Musculoskeletal imaging

Imaging methods

Conventional radiography

The main purpose of conventional radiography is to provide information related to the position, shape, dimensions, outline and structure of the bones. In this regard, it is imperative to accomplish the following:

A. Optimal choice regarding electrical parameters so that both soft parts and bone structures can be properly visualized;

B. The radiography carried out must comprise at least one joint of the examined bone;

C. The radiological examination shall comprise X-rays carried out in at least two perpendicular incidences in order to achieve a good appreciation of the localization, dimensions of the lesion and also changes generated by the lesion itself over the adjacent structures;

D. Symmetrical regions must always be explored bilaterally in order to allow a comparative analysis of them.

Imaging methods

Ultrasonography

Ultrasonography (US) is an affordable, inexpensive and non-radiating imaging technique that uses ultrasounds to visualize pathological changes in ligaments, tendons, muscles, synovia, subcutaneous cellular tissue, vascular and nervous structures.

The US exam has many advantages:

- allows assessment of tendino-ligamentary and muscular lesions;
- can detect tumoral masses developed in soft tissues;
- may establish the contents of a mass (liquid or tissue);
- allows assessment of intra-or perilezional vascularisation;
- allows an US-guided interventional approach of soft parts tumors.

The disadvantages of this technique include low accuracy in the characterization of bone lesions and it is operator dependent.

Imaging methods

Computed Tomography

The Computed tomography exam (CT) is a quick, non-invasive, painless and indispensable method for evaluating tumor pathology developed in soft bones and tissues, as well as for assessing traumatic pathology.

This examination allows multiplanar acquisition of images with a resolution far superior than conventional radiography, offering the possibility to diagnose and appropriately characterize lesions that affect the musculoskeletal system.

Compared with conventional radiography, the CT exam provides information about articular congruences, bone structure and joint. The CT exam can be performed with an intravenous contrast agent that allows assessment of intratumoral vascularization and bone injury extension, thus contributing to a good appreciation of tumor staging.

Imaging methods

Magnetic Resonance Imaging

Magnetic resonance imaging (MRI) is a painless, non-invasive and non-radiating imaging technique useful in diagnosing trauma, tumors, inflammations and infections that affect the musculoskeletal system. Unlike the CT exam that involves a relatively low image acquisition time, the MRI exam involves a considerably higher duration for images to be acquired, which is why the CT examination is preferred for diagnostic traumatic pathology.

The MRI examination allows a good assessment of the musculoskeletal structures, as well as articular space and cartilage. In addition, MRI can be used to detect bone edema. The usefulness of MRI is especially noted in the early stages of rheumatoid arthritis and sacroileitis.

Imaging methods

Artrography

Arthrography involves the examination of the articular space in an invasive manner by injecting a contrast agent inside the joint space. This imaging method implies a good knowledge of the articular anatomy. The nature of the contrast agent varies according to the type of examination that is used further on (artrography, artro-CT, artro-MR).

The usefulness of arthrography consists in highlighting the changes that affect the articular space and surfaces and also joint capsule.

Imaging methods

Bone scintigraphy

Bone scintigraphy involves the administration of a radiotracer (radioactive isotope), followed by the detection and recording of the gamma emission from the radionuclide. The most commonly used radiotracers are Technetium-99 and 18F-Fluorodeoxyxiglucosis (18F-FDG).

Bone scintigraphy performs a whole-body examination which is useful in early diagnosis of malignant tumors, as well as in detecting bone secondary lesions (metastases).

Imaging methods

Hybrid imaging

PET-CT and PET-MR are modern imaging means that involve the use of a radioactive radiotracer with dual acquisition of PET and CT or MRI images. Most commonly, 18F-fluorodeoxyxiglucosis (18F-FDG) is used as radiotracer. The imaging methods described above can detect lesions that exhibit intense radiotracer enhancement due to an intense metabolic activity.

General bone anatomy

Classification of bones based on their dimensions:

A. Long bones (limb bones; consisting of diaphysis and two epiphyses);

B. Flat bones (skull bones; length and width are equal, greater than thickness);

C. Short bones (vertebral bodies, carpal bones, tarsian bones; The three dimensions are almost equal).

General bone anatomy

Classification of joints based on the degree of mobility:

A. Synarthrosis – fixed joints that connect bone extremities using cartilage bands (synchondrosis). In time, the cartilaginous bands calcify and synostosis are formed. Example: neurocranium joints;

B. Amphiarthrosis – low mobility joints that connect bone extremities through a fibro-cartilaginous structure;

C. Diarthrosis – mobile joints that exhibit a much more complex structure. Diarthrosis comprises the bone extremities that form the joint, the joint capsule and the synovial membrane. The synovial membrane produces a small amount of synovial fluid that facilitates movements inside the joint.

Basic bone radiological changes

Shape Changes:

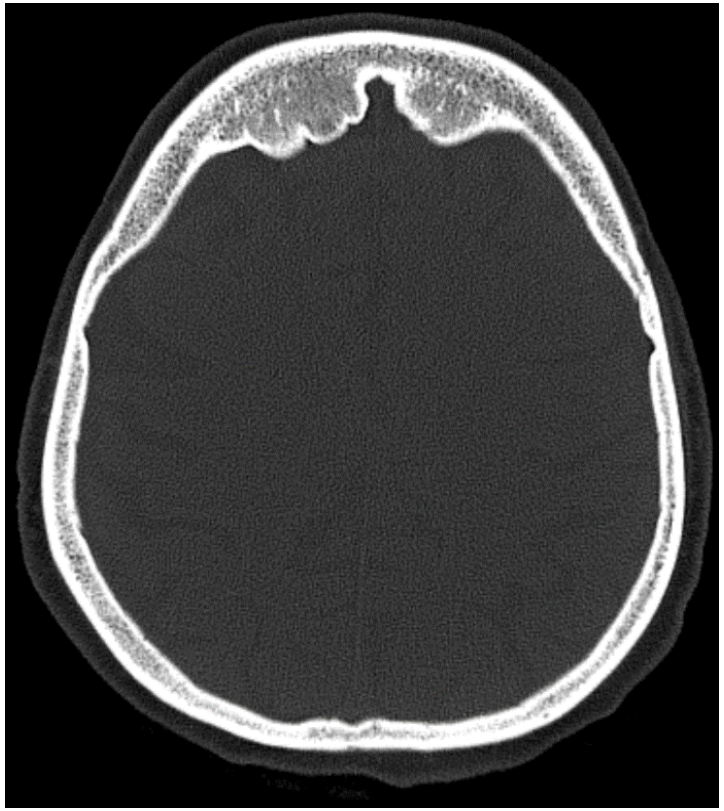
A. Hyperostosis – changes affecting the bone shape and size due to partial or integral thickening;

B. Exostosis – deformation of the bone structure by developing a bone production that protrudes from the bone contour and has similar morphology to the normal bone from which it is formed;

C. Oedostosis – bone deformation with an increased transverse diameter due to structural changes that develop slowly and push the cortical of the bone;

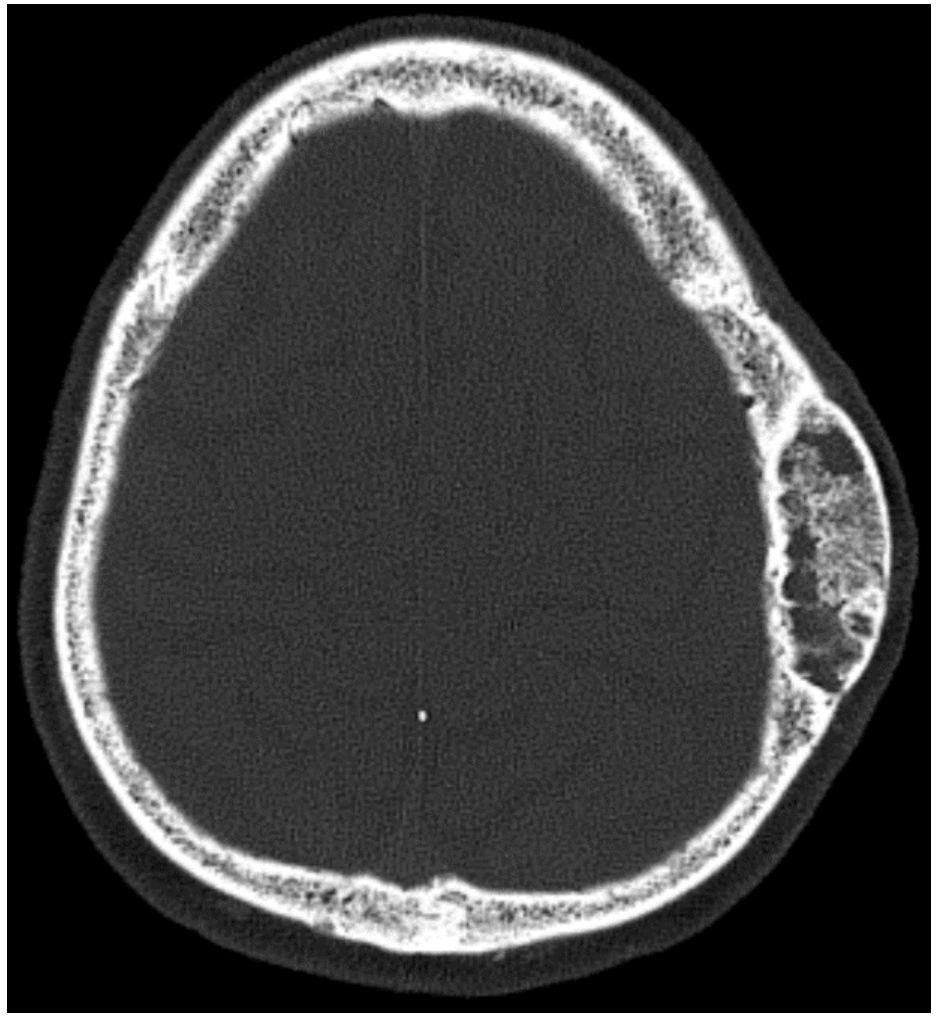
D. Scoliostosis – pathological bowing of the bone.

Basic bone radiological changes



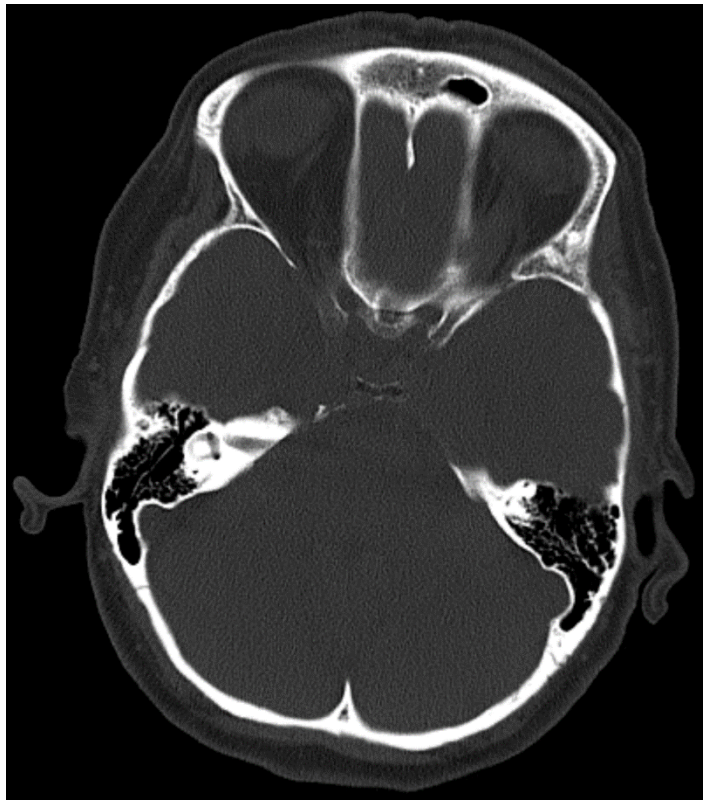
Basic bone radiological changes

Basic bone radiological changes



Basic bone radiological changes

Basic bone radiological changes



Basic bone radiological changes

Changes in size:

A. Aplasia/Agenesia – congenital absence of one or more bone structures;

B. Hypoplasia – small size of the bone, but with normal shape and structure;

C. Hyperplasia – exaggerated development of the bone, but with normal shape and structure.

Basic bone radiological changes

3. Contour Changes:

A. Irregular outline;

B. Interrupted outline;

C. Duplicated outline.

Basic bone radiological changes

4. Structural changes:

A. Destructive changes (osteoporosis, osteolysis, osteonecrosis, atrophy due to pressure);

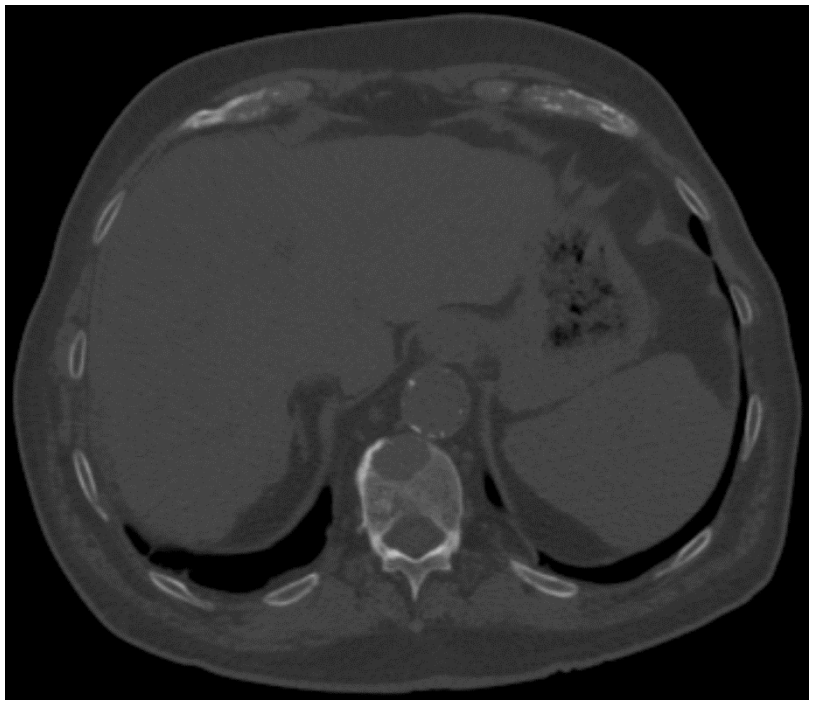
B. Constructive changes (osteosclerosis, periostosis, heterotopic ossifications)

Basic bone radiological changes

Osteoporosis is the reduction of bone mass accompanied by the alteration of the bone ahitecture. When the osteoporotic process affects the spongious bone tissue, a reduced intensity of the bone trabeculae and also a reduced thickness of the trabeculae. Osteoporosis changes affecting the compact bone tissue decrease its intensity and generate thinning of the cortical bone.

Basic bone radiological changes

Osteolysis involves a complete and simultaneous destruction of both mineral and protein components. Osteolysis can occur in conditions such as malignant tumors and inflammatory or toxic disorders. On X-ray, osteolytic lesions are seen as areas of complete bone resorption of varying size, being delimited by an osteosclerotic rim. Thus, the structure of the bone disappears completely in the affected area.

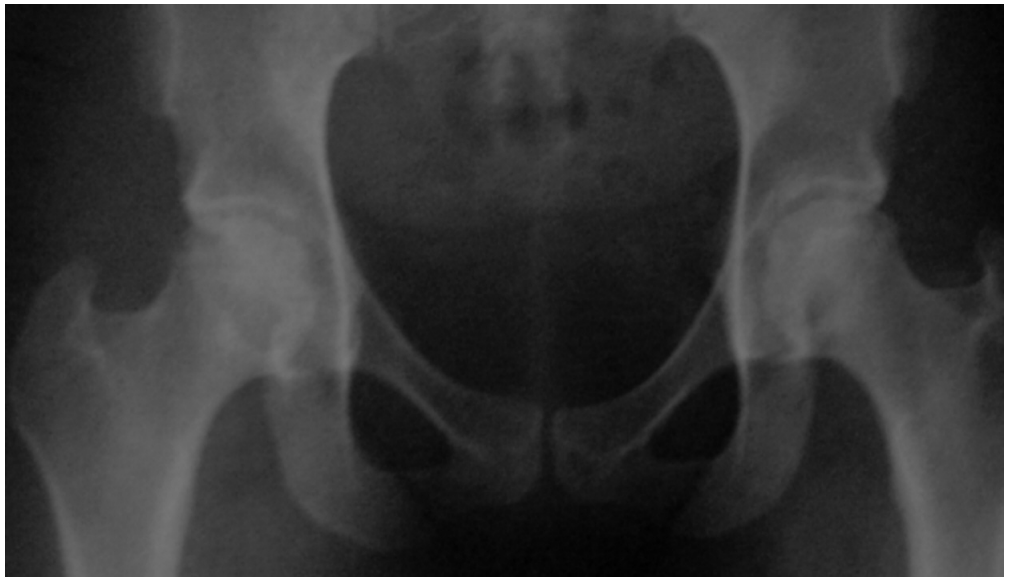


Basic bone radiological changes

Atrophy due to pressure occurs after a prolonged mass effect generated over a bone structure. Thus, the bone appears thin, undergoes plastic changes (scoliostosis) and develops edema in the affected area. If the intensity of the pressure on the bone increases above a threshold limit, there is an increased possibility of developing fractures at this level.

Basic bone radiological changes

Osteonecrosis involves blocking the nutritive vascular intake of a certain bone region. Osteonecrosis may occur as a result of trauma, infectious disorders or bone subjected to an increased extrinsic pressure. On X-ray, osteonecrosis translates into an area of circumscribed osteolysis that presents a bone fragment inside which is called bone sequelae.



Basic bone radiological changes

Osteosclerosis developed in the spongy bone tissue is called spongiosclerosis and the one developed in the compact bone tissue carries the name endostosis.

On X-ray, spongiosclerosis is seen as thickening of the bone trabeculae and reduced size of the space between the bone trabeculae. Endostosis refers to the osteosclerotic process that develops on the internal contour of the compact bone and evolves towards the medullary canal. Radiologically, endostosis translates into a thicker cortical bone and a decreased diameter of the medullary canal.

Basic bone radiological changes

In adults, the periosteum is not normally visible on X-ray. **Periostosis** involves the formation of bone tissue in the periosteum, unrelated to the physiological process of growing in thickness. Radiologically, periostosis can be linear (well-delimited linear opacity that doubles the external contour of the bone) or lamelar (multiple linear opacities with similar disposition to the linear periostosis). Periostosis may also occur in the form of triangular periostotic spurs in the periphery of expansive malignant tumor masses.

Basic bone radiological changes

Heterotopic ossifications represent the development of bone tissue in areas where they do not normally develop. These may affect tendons, ligaments, muscles.

Traumatology

Fractures represent the interruption of bone continuity. Fractures can occur through several mechanisms: traction, torsion, flexion, shearing and compression. Also, the resistance of the bone subjected to the action of a traumatic agent plays an extremely important role.

The fracture occurs either through the action of a high intensity traumatic agent that exceeds the strength and elasticity of a normal shaped bone, or through the action of an intermediate intensity traumatic agent on a bone with low resistance due to different disorders (eg, osteoporosis).

Traumatology

The radiological examination in case of fractures must specify a series of details that will significantly influence the subsequent therapeutic management of these patients:

- precise identification and location of the fracture:

Fractures can affect any type of bones (long, short, flat) and any segment of the bones (epiphysis, metaphysis, diaphysis). Most commonly, fractures occur in the long bones.

- identifying the type of fracture:

a. incomplete fracture (the fracture does not completely separate the fractured fragments and affects only one bone cortical);

b. complete fracture (the fracture completely separates two or more fractured fragments and affects both corticals of the bone).

- describing the fracture trajectory:

a. transversal;

b. longitudinal;

c. oblique;

d. spiroid.

Traumatology

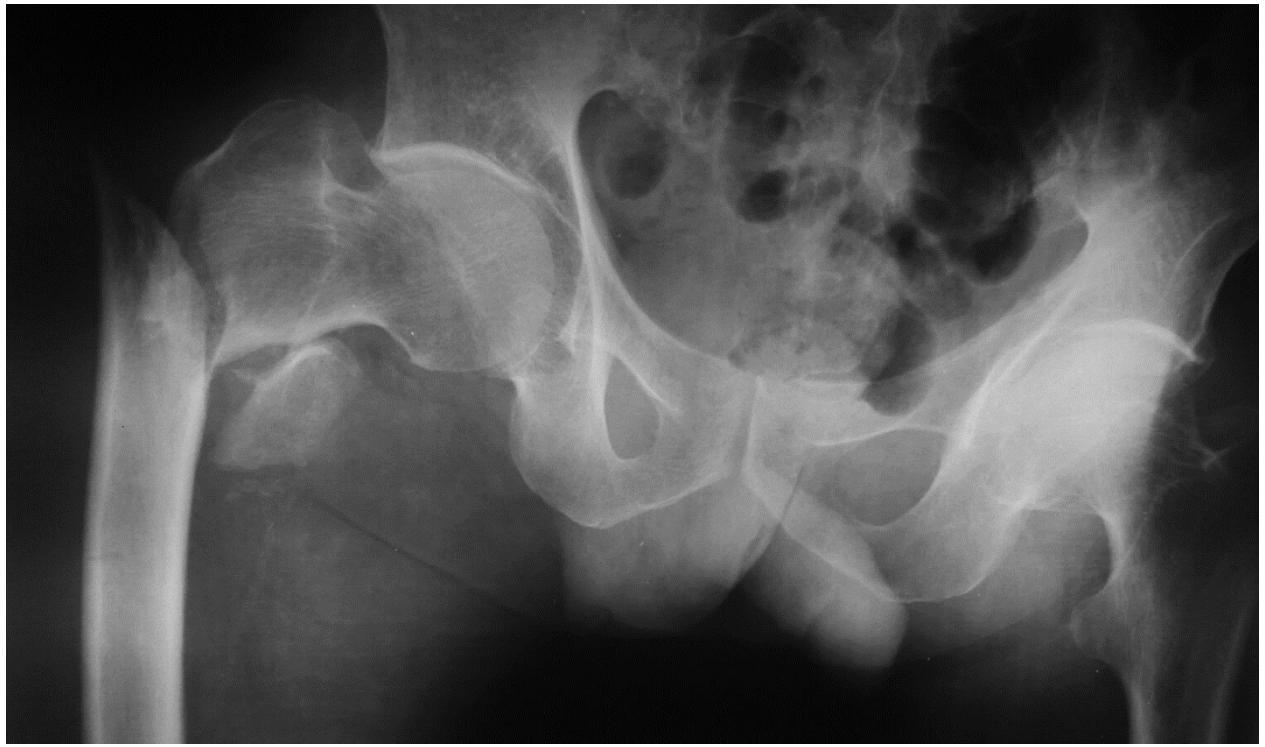
- presence / absence of possible displaced fractured bone fragments:

The displacement of fractured bone fragments is not always achieved, in which case the correct name is fracture without displacement. In case of displaced fractures, the fractured bone fragments can move in all three planes (translation, fracture, rotation, angular, telescoping).

- presence / absence of associated lesions:

Bone fractures can be associated with skin lesions in case of open fractures. Also, due to the impact that causes the fracture of a certain bone segment, the traumatic agent can simultaneously cause vascular or nervous injuries, dislocations or sprains.

Traumatology



Traumatology

Traumatology

Traumatology

Evolution of bone fractures

The evolution of the bone fracture can be towards healing (calus formation) or towards developing complications.

The development of the callus is realized during ***three stages***:

a. Inflammatory phase - following the action of the traumatic agent and the formation of the fracture pathway, a hematoma is formed at this level, which passes through several evolutionary phases and, finally, the plasma is resorbed and a fibrin-protein clot results. In this stage, a demineralization process affecting the fractured bone ends is highlighted, and the fracture path appears enlarged.

Evolution of bone fractures

b. Cellular proliferation phase - the fibrin-protein clot formed previously is invaded by fibroblasts from the adjacent structures, but also by osteoblasts from osteocyte reconversion. The mineral salts mobilized from the fractured bone fragments accumulate inside the fractured area on the new bone matrix developed at this level.

On an X-ray, in this stage the outline of the bony extremities adjacent to the fracture path is diffuse. At approximately 3-4 weeks, in case of a favorable evolution of the fracture, the appearance of the primitive bone callus of reduced intensity is observed. The intensity of the bone marrow increases progressively and the fracture path becomes more and more difficult to see. Finally, the fracture path is no longer visualized and a globular or fusiform opacity that exceeds the bone cortex is seen around the fractured fragments.

Evolution of bone fractures

c. Remodeling phase - in case of a favorable evolution of the fracture, after immobilizing the fractured segment, the mobilization of the patient begins under the guidance of the orthopedic physician. Thus, the generated mechanical forces stimulate the physiological reshaping of the newly formed bone tissue. This extremely complex process can take from several months up to 2 years. After correct and complete healing, the fracture path completely disappears and the continuity and functionality of the fractured bone returns to the initial pre-fracture stage.

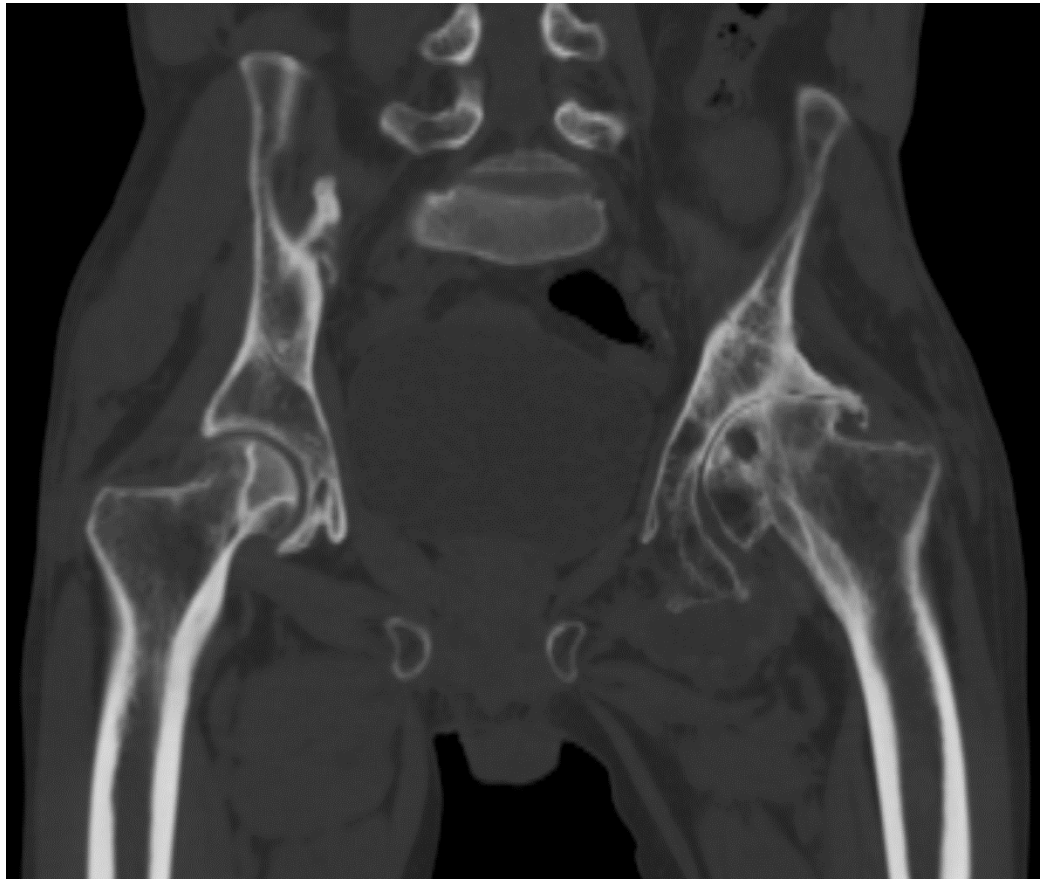
Evolution of bone fractures

Fractures do not always have a favorable evolution. Complications that may occur in the evolution of a fracture include:

- ***delayed callus formation*** (the fractured bone fragments do not weld during the time necessary to consolidate a similar fracture);
- ***pseudarthrosis*** (fracture does not consolidate at least 6 months after trauma);
- ***vicious callus*** (the bone fragments are fixed in a vicious position);
- ***immobilization osteoporosis*** (determined by the suppression of the functional activity);
- ***aseptic necrosis*** (the fracture path and / or the osteosynthesis materials used may affect the vascularization of the bone structure).

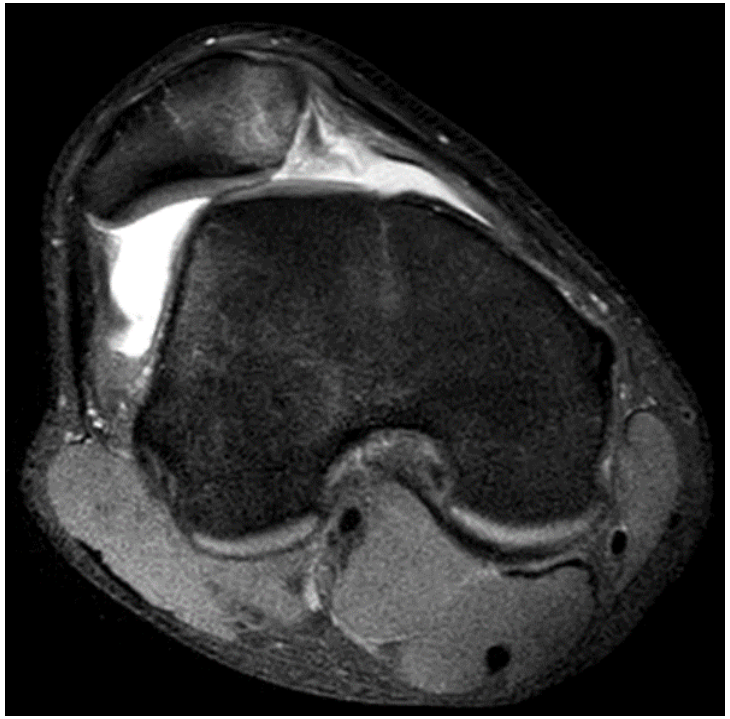
Evolution of bone fractures

Evolution of bone fractures



Traumatology

Dislocation represents the partial or total loss of contact between the articular surfaces. They may or may not be associated with fractures.



Traumatology

The sprain implies the existence of capsulo-ligamentary lesions. The changes determined by the sprain are not visible on conventional radiography. In this regard, the MRI examination is the method of choice in the imaging exploration of sprains in order to completely assess lesions affecting tendons, ligaments and joint capsule.

Inflammatory-infectious disorders

1. Acute osteomyelitis

Bone infection is referred to as osteitis or osteomyelitis, and the pathogen can reach the bloodstream from a distant infectious outbreak or through direct inoculation like in open fractures.

The most common infectious etiological agent involved in the onset of acute osteomyelitis is staphylococcus aureus (over 90% of cases). The infection is frequently located in the metaphysis of the long bones due to the rich vascularization and slow blood flow at this level.

Inflammatory-infectious disorders

1. Acute osteomyelitis

On an X-ray, ***the initial congestive phase*** is not accompanied by suggestive pathological changes in the affected bone region.

In the suppurative phase, about 3-4 weeks after the onset, linear or lamellar periostosis is present. Also, osteolytic areas that contain structures similar to bones are noticed. These are actually the areas of bone necrosis that initially appear diffusely delimited, but within a few months from onset they become sharply delimited by the rest of the bone through radiolucent bands. When they become completely isolated, they are called bone sequestrae.

With the onset of linear or lamellar periostosis, the ***bone regenerates*** and progressively refills the area previously affected by osteomyelitis.

Inflammatory-infectious disorders

1. Acute osteomyelitis

Inflammatory-infectious disorders

2. Chronic osteomyelitis

Chronic osteomyelitis represents an unfavorable evolution towards the chronicization of an acute osteomyelitis. On an X-ray, the presence of hyperostosis is noticed in the area where acute osteomyelitis previously developed. In evolution, in the affected bone area, osteolytic zones can develop and become surrounded by osteosclerotic areas corresponding to the intra-osseous abscesses. In addition, within the osteolytic areas bone sequestrae can be highlighted.

Inflammatory-infectious disorders

3. Tuberculous osteoarthritis

Tuberculous osteoarthritis is caused by an infection with Koch bacillus and frequently occurs secondary to pulmonary tuberculosis. Tuberculous osteroarthritis can be located in the bone initially and subsequently develop into the joint or it can be located in the joint from the very beginning. Epiphyses and metaphyses of the long bones are most commonly affected (coxo-femoral joints, knees and tibio-tarsal joints). A particular location of infectious osteoarthritis is in the spine, where it is called Morb Pott.

On an X-ray, the following changes can be identified:

- ***changes affecting the position and / or shape of the bones*** (permanent vicious attitudes - subluxation, coxa vara, coxa valga, rotation, abduction, adduction, etc.);
- ***changes affecting the bone structure*** (osteoporotic changes, the articular surfaces have an imprecise outline, marginal osteolytic areas with an appeareance similar to geodes or erosions that may have bone sequestrae inside);
- ***changes affecting the joint space*** (in the early stages, the joint space appears enlarged; in evolution, the the joint space progressively reduces until it disappears);
- ***changes in the soft parts*** (development of cold abscesses).

In most cases, healing is done by ankylosis, which, from a radiological point of view, appears as a continuity between the two bony extremities that make up the affected joint.

Inflammatory-infectious disorders

4. Vertebral tuberculosis (Morb Pott)

Morb Pott is frequently located in the dorsal-lumbar transitional vertebral bodies and always affects at least two vertebral bodies and the intervertebral disc between them. Spinal tuberculosis does not affect the vertebral arches, which is why it does not associate neurological phenomena.

On an X-ray, the following aspects may be present in vertebral tuberculosis:

- ***osteoporosis of the vertebral bodies and lysis of the affected vertebral plates***;

- ***the reduction in size until disappearance of the intervertebral space***;

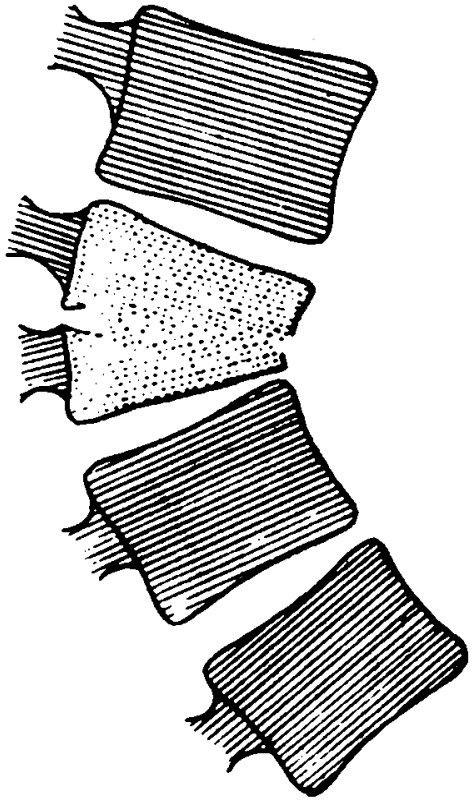
- ***changes of position*** (angular kyphosis - gibus, scoliosis) occur due to the destruction of the vertebral hemibody (cuneiform cleavage);

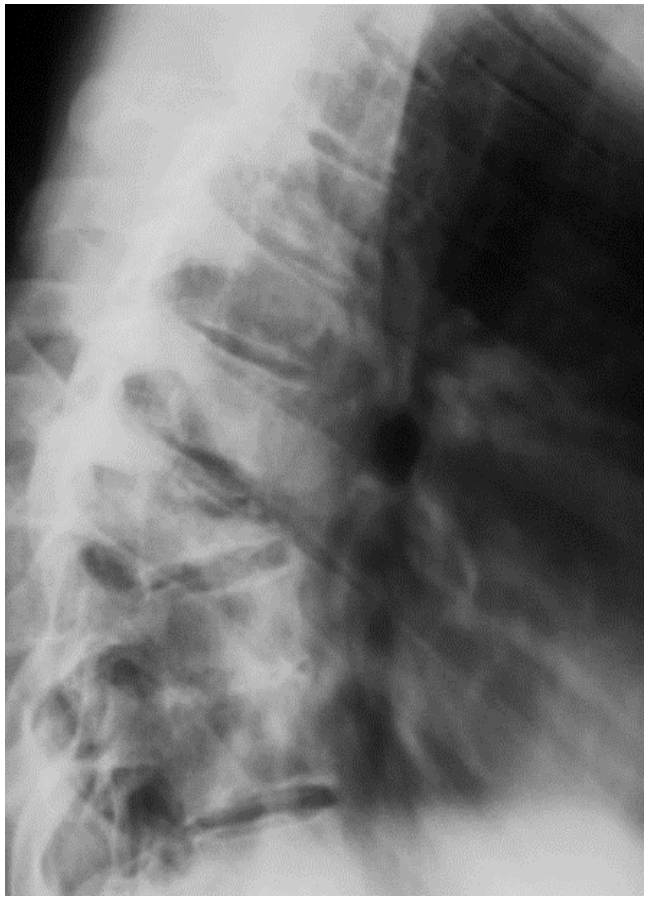
- ***presence of cold paravertebral abscesses*** - fusiform, uni- or bilateral paravertebral opacities, well delimited, with external convex contour, adjacent to the affected vertebral bodies.

The CT examination can accurately describe the pathological changes produced in the bone structures. In addition, an MRI examination can be performed to assess the degree of disc impairment, the extension in the soft parts and the presence of paravertebral abscesses. On the MRI examination, bone edema, intradiscal and soft tissue edema appears in hypo T1 and hyper T2, while postcontrast sequences show an intense contrast uptake at this level. Paravertebral abscesses appear in the form of well-delimited collections, with fluid signal (hypo T1, hyper T2), with peripheral gadophilia.

Inflammatory-infectious disorders

4. Vertebral tuberculosis (Morb Pott)



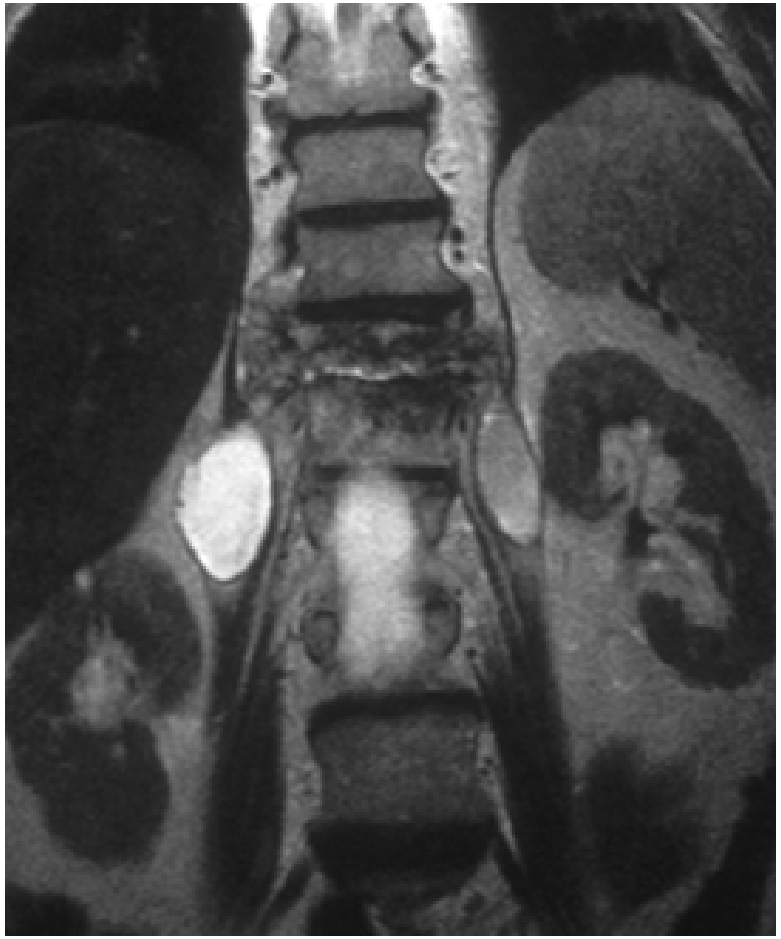


Inflammatory-infectious disorders

4. Vertebral tuberculosis (Morb Pott)

T1

T2



T2

Inflammatory-infectious disorders

5. Rheumatoid arthritis

Rheumatoid arthritis is a chronic inflammatory condition that involves a symmetrical, bilateral involvement of several joints, usually the peripheral joints. Articular involvement in rheumatoid arthritis frequently begins with interest in the metacarpophalangeal and proximal interphalangeal joints, as well as the fist joint. In evolution, the disease can affect other joints such as the shoulder, elbow, hip, knee, metatarsophalangeal and proximal interphalangeal joints of the foot.

Inflammatory-infectious disorders

5. Rheumatoid arthritis

In the early stages of rheumatoid arthritis, the X-ray may look normal or may have the following changes:

- swelling of the periarticular soft parts;
- joint spaces with reduced size;
- demineralization of the affected bone structures, mainly affecting the epiphyses.

In the advanced phases of rheumatoid arthritis, the X-ray identifies, in addition to the changes previously described in the initial phases, the following aspects:

- disappearance of the joint space;
- irregular contour of the bony extremities that make up the affected joint;
- the presence of marginal erosions;
- deviations, subluxations and dislocations due to bone destruction processes.

Inflammatory-infectious disorders

5. Rheumatoid arthritis

Inflammatory-infectious disorders

6. Ankylosing spondylitis

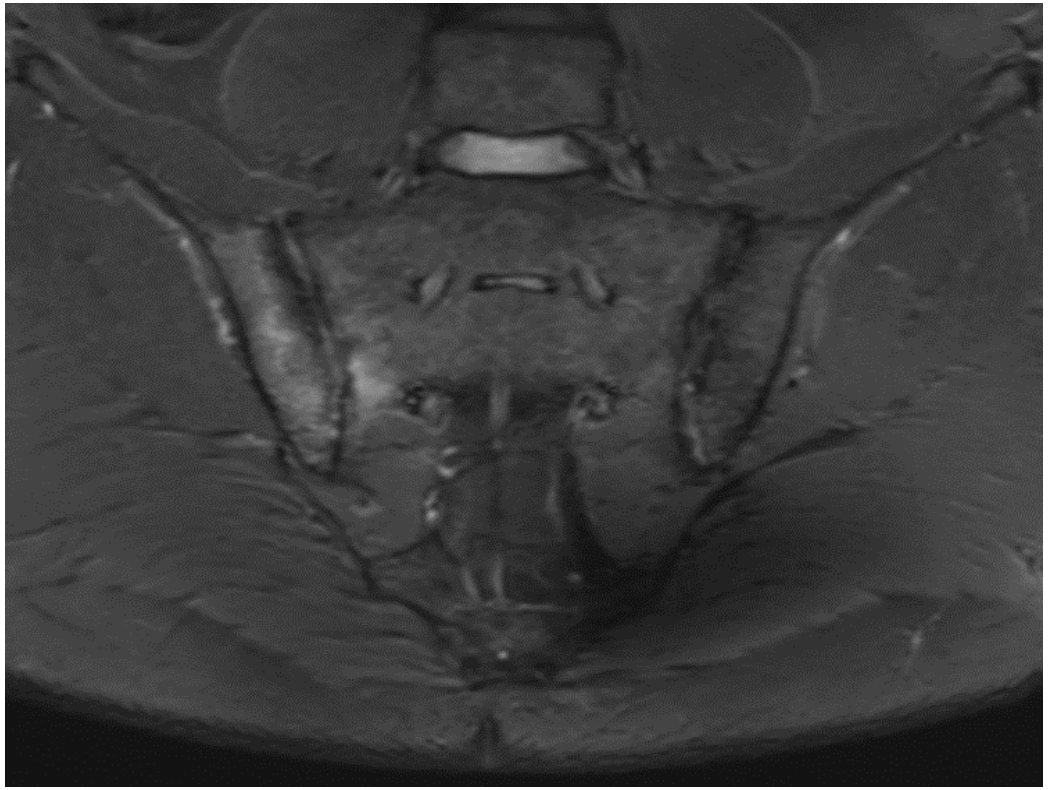
Ankylosing spondylitis is a chronic progressive inflammatory disorder that is of particular interest to the axial skeleton. This disease most commonly affects men in the age range of 15-30 years. The disease begins at the sacro-iliac and lumbar-sacral level and then progresses upwards to the thoracic and cervical spine.

In the initial stages, the changes of sacroiliitis may be asymmetrical, unilateral, but in the evolution of the disease they become symmetrical, bilateral. On an X-ray, the sacro-iliac changes start with the sacro-iliac marginal demineralization that acquires an imprecise contour and generates pseudoenlargement of the sacro-iliac joint spaces. Subsequently, osteosclerotic changes affecting the sacro-iliac joint slopes and the presence of erosions are noted.

In the final stage of the disease, we notice the disappearance of the joint space, with the installation of ankylosis. The MRI examination is of great utility in detecting the incipient changes of sacroiliitis by highlighting the sacro-iliac edematous changes in hypo T1 and hyper T2 and STIR.

Inflammatory-infectious disorders

6. Ankylosing spondylitis



STIR

Inflammatory-infectious disorders

6. Ankylosing spondylitis

In the axial skeleton, the disease begins with osteosclerotic changes affecting the anterior corners of the vertebral bodies. In this phase, the MRI examination can distinguish between active (Modic I type changes - bone edema in hypo T1, hyper T2 and STIR) and inactive lesions (Modic II type - lipomatous degeneration in hyper T1, T2 and hypo STIR).

In the evolution of the disease, the vertebrae acquire a square aspect. Also, the presence of Andersson lesions (non-infectious spondylodiscitis) is noted. Later on, syndesmophytes (ossification of the intervertebral ligaments joining the corners of two adjacent vertebrae) start to develop. In the evolution of the disease, the fusion of the vertebral bodies through several syndesmophytes appears and gives the radiological appearance of "bamboo column".

Arthrosis

1. Vertebral arthrosis

Vertebral arthrosis changes are most commonly located at the cervical and lumbar segments of the spine. In the cervical spine, arthrosis is frequently located at the C5-C6 intervertebral disc. In the lumbar spine, arthrosis is usually located at the T12-L1, L4-L5 and L5-S1 intervertebral discs.

Conventional radiography shows the following changes in spine arthrosis:

- the intervertebral discs have a reduced height;
- the presence of marginal osteophytes;
- osteosclerosis of the vertebral plates;
- the presence of spine listhesis.

The MRI exam can additionally provide the following information:

- decreased hydric disc content of the intervertebral discs;
- presence / absence of Modic I (bone edema) type changes in hypo T1, hyper T2 and STIR;
- presence / absence of Modic II (lipomatous degeneration) changes in hyper T1, T2 and hypo STIR.

Arthrosis

1. Vertebral arthrosis

T2

Arthrosis

2. Hip arthrosis

Conventional radiography shows the following changes in hip arthrosis:

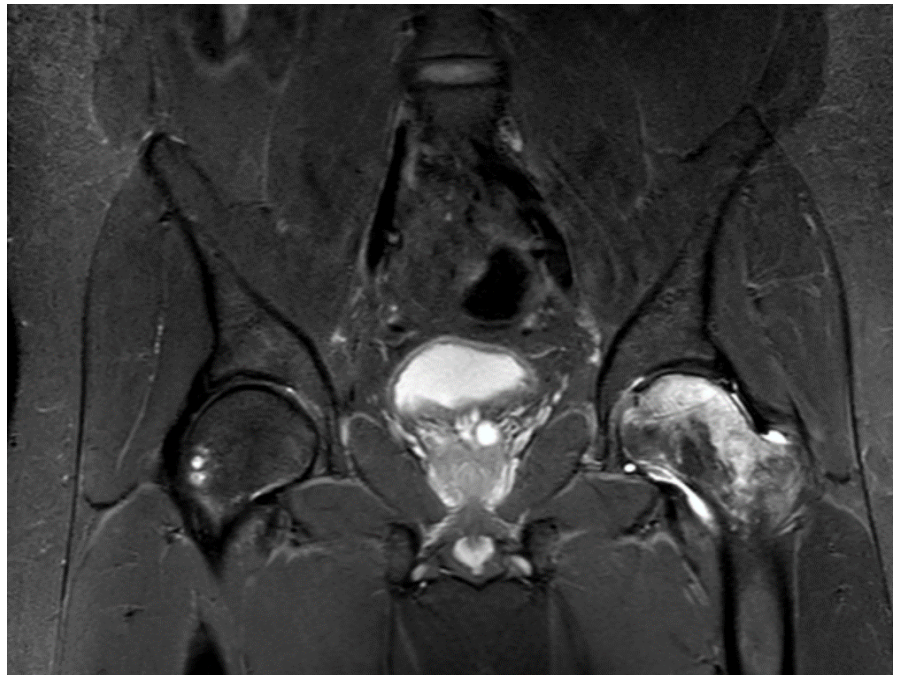
- narrowing of the coxo-femoral joint space;
- osteosclerotic changes in the femoral head and acetabulum;
- deformed femoral head;
- presence of marginal osteophytes predominantly at the acetabular level.

The MRI examination for patients with hip arthrosis additionally provides the following information:

- the presence / absence of bone edema in hypo T1, hyper T2 and STIR;
- the presence / absence of lipomatous degeneration changes in hyper T1, T2 and hypo STIR;
- the presence / absence of osteosclerotic changes in hypo T1, T2 and STIR;
- the presence / absence of subchondral, round-oval, well-delimited bone cysts, in hypo T1, hyper T2 and STIR;
- presence / absence of labrum lesions;
- presence / absence of coxo-femoral intra-articular fluid.

Arthrosis

2. Coxo-femoral arthrosis



SPAIR

Arthrosis

3. Gonarthrosis

Conventional radiography shows the following changes in gonarthrosis:

- narrowing of the tibio-femoral joint space;
- osteosclerotic changes in the femur condyles and tibial plateau;
- pronounced tibial spines;
- presence of marginal patellar, tibial and femoral osteophytes.

The MRI examination for patients with gonarthrosis additionally provides the following information:

- the presence / absence of bone edema in hypo T1, hyper T2 and STIR;
- the presence / absence of lipomatous degeneration changes in hyper T1, T2 and hypo STIR;
- the presence / absence of osteosclerotic changes in hypo T1, T2 and STIR;
- the presence / absence of subchondral, round-oval, well-delimited bone cysts, in hypo T1, hyper T2 and STIR;
- presence / absence of meniscal or ligament lesions;
- presence / absence of tibio-femoral intra-articular fluid.

Arthrosis

3. Gonarthrosis

Arthrosis

3. Gonarthrosis

SPAIR

SPAIR

SPAIR

Femoral head aseptic osteonecrosis

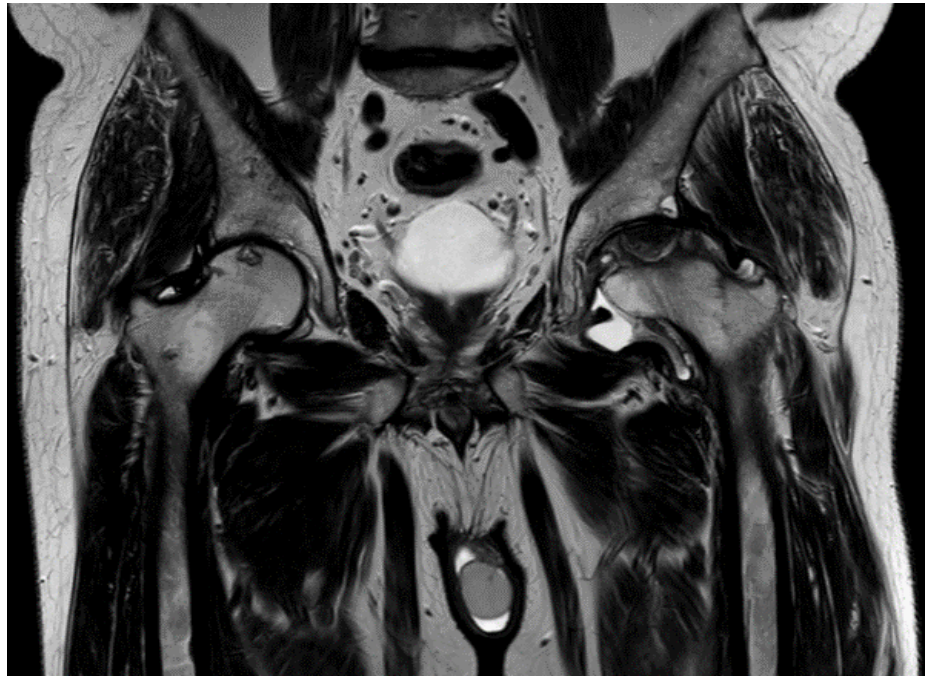
Aseptic osteonecrosis of the femoral head is a condition that occurs due to impaired vascularization of the femoral head. The disease is more common among men in the range of 30-50 years. Currently, a number of classifications are available for the ONACF staging (Ficat-Arlet, Steinberg, ARCO).

The Ficat-Arlet classification is as follows:

- ***stage 0:*** normal radiological appearance; normal MRI appearance;
- ***stage I:*** normal radiological appearance; MRI examination reveals bone edema;
- ***stage II:*** intricate osteolytic and osteosclerotic changes in the femoral head;
- ***stage III:*** the presence of a radiolucent semilunar subcortical area in the femoral head;
- ***stage IV:*** marked degenerative changes with flattening of the femoral head and disappearance of the joint space.

The imaging method of choice for diagnosing this disease is MRI.

Femoral head aseptic osteonecrosis



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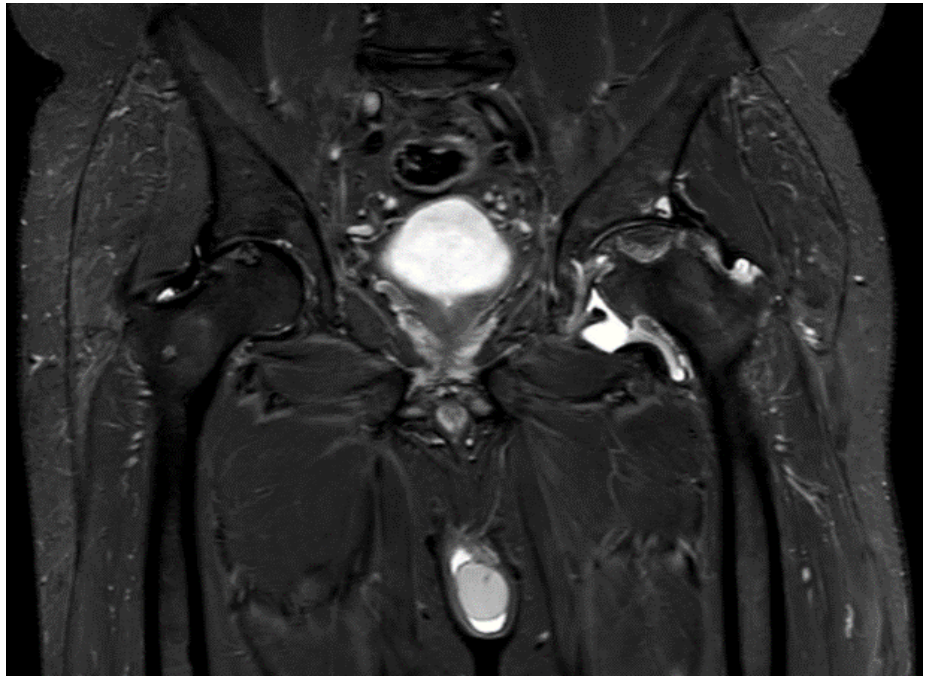
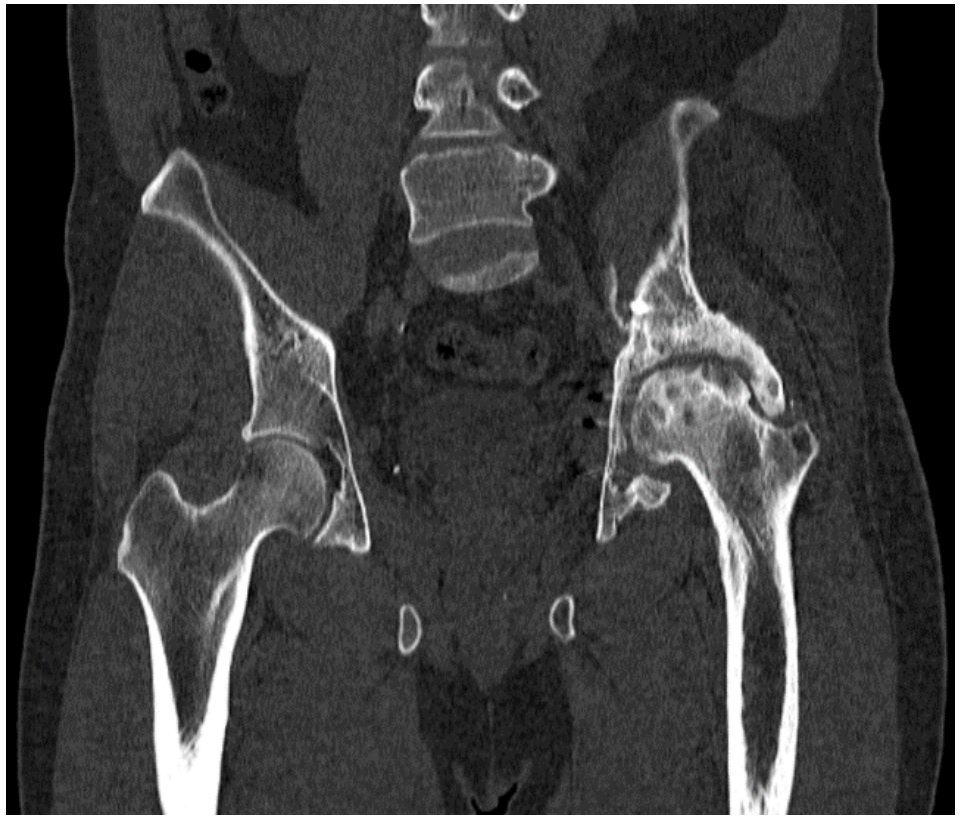


STIR

Femoral head aseptic osteonecrosis



Benign bone tumors

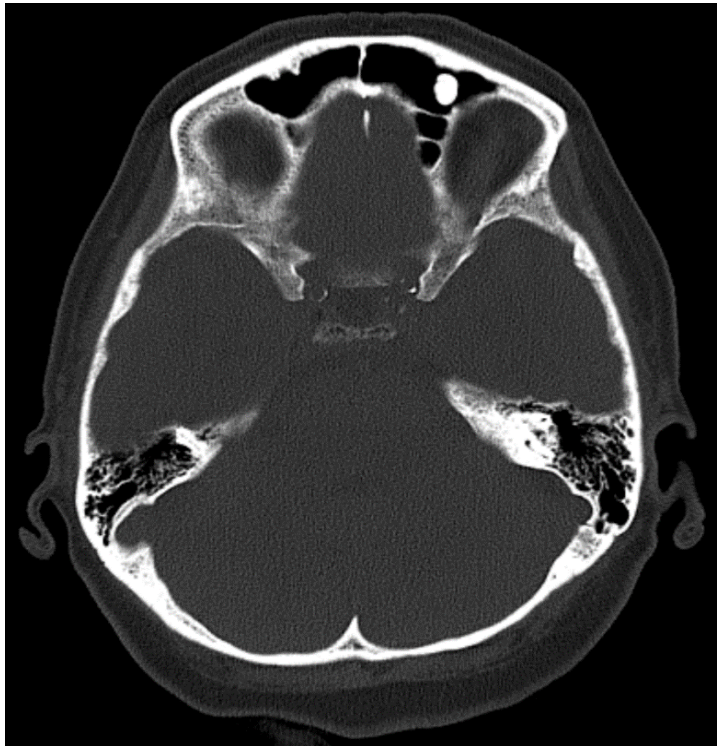
Characteristics of benign bone tumors:

- frequently located in the metaphysis and extend to the diaphyseal level;
- well delimited by a net contour;
- do not interrupt the bone cortex;
- do not cause periosteal reaction;
- generate mass effect on adjacent soft structures, but do not infiltrate them;
- have a slow evolution over time.

Benign bone tumors

1. Osteoma

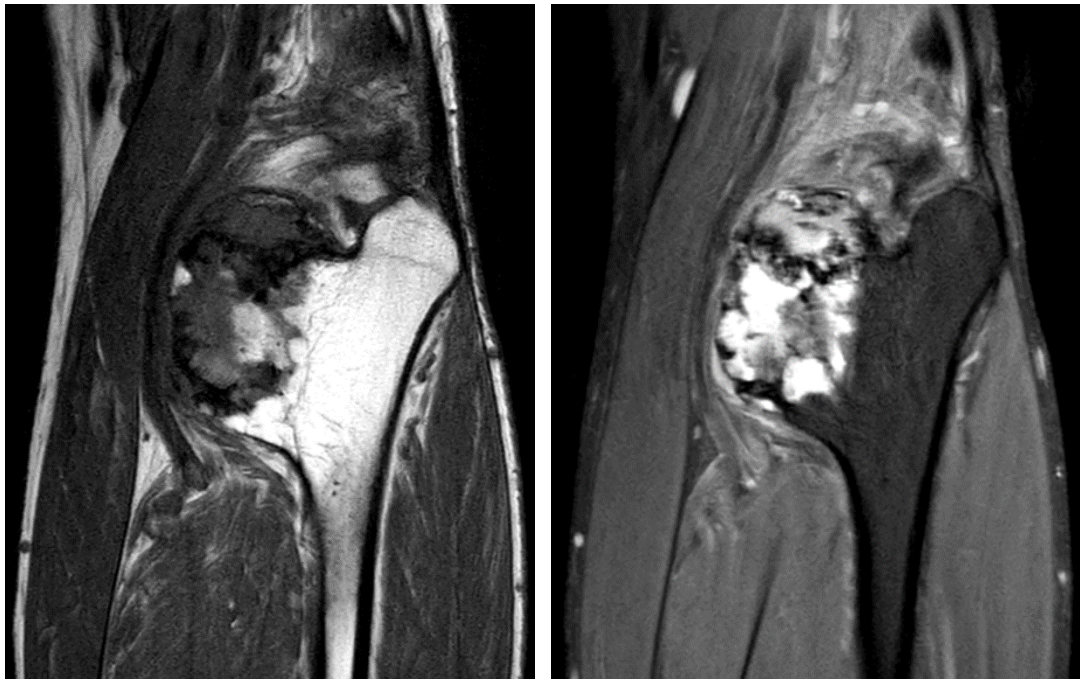
Osteoma is a benign bone tumor that is radiologically highlighted as an osteosclerotic area, developed on the cortex of the affected bone and is well delimited by a regular contour.



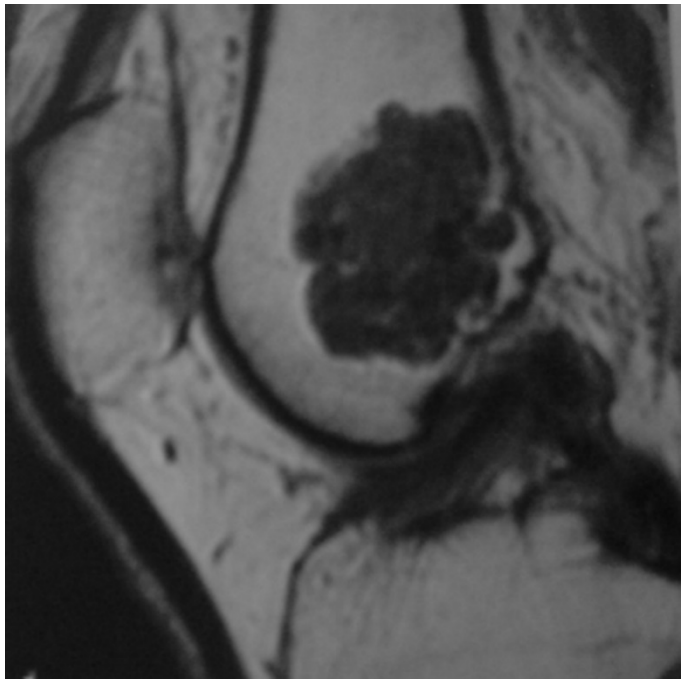
Benign bone tumors

2. Chondroma

Chondroma is a benign bone tumor that usually develops in the bone marrow cavities of the long bones. Depending on the location at the bone level, the name of this type of tumor is either ***enchondroma*** (central bone location) or ***ecchondroma*** (peripheral bone location). On an X-ray, this type of tumor is visualized as an osteolytic area well delimited by the bone cortex, without interrupting it and it can present multiple calcifications inside. This type of tumor can become malignant in evolution.



ecchondroma

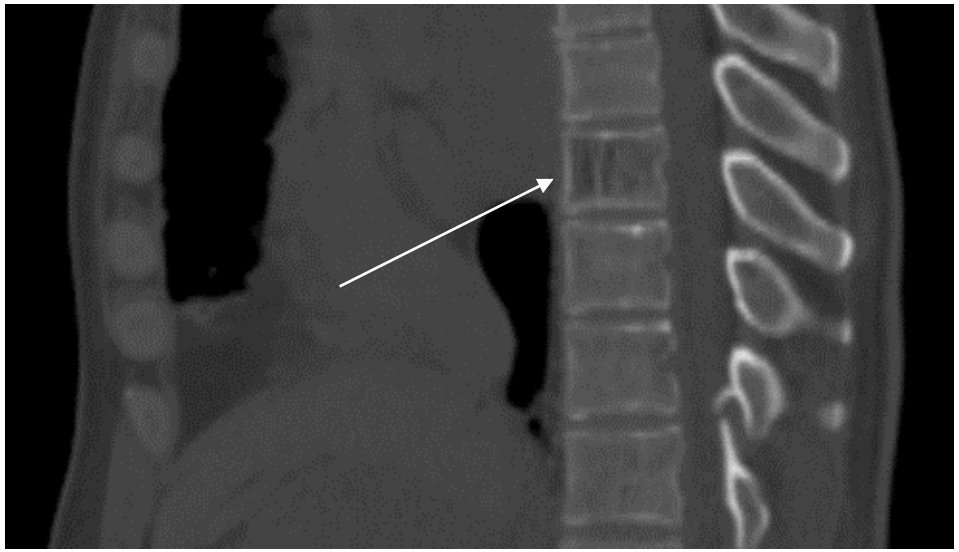


enchondroma

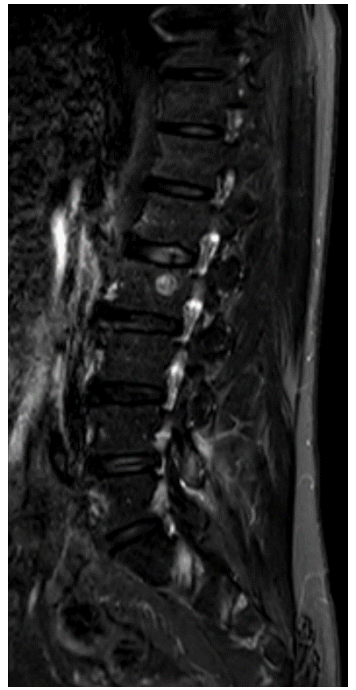
Benign bone tumors

3. Hemangioma

Hemangioma is a commonly encountered benign vascular tumor. In the spine, the hemangioma determines a vertical arrangement of the spongy trabeculae. The MRI examination can diagnose hemangiomas with an increased accuracy (iso-/ hypo T1, hyper T2 and STIR, intense postcontrast enhancement).



T2



STIR

Benign bone tumors

4. Non-ossifying fibroma

Non-ossifying fibroma is one of the most common benign fibrous tumors that develop in the bones. It frequently affects pediatric patients, with a peak of incidence in the range 10-15 years. For the diagnosis of this pathology, conventional radiology, CT and MRI examinations may prove useful.

The CT examination and conventional radiology reveal a multiloculated osteolytic lesion, well delimited by an osteosclerotic rim. It usually presents an eccentric localization inside the affected bone and does not cause periosteal reaction nor does it interrupt the bone cortex.

On the MRI examination, the non-ossifying fibroma has a variable appearance. In the initial stages, the lesion appears iso-/ hyper T2, being well delimited by an osteosclerotic rim in hypo T2. In evolution, the tumor begins to ossify and a low signal is noticed in all sequences.

Benign bone tumors

4. Non-ossifying fibroma

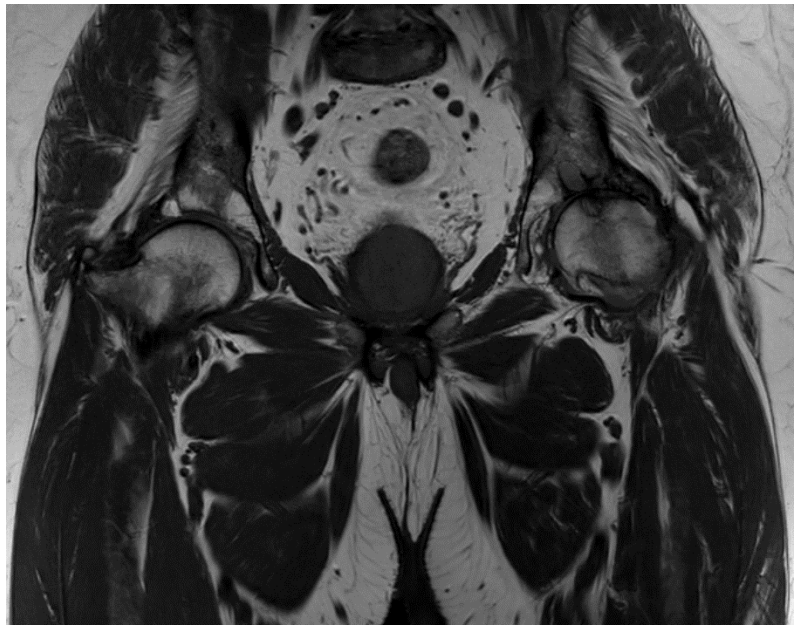
T1 ***T2*** ***SPAIR***

Benign bone tumors

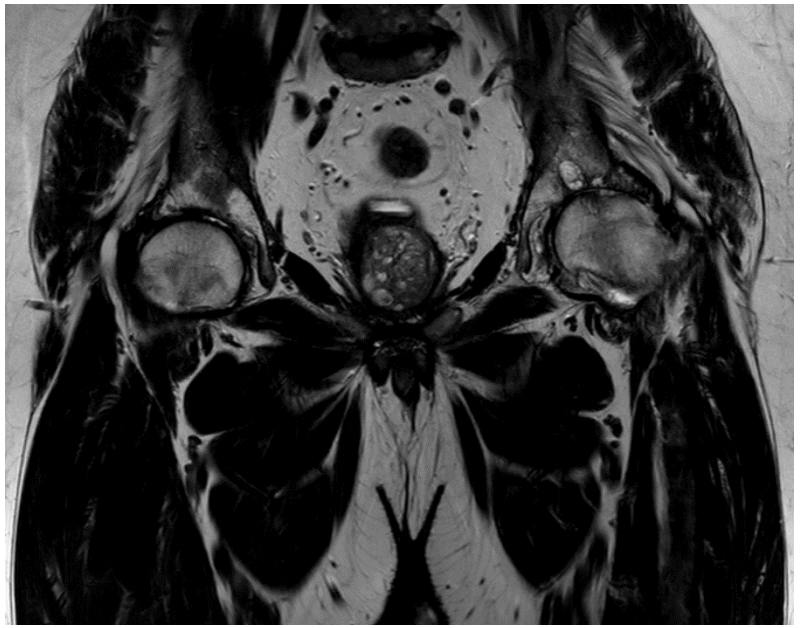
5. Simple bone cyst

The simple bone cyst is a benign lesion that is radiologically seen as a well-defined area of osteolysis, which determines the thinning of the bone cortex without interrupting it. Peripherally, the lesion may have an osteosclerotic rim revealed by the CT examination.

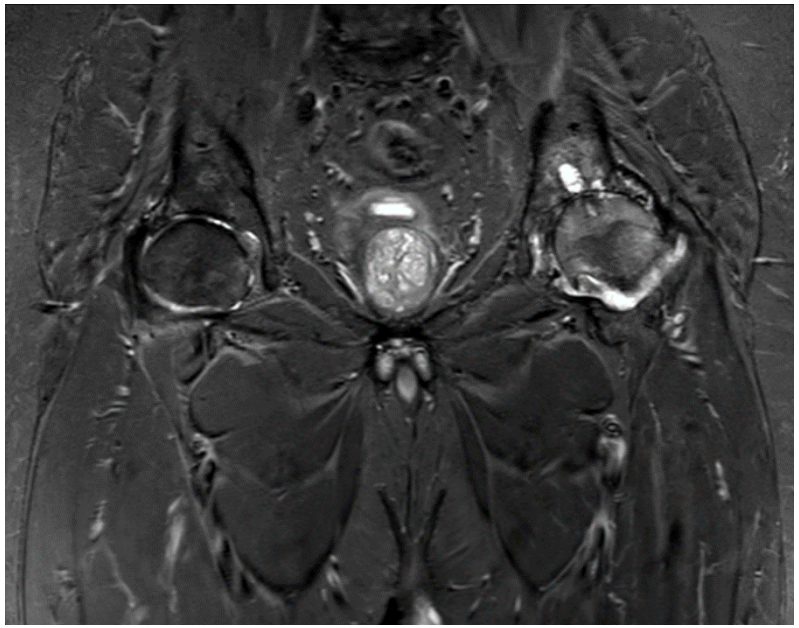
The MRI exam confirms the homogeneous, well-defined aspect of the cyst, seen in hypo T1 and hyper T2, without contrast enhancement.



T1



T2



SPAIR

Malignant bone tumors

Characteristics of malignant bone tumors:

- frequently located in the metaphysis;
- imprecisely delimited;
- interrupt the bone cortex – triangular opacity (Codmann triangle);
- cause a speculated periosteal reaction;
- infiltrate the adjacent structures;
- have a fast evolution over time.

Malignant bone tumors

1. Osteosarcoma

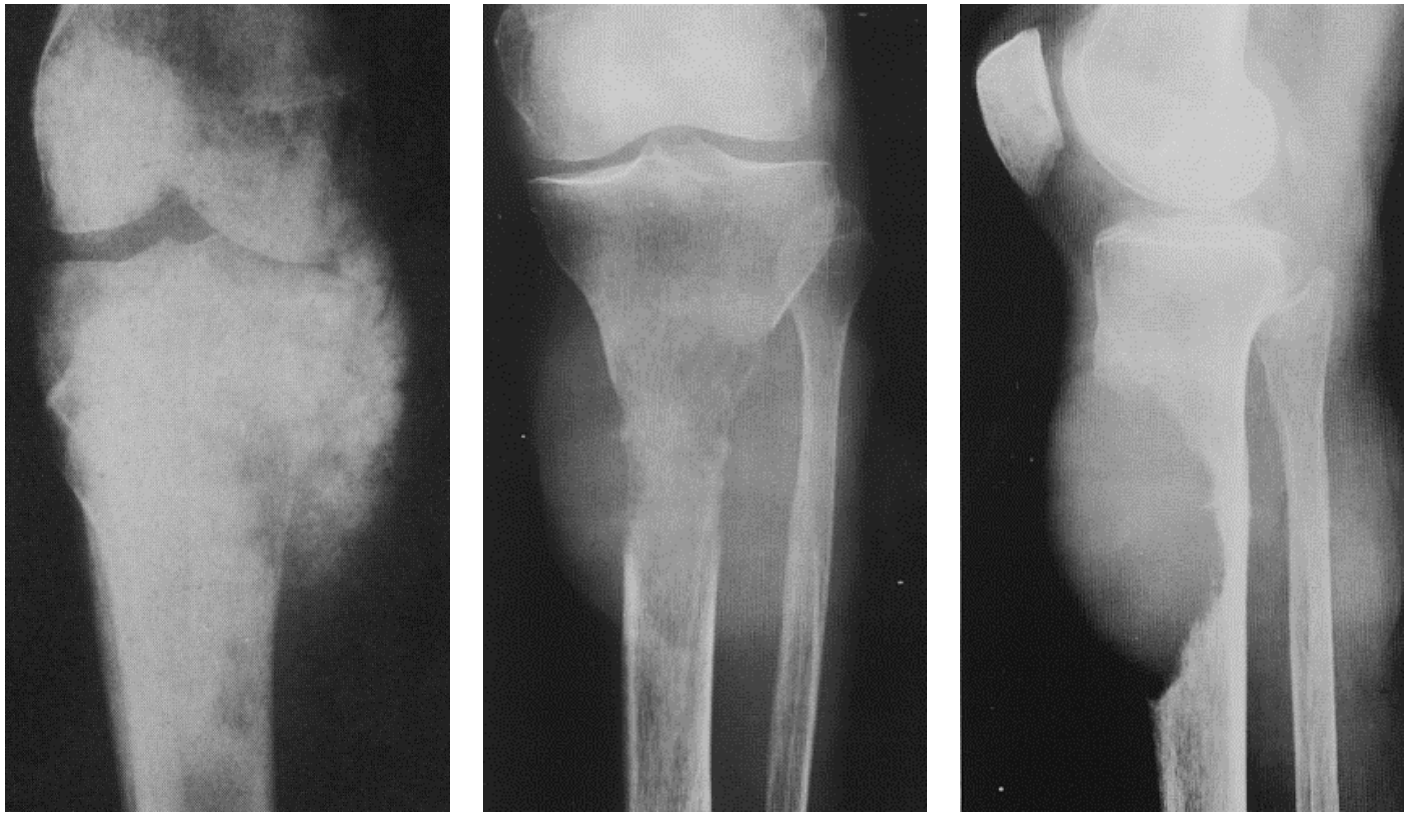
Osteosarcoma is one of the most common primary malignancies developed in the bones. It frequently develops in young people, under 30 years of age. Radiologically, there are three forms of osteosarcoma: ***osteogenic osteosarcoma***, ***osteolytic osteosarcoma*** and ***mixed osteosarcoma***.

Osteogenic osteosarcoma is radiologically visualized as a diffusely delimited osteosclerotic area that causes disruption of the bone cortex and invades the adjacent soft parts.

Osteolithic osteosarcoma is radiologically visualized as a diffusely delimited osteolytic area that causes disruption of the bone cortex and invades the adjacent soft parts.

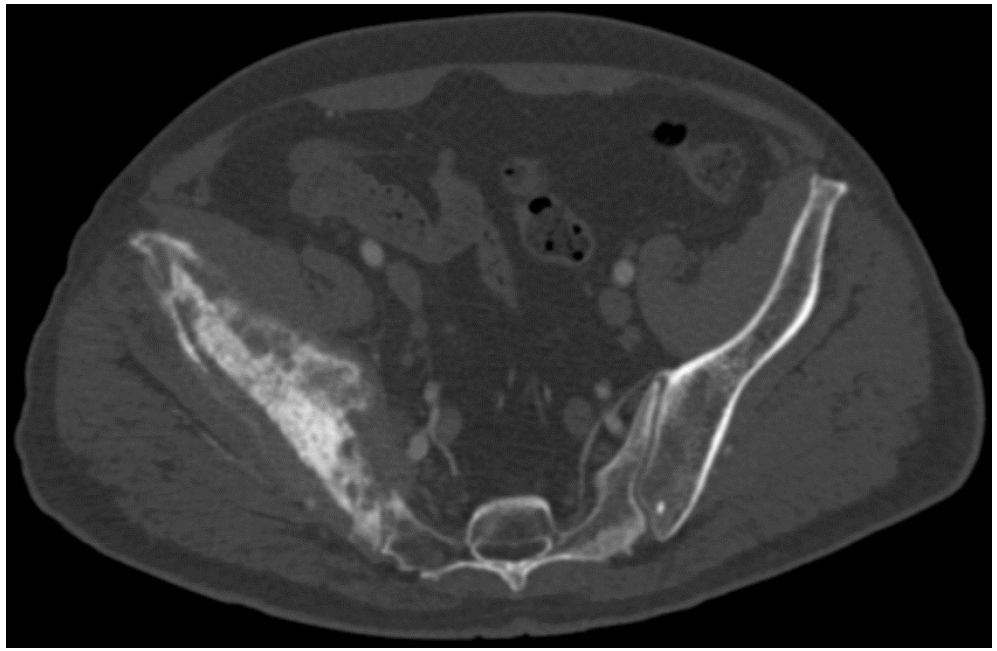
Malignant bone tumors

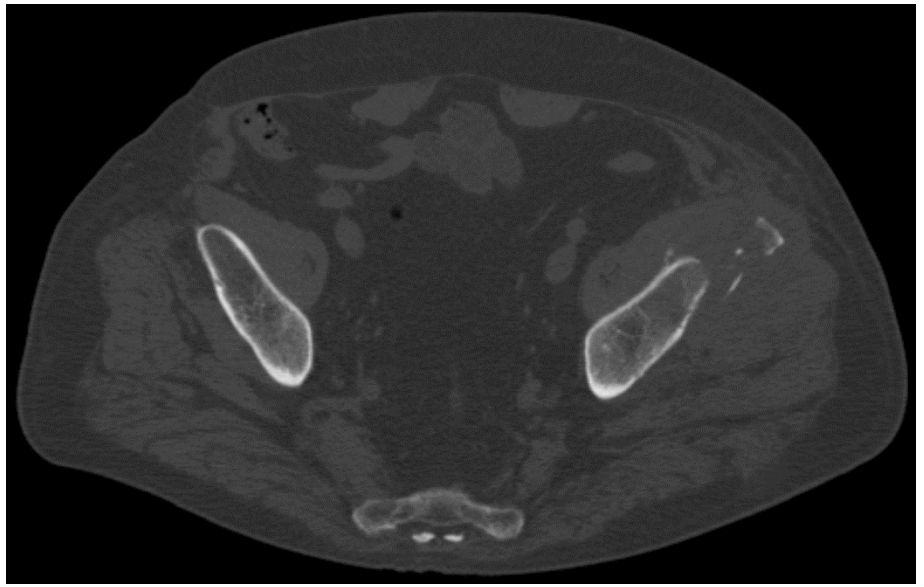
1. Osteosarcoma

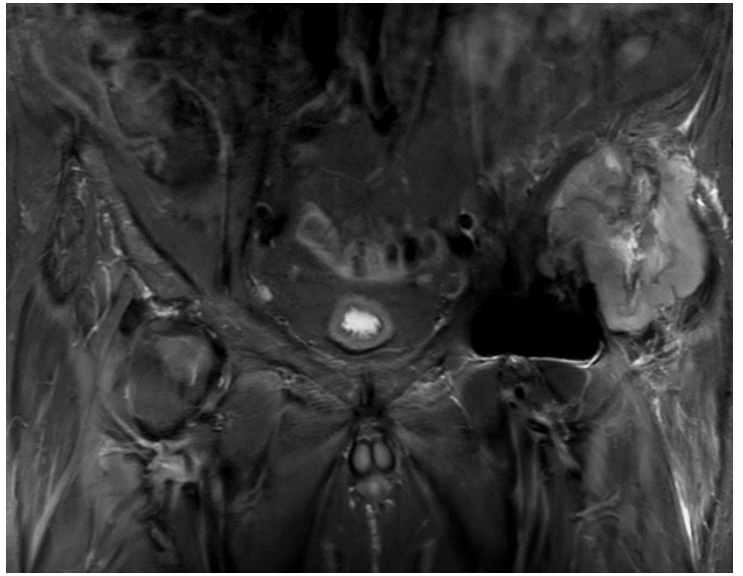


Malignant bone tumors

1. Osteosarcoma







Malignant bone tumors

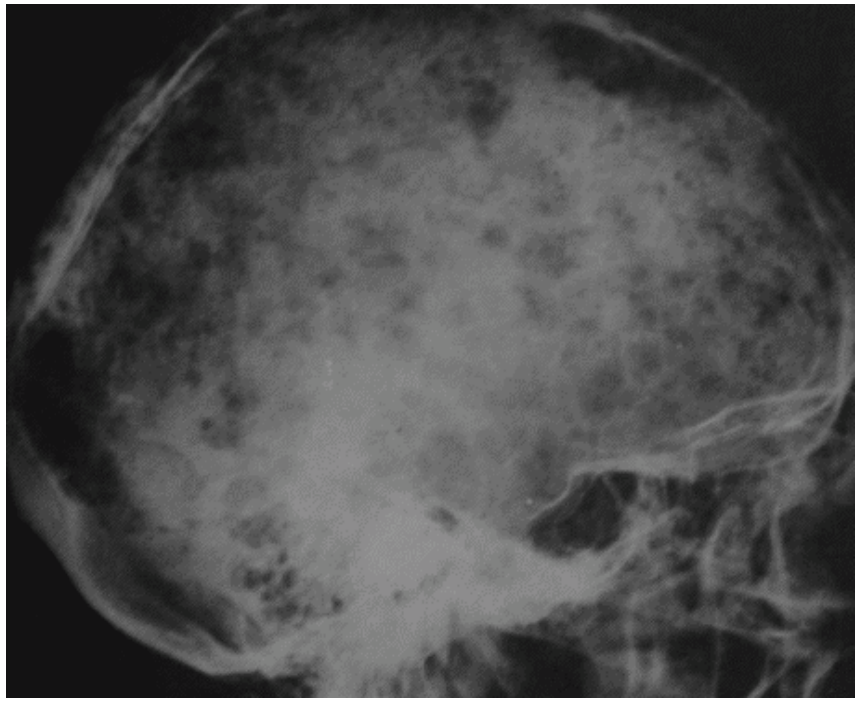
2. Chondrosarcoma

Chondrosarcoma is either a ***primary*** (developed as a malignant lesion from the very beginning) or ***secondary malignacy*** (a chondroma that became malignant). Similar to the chondroma, this type of tumor is visualized as an imprecisely defined osteolytic area that interrupts the bone cortex and extends in the adjacent soft parts.

Malignant bone tumors

3. Multiple myeloma

Multiple myeloma is the most common malignant bone tumor developed in adulthood (> 40 years). Most commonly, the lesions encountered in multiple myeloma are located in the skull, spine, ribs, pelvis and also in the diaphysis of the long bones (femur, humerus, etc.) and appear as well or imprecisely deliniated osteolytic lesions.



Malignant bone tumors

3. Multiple myeloma

Malignant bone tumors

4. Bone metastases

Bone metastases are the most common malignant bone tumors.

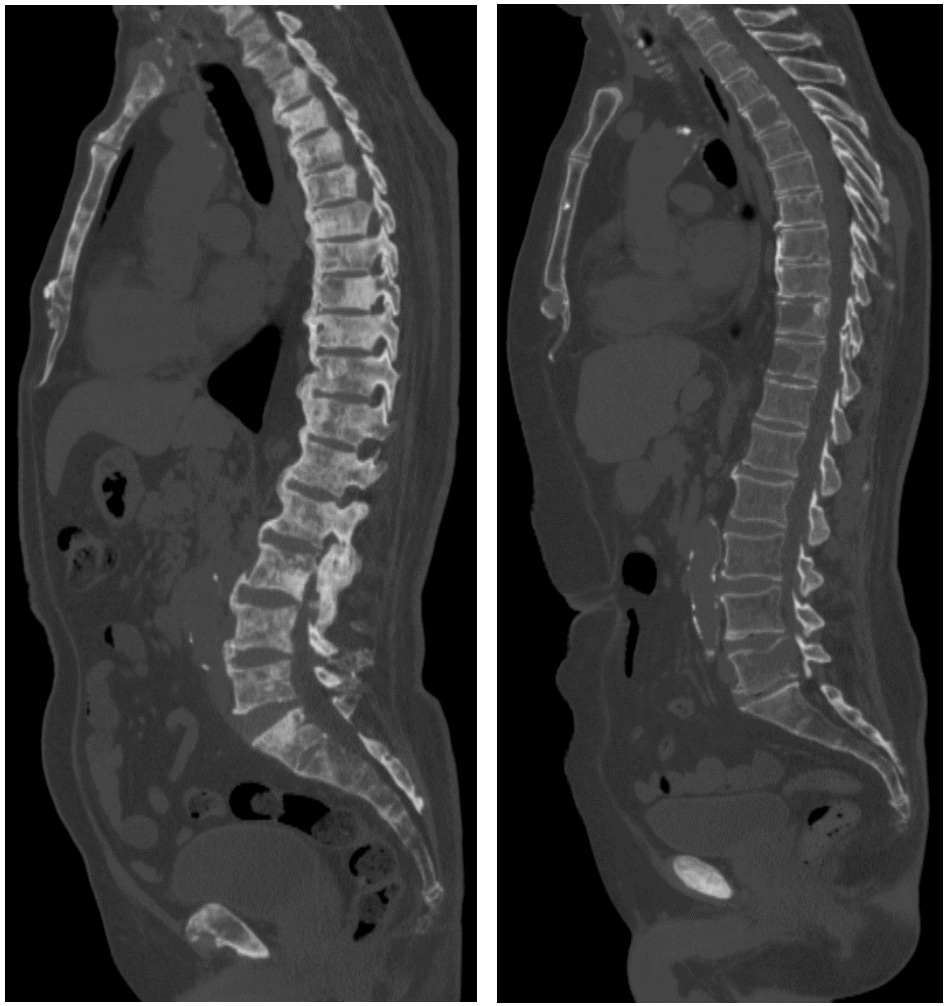
In most cases, the lesions are multiple and affect multiple distinct bone structures. The regions where bone metastases develop frequently are the vertebral bodies, the pelvic bones and the skull.

Among the primary malignancies that lead to development of bone metastases are: prostate cancer, pancreatic cancer, bronchopulmonary cancer, breast cancer, cervical cancer etc.

On X-ray, bone metastases are classified as: ***osteosclerotic*** and ***osteolytic***.

Malignant bone tumors

4. Bone metastases



Malignant bone tumors

4. Bone metastases

T2

STIR