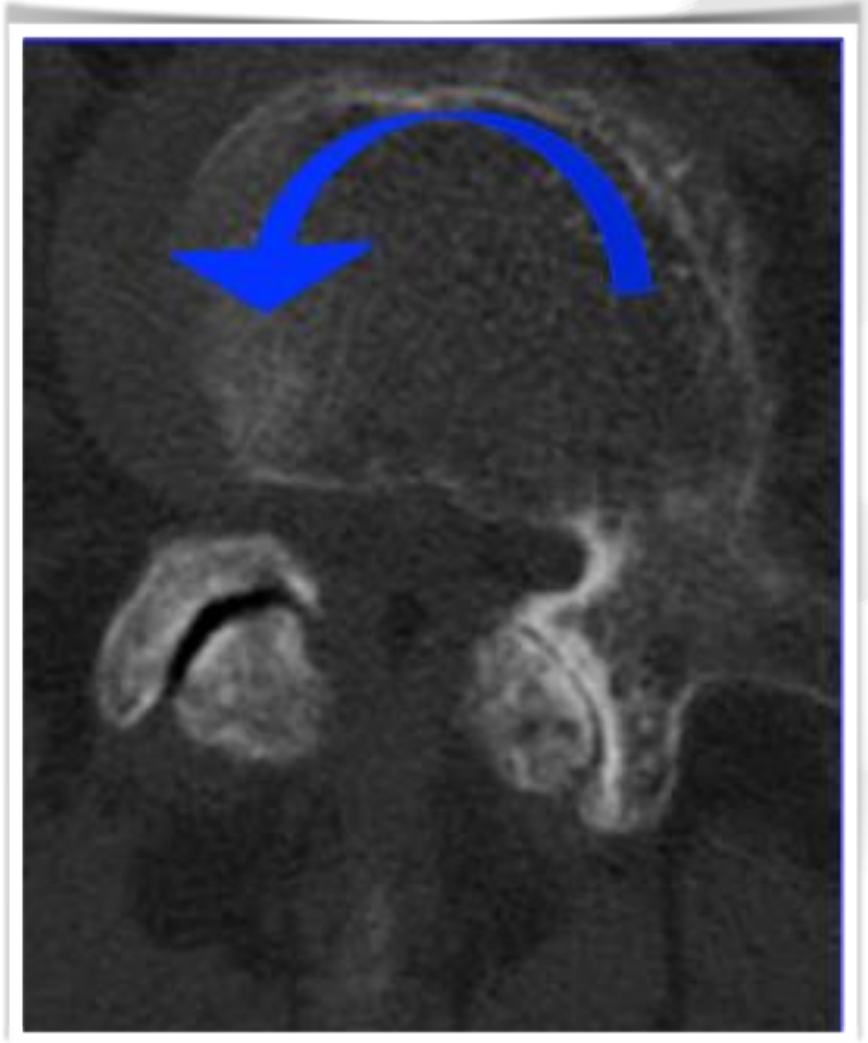
Facetogenic back pain

- Back pain
- Thigh pain
- Worse on extension
- Pain on getting out of bed
- Pain on arising from sitting





Disc v facet arthritis



MRI v CT

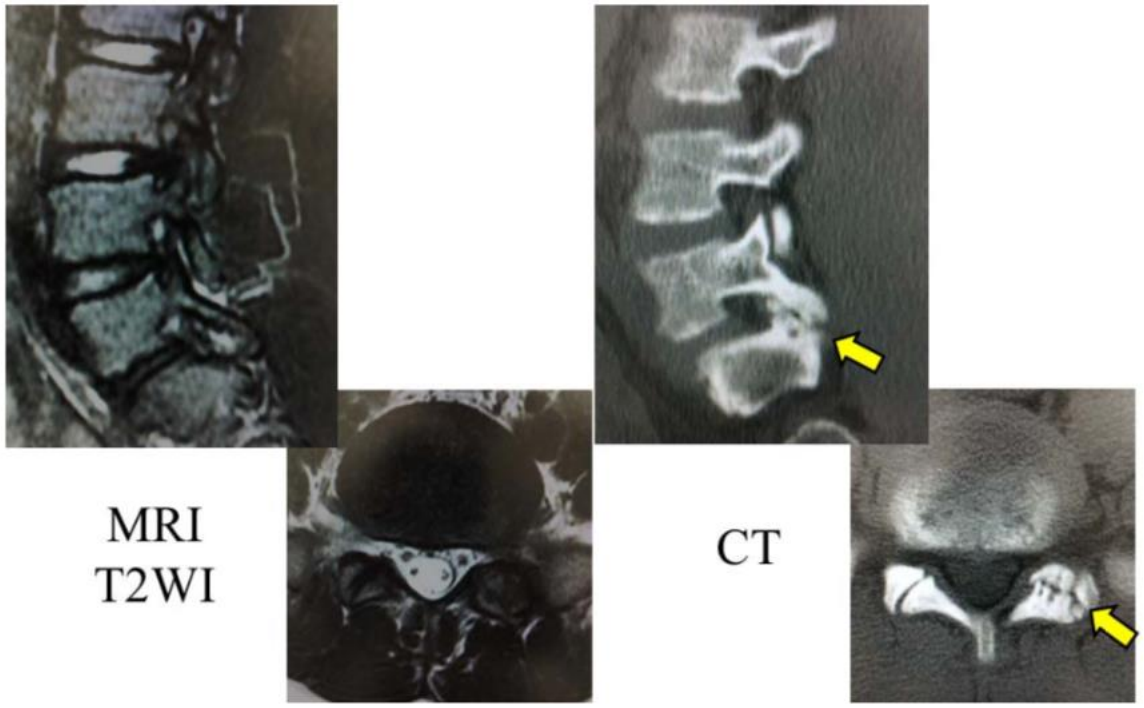


Figure 7. Magnetic resonance imaging (MRI) T2-weighted image (T2WI) and CT scan for case 3 (a 15-year-old with facet joint arthritis). Although there were not obvious abnormal findings on MRI, CT clearly showed osteoarthritis of left facet joint (arrow) at the level of L5-S1. Left: MRI T2-weighted image. Right: CT. Abbreviations: CT, computed tomography.

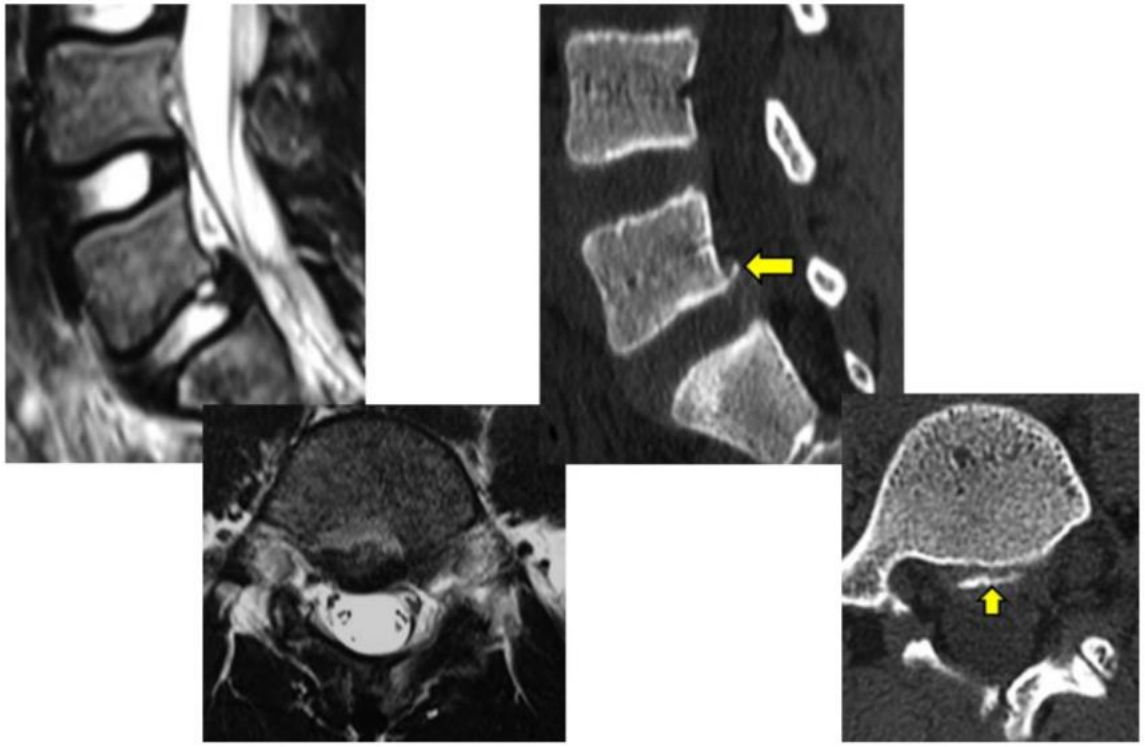
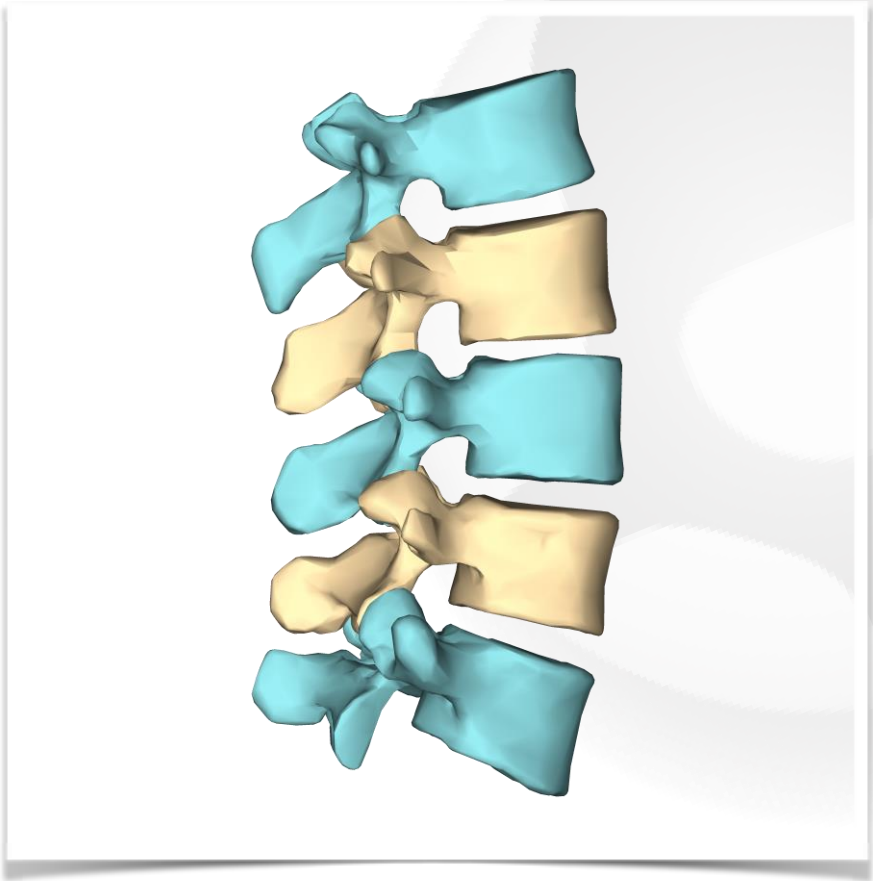
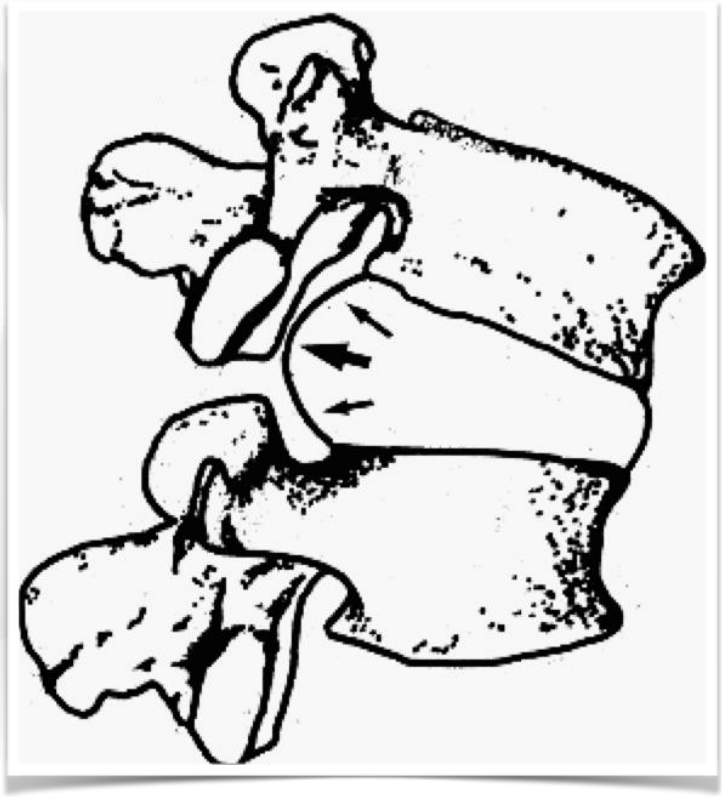


Figure 8. Magnetic resonance imaging (MRI) T2-weighted image and CT scan for case 4 (a 12-year-old with a lumbar apophyseal ring fracture). T2-weighted MRI showed only slight central bulging of the L5-S1 disc, whereas CT revealed an apophyseal ring fracture (arrow) at the level of the caudal L5 endplate. Abbreviations: CT, computed tomography.

Discogenic v Facetogenic

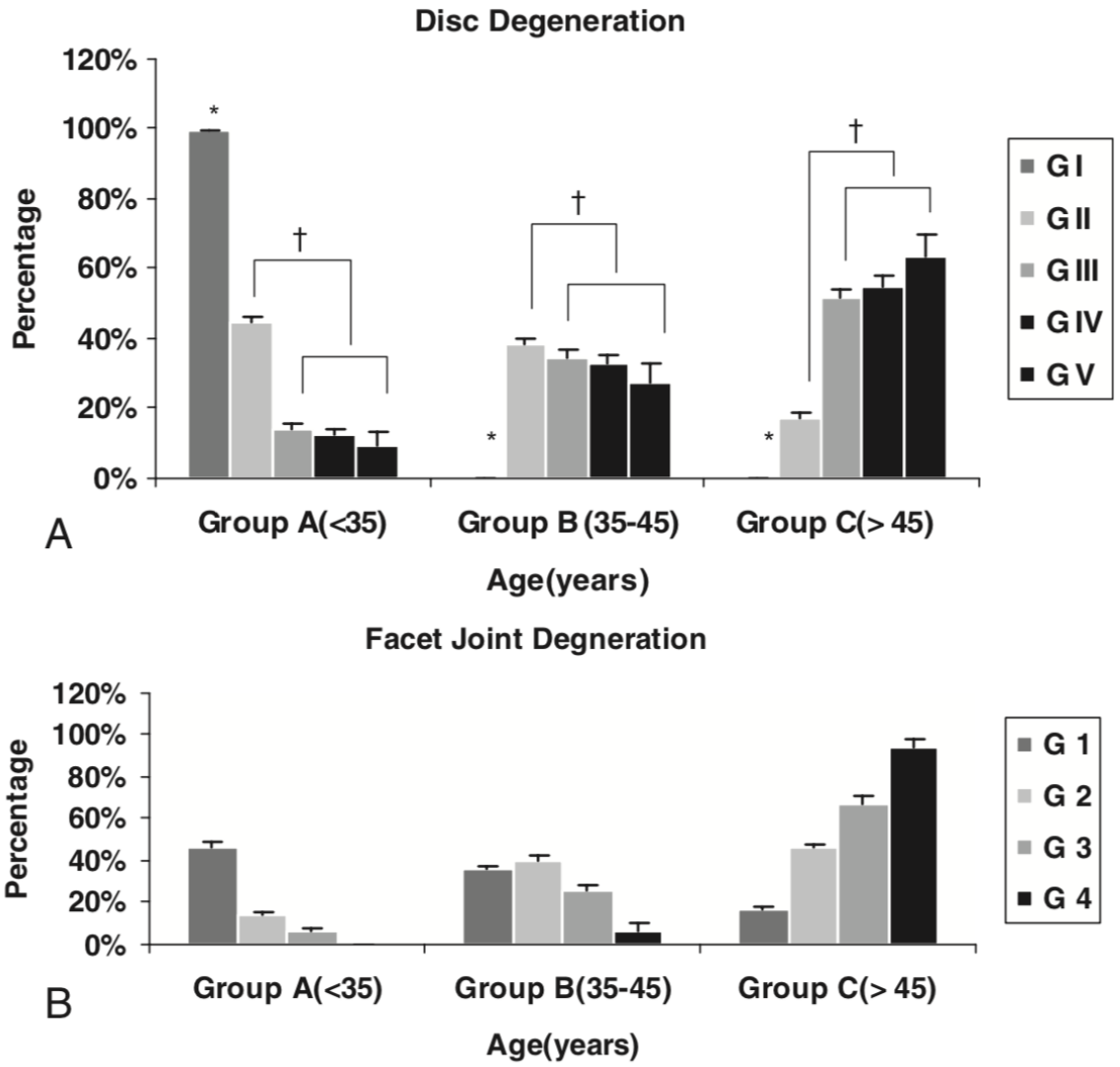


Extension



Flexion

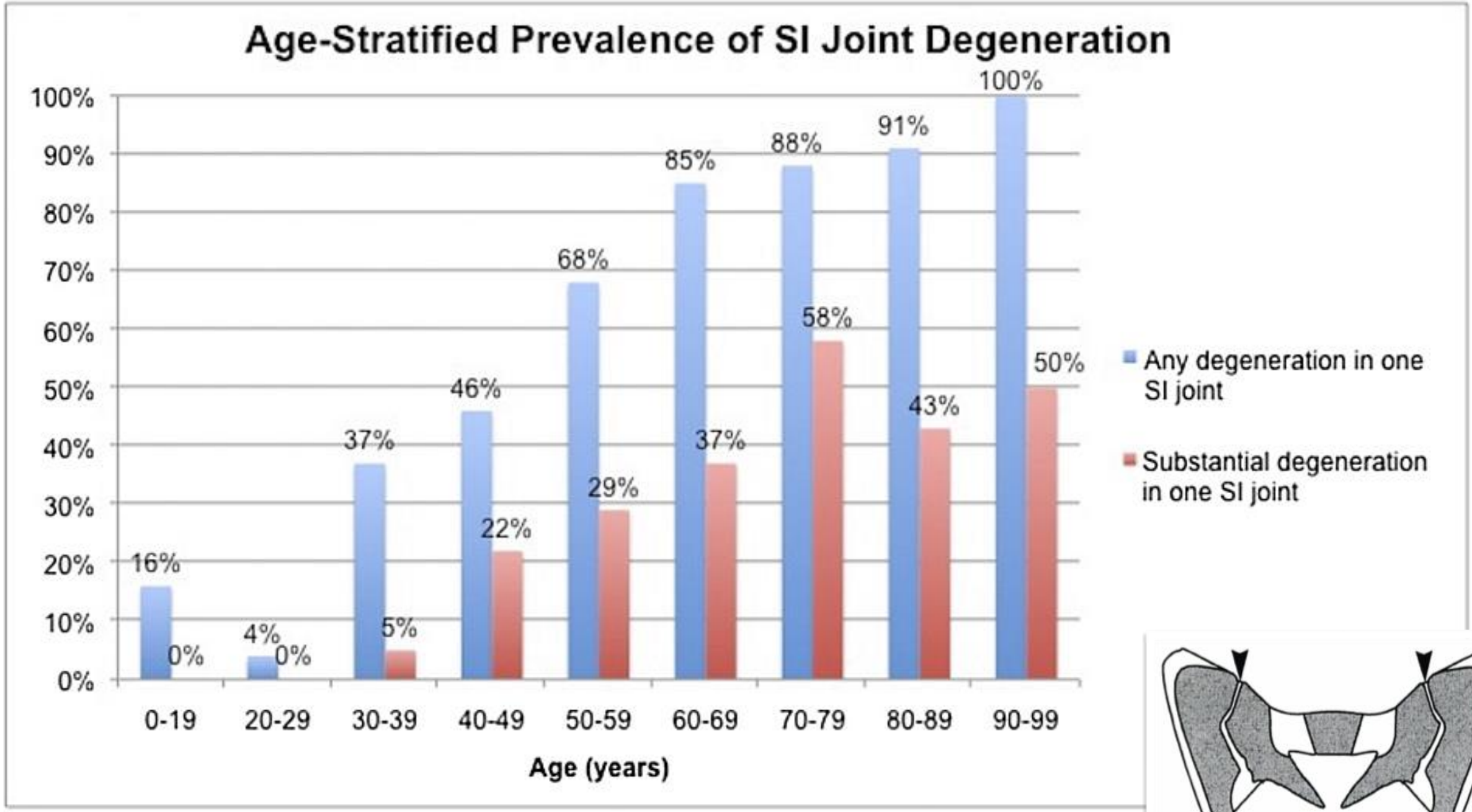
Temporal changes: disc v facet arthritis



SPINE Volume 34, Number 23, pp 253

Lumbar Segmental Mobility According to the Grade of the Disc, the Facet Joint, the Muscle, and the Ligament Pathology by Using Kinetic Magnetic Resonance Imaging

Min Ho Kong, MD,* Yuichiro Morishita, MD, PhD,† Wubing He, MD,†
Masashi Miyazaki, MD,‡ Haihong Zhang, MD,† Guizhong Wu, MD,†
Henry J. Hymanson, BS,† and Jeffrey C. Wang, MD†



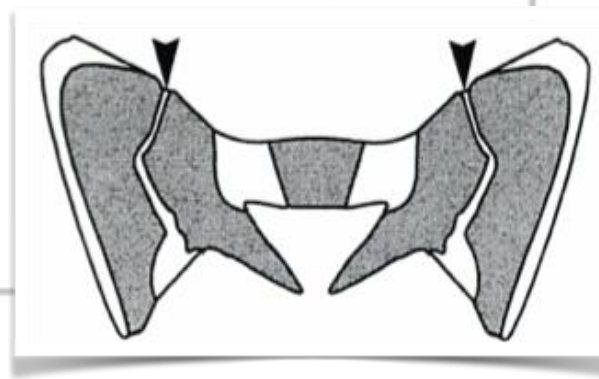


Fig. 6

Prevalence of sacroiliac (SI) joint degeneration per decade of life.

Red flags for back pain

Cauda Equina Syndrome

- Severe or progressive bilateral neurological deficit of the legs, such as major motor weakness with knee extension, ankle eversion, or foot dorsiflexion.
- Recent-onset urinary retention (caused by bladder distension because the sensation of fullness is lost) and/or urinary incontinence (caused by loss of sensation when passing urine).
- Recent-onset faecal incontinence (due to loss of sensation of rectal fullness).
- Perianal or perineal sensory loss (saddle anaesthesia or paraesthesia).
- Unexpected laxity of the anal sphincter.

Spinal fractures

- Sudden onset of severe central spinal pain which is relieved by lying down.
- A history of major trauma (such as a road traffic collision or fall from a height), minor trauma, or even just strenuous lifting in people with osteoporosis or those who use corticosteroids.
- Structural deformity of the spine (such as a step from one vertebra to an adjacent vertebra) may be present.
- There may be point tenderness over a vertebral body.

Cancer

- The person being 50 years of age or more.
- Gradual onset of symptoms.
- Severe unremitting pain that remains when the person is supine, aching night pain that prevents or disturbs sleep, pain aggravated by straining (for example, at stool, or when coughing or sneezing), and thoracic pain.
- Localised spinal tenderness.
- No symptomatic improvement after four to six weeks of conservative low back pain therapy.
- Unexplained weight loss.
- Past history of cancer — breast, lung, gastrointestinal, prostate, renal, and thyroid cancers are more likely to metastasize to the spine.

Infection:

Discitis, Vertebral osteomyelitis, epidural abscess

- Fever
- Tuberculosis, or recent urinary tract infection.
- Diabetes.
- History of intravenous drug use.
- HIV infection, use of immunosuppressants, or the person is otherwise immunocompromised.

‘Non specific’ back pain

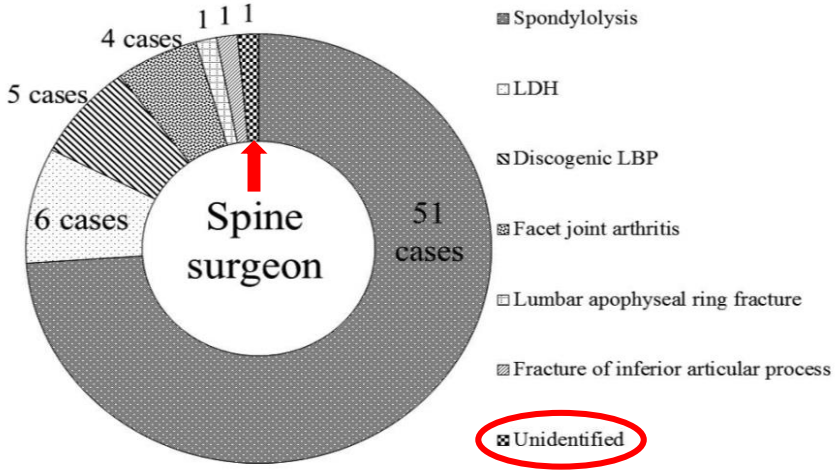


Figure 3. Diagnoses of low back pain made by a spine surgeon. Abbreviations: LBP, low back pain; LDH, lumbar disc herniation.

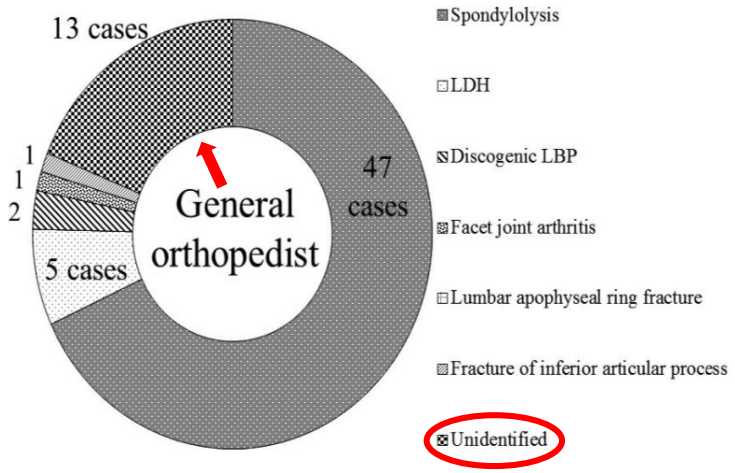


Figure 2. Diagnoses of low back pain made by general orthopedic surgeons. Abbreviations: LBP, low back pain; LDH, lumbar disc herniation.

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https://doi.org/10.14444/6024

Low Back Pain in Adolescent Athletes: Comparison of Diagnoses Made by General Orthopedic Surgeons and Spine Surgeons

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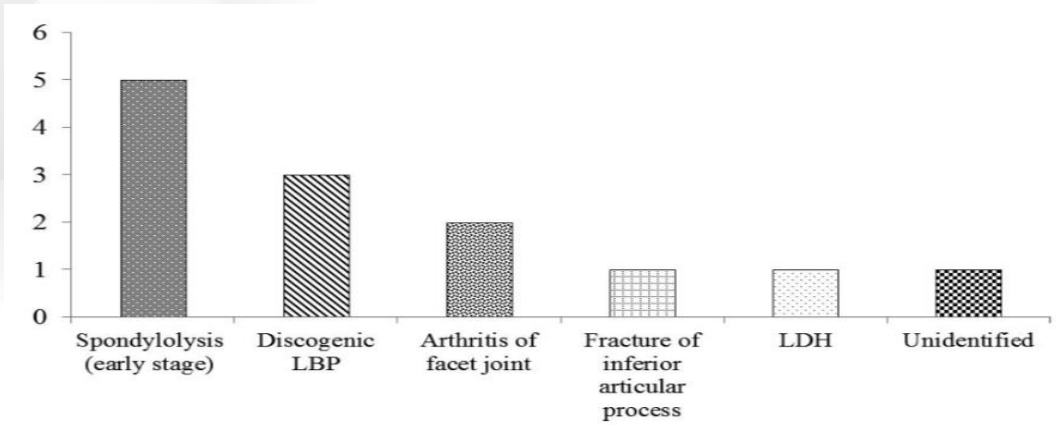
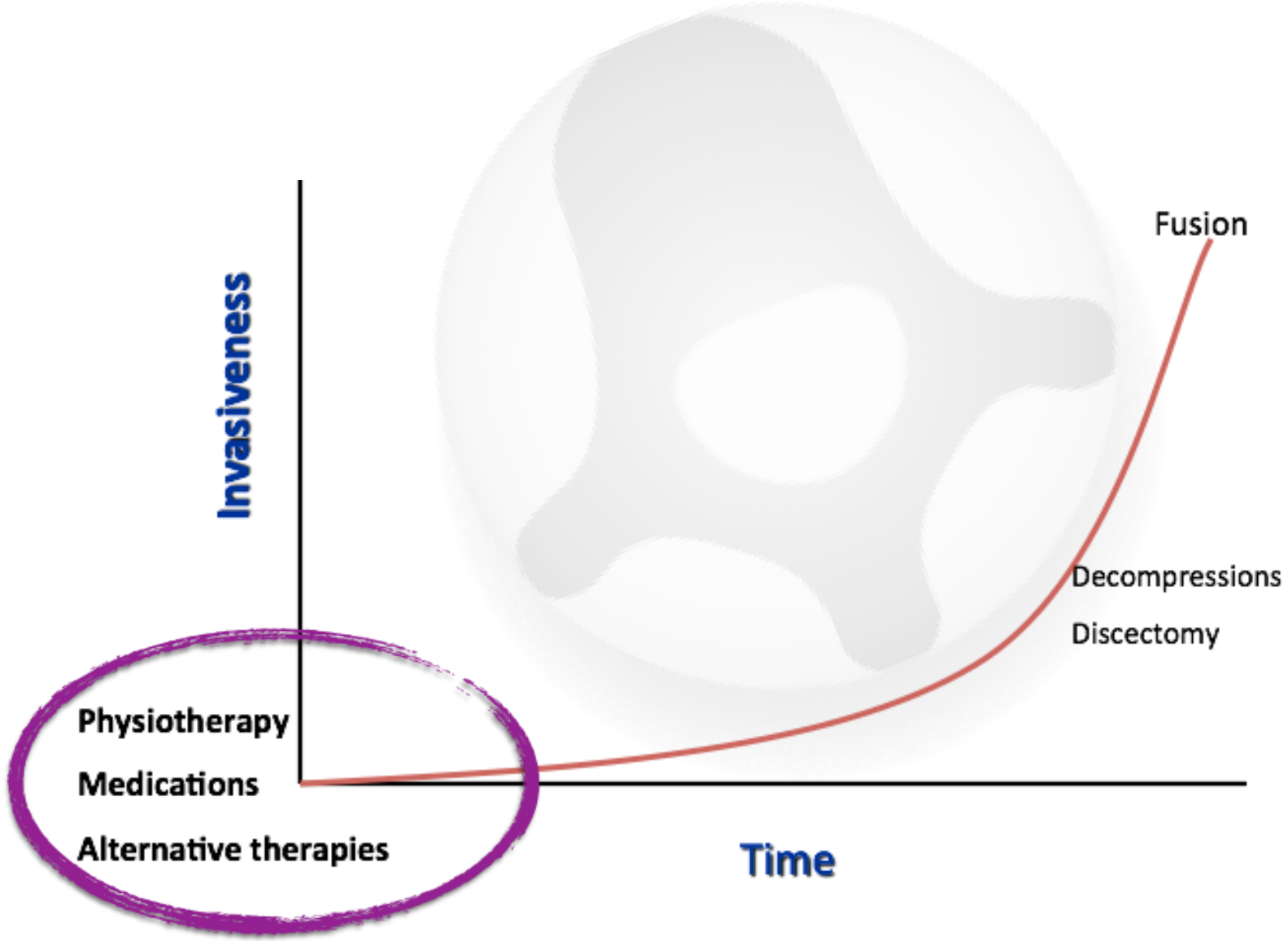
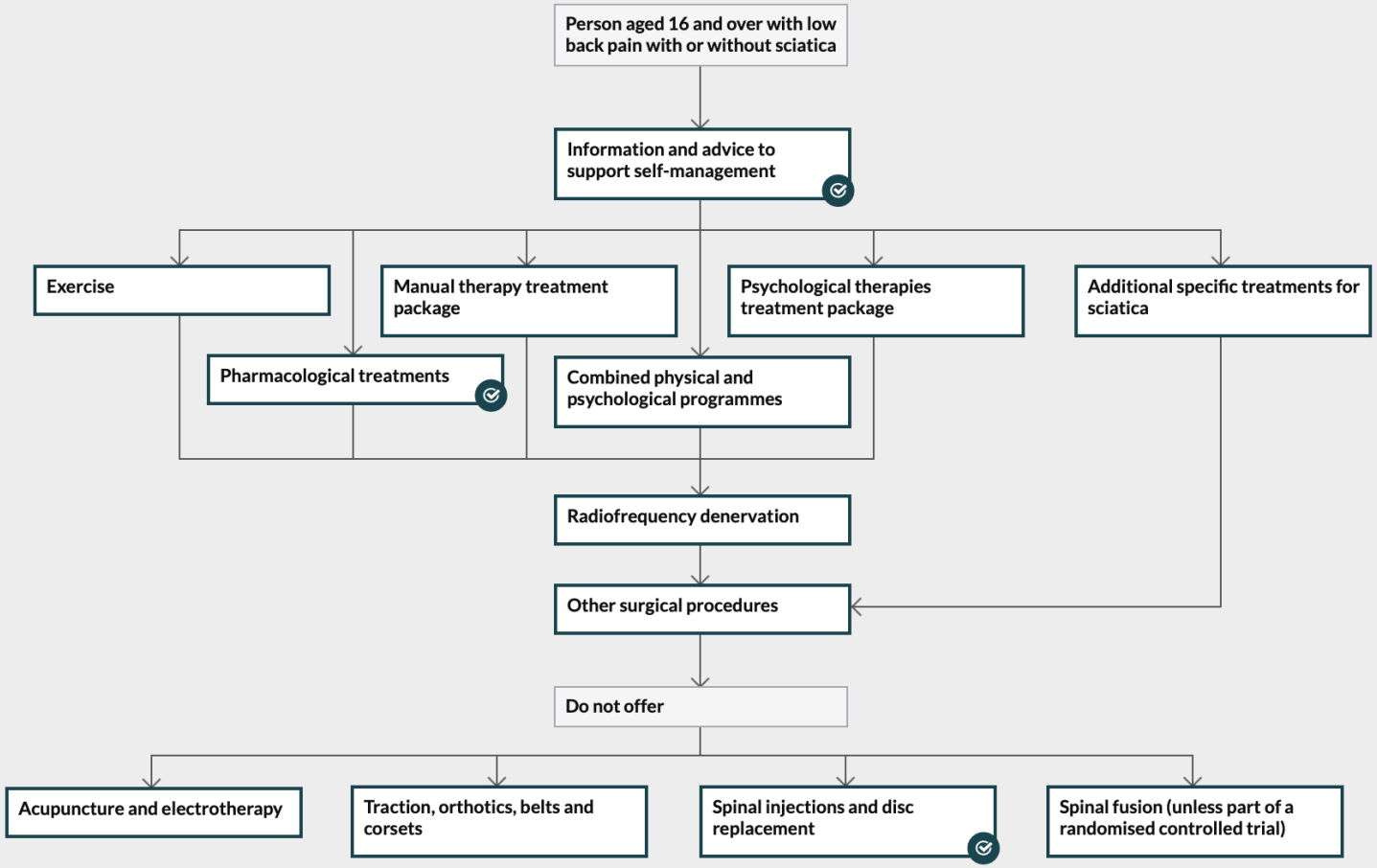
[1]*Department of Orthopedics, Institute of Health Biosciences, The University of Tokushima Graduate School, Tokushima, Japan,* [2]*Hachioji Sports Clinic, Hachioji, Japan*



Treatment options



Managing low back pain and sciatica



1.3 Invasive treatments for low back pain and sciatica

Non-surgical interventions

Spinal injections

1.3.1 Do not offer spinal injections for managing low back pain.

Radiofrequency denervation

1.3.2 Consider referral for assessment for radiofrequency denervation for people with chronic low back pain when:

- non-surgical treatment has not worked for them **and**
- the main source of pain is thought to come from structures supplied by the medial branch nerve **and**
- they have moderate or severe levels of localised back pain (rated as 5 or more on a visual analogue scale, or equivalent) at the time of referral.

1.3.3 Only perform radiofrequency denervation in people with chronic low back pain after a positive response to a diagnostic medial branch block.

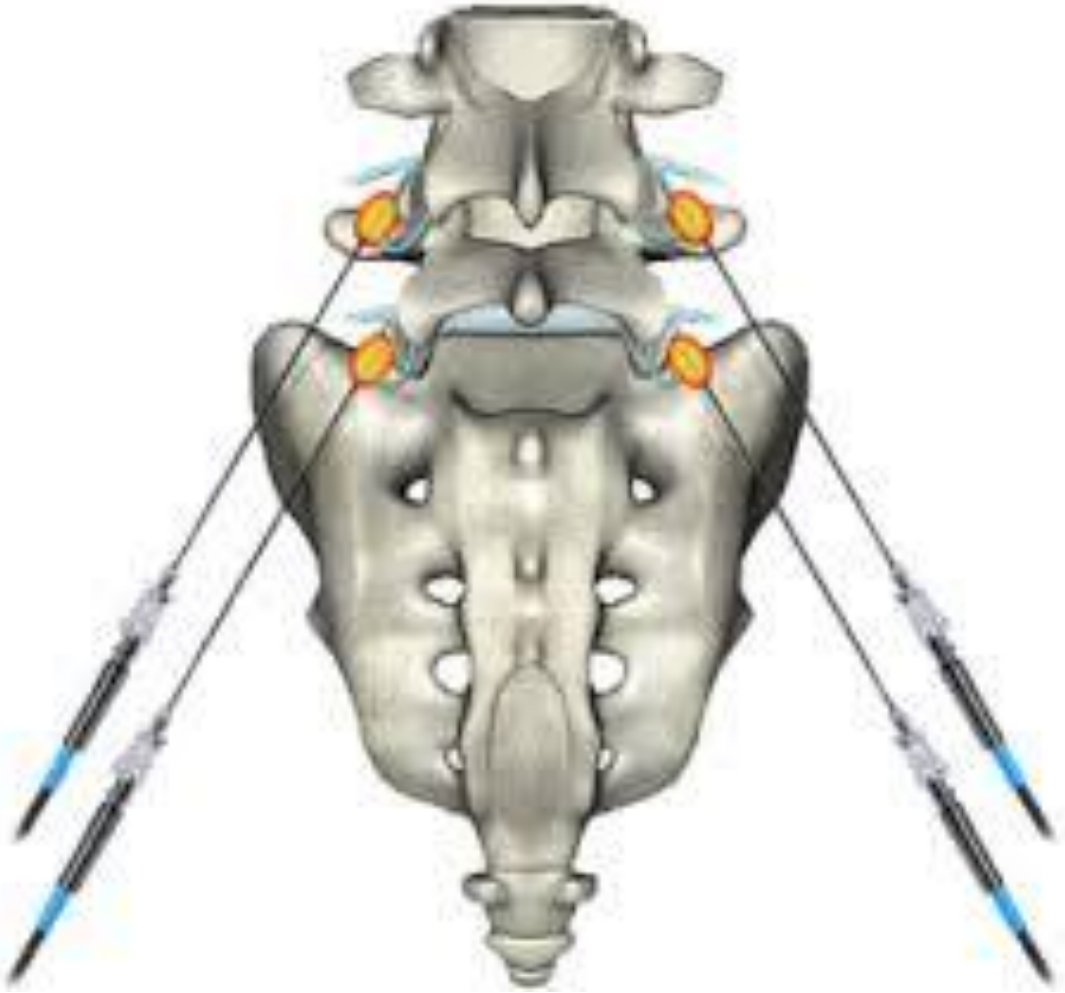
1.3.4 Do not offer imaging for people with low back pain with specific facet join pain as a prerequisite for radiofrequency denervation.

Epidurals

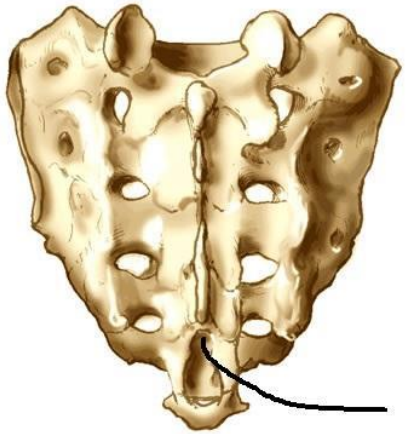
1.3.5 Consider epidural injections of local anaesthetic and steroid in people with acute and severe sciatica.

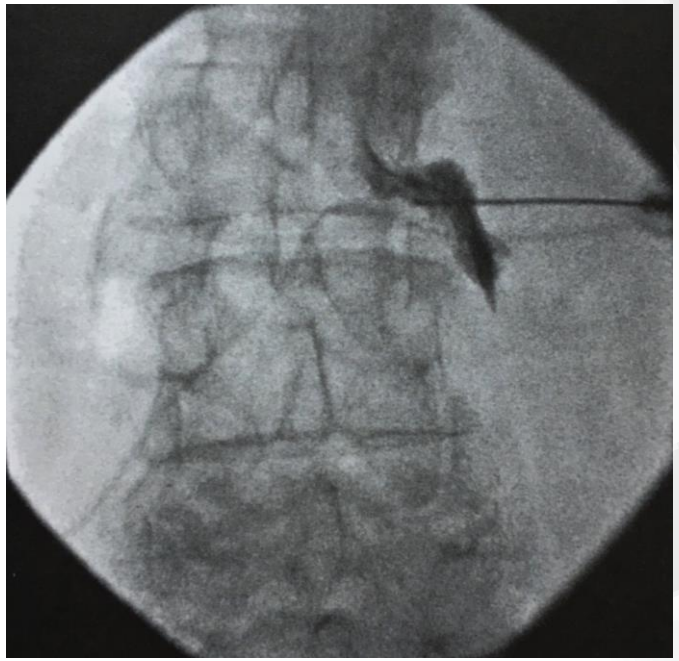
1.3.6 Do not use epidural injections for neurogenic claudication in people who have central spinal canal stenosis.

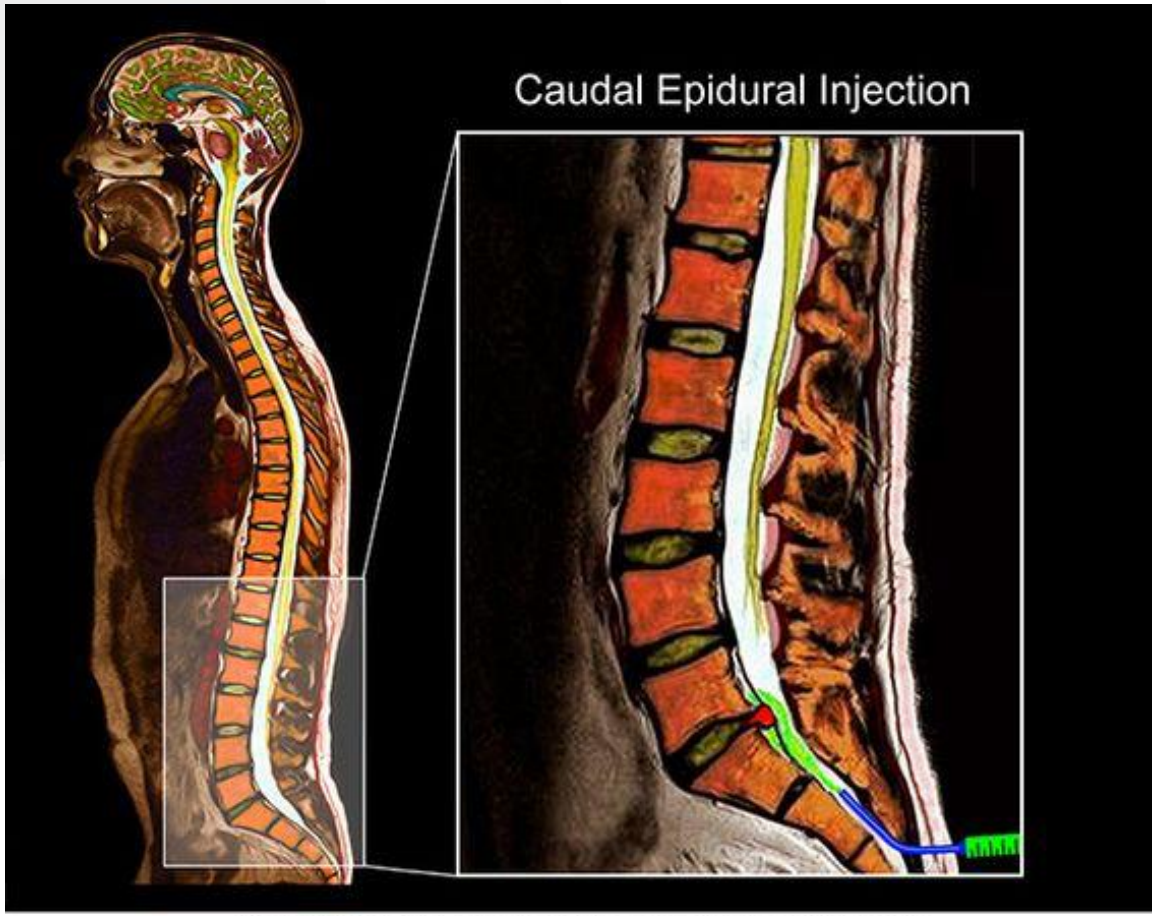
Facet joint medial branch blocks and ablation



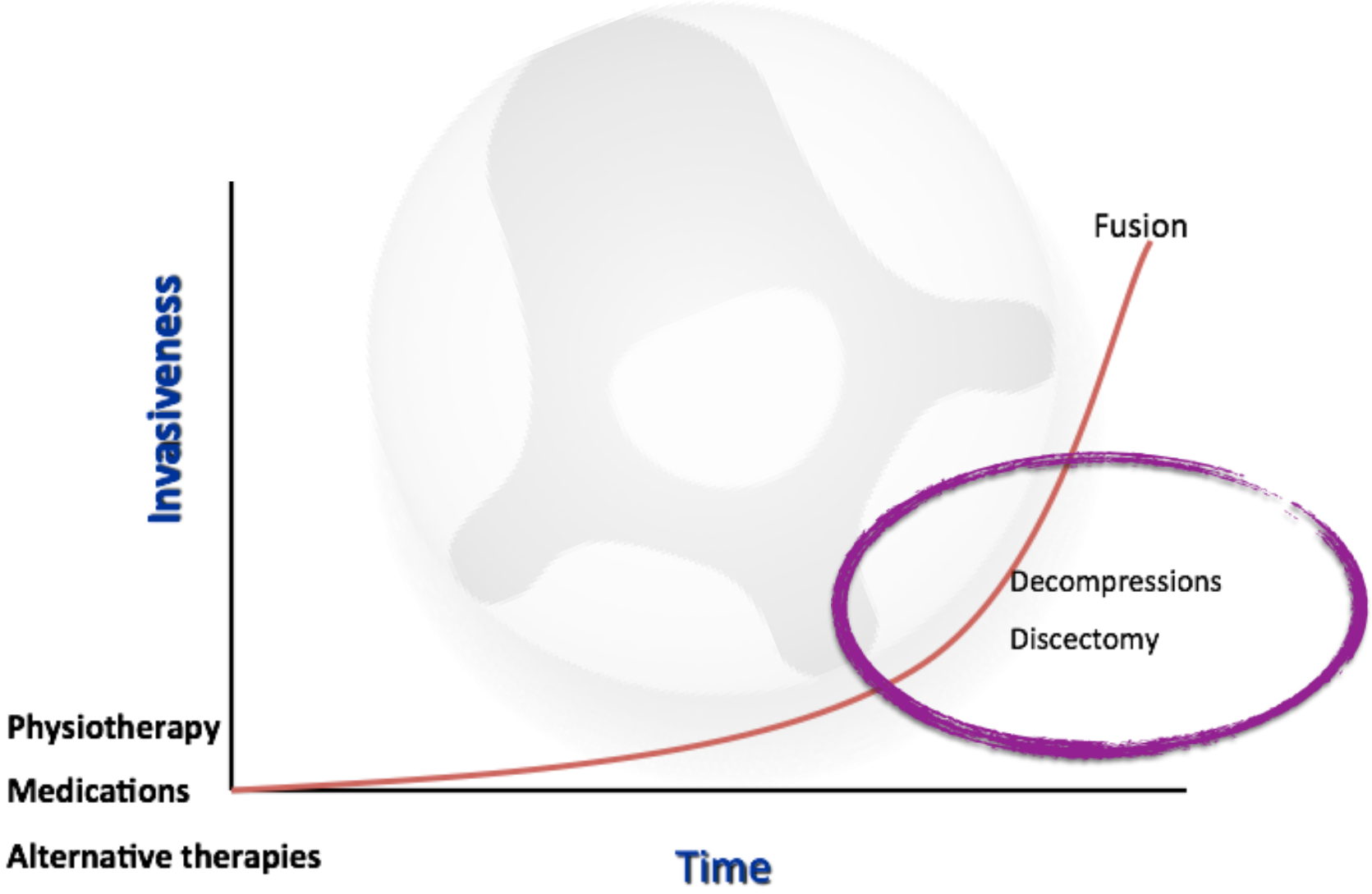
Nerve root blocks
Epidural injections







Treatment options



Surgical interventions

Surgery and prognostic factors

1.3.7 Do not allow a person's BMI, smoking status or psychological distress to influence the decision to refer them for a surgical opinion for sciatica.

Spinal decompression

1.3.8 Consider spinal decompression for people with sciatica when non-surgical treatment has not improved pain or function and their radiological findings are consistent with sciatic symptoms.

Spinal fusion

1.3.9 Do not offer spinal fusion for people with low back pain unless as part of a randomised controlled trial.

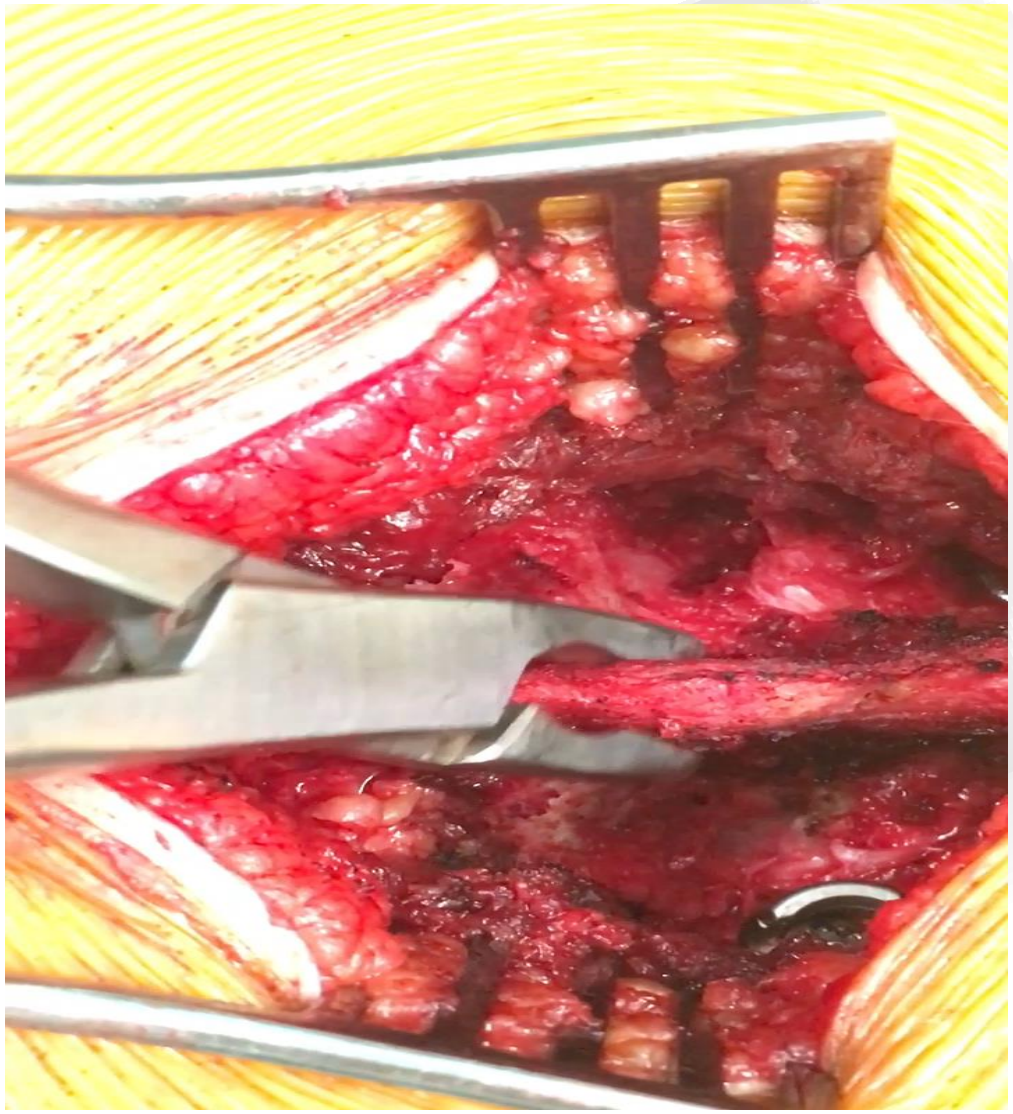
Disc replacement

1.3.10 Do not offer disc replacement in people with low back pain.

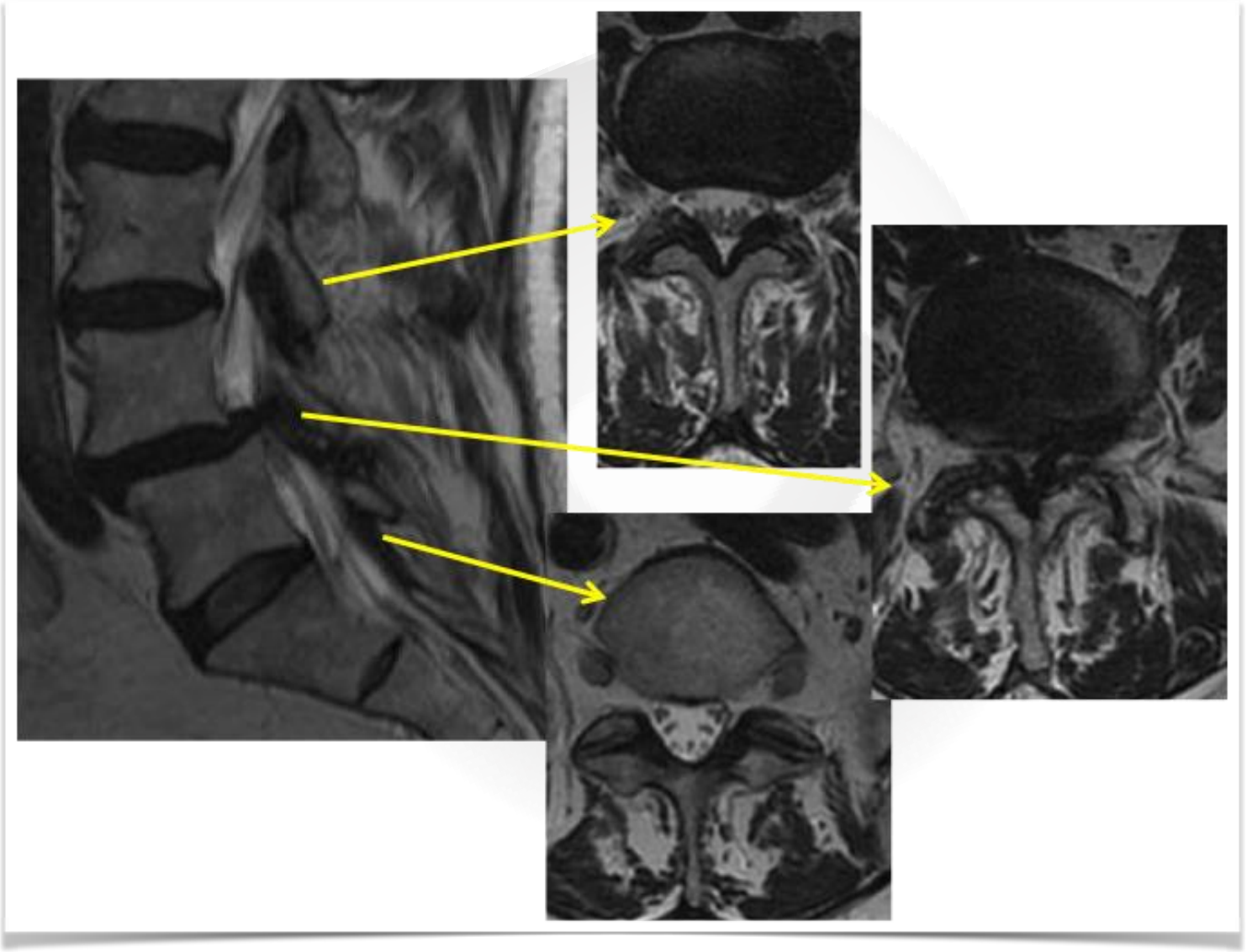
Lumbar canal stenosis

- Narrowing of the spinal canal
- Neural compression
- Directional compression
- Constitutional shape
- Claudication
- Instability

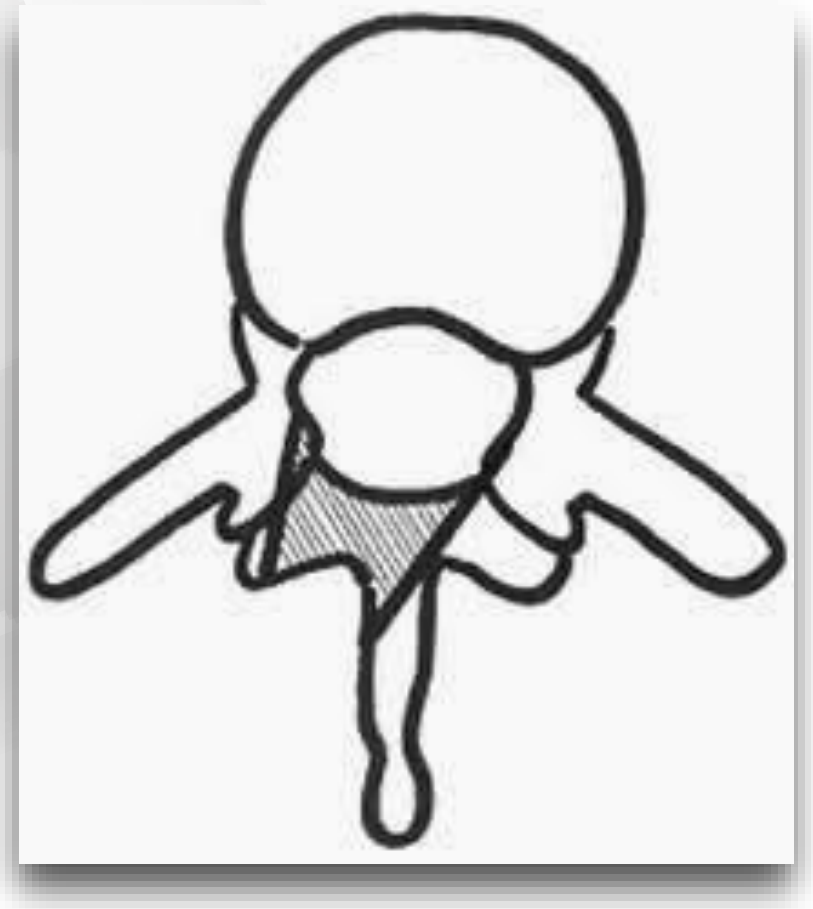
Spondylolysis

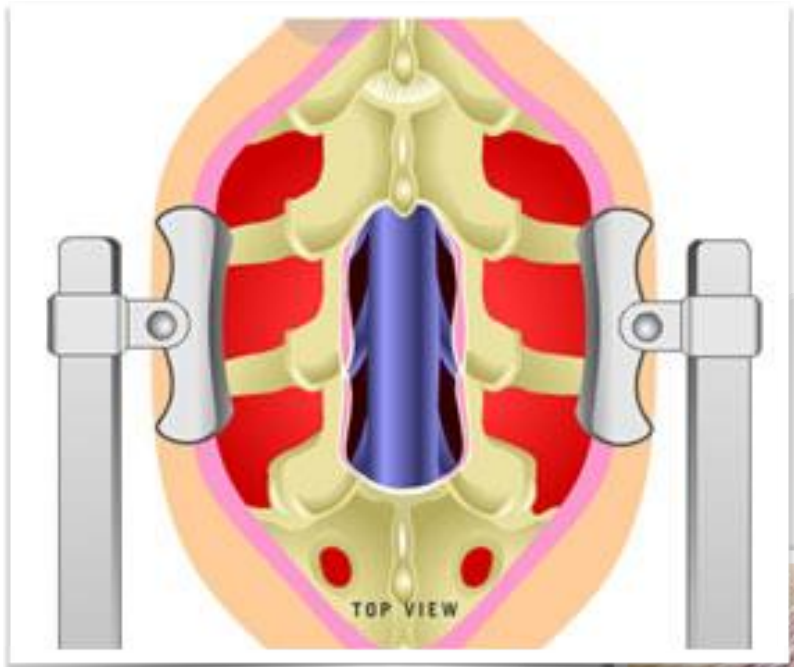


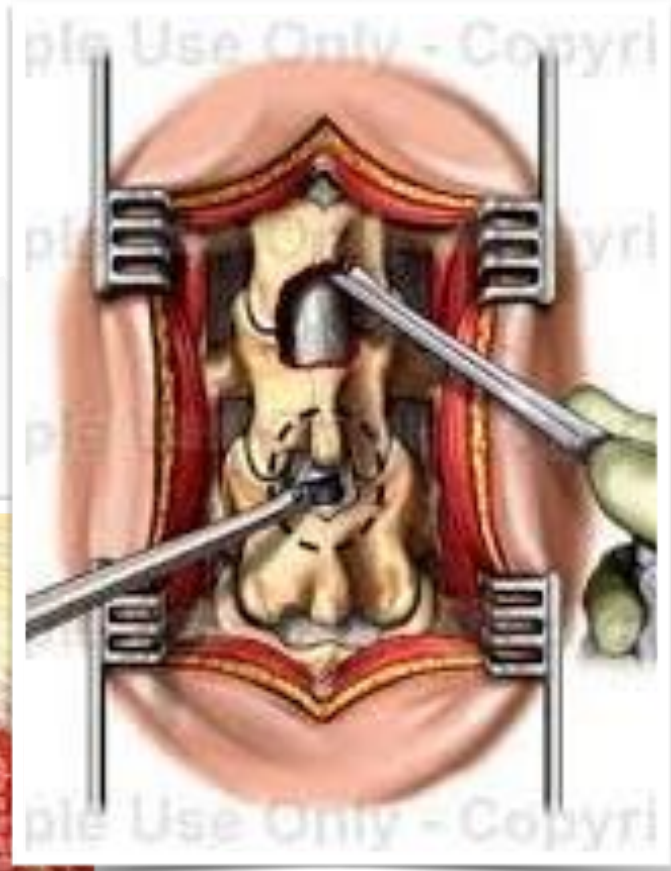
Degenerate spondylolisthesis



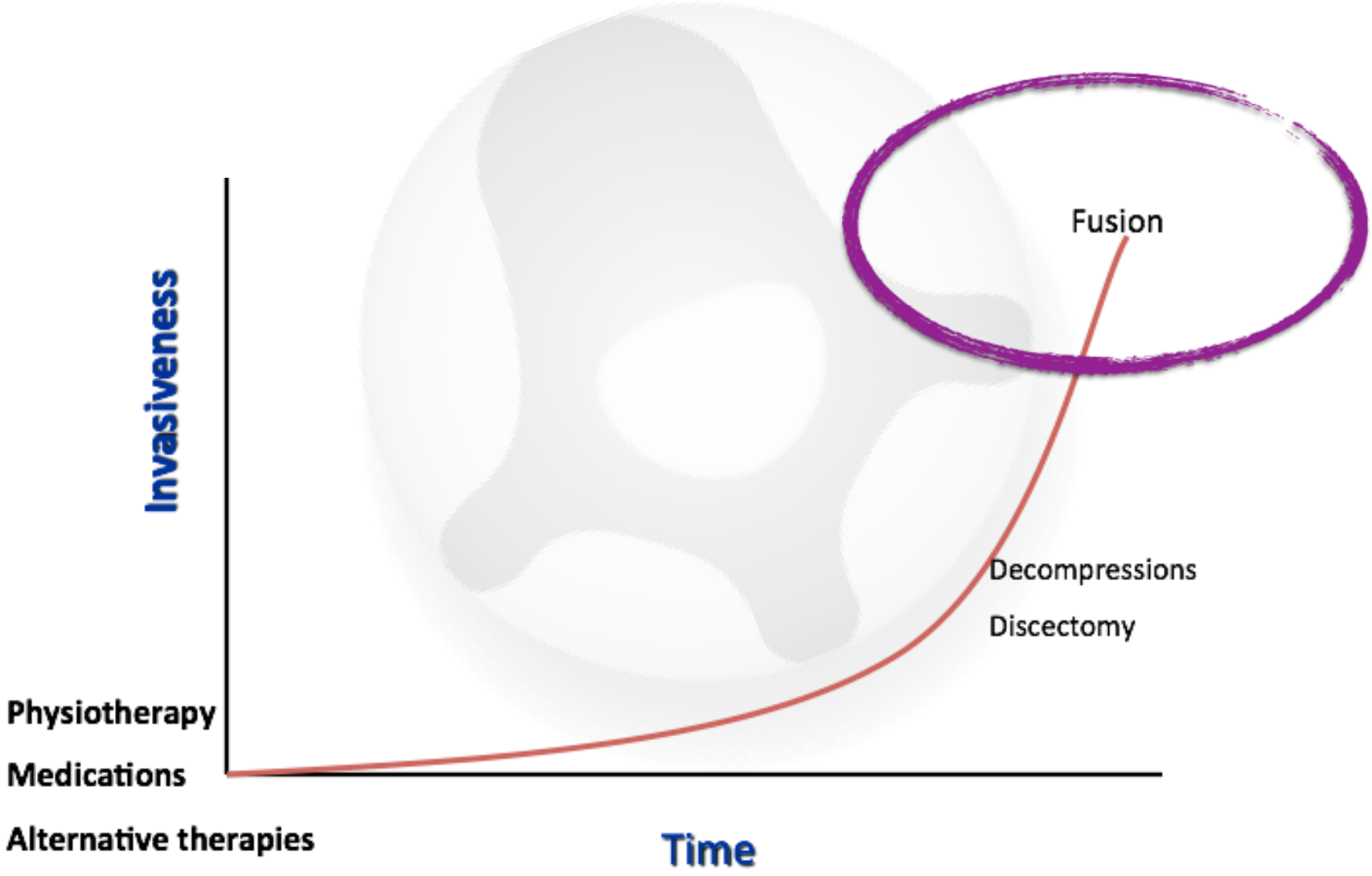
Lumbar decompression



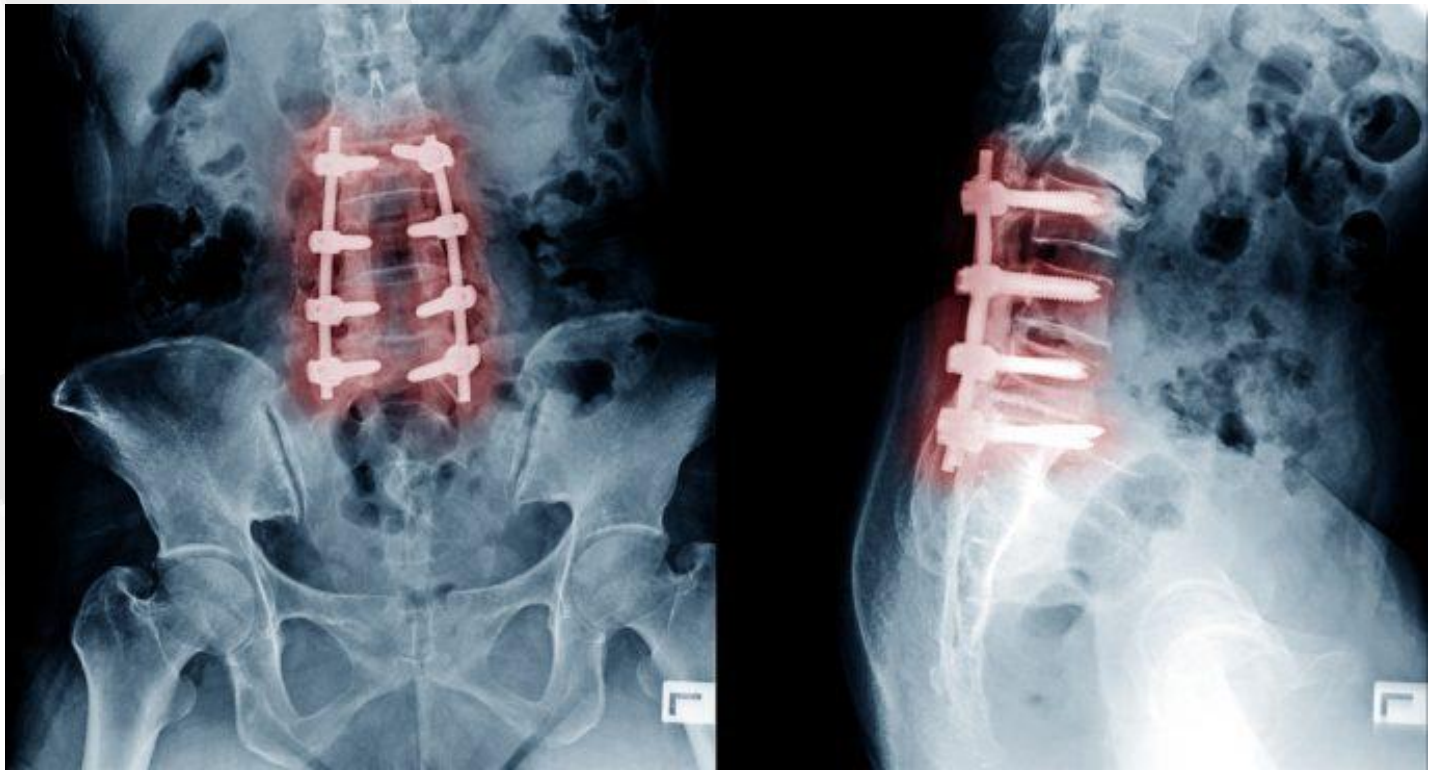




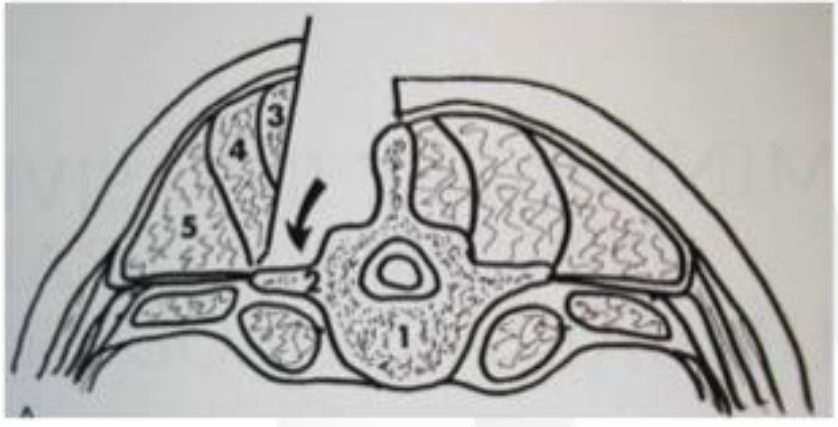
Treatment options

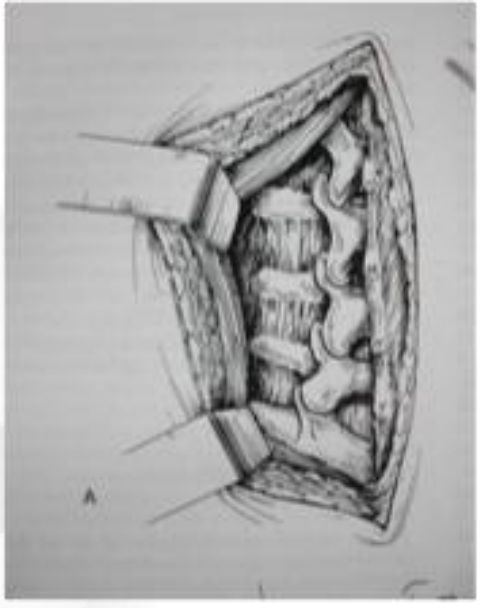


Instability

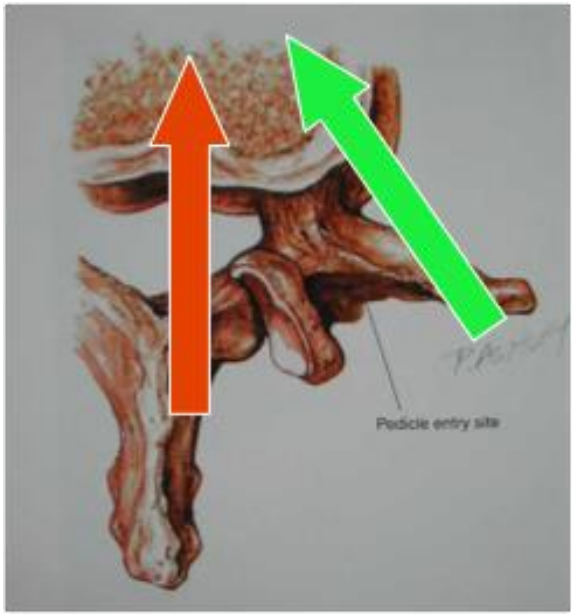


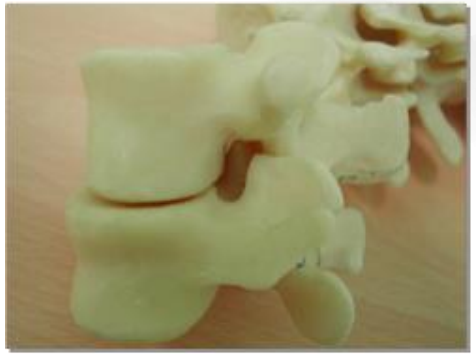
Postero-lateral fusion





Inter-body fusion





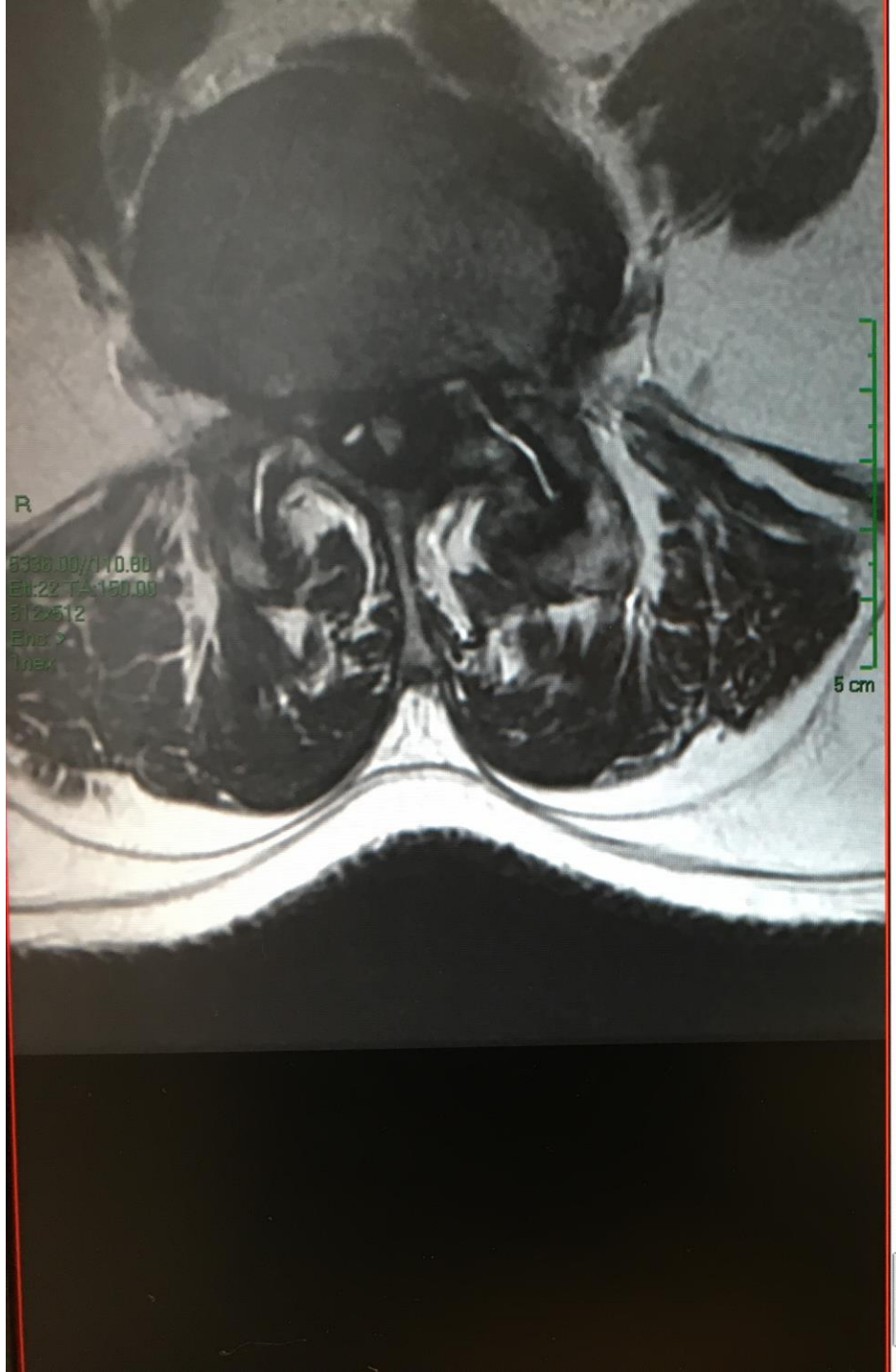
ALIF

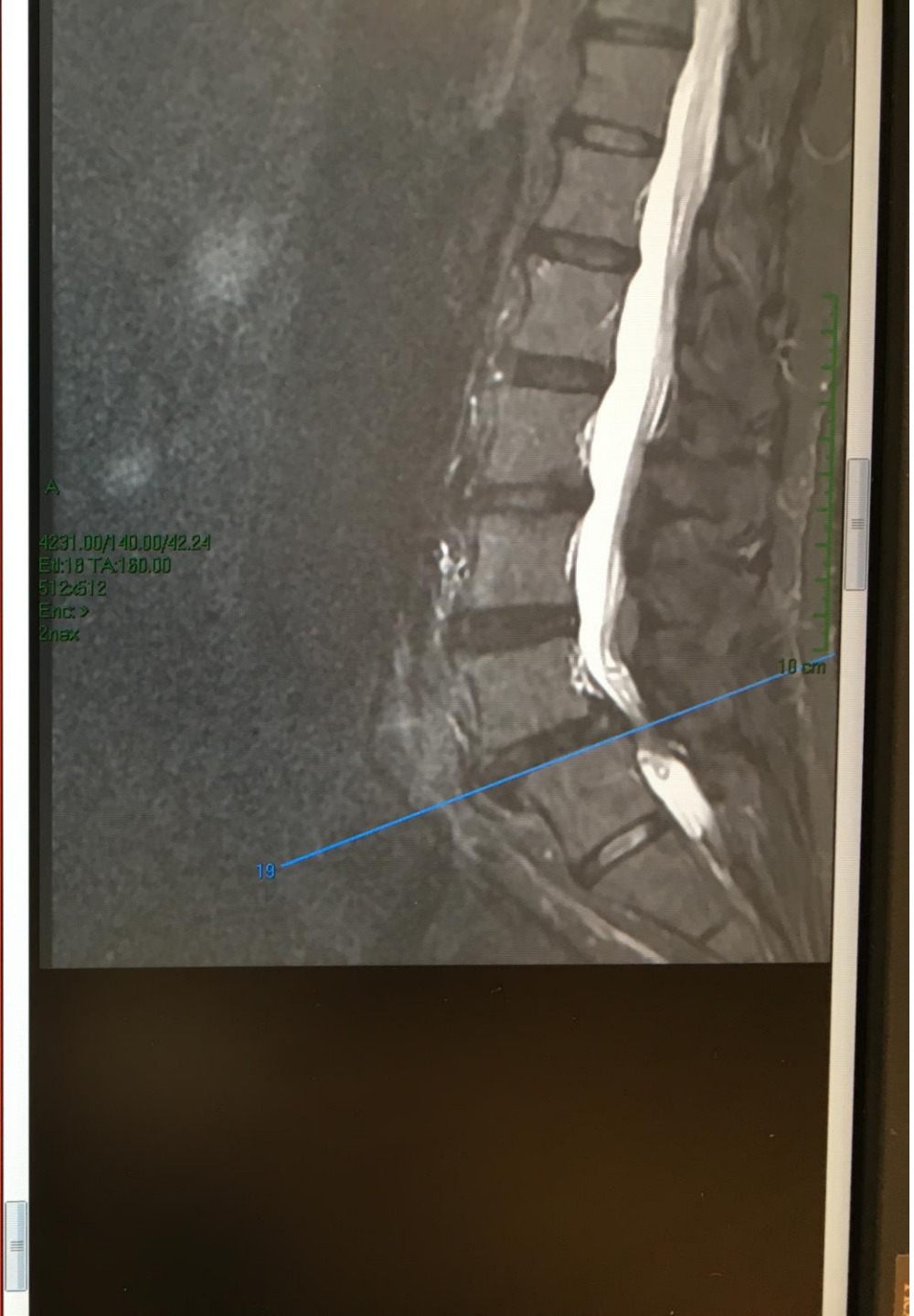
PLIF

TLIF

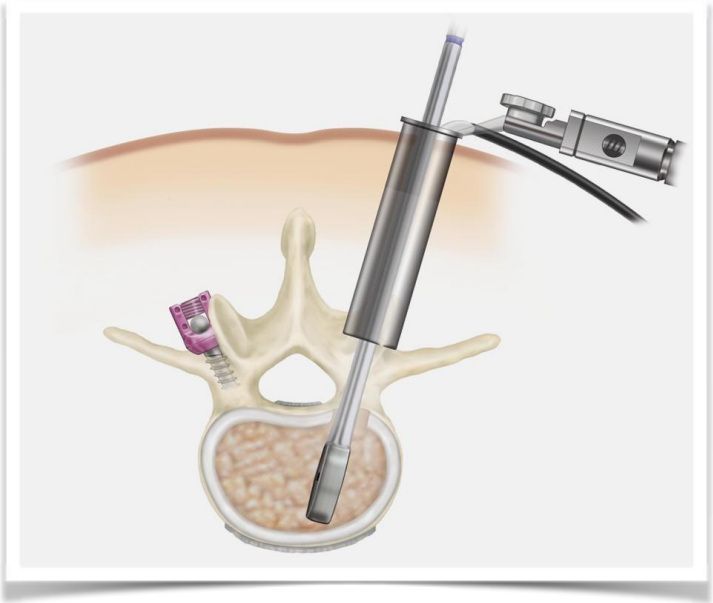
XLIF

DLIF

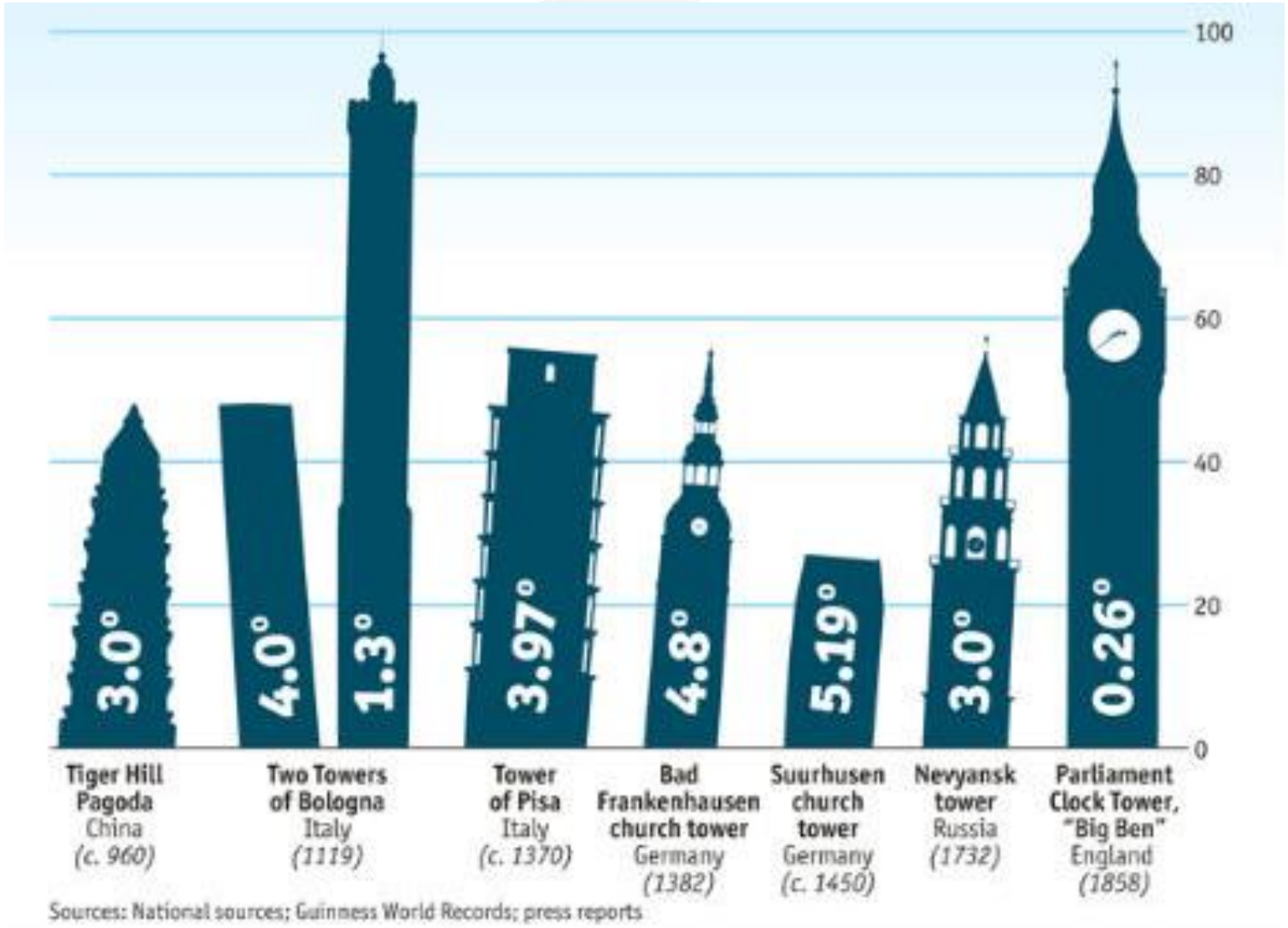

R
5 cm


A
10 cm
19

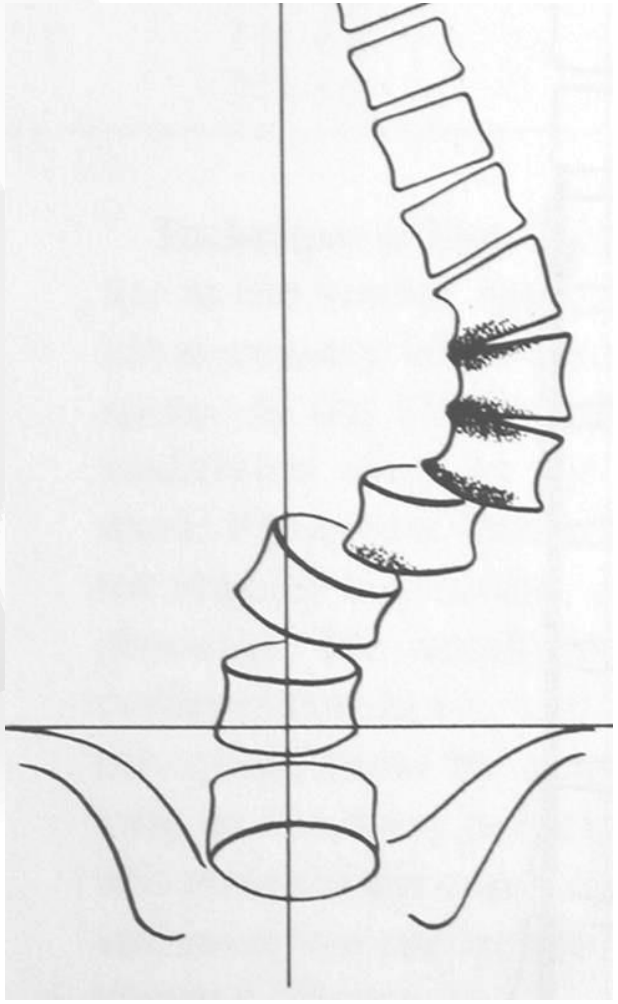
Minimally invasive surgery



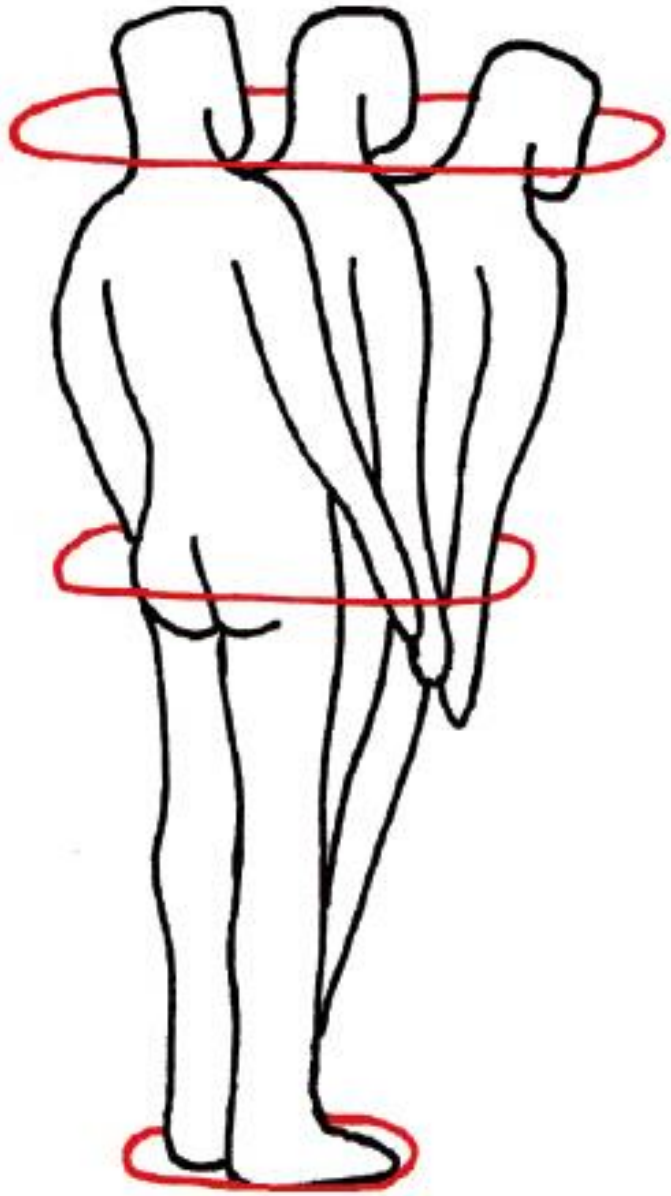
Spinal column failure



The coronal plane deformity



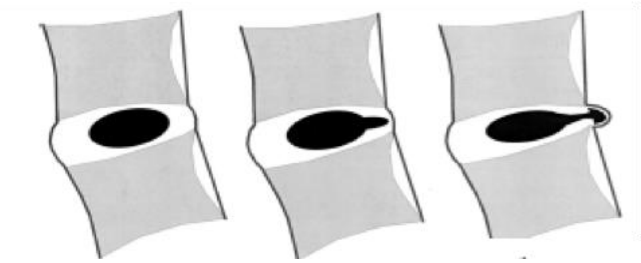
Cone of economy

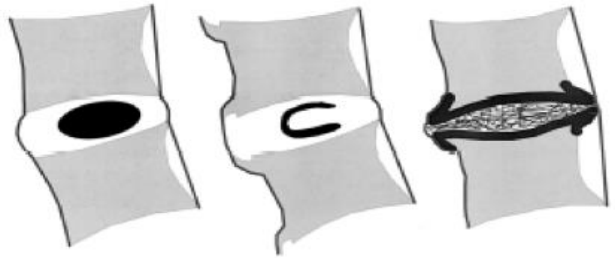


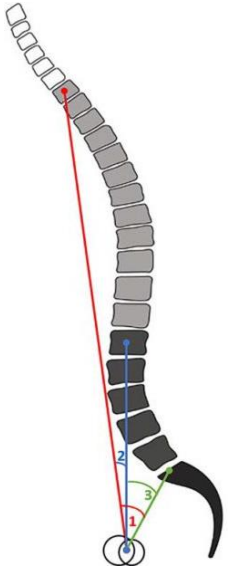
Prof Jean. Dubousset

The sagittal plane deformity

The degenerative cascade





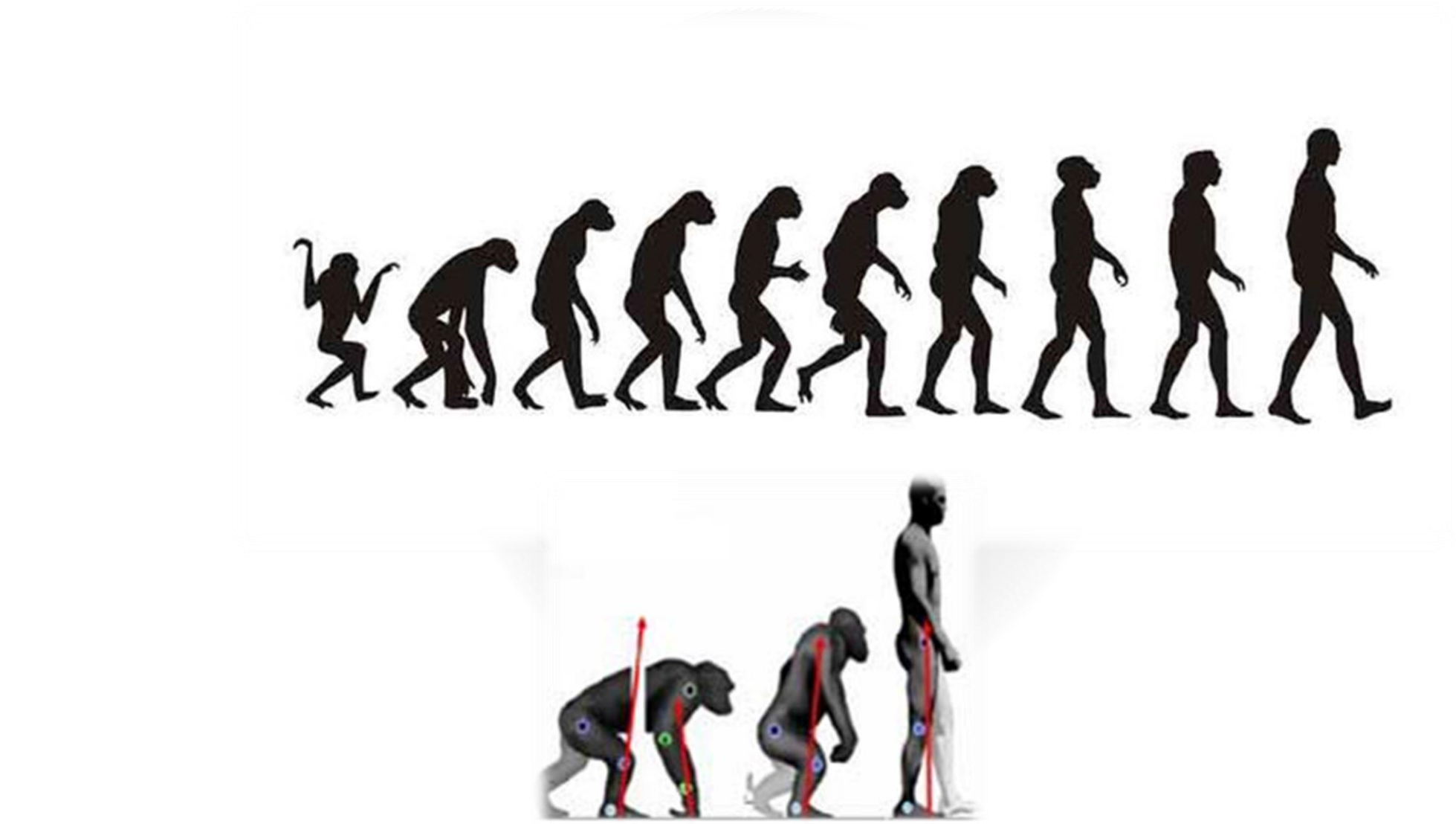


The ‘Radiculopathy’ pathway

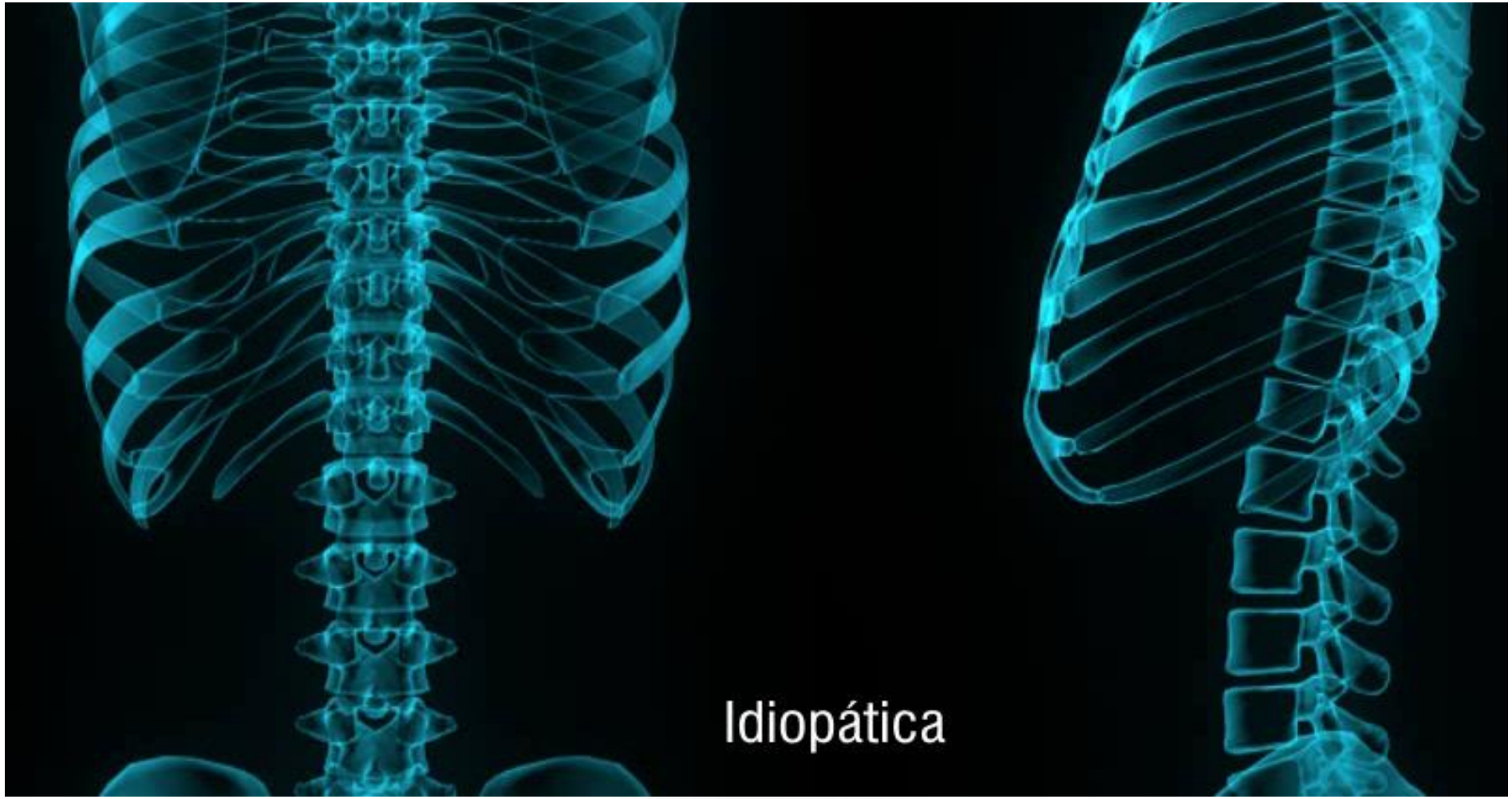
The ‘Degeneration’ pathway

The ‘Deformity’ pathway

Evolution of the Lumbar Lordosis



Life is a kyphosing event

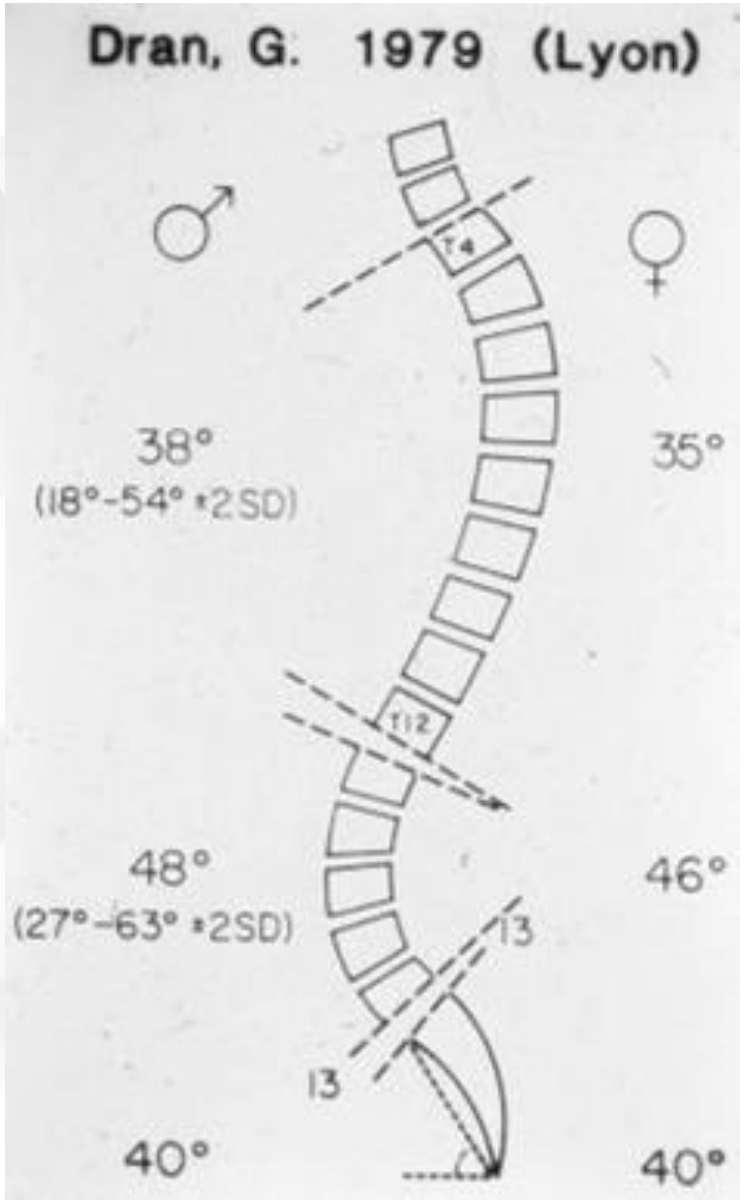

Idiopática

Thoracic kyphosis:

38° ± 18

Lumbar lordosis:

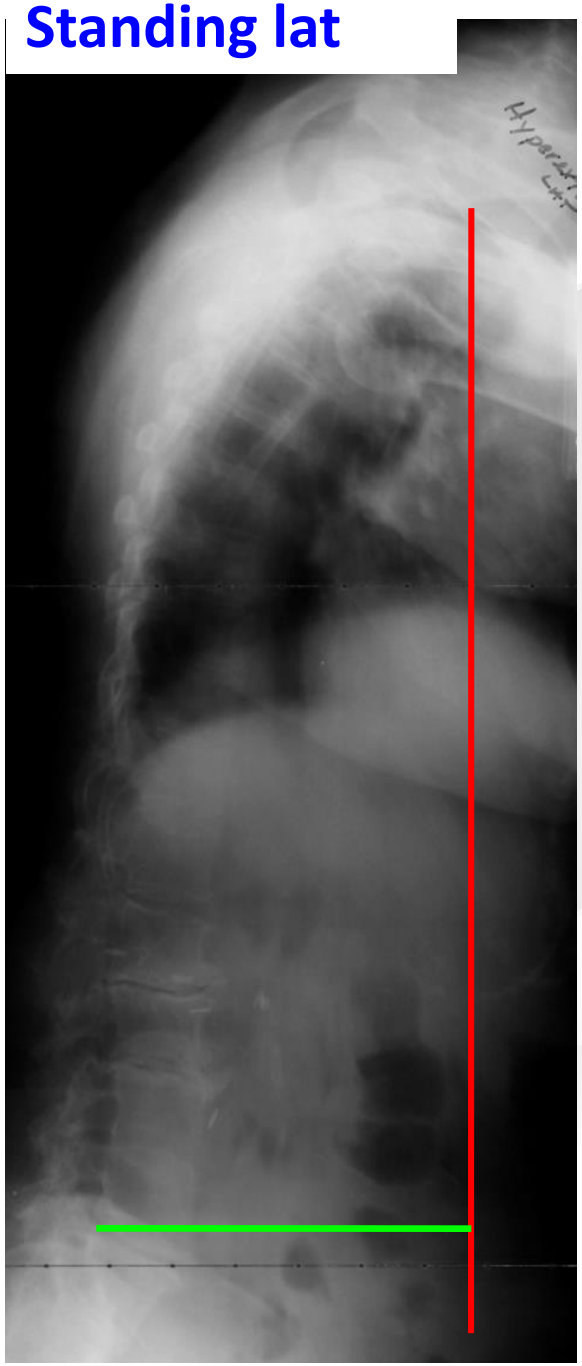
48° ± 18



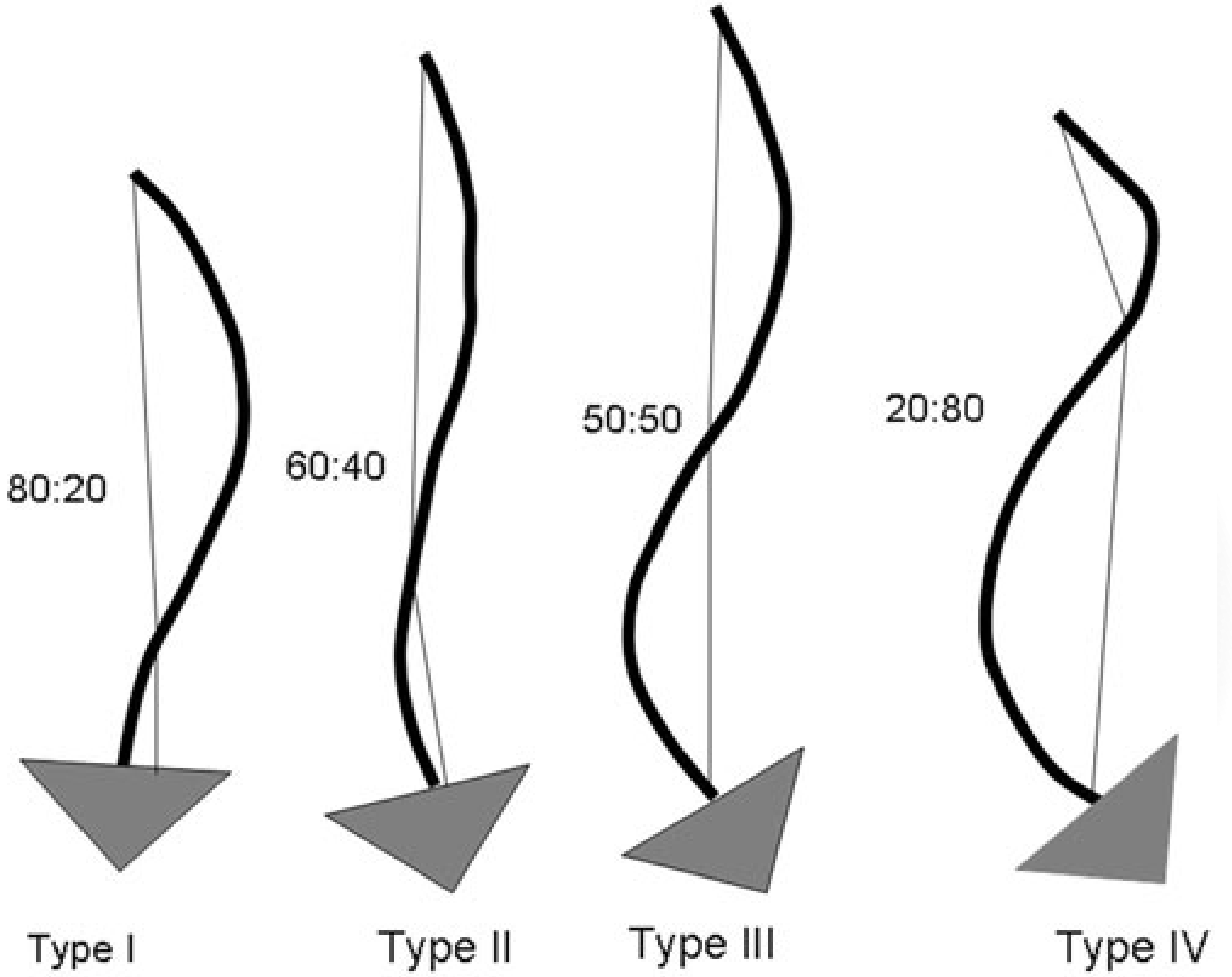

T1 offset
L1 offset
SACRAL TRANSLATION
SAGITTAL VERTICAL AXIS
C7 PLUMB LINE

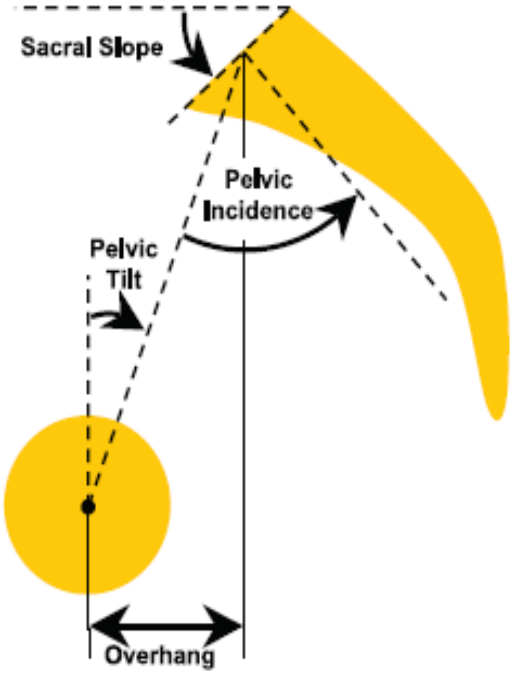

15 9:45AM

Standing lat



Hyperext lat

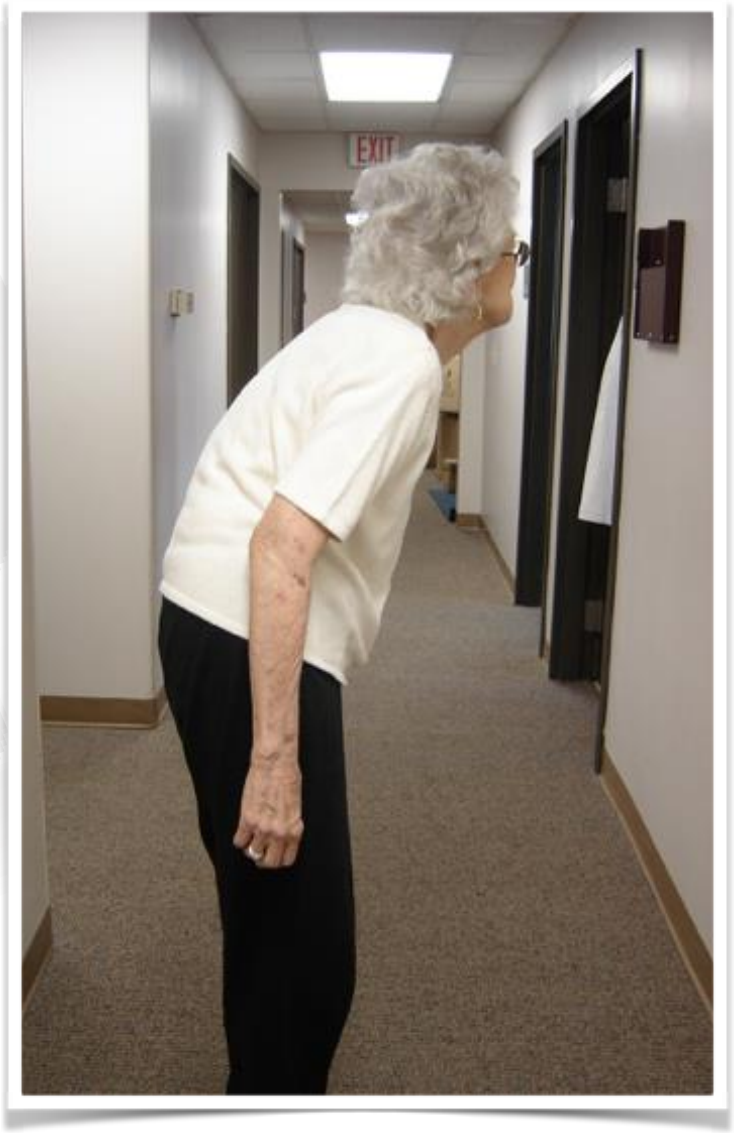




Roussouly Spine 30 (3): 346 - 353

Degenerate deformity

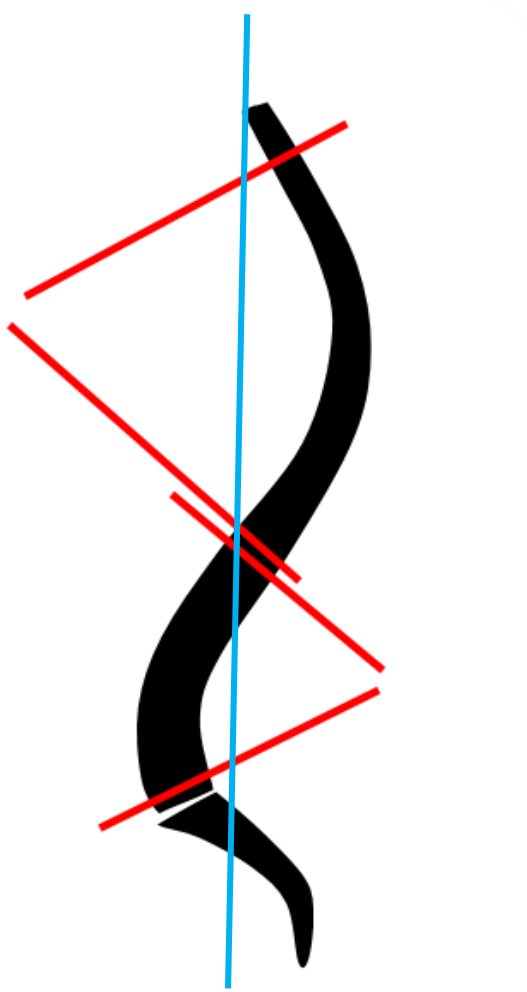
- Loss of ability to stand upright
- Mechanical dis-advantage
- Asymmetric degeneration
- Spinal column ‘collapse’

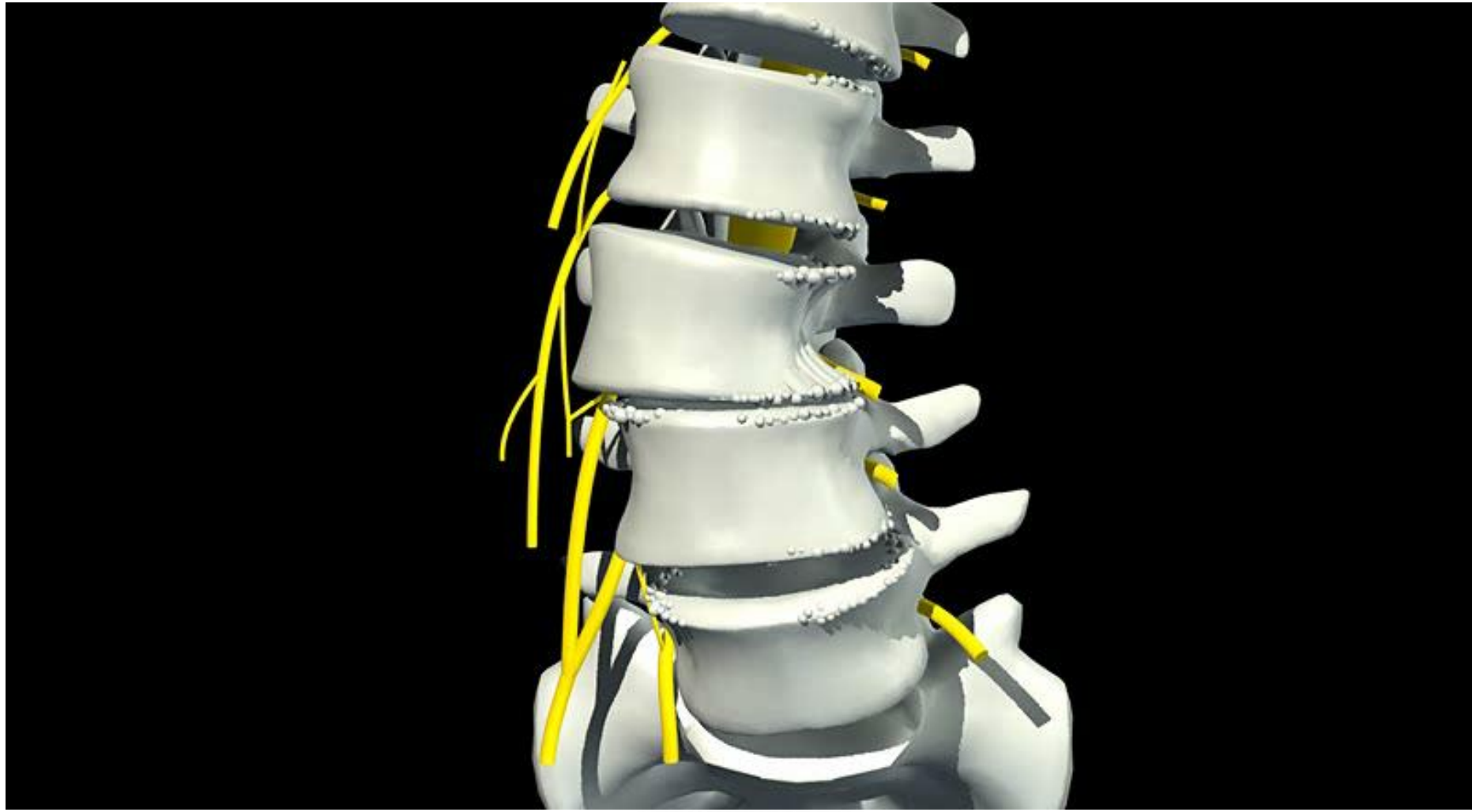


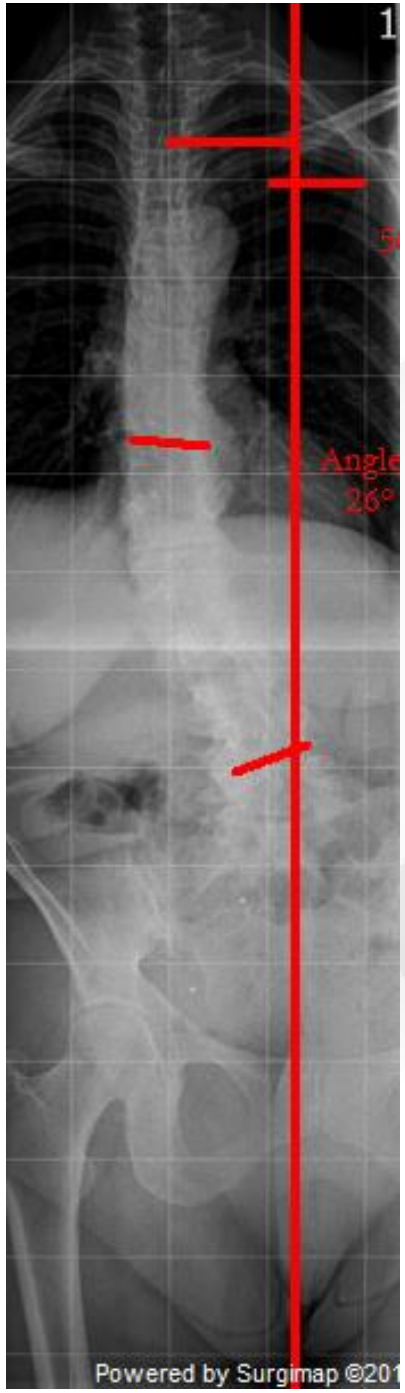

[H]
[F]

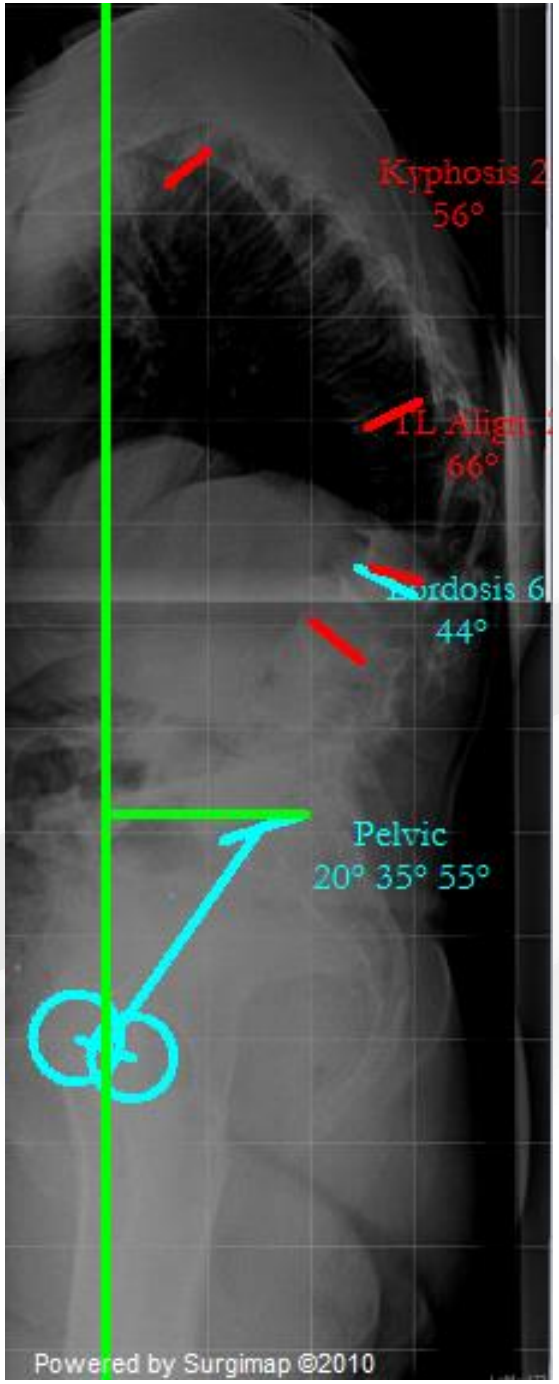
Aims of intervention

- Restore the lordosis
- Restore the plumb line
- Restore the ‘curves’









59 / F

AP Cobb 26°

CSL 7 cm

Pelvic:

PI 55°

SS 20°

PT 35°

LL 44°

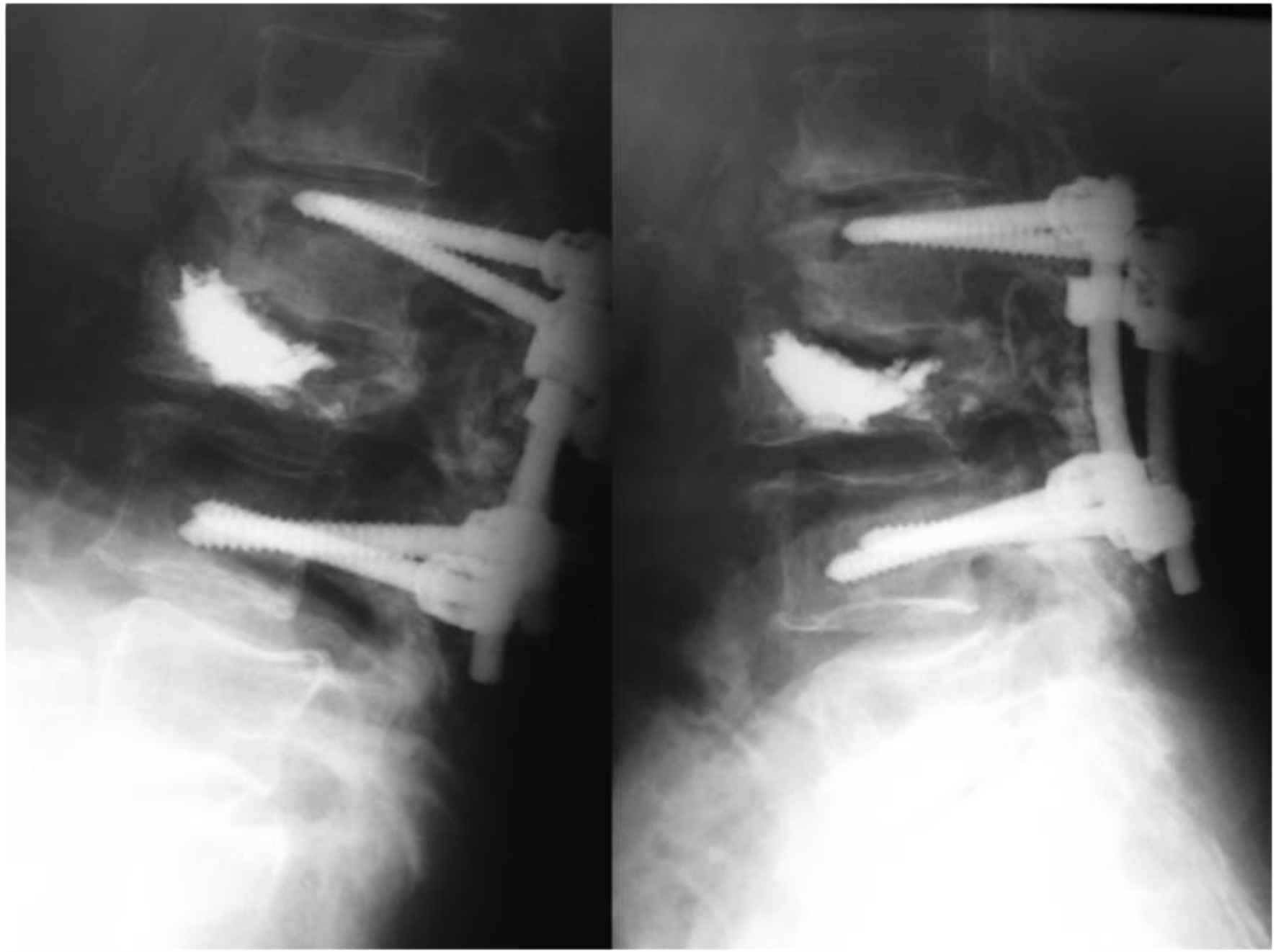
TL 66°

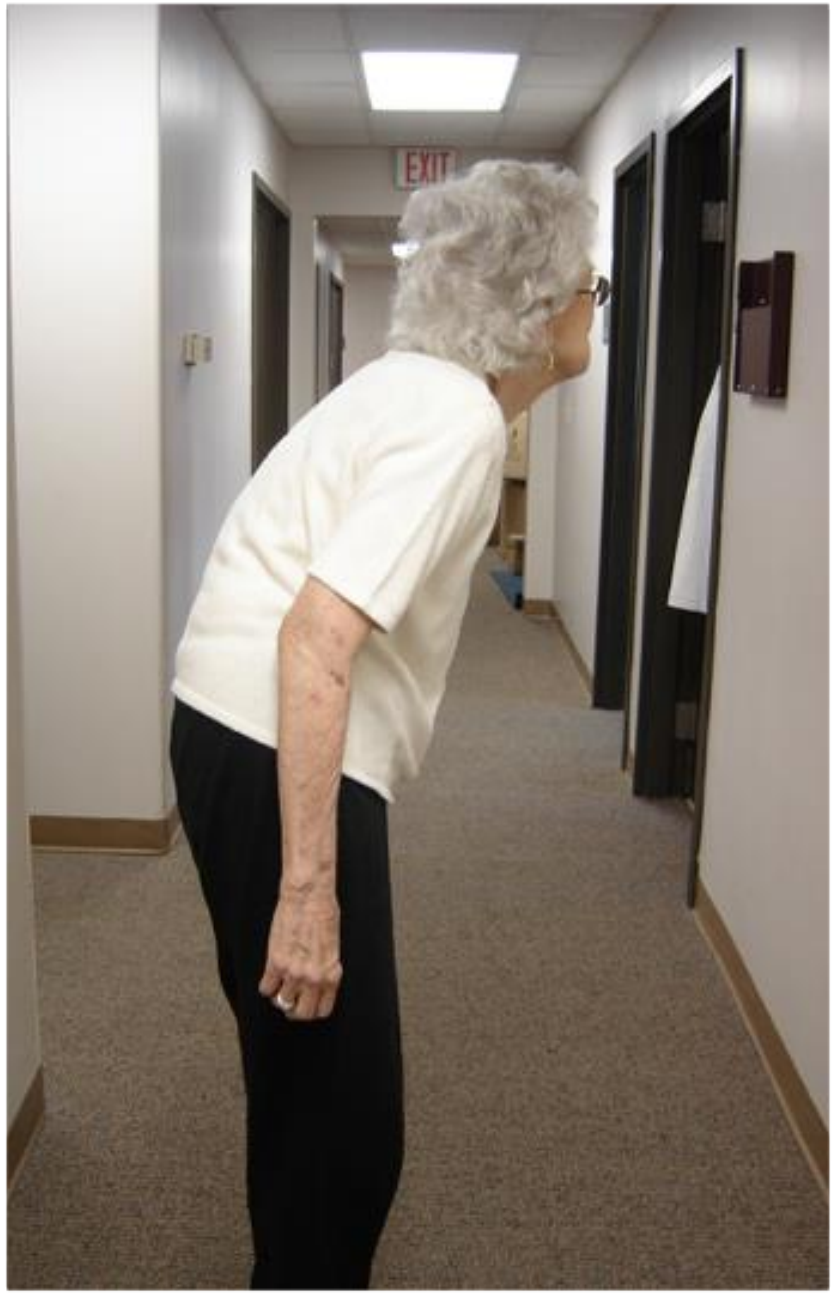
TK 56°

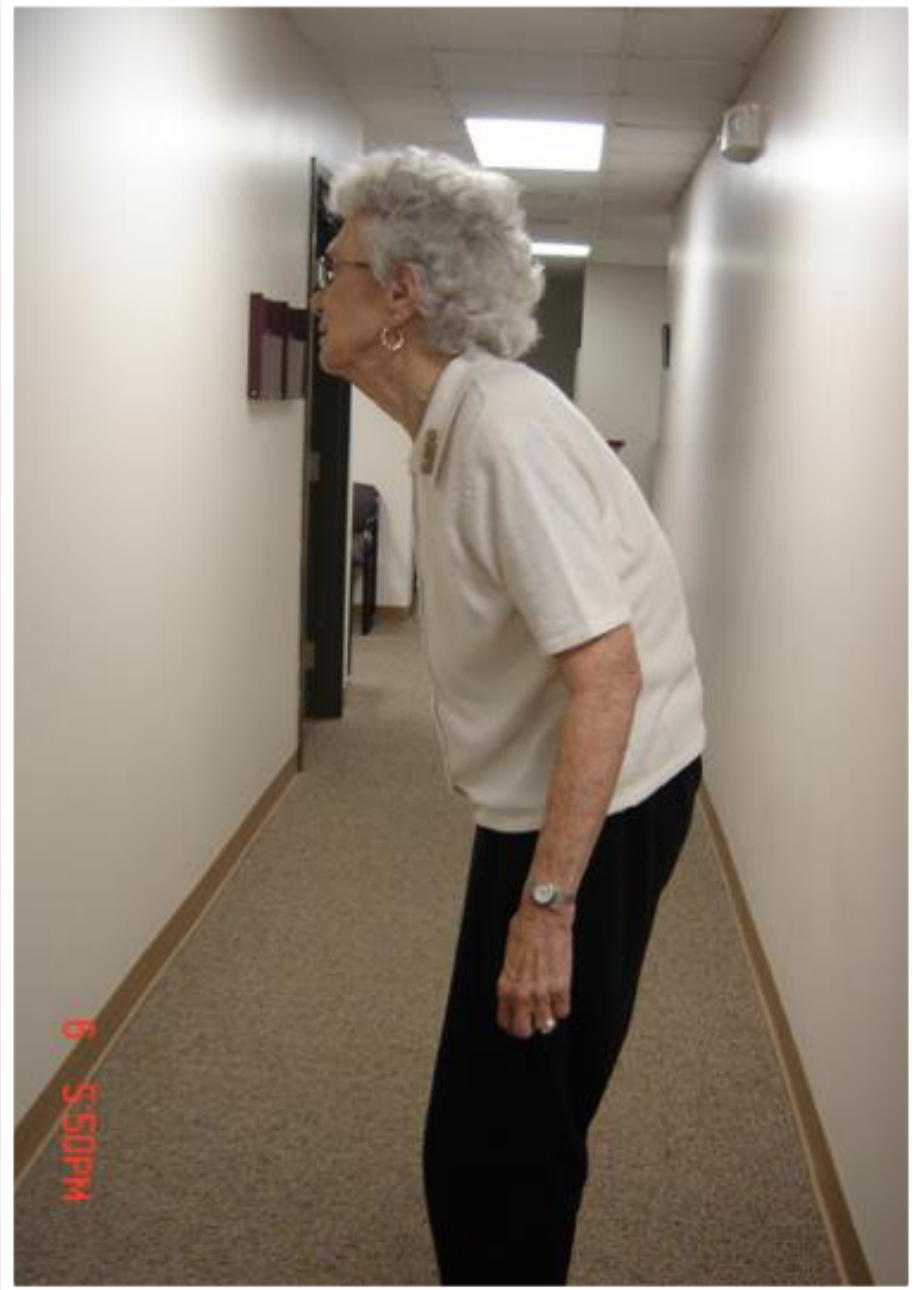
SVA 11 cm

Creation of lordosis

- Excise facet joints
- ‘Open’ degenerate disc spaces
- Osteotomies
- Measure the PI, and build in the lordosis




EXIT


6 5:50PM


COLUMBIA REGIONAL HO
15
Spin -90
Tilt -2

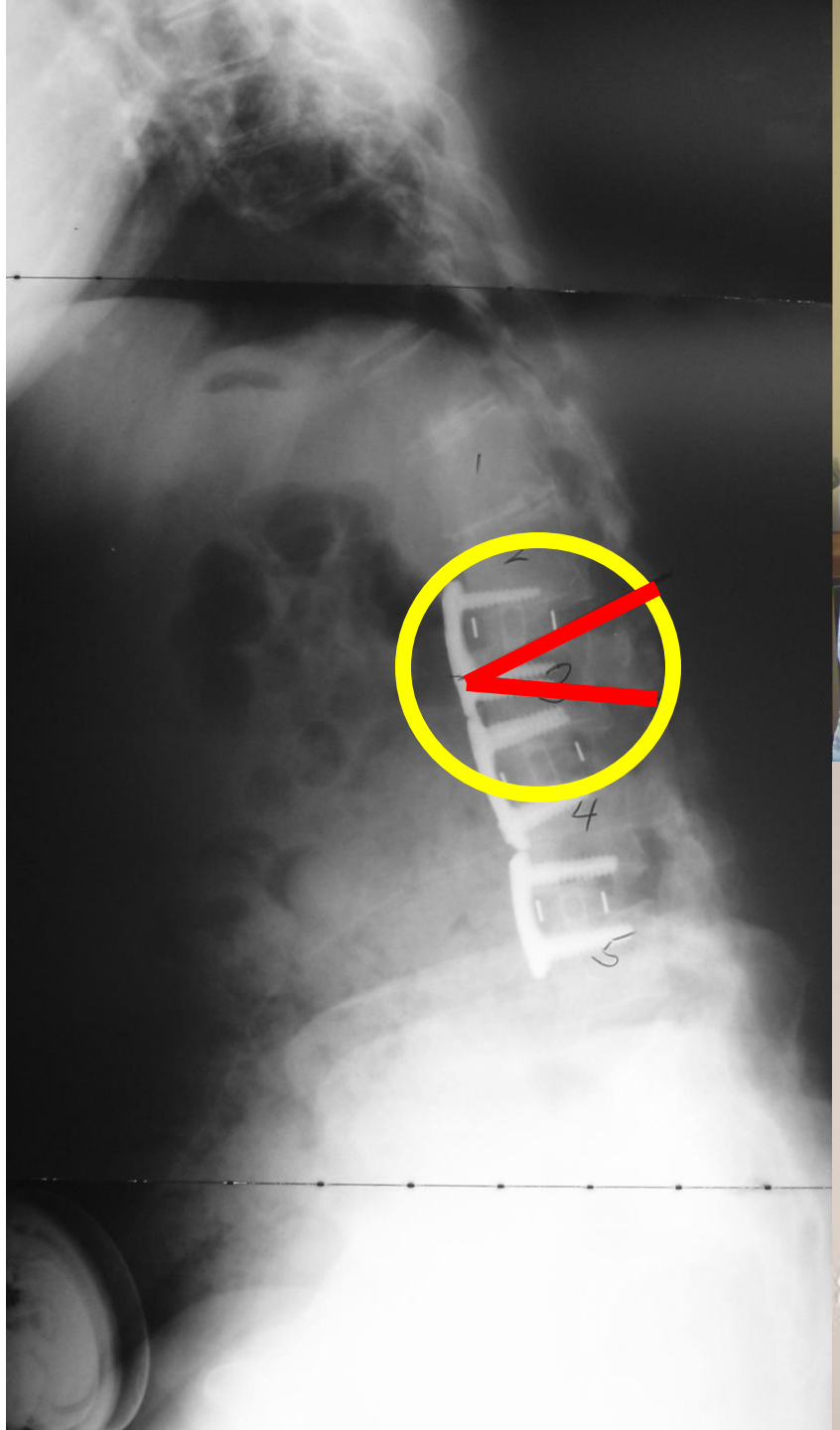

18 1:54PM


ERECT
AP


Spin. -0
Tilt. 0
A

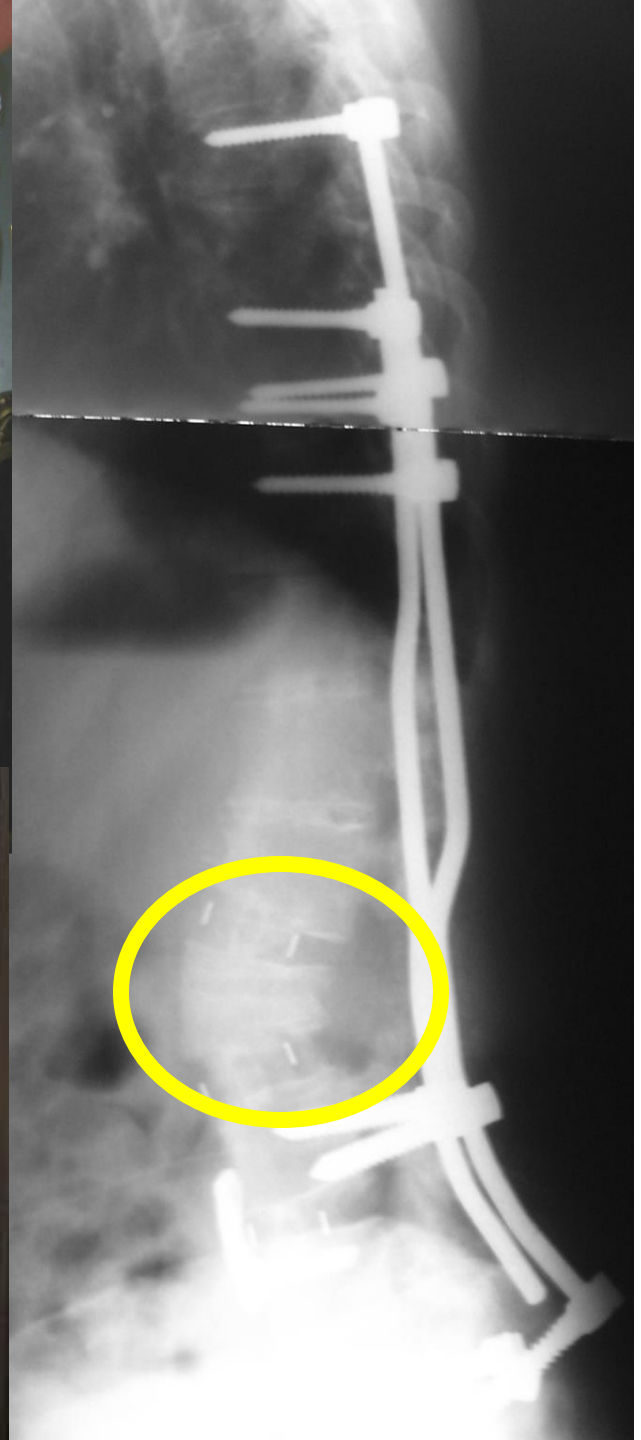

PA
WT BEARING


LATERAL
ERECT




PRE


POST



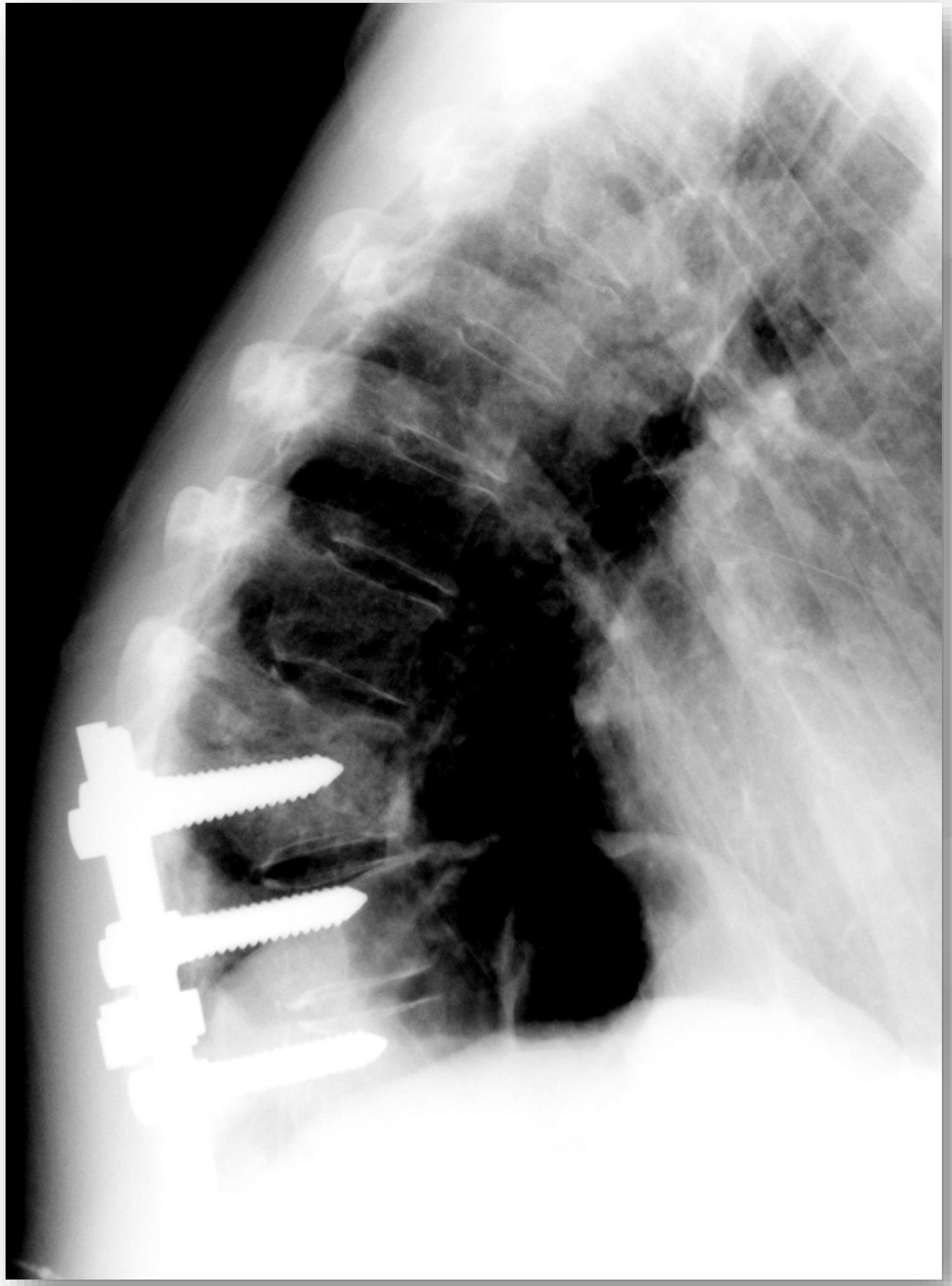
Surgical reconstruction: Adult Spinal Deformity

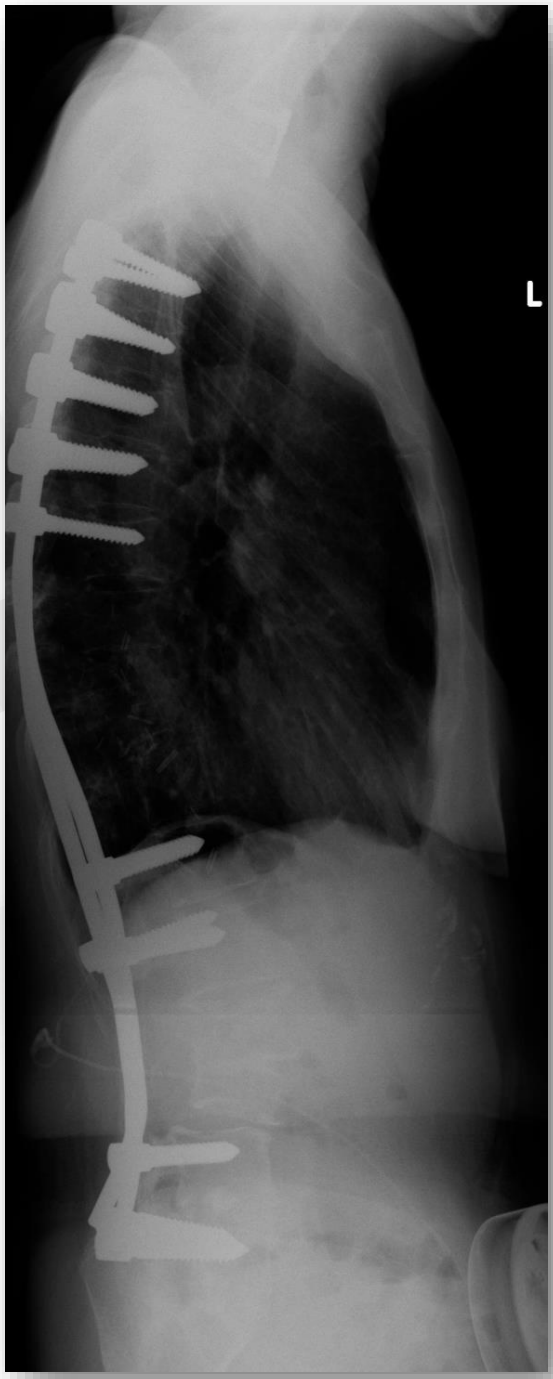
- Major operation
- Preop risk stratification
- 2 spinal surgeons
- Spinal cord monitoring
- ITU, Rehabilitation

Problems

- Realistic expectations
- Medical co-morbidites
- Osteoporosis
- Junctional problems

- High complication rates
- Medical and technical
- Need careful risk stratification
- Rehabilitation and counselling

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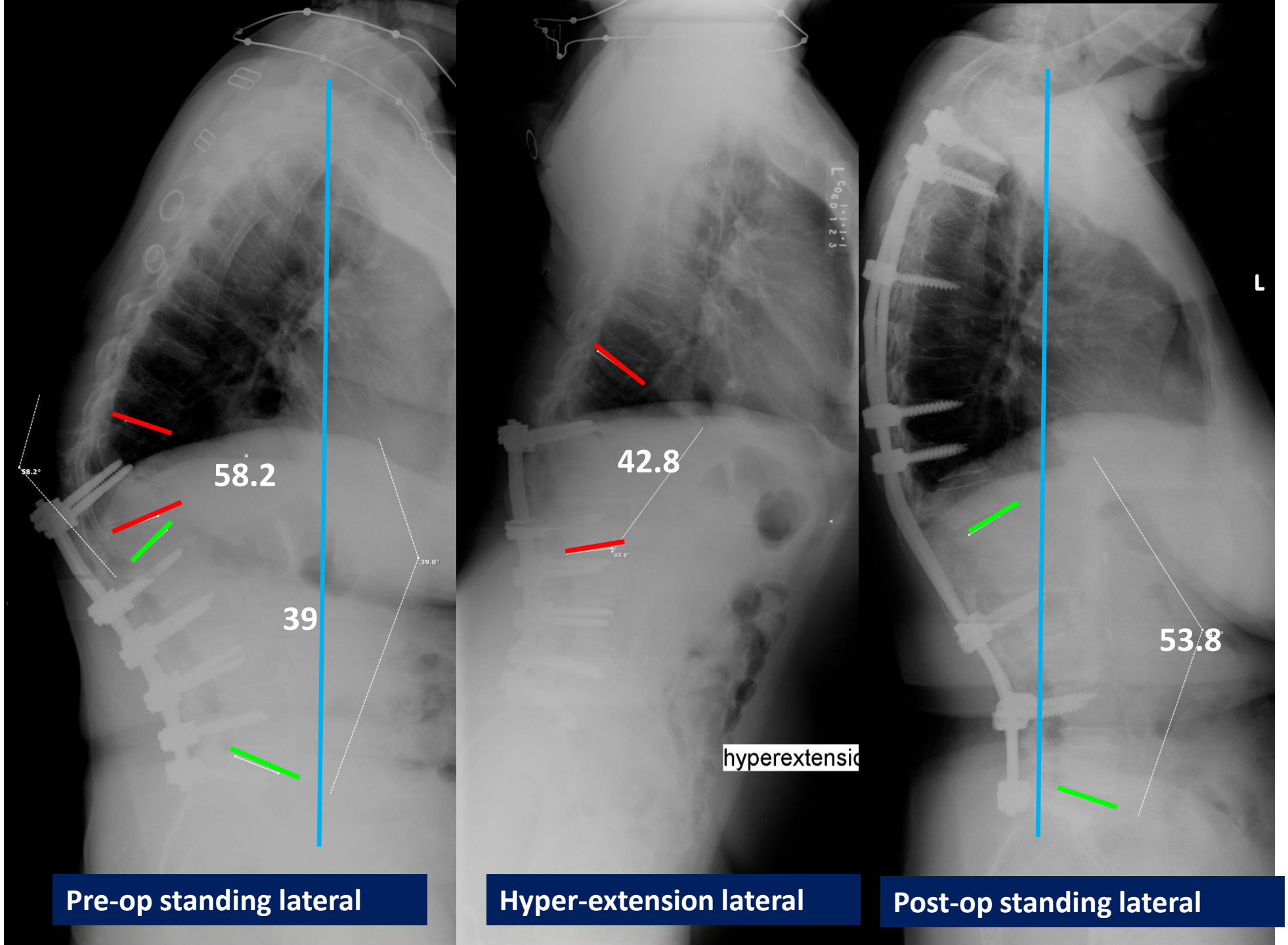
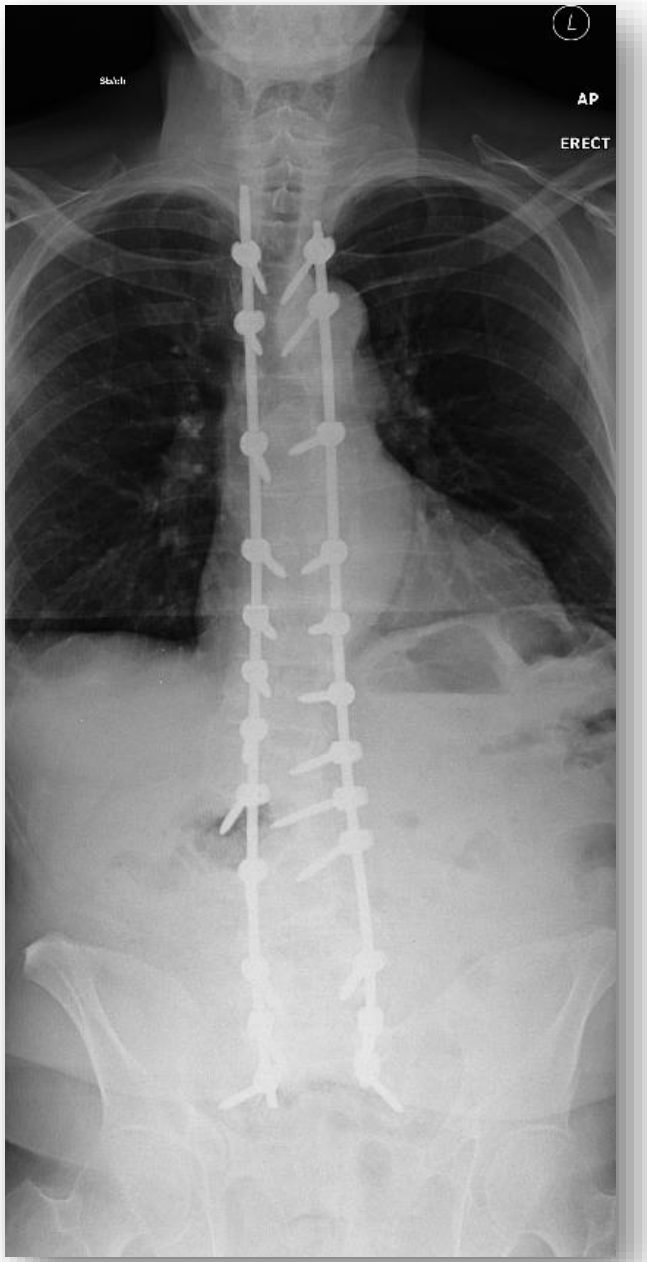
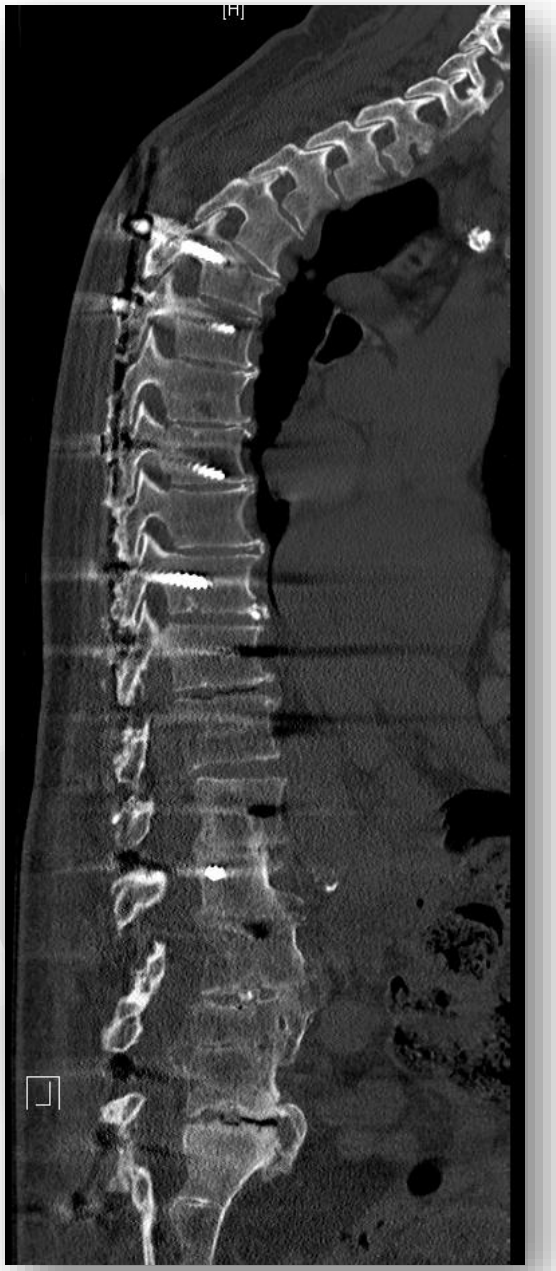

58.2
39
42.8
hyperextensio
L
53.8
Pre-op standing lateral
Hyper-extension lateral
Post-op standing lateral


AP
ERECT


WT BEARING







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R
PA ERECT
T


<FlipH=NO><Rotate=0°>
R
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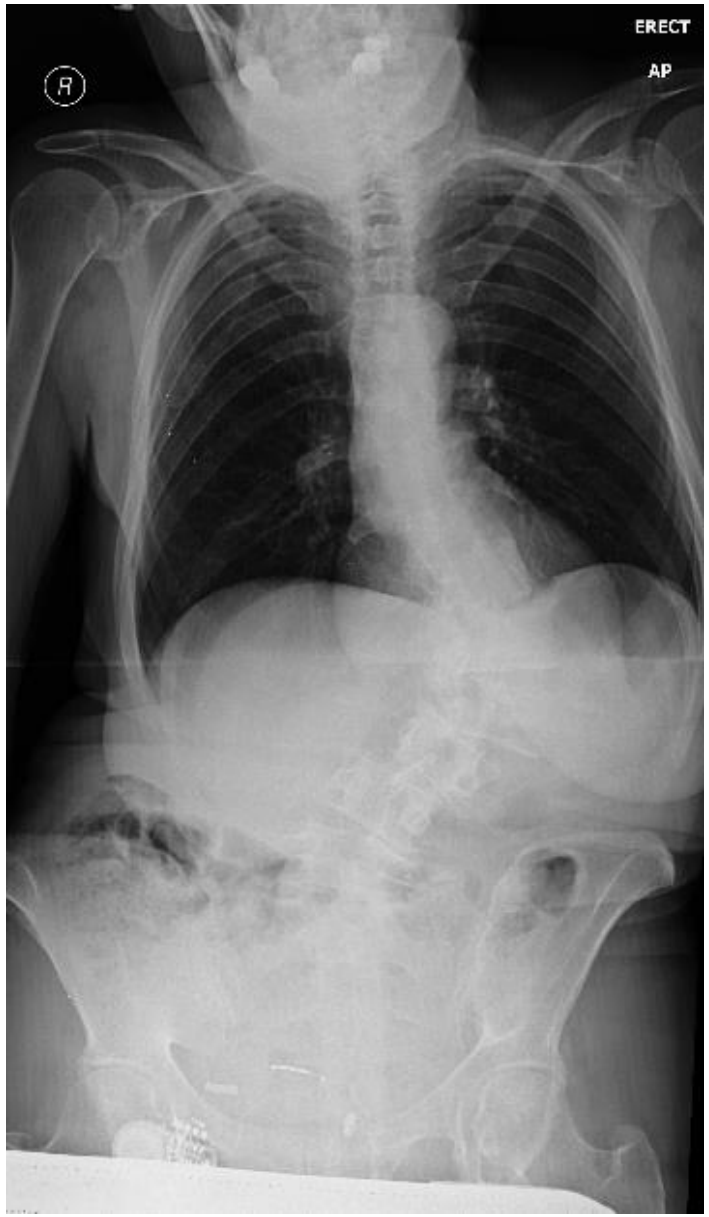
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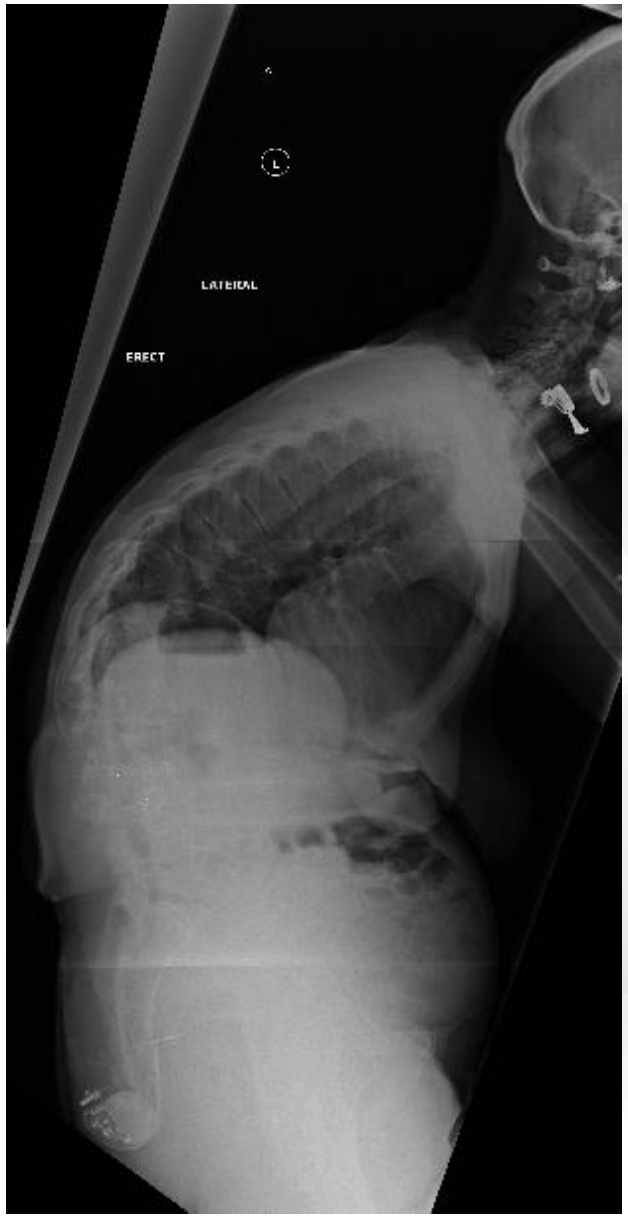

L
LATERAL
ERECT


R
L
PA
ERECT


R
ERECT

When to refer

Back pain: Degenerative pathway

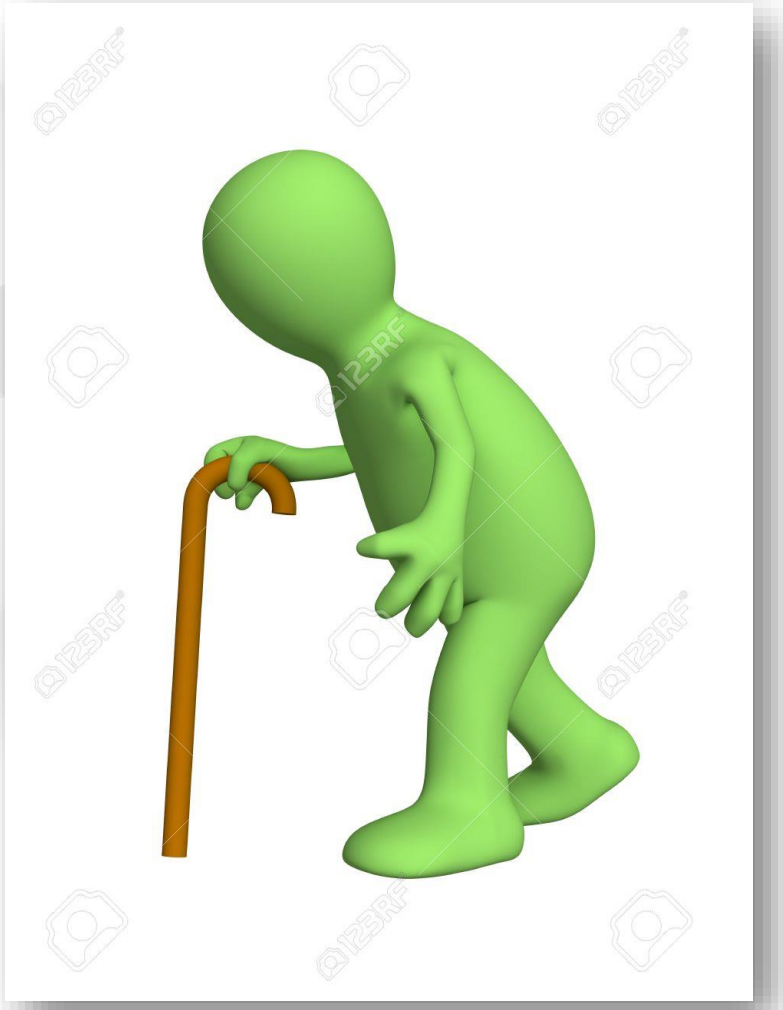
- Intrusive, non-resolution with simple measures
- Review of ‘flags’

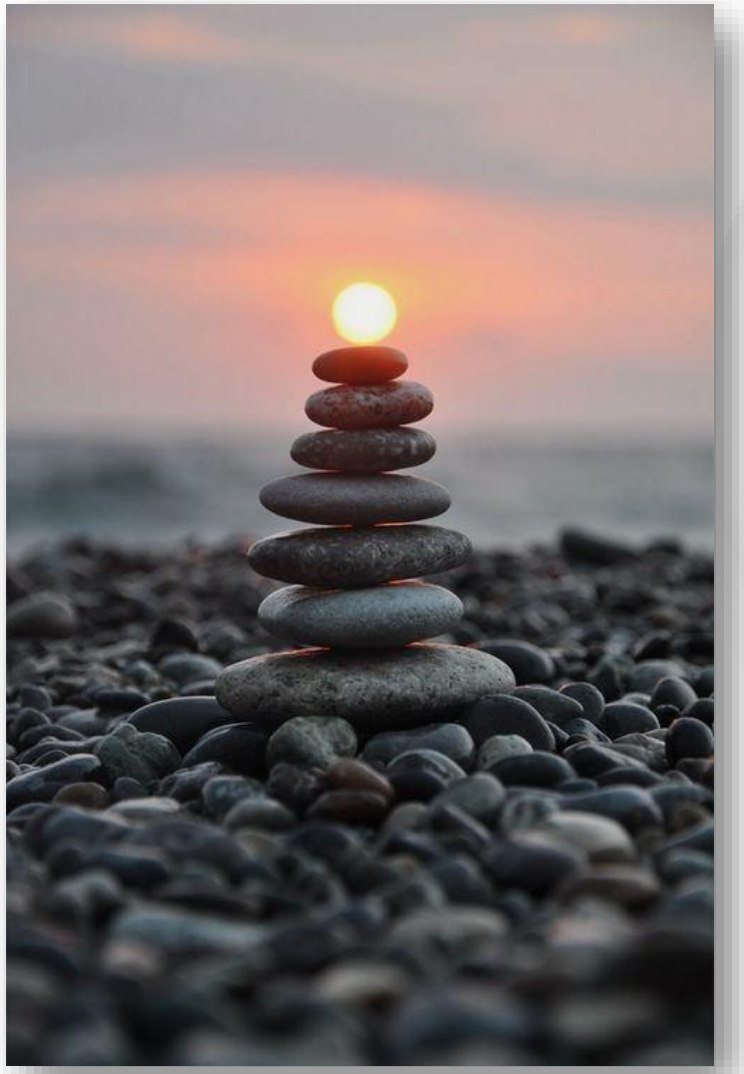
Leg pain: Prolapse / stenosis

- > 6 weeks
- Neurolgy
- Multiple / frequent exaccerbactions

Column failure: Deformity pathway

- Loss of horizontal gaze
- Stooping
- Muscle fatigue pain





- Not everyone needs an operation
- Understanding expectations
- Tailor management to NICE
- Review over time

Suggested reference websites

www.NICE.org.uk

www.srs.org

www.sauk.org.uk

www.mehtaspine.com

www.backcare.org.uk

https://bestpractice.bmj.com