Lesions on pelvic bones: Spectrum and radiologic findings

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Learning objectives

This paper reviews the pelvic bones lesions observed in our center, with a description of radiographic findings and characterization of lesions using different techniques: conventional radiology, ultrasound, CT and MRI.

Background

Pelvic bones lesions are rare lesions. There are a variety of benign and malignant lesions (primary tumors and metastases), being the most frequent metastatic lesions.

CT and MRI demonstrated the origin of the lesion, its extension and radiographic features. Some tumors have certain radiologic features that suggest radiologic diagnosis. However in many cases biopsy is required for a definitive histological diagnosis.

Most pelvic bone tumors are asymptomatic, or may present with nonspecific symptoms (pain, palpable mass, neurological deficits). This lesion has a slow growth rate, a reason for a delayed diagnosis. In case of a large tumor mass, involved neurovascular structures or affected pelvic organs may be clinically manifested [1].

Usefulness of each imaging techniques: Conventional radiography, ultrasound, CT and MRI.

Conventional radiology is an exploration with limited value and low sensitivity. The persistence of the symptoms is an indication for CT or MRI.

Ultrasound can delimited the soft tissue component of the tumor, on the other hand may be useful to guide biopsies.

For suspected pelvic bone lesion the CT is one of the technique of choice. CT is a sensitive technique for detecting pelvic lesion, depict lytic or blastic patterns, determine location, involvement of cortex or not, presence or absence of calcifications, vascularity and soft tissue component. It also asses the extension into the sacral canal, sacroiliac joint, coxofemoral or pelvic areas, and is useful as a guide for obtaining sample for histological study. Based on the thin axial sections CT scan 2D and 3D reconstructions were performed.

MRI is another technique of choice, especially in lesions affecting the spinal canal and nerve roots. One of the great advantages of MRI is its excellent soft-tissue contrast.
Angiography may be useful in cases that require a vascular mapping before surgery or preoperative embolization.

**Lesions in the pelvic bones.**

The presence of hematopoietic bone marrow plays an important role in the distribution of malignant lesions. The sacrum and iliac bones are common sites of metastatic disease, and hematologic malignancies, including myeloma, lymphoma and Ewing sarcoma. Metastases are the most common neoplastic lesion. Lesions may also arise from the different component of the sacrum: bone, cartilage, notochord remnants, etc [1,2].

In this review we include different types of tumors and pseudotumoral lesion of the pelvic bones, in some cases diagnosed by needle biopsy or anatomopathologic study of surgical piece. In other cases the diagnosis is radiological or assess the evolution of the lesion.

**Imaging findings OR Procedure details**

**BENIGN TUMORS**

**Giant Cell Tumors**

GCT is the second most common primary sacral tumor after chordoma. These tumors are most common in the 2nd-4th decades of life. There is a female predominance (ratio 2:1). The most common symptoms of this lesion are pain and neurological deficit.

Although they have a locally aggressive behavior most are benign, rarely may metastasize (2-5%), usually after radiotherapy.

Spine is affected in 3-7% of cases, but with respect to spinal involvement, the sacrum is the most common site, in about 90% of cases, especially in the upper sacrum and frequently lateralized in a sacral wing. GCT generally has a subchondral location in both long and flat bones, which may result in transarticular spread, through the sacra-iliac joints and intervertebral discs. This is a distinctive feature of GCT which is very rare in other sacral lesions [2].

In most cases CT shows a soft tissue mass lesion manifest as a lytic, expansive with sclerotic margins and destructive process that is often eccentrically located, with hemorrhagic and fibrous component (Fig 1). The MRI of a GCT often show heterogeneous signal intensity regardless of the pulse sequence used. The lesion has low to intermediate signal intensity on the T1-and T2 weighted images. This appears
to be caused by the relative collagen content of fibrous components and hemosiderin within the tumor. MRI performed after intravenous contrast material also shows significant enhancement of the lesion, which reflects its increased vascular supply. The lesions may have a central necrosis, hemorrhagic foci or areas with fluid-fluid levels. Angiography can be used in preoperative embolization, with the aim of reducing tumor size and intratumoral vascularization in order to minimize intraoperative bleeding [3].

At the risk of sarcomatous transformation, the radiotherapy should be reserved for patients with incomplete excision or local recurrence.

**Chondromyxoid fibroma (CMF)**

Chondromyxoid fibroma (CMF) is a rare, benign chondroid/myxoid matrix-producing tumor of the bone, that usually occur in metaphyses of long tubular bones. Flat bone involvement is even more uncommon affecting the ilium, vertebrae, skull, facial bones, and ribs. Affect young adults during the 2nd or 3rd decades of life and is more frequent in males than females (ratio 1.5:1).

Radiological features of CMF are a lytic geographic lesion with sclerotic rim and sometimes bubbly-appearing lesion. CT scans may show calcification within the tumor that is not visible on conventional radiographs (Fig 2).

The tumor typically demonstrates low signal intensity on T1-weighted images and heterogeneous, high signal intensity on T2-weighted images. Enhancement following intravenous administration of gadolinium is typically heterogeneous [4].

CMFs are relatively easy to treat by curettage with bone grafting or resection, with minimal risk of recurrence.

**Fibrous Dysplasia.**

This lesion is an abnormal bone-forming mesenchymal tissue which manifests as a osteoblastic differentiation and maturation defect, in which normal bone marrow is replaced by fibro-osseous tissue. The incidence between female and male is similar.

Fibrous dysplasia is categorized as either monostotic: 70-80% of all cases, and polyostotic forms: 20-30%. The monostotic form involves the femur, tibia and ribs. The polyostotic form usually affects the skull, facial bones, pelvis and spine, these lesions are often on the same side of the body, on bilateral cases this distribution is asymmetric.

Radiographs show a lytic and expansive lesion, that demonstrate the replacement of the bone marrow by fibrous tissue, usually this lesion may have a sclerotic rim. Matrix mineralization occur later resulting in a ground glass and then a dense sclerotic lesion.
CT scanning is not often required for diagnosis, however is useful in evaluating the extent of disease in complex locations, such as the pelvis, facial bones, chest wall and spine. On MRI this lesion has equal or low signal compared to muscle on T1-weighted images, and low signal on T2-weighted images. In some cases, fluid-fluid level was identified [2,5].

Fibrous dysplasia undergo malignant transformation to osteosarcoma or fibrosarcoma (0.4 to 1%) and may be suspected due to a change in the radiologic appearance of the lesion, for example rapid growth, extension into soft tissues and lytic areas on previously mineralized matrix.

**Osteochondroma**

Osteochondroma are often referred to as an osteocartilaginous exostosis, is a lesion composed of cortical and medullary bone with an overlying hyaline cartilage cap. Pathological and radiological features of this lesion are that represents a continuity of medular and cortical normal bone covered by a thin proliferative cartilage [5].

Solitary osteochondromas occur most often in young male patients: 20-40 years. Hereditary forms of multiple exostosis affect earlier age in the first decade of life. Most osteochondromas are asymptomatic and represent an incidental finding, sometimes associated with trauma event or RT treatment especially in pediatric patients. Radiographs may be the only imaging study required, but in pelvic location often use CT and MRI that also demonstrates cortical and medullary continuity between the osteochondroma and parent bone. On MRI cartilage cap has similar signal intensity to growth cartilage, is hypo or isointense on T1-weighted images and hyperintense on T2-weighted images (Fig 4).

The treatment of choice is surgery. Recurrence is rare. As benign lesions, osteochondromas have no propensity for metastasis. In less than 1% of solitary osteochondromas, malignant degeneration of the cartilage cap to secondary chondrosarcoma has been described. New onset of pain, continued or rapid growth lesion and a hyaline cartilage cap greater than 1.5 cm in thickness, after skeletal maturity, suggest malignant transformation, which is more common in cases of multiple osteochondromatosis [2].

**MALIGNANT TUMORS**

**Metastases**
Metastases are the most common lesions of the pelvic bones and its origin including: breast, prostate, lung, kidney, head and neck (thyroid), gastrointestinal and skin (melanoma).

Metastases may have lytic, blastic or mixed radiological growth patterns. The presence of multiple lesions suggests this possibility or multiple myeloma. One metastatic lesion usually requires a biopsy to differentiate from primary tumor.

Breast and prostate metastases are usually blastic (Fig 5), lung metastases normally forms lytic (Fig 6) and only 30% blastic metastases. Renal metastases may be very aggressive and expansive, can be large with cortex involvement, and with bleeding risk at the time of biopsy.

**Multiple Myeloma (MM) and Plasmocytoma**

MM is a monoclonal proliferation of malignant plasma cells, causing multiple destructive lytic lesions. Plasmacytoma is a unifocal lesion and usually has a better prognosis and earlier presentation than MM. The cells may cause soft-tissue masses or lytic lesions in the skeleton, may involve any bone, but the predominant sites include the vertebral column, ribs, skull, pelvis and femora. The classic appearance of MM is a multiple, small, lytic lesions (Fig 7). Sclerotic forms have been described although rare.

Plasmocytomas are usually larger than MM and is often associated with soft-tissue component . Although rare multicystic appearance like "bubbles" have also been described.

On MRi MM and plasmocytomas show low signal on T1-weighted images and which becomes high in signal intensity on T2-weighted images and STIR sequences (Fig 8). Present a homogeneous enhancement after contrast administration.

**Lymphoma**

Most primary bone lymphomas are bone diffuse large B-cell lymphomas, manifestation of extranodal non-Hodgkin's disease. These rare tumors are common in the 5th-7th decades of life and have a male strong predominance (ratio 8:1).

Mainly involve the femur, spine and pelvis. Primary bone lymphoma may has lytic, permeative, sclerotic or mixed appearance and frequently associated with soft-tissue mass (80-100%). The radiographic appearances of primary bone lymphoma are variable, but some radiological findings may suggest it, as a extensive disease within the bone marrow associated with a surrounding soft-tissue mass but without extensive cortical
destruction (Fig 9). CT is helpful for detecting cortical erosion and demonstrating a sequestrum. On MRI T1-weighted images reveal areas of low signal intensity within the marrow; these areas generally appear bright on T2-weighted images. Peritumoral edema and reactive marrow change can also produce high signal intensity on T2-weighted images [6].

**Chordoma**

Chordoma is the most common primary tumor of the sacrum and represents 2 - 4% of bone neoplasms. These lesions derive from notochordal remnants and have midline or paramedian location. Chordomas involve the sacrococcygeal region in 50%-60% of cases. There is a broad age distribution, with most individuals presenting in the 4th to 7th decade with a peak in the 5th decade. There is a male to female ratio of 2-3:1.

At imaging chordoma typically manifests as a large destructive sacral mass with secondary soft-tissue extension. CT demonstrates lytic bone lesion with presacral and sacral soft-tissue mass (Fig 10). Areas of punctate calcification are noted in 30-70% of cases.

At MRI the most mainly feature of chordoma is the high signal intensity seen on T2-weighted images. The combination of high T2 signal intensity and a lobulated sacral mass that contains areas of hemorrhage and calcification is strongly suggestive of a chordoma (Fig 11). On T1-weighted images the lesion has a low or equal signal intensity to muscle, hemorrhage and mucinous material also show high signal intensity on T1-weighted sequences. Differential diagnosis of this tumors includes giant cell tumor, metastasis, chondrosarcoma, myxo-papillary ependymoma, and plasmacytoma [7].

Chordoma is a low grade tumor with slow growth but a poor prognosis, its mortality is associated with high incidence of local recurrence, almost 100%. The current treatment options include radical surgery and radiotherapy in case of partial resection or unresectable tumors, or palliative treatment. Recent reports consider that MRI guided percutaneous radiofrequency ablation as an alternative to surgery for local recurrences or even as a first option therapy [8].

**Osteosarcoma**

Osteosarcoma is a high-grade tumor, with variable amounts of osteoid, cartilage or fibrous tissue. Pelvic osteosarcomas are rare, they account for 4-10% of all osteosarcoma. Usually affect in the 4th to 5th decade of life.
They have a poorer prognosis than those located in the appendicular skeleton, due to pelvic osteosarcoma are diagnosed in advanced stage of disease with a large component of tumor mass. Some osteosarcomas arising in Paget’s disease or previously bone irradiated. Radiation-induced sarcomas are osteosarcoma about in 90% of cases, followed by fibrosarcomas and rarely chondrosarcomas and malignant fibrous histiocytoma.

Low-dose radiotherapy may determine changes that may be reversible, known as radiation osteitis, at high doses can cause cell damage and appearance of atypical cell clones. The radiation osteitis usually occurs before sarcomas (Fig 12). Previous radiotherapy and stability of the observed changes in images studies suggest the diagnosis of radiation osteitis. A component of tumor mass is usually observed in sarcoma and not in radiation osteitis.

Radiography and CT may demonstrate a purely lytic, mixed or predominantly osteoblastic pattern. CT depicts matrix mineralizationand soft tissue extension. Non-mineralized matrix of osteosarcomas are not specific on MRI, this areas may have low to intermediate signal intensity on T1-weighted images and usually have a high signal intensity on T2-weighted images. Areas of bone formation are identified as hypointense areas in all sequences (Fig 13).

The diagnosis of radiation-induced sarcoma is based on four conditions, a long latency period after radiotherapy, the radiation field, demonstrate sarcomatous changes in histology and radiation-induced sarcoma should be differentiated original lesion histologically prior to radiotherapy [9].

**Malignant fibrous histiocytoma**

Malignant fibrous histiocytoma is a malignant tumor that is grouped with fibrosarcoma. It may be primary or secondary tumors arising in benign preexisting lesions or previously irradiated bone. There is a slight male predominance that is approximately 2th - 6th decades of life. Radiography show a permeative lytic pattern usually without periosteal reaction and with soft tissue mass (Fig 14).

**PSEUDOTUMORAL LESION**

**Paget’s disease**

Paget’s disease is a progressive disorder of bone remodeling that commonly involves the spine, pelvis, legs, or skull, although any bone can be affected. This disorder can present
in a monostotic or polyostotic form. Paget's disease affects 10% of the population in the 8th decades of life.

The radiographic findings depend on stage of the disease; could be lytic, sclerotic or lytic-sclerotic. During its active phase predominates a lytic pattern. In sclerotic pattern is observed a coarse trabecular endosteal and periosteal new bone formation (Fig 15 a). MRI findings are equally variable, in the active phase, the fibrovascular matrix shows low signal intensity on T1- weighted images and high signal intensity on T2- weighted images. In the sclerotic stage, sclerosis areas show low signal intensity on T1 and T2-weighted images (Fig 15 b).

Lytic phase of Paget's disease can be confused with metastatic or osteomyelitis, while sclerotic phase with metastatic prostate or breast cancer, sclerosing forms of lymphoma or myeloma, or chronic osteomyelitis. Sarcomatous degeneration is a rare complication (less than 1%), its prevalence increases with age and number of bones affected. Soft tissue component suggests malignant transformation (osteosarcoma, chondrosarcoma or less frequently fibrosarcoma) [10].

Images for this section:
**Fig. 1:** Giant Cell Tumor: 39-year-old woman with right hip pain. X-ray shows loss of wing right iliac contour (circle). CT: Lytic lesion in the right iliac crest with cortical destruction and soft tissue mass on both sides of the ilium (arrow). Diagnosis was obtained at surgery.
**Fig. 2:** Chondromyxoid Fibroma: 46-year-old man with chronic low back pain. Axial and reconstructions 2D (coronal and sagittal) CT shows a large sacral expansive lytic lesion with sclerotic margins (arrow) that affects vertebral body and posterior arch (arrowhead). The pathological diagnosis obtained by CT-guided biopsy demonstrated Fibroid chondromyxoid.

![Image of Chondromyxoid Fibroma](image)

**Fig. 3:** Polyostotic Fibrous Dysplasia: Axial CT, coronal and sagittal multiplanar reconstructions (MPR) depicts multiple lytic lesions with sclerotic margins (arrowhead) and ground glass areas (arrow).

![Image of Polyostotic Fibrous Dysplasia](image)
Fig. 4: Osteochondroma: CT (axial plane and 3D) and MRi (T1-weighted images and STIR sequences) images shows a lesion in the left ischiopubic ramus (arrowhead). CT and MRi demonstrates the continuity of the lesion (marrow and cortical bone) with underlying healthy bone. STIR sequences shows a tiny cap cartilage (circle). Another pedunculated osteochondroma in right iliac wing (arrow).
Fig. 5: Blastic metastases: a) Patient with prostate (circle on X-ray) and breast bone metastases (arrowhead on CT). b) Multiple bone metastases in a patient with prostate cancer with exuberant periosteal reaction (white arrow on coronal MPR). Hypervascular metastases: c) Renal cancer with Axial CT scan and 3D (yellow arrow).

Fig. 14: Malignant fibrous histiocytoma: 81-year-old woman with palpable soft tissue mass. a) Radiograph: Poor margins lytic lesion in right iliac bone (circle). CT (axial and coronal planes): Destruction of the right iliac wing with a large heterogeneous soft tissue mass (arrow). b) MRI: T1, STIR and T1 Fat Sat Gad sequences: Heterogeneous soft tissue mass involves the right iliac bone, mainly hypointense with hyperintense foci (haemorrhage) on T1-weighted images, heterogeneous on STIR with not uniform enhancement on T1 Fat Sat Gad (arrow).
Fig. 11: Sacral Chordoma: X-ray shows a large lytic lesion in sacrum (arrow), CT depicts a presacral soft tissue mass (*) with a small calcification (arrowhead). RMi demonstrates a sacral lesion (yellow arrow) involving sacral foramina and other lesion in L4 (white arrow).
**Fig. 13:** Radiation induced osteosarcoma: Patient with history of endometrial neoplasia and pelvic radiotherapy: a) X-ray show an osteoblastic lesion in the left iliac, CT (MPR and 3D reconstructions) reveals a large mass with osteoid matrix. b). MRI: On T1-weighted imaging shows a large left iliac lesion with infiltration of bone marrow and soft tissue component (arrow). On T1 Fat Sat Gad the lesion has a peripheral enhancement (arrow).
**Fig. 12:** Radiation induced osteitis: Patient with history of radiation therapy, CT shows a lesion with mixed pattern (arrow) affecting sacrum.

**Fig. 9:** Large B-cell lymphoma: 53-year-old man, TC: Lytic lesion in the left iliac bone (circle) with soft-tissue mass invades left gluteal muscles (*). Ultrasound shows hypoechoic mass in gluteal muscles (*). Bone CT-guided biopsy and soft tissue ultrasound-guided biopsy demonstrates lymphoma.
Fig. 8: Plasmacytoma: Axial CT depicts a lytic lesion with large soft-tissue component infiltrating the sacral canal (arrow). MRI (arrowhead): a) On T1-weighted images plasmocytoma has low signal intensity, b) on T2 and c) STIR sequences is hyperintense and heterogeneous.
Fig. 10: Sacral Chordoma: CT (axial and sagittal planes) shows a large heterogeneous sacral soft-tissue mass (*) on presacral space invading the sacral canal. The lesion contacts with the rectal wall. 3D images reveals the extension of bone destruction(arrow).
Fig. 7: Multiple Myeloma: CT axial and coronal planes shows a expansive lytic lesion with cortical disruption (arrow) in the left iliac wing.
**Fig. 6:** Lytic metastases: a) Metastatic bladder cancer: 81-year-old man with a large lytic lesion on conventional radiography, with destruction of the inner wall of the acetabulum (circle). TC: lytic lesion with a large soft tissue mass (arrow). b y c) CT and MRI studies in others two different patients. Each column represents different patients with lytic metastatic lung cancer.

**Fig. 15:** Paget's Disease: a) y b) 2 different patients with pelvic lesions. Assessed with conventional radiographs, CT and MR.
Conclusion

CONCLUSION

Tumors on pelvic bones are relatively common lesions with a predominance of metastatic origin. In many cases conventional radiology not detected these lesions. For this reason CT and MRI contribute to identification, diagnosis, staging, planning of biopsy, surgical treatment and postsurgical follow-up.

Personal Information


References


