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Radiology

The Role of Imaging in the Differential Diagnosis between Metastases and Vertebral Osteoporosis

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Abstract **Case Report**

The spine is the most frequent site of bone metastases, particularly those originating from breast and lung cancers. Vertebral osteoporosis, on the other hand, is a common benign condition, usually asymptomatic from a neurological standpoint, but which can sometimes be complicated by vertebral compression fractures causing pain, radiculopathy, or, more rarely, neurological deficits. Distinguishing between osteoporotic and metastatic fractures is a major diagnostic challenge, relying primarily on imaging. Osteoporosis is characterized by diffuse and homogeneous bone demineralization. Vertebral compression fractures are often multiple, predominantly in the thoracolumbar region, with biconcave or wedge-shaped forms. On imaging, the cortical bone remains recognizable and reconstructible, without bone obliteration. On MRI, old osteoporotic vertebral compression fractures show a normal or hyperintense signal on T1-weighted images, while recent forms show a localized, well-defined T1 hypointensity with homogeneous contrast enhancement. The presence of an intrasomatic void is a strong sign suggestive of a benign etiology. Conversely, vertebral metastases cause osteolytic or mixed lesions, often irregular, with cortical effacement, involvement of the posterior wall, and extension to the pedicles, sometimes creating the appearance of a "blind vertebra." The compression fractures are disorganized and frequently accompanied by soft tissue extension or epidural invasion. On MRI, tumor replacement of the bone marrow appears as a diffuse, poorly defined T1 hypointensity with heterogeneous enhancement after gadolinium injection. In conclusion, cross-sectional imaging, particularly CT and MRI, plays a fundamental role in the differential diagnosis between metastases and vertebral osteoporosis, conditioning therapeutic management.

Keywords: Vertebral Osteoporosis, Vertebral Metastases, (CT scan), T1/T2 Signal, Gadolinium Enhancement, Posterior Wall Involvement.

INTRODUCTION

The spine is the most frequent site of bone metastases.

Metastases from breast and lung cancers are the most common. Osteoporosis does not usually present with neurological signs, but sometimes paraplegia, paraparesis, or radiculalgia may occur due to an intraspinal bone fragment. Through a review of the literature, we report in this paper the radiological features and the differential diagnosis between metastases and vertebral osteoporosis.

OSTEOPOROSIS [1-3]

It does not usually present with neurological signs, but sometimes paraplegia, paraparesis, or radiculalgia may occur due to an intraspinal bone fragment. Osteoporosis is accompanied by diffuse and homogeneous demineralization. Standard radiography is not very sensitive for diagnosing demineralization since bone loss must be > 30% to be visualized with conventional radiography.

CT scans are more sensitive. The non-weight-bearing horizontal trabeculae first disappear after thinning; some vertical trabeculae disappear, while others hypertrophy, giving the vertebra a striated appearance.

Bone atrophy weakens the vertebrae, whose resistance becomes insufficient for the stresses they are subjected to. Fractures then occur following minor trauma. Vertebral compression fractures are one of the major signs of osteoporosis; they are usually multiple and predominate in the thoracolumbar region, especially between T12 and L4.

They occur sequentially but without any particular order along the spine. This results in an irregular arrangement of compressed vertebrae and vertebrae of normal height.

The compression is most often biconcave in the thoracolumbar region and wedge-shaped in the thoracic region. Childhood osteoporosis results in a homogeneous biconcavity of all vertebrae. Intraspongious herniations occur in biconcave vertebrae adjacent to a collapsed vertebral endplate and must be distinguished from osteolysis. An important sign in osteoporotic compression fractures is that the fractured cortical bone is not obliterated; the cortical outline can be reconstructed, like a puzzle, using the various fragments without any missing pieces.

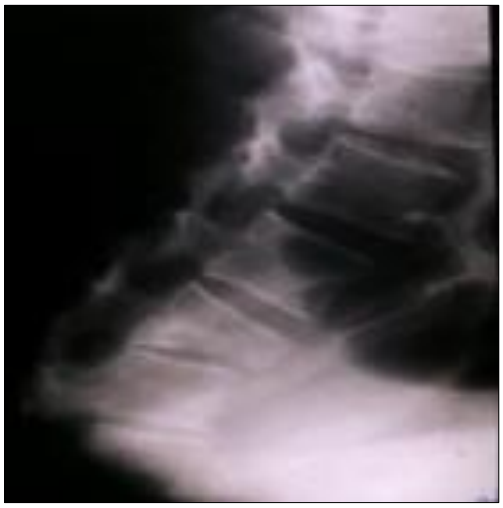

Figure 1: Wedge-shaped compression

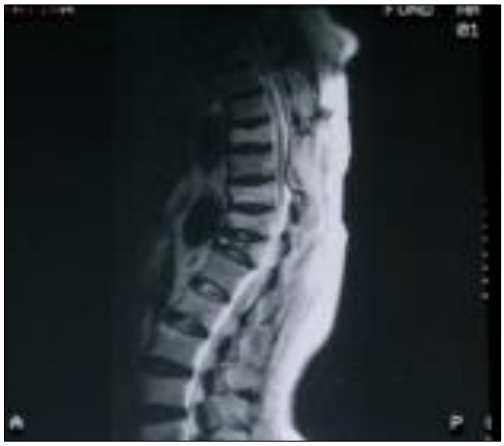

Figure 2: Sagittal section T2 showing harmonious, staggered, biconcave settlements

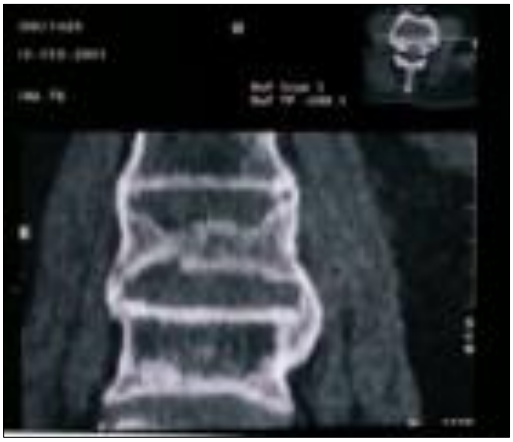

Figure 3: Regulated osteoporotic compression of L3 on coronal reconstruction on CT scan A.

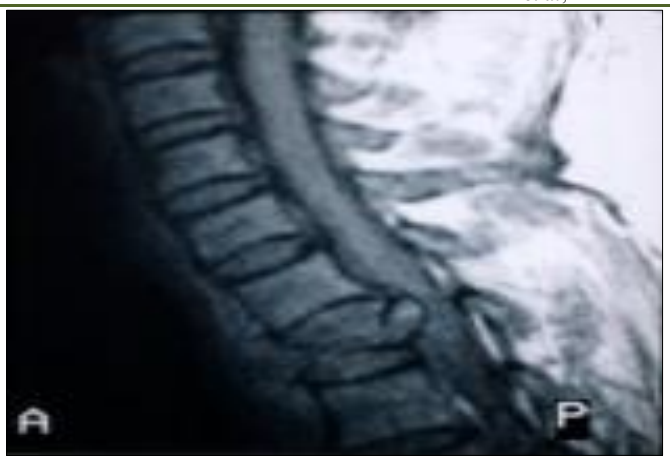

Figure 4: T1 sagittal section showing secondary localization with cortical lysis, posterior wall recession and anterior and lateral epidural infiltration.

Figure 5: Sagittal T1-weighted image showing secondary lesions with cortical lysis, posterior wall recession, and anterior and lateral epidural infiltration

On CT scan: Part of the tumor may be necrotic.

In Localized Forms: the compression fracture is angular and located opposite the osteolysis. Advanced forms present as a flat, disc-shaped fracture.

These fractures may be accompanied by extension into the spinal canal, producing a convex protrusion posteriorly and laterally located in an anterolateral angle of the spinal canal.

On MRI: In malignant compression fractures, the replacement of normal spinal cord tissue by tumor tissue is accompanied by signal loss.

The low signal intensity of tumor compression fractures is randomly distributed and its borders are indistinct. Gadolinium enhancement is heterogeneous, with areas that do not enhance and others that enhance intensely.

In recent compression fractures, there is a small circumferential thickening (< 1 cm) of the soft tissues related to a post-fracture hematoma. On MRI, vertebral compression fractures appear isointense to other vertebrae on T1-weighted sequences, or even hyperintense (due to fatty involution of the red bone marrow). However, for recent fractures:

A T1 hypointensity is observed, also found in malignant fractures. This T1 hypointensity in cases of recent osteoporosis corresponds either to an intracorporeal hematoma, edema, or an inflammatory infiltrate. The hypointensity is localized, with well-defined borders, located in the vertebral endplate adjacent to the fracture. Gadolinium enhancement is homogeneous. On T2-weighted sequences: The signal of osteoporotic fractures is normal or hyperintense, located below the fractured endplate. Pseudo-malignant osteoporotic fractures correspond to a rapid collapse of the vertebral body with osteolysis and bone fragmentation, clearly visible on CT scans. The phenomenon of disc voids in osteoporosis: A linear, air-filled image may be identified in some cases related to bone necrosis; this suggests a benign etiology.

This is a compression fracture containing a linear, gas-filled image located beneath the superior endplate. It is most often observed in individuals around 50 years of age. The thoracolumbar region is most frequently affected, with associated spinal hypertransparency. These could be osteoporotic

compression fractures secondarily complicated by bone ischemia.

The presence of intrasomatic voids argues against a neoplastic or infectious etiology.

On MRI:

Most of the vertebra adjacent to the void image shows a significantly decreased signal on the T1 and T2 sequences. At the level of the gas, a localized linear area of very intense hyperintensity appears, surrounded by an area of hypointense signal. This localized hypersignal is different from the diffuse hypersignal of metastases and infectious spondylodiscitis.

VERTEBRAL METASTASES

Compression fractures are irregularly distributed. Metastases from breast and lung cancers predominate in the thoracic region. These are lytic or mixed lesions. On standard radiography, cortical and cancellous bone osteolysis of the metastases is irregular and almost always evident. Cortical obliteration is clear.

In this case, it is not possible to reconstruct the vertebral body using remaining fragments.
The posterior wall is often affected by cortical osteolysis without fracture, with posterior wall retraction.
Fracture lines, when visible, have indistinct edges.

Osteolysis extends toward the posterior arch, particularly to the pedicles. The appearance of a blind vertebra with obliteration of a pedicle is characteristic. Metastatic compression is accompanied by soft tissue extension, remaining focal and lateralized, adjacent to the area of vertebral osteolysis. Epidural invasion can threaten the dural sac.

CONCLUSION

Cross-sectional imaging provides elements for the differential diagnosis between metastases and vertebral osteoporosis.

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