Ten (Potentially Overlooked) Spinal Conditions & Their Implications

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Conditions

1. Bertolotti syndrome
2. Klippel-Feil syndrome
3. Scheuermann’s disease
4. Kyphoscoliosis
5. Morbid obesity
6. Narrow spinal canal
7. Diffuse idiopathy skeletal hyperostosis (DISH)
8. Chronic smoking effects
9. Adjacent segment degeneration
10. Isthmic spondylolisthesis

Clinics in Surgery

Editorial
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Aetiological Apportionment in Spine-Related Medicolegal Matters: A Neurosurgical Perspective

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Editorial

Medicolegal matters related to the spine can be quite complex from an aetiological perspective. By the time an assessee presents to a neurosurgeon/spinal surgeon for an Independent Medical Examination (IME), the condition may be chronic and subject to one or more spinal surgeries or claimed injuries/aggravations. Further, the clinical presentation may be adversely influenced by the compensation/litigation umbrella itself [1]. In order to better understand causation in such circumstances, a thorough IME needs to be undertaken involving a methodical, scientific and impartial approach, with careful consideration of a plethora of potentially contributing factors (Table 1). As an actively operating neurosurgeon who also regularly undertakes IMEs, the present Editorial summarizes the author's decision-making process (which has been evolutionary with experience) in relation to aetiology, during almost 15 years and almost 2,000 reports in the medicolegal area.

Fundamental Approach

As expected, a systematic medical history and comprehensive clinical examination by the IME specialist are essential. Ideally, there is consistency between the stated medical history, the examination findings, documentary information, and imaging data. In reality, in the author's experience, this is often not the case. In the History component, there should be questions regarding the originating "index" (and any subsequent) injury, as well as details regarding the alleged mechanism of injury, the latter of which may involve substantial forces or, alternatively, relatively trivial or innocuous mechanical circumstances. Relevant past history in relation to the spine should also be enquired about, given its aetiological significance and its potential as a focal point in any future cross-examination. This includes any previous (pre-incident/pre-existing) spinal symptoms, injuries/accidents, surgeries and insurance/compensation claims. A family history of relevant spinal conditions and/or surgeries needs to be asked about. A smoking history must also be obtained given this activity's implications regarding accelerated spondylosis and adverse surgical outcomes [2]. As the history is being obtained, concurrent observations regarding unusual posturing or excessive transfers and pain vocalization or catastrophizing, level of eye contact, any leading or influential interaction with an attending support person, and vagueness or evasiveness of responses particularly to relevant past history, should be noted. In subsequent careful review of pertinent documents accompanying the matter, historical variations (particularly pertaining to the originating circumstances and symptoms thereafter) communicated by the assessee are to be identified, along with any lack of contemporaneous symptom reporting/documentation. With regard to the claimed originating or "index" injury/incident involving the spine, it should be recognized if the condition's natural history or treatment's expected outcome is being followed and, if not, why not?

The physical examination carried out systematically is, in the author's opinion, as important as general observations of the assessee made outside of formal physical/neurological testing. The latter, which may be in addition to "Waddell signs" after the seminal work of Waddell and colleagues, [3] are paramount to helping determine if a *bona fide* physical injury still exists, as opposed to "functional overlay". Clinical inconsistencies and non-physiological presentation should be looked for, including: marked hypersensitivity to light touch; variable gait and movement ranges between passive and active observation; nociceptive guarding or refusal of movements; collapsing or excessively slow and stiff gait; non-myotomal and non-dermatomal symptom distribution (particularly without accompanying reflexopathy); or "textbook-exact" neurological symptoms in the absence of substantiating/objective signs. Absence of symptoms while testing during conversational distraction is also important to note.

The relevant medical imaging should be carefully studied by the IME specialist, as opposed to substantial reliance on radiological reports. Remote access to Picture Archiving and Communication

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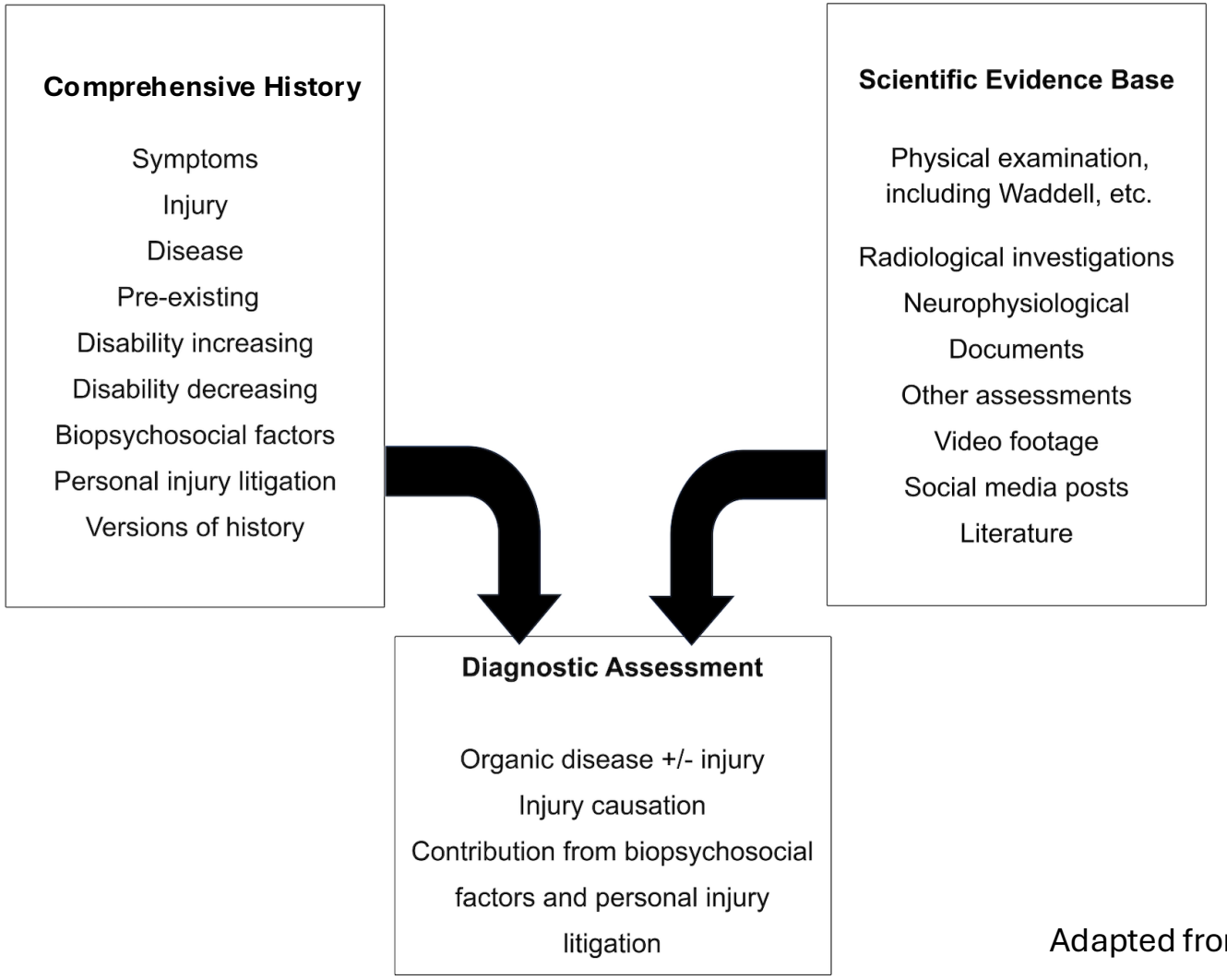
Some important factors that may be causally underappreciated might include: Bertolotti syndrome [5] (with pseudoarthrosis, sacral-alar fusion and low back pain); Klippel-Feil syndrome [6] (with predisposition to adjacent segment disease and cervical spondylotic myelopathy); Scheuermann's disease [7] (with associated kyphoscoliosis and thoracic and/or lumbar pain); morbid obesity [8] (associated with low back pain and physical deconditioning); a congenitally narrow spinal canal [9,10] (predisposing to accelerated spondylosis); diffuse idiopathic skeletal hyperostosis [11] (DISH; with, e.g., bulky thoracic osteophytosis and/or ossification of the posterior longitudinal ligament and associated symptoms); a heavy chronic smoking history [2] (accelerated spondylosis, increased post-operative complications and poorer post-surgical outcomes); previous local spinal instrumentation [12] (with predisposition to adjacent segment disease/accelerated adjacent segment degeneration); and presence of isthmic spondylolisthesis [13] (with expected temporal progression and symptomatology).

Adapted from Khurana (2022)

Context (take-home message)

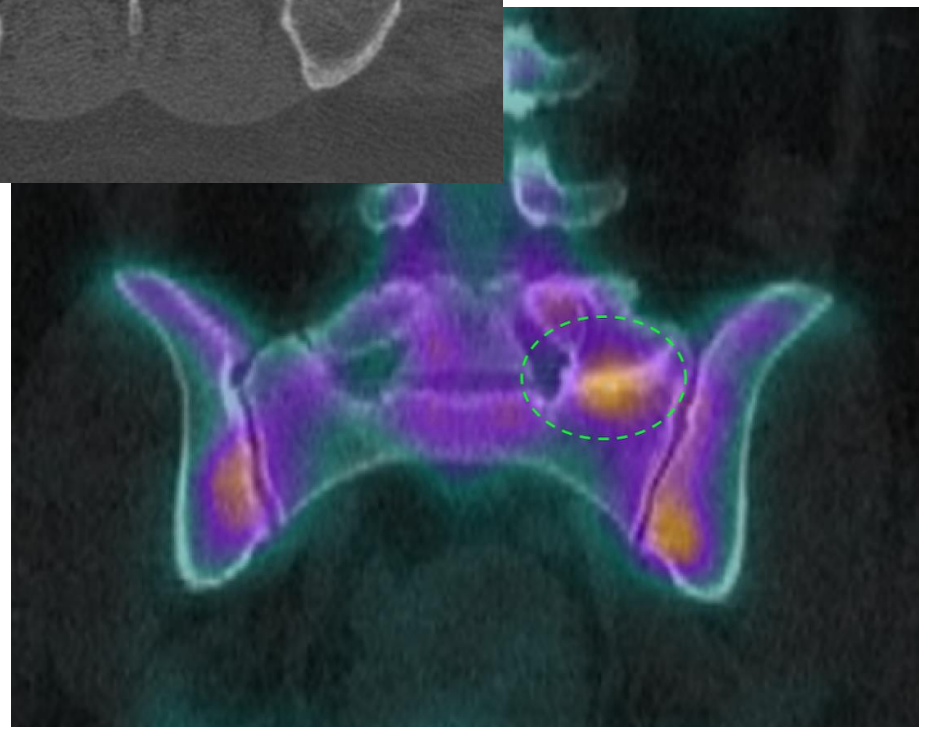


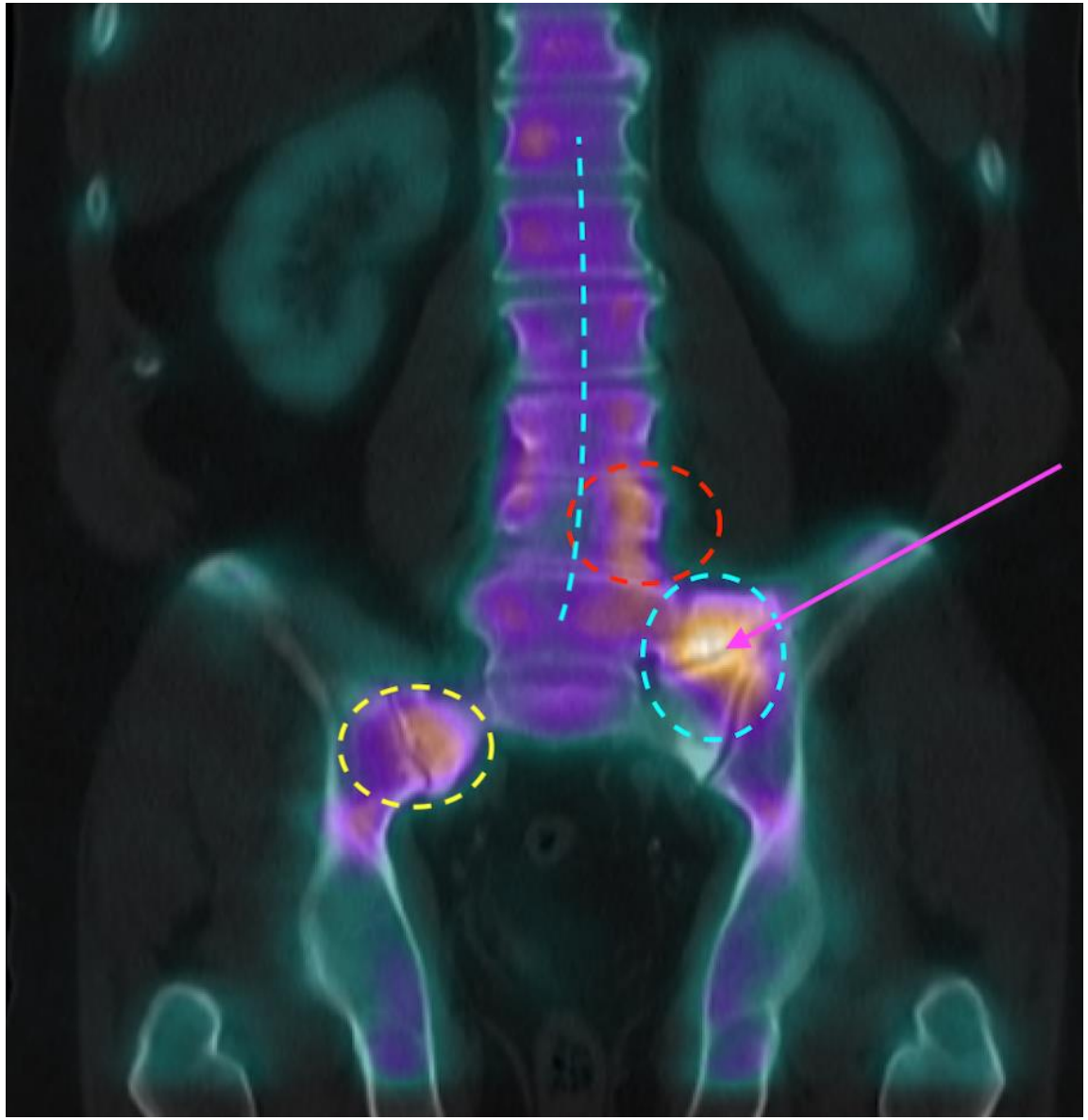
Adapted from Khurana & Brazenor (2024)

1. Bertolotti syndrome

- Transitional (lumbosacral junction) segment
- Partial or total fusion
- Enlarged transverse process to sacrum and/or ilium
- Associated with low back pain and/or sciatica
- Readily missed on a MRI
- 4-8% prevalence
- Adjacent segment degeneration from pseudoarthrosis

1. Bertolotti syndrome

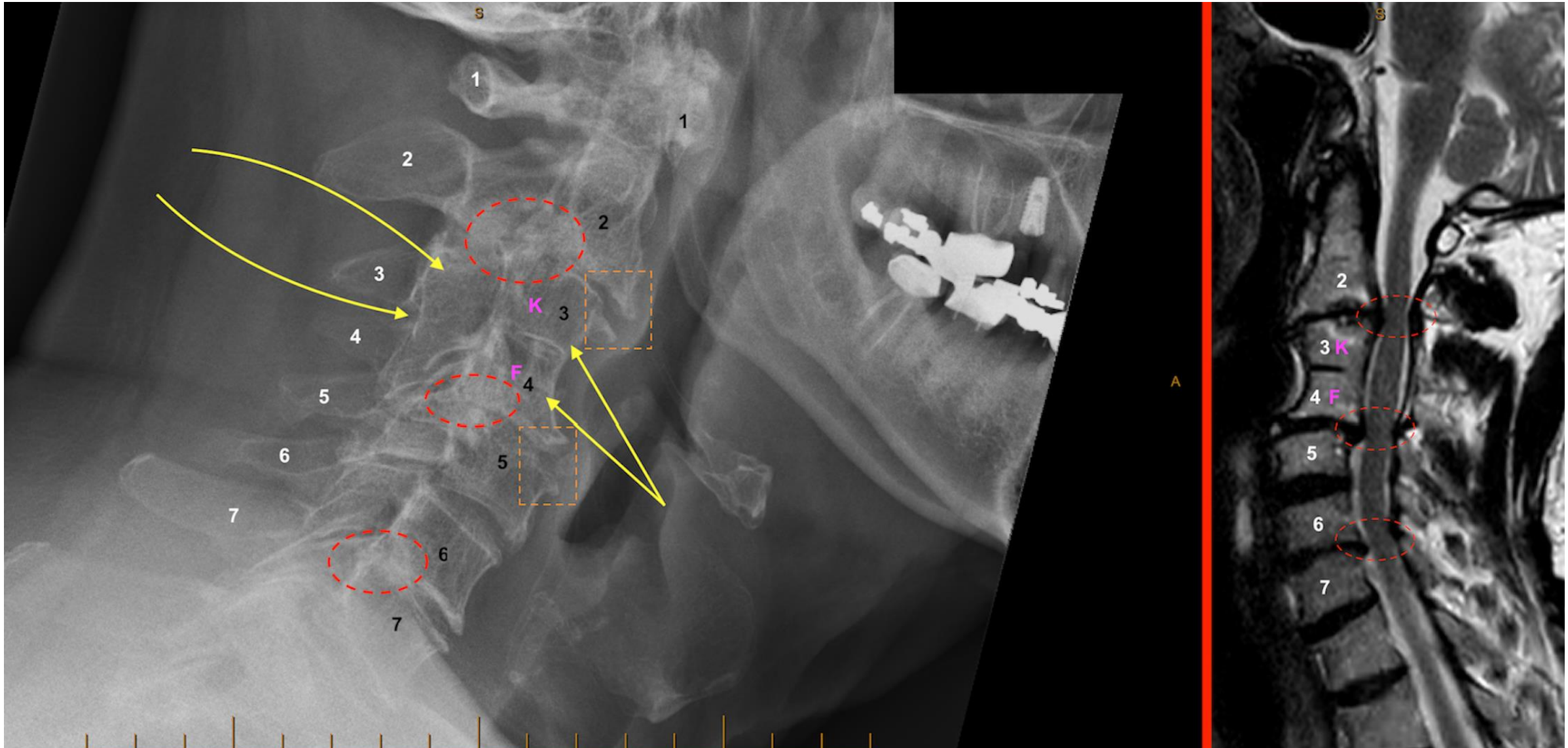




2. Klippel-Feil syndrome

- Congenital cervical fusion from failed segmentation of somites
- Classic triad: Short neck, low posterior hairline, restriction of neck motion
- Prevalence 0.71%
- Associated with adjacent segment degeneration, degenerative cervical myelopathy (DCM)
- RR DCM in KFS pts = 3.3
- Neck pain, restricted movements; +/- myelopathy/long tract signs

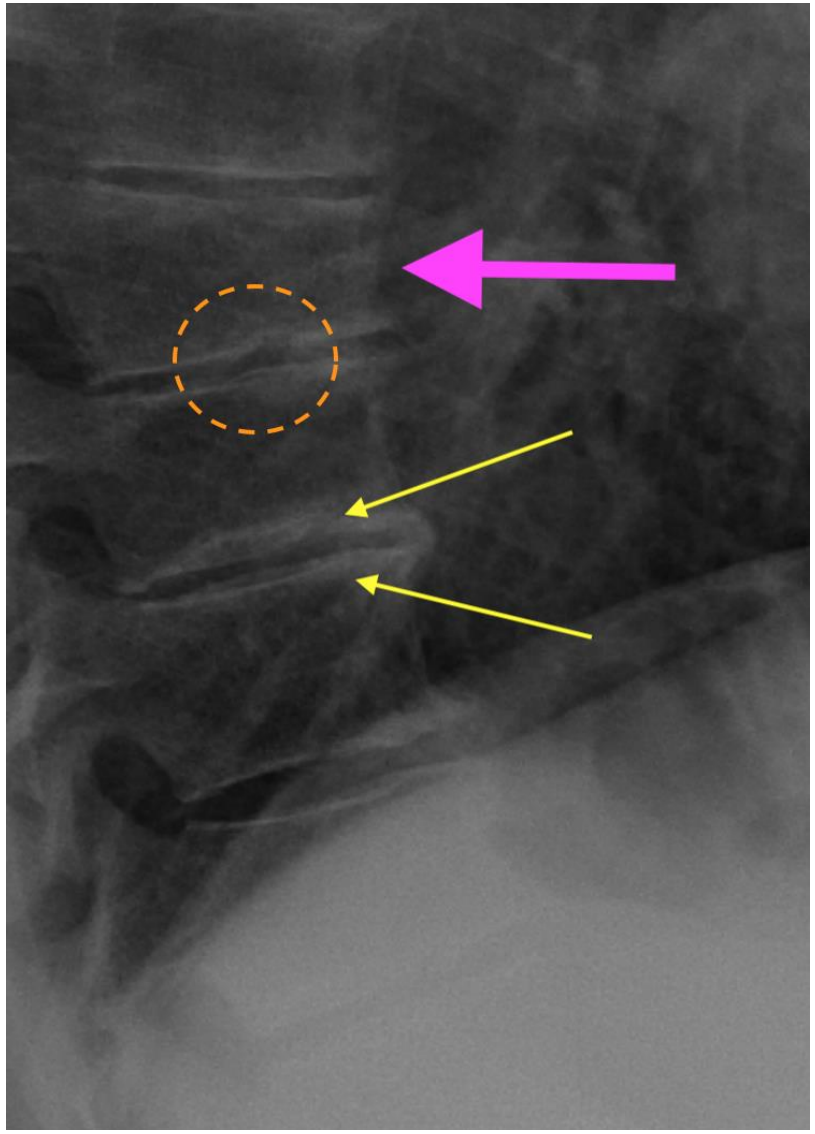
2. Klippel-Feil syndrome

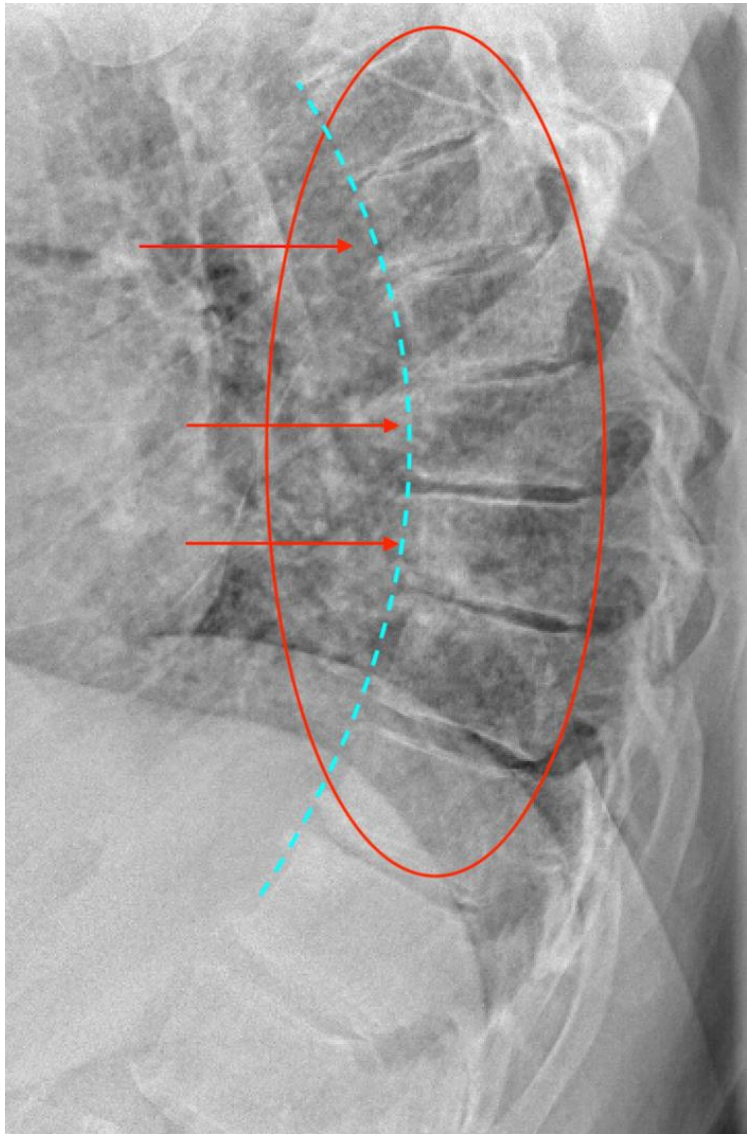


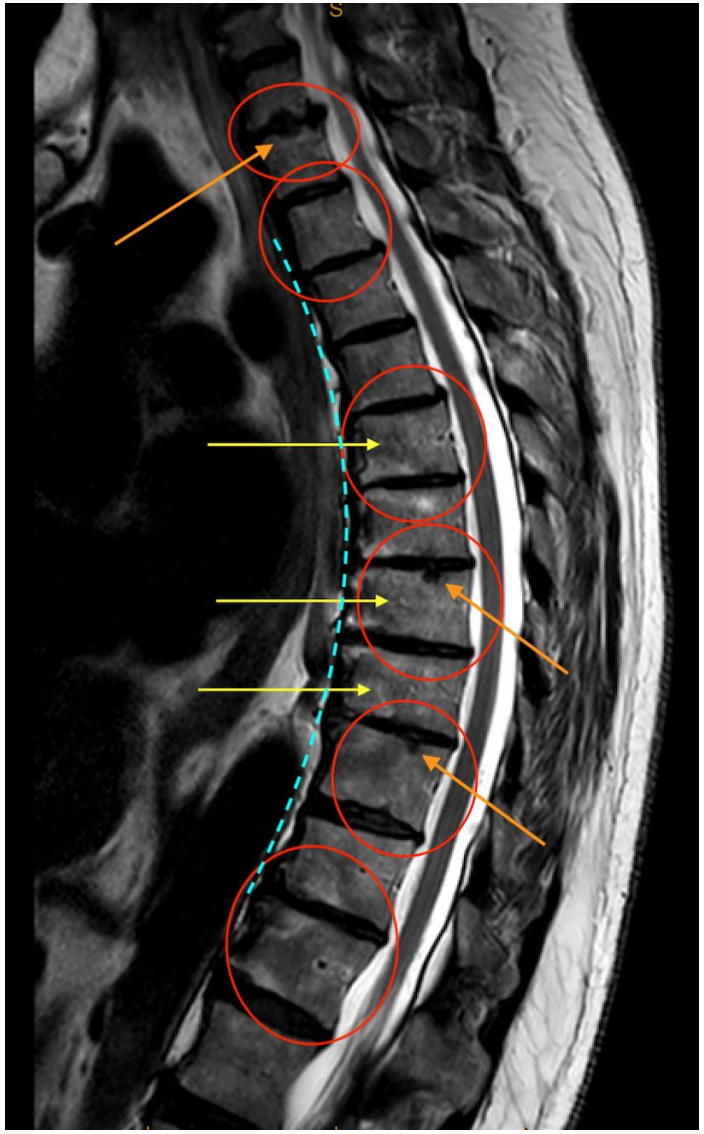
3. Scheuermann’s disease

- Classic thoracic but also atypical lumbar form
- Thoracolumbar pain
- High prevalence (18-40%) of SD-like features in radiol. series
- Structural thoracic kyphosis (exaggerated)
- Schmorl’s nodes, wedged vertebrae, sclerotic endplates
- Can also cause neck pain
- Also associated with lumbar hyperlordosis (thought compensatory)

3. Scheuermann’s disease



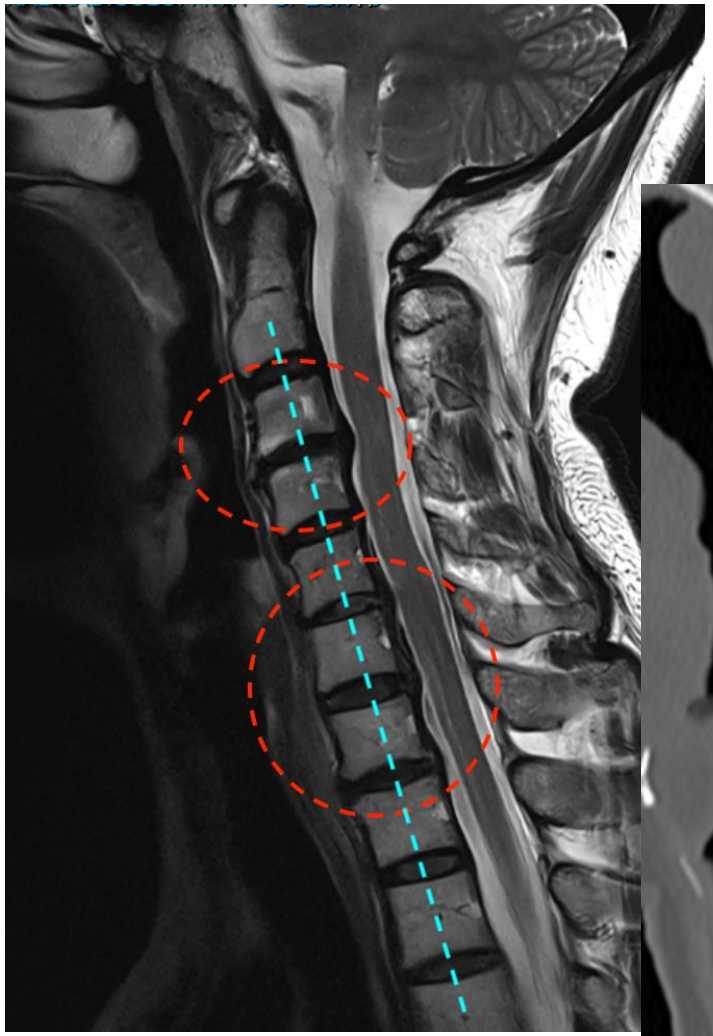


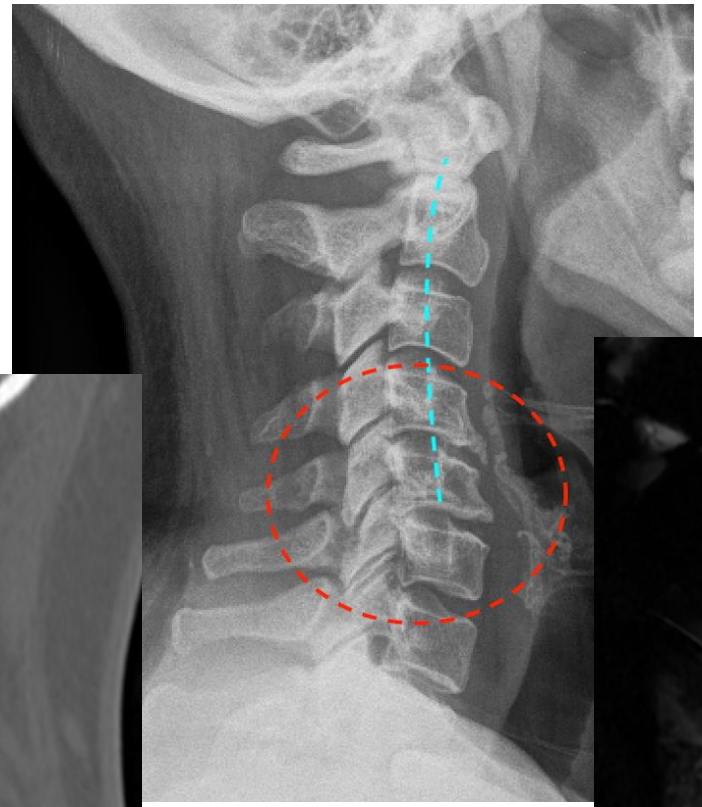


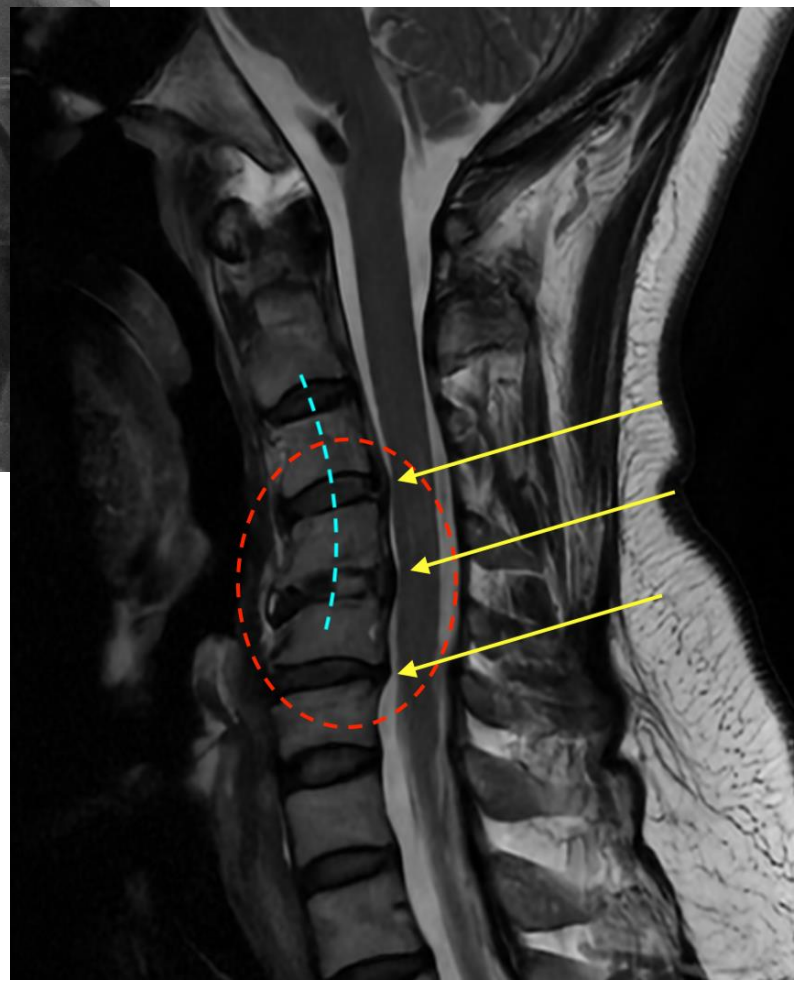
4. Kyphoscoliosis

- Cervical alordosis/kyphosis; thoracic kyphosis; scoliosis
- Inflection points with increased biomechanical forces (degen.)
- Scoliosis associated with increased risk of recurrent lumbar disc herniation after microdiscectomy
- Cervical kyphosis: Genetic; degenerative; ank. spond.; post-laminectomy; smoking; trauma
- Neck pain, radiculopathy, myelopathy
- Severe: horizontal gaze, swallowing, breathing problems
- Anomalies not infrequently overlooked by reporting radiologists

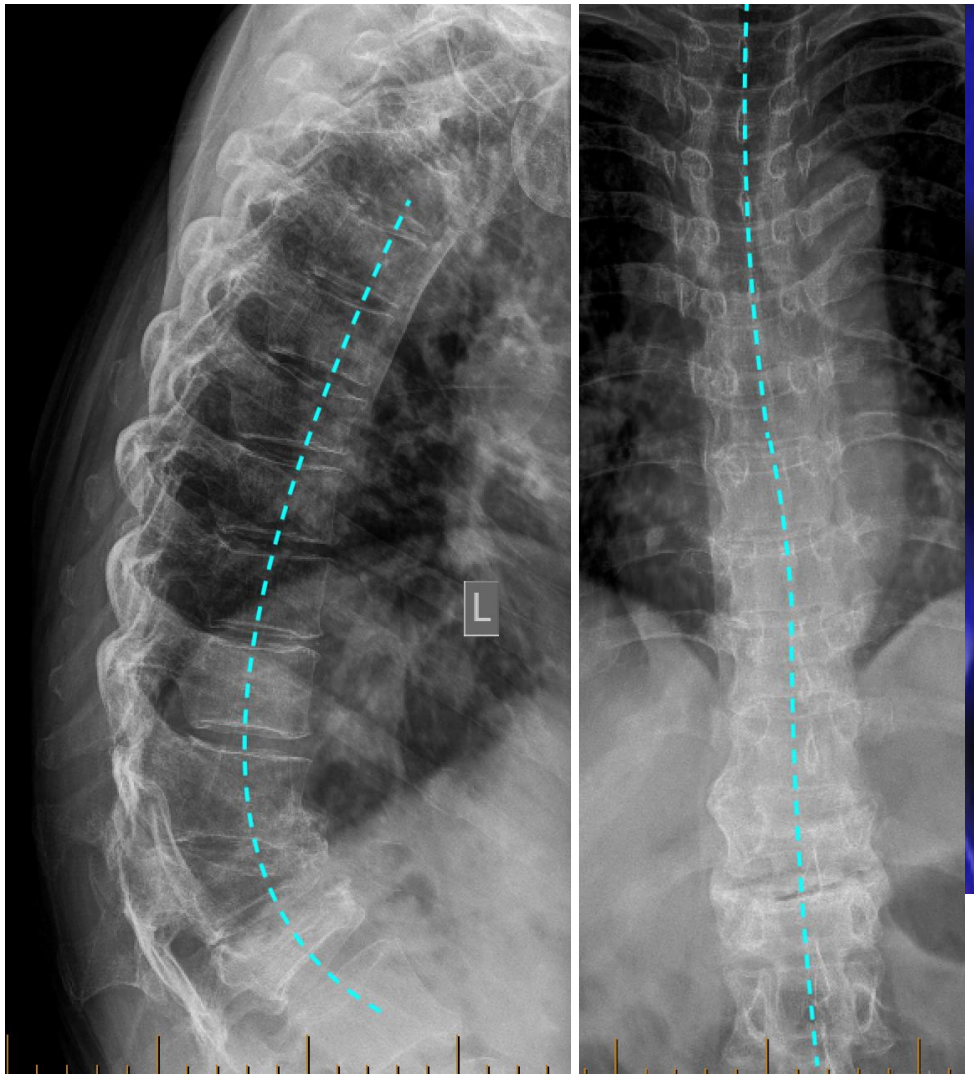
4. Cervical kyphosis

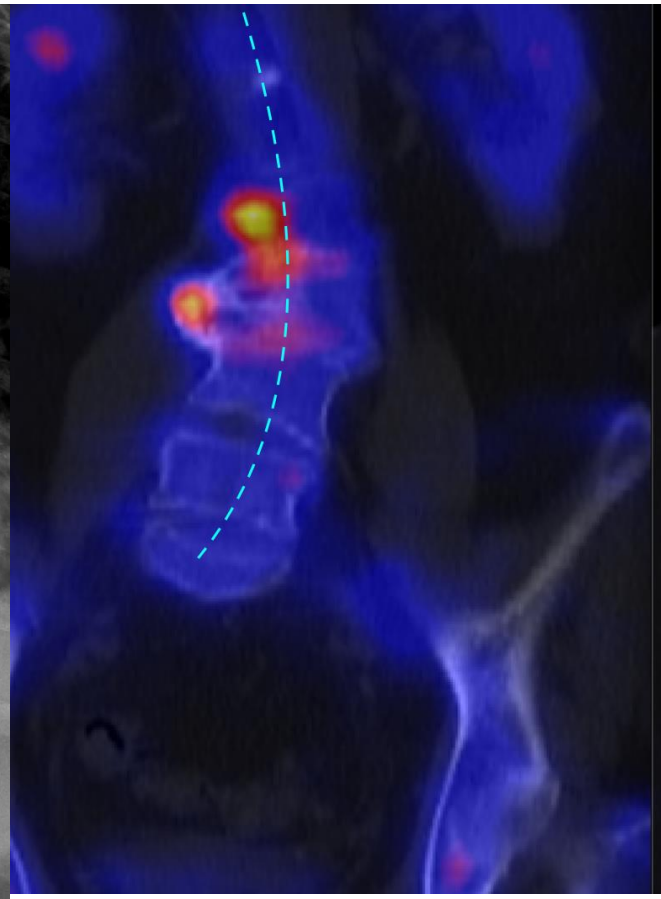
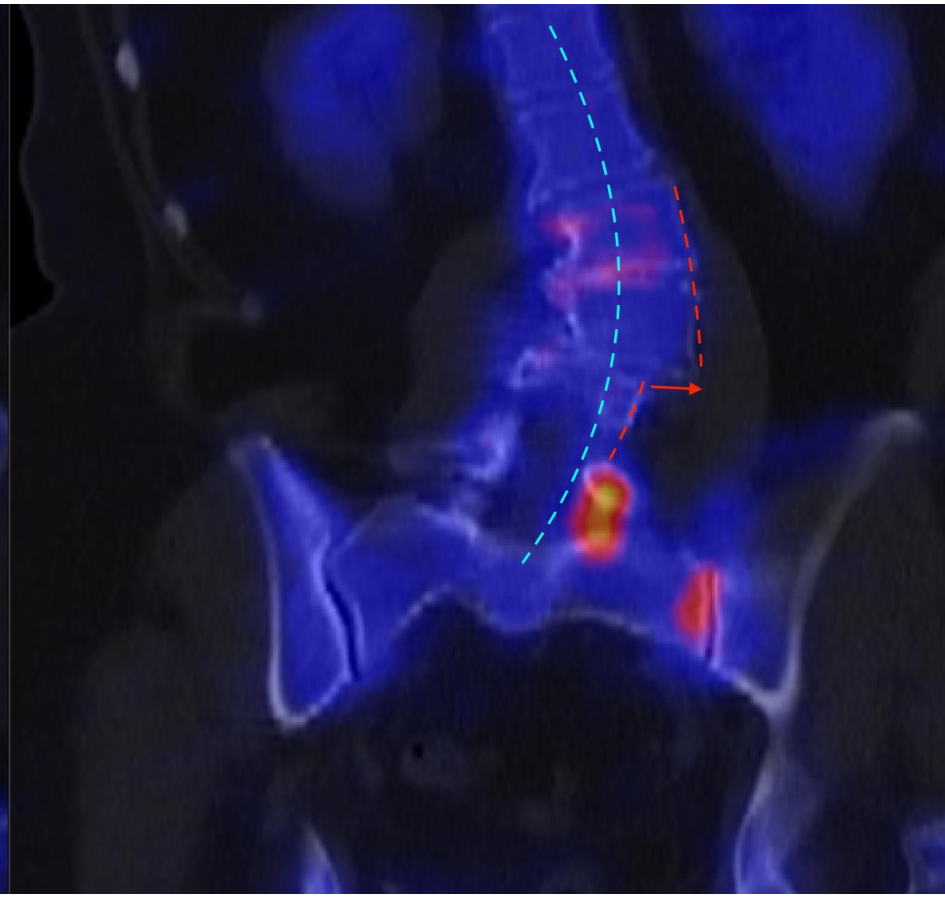




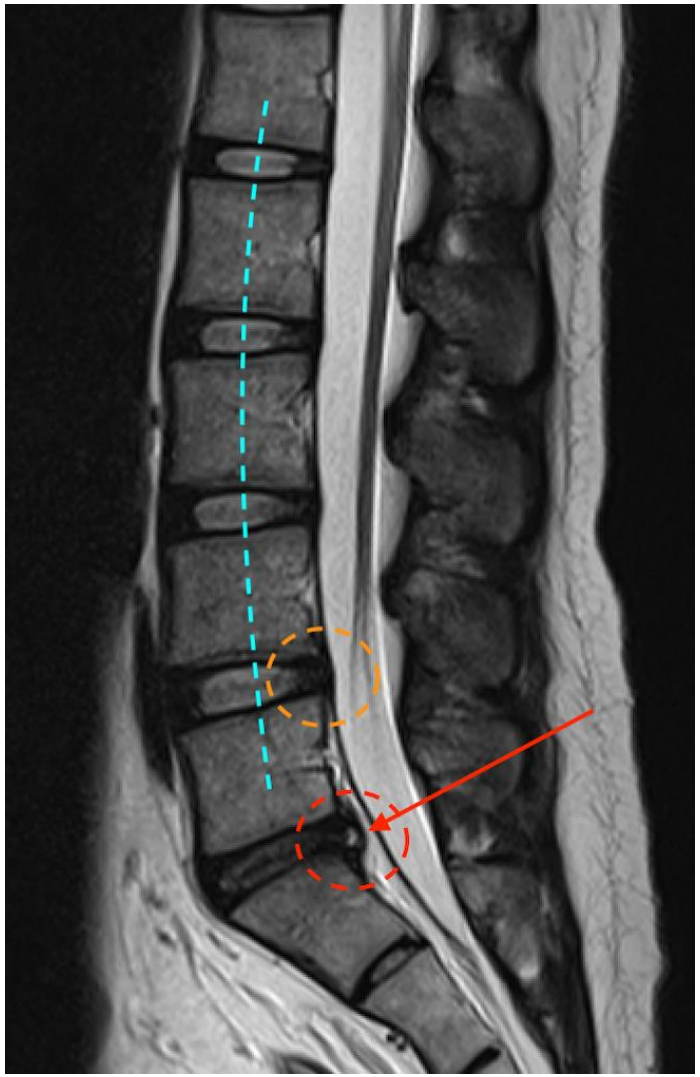


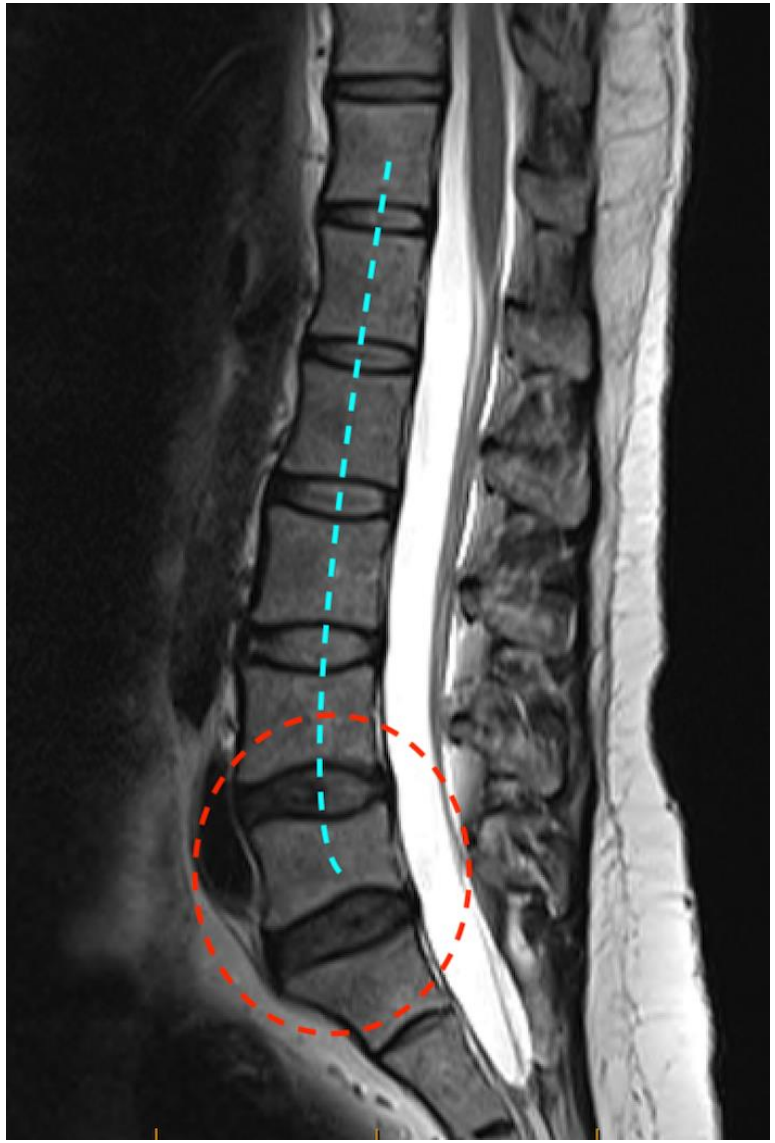
4. Kyphoscoliosis

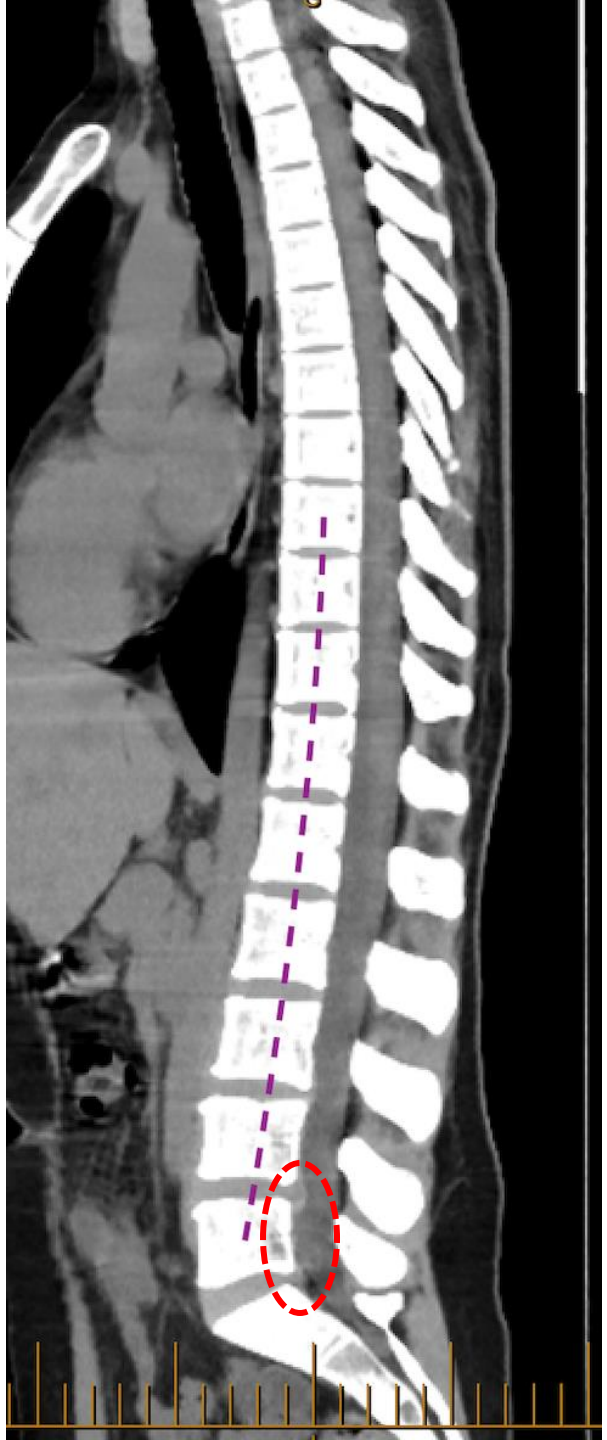


4. Lumbar alordosis



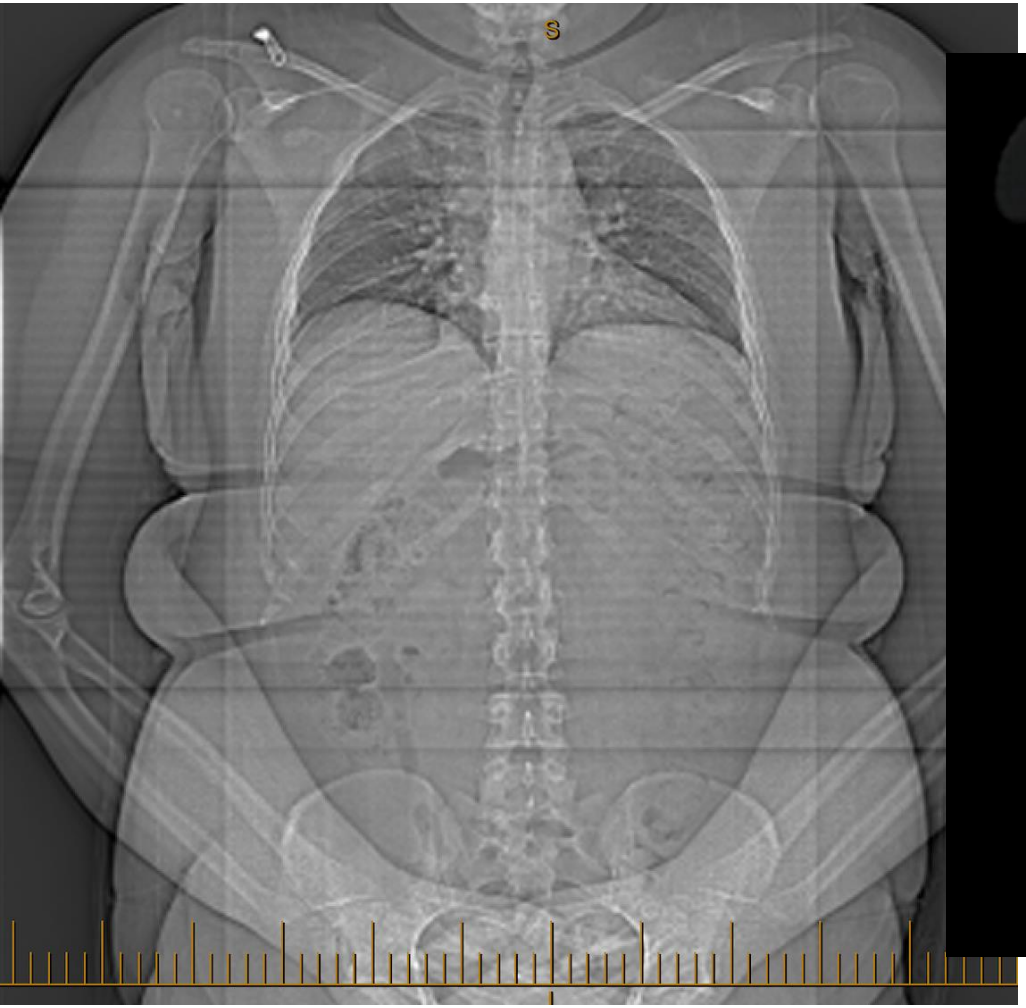


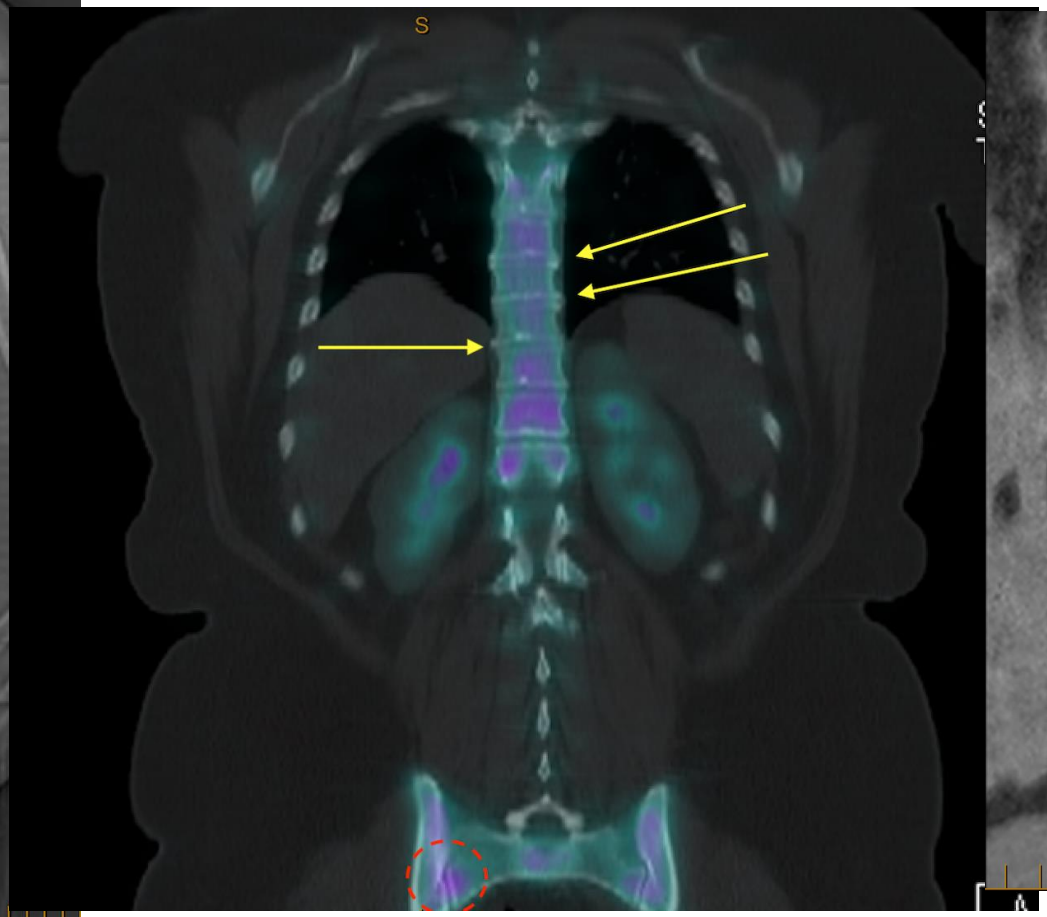


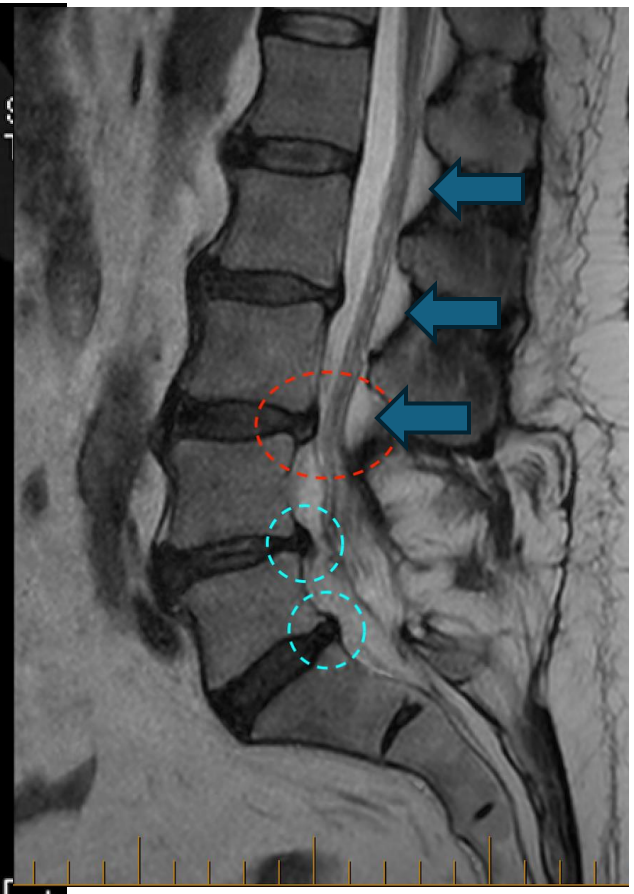
5. Morbid obesity

- Meta-analysis; sig. higher LBP; chronic symptoms
- Obesity (BMI at least 30)
- BMI > 35 also associated with thoracic kyphosis and upper torso pain, esp. in women
- BMI 30-35 2x chronic pain; BMI > 35 4x chronic pain
- Association with osteoarthritis, epidural lipomatosis (exac. stenosis), sacroiliitis
- Associated with longer operation times, more blood loss and post-operative complications in multilevel ACDF

5. Morbid obesity



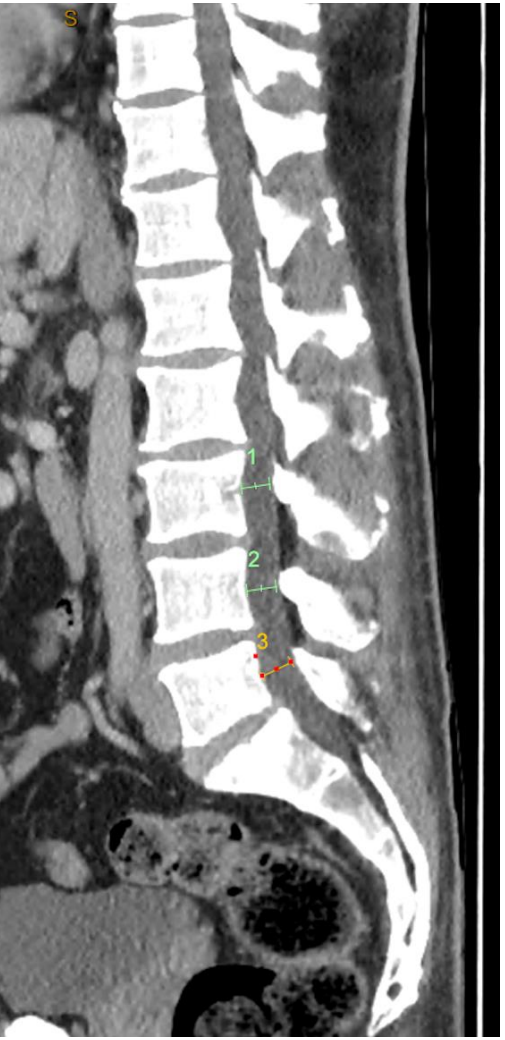


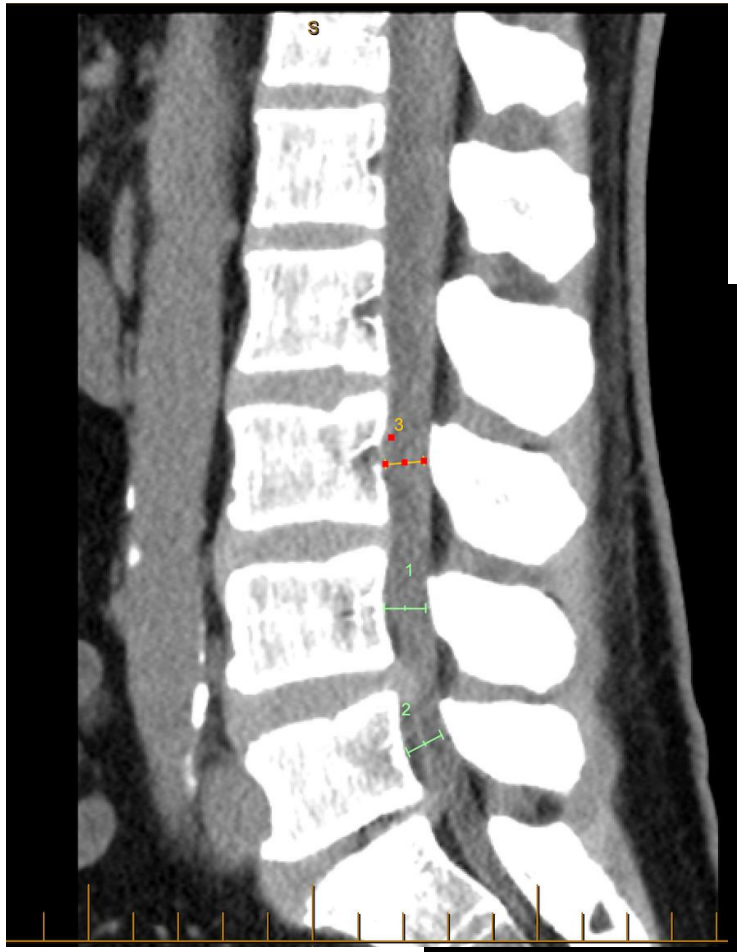


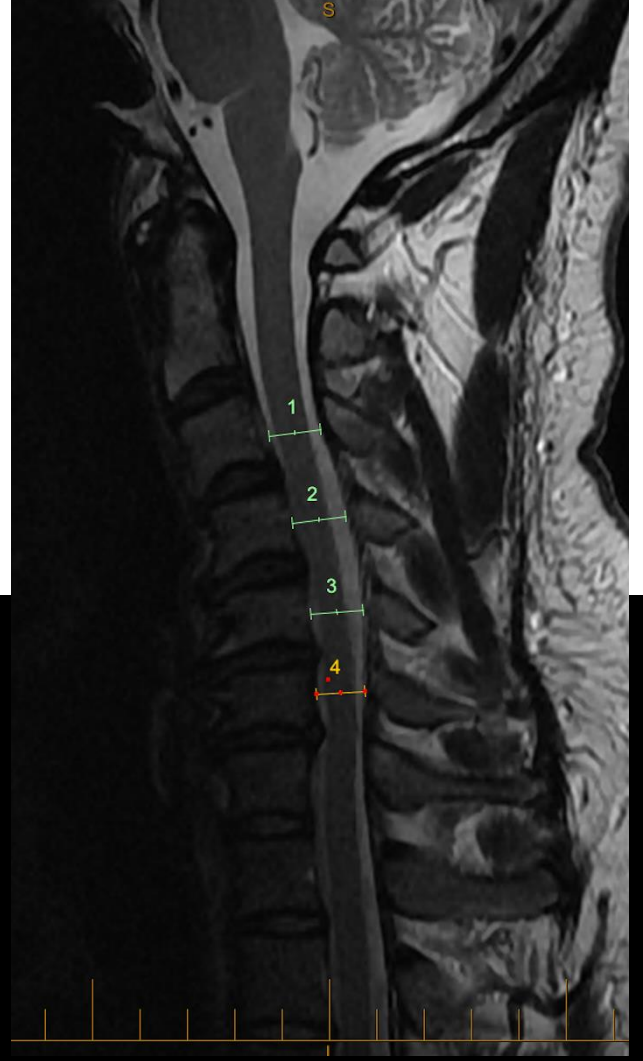
6. Narrow spinal canal

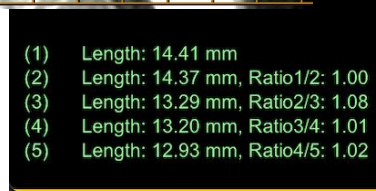
- Seminal papers on normative MR cervical and lumbar spinal canal diameters
- Ulbrich et al. (2014), Pierro et al. (2017)
- Diameters categorized by gender and height
- Published tables with key spinal levels, averages and AP canal vs. sac diameters
- Associated with acceleration of spondylosis
- Exacerbates stenosis, spinal pain; “thick and short pedicles”
- Anomalies sometimes overlooked by reporting radiologists

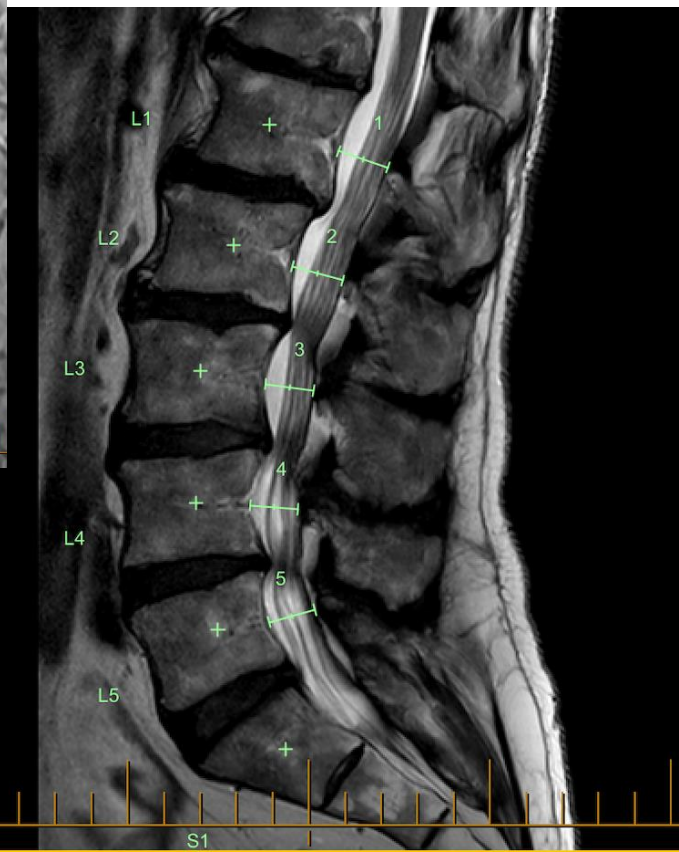
6. Narrow spinal canal







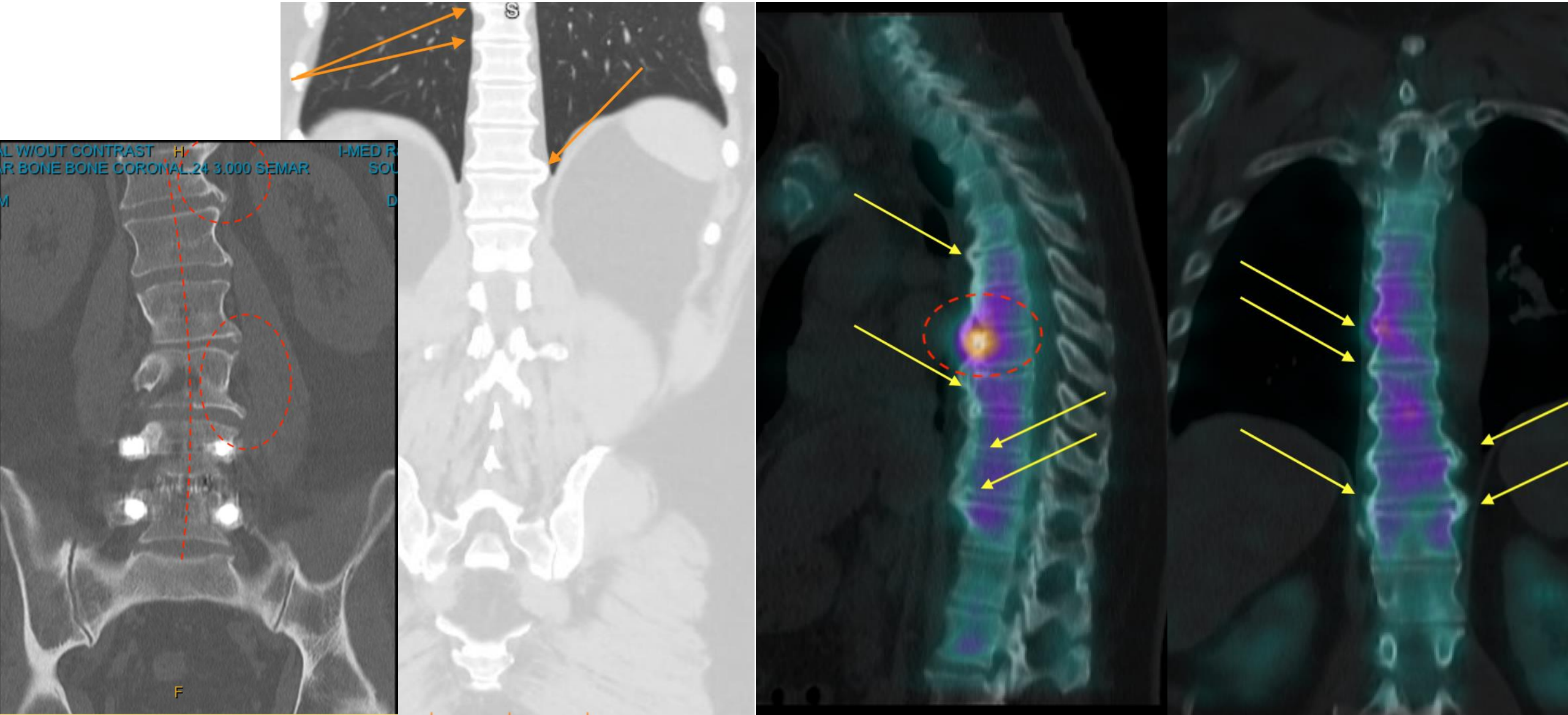




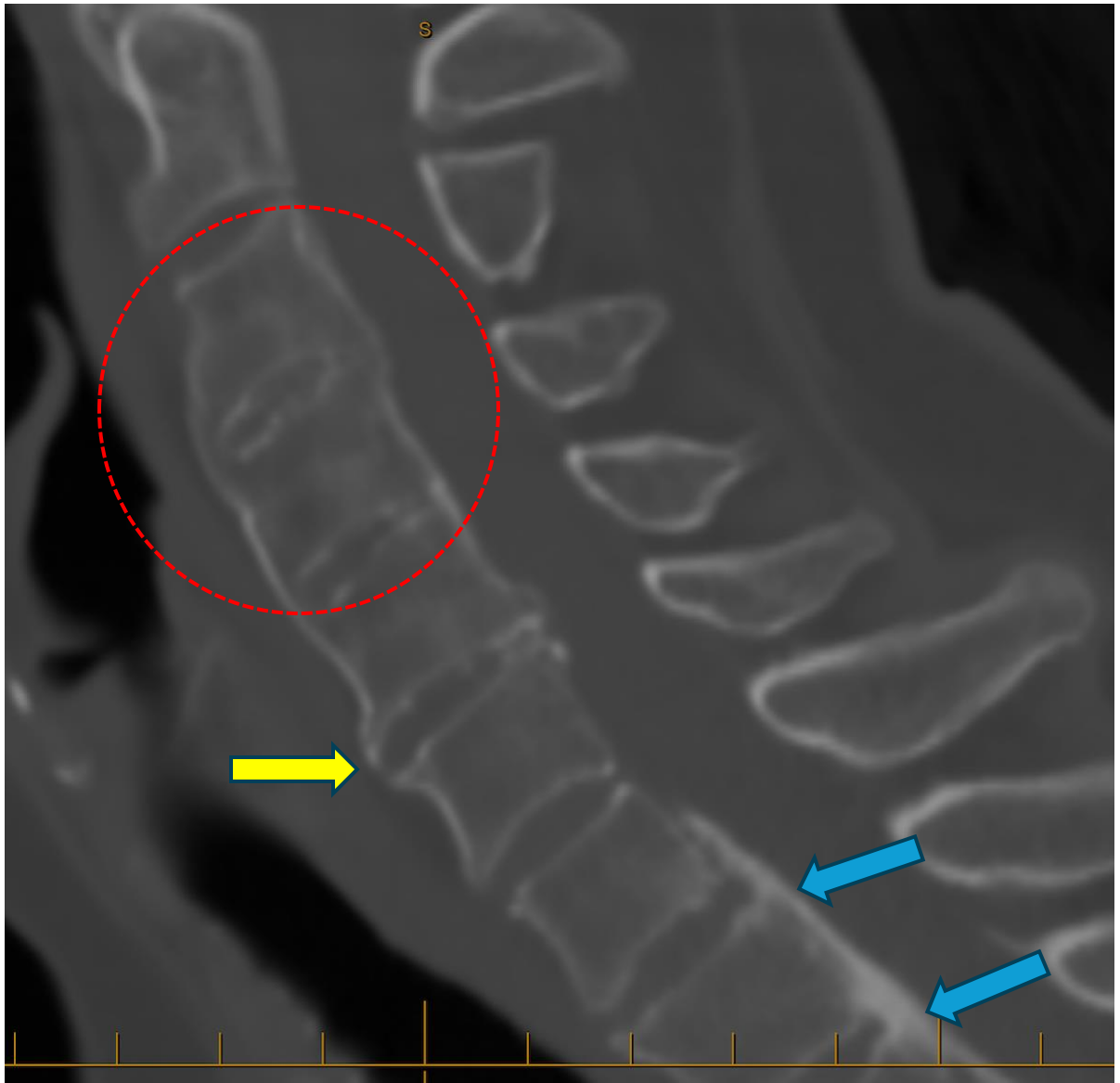
7. Diffuse idiopathic skeletal hyperostosis

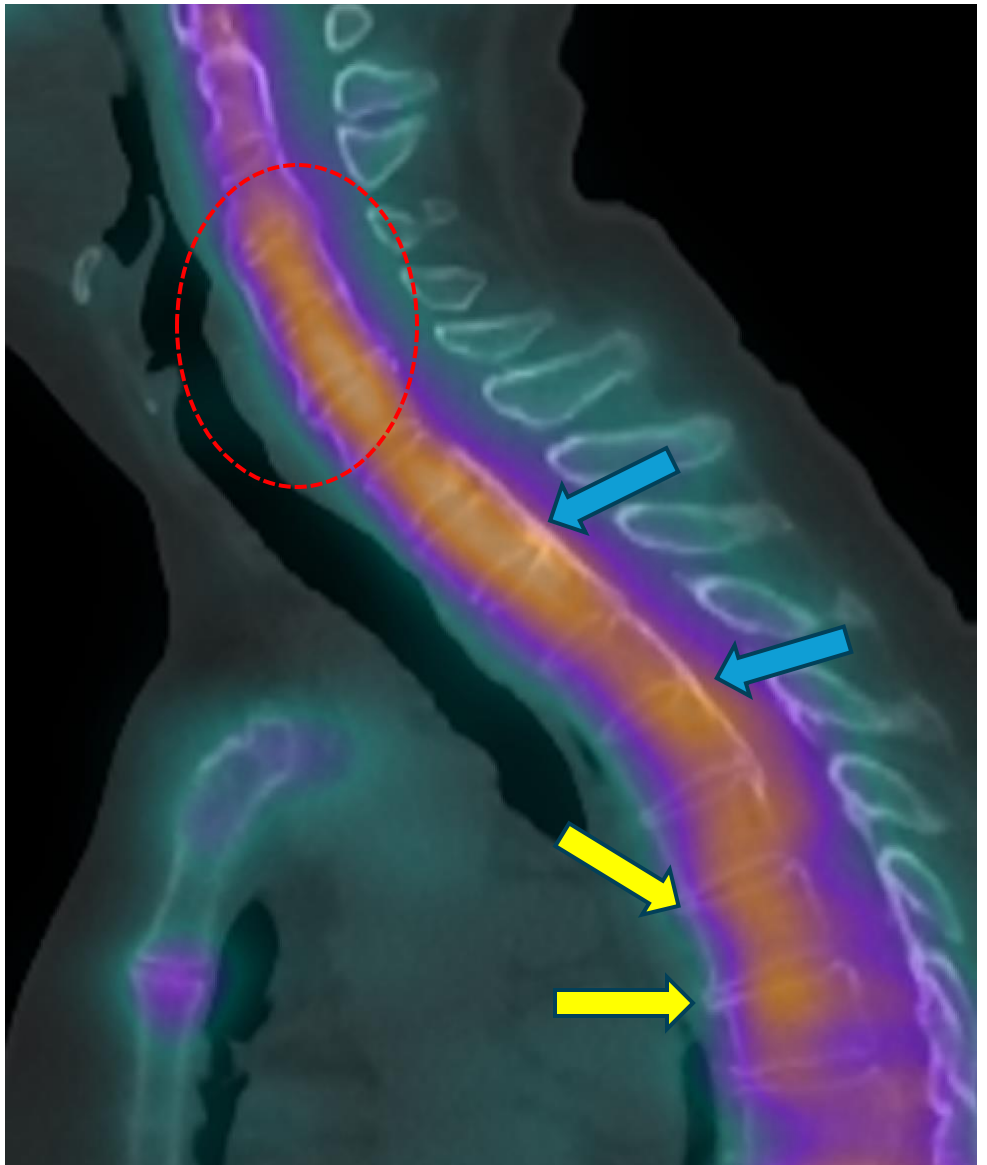
- DISH; most prominent in thoracic spine, ≥ 4 consec. vert.
- Associated with OPLL, spinal pain and stiffness
- Risk factors include DM, obesity, HL, HTN +/- gout, RA
- More common and severe in men; age > 50
- Bulky right anterolateral thoracic osteophytes, preserved disc space, abN SPECT tracer, OPLL, +/- fracture predisposition
- Exac. of local stenosis, dysphagia, myelopathy

7. Diffuse idiopathic skeletal hyperostosis



7. DISH v. ankylosing spondylitis (AS) v. KFS





8. Chronic smoking

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Review Article

Adverse impact of smoking on the spine and spinal surgery

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ABSTRACT

Background: Tobacco smokers and companies are well aware that smoking increases the risks for cancers, vascular morbidity, and early mortality. This is a review of the plethora of adverse effects chronic smoking has on spinal tissues and spinal surgery.

Methods: Medline (PubMed) and Google Scholar databases were searched for pertinent literature through keywords related to smoking, spondylosis, and spinal surgery.

Results: Smoking accelerates spondylosis by impairing spinal tissue vascular supply through atherosclerosis and thrombosis, while inducing local hypoxia, inflammation, proteolysis, and cell loss. It, thus, compromises disc, cartilage, synovium, bone, and blood vessels. It can lead to early surgery, delayed wound healing, increased surgical site infection, failed fusion, more re-operations, and chronic spinal pain.

Conclusion: There is ample evidence to support surgeons' declining to operate on chronic smokers. The need for immediate and permanent smoking cessation and its potential benefits should be emphasized for the patient considering or who has undergone spinal surgery.

Keywords: Pseudarthrosis, Smoking, Spinal fusion, Spondylosis, Surgery, Tobacco

INTRODUCTION

Mainstream cigarette smoke drawn into a smoker's mouth consists of 8% tar and 92% gaseous components and contains thousands of toxic chemical compounds, about 10^{15} free radicals per puff, and the addictive substance, nicotine.[1,7,13] Anti-smoking media campaigns usually emphasize the adverse health effects of cigarette smoking as including emphysema and chronic bronchitis, lung and other cancers, and cardiovascular diseases.[21] Here, the substantial negative impact of smoking on the spine and spinal surgery is emphasized, as cigarette smoke toxins compromise spinal blood flow and nutritional supply,[1,9] accelerate spondylosis,[12] and increase other surgical complications such as skin incision necrosis and dehiscence, delayed wound healing, and infection [Table 1].[15,20,26]

METHODS

The literature was reviewed using keyword searches on Medline (PubMed) and Google Scholar search engines. Keywords included smoking, complications of spinal surgery, disc arthroplasty,

8. Chronic smoking

ABSTRACT

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8. Chronic smoking

Earlier operation and increased reoperation rate

Tobacco smokers are more likely to develop symptomatic cervical spondylotic myelopathy, typically warranting spinal surgery approximately two decades earlier than their nonsmoking counterparts.[11] Cessation of smoking for those undergoing cervical spine surgery is critical to avoid the two-fold greater incidence for developing "surgical" adjacent segment disease versus nonsmokers.[4,14,17] Further, smoking serves as an independent predictor for re-operation following single or multi-level lumbar laminectomies, where re-operations include surgery for other nondegenerative complications (e.g., adjacent segment disease, wound infection, dehiscence, and pseudarthrosis) [Table 1].[6,14]

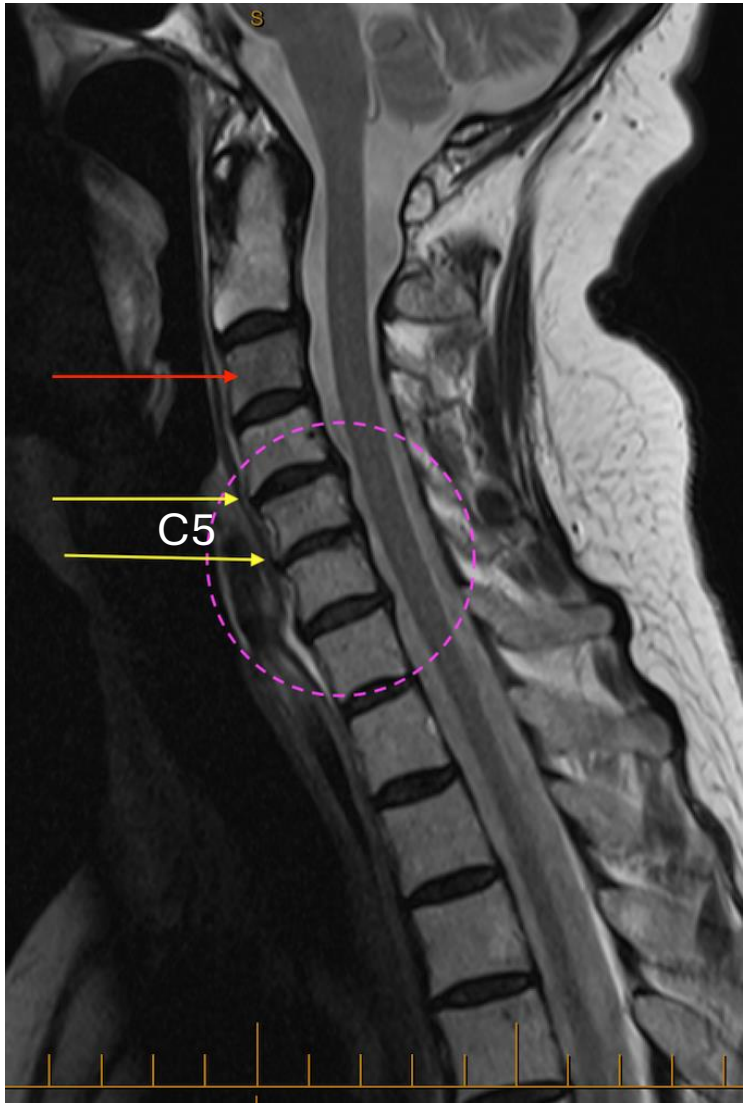
Smoking increases rates of fusion failure

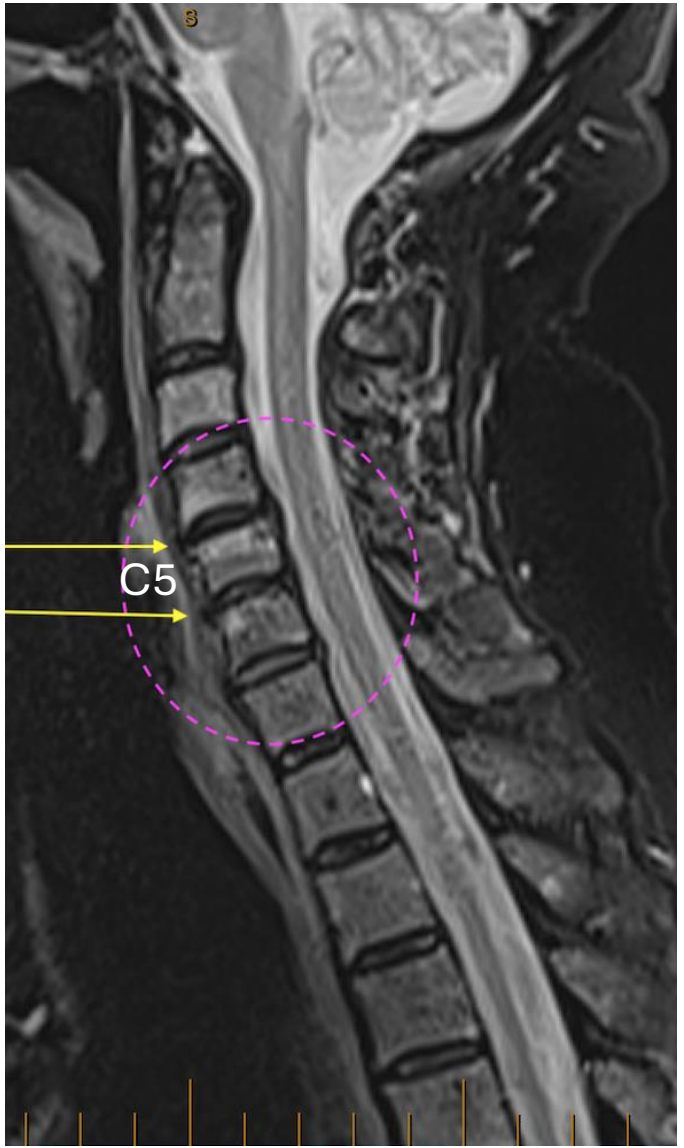
Smoking is known to impede all stages of bone healing and fusion.[4,12,14] Smoking initially inhibits the normal inflammatory response (first stage) and decreases fibroblast and osteoblast proliferation and function (first and second stages).[4,12] It then disrupts the normal vascular supply and neovascularization (second stage), while promoting bone's net resorption instead of its net formation (third stage).[4,14] Notably, smokers have a two-fold greater rate of pseudarthrosis following lumbar or cervical fusion surgery.[3,4,10,13,16] In addition, lower rates of fusion are encountered in smokers undergoing multi-level posterolateral fusions versus single-level arthrodesis [Table 1].[5]

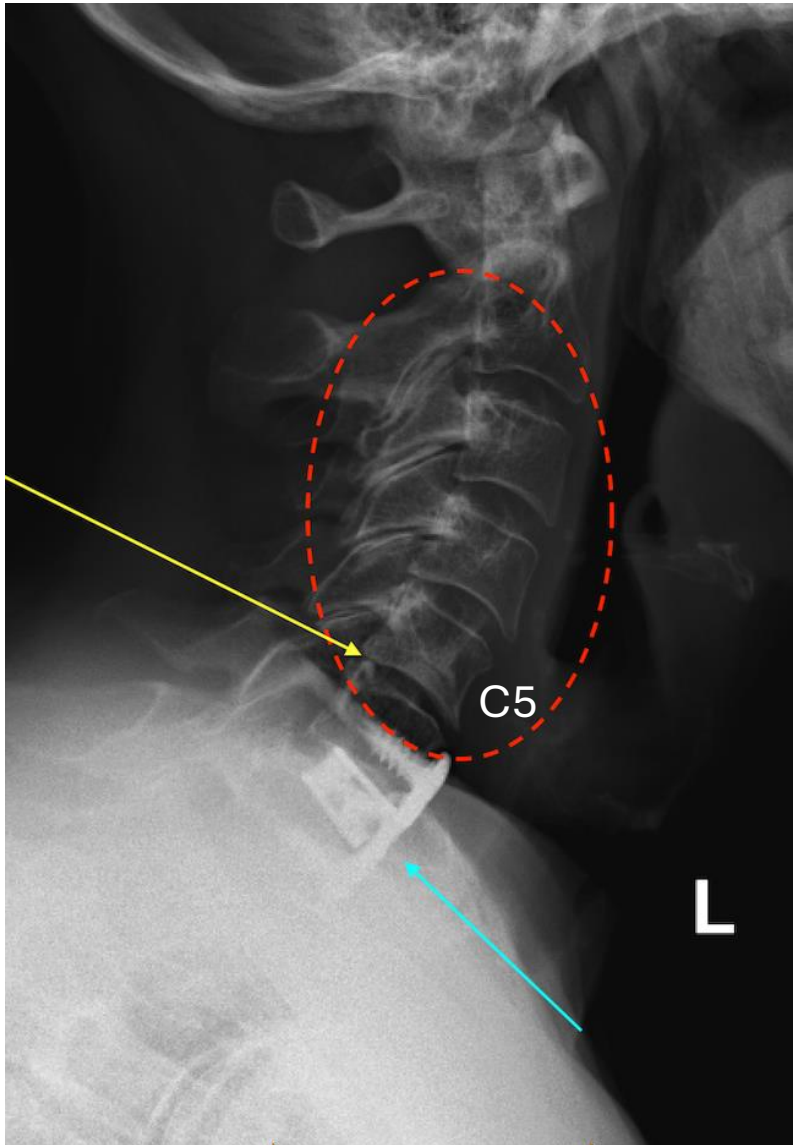
9. Adjacent segment degeneration

- “Degeneration” (ASDe) vs. “disease” (ASDi)
- Degeneration co-existing pre-fusion
- Disease accelerating post-fusion
- Risk factors include time, fusion of any type (congenital, e.g., KFS; acquired, e.g., surgical); smoking; multiple levels
- Average time to revision surgery for ASDi 4-5 years
- Adjacent level new disease (symptomatic) 4% per year

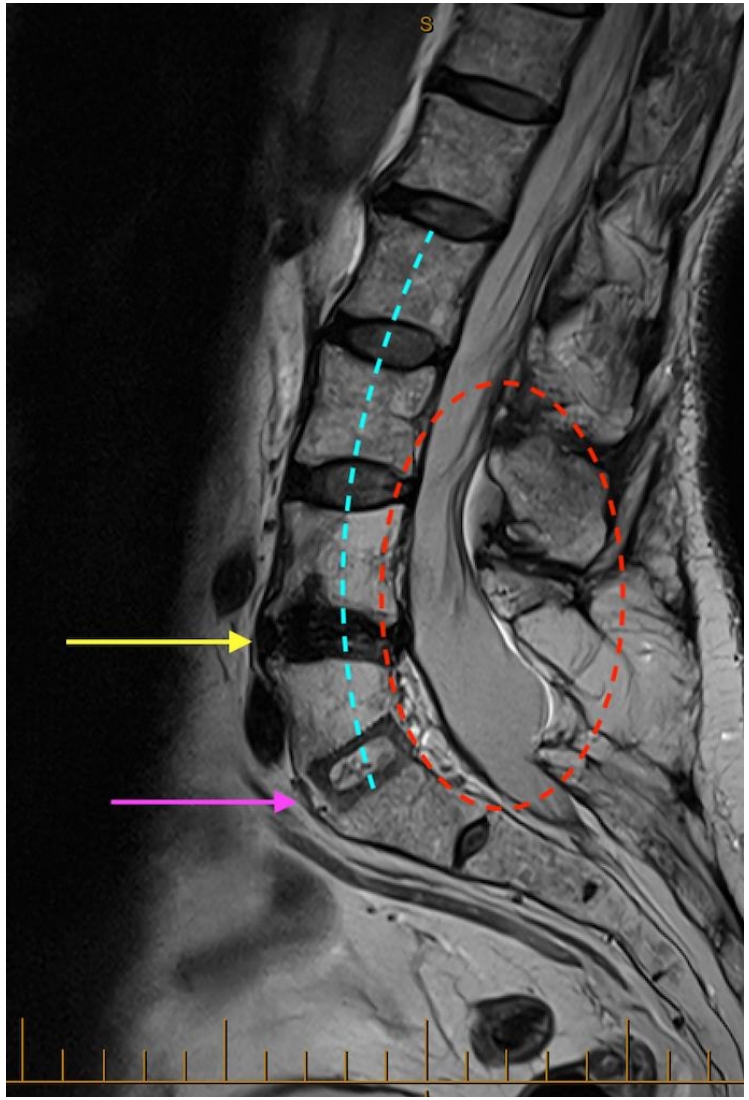
9. Adjacent segment degeneration

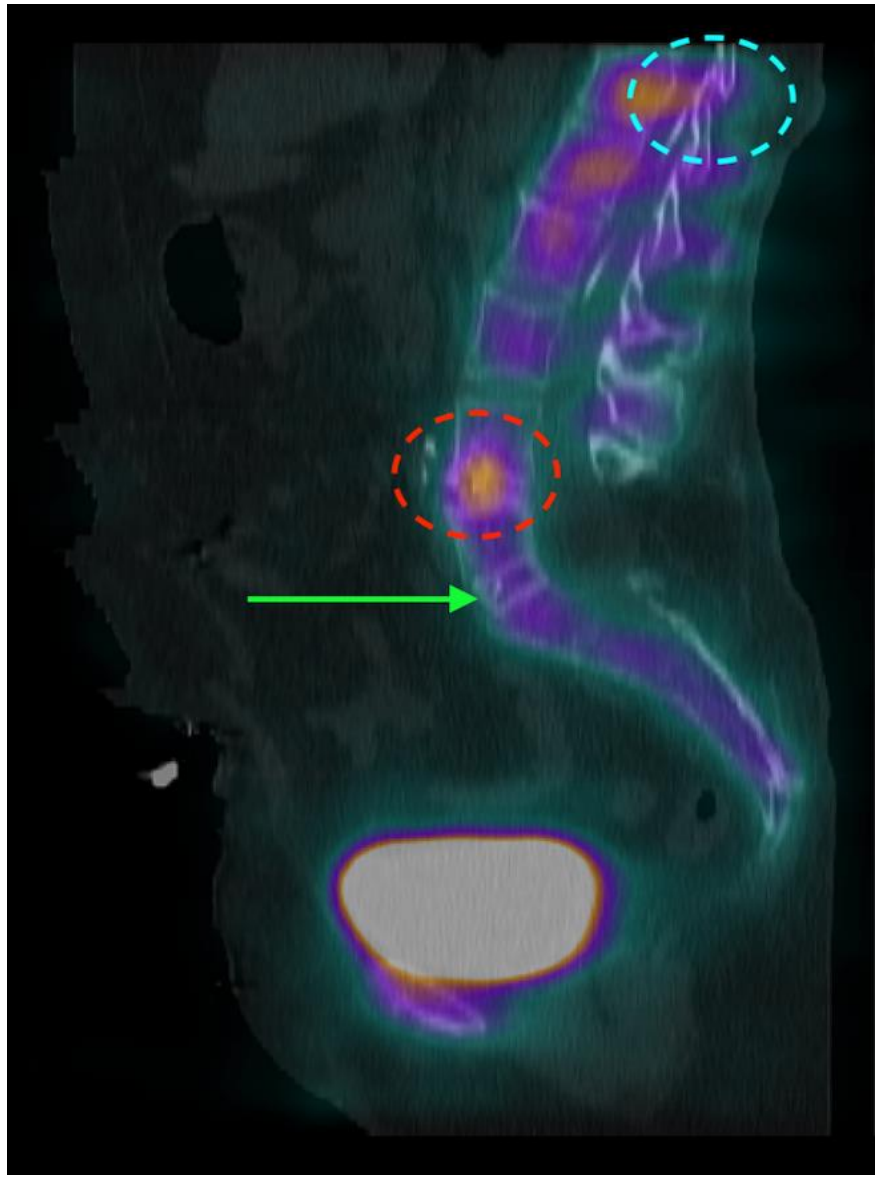




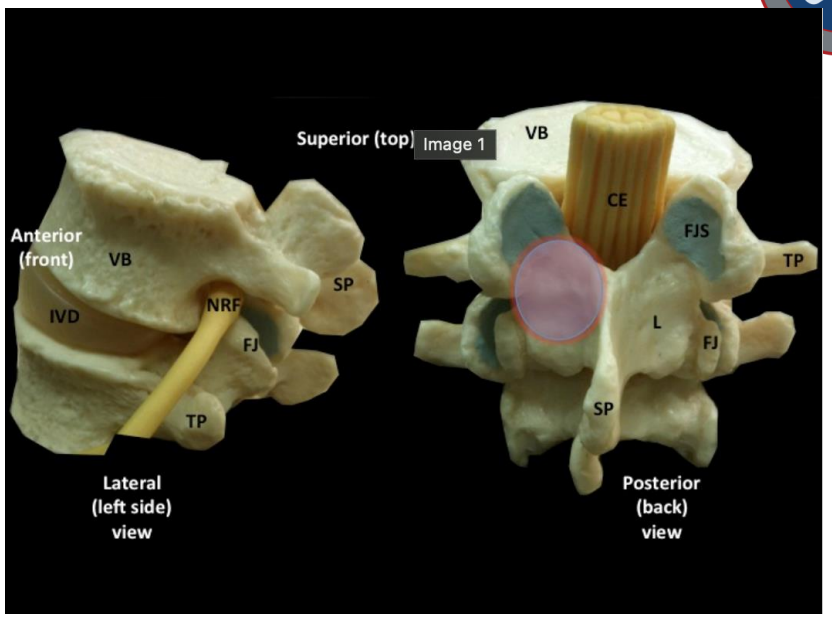


9. Adjacent segment disease



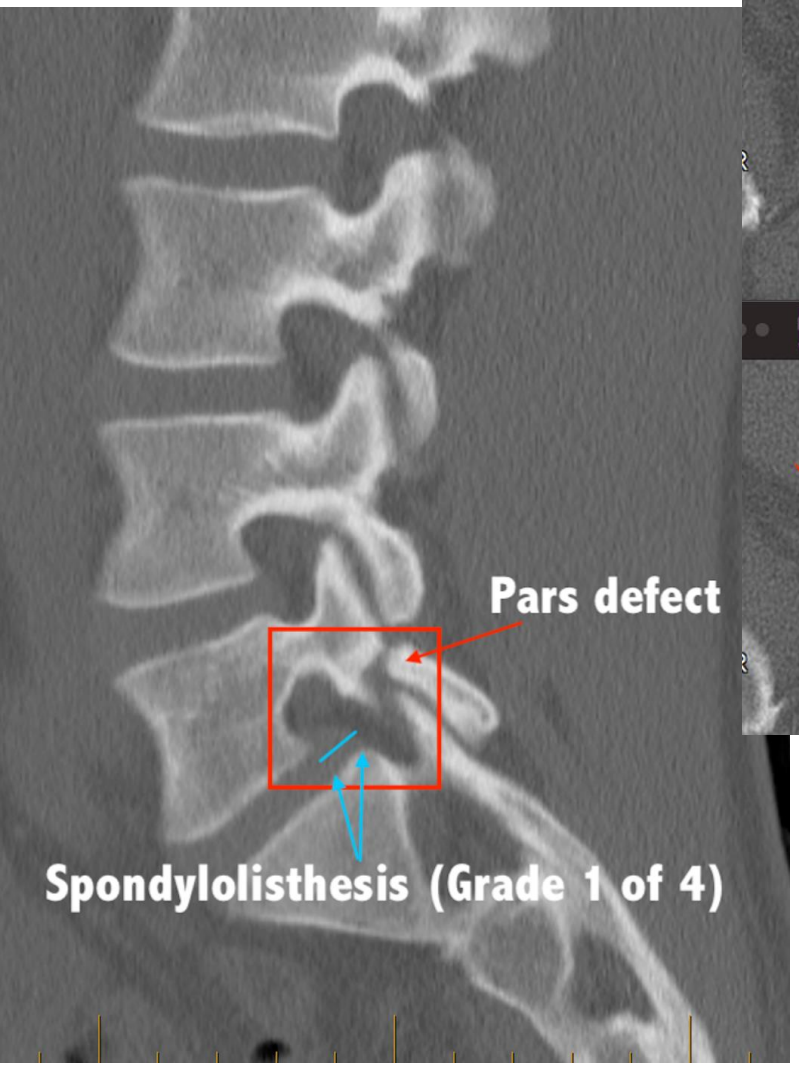


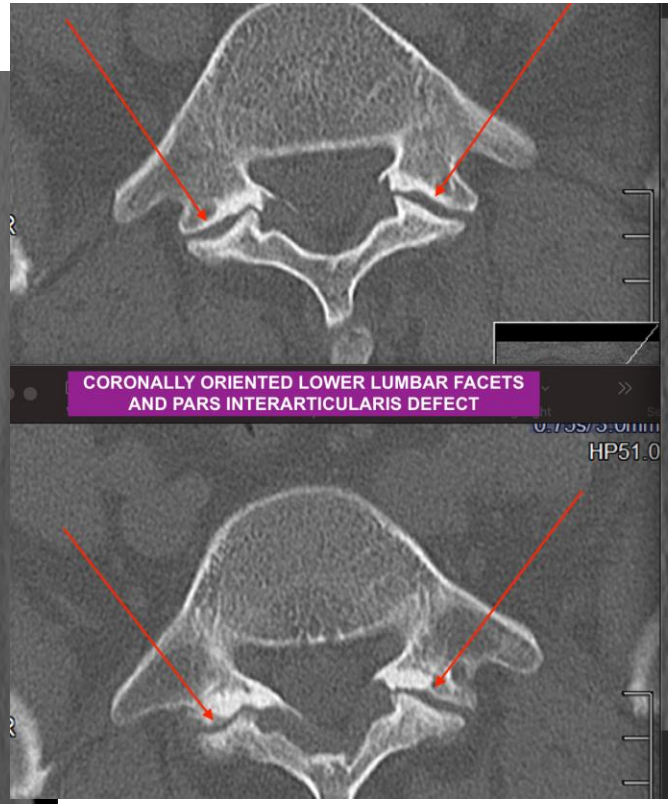
10. Isthmic spondylolisthesis

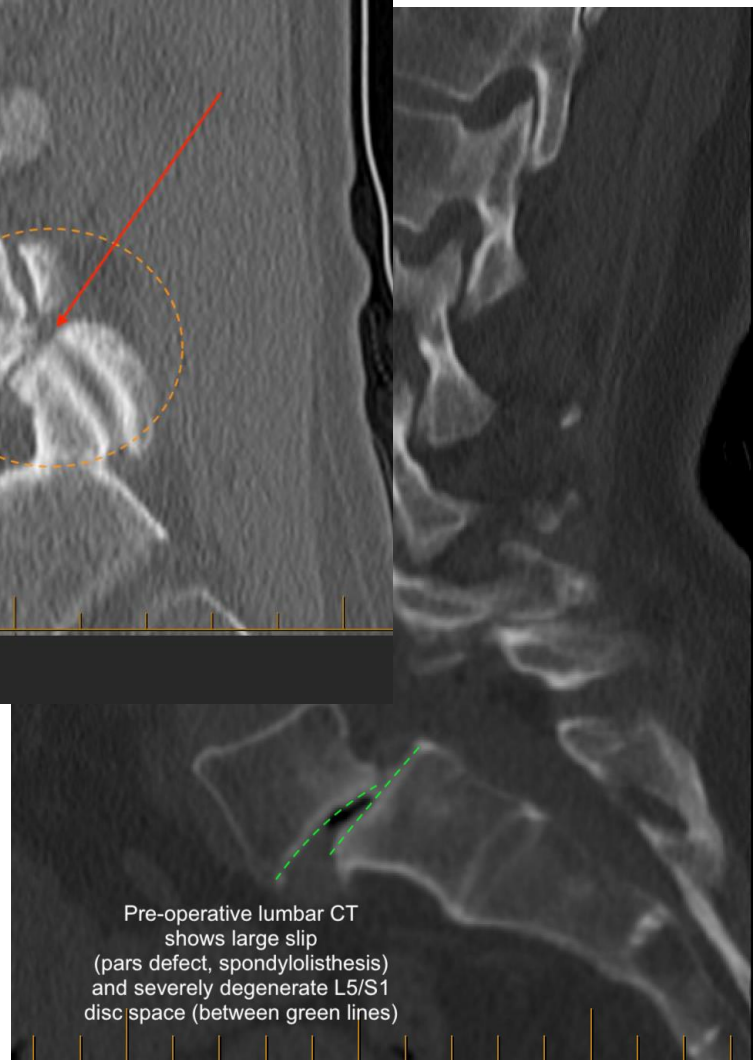


- *Pars interarticularis* absence or injury
- Prevalence 3-12% (asymptomatic adults)
- AKA ‘spondylolysis’, ‘pars defect’
- RFs incl. hyperextension, rotation sports
- Low back pain, gradual onset, progression, worse with extension
- Meyerding grade I-V (where V > 100% spondyloptosis)
- Surgically treated at mean age early 60s
- Nat. Hx radiol. progression, with symptoms (early 30s - mid 50s)
- disc degen. may be key to progression (facets already compromised)

10. Isthmic spondylolisthesis



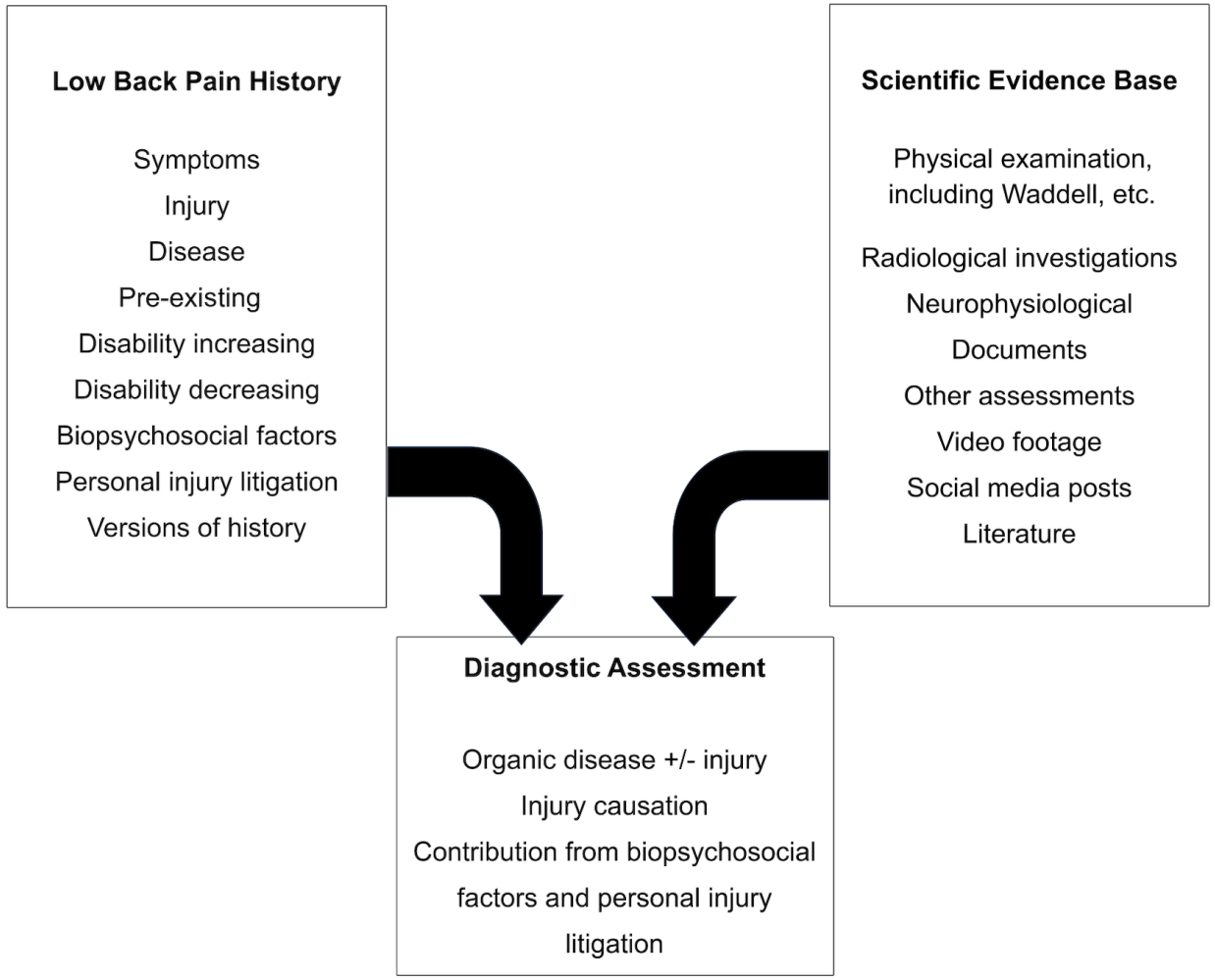




Recap

1. Bertolotti syndrome
2. Klippel-Feil syndrome
3. Scheuermann's disease
4. Kyphoscoliosis
5. Morbid obesity
6. Narrow spinal canal
7. Diffuse idiopathy skeletal hyperostosis (DISH)
8. Chronic smoking effects
9. Adjacent segment degeneration
10. Isthmic spondylolisthesis

IME context



Thank you

AMLC

Khurana (2021) – Smoking and spinal implications

Khurana (2022) – Aetiological apportionment

Khurana & Brazenor (2024) – Forensic approach

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