MAIN SPLITS ON SPONDYLODISCITIS DIAGNOSIS

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DISCLOSURE PARAGRAPHS:

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- Spondylodiscitis is defined as the infectious involvement centered on the intervertebral disc and the adjacent vertebral bodies.
- In children infection often starts in the intervertebral disc itself because direct blood supply is still present.
- In adults infection begins at the vertebral body endplate, extending into the intervertebral disc space and then into the adjacent vertebral body endplate.
- It corresponds to 2 - 7% of all osteomyelitis, and it has a mortality rate of 2 - 12% of cases (when pyogenic).
- The pyogenic spondylodiscitis spinal column involvement is more common in lumbosacral column (48%), than thoracic (35%) and cervical (6.5%) columns.
- When not pyogenic the thoracic spine is often affected, than lumbosacral and cervical columns.
PYOGENIC SPONDILODISCITIS:
- In pyogenic spondylodiscitis *Staphylococcus Aureus* is the most common pathogen in immunologically normal patients and *Salmonella sp.* is the most common in patients with sickle cell anemia. The pyogenic spondylodiscitis epidemiology has a bimodal distribution, with two peaks, one in childhood and the other in the 6th to 7th decades of life. It is more frequent in male subjects and is related with some predisposing factors such as:
  - remote infection (present in 25% of cases),
  - use of intravenous drugs, immunosuppression,
  - chronic medical conditions,
The pyogenic infection spread occurs by hematogenous (major route) or contiguity of the adjacent bones in 95% of cases. Iatrogenic and postoperative disseminations occurs in 2.5% to 5% of cases.
NON-PYOGENIC SPONDYLODISCITIS:

In non-pyogenic spondylodiscitis the most common pathogens includes *Mycobacterium tuberculosis*, *Cryptococcus neoformans*, *Candida sp.*, *Brucellae sp.* and *Granulomatous*. It is more prevalent between the 5th and 6th decades of life and in male patients. **Predisposing factors** includes:

- immunosuppression,
- chronic medical conditions,
- diabetes mellitus,
- malnutrition.

The non-pyogenic infection spread also occurs by hematogenous or contiguity of the adjacent bones.
**CASE 1:** 41 years old male patient with rheumatoid arthritis complaining of severe lumbar pain for two days.

Coronal (A) and sagittal (B) T2W Fat sat images depict *edema on L3-L4 endplates*, initially described as Modic I degenerative changes ([white arrows](#)).

Sagittal (C) and axial (D) T1W post-contrast images reaffirm the *edema on L3-L4 endplates* ([white arrows](#)) and make clearer the adjacent paravertebral soft-tissue commitment ([red arrows](#)).
**CASE 1:** 41 years old male patient with rheumatoid arthritis complaining of severe lumbar pain for two days.

After two days the patient returns unable to walk due to severe pain and a new MRI was performed.

Coronal (A) and sagittal (B) T2W images and sagittal pre- (C) and post- contrast (D) T1W images demonstrate the imaging findings worsening with marked soft-tissue commitment forming abscesses in the psoas muscle (white arrows) and epidural space (red arrows), consistent with an infectious origin.
**MAIN SPLITS ON SPONDYLODISCITIS DIAGNOSIS**

- **CASE 1:** 41 years old male patient with rheumatoid arthritis complaining of severe lumbar pain for two days.

One month after the beginning of the antibiotics therapy the patient returns and a new MRI is performed.

Coronal (A) and sagittal T1W post-contrast (C) images of the exam acquired at the occasion of spondylodiscitis diagnosis.

Coronal T2W (A) and sagittal T1W post-contrast (C) images of the exam acquired one month after the beginning of the antibiotics therapy show an apparent “worsening” of discal and vertebral bodies commitment (white arrows). However this is the expected outcome of the imaging aspect in the set of effective antibiotics therapy. In this case, the improvement is evident as one realizes that there is a significative regression of the soft-tissue commitment and both the abscesses in the psoas muscle and epidural space (red arrows).
CASE 1: TEACHING POINTS

- Infectious spondylodiscitis have a higher prevalence in immunosuppressed patients (treatment for rheumatoid arthritis).

- In cases of espondilodiscal involvement suggestive of Modic I, we should pay attention to the adjacent soft tissues involvement, as this may be the only sign of an infectious etiology.

- In the post-treatment control images of infectious spondylodiscitis there is commonly a dissociation between clinical improvement and imaging findings. In this case, reduced adjacent soft-tissues involvement may indicate good therapeutic evolution.
CASE 2: 23 years old male patient with recent non-irradiated lumbar pain.

Sagittal T1 (A), T2 (B), T2 fat-suppressed (C) and enhanced T1 (D) showing small fluid collection in L4 vertebral body from superior vertebral plateau (white arrows) associated with exuberant adjacent bone marrow edema and enhancement (red arrows). This findings suggests infectious commitment.
CASE 2: 23 years old male patient with recent non-irradiated lumbar pain.

Sagittal enhanced T1 (A) and T2-fat-suppressed MRI (b) showing endplate defects or intranuclear cleft bending of the disk (red arrow) within the superior L4 endplate. This finding favors the diagnosis of acute Schmorl node.
- Although the image aspect is highly suggestive of spondylodiscitis, it must be considered the possibility of other entities such as an acute Schmörl node.

- Thus, the disc morphology, particularly the identification of endplate defects or intranuclear cleft bending of the disk, may be helpful for the correct diagnosis of acute Schmörl's nodes.
CASE 3: 42 years old male patient with lumbar pain for few weeks and poor general condition.

Sagittal T1 (A) and T2 (B) and T2-fat-suppressed (C) MRI showing sharp hypointensity in T1 and T2-WI (white arrows) of the L4 and L5 vertebral bodies with fluid collection in L4 (red arrows) and adjacent bone marrow edemae edema. However there is just mild degenerative changes in L4-L5 intervertebral disc (blue arrows).

Coronal MPR CT reconstruction (D) showing permeative calcifications among the necrotic areas in vertebral bodies (yellow arrows).
CASE 3: TEACHING POINTS

- In cases of suspected tuberculous spondylodiscitis findings of exuberant but indolent destructive process are common, such as: sclerotic margins, lobulated fluid collections and calcifications among the necrotic areas in the CT scans.

- In addition, there is often a dissociation between the degree of involvement of the vertebral bodies and adjacent soft tissues relative to the intervertebral disc, which seems relatively spared.

- Finally, the sharp hypointense T1 and T2 signal in the affected vertebral bodies, even greater than that present in cases of pyogenic discitis, may be a clue to guide the diagnosis of tuberculous or fungal etiology.
**CASE 4:** 47 years old male patient with intermitent lumbar pain for few days that radiates into the buttocks.

Sagittal T2 fat-suppressed (A) MRI showing focal bone marrow edema in L4 vertebral body (white arrow).

Sagittal T1 (B) and T1-enhanced (C) MRI showing sharp hypointensity (red arrows) and mild enhancement (blue arrows). This findings admit spondylodiscitis as the major diagnosis.

The patient returns with the same pain and a new MRI is performed after few weeks: Sagittal T1 (D) and T1-enhanced (E) MRI showing hypointensity (red arrows) and enhancement (blue arrows) in L4 vertebral body. However, there is no destructive changes or even cortical vertebral plateau irregularities (yellow arrows). With these findings the patient underwent to a biopsy and was diagnosed with lung cancer metastasis.
CASE 4: TEACHING POINTS

- When facing a vertebral body with hypointense T1 signal the hypothesis of SPONDYLODISCITIS should indeed be considered in the differential diagnosis.

- However, if this there is a sharp hypointensity on T1, a nodular configuration or, especially, if there is no spondylodiscal locoregional destruction, other hypotheses must be considered, such as TUMORS.
CASE 5: 46 years old female patient with history of previous neuroendocrine tumour complaining of lumbar pain for about two weeks.

Coronal (A) and sagittal (B) T1W images demonstrate a marked low signal intensity (white arrows) on the vertebral body of T6 extending to the inferior disk and a lobulated central area (red arrows). Sagittal T2W (C) and T2W Fat sat (D) images characterize the central area as a heterogeneous collection with lobulated contours (blue arrows). With such findings and the neoplastic history, the possibility of a secondary tumoral lesion was assumed as the first diagnostic hypothesis.
**CASE 5:** After 3 months the patient returns for a new control MRI.

Sagittal T1 pre- (A) and sagittal (B) and axial (C) T1W post-contrast images depict an increase in the extension of the area with marked low signal intensity in the vertebral body of T6 (white arrows) with greater extension to the inferior disk, superior endplate of T7 and left interapophysary joint (blue arrow). There is also an increase of the collection with lobulated and sclerotic contours and heterogeneous hyperproteic content (red arrows).

Sagittal CT image (D) reveal calcifications amid the collection in the vertebral bodies (yellow arrow) and reaffirm the lobulated and sclerotic contours that surround it. The findings make the hypothesis of tuberculous spondylodiscitis stronger, that was later confirmed through biopsy.
- The pathogens that do not produce proteolytic enzymes, such as *mycobacteria*, tend to **spread and compromise the disc space more slowly**. This pathogens also lead to later clinical manifestations with a **cycle of destruction and repair** taking several months to be completed.

- The appearance of **fluid collection with sclerotic and lobulated halo**, with permeative calcifications, is highly suggestive of **TUBERCULOUS SPONDYLODISCITIS**.

- Finally, **few cancers affect subsequent vertebral bodies in a continuum with the disc commitment**. An example of this manifestation occurs in **LYMPHOMAS and PROSTATE METASTASES**.
CASE 6: 36 years old male immunosuppressed patient (HIV with anal lymphoma) with lumbar pain for few days after radiotherapy.

Sequential sagittal T2 (A) and T1-enhanced (B) showing fluid collections and bone marrow edema (white arrows) in contiguous lumbar vertebral bodies with intervertebral disc commitment (red arrows). These findings favors the diagnosis of pyogenic spondylodiscitis.

Despite the suggestive aspects of infectious spondylodiscitis, the antibiotic therapy did not improve illness resolution. Patient died and the diagnosis of lymphoma was confirmed in these vertebral bodies.
- Even in cases whose spectrum of imaging findings clearly suggest infectious spondylodiscitis, **CLINICAL DATA** should always guide the diagnosis / treatment plan.

- As exemplified by the case, **there are some rare tumors** that can show indistinguishable imaging findings of an infectious spondylodiscitis with contiguous involvement of two vertebral bodies and the corresponding intervertebral disc. The **LYMPHOMA** and **PROSTATE TUMOR METASTASIS** are the two main tumoral causes.
**CASE 7:** 16 years old male patient with abdominal pain, and 1 month hospital internship, when this lumbar MRI was performed.

Sagittal T1 (A), T2 (B), T2-fat-suppressed (C) and enhanced-T1 (D) showing bone marrow edema (white arrows) and enhancement (red arrows) in the L4 superior vertebral plateau without cortical irregularities or erosions, fluid collections nor disc commitment. In parallel, blood culture showed *Salmonella sp.* growth.
CASE 7: 16 years old male patient with abdominal pain, and 1 month hospital internship, when this lumbar MRI was performed.

Patient started antibiotic therapy with clinical and laboratorial improvement and after 1 month new RM control was performed.

Sequential coronal images T2 (A and B) and sagittal enhanced-T1 (C and D) MRI showing more bone marrow edema and enhancement of the L4 vertebral body (white arrows) and now with cortical erosions and irregularities of the vertebral plateau (red arrows). These findings and evolution favors the diagnosis of pyogenic spondylodiscitis.
After 6 months of antibiotic therapy with ciprofloxacin the patient underwent a MRI control.

CASE 7: 16 years old male patient with abdominal pain, and 1 month hospital internship, when this lumbar MRI was performed.

Sequential axial post-contrast T1 (A and B) images performed one month after the start of antibiotic treatment showing erosion in the vertebral plateau (white arrows) with intense contrast enhancement.

Sequential axial post-contrast T1 (C and D) images performed after 6 months of antibiotic therapy showing marked regression of findings suggestive of inflammatory / infectious activity, remaining sequelae changes (red arrows).
CASE 7: TEACHING POINTS

- In children under 6 years of age the infectious process begins in the intervertebral disc, as there are still local vascularization. Then the process extends to the adjacent vertebral bodies.

- From adolescence, the process begins in the endplate of the vertebral plateau, the more vascularized area at this stage, and then extends to the disk and adjacent vertebral body.

- In infants up to 6 months old the infection is not locally restricted and quickly progresses with septicemia.
**CASES 8:**

A) 19 years old male patient with sickle cell anemia and intense lumbar and hip pain.

Radiographic image of the lumbar vertebrae showing the classic "H-shaped vertebrae", commonly found in sickle cell anemia as sequelae of previous bone infarcts (white arrows). Sagittal T1-WI MRI image (B) showing diffuse hypointensity of the vertebral bodies (red arrows). Sagittal T2 image (C) and post-contrast-T1 (D) characterize an acute infarction in L3 with central area that does not enhance (yellow arrows) and bone marrow edema and enhancement surrounding (blue arrows). Therefore, the pain is determined by bone infarction, with no infectious causes related.
**CASES 8:**

**B)** 24 years old male patient with sickle cell anemia.

Sagittal T1 (A), T2 (B) and T1-enhanced (C) fat-suppressed images showing characteristic findings of acute bone infarction in sickle cell anemia characterized by marked hyperintensity on T1 (white arrows) and T2 (red arrows) and predominantly perioheric enhancement (blue arrows) peripheral. The hyperintensity on T1 pre-contrast fat-suppressed image (A) is caused by dense red blood cells sequestered in the bone marrow and subperiosteal spaces.
**CASES 8:**

C) 22 years old male patient with sickle cell anemia.

Coronal enhanced T1-weighted images (A and B) showing the findings of spondylodiscitis / infectious osteomyelitis with intraosseous collections with peripheral enhancement (white arrows) and multiple paraspinal and psoas muscle abscess (red arrows).
Differentiating between a bone infarction and an infectious spondylodiscitis is a diagnostic challenge. Both conditions can lead to areas of edema and heterogeneous enhancement.

- The hyperintensity on T1-fat-suppressed-weighted images without contrast represent areas of medullary infarction, with dense red blood cells sequestered in the bone marrow and subperiosteal spaces. These areas also have hyperintense signal in T2, but the enhancement is only peripheric.

- The soft tissue involvement may favor the diagnosis of Infectious Spondylodiscitis.
CASE 9: 68 years old female patient with chronic renal disease and progressive cervical pain for weeks.

Lateral radiographic image (A) of the cervical spine showing extensive destructive changes in C4 and C5 vertebral bodies with partial collapse / anterior wedging (white arrows). Sagittal T1 (B) and T2 (C) images confirming the vertebral collapse (red arrows), but despite the irregularitis of the vertebrae plateaus, there are sharp cortical reaction sclerosis, intradiscal gas (blue arrow) and paraspinal / epidural soft tissue commitment.
CASE 9: 68 years old female patient with chronic renal disease and progressive cervical pain for weeks.

Sagittal (A) and axial (B) T1 images showing discrepancy in the pattern of involvement of the vertebral bodies and interapophyseal joints (white arrows), relatively preserved against the extensive commitment of the vertebral bodies. These findings strongly favor the diagnosis of spondylopathy of patients with renal chronic disease in relation to infectious Spondylodiscitis.
- In patients with chronic renal disease, the finding of exuberant destructive involvement of the vertebral bodies can easily be misinterpreted as a spondylodiscitis.

- A valuable tip to help in the differential diagnosis of a spondylopathy of patients with chronic kidney disease is the relative preservation of facet joint.

- Another finding that favors the diagnosis of spondylopathy of patients with chronic kidney disease is the intradiscal gas finding.
**CASE 10:** 52 years old male patient with diabetes and lumbar pain. Lateral radiograph (A) and sagittal CT MPR image of the lumbar spine showing cortical erosions and bone fragmentation of the L5-S1 vertebral plateaus (**white arrows**) with intradiscal gas (**red arrows**), diffuse bone sclerosis and bone formation (**blue arrows**). The findings admit infectious spondylodiscitis as one of the main hypotheses. Notice that, similar to what occurs in spondylopathy in chronic renal patients the interapophyseal joints are spared (**yellow arrow**).
CASE 10: 52 years old male patient with diabetes and lumbar pain.

Sagittal T1 (A), T2 (B) and T1-post-contrast (C) images reinforce the hypothesis of infectious spondylodiscitis showing cortical fragmentation and sclerosis of the L5-S1 vertebral plateaus (white arrows), extensive bone marrow edema with hypointense signal on T1, hyperintense signal in T2 and contrast enhancement (red arrows) of the vertebral bodies, and fluid collection in the intervertebral space with peripheral contrast-enhancement (blue arrow). These findings favor the diagnosis of infectious spondylodiscitis, but after further investigation, the diagnosis of spinal neuroarthropathy (Charcot) was made.
CASE 10: TEACHING POINTS

- Just like the case of spondylopathy in patients with chronic kidney disease in patients with **spinal neuroarthropathy** the differential diagnosis of espondilodiscal involvement in relation to an infectious spondylodiscitis can be **very difficult**.

- In spinal neuroarthropathy the dissociation between the involvement of the vertebral bodies / discs and facet joint should also be used as a hint to guide the differential diagnosis, as well as in spondylopathy of patients with chronic kidney disease, the **interapophyseal joints are also spared**.

- In addition, the finding of **intradiscal gas and reactive sclerosis** in the tomographic studies or magnetic resonance imaging also favor the hypothesis of spinal neuroarthropathy.
CASE 11: 38 years old male patient with lumbar metalis arthrodesis and lumbar pain.

Anteroposterior (A) and lateral (B) radiographs views of the lumbar spine showing L2-L5 metal arthrodesis (white arrows) and degenerative changes in L1-L2 level characterized by sharply disc space narrowing, cortical bone sclerosis and irregularities in affixed vertebral plateaus (red arrows).
CASE 11: 38 years old male patient with lumbar metalis arthrodesis and lumbar pain.

Sagittal T1 (A), STIR (B), T2 (C) and T1-post-contrast (D) demonstrate marked reduction in L1-L2 disc height (white arrows), cortical bone irregularities and erosions of the vertebral plateaus (red arrows), bone marrow edema (blue arrows) and small anterior epidural collection (yellow arrows). The image findings favors for the diagnosis of infectious spondylodiscitis, but with the characterization of a hematoma (hyperintensity in T1-pre-contrast), the diagnosis of secondary degenerative changes related to the post-spinal fusion adjacent segment disease was firmed.
- In the post-junctional arthrodesis syndrome the level immediately above the arthrodesis ends up receiving an axial overload which can trigger the cascade of spondylodiscal degenerative changes.

- The spectrum of findings may sometimes overlap to a infectious spondylodiscitis. For accurate differential diagnosis attention should be paid to the involvement of paraspinal soft tissue, much more exuberant than in purely degenerative contexts non-inflammatory / infectious.

- In the exemplified case the retrovertebral fluid collection appeared as confounder, but after characterized as a hematoma, the diagnosis of spondylodiscitis lost power at the expense of a junctional post-fusion syndrome.
CONCLUSION:

- Imaging studies plays an essential role in the early diagnosis of infectious spondylodiscitis.

- Still, the diagnostic approach is subject to various traps, even in cases whose spectrum of findings are characteristic.

- Thus, knowing these pitfalls should be general knowledge of radiologists, especially those with particular interest in musculoskeletal radiology.


