

Air in the spinal canal: How did it get there?

Angela Guarnizo MD, Carlos Torres MD, FRCPC.

Department of Radiology

University of Ottawa, The Ottawa Hospital

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Disclosure of Conflict of Interest

- No Disclosures

Objectives

1. Describe the imaging findings associated with internal and external pneumorrhachis.
2. Review the common and infrequent pathologies leading to the presence of air within the epidural and/or subarachnoid spaces of the spinal canal.

Pneumorrhachis

- ✓ Corresponds to the presence of air within the epidural and/or subarachnoid spaces of the spinal canal.

Internal

(intradural, subdural or subarachnoid)

- Related to severe head or spine injury
- Associated to a dural tear

External

(extradural, epidural)

- Related to penetrating injury
- Usually in the posterior epidural space due to reduced resistance of the connective tissue

Clinical Findings

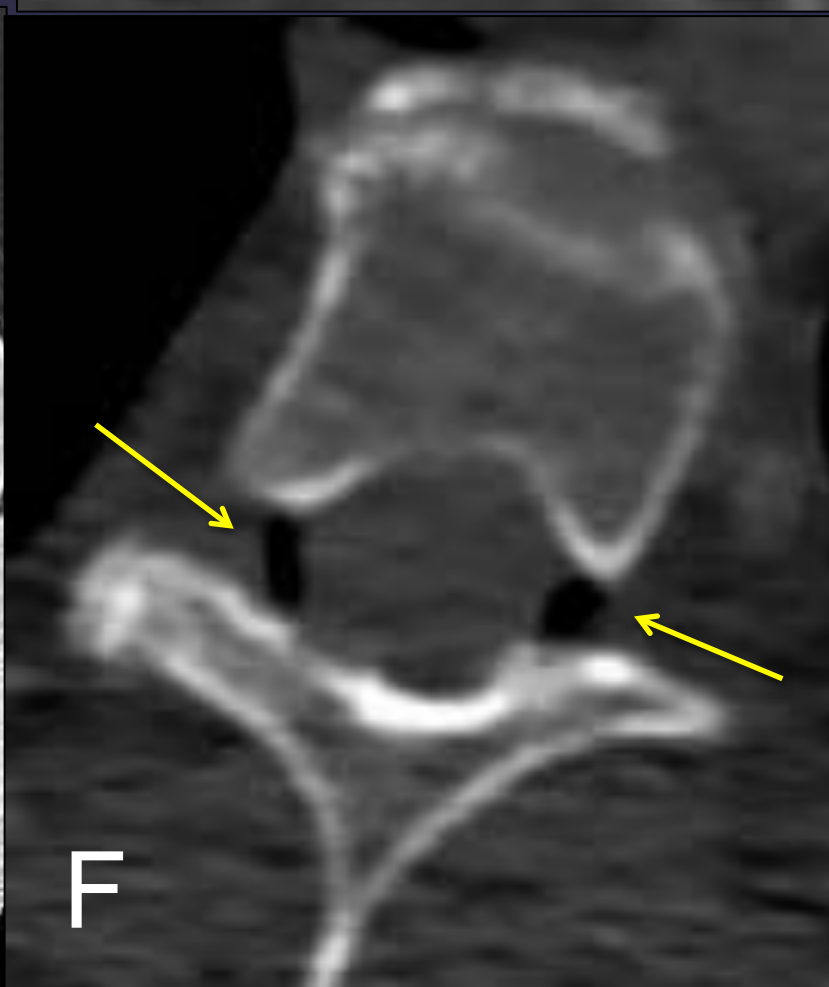
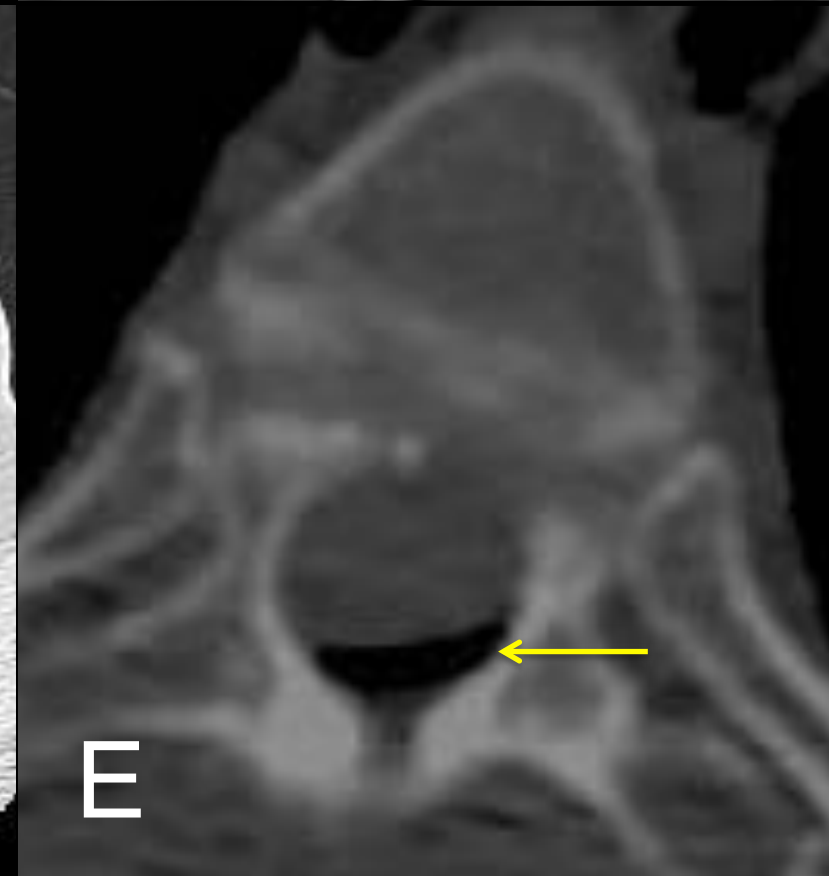
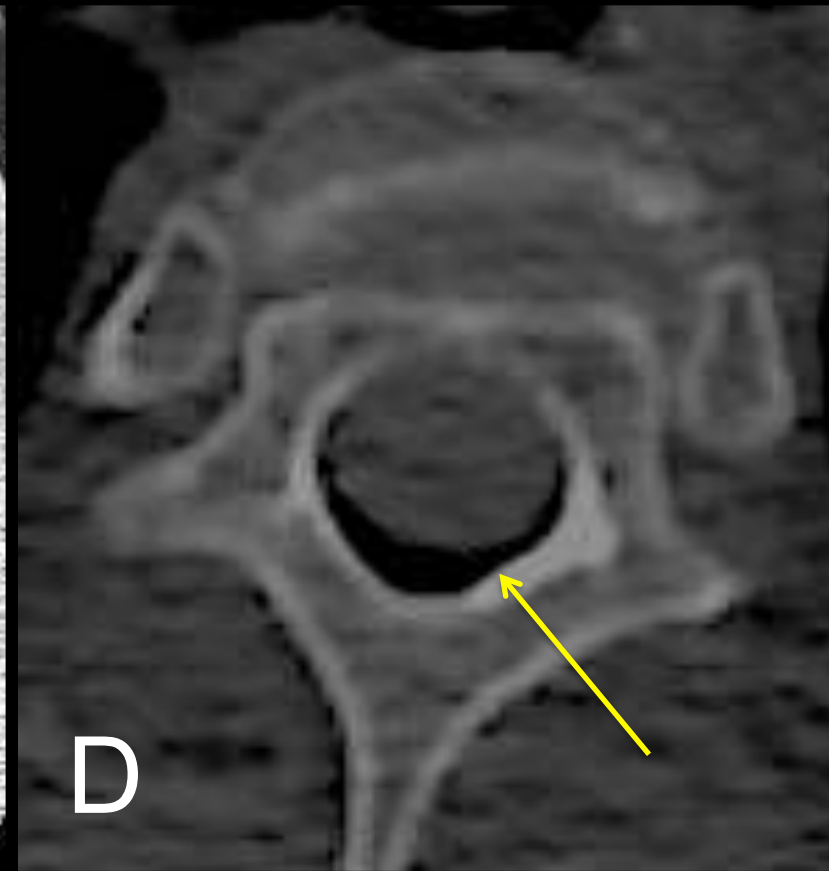
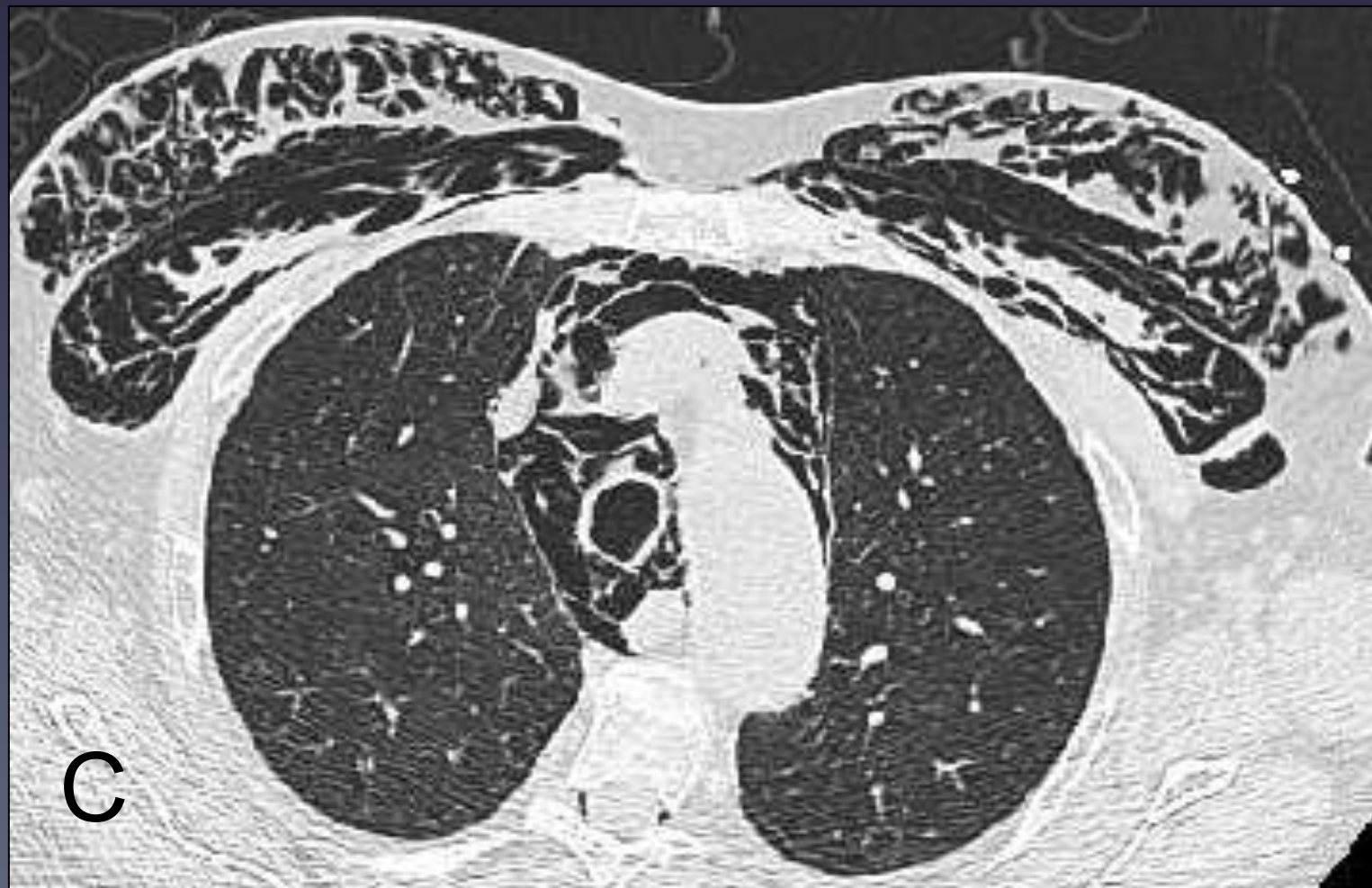
- ✓ Most cases asymptomatic
- ✓ The one way air valve mechanism caused by the intradural air trapped in the cerebrospinal compartment can cause tension pneumorrhachis and pneumocephalus
- ✓ In cases of iatrogenic pneumorrhachis, the introduction of air into the spinal canal behaves as a space occupying lesion that may cause focal neurological deficits
- ✓ The air trapped in the subcutaneous soft tissues may cause pain and discomfort

Causes of Pneumorrhachis

Non Traumatic

Increase intra-thoracic pressure

- ✓ Usually secondary to increased intrabronchial pressure and secondary alveolar rupture
- ✓ Most of the cases are secondary to *violent coughing, airway diseases and barotrauma due to Valsalva*
- ✓ The lack of fascial planes allows air under high pressure within the posterior mediastinum to dissect along the prevertebral fascial planes, air then extends into the neural foramina and into the epidural space



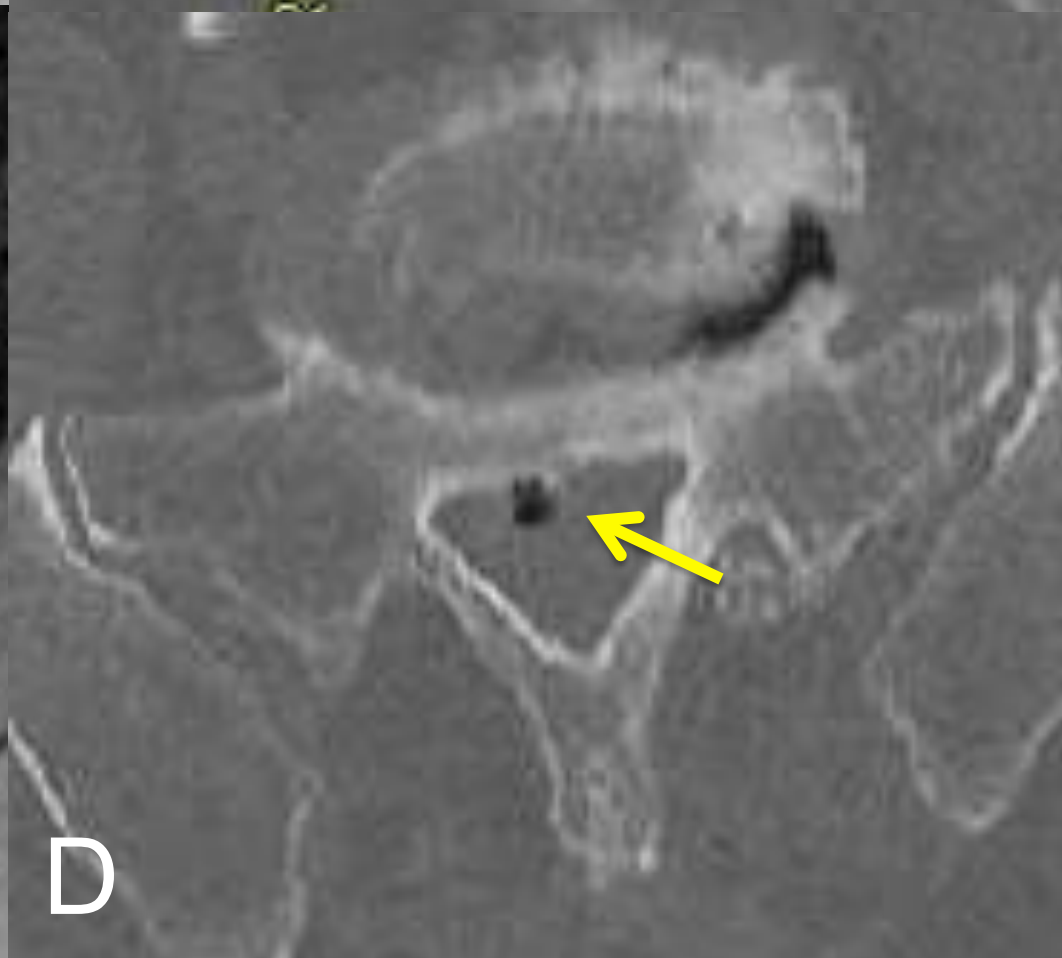
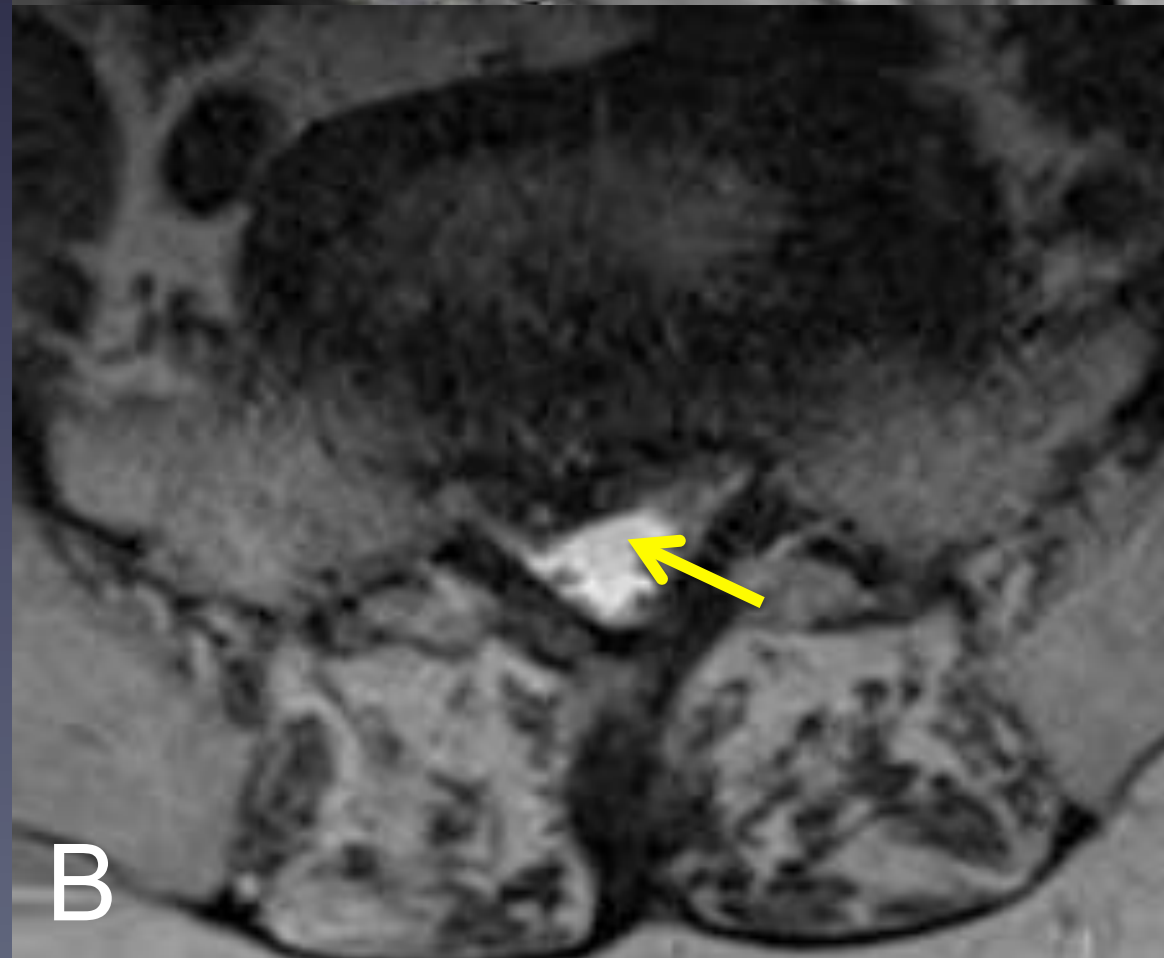
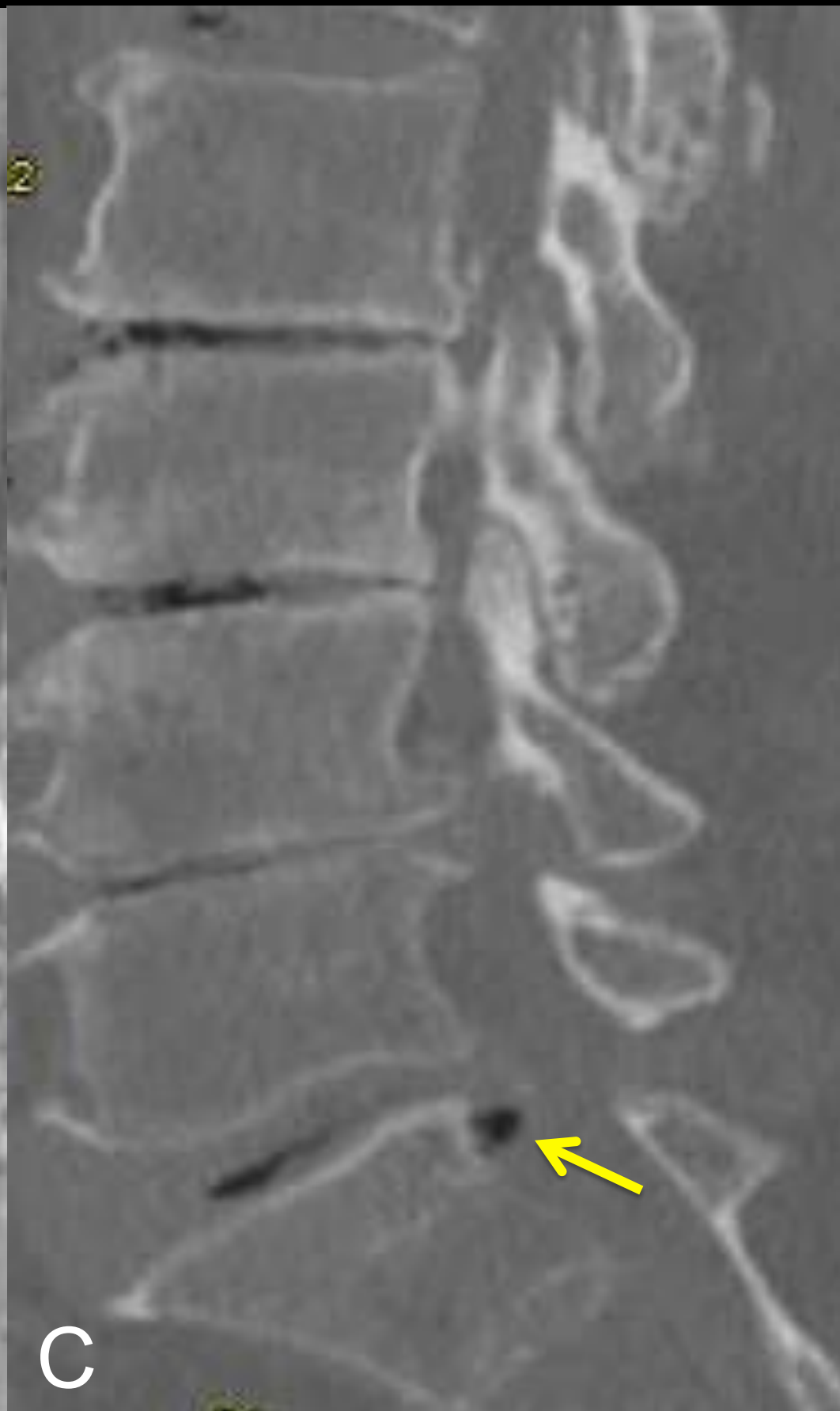
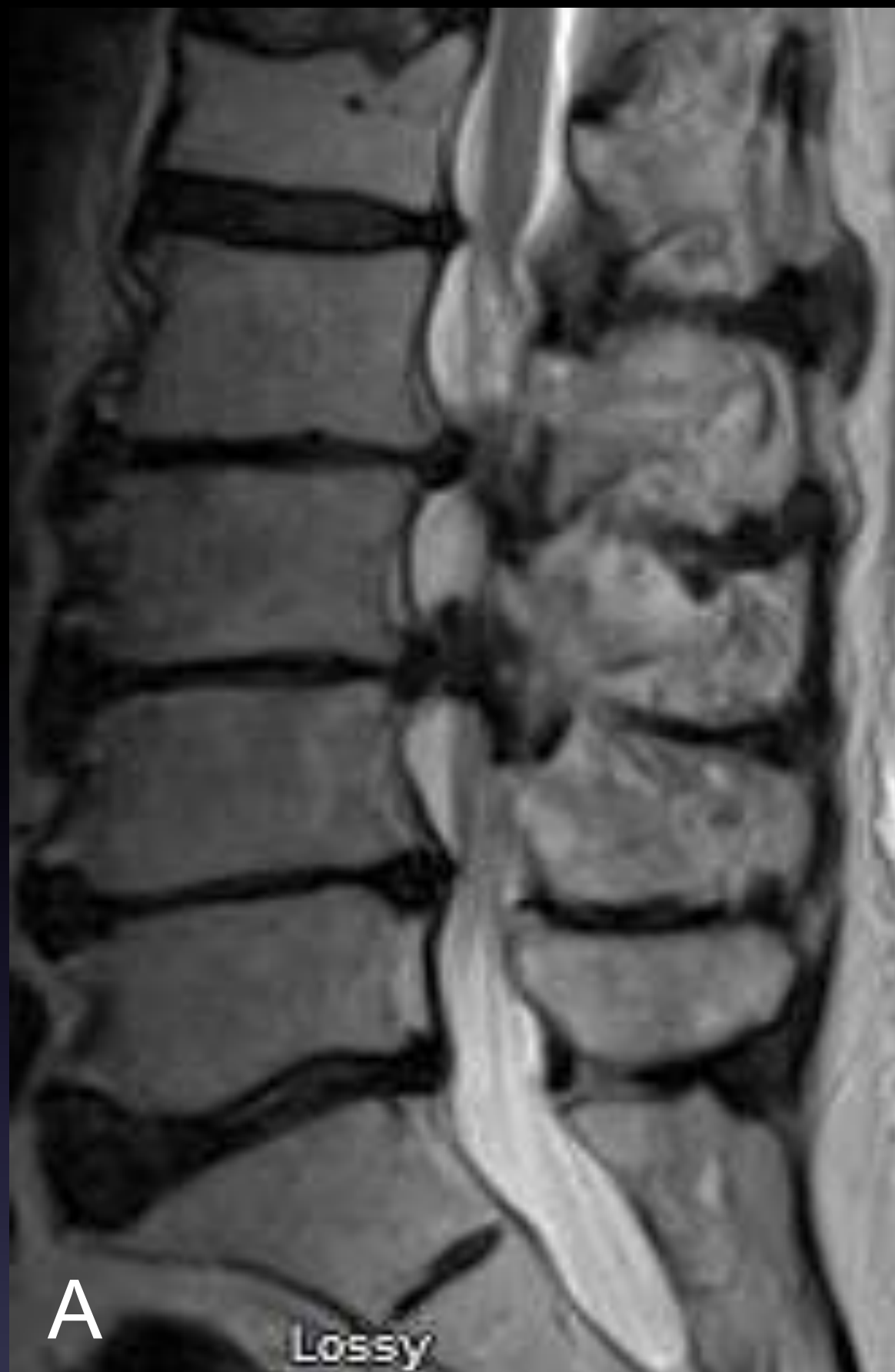
A 85 y/o female post intubation for fistula repair.

Axial chest CT images (A,B,C) show extensive subcutaneous emphysema and pneumomediastinum.

Axial images centered in the thoracic spine at the same levels (D,E,F) show air within the posterior and lateral aspect of the spinal canal

Degenerative Disease

- ✓ Degenerated nucleus pulposus of the disc can herniate into the spinal canal or into the neural foramen resulting in herniated disc with gas
- ✓ In long standing disease the gas within the disc is expelled by “valve mechanism” through a weak spot in the annulus fibrosus. The air usually remains within a capsule or pseudocapsule
- ✓ Prolonged distraction within the facets produces gas that can be seen within cysts of the ligamentum flavum



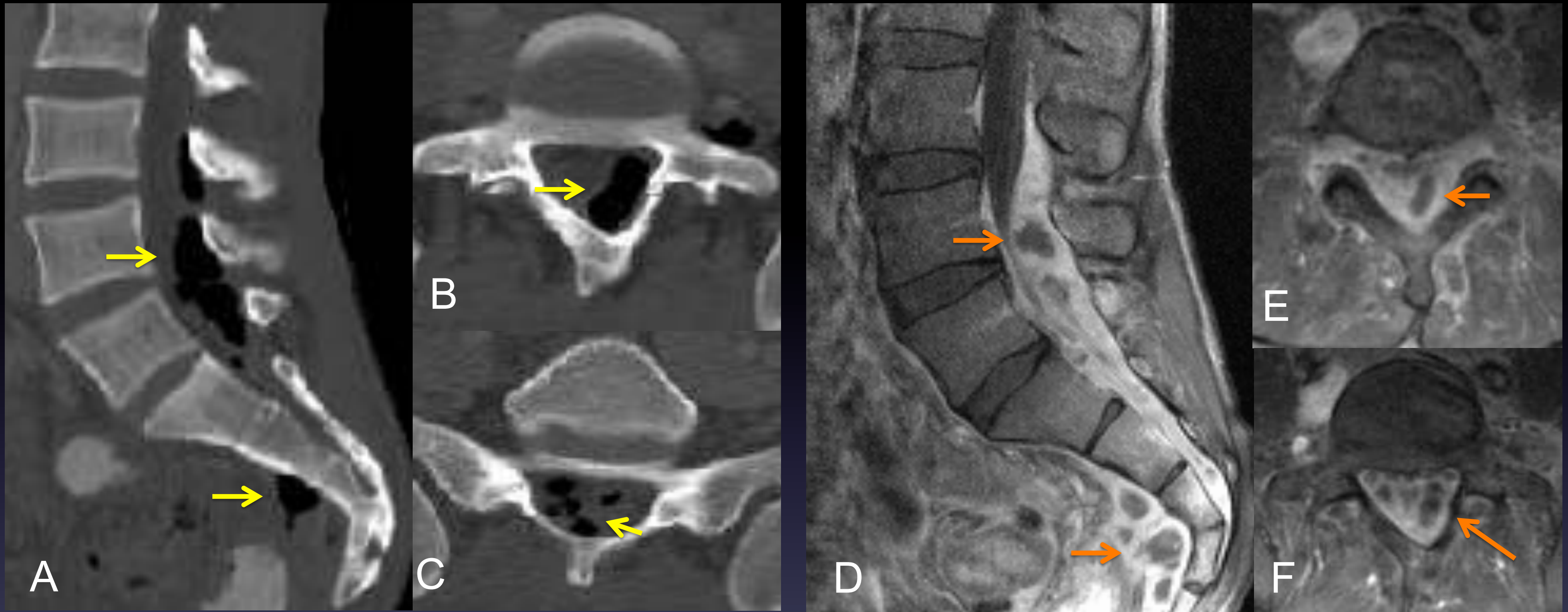
74 y/o male with back pain and right leg pain.

Sagittal and axial T2W images (A,B) of an MRI of the lumbar spine, show constitutional narrowing of the spinal canal and multilevel degenerative changes. Right central disc protrusion at L5-S1 causes effacement of the right subarticular recess.

Sagittal and axial images (C,D) of a CT scan of the lumbar spine show vacuum phenomenon at multiple disc levels and air within the herniated disc at L5-S1

Infection

- ✓ Most frequent in immunocompromised patients or patients with IVDU
- ✓ Intra spinal air could be related to **rapid progression of infectious inflammatory** process usually in cases of *S. aureus* infection.
- ✓ Pneumorrhachis can be seen in cases of **fistula between the rectum and the spinal canal** leading to abscess formation within the epidural space.



A 31 y/o male with right lower abdominal pain for 1 – 2 months. CT of lumbar spine, sagittal and axial images (A, B, C) showing air in the presacral region and within the spinal canal.

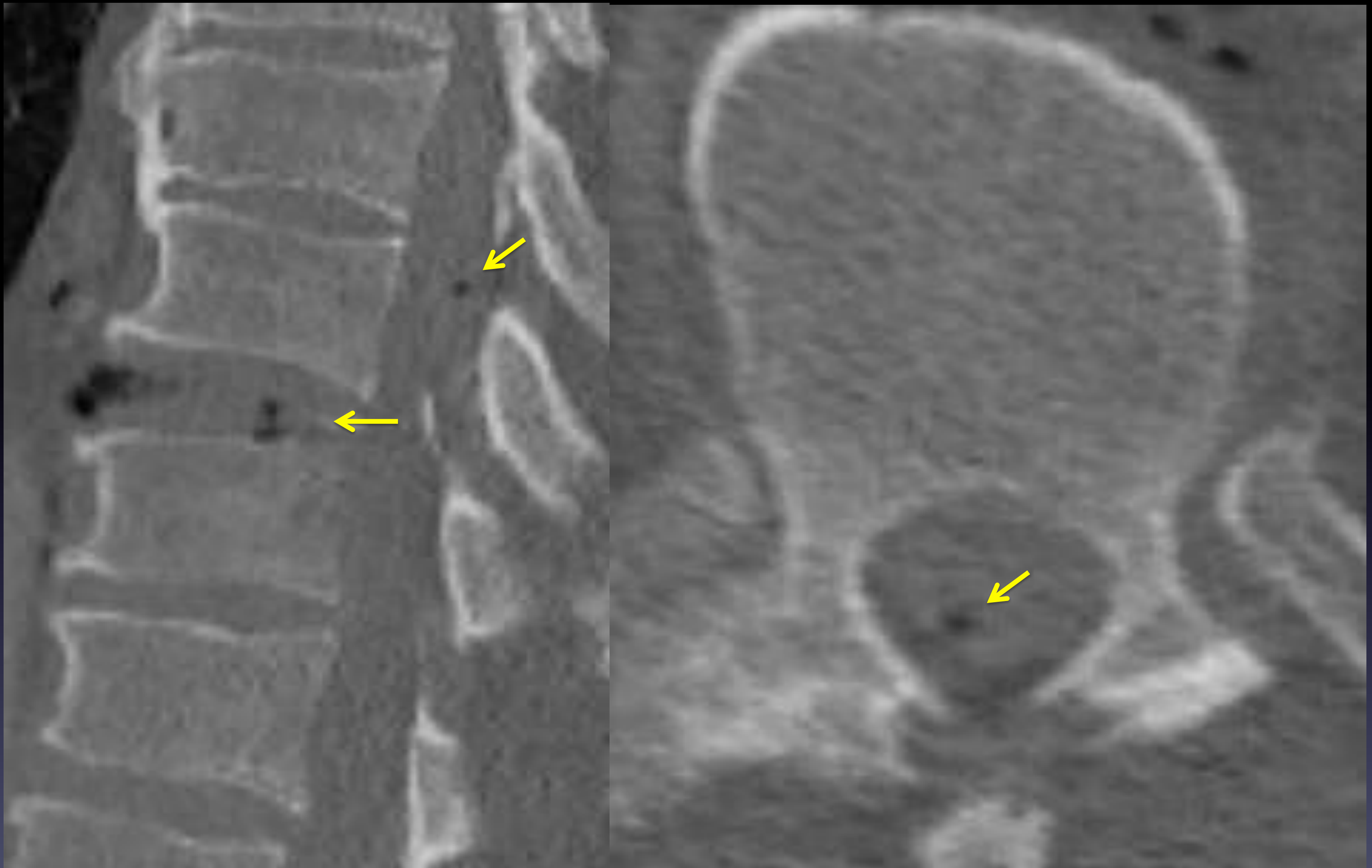
Sagittal and axial T1-weighted sequences post contrast (D, E, F) show an epidural abscess extending from L3 to the sacrum and a multiloculated fluid collection in the presacral space.

Causes of Pneumorrhachis

Trauma

Trauma

- ✓ Marker of severe injury
- ✓ Extradural air: associated with penetrating injury without intracranial air and without dural tear
- ✓ Intradural air: develops from a fistula caused by dural and pleural tears in thoracic spine trauma
- ✓ Can be associated with skull base fractures
- ✓ The dural tear allows the communication with the subarachnoid space.
- ✓ Patients with dural tear have 25% risk of meningitis and 16% mortality rate.



A 58 y/o male belted driver and MVC, presenting with paraplegia from the level of T12. Sagittal and axial CT images of the thoracic spine show widening of the intervertebral T9-T10 disc space with associated mild T9 retrolisthesis. There is gas within the disc and within the spinal canal (arrows).

Causes of Pneumorrhachis

Iatrogenic

Iatrogenic

- ✓ Usually after epidural anesthesia or lumbar puncture. Other causes include chest tube placement and surgery
- ✓ The pressure in the epidural space is lower than in the subarachnoid space. The air enters into the epidural space due to loss of resistance
- ✓ In cases of lumbar puncture or epidural anesthesia the air passing through the stylet-free puncture needle enters into the epidural space



A 75 y/o female with previous T9-L1 fusion presenting with progressive weakness and pain in lower extremities. Sagittal and axial CT myelogram showing small amount of air in the anterior epidural space post lumbar puncture



A 54 y/o male ongoing pain and weakness in left leg. Post op of CSF leak repair. Sagittal and axial CT images of a lumbar myelogram show extensive postoperative changes from T11 to L5 with a large amount of air in the posterior epidural space causing compression of the thecal sac and cauda equina nerve roots.

Treatment

- ✓ The management is individualized
- ✓ In cases of internal pneumorrhachis, which is usually associated with severe injury, it requires urgent intervention to prevent morbidity and mortality
- ✓ Cases of external pneumorrhachis usually resolve spontaneously
- ✓ Prophylactic management with antibiotics is not recommended

Conclusion

- ✓ Pneumorrhachis is an unusual self limited finding, which could be associated with different etiologies, mostly iatrogenic
- ✓ Identification of air within the spinal canal should prompt an immediate search for a potential unexpected underlying pathology

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