"Air" in bones: a pictorial assay

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Learning objectives

To illustrate that the presence of a vacuum within the osseous structures is often suggesting a pathogenetic mechanism and may highlight the underlying pathology.

Background

Air is commonly seen with imaging in various parts of the human body. Although air is a normal finding in the respiratory and digestive systems, it is pathologic when seen in the integumentary, musculoskeletal, cardiovascular and central nervous system. The use of terms air and vacuum in radiological reports is misleading since nitrogen is the major constituent of these very low density areas within the bones and joints and the term gas is more appropriate. Gas in joint spaces is a very frequent finding and a strong indication of degenerative joint disease whereas intraosseous gas is an unusual finding but its presence has been described as a sign in a variety of clinical conditions. D. Resnik in 1981 published a radiographic study of vacuum phenomena on cadaveric spines. [1]

Imaging findings OR Procedure details

This study includes base or reformatted CT images from patients of both genders with a wide age-range. The gas collection was helpful to establish the diagnosis or narrow the differential diagnosis in all cases. The intraosseous gas was detected incidentally and its presence was confirmed by measuring the "Hounsfield" units. The cutoff point that we used to attribute a low density collection to gas was -120HU.

There are different ways that air enters an osseous structure.

In case of infection, air is produced and released by anaerobes or gas-forming aerobes. This is a well documented knowledge in soft tissue infections. In osteomyelitis, gas collection is infrequently encountered and could mislead the correct diagnosis when depicted. Associated imaging and clinical findings are required for the correct diagnosis. As the infectious-related gas is generated under high pressure, diffuse and small radiolucent collections (bubbles) are seen. [2-5] (Fig. 1).

On the contrary, close to a degenerated joint, gas collects under negative pressure and creates distinct and larger gaseous cavities or clefts. Such lesion can be seen in virtually any bone but they are most commonly located in the sacrum, ileum, ribs and vertebrae (Fig 2,3). In the vertebral column they appear as intaosseous pneumatozyst, and are mostly seen in the cervical and upper thoracic region in the posterolateral corner of the
vertebra (Fig 4-7). The extension of gas from neighboring intervertebral disk, facet, and uncovertebral joint into the subchondral bone through the vertebral end plate might be the possible pathomechanism[4]. They are assumed to progress to a fluid filled cyst and later in their evolution to be replaced by granulation tissue [6,7] (Fig.8.9).

A rare location of gas collections suggesting a degenerative cause in the vertebral column is in case of spinous process impingement (Baastrup disease) or "kissing spine" mostly involving the lower two lumbar segments [8] (Fig 10-13).

Mechanical instability and motility drives the air between the osseous fragments under negative pressure and that results in the "vacuum phenomenon" that has been reported as a definite CT sign of non-united fracture (Fig 14) or unstable osteochondral injury (Fig 15) The diagnostic value of this sign is limited by the fact that its absence cannot be used to establish union if no bony bridging is seen [9].

Intraosseous gas is a finding that highlights bone ischemia in the setting of avascular necrosis (AVN) in the long bones, mostly in the proximal femur and the proximal humerus, the talus, and rarely the carpal lunate, the metatarsal head and the tarsal navicular bone. The "crescent sign" is a curvilinear gas collection in the subhondral bone that is a established criterion of stage III AVN [10] (Fig16,17).

In the spine, the presence of gas has been described as "the intravertebral vacuum phenomenon" (IVP) or "cleft" sign, corresponding to a well-accepted sign of a benign disorder, and could exclude malignant infiltration of a vertebra [11,12](Fig 18-20). The exact mechanism is not clear but osteoporosis and resulting bone ischemia associated with non-healing vertebral collapse and pseudoarthrosis is condisered to be the pathogenetic mechanism [13]. Since pathological vertebral fractures are a major challenge in radiology, the correct diagnosis of such is important in patient management. The specificity of IVP as an indicator of osteonecrosis underlying the pathological fracture is 99%. Case reports though have attributed gas collection following a metastatic deposit [14].

Gas within a bone tumor such as an osteochondroma, might suggest pathologic fracture with resulting instability (Fig. 21).

Images for this section:
Fig. 1: Osteomyelitis in the spinous process of lumbar vertebra after iatrogenic inoculation. Note the "bubbly" appearance of the gas collection.
Fig. 2: 74 year old male. CT examination of the lumbar spine
Fig. 3: 37 year old female
Fig. 4: 55 year old male. CT examination of the cervical spine.

Fig. 5: Same patient as previous
Fig. 6: 54 year old male. Section through C6. Note the typical location in the posterolateral corner.
**Fig. 7:** Same patient as previous. Sagital reformation.

![Sagittal reformation image]

**Fig. 8:** 62 year old female patient. Transverse section through C5. Note the pneumatocyst as it fills in with fluid.
Fig. 9: Same patient as previous. Sagital reformation.
**Fig. 10:** 62 year old female. Baastrup disease or "kissing spine". Sagital reformation
**Fig. 11:** 68 year old male. Transverse section though L4.
Fig. 12: 62 year old female. Transverse section through L4
Fig. 13: 78 year old female. Section through L3.
Fig. 14: 7 year old male. Fracture of inferior ramus of the ishium
**Fig. 15:** 15 year old female. Unstable osteochondral lesion seen in talus.
Fig. 16: 27 year old male. Idiopathic avascular necrosis of the hip.
Fig. 17: Same as previous. Coronal reformation.
**Fig. 18:** 84 year old female. Intravertbral vacuum phenomenon.
Fig. 19: 76 year old female. Incidental finding during CT Angiography.

Fig. 20: 71 year old female. Known osteoporosis.
Fig. 21: Ostochondroma
Conclusion

The presence of a gas within the osseous structures is commonly suggesting a mechanism and highlights the underlying pathology. Familiarity with the rare cases presented herein, contributes to accurate diagnosis.

Personal Information

References

8. Resnick D: Digenerative didseases of the spinal column. Radiology 1985;156: 3-14