Bone Metastasis, despite everything!

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Learning objectives

• To describe unusual patterns of bone metastasis as they can be misdiagnosed as other injuries in X-ray or CT examinations.
• To present uncommon manifestation of the bone metastasis based on the radiologic patterns.
• Show uncommon features of the bone metastasis based on the anatomical localization.
Background

Bone metastases are the most frequent malignant osseus tumors and must be considered as differential diagnostic in the study of bone lesions, especially in oncological and elderly patients.

They often affect the medullar bone of the axial skeleton and metaphysis or diaphysis when a long bone is involved. They can show osteolytic, osteoblastic or mixed patterns. Generally, the tumor appears without periosteal reaction and with no soft tissue component. Nevertheless, there are some unusual presentations of bone metastasis that could be misdiagnosed as primary tumors or non-neoplastic entities.

Throughout the last decade, a lot of unusual bone metastases cases have been compiled; initially they were diagnosed as a different entity other than metastases. These lesions have been classified according to anatomical location and radiological pattern.

All cases have been confirmed by percutaneous biopsy and one year clinical-radiological follow up at least.
Findings and procedure details

UNUSUAL RADIOLOGICAL APPEARANCES OF BONE METASTASES:

A. ANATOMICAL LOCATION:

• **Anatomical area:** A bone metastasis located distal to knee or elbow is an uncommon localization, due to the limitation of vascular routes and the lack of medullar bone. It can be confused with articular pathology. We found examples of these lesions in lung, breast and endometrial neoplasm. Fig. 1 on page 7 Fig. 2 on page 7

• **Anatomical segments:** The epiphysis is a location where is rare to find solitary metastasis. When it occurs, it could be misdiagnosed as a primary tumor, joint lesion or bone ischemia Fig. 3 on page 8. The vertebral arch, which is the "great forgotten" in plain film report, is an unusual location of metastasis to occur without affecting the vertebral body Fig. 4 on page 9. Sesamoid bone, as the patella, is another rare location for metastasis Fig. 5 on page 10.

• **Cortical bone:** It's an atypical location due to poor endothelial vascularization compared to the endosteal area. The cortical metastasis are mainly located in the lower extremities and come from lung Fig. 6 on page 11, breast, melanoma and kidney neoplasm. They tend to be well defined lesions and 50% of them have soft tissue component. Fig. 7 on page 12

• **Soft tissue:** Predominant muscle location are diaphragm, rectus abdominis, deltoid, ileopsoas, intercostal and paravertebral muscles Fig. 8 on page 13. The origin may be come from breast, kidney, lung or gastrointestinal system. On MRI these lesions show important edema, suggesting inflammatory-infectious process Fig. 9 on page 14.

• **Previously pathological areas:** It's uncommon that a metastasis affects an area with a previous pathology (infection, Paget disease, fractures....) or surgically manipulated bone. Due to vascular and local tissue resistance alterations in these areas, metastasis can appear. We show two cases that have been documented in association with surgical prostheses, one of which corresponded to an osteolytic prostatic metastasis. Fig. 10 on page 15

B. RADIOLOGICAL PATTERN:
• **Periosteal Reaction**: It's a very uncommon bone metastasis pattern. For example, some prostate, bladder and gastrointestinal malignancies can present as a "sunburst" appearance, resembling osteosarcoma Fig. 11 on page 16.

• **Calcification-ossification**: Calcified or ossified matrix has been observed in cases of metastatic disease in gastrointestinal, bladder, breast and lung cancer. It could affect bone or soft tissue. This kind of pattern must be differentiated from primary tumors as chordoma Fig. 12 on page 17 osteosarcoma Fig. 13 on page 18 Fig. 14 on page 19, chondrosarcoma Fig. 15 on page 20 Fig. 16 on page 21, and also from benign lesions such as myositis ossificans.

• **Intraosseous gas**: The presence of intraosseous gas is characteristic of torpid evolution of vertebral fractures or Schmörl hernia. It has rarely been described in cases of infections or metastasis. We observed these feature in a case of breast cancer with pathological fracture Fig. 17 on page 22.

• **Bone enlargement**: It’s a rare finding in bone metastasis. It could simulate entities such as Paget's disease, haemangioma or chronic osteitis.

• **Articular involvement**: may be due to invasion of the joint space from a subchondral bone lesion or by direct implantation into the synovium by the primary tumor. This sign has been observed in highly vascularized tumors as renal carcinoma Fig. 18 on page 23.

• **Abscess pattern**: It appears characteristically in metastatic disease from keratinizing carcinomas (lung, bladder, esophagus). The radiological appearance consists of a bone or soft tissue cavity fill with liquid or semi-liquid fluid, looking as an abscess on CT or MRI Fig. 19 on page 24 Fig. 20 on page 25.

• **"Minibrain" pattern**: This pattern has been described in the vertebral body in cases of primary myeloma or plasmocytoma. Exceptionally it has been observed in a case of breast carcinoma metastasis Fig. 21 on page 26.

• **"Bull's eye" pattern**: Also known as "target metastasis" these terms describe an osteolytic area surrounded by a sclerotic halo. It is uncommon as initial sign in metastasis. However, it is seen more regularly in osteolytic metastasis after chemotherapy or radiotherapy treatment Fig. 22 on page 27.

• **Haemangioma pattern**: The radiological appearance is a prominent trabecular pattern with hypodense center and sclerotic edges, like a typical haemangioma Fig. 23 on page 28.

• **Infiltrating pattern**: It has been seen in those aggressive lesions that invade bone and soft tissue simultaneously without altering either the bone.
density or the bone structure. It has been described in lymphoproliferative disorders and it is exceptional in metastasis. Fig. 24 on page 29 Fig. 25 on page 30 Fig. 26 on page 31

• "Hourglass" pattern: It's the radiological image resulting from the spread of a tumor on both sides of the intervertebral foramen with little or no bone remodeling. It is characteristic of neurogenic tumors like neurofibroma and schwannoma, although we also observed it in soft tissue metastasis of myxoid liposarcoma Fig. 27 on page 32.
Fig. 1: Plain radiograph shows osteolytic lesion with geographic pattern in distal tibia, affecting the epiphysis. The origin was an endometrium cancer.

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Fig. 2: Plain x-ray shows an osteolytic aggressive lesion located in the distal phalanx of the second finger. It comes from a lung carcinoma.

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Fig. 3: Plain film showing metastatic osteolytic lesion in the distal femur with pathological fracture, from a lung cancer. It simulates a primary tumor, especially giant cell tumor.

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**Fig. 4:** CT-guided biopsy of aggressive lytic lesion with little soft tissue component associated, without involvement of the vertebral body

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Fig. 5: Plain x-ray shows metastatic lesion of patella with lytic appearance and permeative pattern

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Fig. 6: Plain radiograph showing a well-defined lytic cortical lesion. It corresponds a metastasis of lung neoplasia

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Fig. 7: Ultrasound shows soft tissue mass associated with cortical irregularity. This corresponds a bone metastasis from lung carcinoma

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Fig. 8: Enhanced CT scan showing soft tissue mass affecting the right paravertebral muscle with heterogenous enhancement, corresponding to breast metastasis.

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Fig. 9: MRI showing a metastatic lesion involving left psoas musculature with perilesional edema without bone involvement and heterogenous enhancement after gadolinium administration.

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Fig. 10: Plain x-ray show an ill-defined osteolytic lesion with loss of cortical bone and soft tissue mass. It corresponded to a metastatic prostate neoplasia in a patient with hip arthroplasty

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Fig. 11: Plain x-ray shows a voluminous femoral lesion with permeative pattern, cortical destruction, calcification and "sunburst" periosteal reaction, secondary to bladder neoplasm.

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**Fig. 12:** Osteolytic lesion which affects the sacrum, with small calcifications and destruction of anterior cortical bone without joint involvement that simulates a chordoma, but being a metastasis from colorectal adenocarcinoma

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**Fig. 13:** Plain x-ray of 65 y.o male patient that shows a solitary aggressive osteolytic lesion with ossified matrix located in posterior wall of acetabulum. Initially it was misdiagnosed with osteosarcoma

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**Fig. 14:** CT scan shows the same lesion of previous patient. CT-guided biopsy confirms the metastatic bone lesion from colorectal cancer.

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**Fig. 15:** 82 y.o male patient with prostatic cancer. In a routine chest plain film appears a solitary nodule located in the 2nd costochondral cartilage.

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Fig. 16: CT scan of the previous patient shows a calcified nodule with typical chondroid pattern. It was misdiagnosed with a chondroid tumor. However, biopsy confirms the metastatic origin from prostatic cancer.

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Fig. 17: Patient with breast carcinoma. CT scan shows pathological fracture of lumbar vertebral body with permeative pattern. There is some gas image inside the lesion.

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Fig. 18: CT scan showing a bone metastasis with large soft tissue component and necrotic center, extending to the right sacroiliac joint. Percutaneous biopsy confirmed the metastasis from renal carcinoma

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Fig. 19: Abscessified metastases in anterior femoral muscle compartment. A well-defined, hypodense collection is observed with peripheral enhancement on CT.

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**Fig. 20:** Purulent material was aspirated from the abcessified area of previous patient.

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**Fig. 21:** CT scan shows lytic lesion in vertebral body, no sclerotic margens, with sharp edges and "minibrain" pattern whose biopsy was positive for breast carcinoma.

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Fig. 22: Plain x ray shows multiple metastatic foci in the ilium, some of them showing the "Bull's eye" pattern

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Fig. 23: CT image shows trabecular pattern of vertebral body in a metastatic breast carcinoma, simulating a haemangioma

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Fig. 24: Simple plain x-ray of lower cervical segments with normal bone structure and density in a patient with cervicobrachialgia

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Fig. 25: Saggital T2WI MRI of the same patient shows C7 vertebral body hyperintensity and adjacent soft tissue component

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Fig. 26: CT of previous patient, shows C7 segment with normal bone appearance and increase prevertebral and epidural soft tissues. The biopsy confirmed metastatic involvement from lung cancer

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**Fig. 27:** Axial T1WI MRI showing metastatic lesion in "hourglass" pattern occupying the right vertebral foramen

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Conclusion

Characteristically, bone metastases have been described as solitary or multiple lesions that affect specifically the medullar bone. They could have osteoblastic, osteolytic or mixed radiological pattern. However, there are several unusual bone metastases presentations that can simulate other bone lesions. Therefore, radiologist should consider them as a differential diagnosis in the evaluation of the radiological image of bone lesion.
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