Pelvic bone lesions. A Radiologic Pictorial Review

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Learning objectives

To describe the most common benign and malignant pelvic bone tumors, according the most frequent radiological findings and clinical features (pain, age, sex...).

We shall try to focus on typical imaging findings and classical radiographic appearances for each pathology, and make a review for a systematical approach to the differential diagnosis of pelvic bone tumors and tumor-like lesions.
Lesions involving pelvic bone are sometimes difficult to evaluate due to singular anatomy of the pelvic bones. Radiographic evaluation of this region involves knowledge of a few anatomical landmarks. This characteristic location includes common benign tumors like simple bone cyst and fibrous lesions, and malignant tumors like metastasis or myeloma. There are other uncommon lesions like chordoma and osteoblastoma which could affect pelvic bones.
The **pelvis bone** is composed of four bones: the **two hip bones laterally** the **sacrum and coccyx** behind. It is a **bony ring**, interposed between the movable vertebrae of the vertebral column which it supports, and the lower limbs upon which it rests.

It is divided by an oblique plane passing through the prominence of the sacrum, the arcuate and pectineal lines, and the upper margin of the symphysis pubis, into the greater and the lesser pelvis.

The hip bone is a large, flattened, irregularly shaped bone, constricted in the center and expanded above and below. It meets its fellow on the opposite side in the middle line in front, and together they form the sides and anterior wall of the pelvic cavity. It consists of three parts, the ilium, ischium, and pubis, the union of the three parts takes place in and around a large cup-shaped articular cavity, the acetabulum, which is situated near the middle of the outer surface of the bone.

The **ilium**, so-called because it supports the flank, is the uppermost and largest bone of the pelvis, is divisible in two parts, the body and the ala; the separation is indicated on the top surface by a curved line, the arcuate line, and on the external surface by the margin of the acetabulum. The wing of ilium (or ala) is the large expanded portion which bounds the greater pelvis laterally. It presents for examination two surfaces (an external and an internal) a crest, and two borders (an anterior and a posterior). The body enters into the formation of the acetabulum, of which it forms rather less than two-fifths.

The **ischium** is the lowest and strongest portion of the bone; it proceeds downward from the acetabulum, expands into a large tuberosity, and then, curving forward, forms, with the **pubis**, a large aperture, the obturator foramen. The pubis extends medialward and downward from the acetabulum and articulates in the middle line with the bone of the opposite side: it forms the front of the pelvis and supports the external organs of generation.

The **acetabulum** is a deep, cup-shaped, hemispherical depression, directed downward, lateralward, and forward. It is formed medially by the pubis, above by the ilium, laterally and below by the ischium, for articulation with the head of the femur.

The **obturator foramen** is a large aperture, situated between the ischium and pubis. It is bounded by a thin, uneven margin, to which a strong membrane is attached, and presents, superiorly, a deep groove, the obturator groove, which runs from the pelvis obliquely medialward and downward. Through the canal the obturator vessels and nerve pass out of the pelvis.

The hip bone articulates with its fellow of the opposite side, with the sacrum and femur.
The **sacrum** consists of cancellous tissue enveloped by a thin layer of compact bone and articulates with four bones; the last lumbar vertebra above, the coccyx below, and the hip bone on either side.

The sacral and coccygeal vertebrae consist at an early period of life of nine separate segments which are united in the adult, so as to form two bones, five entering into the formation of the sacrum, four into that of the coccyx. Sometimes the coccyx consists of five bones; occasionally the number is reduced to three.

The sacrum is a large, triangular bone, situated in the lower part of the vertebral column and at the upper and back part of the pelvic cavity, where it is inserted like a wedge between the two hip bones; its upper part or base articulates with the last lumbar vertebra, its apex with the coccyx. It is curved upon itself and placed very obliquely, its base projecting forward and forming the prominent sacrovertebral angle when articulated with the last lumbar vertebra; its central part is projected backward, so as to give increased capacity to the pelvic cavity.

We present the simpliest approach to pelvic bone lesions we found, according to our circumstances working in a second level hospital as we are.

In our aim to make the best differential diagnosis, the following diagram (**Fig. 2 on page 9**) should guide us through this complex lesions.

Metastases and myeloma are the first lesions we have to think about because of haematopoietic bone marrow present in pelvic bones.

**METASTASIC DISEASE** (**Fig. 3 on page 9**, **Fig. 4 on page 10**, **Fig. 5 on page 11**, **Fig. 6 on page 12**, **Fig. 7 on page 13**, **Fig. 8 on page 14**)

Metastases are the commonest malignant tumours, usually derived from lung, breast, prostate,...We will find more frequently osteolytic lesions, usually multiple lesions. However, the metastases derived from breast and prostate cancer could be osteoblastic lesions. In the case of an isolated lesion, differential diagnosis can be difficult and requires biopsy.

**MYELOMA / PLASMOCYTOMA** (**Fig. 9 on page 15**, **Fig. 10 on page 16**, **Fig. 11 on page 17**, **Fig. 12 on page 18**)

Myeloma is the second commonest lesion, usually osteolytic without a peripheral rim of sclerosis. Plasmocytoma usually presents as an isolated, osteolytic and space-occupying lesion, larger than multiple myeloma lesions.

**BONE LYMPHOMA**
Bone lymphoma can be a primary bone lesion, and can be part of systemic disease both, and it’s unusual under 10 years old.

Gerver describe three signs nonspecific but suggestive of lymphoma:
- intensity and extent of uptake on scintigraphy
- massive bone marrow invasion on MRI, despite normal radiography findings
- large soft tissue mass without visible cortical lesion on CT

This characteristics highlight the need for complete studies in those patients with persistent pain with normal radiography.

**PRIMARY BONE TUMOURS**

- **BENIGN**

1. **FIBROUS DYSPLASIA** ([Fig. 13](#) on page 19)

   In general, fibrous dysplasia presents as lytic and well-defined lesion, and mostly are found in children and young adults.

   This kind of lesions usually presents as a solitary lesion, but there are a polyostotic form, affecting different bones at the same time. It may contain cystic parts and calcifications.

2. **ANEURISMAL BONE CYST** ([Fig. 14](#) on page 20)

   80% of aneurismal bone cyst are discovered under 20 years old. The most common appearance of this lesions is an osteolytic expansile lesion surrounded by a thin layer of bone. Sometimes can be associated with a soft tissue mass. ABC is composed by a multiples multiloculated blood-filled spaces separated by septations.

   The diagnosis is highly suggested by the absence of a solid component, marked high intensity signal on MRI T2-weighted sequences and cortical rim seen on CT.

3. **OSTEOID OSTEOMA**

   Usually affects men between 10 and 20 years ago, and presents with nigth pain relieved by salicilates. Osteoid osteoma appears as a small lytic lesion (<2 cm) surrounded by perilesional bone sclerosis on CT. On MRI we will find low intensity signal on T1-weighted
sequences, and intermediate to high signal on T2-weighted images. It can produce edema in the near bone marrow and soft tissues.

4.- OSTEOBLASTOMA (Fig. 15 on page 21, Fig. 16 on page 22, Fig. 17 on page 23)

The mean age of patients at presentation is 20 years. Osteoblastomas may be considered a larger variant (>1.5 cm) of osteoid osteoma, with a similar behaviour clinically and histologically. Appears as a lytic lesion surrounded by sclerotic rim, but sometimes can have an aggressive appearance. On MRI Y2-weighted images shows a high intensity signal around the tumor and adjacent soft tissues because of an inflammatory reaction.

5.- EOSINOPHILIC GRANULOMA

EG is a monosystemic osseous form of Langerhans cell histiocytosis, and typically affects patients under 20 years. Local pain is the chief symptom.

May present as well defined osteolytic lesion with benign periosteal reaction or as a more aggressive lesion with ill defined margins. MRI usually demonstrates large perilesional edema.

6.- HAEMANGIOMA

Very common lesions on the spine, becomes unusual when we are talking about sacral bone involvement

GIANT CELL TUMOR

Some authors classify GCT as a benign tumor, and other authors consider this lesions as a malignant tumor. It is usually benign, but can undergo malignant transformation.

Affecting people between 15 and 40 years old, giant cell tumors are purely lytic lesions, which tends to cross sacroiliac joint, and usually presents as an heterogeneous lesion because of the presence of necrosis and hemorrhage.

High content of this tumor in fibrotic tissue or hemorrhagic areas give to this kind of tumor a low signal intensity on T2 weighted images.

- MALIGNANT
1.- CHORDOMA

The most frequent primitive tumor of the sacrum, arising from embrionic remnants of the notochord. This tumor is only observed in the spine. Chordomas are slow-growing tumors, that are commonly discovered as a large mass occupying the pelvis.

Is not unusual to find calcifications inside this tumor (50-60% of cases).

2.- CHONDROSARCOMA

In the spine, including sacrum, chondrosarcomas are more common than osteosarcomas.

Its mean age of presentation is 45 years old, as a large destructive lesion with chondroid matrix mineralization. At MRI images after contrast administration we will find peripheral and septal enhancement.

3.- EWING SARCOMA

90% occurs between the ages of 10 and 30 years. Ewing sarcoma is an osteolytic and destructive lesion, with a large soft tissue mass in several cases. We will find usually reactive bone sclerosis adjacent to lesion, more frequently in flat bones as iliac bone. MR imaging appearance of this lesions is nonspecific.

4.- OSTEOSARCOMA

Osteosarcoma arises in long bones more frequently than in short and flat bones. For this reason is unusual find an osteosarcoma affeting pelvis bones, except in those patients with Paget’s disease or previously irradiated lesions.

The MR imaging of nonmineralized areas is nonspecific (low to intermediate on T1-W, high on T2-W).

5.- FIBROSARCOMA

Fibrosarcomas arise from a pre-existing lesion in about 25% of cases, and are very uncommon lesions affecting pelvis bones.
Fig. 2

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Fig. 3

Pelvis bone metastases derived from breast neoplasm. Axial CT scan of the pelvis shows multiple osteolytic and osteosclerotic lesions in the sacrum and left iliac bone (*).
Pelvic bone metastases of breast cancer. Axial CT scan of the pelvis shows irregular osteolytic and osteosclerotic lesions of sacrum and iliac bone(*)

Fig. 4

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Fig. 5

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Axial CT scan of right femur shows aggressive expansile lesion adjacent to distal femoral stem tip through femoral head, shows soft-tissue mass adjacent to arthroplasty (arrow) and acetabulum (arrow) with cortical destruction. The result of anatomopathological examination revealed adenocarcinoma metastases.

Fig. 6

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Axial CT scan of a patient with total hip right arthroplasty shows aggressive expansile, cortical destructive, soft tissue mass (arrow) involving sacroiliac joint, due to adenocarcinoma metastases with unknown primary site.

Fig. 7

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Fig. 8

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Fig. 9

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69 year old men with lumbar pain. Sagittal T1-weighted MR image shows a hypointense sacral mass (arrow) that extends into the sacral canal.

Fig. 10

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Fig. 11

Sagittal CT scan of the lumbo-sacral spine shows a lytic soft-tissue mass involving sacrum and extending to sacral canal (arrow).

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Fig. 12

Axial CT scan of the pelvis shows an expansile lytic soft-tissue mass that involves sacrum and obliterates the sacral foramens.

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Fig. 13

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Axial CT scan. Incidental left iliac bone lesion (arrow), solitary, lytic lesion, well-defined margins with narrow transition zone, slightly expansile, with thin sclerotic margin, thickening and sclerosis is observed in the other parts of the cortex (*). Typical findings in simple bone cyst.

Fig. 14

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Fig. 15

26 year-old woman with hip pain. (a) Plain hip radiograph demonstrate radio-lucent defect located at the right iliac wing, the lesion is well circumscribed (arrow). (b) Axial CT scan. Solitary, lytic lesion, well-defined margins with cortical destruction within the right iliac bone (arrow).

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26 year-old woman with hip pain. (a) Coronal right hip T1-WI MR shows intermediate signal lesion with cortical destruction (arrow). (b) Axial right hip T2-WI MR and (c) STIR WI demonstrates hyperintense nature of the lesion with associated reactive marrow edema reflecting the inflammatory reaction around the lesion. (arrow).
Fig. 17

26 year-old woman with hip pain. (a) Axial right hip fat-suppressed weighted MR image. The lesion is hyperintense in this image (arrow). (b) Axial contrast-enhanced magnetic resonance image. This image demonstrates enhancement in the lesion (arrow). The diagnosis of suspicion was osteoblastoma, not anatomo-pathological proved.
Sacral chordoma in an elderly man. Axial CT scan of the pelvis shows a destructive soft-tissue mass centered within the sacrum. The mass extends across the pelvis.

Fig. 21

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Sacral chordoma in an elderly man. On CT scan, sacral chordoma show large lytic lesion centered in the midline and an associated soft-tissue mass containing calcifications.

Fig. 20

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Fig. 19

Coronal CT scan of the abdomen and pelvis shows a lytic soft-tissue mass that involves sacrum (arrow).

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Fig. 18

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Sagittal CT scan of the pelvis shows a lytic large soft-tissue mass that involves sacrum and have a large presacral soft-tissue component.
Fig. 22

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Conclusion

This paper attempts to provide a comprehensive overview of the spectrum of pelvic bone tumors and their radiological appearances, in order to help reaching a differential diagnosis as accurate as possible.
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