Benign bone tumors: diagnosis and therapeutic options

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Learning objectives

- Knowing the epidemiological and the radiological characteristics of the main benign bone tumors. - Knowing for each suspected tumor the main differential diagnoses and how to distinguish them. - Knowing the actions to be taken for every benign tumor.
Background

Conventional radiography has an important place in bone lesion. In lytic lesion, it either helps to do the diagnosis or is sufficient to do it and avoid other needless exam.

Once a lytic lesion is identified, a radiologist must be able to provide a definitive diagnosis or a reasonable differential diagnosis for the lesion and provide appropriate recommendations to the referring clinician.

To approach the diagnosis of an osteolytic lesion, some radiographic signs have to be described and constitute clues for diagnosis. After their description, they are confronted to some epidemiologic data and the clinical context.

I-Radiographic signs

I-1-Patterns of osteolysis:

The radiological appearances of bone destruction has been summarized in a classification system by Lodwick. The system is very useful to describe the aggressiveness of a bone tumor. Lodwick described three types of destruction

I-Geographic destruction (Fig. 1 on page 7):

IA: geographic sclerotic margin

IB: geographic unsharp margin

IC: geographic no margin

II-Moth eaten like destruction (Fig. 2 on page 7):

Areas of destruction with ragged borders. Destruction is similar to moth-eaten clothes with holes of destroyed bone. It implies more rapid growth

III-Permeative destruction (Fig. 2 on page 7):

III defined lesion with multiple "worm holes"; It implies an aggressive malignancy

I-2-Matrix:

In regard to tumor matrix, mineralization of both chondroid and osteoid matrix can be visible on radiographs. Mineralization of chondroid matrix is seen as dot-like, popcorn-like, arcs and rings of calcifications within the bone tumor, while osteoid matrix has a
cloud-like, wispy, cotton like appearance. Some lesions that can have radiographically visible chondroid matrix include enchondroma, chondroblastoma, and chondrosarcoma. Osteoid matrix can be seen in osteosarcoma and osteoid osteoma/osteoblastoma.

**I-3-Periosteal reactions:**

Periosteal reaction is either solid or interrupted. Interrupted periosteal reaction indicates that the associated lesion is aggressive

-solid periosteal reaction(Fig. 3 on page 8): With slow-growing processes, the periosteum has plenty of time to respond to the process. That is, it can produce new bone just as fast as the lesion is growing. Therefore, one would expect to see solid, uninterrupted periosteal new bone along the margin of the affected bone.

-lamellated periosteal reaction(Fig. 3 on page 8 b,c): with rapidly growing processes, the periosteum cannot produce new bone as fast as the lesion is growing. Therefore, we see an interrupted pattern which can manifest itself in several ways, depending on just how steadily the lesion grows. If the lesion grows unevenly in fits and starts, then the periosteum may have time to lay down a thin shell of calcified new bone before the lesion takes off again on its next growth spurt. This may result in a pattern of one or more concentric shells of new bone over the lesion. This pattern is sometimes called lamellated or "onion-skin" periosteal reaction

-sunburst, hair on end (Fig. 4 on page 9): If the lesion grows rapidly but steadily, the tiny fibers that connect the periosteum to the bone (Sharpey's fibers) become stretched out perpendicular to the bone. When these fibers ossify, they produce a pattern sometimes called "sunburst" or "hair-on-end" periosteal reaction, depending of how much of the bone is involved by the process.

-Interrupted periosteal reaction(Fig. 5 on page 10):

Codman's triangle: When a process is growing too fast for the periosteum to respond with even thin shells of new bone, sometimes only the edges of the raised periosteum will ossify. When this little bit of ossification is seen tangentially on a radiograph, it forms a small angle with the surface of the bone, but in fact not a complete triangle. So, when a process is growing too fast for even the Sharpey's fibers to ossify, one may only see a soft tissue mass arising from the bone, perhaps with small Codman's triangles at its margins or a plurilamellar interrupted periosteal reaction

-complex pattern of periosteal reaction (a fracture or infection in the same area as a tumor)Fig. 6 on page 11

**I-4-Extension:**
-soft tissue extension: Usually implies malignancy or aggressive benign lesion such as osteomyelitis with infiltration of fat

-multiple lesions

II) Clinical data and location

II-1-Age

the age of the patient is an important piece of information in musculoskeletal radiology. Typically, only certain lesions occur within any given age range; therefore, the age of the patient must be considered in order to generate a correct differential diagnosis

II-2-Clues by location of lesion:

II-2-1-In the transverse plane:

Location in the transverse plane can lead to diagnosis:

Central (enchondroma), Eccentric (giant cell tumor, chondromyxoid fibroma), Cotical (Non ossifying fibroma, osteoid osteoma), Parosteal (parosteal osteochondroma)

II-2-2-In the longitudinal plane:

- Epiphyseal
- Metaphyseal
- Diaphyseal

II-2-3-Characteristic location:

Some locations lead to particular diagnosis (e.g. chordoma for the clivus or the sacrum, adamantinoma for the tibia…)

II-3-Clinical and biological data:

It is important to consider the clinical and biological context, e.g; A lytic lesion in patient with pain, fever, a hyperleucocytosis reminds an osteomyelitis…

When a lytic lesion is suspected, the radiologist must keep in mind the possibility of a normal variant, such as a pseudocyst and the existing of "leave me alone lesion". Indeed, those lesions are benign and have a characteristic radiographic
appearance and/or location that are inherently diagnostic and have to be known to avoid further unnecessary exams.
Images for this section:

**Fig. 1:** Geographic osteolytic lesion of Lodwick classification

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Fig. 2: Moth eaten like and Permeative destructions of Lodwick classification (II and III)

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**Fig. 3:** Solid(a), unilamellated(b) and multilamellated(c) periosteal reactions.

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Fig. 4: periosteal reactions: hair on end(a) and sunburst(b)

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**Fig. 5:** Interrupted periosteal reactions: Codman’s triangle (a), multilamellated interrupted periosteal reactions (b, c)

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**Fig. 6:** Complex periosteal reaction

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Imaging findings OR Procedure details

I-Benign Bone forming tumors

I-1. Osteoid osteoma (OO):

Definition: OO is a benign tumor containing a nidus of osteoid tissue hypervascularized. Its size is less than 2 cm. It is surrounded by reactive sclerosis.

The recent nidus is hypervascularized, the former is calcified.

Frequency: 12% of benign bone tumors.

Age: 10-30 years. Sex ratio: 2 - 3 H / 1 F

Clinical presentation:

- Nocturnal pain relieved by aspirin.
- Stiff and painful scoliosis without neurological signs in children.
- Swelling.

The osteoid osteoma simulating a joint arthritis.

Topography (Fig. 7 on page 30):

Metaphysis or diaphysis of long bones: superior extremity of femur, tibia and humerus.
Posterior arch of the spine (lumbar), hands, feet.
Cortical, spongy or sub periosteal bone (femoral neck and slope).

Conventional radiography:

A geographical Osteolysis <2 cm, sometimes calcified, surrounded by a large condensation which sometimes blows the cortical bone and can hide the nidus. Sometimes periosteal reaction.
Spine: enlarged hemi-arch in the concavity of the scoliosis.
Sub periosteal: notch and peripheral condensation.
Intra-articular: effusion, weakness, some condensation: simulates arthritis.

Scintigraphy Te99m:

Central intense uptake in a diffuse uptake.
Useful if pain and normal standard radiography.

CT examination (Fig. 8 on page 30, Fig. 9 on page 31):

the best exam to find the nidus.
Contrast injection is unnecessary.

MRI:

Nidus is poorly visible.
It shows peripheral edema (hypointense T1, hyper intense T2, contrast enhancement), which mimics infection or malignancy.
Differential diagnosis:

bone forming tumors, sclerotic lesions, bone lesions with radiolucent centers, periosteal reaction, infection, osteosarcoma, Hemangioma, osteoma

Treatment Options for this Tumor:

- Surgical excision of the nidus
- Percutaneous destruction with laser, Radio frequency or ethanol.

I-2. Osteoblastoma (OB):

Definition: Osteoblastoma is a solitary, benign bone-forming tumor also called "giant osteoid osteoma" because size > 2 cm. Comparing to OO, peripheral sclerosis is less important but OB more frequently thins the cortex and blow-out the bone.

Frequency: 3% of benign bone tumors.

Age: 10 to 30 years Sex ratio: 1H/2 F.

Clinical presentation: Less painful than osteoid osteoma, scoliosis rare.

Topography (Fig. 10 on page 32):

- Spine: posterior arch (lower back)
- Metaphysis or diaphysis of long bones (femur, tibia, humerus): Cortical, medullary or periosteal.
- Skull, face, mandible (cementoblastoma), extremities.

Conventional radiography:

- Spine: geographic osteolysis or condensation, important cortical blowhole
- Long bone: geographic osteolysis, condensation rarer than osteoma osteoid, the bone loss may contain ossifications. Sometimes, pseudo-malignant feature.
- Cementoblastoma: ossified lesion surrounded by a radio-transparent halo.
- Extremities: gap containing partitions with cortical blowhole.

Scintigraphy: uptake Simulator to that of osteoid osteoma.

CT: bone matrix, thin cortical but continous.

MRI: hypointense on T1, moderate hyper signal on T2.

Peritumoral edema

Clinical form: aggressive osteoblastoma or malignant:
Radiological signs: as osteoblastoma but Local recurrence and sometimes metastasis.

Differential Diagnosis:

The differential diagnosis of osteoblastoma includes osteoid osteoma, osteosarcoma, giant cell tumor and aneurysmal bone cyst.

Treatment Options for this Tumor:

A biopsy is performed to confirm the diagnosis.
Surgical resection by curettage, intralesional excision or en-bloc excision are all treatment options depending on the site.

Cryosurgery, radiation and chemotherapy may be used in aggressive and surgically unresectable lesions of the spine.

I-3. Osteoma:

**Histology:** Development of dense bone from the periosteum.

**Frequency:** 0.4% of the population.

**Age:** from 30 to 50 years, **Sex ratio:** 2 H / 1 F

**Clinical presentation:** asymptomatic: incidental finding on imaging of the sinuses. Symptoms only present if their location within the head and neck region is causing problems with breathing, vision, or hearing. Sometimes: swelling, recurrent sinusitis, mucocele.

**Topography** ([Fig. 11 on page 33]): frontal sinus (50%), other sinuses, skull, maxilla, Internal auditory meatus, rarely long bones

**Conventional radiography:** Central osteomas are well delineated sclerotic lesions with smooth borders, without surface irregularities or satellite lesions; very dense opacities, homogeneous, well circumscribed, round or lobed ([Fig. 12 on page 34]). Peripheral osteomas are radiopaque lesions with expansive borders that may be sessile or pedunculated.

**CT:** incidental findings.

**Clinical forms:**
- **Gardner syndrome:**
  - Autosomal dominant. Multiple osteomas (sinus and long bones)
  - Polyposis coli (risk of degeneration) + dental anomalies
  - Soft tissue tumors (fibroma, lipoma subcutaneous, desmoid tumor, epidermal cyst).
- **Parosteal osteoma:**
  - Border-malignant Benign because of local recurrence.
  - From 20 to 40 years, posterior knee.
  - Dense juxta-cortical mass lobed.

**Differential diagnosis:**

Need to be differentiated from enostosis which also appear as densely sclerotic well-defined lesions on x-ray.

**Treatment options:**

If asymptomatic: abstention.

If cosmetic problem or local complication: Surgery.
**I-4. Bone island**

It consists of well-differentiated mature bone tissue within the marrow, also referred to as enostosis. A coincidental finding.

**Differential diagnosis:** osteoblastic metastasis (breast- or prostate cancer).

**II-Benign cartilage forming tumors:**

**II-1. Chondroma**

**Definition:** Enchondroma is a solitary, benign, intramedullary cartilage tumor

**Frequency:** 12% of benign bone tumors.

**Age:** from 20 to 40 years, **Sex ratio:** 1H/1F

**Clinical presentation:** asymptomatic, swelling, pathologic, fracture, deformities. If pain appears and the tumor increases in size, suspect malignant transformation, especially if the tumor was near the belts.

**Topography** *(Fig. 13 on page 35)*: small bones of the hands (50%) (metacarpophalangeal), feet, long bones (meta or diaphysis), rib

**Conventional radiography:** geographic osteolysis bordered with osteosclerosis, blowhole cortical, containing pitted calcifications *(Fig. 14 on page 36).* The tumor may be consists in a heap of calcifications *(Fig. 15 on page 37).*

**CT scanning:** analysis and detection of calcifications of the matrix.

**MRI:** T1 hypo intense, T2 hyper intense (hyaline cartilage rich in water) calcifications: low signal on T1 and T2. Late contrast enhancement with speckled appearance *(Fig. 16 on page 38).*

**Complications:**

- Fracture

- Degeneration in chondrosarcoma: the risk increases near the belts, very rare in extremities.

**Clinical forms:**

1. **Ollier’s disease:** is not hereditary, unilateral shortening or deformity of a limb; Many chondromas of the long bones, high risk of degeneration.

2. **Maffucci syndrome:** multiple Enchondromatosis with angiomatosis of soft parts, phleboliths soft tissue, high risk of degeneration.

3. **Juxtacortical chondroma:** calcified soft tissue mass adjacent to the cortical bone of a finger or a toe.

**Differential diagnosis:**
- In some locations it can be difficult to differentiate between enchondroma and bone infarct.

- It is almost impossible to differentiate between enchondroma and low grade chondrosarcoma based on radiographic features alone.

Features that favor the diagnosis of a low-grade chondrosarcoma:

- Higher age
- Size > 5 cm
- Activity on bone scan
- Fast enhancement on dynamic contrast enhanced MR series
- Endosteal scalloping of the cortical bone

**Treatment options:**

Asymptomatic chondroma in extremities: Abstention

Painful or worrisome lesions should be treated with biopsy followed by intralesional resection. Large defects can be filled with bone graft. All specimens must be analyzed carefully for malignancy.

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**II-2. Chondroblastoma**

**Histology:** benign tumor made of chondroblasts, giant cells and cartilage.

**Frequency:** <1% of primary bone tumors

**Age:** 5 to 25 years, **sex ratio:** 2 H / 1 F

**Clinical presentation:** pain, restricted mobility.

**Topography:** (Fig. 17 on page 39): epiphyses of long bones before welding of the cartilage growth: humerus, femur, tibia, apophyses, pelvis, tarsus and patella.

**Conventional radiography:** geographic osteolysis with dense peripheral osteosclerosis, sometimes blowhole cortical, calcifications and solid periosteal reaction.

**CT:** detection of calcifications, bone cortical thin

**MRI:** Needless, sometimes misleading. Intermediate signal on T1 and T2, peripheral rim of low signal on T1 and T2. Peripheral edema (hypo intense T1, hyper intense T2) reminds pseudo-osteitis or malignant tumor.

**Clinical forms:**

- Extension to the metaphysis,
- Blowhole cortical
- Expansion to joints,
- Pseudo-aggressive feature (Fig. 18 on page 39, Fig. 19 on page 40, Fig. 20 on page )
- condensing tumor

**Differential diagnosis:** of an epiphyseal lesion in young patients: chondroblastoma, osteomyelitis and ganglion cyst.

**Treatment options:** surgery

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**II-3. Chondromyxoid fibroma (CMF)**

**Definition:** benign tumor containing fibrous tissue, chondroid and myxoid.

**Frequency:** 0.5% of primary bone tumors.

**Age:** 10 to 30 years, **sex:** H > F

**Clinical presentation:** moderate pain, chronic functional disability.

**Topography (Fig. 21 on page 41):** metaphyses of long bones of the lower limb mainly proximal tibia

**Conventional radiography (Fig. 22 on page 42):** geographic osteolysis, multilobed, with dense peripheral rim and partitions. Although the name suggests that CMF is a chondroid lesion, calcifications are usually not seen.

Sometimes blowhole cortex.

**Clinical form:**

- Central location: fusiform expansion.
- Eccentric lesion: cortical sometimes invisible on conventional radiography.
- Hemispherical bone defect: cortical notch.
- Pseudo-malignant feature: cortical destruction, periosteal reaction.

**Differential diagnosis:** CMF resembles Nonossifying fibroma

**Treatment options:** surgery

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**II-4. Exostosis = Osteochondroma:**

**Definition:** Solitary osteochondroma is a developmental abnormality of bone. It occurs when part of the growth plate forms an outgrowth on the surface of the bone. This bone outgrowth may or may not have a stalk. When a stalk is present, the structure is called pedunculated. When no stalk is present, it is called sessile. It is covered with a cartilaginous cap <1 cm in adults)

**Frequency:** 35-40% of benign bone tumors

**Age:** 10 to 30 years **sex** equally in males and females

**Clinical presentation:** asymptomatic, sometimes pain, swelling.
If increases in volume in adult suspect degeneration in chondrosarcoma.

**Topography** (Fig. 23 on page 43): metaphyses of long bones (lower limbs> upper limbs), belts, ribs, posterior vertebral arch.

**Conventional Radiography** (Fig. 24 on page 44): perpendicular to the metaphysis, goes to the diaphysis.

The cortical and cancellous bone of the exostosis and the bone holder are in continuity.

Sessile or pedunculated.

Cap sometimes calcified.

**CT**: cartilage cap <1 cm.

**MRI**: may be used to look for cartilage on the surface of the bony growth Cortical low signal on T1 and T2, spongy fat signal

Cartilaginous cap hypointense T1, hyperintense T2: <1 cm.

No contrast enhancement early. Calcifications not seen.

**Complications**

1. Degeneration in chondrosarcoma
   - Radio standard: cortical break, large calcifications in soft tissue.
   - CT: dense matrix in the center, anarchic calcifications, cap cartilaginous> 1 cm, regardless of mineralized tissue, a lot of soft tissue
   - MRI: cartilage cap> 1 cm, contrast enhancement .


3. Bursitis of the Knee or the shoulder.

4. Spinal cord compression

5. Pathologic fracture

**Clinical form**

1. Exostosis disease family:

   Autosomal dominant, occurs <20 years: Multiple exostoses, extended femoral necks, coxa valga, short ulna, curved, radial head dislocation.

   High risk of complications.

2. Hemimelic epiphyseal dysplasia: 'Tarsomegaly'

   Unilateral epiphyseal exostosis <10 years. Talus, tarsal bones, lower extremity of the femur and tibia. Hypertrophy of the pineal gland (calcified mass).

3. Post-radiation osteochondroma

4. Sub-ungual Exostosis - First toe

**Treatment options:**

Asymptomatic exostosis: abstention.
If suspected degeneration: Surgical biopsy

**III-Fibrous bone lesions:**

**III-1. Fibrous Cortical defect (FCD) and non-ossifying fibroma (NOF):**

**Definition:** It is a benign well-defined lesion made of fibrous tissue, fibroblasts and giant cells. Generally, the FCD for the young child disappears during growth. NOF probably corresponds to a FCD non-involuted. FCDs are small (< 3 cm), eccentrically located, metaphyseal cortical defects, fibroxanthomas (>3 cm) are larger, eccentric, intramedullary lesions that abut the cortex; they have a typical, superficial, scalloping pattern in the adjacent cortex.

**Frequency:** FCD: 30 - 40% of children from 6 to 11 years, NOF: 5% of benign bone tumors biopsied.

**Sex ratio:** 1.5 H / 1F

**Clinical presentation:** asymptomatic, except if pathologic fracture (FNO).

**Topography (Fig. 25 on page 45):** FCD: cortical metaphysis of long bones: femur, tibia, fibula and humerus. NOF: the same location but may concern medullary.

**Conventional radiography (Fig. 26 on page 46):**

FCD: well defined cortical osteolysis.
NOF usually has a sclerotic border and can be expansile.
NOF may occur as a multifocal lesion.
No periosteal reaction (except if pathological fracture).
The radiographic appearance is almost always typical

CT scan and MRI are needless: they show the cortical lysis.
MRI shows fibrous signal (low signal T1 and T2) and different aspect of contrast enhancement.

**Scintigraphy:** needless: fixing small.

**Evolution:**

DC disappears or condenses.
FNO migrates to the diaphysis and / or condenses; They regress spontaneously with gradual fill in.

**Clinical form:**

**Jaffe-Campanacci syndrome:** association of multiple non-ossifying fibromas with cafe au lait skin patches, mental retardation, hypogonadism or cryptorchidism, ocular disease and cardiovascular malformations. The FNO disappear spontaneously.
The multiple FNO are found in 38% of cases of neurofibromatosis.
Neurofibromatosis was found in 5% of cases of multiple FNO.

**Treatment options:**
Ill-2. Fibrous dysplasia:

**Definition:** It is an uncommon benign disorder characterized by a tumor-like proliferation of fibro-osseous tissue: an immature tissue that cannot differentiate into mature bone. This may be due to a mutation in a cell surface protein.

It is normally a monostotic (solitary) tumor that arises during periods of bone growth in older children and adolescents and slowly enlarges.

**Frequency:** Monostotic fibrous dysplasia accounts for 75 to 80% of cases. Polyostotic fibrous dysplasia may occur as multiple lesions in adjacent bones and accounts for 7% of benign bone tumors. Most patients are diagnosed in the first three decades of life. Polyostotic fibrous dysplasia are typically diagnosed in the first decade of life.

**Sex:** Females and males are equally affected.

**Topography:** Fibrous dysplasia can occur anywhere but is usually found in the proximal femur, tibia, humerus, ribs, and craniofacial bones. Skeletal deformities can occur as a result of repeated pathological fractures through affected bone.

**Clinical presentation:** Monostotic fibrous dysplasia is asymptomatic incidentally finded on x-ray. Pain and swelling at the site of the lesion or pathological fracture can also be present. Female patients may have increased symptoms during pregnancy.

**Conventional radiography:**

Well defined osteolytic lesion in a long bone with a ground glass or hazy appearance of the matrix. There is a narrow zone of transition and no periosteal reaction or soft tissue mass. The lesions are normally located in the metaphysis or diaphysis.

There is sometimes focal thinning of the overlying cortex, called "scalloping from within". The radiological appearance can be a bone deformity, discrete lucency, patchy, sclerotic, expansile. FD may also contain cystic parts, calcifications and ossifications.

**MRI or CT scans** can be helpful in delineating the extent of the lesion and identifying possible pathological fractures

**Clinical forms**

-autosomal dominant disorder affecting the mandible and maxilla bones in children in their teenage years.
- Polystotic fibrous dysplasia is known to have multiple associations with other disorders:

* Albright’s syndrome: combination of polyostotic fibrous dysplasia, precocious puberty, and cafe au lait spots

* Mazabraud’s syndrome: association of fibrous dysplasia and soft tissue tumors

* Other endocrine abnormalities including hyperthyroidism, Cushing’s disease, thyromegaly, hypophosphatemia, and hyperprolactinemia have been associated with fibrous dysplasia.

**Differential diagnosis:**

- In young patients with location in proximal humerus or femur: solitary bone cyst or aneurysmal bone cyst.

- In eccentric locations: NOF or adamantinoma (tibia).

- When calcifications are present: chondroid lesion (enchondroma).

**Treatment:** the biopsy confirms the diagnosis, but surgery is not necessary for an asymptomatic lesion unless there is a risk for pathological fracture.

- Lesions whose behavior is latent do not need any evaluation or treatment because of the high risk of local recurrence after surgery.

- After surgery, biphosphate medicines long-term are effective in reducing symptoms and increasing cortical thickness.

**IV- Vascular bone lesion: Hemangioma**

**Definition:** It is a benign bone common lesion characterized by vascular spaces lined with endothelial cells.

**Age:** The peak incidence is in the fifth decade

**Sex ratio:** 1 male/2 females.

**Topography** *(Fig. 29 on page 49):* About 50% of osseous hemangiomas are found in the vertebral bodies (thoracic especially) and 20% are located in the calvarium. The remaining lesions are found in the tibia, femur and humerus (Metaphysis or diaphysis)

**Clinical presentation:** asymptomatic, discovered on x-ray or autopsy.

Vertebral hemangiomas can cause neurological symptoms if they extend into the epidural space. Symptoms may vary with other factors that cause vascular distension or reactivity, such as dependency, activity, pregnancy and menstruation.
Conventional radiography (Fig. 30 on page 50): It depends on the location of the lesion:

- **Asymptomatic vertebral angioma**: Demineralization with coarse vertical trabeculae: grid aspect, a "corduroy" appearance.

- **Symptomatic and compressive vertebral angioma T3 - T9**: blowing the posterior wall, extending into the posterior arch and the soft tissues.

- **Calvarial angioma**: geographic gap containing honeycomb, blowing the cortical: resemble radiating wheel spokes.

- **Hemangiomas in the metaphysis or epiphysis of long bones** appear as poorly defined lytic lesions that give a spiculated pattern known as "Irish lace". Normally there are multiple, small, somewhat irregular lytic areas surrounded by variable areas of sclerosis.

**CT (Fig. 30 on page 50):**
- Asymptomatic vertebral body angioma: on axial CT scan, vertebral body lesions have a "polka dot" pattern as the vessels are seen in cross section, surrounded by fat (d <- 30 UH)
- Symptomatic and compressive vertebral angioma: irregular trabeculae (honeycomb) surrounded by a stroma tissue density (> 20 HU), hypervascular and sometimes soft tissue damage behind the posterior vertebral wall (bilobed aspect).

**MRI:**
- Asymptomatic vertebral Angioma: Signal fat (hyperintense T1hypointense T1FAT SAT)
- Symptomatic and compressive vertebral angioma: hypointense T1, hyperintense T2 and intensely enhanced, soft tissue reached.

**Clinical forms:**
- Angiomatosis and lymphangiomatosis: <30 years, 2 H / 1 F, bone and visceral hemangiomas (liver, spleen, lungs, brain, soft tissue).
- Clinical presentation: masses, hepato splenomegaly, pleural and pericardial effusions, cardiac and respiratory failure, anemia, DIC.
- **X-RAY**: multiple geographic osteolysis, surrounded by a thin dense border, blowing the cortex. Sometimes soft tissue phleboliths or abnormalities of the lymphatic system.
- **CT**: liquid density.
- **MRI**: fluid signal (serous) or fat (lymph).
- Massive Osteolysis: Gorham's disease: in children and young adults, reaching two adjacent bones, in belts or spine. Osteolysis progresses to "ghost" bone.

**Treatment:** unnecessary unless the lesion is symptomatic

**V-Cell round lesion**: **Eosinophilic granuloma (EG)**
**Definition:** It is a non-neoplastic proliferation of histiocytes, known as part of a spectrum of Langerhans cell histiocytosis formerly known as histiocytosis X. EG is usually monostotic, but can be polyostotic.

**Topography:** EG is found in the skull, mandible, spine and long bones.

**Sex ratio:** The male to female ratio is two to one.

**Age:** It occurs most commonly in children aged 5 to 10.

**Clinical presentation:** EG is normally symptomatic made of Local pain, swelling and the ESR may be elevated.

**X-Ray Appearance** *(Fig. 31 on page 51):* It is non-specific and differs by location.

The skull may have a lesion with sharp, punched out borders that is uneven across the inner and outer table causing a "beveled edge".

Pelvic lesions are often poorly defined.

Spine lesions are normally found in the vertebral body.

EG is found in the diaphysis or metaphysis of long bones in the center of the medullary cavity.

The lesion may cause endosteal scalloping or a periosteal reaction.

**CT scan** and **MRI** delineate the extent of the intramedullary and cortical penetration.

**Differential Diagnosis:** EG should be included in the differential diagnosis of any sclerotic or osteolytic lesion, either well-defined or ill-defined, in patients under the age of 30, includes Ewing’s sarcoma, osteosarcoma, metastases and osteomyelitis. The diagnosis EG can be excluded in age > 30.

**Clinical forms:**

- Letterer-Siwe disease is a fulminant systemic disease that comprises 10% of Langerhan's cell histiocytosis, occurs in children under 3 years old and is rapidly fatal.

- Hand-Schuller-Christian disease (HSC) is a chronic disseminated form of Langerhan's histiocytosis and occurs in older patients. The well known triad of HSC is diabetes insipidus, exophthalmos and skull lesions.

- EG can convert to systemic forms of the disease. It makes up 60-80% of all cases of Langerhan's cell histiocytosis.

**Treatment options:** depends on the form of the disease:

- With localized disease, often a biopsy alone is enough to incite healing.
-Other treatment modalities of EG include curettage, excision, steroid injection, radiation and observation.

-Chemotherapy is recommended for systemic disease.

**VI-Others:**

**VI-1. Solitary bone cyst:**

**Definition:** Solitary bone cyst, also known as unicameral bone cyst, is a true cyst, a fluid filled cavity lined by a thin membrane

**Frequency:** 3% of primary bone tumors. The most frequent peripheral benign bone tumor in children.

**Age:** from 5 to 20 years, **Sex ratio:** 3H/1F

**Clinical presentation:** asymptomatic

**Topography(Fig. 32 on page 52):** metaphysis of long bones mainly proximal humerus and femur but also tibia, calcaneum and pelvis in adults. SBC may migrate from metaphysis to diaphysis during growth of the bone.

**Conventional radiography:** geographic osteolysis well defined inferiorly, blowhole cortical or partitions may be seen. When a fracture leads to diagnose the osteolysis, a fallen fragment is appreciated and allows to affirm the fluid contents. In case of fracture a periosteal reaction is also seen.

**CT scan:** only if uncertain diagnosis. Liquid density, air density in case of pneumatocyst

**Complications:**

Fracture (no delay for consolidation, multilocular cyst)

**Clinical forms:**

-epiphyseal

-coralliform calcification

-pneumatocyst

**Differential diagnosis:**

Differential diagnosis: Aneurysmal bone cyst, Fibrous Dysplasia when cystic.

Usually less expansion compared with ABC.

**Treatment options:**

-asymptomatic : Abstention

-Fracture: plaster
VI-2. Aneurysmal cyst:

**Definition:** solitary expansile well-defined osteolytic bone lesion, that is filled with blood. It is named aneurysmal because it is expansile is thought to be the result of a reactive process secondary to trauma or increased venous pressure.

**Frequency:** 10% of benign bone tumors  
**Age:** under 20 years, **sex ratio:** H/F=1/1 to 1/1.3

**Clinical presentation:** local pain and swelling, pathologic fractures in up to 25% of cases. Spinal lesions can be associated with spinal cord compression or painful scoliosis.

**Topography:** (Fig. 33 on page 53): metaphysis of long bones: femur, tibia, fibula, humerus and posterior arch of spine, pelvis

**Conventional radiography:** an eccentric radiolucency and a purely lytic or, occasionally, trabecular process, with its epicenter in the metaphysis of an unfused long bone. The trabeculae in the cyst may create a soap-bubble appearance in the lesion. The margins of the lesion are well defined, with a smooth inner margin and a rim of bone sclerosis. The expansion or ballooning of the cortex occasionally may result in the loss of the sharp definition of its margin. In this case, the finding should correctly be interpreted as an aggressive lesion rather than as solely diagnostic of malignant change. No periosteal reaction occurs, except when the periosteum is fractured.

**CT:** It can demonstrate the intraosseous and extrasosseous extents of the lesion. CT can be used to appreciate the cortex (destructed or thin), to determine the nature of the matrix of the tumor.

Fluid-fluid levels may be seen in the cysts. Fluid levels are depicted only when the patient is lying motionless for about 10 minutes and when the scans are obtained in the plane perpendicular to that of the fluid levels.

**MRI:** T1-weighted images show low to intermediate signal intensity with or without fluid levels. Acute hemorrhage into the cyst may have high signal intensity.

T2-weighted images show areas of low to intermediate signal intensity or some areas of heterogeneous high signal intensity, depending on the contents of the cyst.

A rim of low signal intensity with internal septa may produce a multicystic appearance. Tumor enhancement with gadolinium is seen in aggressive lesions

**Clinical forms:**

- aggressive ABC: cortical destruction, extension to soft tissues

- underlying lesion like GCT, osteoblastoma or chondroblastoma.
Differential diagnosis:

- Malignant lesions in some locations: It may mimic a sarcoma in the ribs, scapula, or sternum, especially when associated with a large soft-tissue component.

- Fluid-fluid levels also are seen in giant cell tumors, and in telangiectatic osteosarcomas.

Treatment options:

- Biopsy to look for an underlying lesion
- Surgery
- Percutaneous injection of Ethibloc or Embolisation

VI-3. Giant cell tumor:

Definition: Tumor made up of mononuclear stromal cells and multinucleated giant cells. The risk of malignant transformation in fibrous or osteosarcoma is 10 to 20% after several local recurrences.

Frequency: 21% of benign bone tumors.

Age: From 20 to 40 years, Sex: Female > male.

Clinical presentation: Dull pain, swelling, pathologic fracture.

Topography (Fig. 34 on page 54): Epiphyseal-metaphyseal bone near the knee, below the elbow.

Upper limb > lower limb. Pelvis (near the joints), sacrum, vertebral body.

X-ray appearance (Fig. 35 on page 55): Metaphyseal-epiphyseal eccentric osteolysis, containing shear walls, blowing the cortex. Sometimes achieving the adjacent epiphysis.

Sometimes, signs of aggressiveness: ill-defined osteolysis, cortical disruption, extension to soft tissue (sign malignant degeneration or high risk of local recurrence).

CT: The cortex is blown or broken; partitions should not be confused with calcifications, sometimes sero-bloody level.

MRI: Indispensable if the tumor is aggressive: to search intramedullary extension and in soft tissues. Hypointense T1, hyperintense T2, sometimes liquid level.(Fig. 36 on page 56)

Clinical forms:

- Multiple achieving: simultaneously or successively (hands, metaphysis).
- TCG of Paget's disease.

Differential diagnosis:

- ABC may have the same radiographic features but is found in a younger age group.
- Chondroblastoma is also located in the epiphysis, but is seen exclusively in the epiphysis without extension to the metaphysis and is seen in a younger age group.

- Metastases, especially in older patients

**What to do:**

- If low-grade tumors: curettage + filling,
- If radiographically aggressive tumor or early aggressive recurrence after curettage: resection and reconstruction.

**Evolution:**
1. Healing: After curettage, even after one or two recurrences.
2. Recurrence: 35 - 60%, average time £ 6 years.
Radiography: gap adjacent to curettage, delayed assimilation of a bone graft.
3. Malignant degeneration: 10-20%, usually after several recurrences, average time: 13 years
Radiography: signs of aggression: cortical disruption, spicular periosteal reaction, spur Codman, invasion of soft tissues, lung metastases.

**VI-4. Lipoma:**

**Definition:** Like soft tissue lipoma, it consists of mature fat cells separated into lobules by fibrovascular septa.

**Frequency:** Represents 0.3% of primary bone tumors biopsied.
**Age:** Occurs from 40 to 60 years, **Sex ratio:** 1
**Clinical presentation:** asymptomatic, it is an incidental lesion.
**Topography (Fig. 37 on page 57):** metaphysis, sometimes diaphysis of long bones: fibula, femur, tibia: most frequent in lower limb than upper limb.
More rarely: calcaneus, ribs, skull, spine (sacrum).
**X-ray appearance:** geographic osteolysis multilobed containing bony ridges, surrounded by a thin border of condensation, blowing the cortex and sometimes containing dystrophic calcifications.

**CT:** affirms the diagnosis: homogeneous fat content (negative density), occupying the entire tumor.
**MRI:** fat signal (high signal T1, T2, disappearing in saturation fat).
**Clinical form: Parosteal lipoma**
Asymptomatic mass with fat density coupled with a thickened and eroded cortical, sometimes next to bony overgrowth.

**Differential Diagnosis:** unicameral bone cyst, non-ossifying fibroma, aneurysmal bone cyst, chondrosarcoma, fibrous dysplasia
**What to do:** if diagnosis affirmed by the scanner: abstension.
**VI-5. Brown tumor:**

**Definition:** It is a benign tumor occurring in hyperparathyroidism.

**Topography:** It can occur in any bone

**Conventional radiography** *(Fig. 38 on page 57):* osteolytic lesion with sharp margins. Septa and ridges may be seen.

**Differential diagnosis:** ABC, metastases and GCT depending on location and age.

The clinical and biological data have to be known for the diagnosis (renal failure ++).
Fig. 7: The most common locations of Osteoid osteoma in red, the rarer in green.

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Fig. 8: Sagittal CT scan image of spine shows an osteoid osteoma of a the posterior arch. CT is the best examen to detect the nidus.

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Fig. 9: a:Lateral radiograph of the sacro-coccygeal area show no evidence of lytic lesion. b:CT scan with axial and coronal reconstruction: osteoid osteoma appears as a hypodense lesion in the right posterior element of the second coccygeal piece. Note the central nidus calcification.

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Fig. 10: The most common locations of osteoblastoma in red, the rarer in green.

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**Fig. 11:** The most common locations of osteoma in red, the rarer in green.

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Fig. 12: Axial CT scan image shows a very dense opacitie, homogeneous related to an osteoma of the temporal bone.

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**Fig. 13:** The most common locations of chondroma in red, the rarer in green.

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Fig. 14: Chondroma of the left femoral upper metaphysis as a geographic osteolysis borded with osteosclerosis, blowhole cortical and containing pitted calcifications.

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**Fig. 15:** Chondroma of the first phalanx of the fourth right finger: The tumor consists in a heap of calcifications

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**Fig. 16:** MRI of chondroma of the femoral upper metaphysis previously described(fig14): T1 and T1-weighted enhanced MR images show a low signal on T1 and a contrast enhancement with speckled appearance.
**Fig. 17:** The most common locations of chondroblastoma in red, the rarer in green.
**Fig. 18:** A chondroblastoma in pseudo aggressive form involving the dorso lumbar junction.

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**Fig. 19:** Coronal CT scan image of chondroblastoma. CT scan allows better detection of calcifications mainly when they are thin.

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Fig. 21: The most common locations of chondromyxoid fibroma in red, the rarer in green.

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Fig. 22: Chondromyxoid fibroma: geographic osteolysis, with dense peripheral rim and partitions.

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Fig. 23: The most common locations of osteochondroma in red, the rarer in green.

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Fig. 24: Osteochondroma: developmental abnormality of bone perpendicular to the metaphysis, goes to the diaphysis, pedunculated. The cortical and cancellous bone of the exostosis and the bone holder are in continuity. Cap is calcified.

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**Fig. 25:** The most common locations of NOF in red, the rarer in green

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Fig. 26: NOF of the tibia: a well defined cortical osteolysis with a sclerotic border. No periosteal reaction.

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**Fig. 27:** The most common locations of fibrous dysplasia in red, the rarer in green.

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**Fig. 28:** Well defined osteolytic lesion in the right femoral neck with a peripheral sclerosis (blue arrow) and a ground glass or hazy appearance of the matrix. The X ray shows also a fracture of the neck; pathological fracture(red arrow).

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**Fig. 29:** The most common locations of hemangioma in red, the rarer in green.

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Fig. 30: A vertebral hemangioma; on the left, X ray shows demineralization with coarse vertical trabeculae gives a grid aspect, a "corduroy" appearance. On the right, axial CT scan shows vertebral body lesion with a "polka dot" pattern as the vessels are seen in cross section, surrounded by fat.

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**Fig. 31:** Axial CT scan image shows a well defined eosinophilic granuloma associated with a periosteal reaction.

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Fig. 32: The most common locations of solitary bone cyst in red, the rarer in green

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Fig. 33: The most common locations of aneurysmal cyst in red, the rarer in green

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**Fig. 34:** The most common locations of giant cell tumor in red, the rarer in green

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**Fig. 35:** Giant cell tumor presenting as an eccentric lytic lesion in the lateral epi- and metaphysis of the tibia.

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Fig. 36: Giant cell tumor described in fig 35: Axial MR T1,T2, fat suppressed T1 weighted enhanced images show tumor hypointense T1, hyperintense T2 , intensely enhanced and detect soft-tissue extension and the intramedullary extent of the tumor.

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Fig. 37: The most common locations of lipoma in red, the rarer in green

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Fig. 38: Brown tumor in hyperparathyroidism: Well-defined osteolytic lesions in the skull of a patient who had a renal failure.

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Conclusion

The diagnosis approach of a bone lesion is based on an analysis of epidemiological and radiological signs. For benign tumors with favorable outcome, the diagnosis must be based only on radiology and must avoid biopsy. The actions to be taken depend on the symptoms and the possible complications.
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