Pediatric imaging

Imaging methods

Pediatric radiology is a subgroup of radiology that involves performing imaging investigations on fetuses, newborns, children and adolescents.

Considering children are in a continuous development, radiological protection in pediatric imaging imposes an additional requirement regarding radioprotection optimization and a certain justification for each radiological procedure. At the same time, the involved medical personnel is required to have a specific training for pediatric evaluation, a cooperative and experienced medical attitude. Other necessary conditions in pediatric imaging are the examination rooms that must be properly arranged for interaction with pediatric patients.

Imaging methods

The diagnostic imaging of the pediatric pathology can be diagnosed by the following methods: conventional radiography, fluoroscopy, ultrasonography (US), Computed Tomography (CT) and Magnetic Resonance Imaging (MRI).

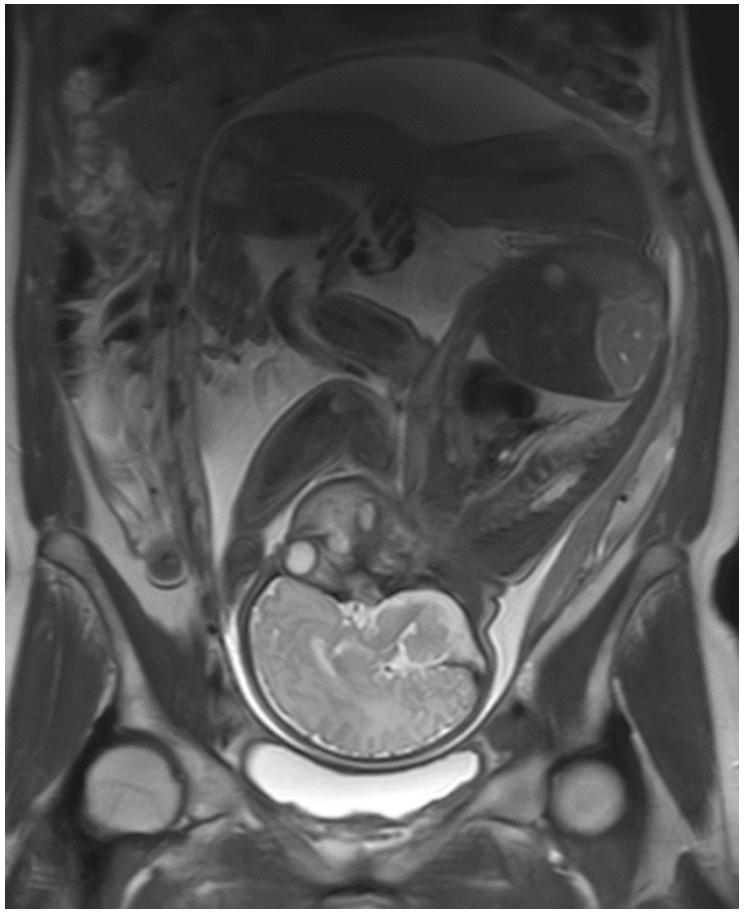
In pediatric pathology, all imaging investigations that require exposure to a high flux of X-rays (conventional radiography, fluoroscopy, CT examination) must be fully justified, as there are numerous pathologies that can be diagnosed through minimally invasive techniques in this category of patients.

Imaging methods

For the evaluation of the fetus, the main imaging method used for pregnancy imaging is US, which is usually performed by gynecologists. If additional information is needed regarding the evolution of a pregnancy, a fetal MRI examination may be performed, which does not use ionizing radiation and allows an excellent multiplanar view of the soft parts and viscera, without being limited in performance by obesity and bone structures.

Fetal MRI examination is particularly useful in assessing fetal neurological pathology. Although, at the time of writing, there is no clear evidence of the harmful effects of fetal MRI examination on the fetus, but two potential harmful effects can be considered: hearing impairment (due to the noise produced by the device during the examination) and the teratogenic effects(could be caused by exposure to the magnetic field and heat generated during the examination). It is important to note that fetal MRI examination is contraindicated in the first trimester of pregnancy.

Imaging methods



Imaging methods

Regarding the oral contrast agents, barium sulphate is authorized for use in children. Alternatively, iodinated contrast agents (Gastrografin) may be used. The use of Gastrografin requires increased attention in pediatric patients because, in case of aspiration, a much more aggressive pneumonia can occur compared to the one caused by barium sulphate.

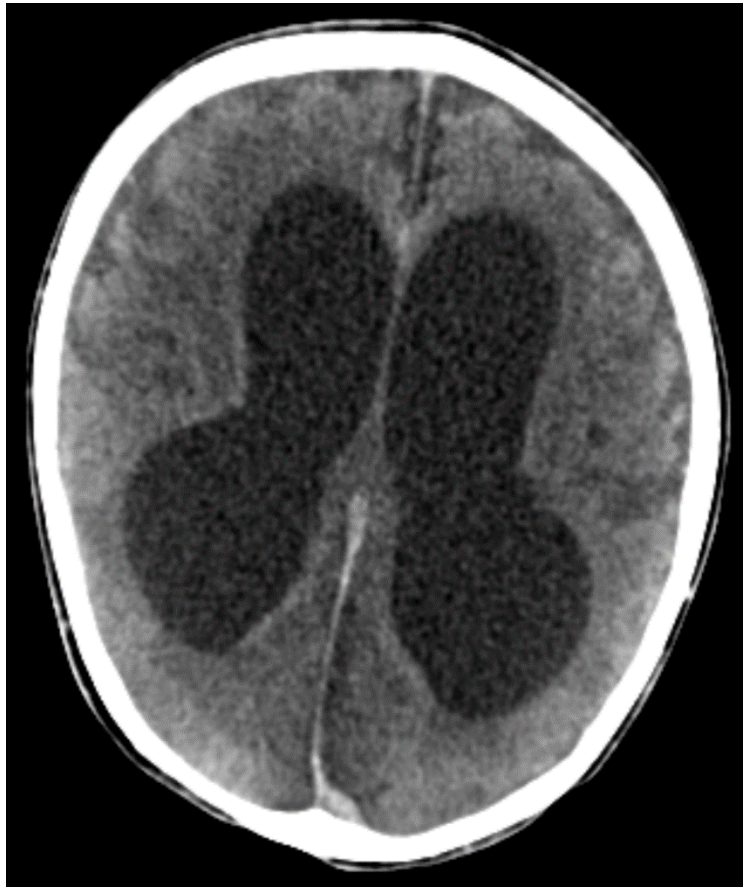
Brain and spine pathology

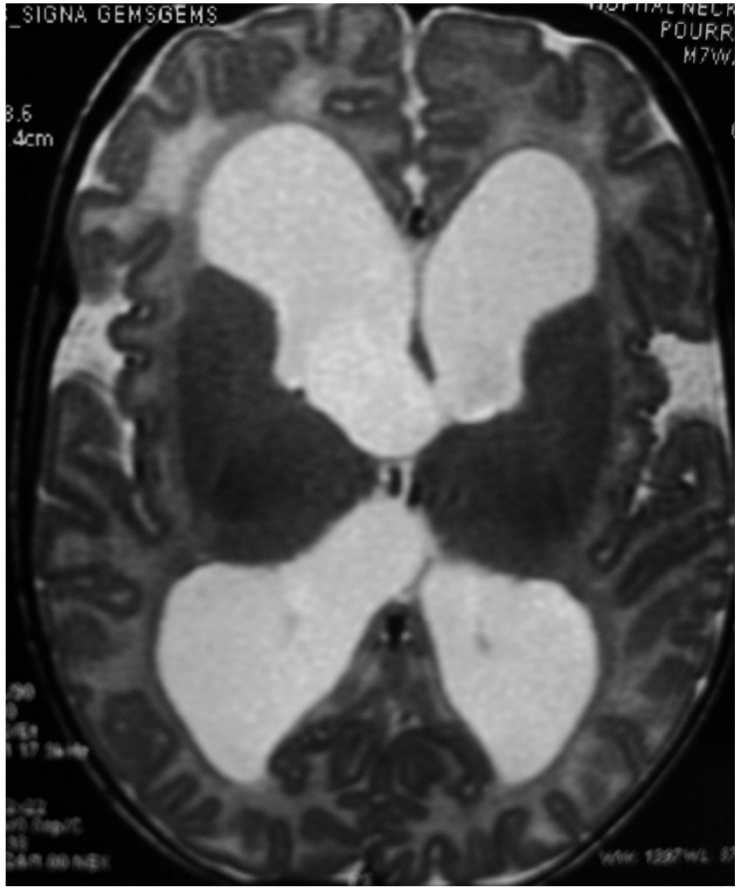
Hydrocephalus is defined by the abnormal accumulation of cerebrospinal fluid (CSF) that causes dilatation of the cerebral ventricles due to circulation and / or resorption abnormalities of the CSF in the brain cavities. Less often, hydrocephalus can also be caused by an increased CSF production. The causes can be either congenital or acquired.

The imaging techniques that can be used in the diagnosis of hydrocephalus are: US, CT, MRI. The three aforementioned methods allow the detection and measurement of cerebral ventricular dilatation, as well as the identification of the cause that led to the installation of hydrocephalus.

Brain and spine pathology

Hydrocephalus





Brain and spine pathology

Brain tumors

Brain tumors comprise both benign and malignant tumors, as well as metastases found in the brain parenchyma. The incidence of metastatic brain tumors increases with age. The classification of brain tumors in children is similar to the one described in adults.

More than half of the brain tumors developed in pediatric patients are astrocytomas and predominantly affect children aged 5 to 8 years. Over 80% of astrocytomas are low grade - grade I (pilocytic astrocytoma) or grade II (diffuse astrocytoma) and involve slow tumor development. The remaining 20% of astrocytomas are high grade - grade III (anaplastic astrocytoma) or grade IV (glioblastoma multiforme) and involve rapid tumor development and increased aggressiveness.

The main imaging methods in brain tumors are CT and MRI.

Brain and spine pathology

Pilocytic astrocytoma

Also known as juvenile pilocytic astrocytoma, this type of brain tumor is considered low-grade, relatively well delineated, which usually affects young population and has a good prognosis. Regarding its location, the pilocytic astrocytoma frequently develops in the cerebellum and along the optic pathway. Some other rare locations for this type of tumor include: brainstem, brain hemispheres, cerebral ventricles, spinal cord.

Regarding the internal structure of the pilocytic astrocytoma, this can be represented by:

- large cystic component and hyperenhancing solid component;
- heterogenenous structure with solid components and cystic areas with central necrosis;
- completely solid.

Brain and spine pathology

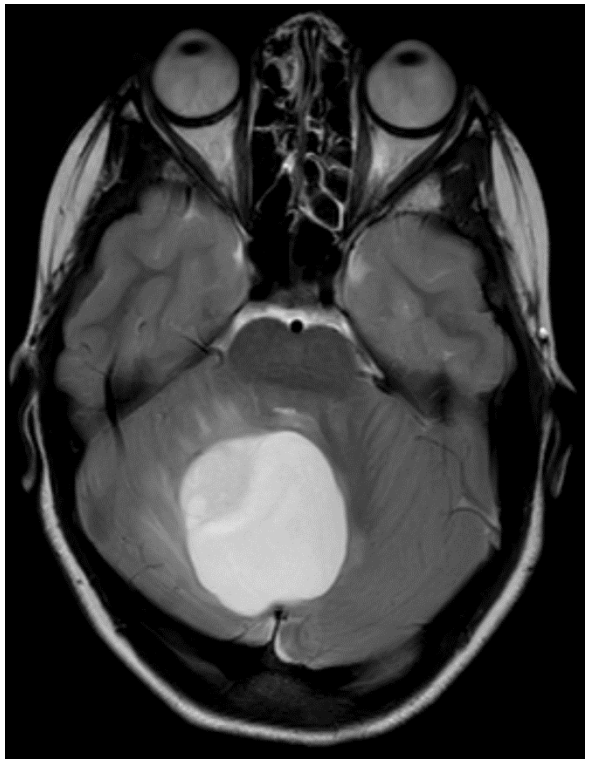
Pilocytic astrocytoma

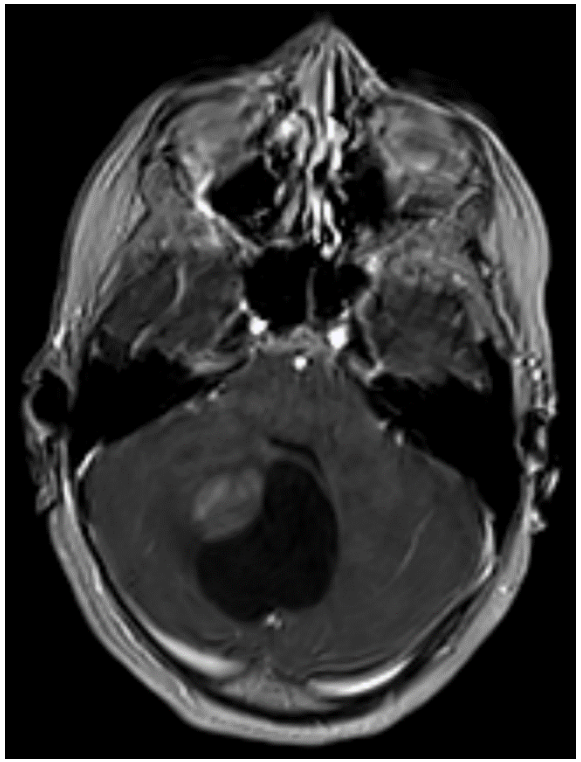
For diagnosis, the postcontrast MRI is usually preferred and highlights the following imaging changes:

- T1: the solid component appears iso/hypointense compared to the healthy cerebral parenchyma; the cystic component appears as hypointense (similar aspect to CSF) if there is no hemorrhage;
- T2: the solid component appears hyperintense compared to the healthy cerebral parenchyma; the cystic component appears hyperintense (similar aspect to CSF);
- postcontrast T1: contrast enhancement of the solid intralesional component and sometimes in the periphery of the tumor.

Brain and spine pathology

Pilocytic astrocytoma





Brain and spine pathology

Medulloblastoma is one of the most common malignancies developed during childhood. Most commonly, this type of tumor appaears as masses developed on the midline at the ceiling of the fourth ventricle, with associated mass effect and hydrocephalus.

Medulloblastoma can be diagnosed both by CT examination and by MRI examination. In case of young, pediatric patients, the use of MRI examination is preferred.

CT: medulloblastoma appears as a mass developed in the vermis, with lack of visualization of the 4th ventricle and obstructive hydrocephalus. Also, this type of tumor can develop in the lateral lobes of the cerebellum. Usually, medulloblastoma appears hyperintens on native CT and is often associated with the presence of necrotic areas and cystic areas. After contrast administration, the tumor shows an intense uptake of the contrast substance.

Brain and spine pathology

Medulloblastoma

MRI:

- T1: hyposignal compared to the cerebral gray matter;

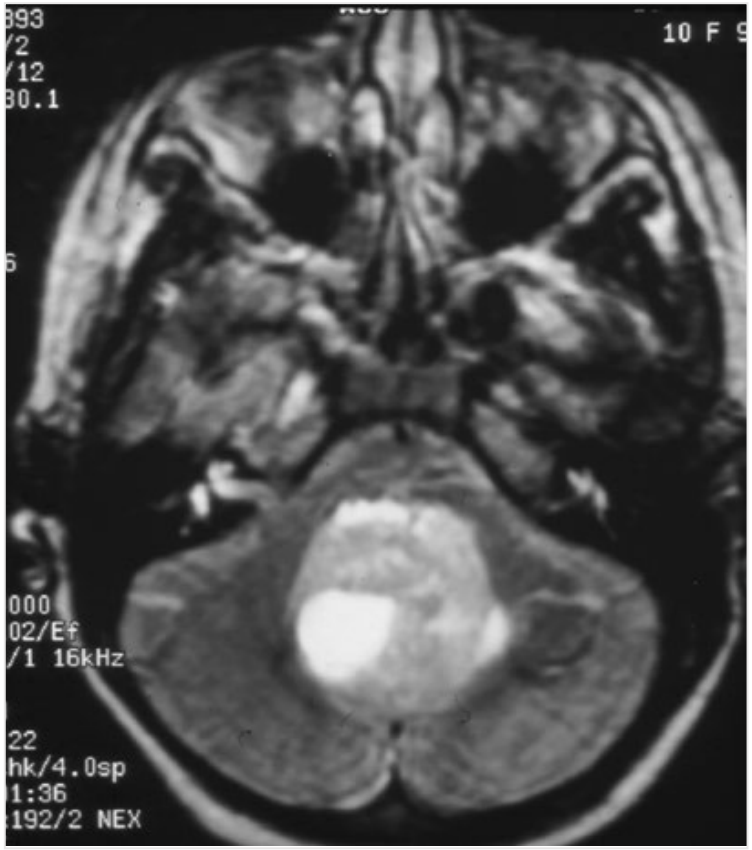
- T2, FLAIR: iso / hypersignal compared to cerebral gray matter, with heterogeneous structure due to calcifications, areas of necrosis and cyst formation and digitiform perilesional edema in hypersignal;

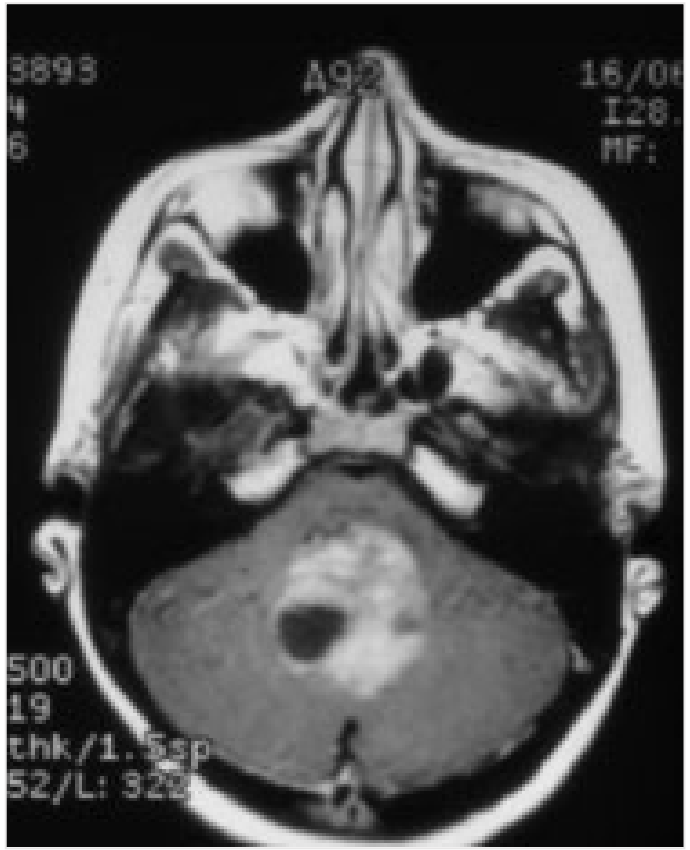
- DWI, ADC: the tumor appears to have hypersignal in the DWI sequence and hyposignal in the ADC map – restricted diffusion;

- T1 postcontrast: heterogeneous uptake of contrast medium.

Brain and spine pathology

Medulloblastoma





Brain and spine pathology

Diffuse astrocytoma/infiltrative glioma - refers to low-grade infiltrative tumors and the inability to accurately delineate between the healthy brain tissue and the tumor mass.

This type of tumor can be diagnosed by CT and MRI examinations, but MRI examination is usually preferred due to the non-radiant nature of the technique.

CT: usually, the low-grade diffuse astrocytoma appears as an iso / hypodense area, without uptake of the contrast substance (the contrast uptake would indicate a high-grade tumor), but with mass effect over the neighboring anatomical structures.

Brain and spine pathology

MRI:

- T1: iso / hyposignal compared to cerebral white matter;

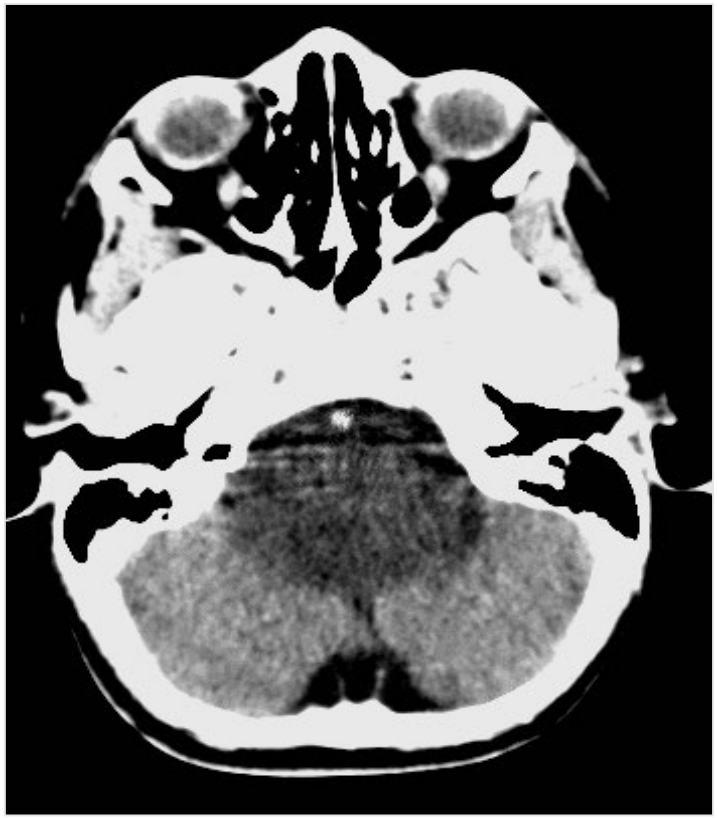
- T2 / FLAIR: hypersignal in the T2 sequence, attenuated in the FLAIR sequence (T2-FLAIR mismatch sign), may present perilesional edema in hypersignal T2 and FLAIR;

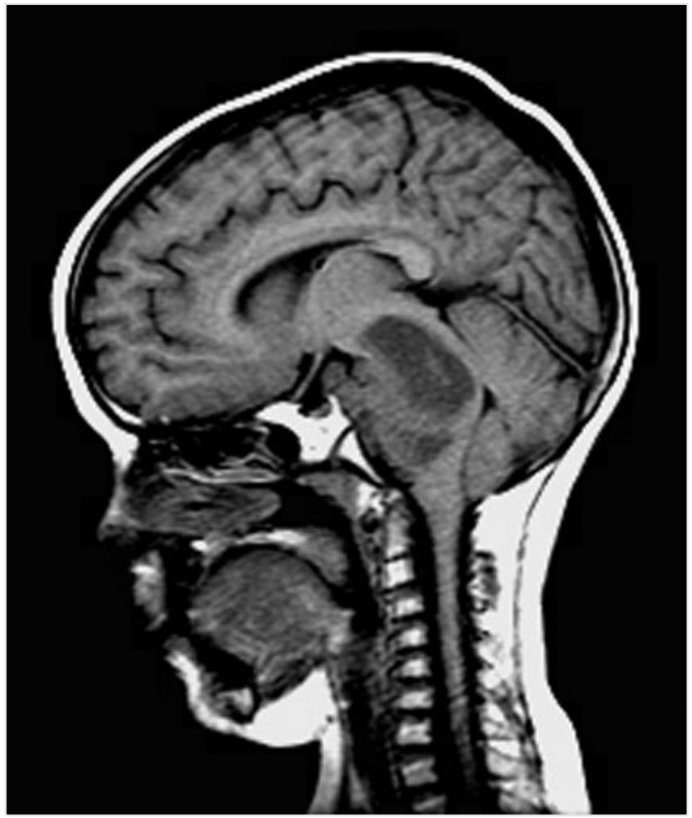
- DWI, ADC: usually does not show significant changes in DWI and in the ADC map; in the event that the presence of the diffusion restriction is noted, the lower the ADC values, the more a high tumor degree is suspected;

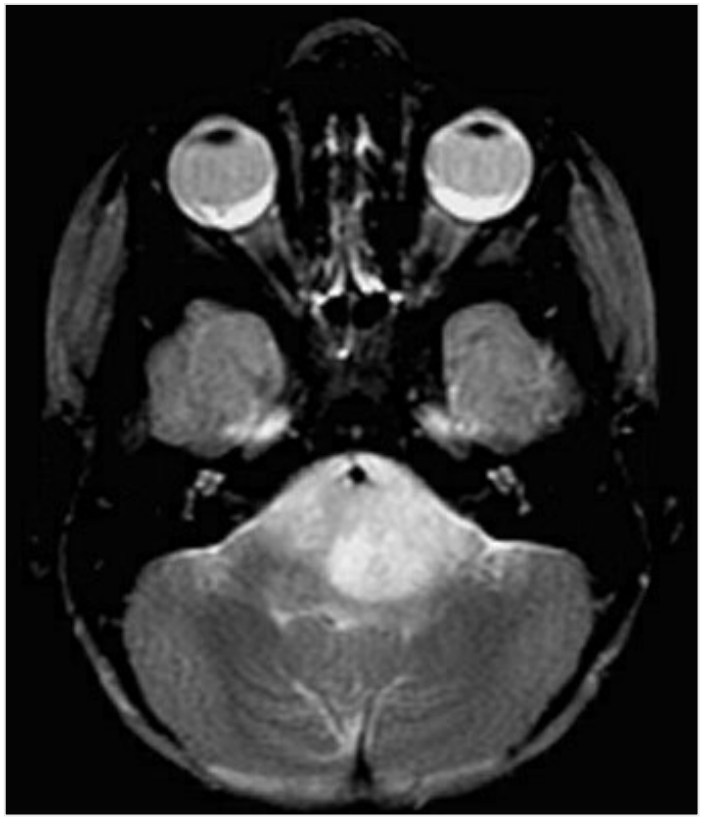
- T1 postcontrast: the lack of contrast enhancement is frequently encountered, but in some cases there may be irregular intralesional areas that enhance; the presence of gadophilia should be considered tumoral progression towards a high degree.

Brain and spine pathology

Diffuse astrocytoma/infiltrative glioma







Brain and spine pathology

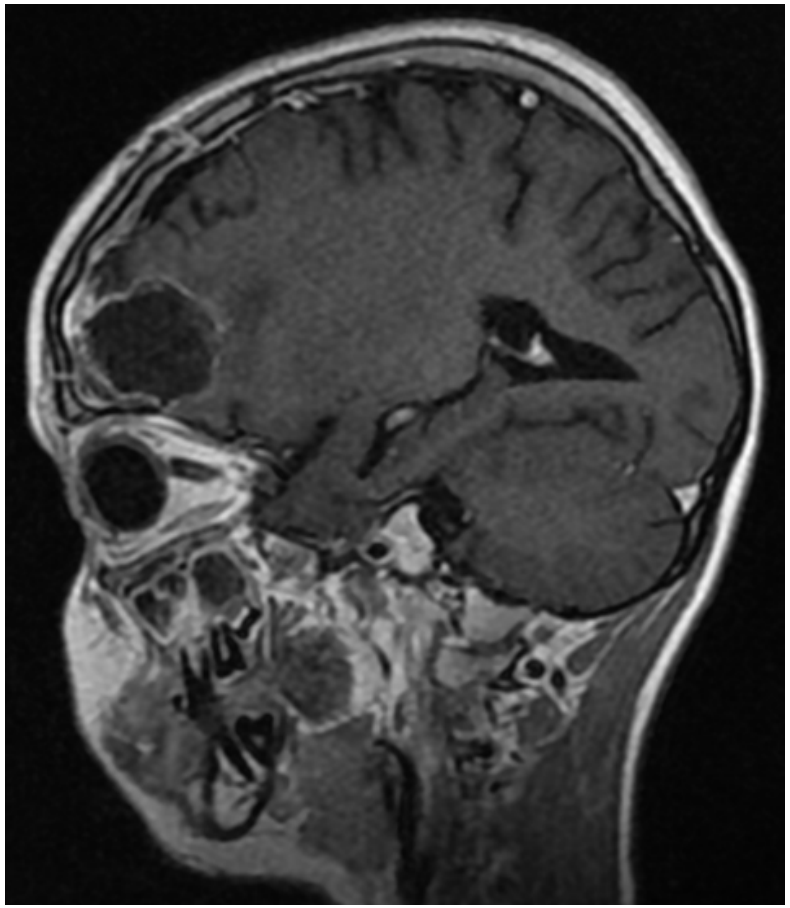
Glioblastoma is an extremely aggressive malignant brain tumor, which has resistance to therapy and is associated with an adverse prognosis.

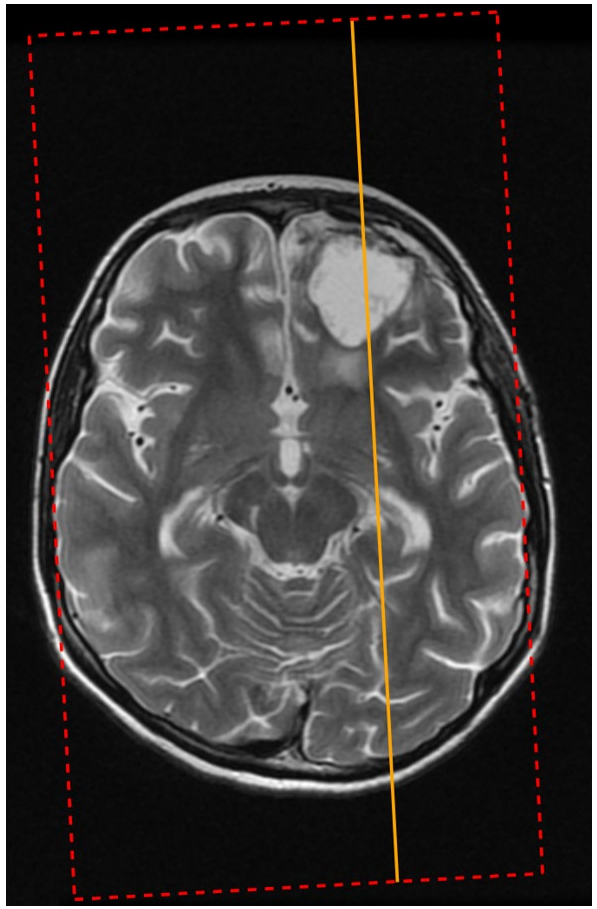
The CT examination reveals an irregularly shaped tumor mass, with necrosis inside, surrounded by marked digitiforme edema that determines mass effect on the adjacent cerebral parenchyma and / or on the ventricular system. Intra-regional bleeding is common. Intratumoral calcifications are rare. Postcontrast, the tumor presents an intense, heterogeneous and irregular uptake of the contrast substance.

The MRI examination reveals a tumor mass in iso- / hypo T1, hyper T2, with heterogeneous structure and gadophilia, with areas of necrosis inside and perilesional digitiforme edema.

Brain and spine pathology

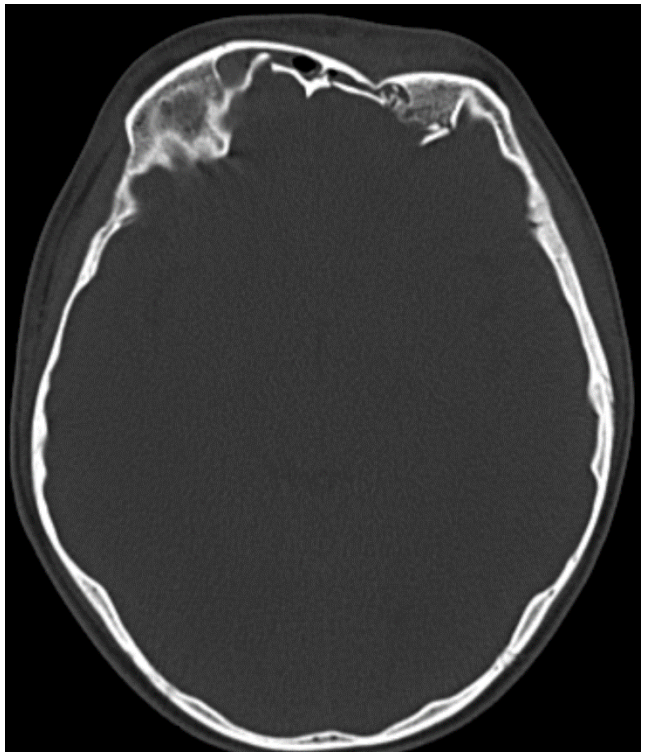
Glioblastoma

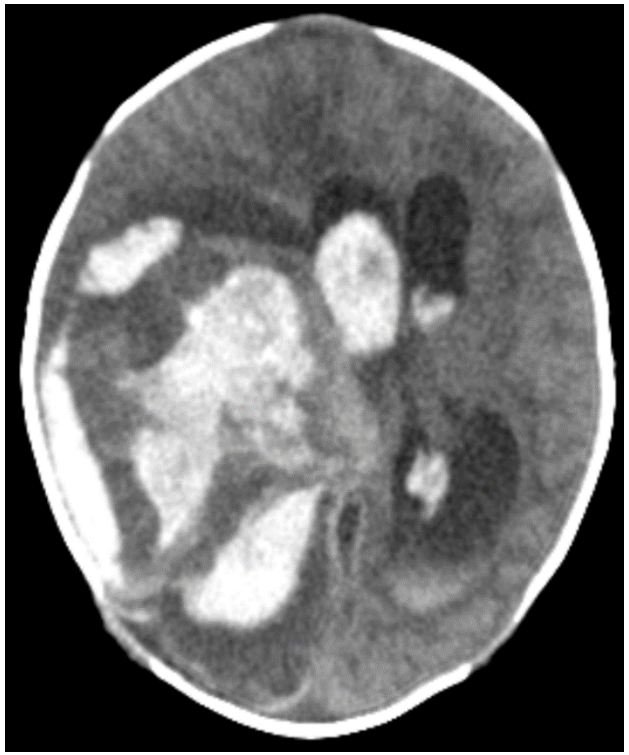




Skull and brain trauma

Conventional X-ray, in frontal and profile incidences is mainly performed to detect bone lesions. A skull X-ray is no longer justified for evaluating patients that suffered skull and brain trauma. The preferred method nowadays is CT. Posttraumatic lesions in pediatric patients have a similar CT and MRI aspect with those described in adults in the previous chapters.





Brain and spine pathology

Intracranial hypertension (HIC) is defined by an increased intracranial pressure values above 7 mmHg in children and includes two forms: vasogenic cerebral edema and cytotoxic cerebral edema.

Vasogenic cerebral edema occurs due to the impairment of the blood-brain barrier and involves extravasation of the fluid content from the capillaries into the surrounding white matter. This type of cerebral edema is commonly encountered in primary or secondary brain abscesses or tumors. Imaging diagnosis is established by CT and MRI.

CT: vasogenic cerebral edema appears as hypodense, expanded in a digitiforme manner and frequently located in the white matter; the differentiation between the white matter and the cerebral gray matter is preserved.

MRI: appears as hyper T2 and FLAIR, without restricted diffusion.

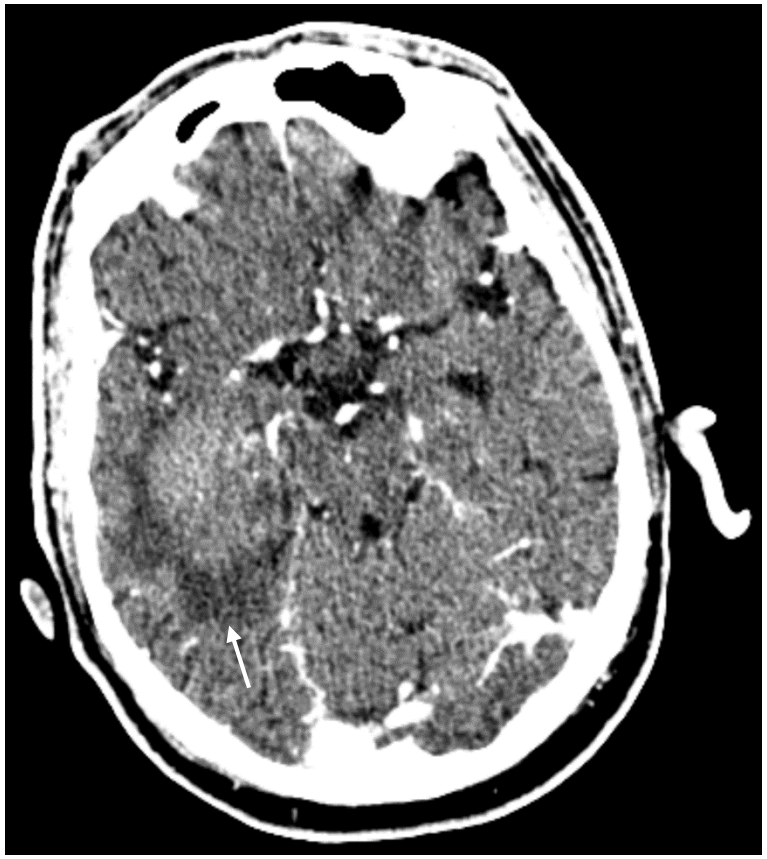
Brain and spine pathology

Cytotoxic cerebral edema assumes the integrity of the blood-brain barrier and occurs in ischemic brain injury.

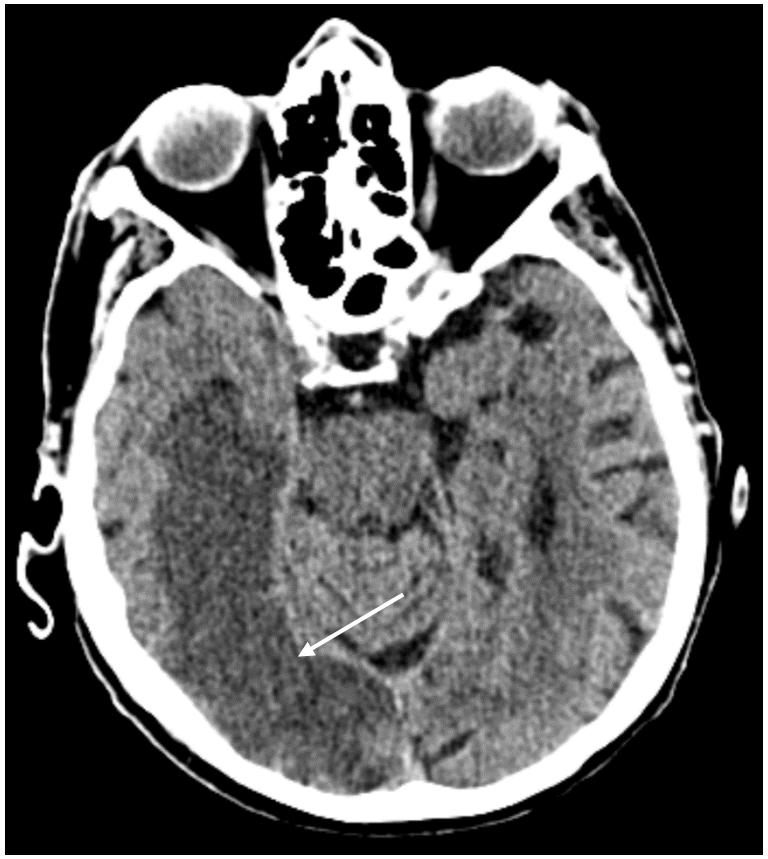
CT: cytotoxic cerebral edema appears as hypodense and is frequently located in the grey substance; the differentiation between the white matter and the cerebral gray matter is lost, and the intergiral grooves are deleted.

MRI: appears as hyper T2 and FLAIR, with restricted diffusion.

Brain and spine pathology

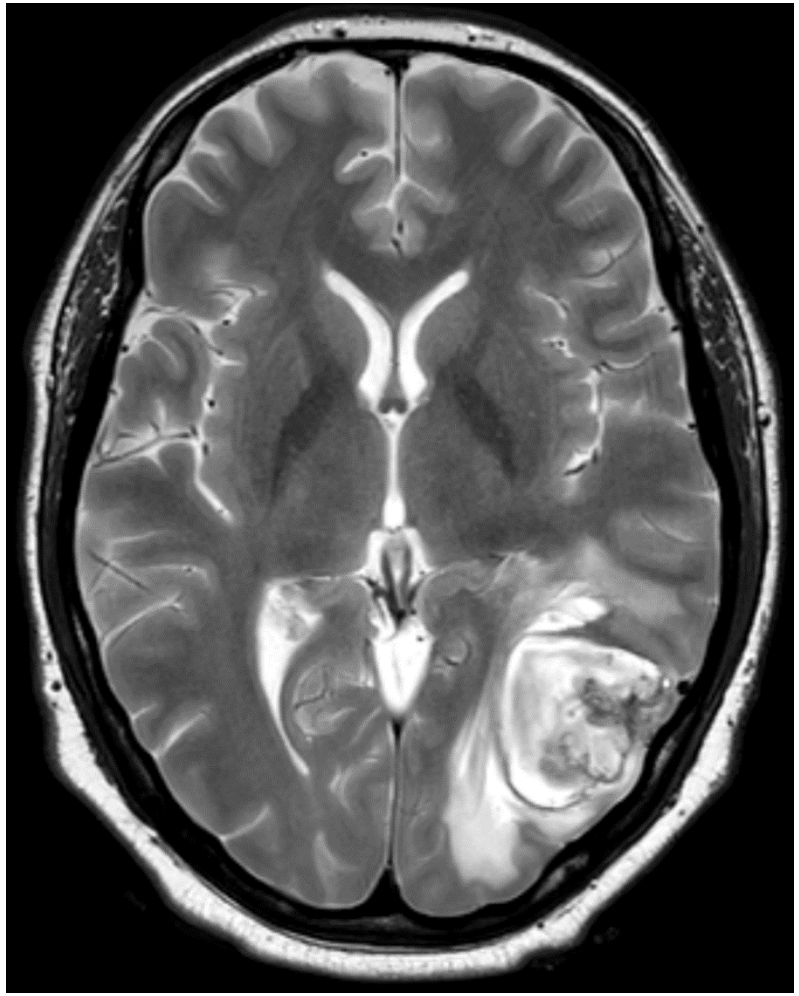


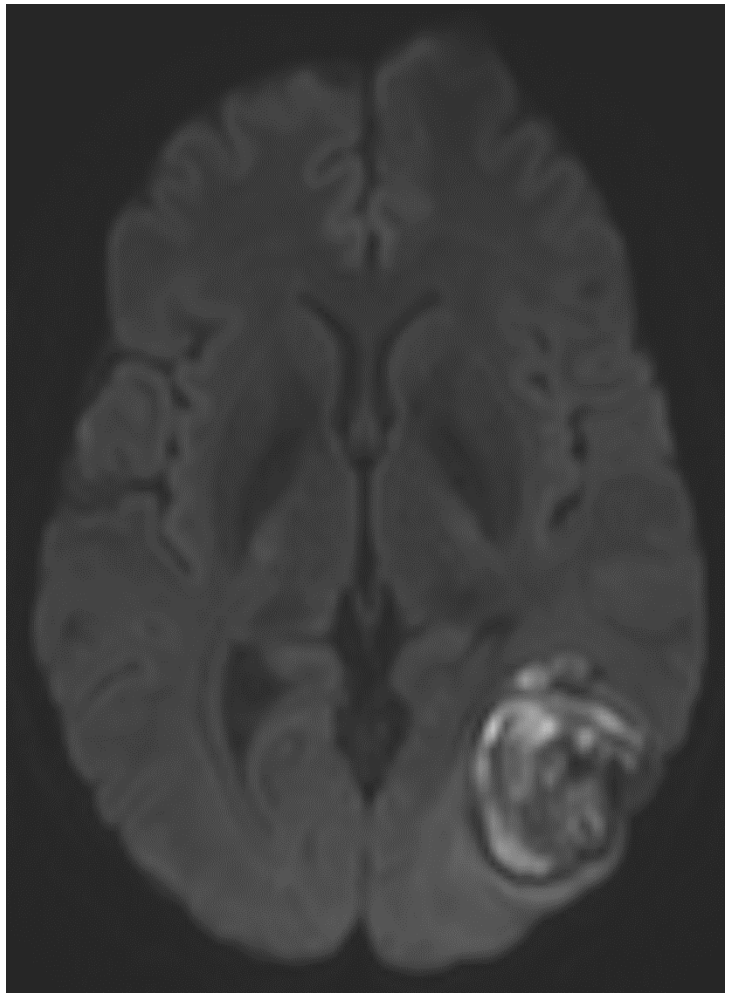
Vasogenic edema



Cytotoxic edema

Brain and spine pathology





Vasogenic edema

Brain and spine pathology

Cerebral abscess is an accumulation of pus, well delimited by a thick wall located in the cerebral parenchyma. In order to establish the imaging diagnosis of cerebral abscess, CT or MRI examination can be used.

CT scan reveals a hypodense lesion well delimited by a thick, iodophilic wall, at the periphery of which there is a spontaneous hypodense edema in the adjacent cerebral parenchyma. The presence of intralesional air content is a pathognomonic change for brain abscess. The evolution towards healing of the abscess is indicated by the decrease in size of the abscess wall, as well as a reduction of the parietal iodophilia.

The MRI examination reveals a lesion in T1 hyposignal, T2 hypersignal, well delimited by a thick wall in T2 hyposignal that presents intense gadophilia. Perilesional edema appears in T2 hypersignal at the periphery of the abscess. The presence of intralesional air content is a pathognomonic change for brain abscess. The evolution towards healing of the abscess is indicated by the decrease in size of the abscess wall, as well as a reduction of the parietal gadophilia.

Brain and spine pathology

b. Congenital cytomegalovirus (CMV) infection is the most common cause of intrauterine infection.

CT: major periventricular parenchymal calcifications, microcephaly, cerebellar hypoplasia.

c. Congenital infection with toxoplasma

The only living carrier of the intracellular parasite Toxoplasma Gondii is the cat. The disease is transmitted either through the consumption of infested meat or through maternal-fetal transmission.

CT: presence of calcifications predominantly in the basal ganglia, cortico-medullary junction, as well as periventricular. The dimensions of cerebral parenchymal calcifications found in patients with toxoplasmosis are smaller than those found in patients with CMV. It can be associated with microcephaly or macrocephaly (in case of hydrocephalus).

d. Congenital rubella infection occurs as a result of transplacental transmission of the rubella virus from mother to fetus. The virus has teratogenic effects.

CT: microcephaly and parenchymal calcifications predominantly in the basal ganglia.

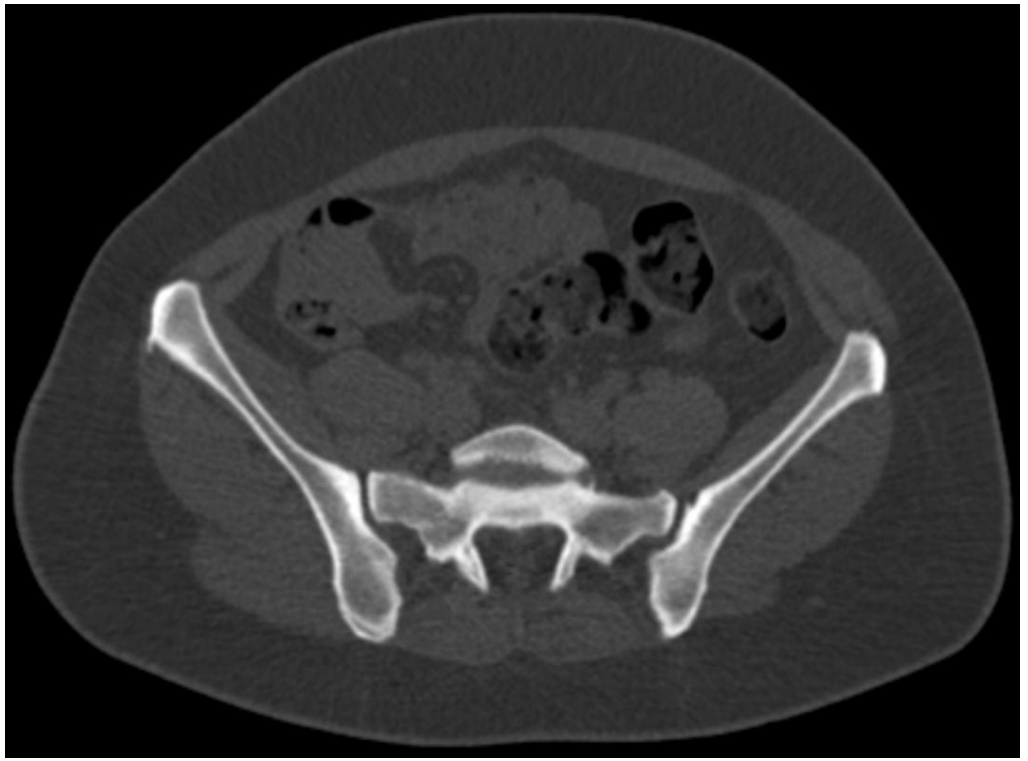
Vertebral malformations

Spina bifida represents an incomplete fusion of the posterior vertebral arch (most frequently affecting L4 and L5).

Spinal disraphism represents an incomplete closure of the neural tube and can be either closed or opened.

Closed spinal disraphism (occult spinal disraphism) – the skin is covering a subjacent spinal malformation – spina bifida occulta.

Opened spinal disraphism – the skin defect exposes some of the spinal content – spina bifida aperta.



Thorax pathology

Pneumococcic pneumonia

Streptococcus pneumonia.

- congestion phase;
- red hepatization phase;
- grey hepatization phase.

Thorax pathology

Pneumococcic pneumonia – congestion phase

RX: diffuse delineated opacity that affects one or more segments or lobes. The intensity of the opacity is reduced and allows the vascular drawing to be seen through it.

CT: reduced lung transparency that affects one or more segments or lobes.

Thorax pathology

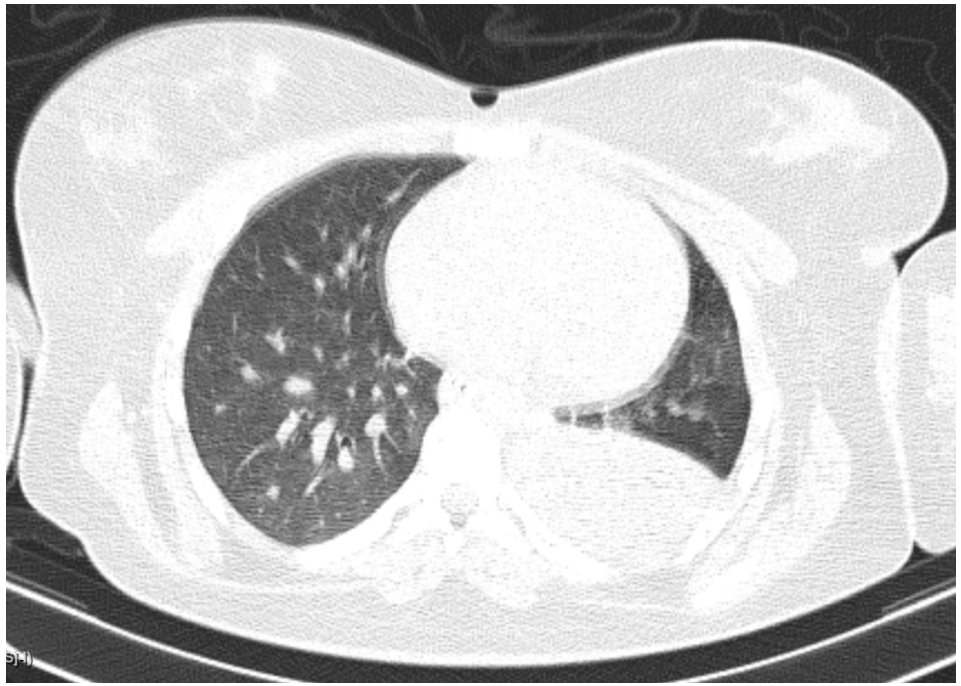
Pneumococcic pneumonia – red hepatization phase

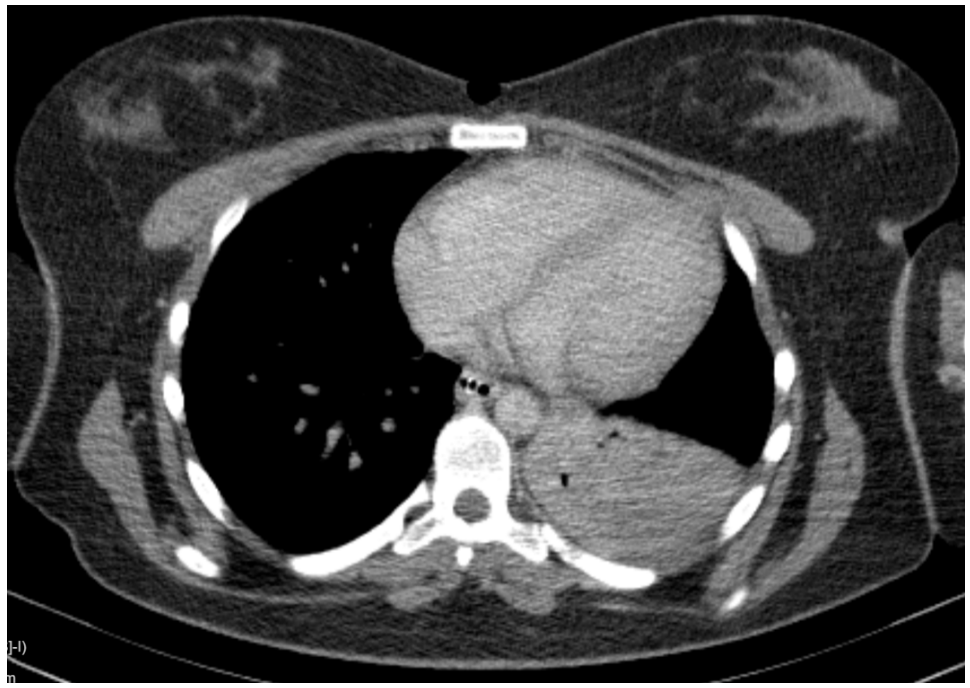
RX: The image described previously in the congestion phase is transformed into a unique triangular opacity, of inframediastinal intensity, which affects one or more segments or lobes. The outline of the opacity is clear when it reaches a fissure (oblique, horizontal) and diffuse when it is lost in the healthy adjacent pulmonary parenchyma. The pathognomonic aspect of this phase is given by the presence of multiple radiolucent linear images represented by the lumen of the bronchi that remains free, unoccupied by the inflammatory exudate. This aspect is the so-called air bronchogram.

CT: Pneumococcic pneumonia in the red hepatization phase is evidenced as a moderately iodophilic consolidation area, with air bronchogram and characteristics similar to those shown on conventional radiography. In addition, the CT examination can detect inflammatory mediastinal and hilar lymph nodes, associated pleural or pericardial effusion, as well as possible complications such as pulmonary abscess.

Thorax pathology

Pneumococcic pneumonia – red hepatization phase



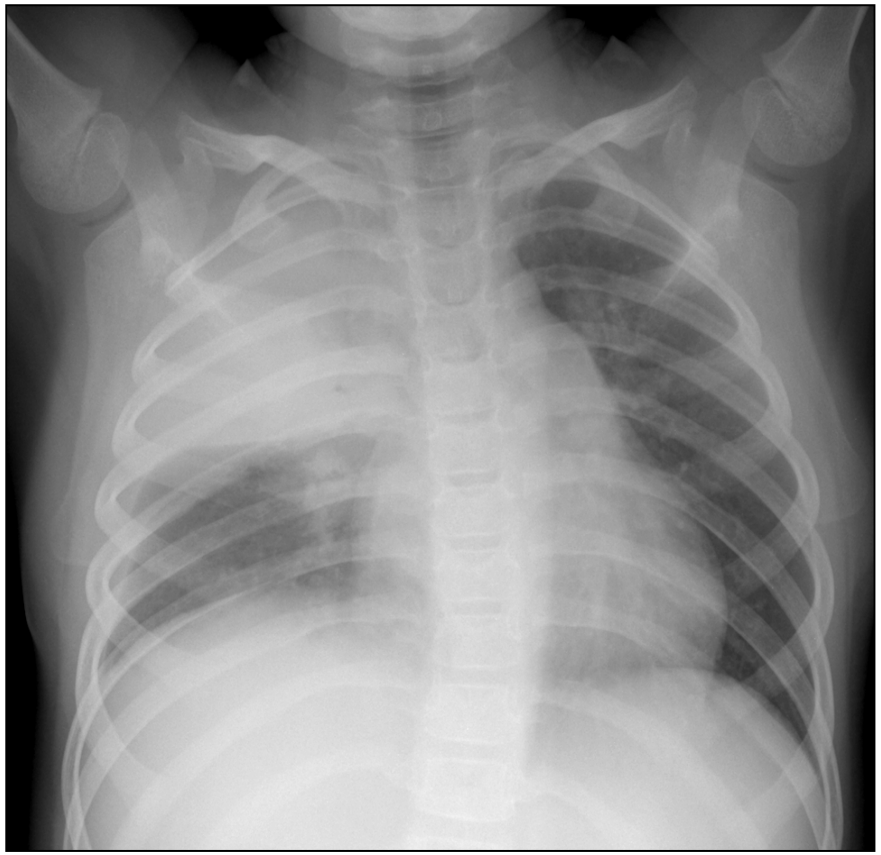


Thorax pathology

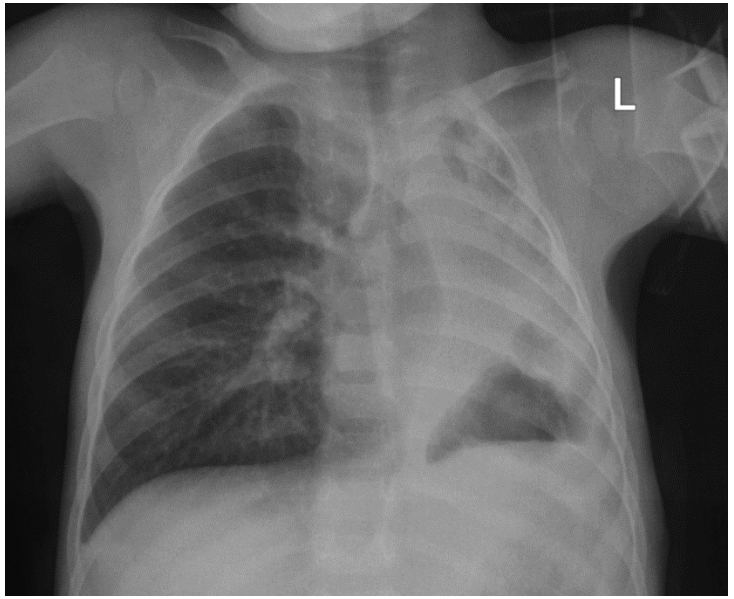
Pneumococcic pneumonia – grey hepatization phase

RX: The opacity previously described in the red hepatization phase now has a homogeneous appearance and an increased intensity. In this phase, the inflammatory exudate occupies the bronchial lumen and air bronchogram can no longer be seen.

CT: the consolidation area has a homogeneous appearance, without air bronchogram.



Thorax pathology



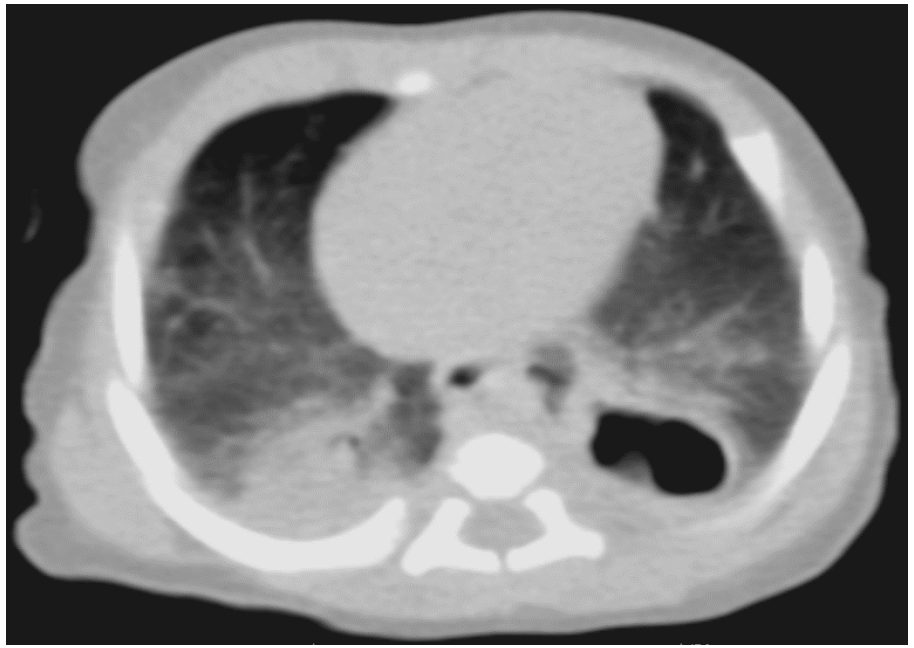
Pneumococcic pneumonia – evolution

Favorable: the pneumonic opacity decreases in size and intensity in 10-14 days until it reaches normal lung transparency - *restitutio ad integrum*.

Unfavorable: chronicization/abscess.

In case of chronicization, the pneumonic opacity persists and has an inhomogenous aspect given by the presence of radiolucent areas alternating with linear opacities represented by the lesions of interstitial fibrosis. The consequence of these fibrotic lesions is the retraction of the ribs, the mediastinum and the diaphragm, developing emphysema and bronchiectasis.

In case of abscess, one or more air-fluid images appear within the consolidation area after a coughing effort accompanied by vomica.



Thorax pathology

Viral pneumonia

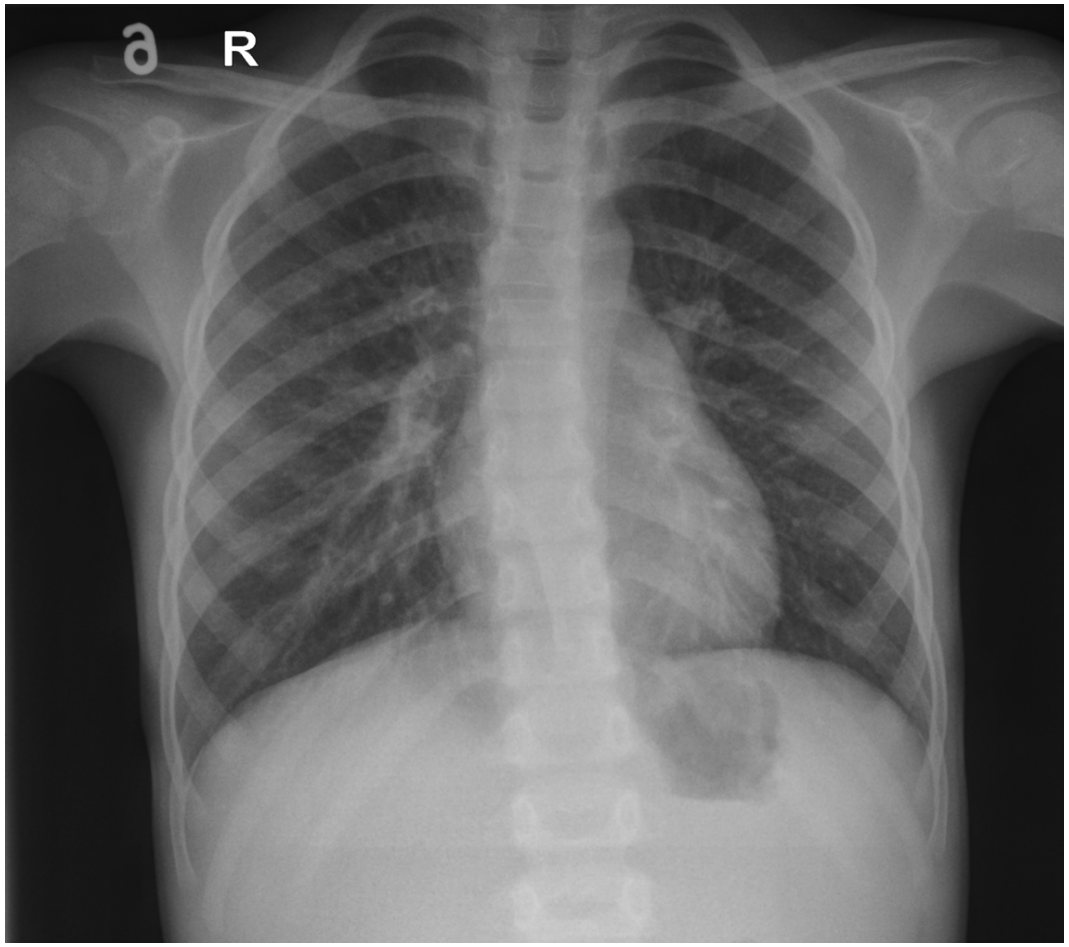
Viral pneumonia is commonly found in the lower lobes.

RX: it appears as uni- or bilateral accentuation of the perihilar peribronhovascular drawing, with the presence of fine, linear opacities that start from the lung hilum and go towards the pulmonary bases. Along these fine, linear opacities, punctiforme opacities are visualized. It is important to note that radiological changes often precede the onset of clinical symptomatology and may be exacerbated in the event of bacterial overinfection.

CT: bilateral perihilar peribronchial thickening and interstitial infiltrates. Pleural effusion, hilar lymphadenopathy and pneumothorax are uncommon findings.

Thorax pathology

Viral pneumonia



Thorax pathology

Bronchopneumonia

From a radiological standpoint, bronchopneumonias are characterized by the presence of confluent nodular opacities of variable dimensions, uni- or bilateral, with high central intensity and diffuse outline. Conventional X-ray or CT can be used to diagnose this disease.

Thorax pathology

Staphilococcal bronchopneumonia

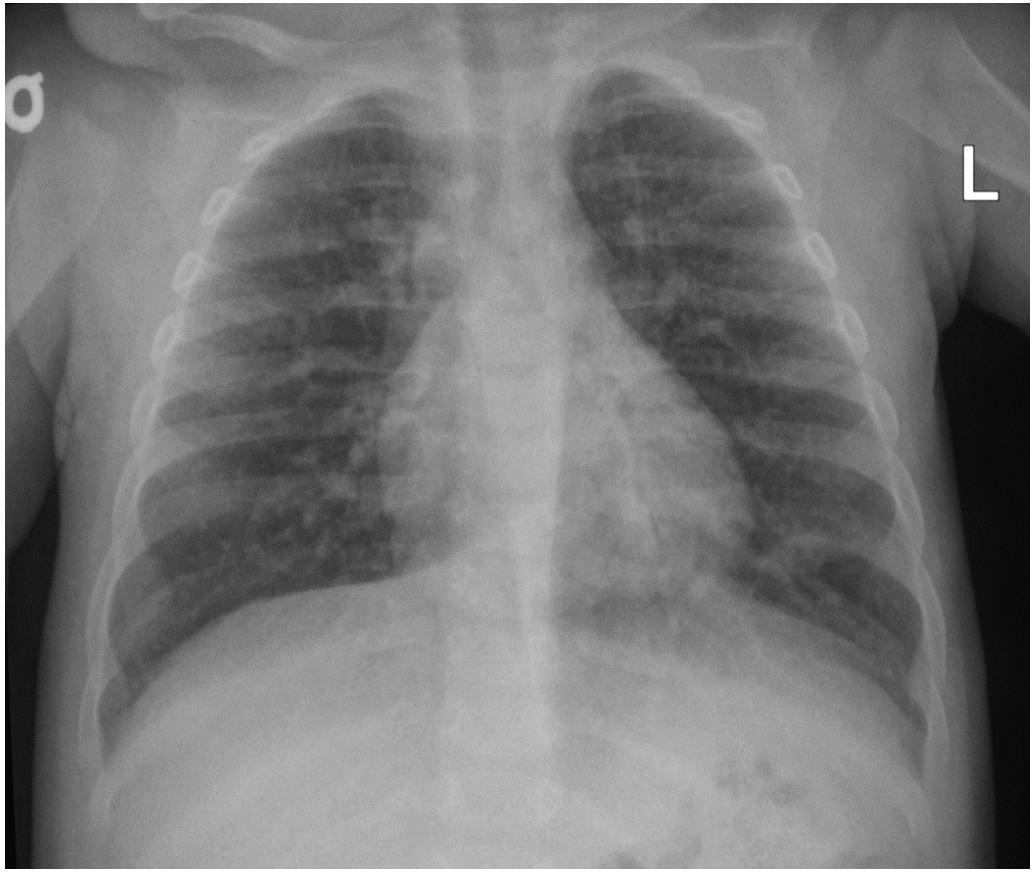
From a radiological point of view, this type of bronchopneumonia is characterized by the presence of nodular opacities of variable dimensions, with homogeneous appearance in the initial phases, well deliniated by a clear outline. In evolution, by eliminating pus content from these opacities, they become radiolucent, well-deliniated focal images, called ***pneumatoceles***. When located subpleurally, the pus content is eliminated in the pleural space.

Staphylococcal bronchopneumonia is characterized by a great variability of the radiological image from one day to another generated by the development of new bronchopneumonic opacities or focal radiolucent images (pneumatoceles). Complications of this pathology include piothorax, piopneumothorax and the presence of pleural effusion.

The CT examination highlights changes similar to the ones described on conventional X-ray but with a more accurate characterization of the complications.

Thorax pathology

Staphilococcal bronchopneumonia



Thorax pathology

Lung abscess

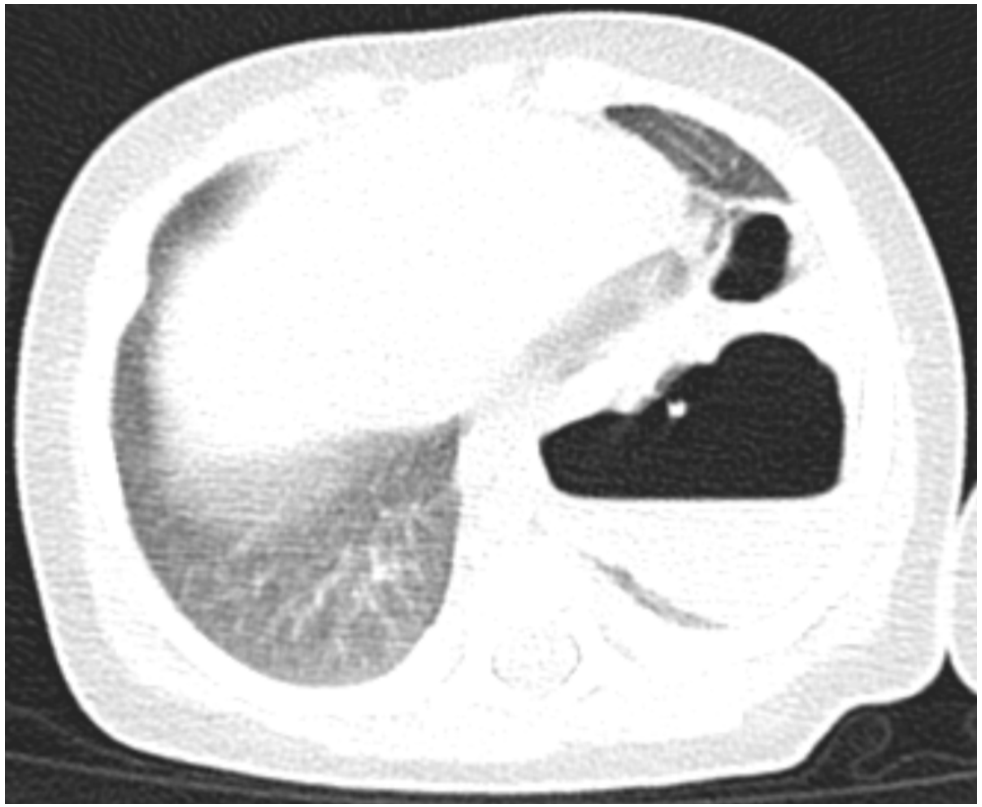
Pulmonary abscess is a localized suppuration in the lung parenchyma resulting from an acute inflammatory process (pneumonia, bronchopneumonia).

RX: the pulmonary abscess implies an initial phase of formation, represented by the pneumonic opacity that increases in intensity and becomes inhomogeneous, with diffuse outlines. Later, after vomica occurs, the air-fluid image appears due to the air that gets inside the lesion from the adjacent bronchia. In this phase, the pulmonary abscess has radiolucent air content in the upper portion and opaque fluid content in the lower portion, with a horizontal separation limit between the two. In the initial stages, the abscess is delimited by a thick, diffuse, low intensity outline that, in evolution, will become clear. The radiological aspect of the pulmonary abscess changes from one moment of the day to another or from one day to another.

CT: the non-evacuated pulmonary abscess appears as a round-oval hypodense lesion with fluid densities inside. Following the evacuation of the pus, the air-fluid image appears, and the aspect is similar to the one identified in conventional radiology.

Thorax pathology

Lung abscess

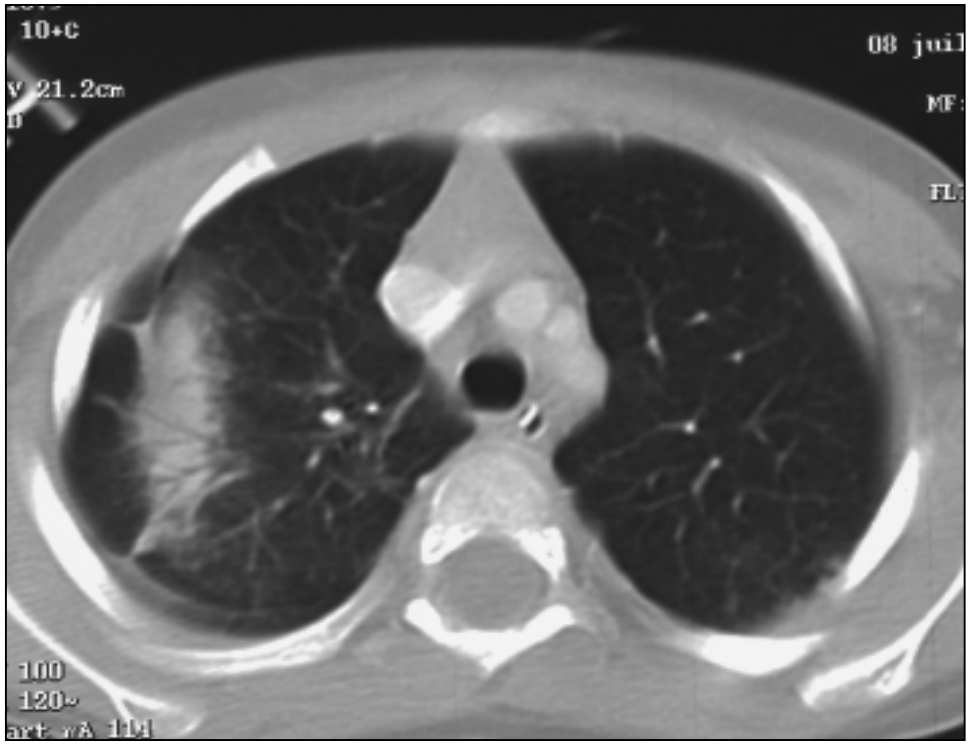


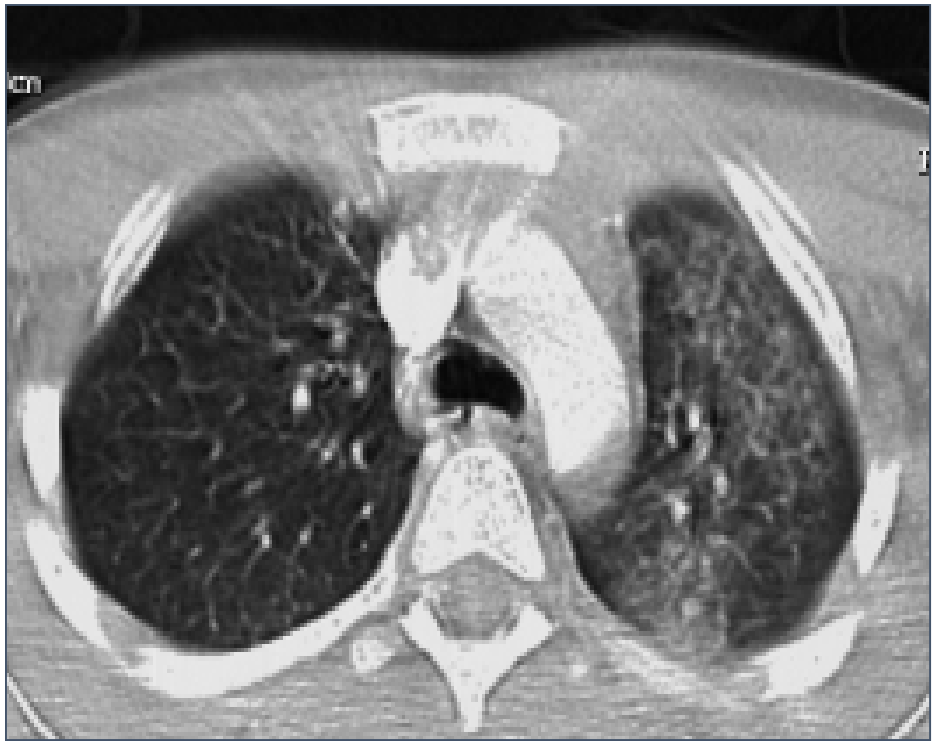
Thorax traumatic pathology

Post-traumatic injuries in pediatric patients are identical in classification (rib fractures, pulmonary contusion, pneumomediastinum, pneumothorax, hemothorax) and in radio-imaging aspects with those described in adults. Chest radiography, in frontal and profile incidences, is performed mainly to identify bone lesions. At this moment, it is no longer justified to use conventional radiography to establish the balance of a thoracic trauma, but it is preferable to perform a CT examination.

Thorax traumatic pathology

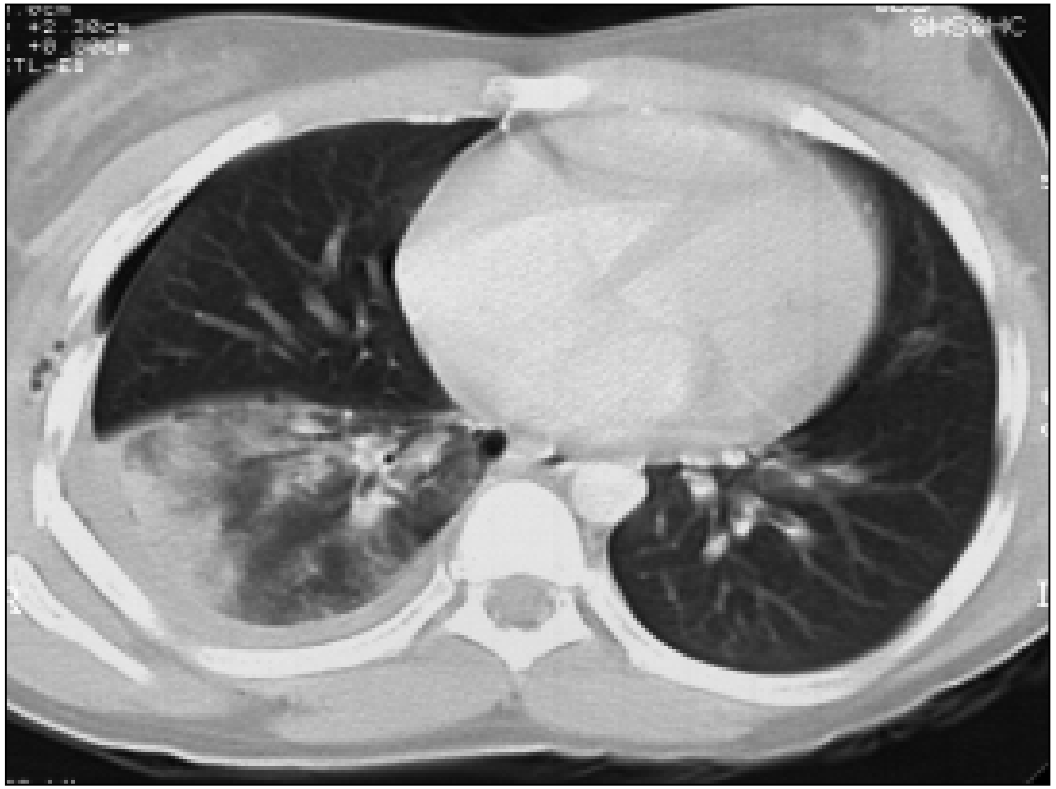
Lung contusion

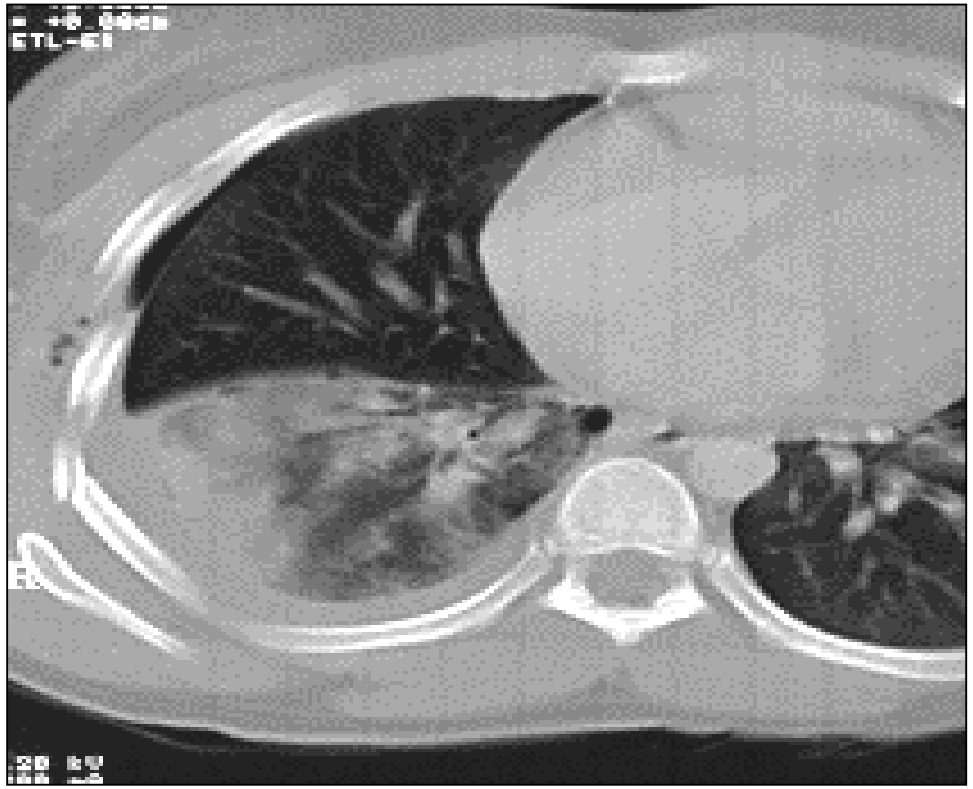




Thorax traumatic pathology

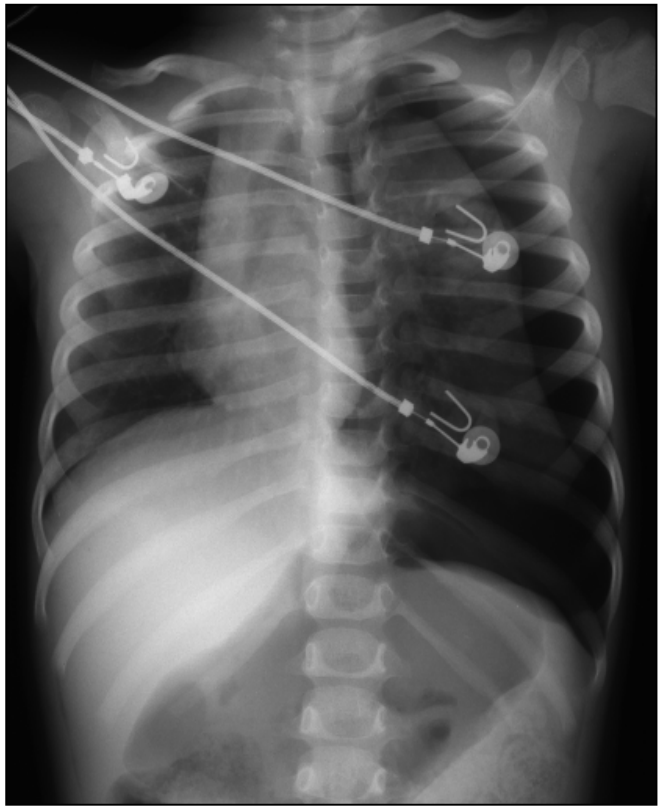
Lung contusion + rib fracture + hemothorax

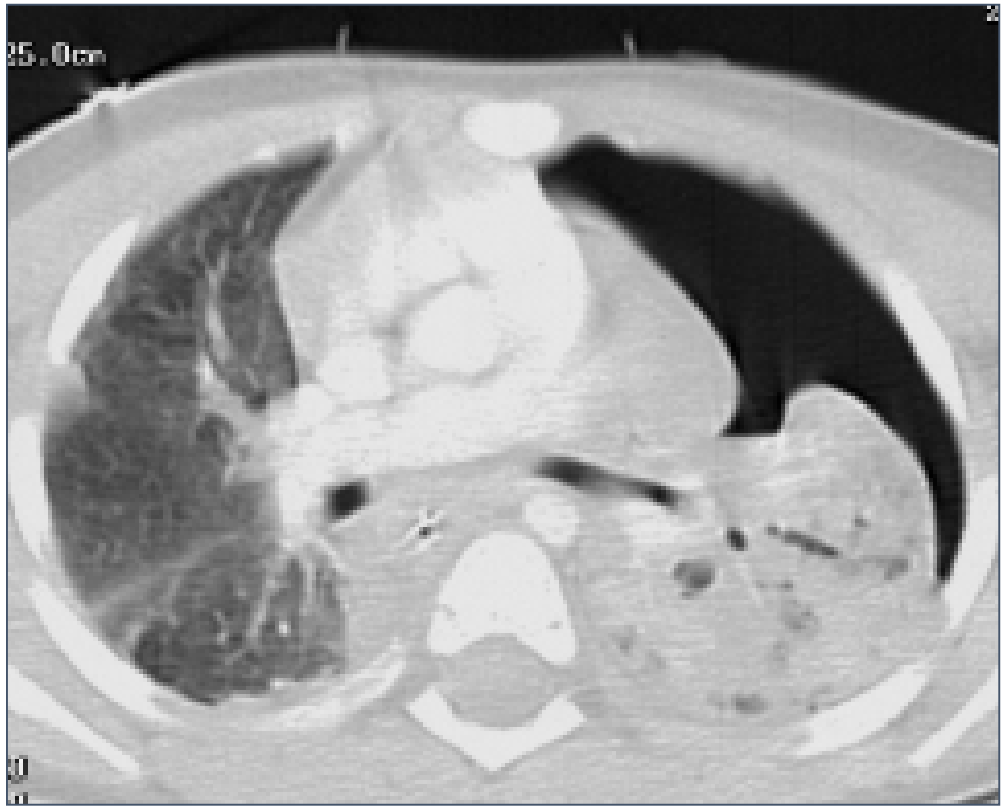




Thorax traumatic pathology

Pneumothorax





Abdominal pathology

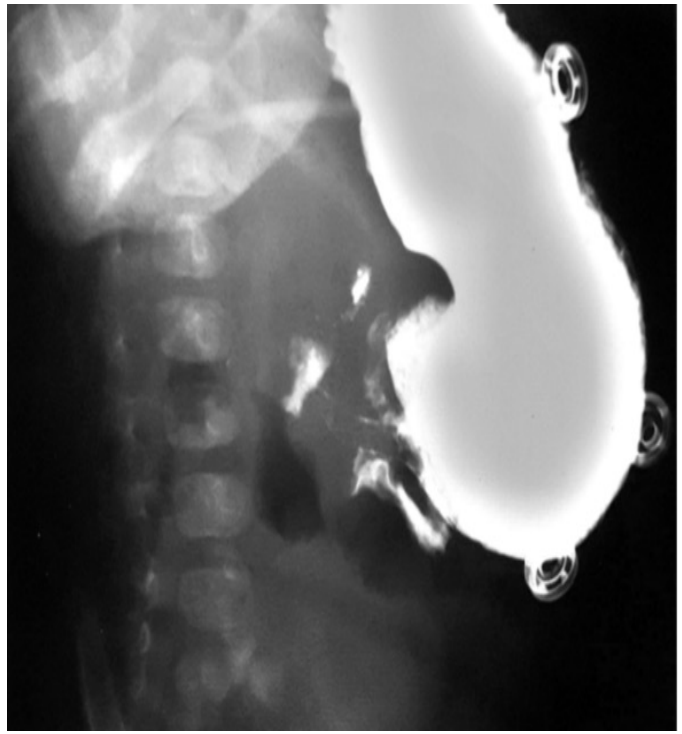
Hypertrophic pyloric stenosis

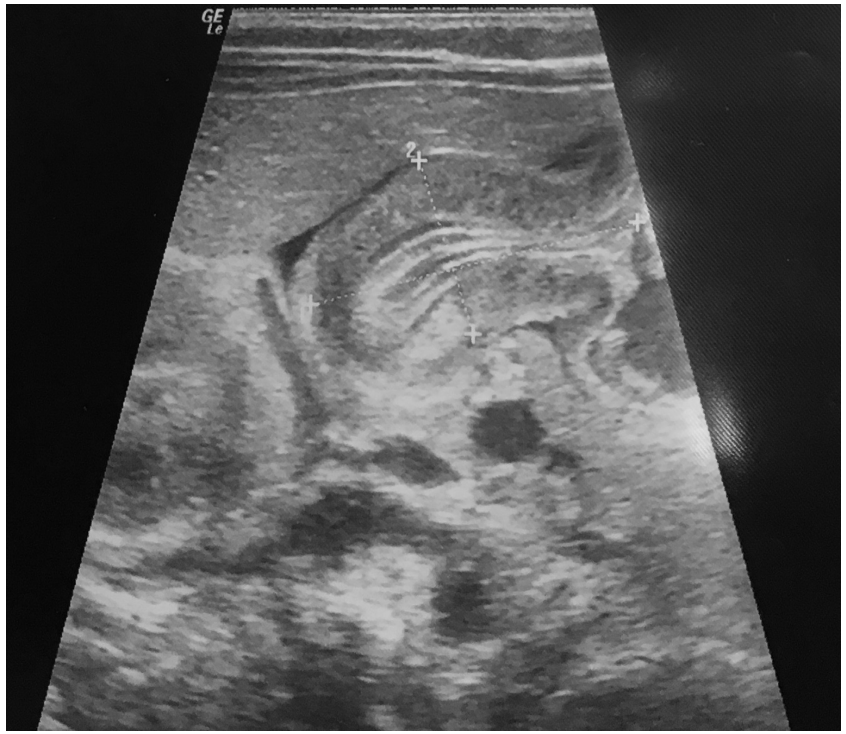
Hypertrophic pyloric stenosis is the most common cause of vomiting in children requiring surgery (it occurs through hypertrophy of the muscular tunic of the pyloric canal).

The barium swallow highlights a filiform and elongated pyloric canal (opacified pyloric canal). In the initial stages, the appearance of a combat stomach appears with the presence of accelerated peristalsis meant to overcome the pyloric obstacle. In evolution, the peristaltic waves decrease, the stomach becomes hypotonic, and the gastric contents are evacuated slowly.

US: identifies a thickened pyloric wall and an elongated pyloric canal.

Abdominal pathology





Abdominal pathology

Ano-rectal malformations

Ano-rectal malformations (MAR) are characterized by a marked abdominal distension, absence of the anal orifice combined with recto-bladder and recto-vaginal fistulas, with the elimination of the meconium in the bladder or in the vagina.

Simple abdominal x-ray: identifies the presence of hydro-aeric levels suggestive of intestinal occlusion, as well as the presence of air in the vagina (in girls) or in the bladder (in boys).

Fistulography: it is the most sensitive technique in highlighting the recto-vaginal or recto-bladder fistulas.

Abdominal pathology

Hirschprung disease

Hirschprung's disease (congenital megacolon) occurs as a result of absent lymph node cells in the distal colon and rectum. Aganglionosis primarily affects the anus, then, through a continuous impairment, it extends proximally. The distal colonic segment is small in size and spastic. The normally innervated bowel appears dilated.

A certain diagnosis can be obtained through endo-rectal biopsy, and the imaging diagnosis is established with the help of irigography.

The irigography (barium enema) will identify an area with a funnel aspect, consisting of 3 elements:

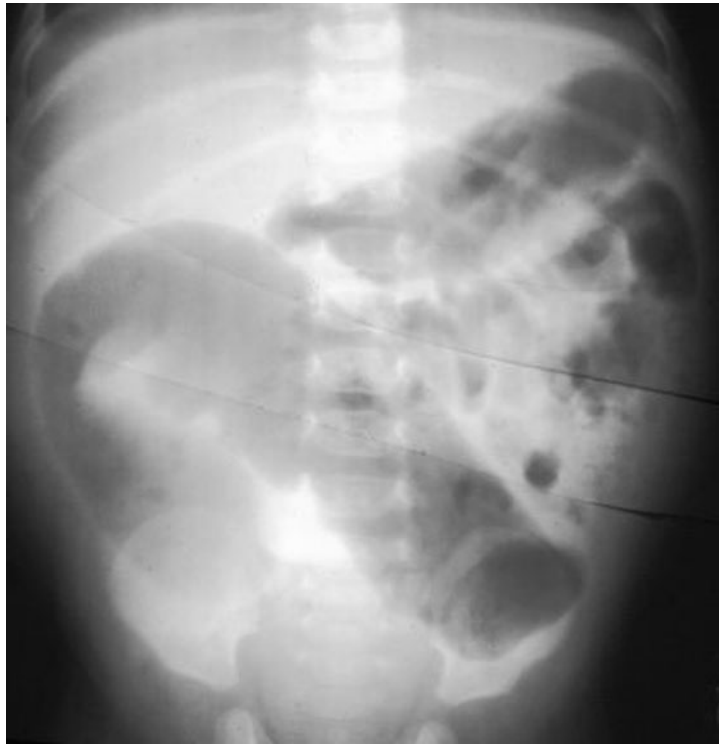
- the distal segment appears small / normal size;
- the intermediate segment has a conical shape;
- the superjacent segment appears significantly dilated (megacolon).

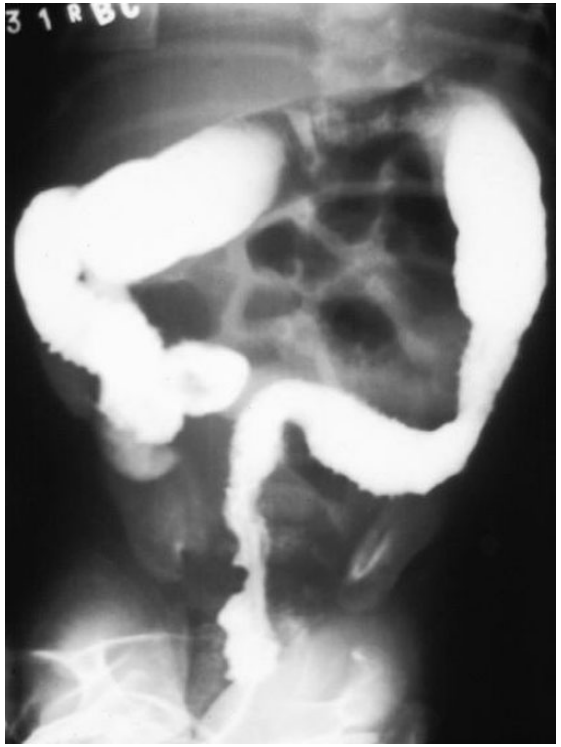
Irigography is an imaging technique that is practiced in the absence of any perforation signs.

The CT examination can detect an increased caliber of the colon.

Abdominal pathology

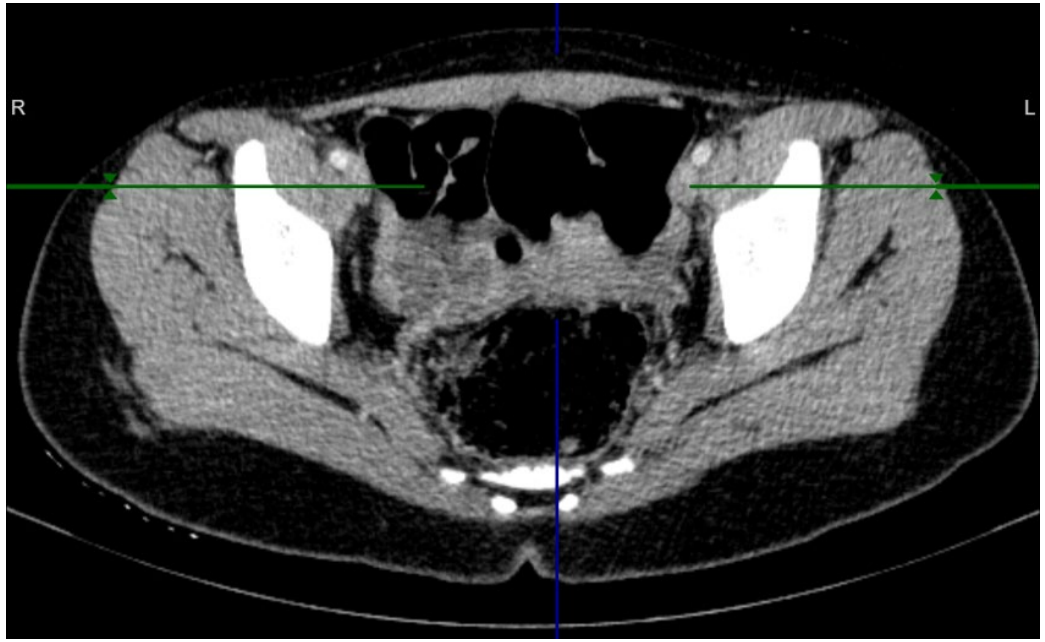
Hirschprung disease

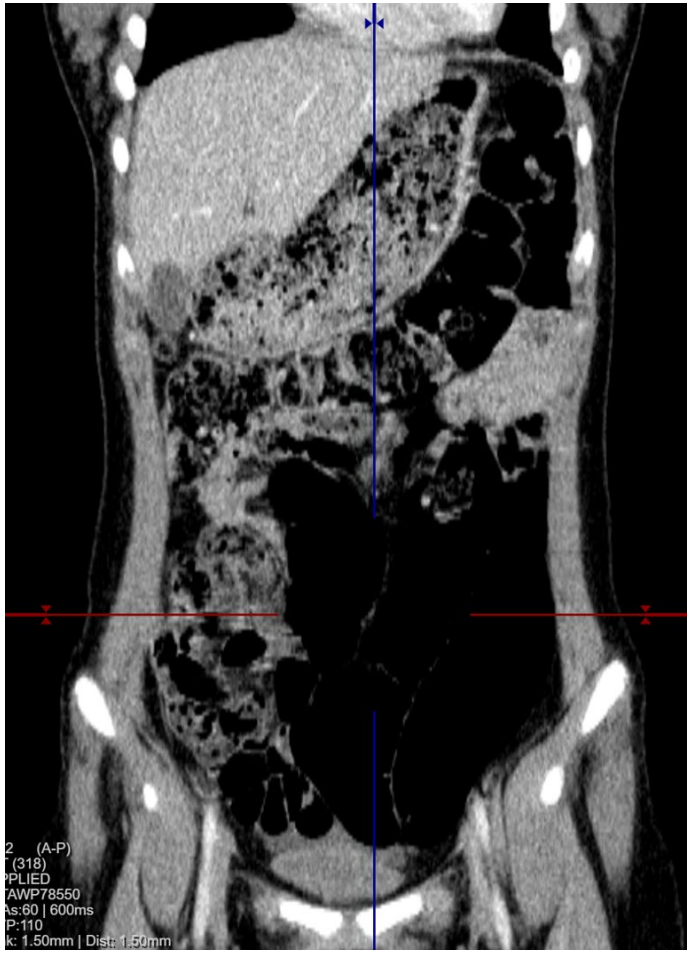




Abdominal pathology

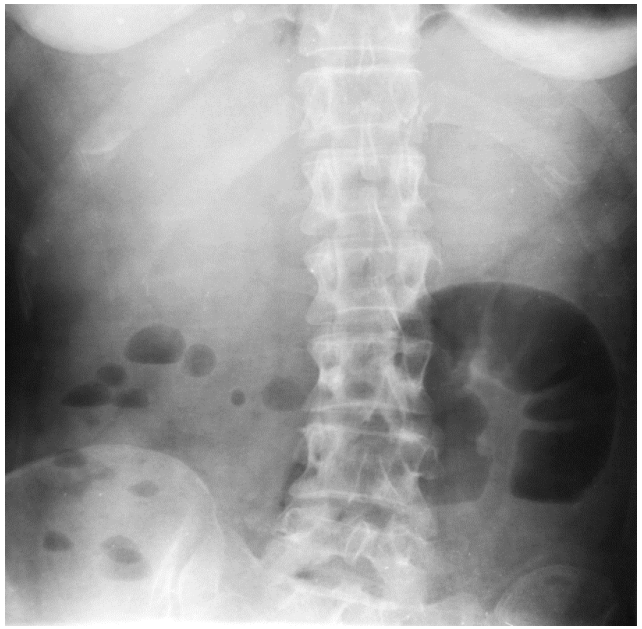
Hirschprung disease





Abdominal pathology

The bowel occlusion can have either mechanical or functional causes. The radiological sign considered pathognomonic and which can be detected on a simple abdominal radiography is the presence of hydro-aeric levels. If the occlusion occurs in the small bowel, the hydro-aeric levels will be located centrally in the abdomen. If the occlusion occurs in the colon, the hydro-aeric levels will be located in the periphery of the abdomen, along the colic framework.



Abdominal pathology

Intestinal volvulus

Simple abdominal radiography can detect the presence of hydro-aeric levels suggestive for intestinal occlusion.

The CT scan can detect the spiral twisting of the affected intestinal segment around its vascular axis and the presence of peritoneal effusion.

Intestinal invagination

The intestinal invagination involves telescoping a proximal intestinal segment into a distal one, causing mechanical occlusion. The most affected region is the ileo-cecal region.

US: identifies an alternation of the mucosal and muscular layers, in the form of hypo- and hyperechoic circles on cross section. Furthermore, US identifies adjacent liquid collections, and with the help of the Doppler mode it evaluates the vascularization of the bowel loops (absence of vascularization - ischemia).

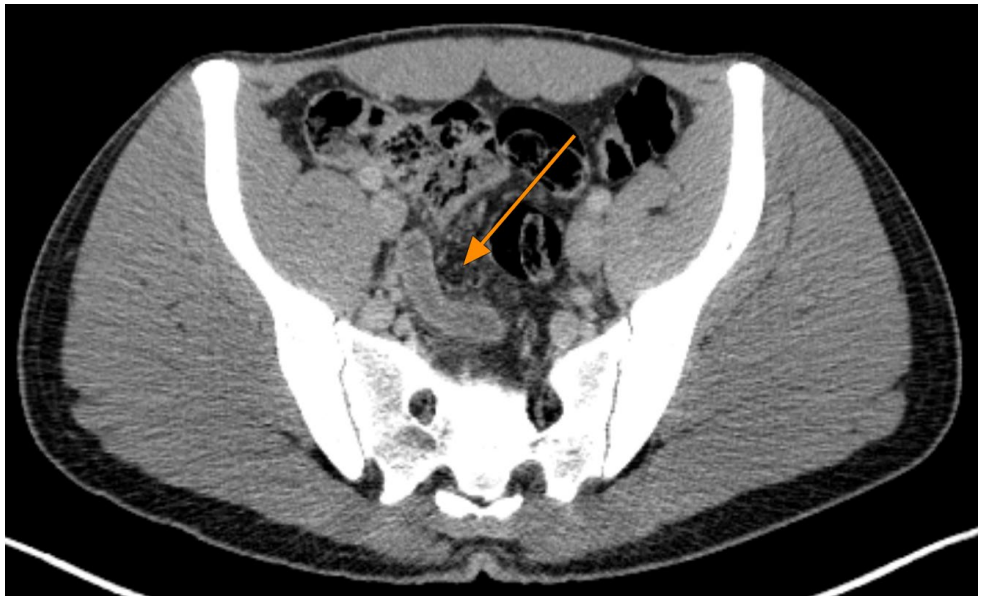
Irigography: it is always performed after excluding any suspicion of intestinal perforation and has a double role, being involved in both diagnosis and treatment.

Abdominal pathology

Acute appendicitis is defined as an acute inflammation of the cecal appendix.

US: identifies the increase in appendicular diameter over 6 mm and wall thickness over 2 mm. The appearance of the appendix is finger-gloved. In certain situations, the presence of a stercolith can be seen as a hyperechoic image with a posterior acoustic shadow.

CT: identifies changes similar to those described by the US. The stercolith appears as a hyperdense image. In addition, a peritoneal collection may be highlighted, and in case of perforation an appendicular parietal defect may appear, with extravasation of the appendix content.



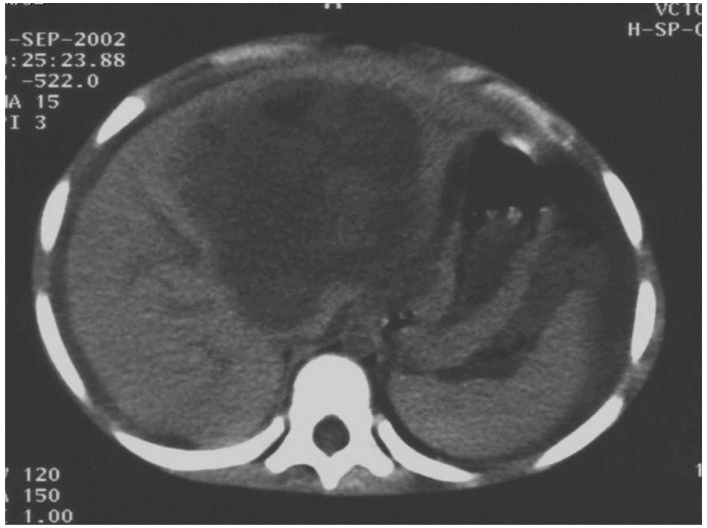
Abdominal pathology

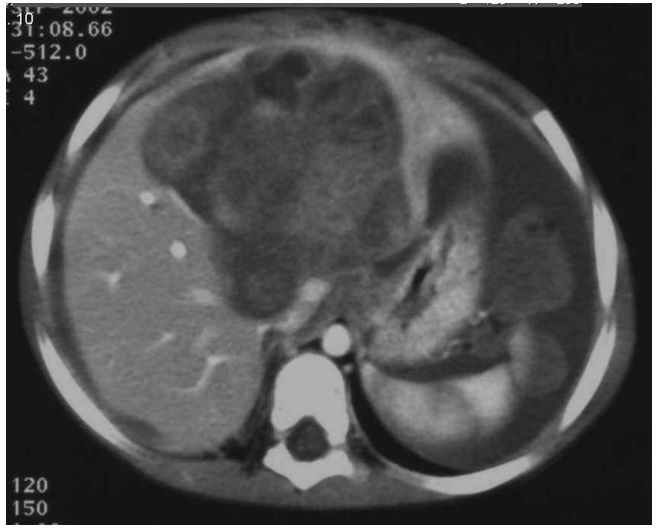
Hepatoblastoma is the most common primary hepatic malignancy in the child.

US: well delimited, solid tumoral mass, with heterogeneous structure due to intralesional areas of necrosis and / or hemorrhage. In Doppler mode - the tumor is well vascularized.

CT: hypodense tumor with heterogeneous structure due to intralesional areas of necrosis and / or hemorrhage + intratumoral calcifications. A chest CT examination may confirm or deny the presence of secondary pulmonary lesions.

MRI: tumoral mass with a heterogeneous aspect both natively and postcontrast, seen as hypo T1 and hyper T2.





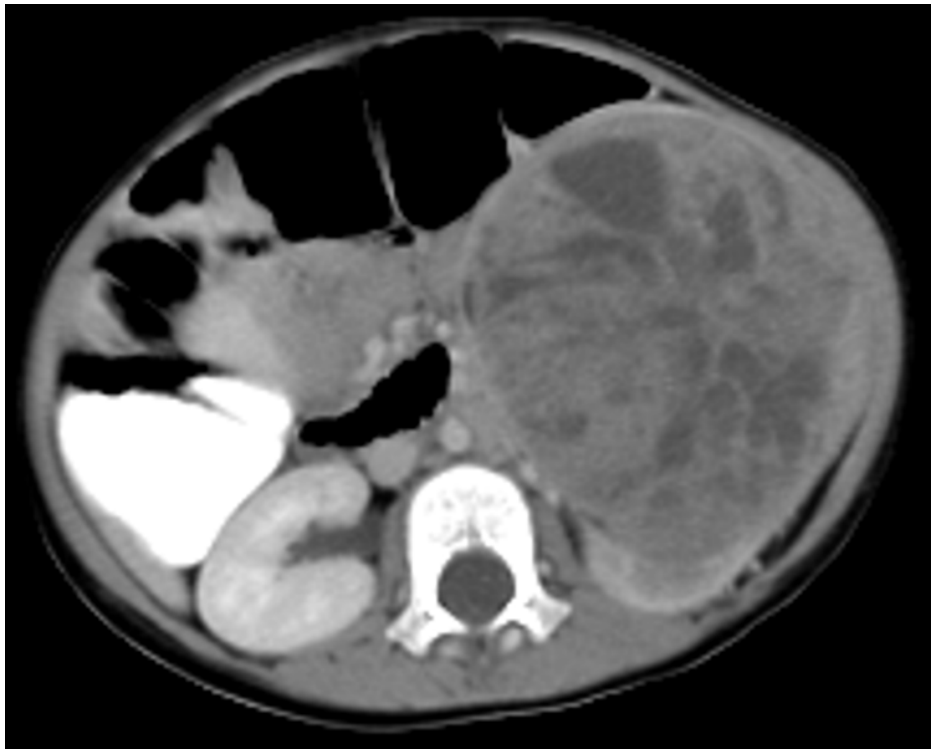
Abdominal pathology

Wilms tumor is the most common primary renal malignancy in the child. In evolution, this type of tumor causes invasion of the renal vein from the same side, as well as of the inferior vena cava.

US: excludes other causes of unilateral renal hypertrophy (eg, ureterohydronephrosis), identifies the presence of a bulky mass, with mixed echogenicity. Exploration in Doppler mode is useful for evaluating the permeability of the renal vein and the inferior vena cava.

CT: hypodense tumoral mass, with a heterogeneous structure both natively and postcontrast. Occasionally, the presence of intratumoral calcifications is noted. A chest CT examination may confirm or deny the presence of secondary pulmonary lesions.

MRI: tumoral mass with a heterogeneous aspect both natively and postcontrast, seen as hypo T1 and hyper T2.



Abdominal trauma

Liver trauma

The most common liver injuries in children are subcapsular hematoma and liver laceration.

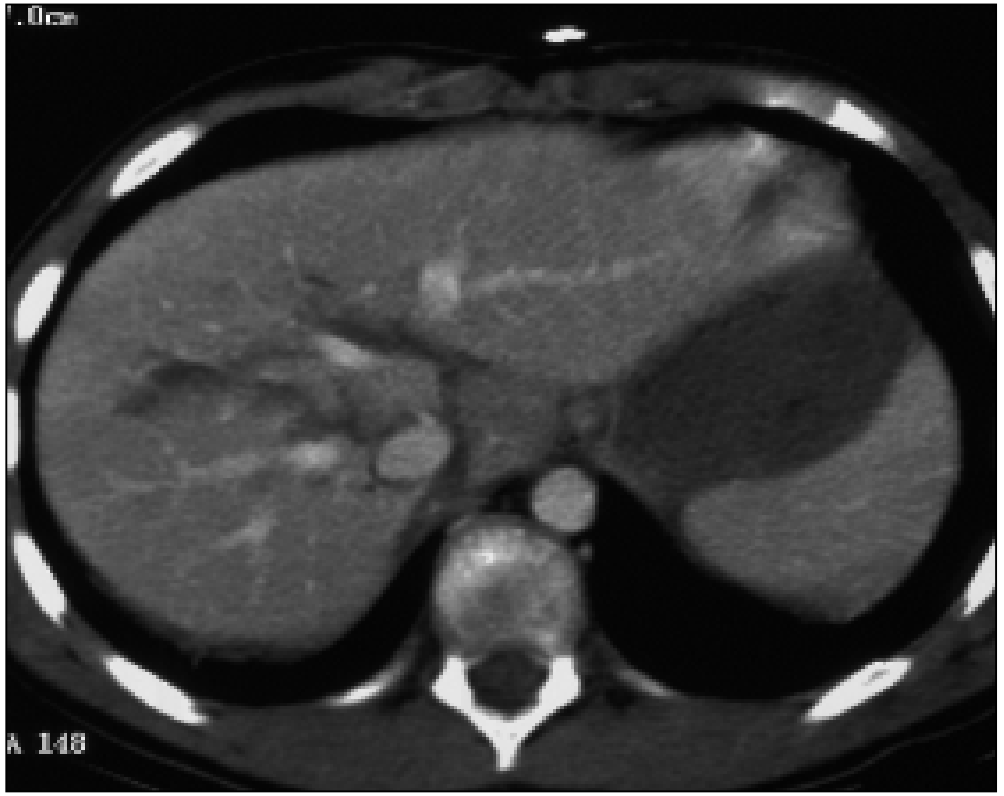
Hepatic subcapsular hematoma occurs following a trauma that acts on the liver and can be highlighted through CT examination. As an aspect, there is a semilunar hematic accumulation located perihepatic, subcapsular, whose appearance varies depending on the time elapsed since the trauma (acute - hyperdense; subacute - isodense; chronic - hypodense).

Liver laceration can occur as a result of a severe trauma affecting the liver region and is visualized by the CT examination in the form of an interrupted contour of the organ that extends inside the liver parenchyma and is sometimes associated with perihepatic hematic accumulation.

Sometimes, a liver trauma can affect the bile ducts, with the formation of a biloma (CT: collection with fluid densities similar to the bile, with a communication path between the bile duct and biloma; MRI: fluid collection with bile-like signal; hepatocyte contrast agents are eliminated through bile and may facilitate the diagnosis of this condition).

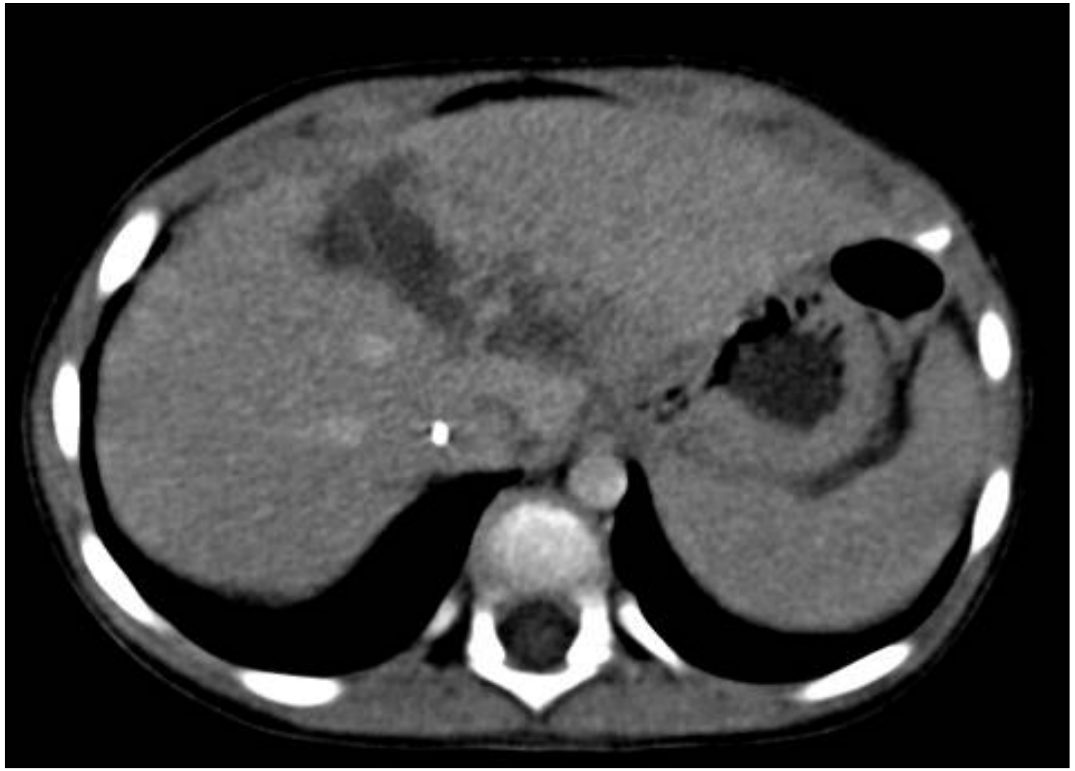
Abdominal trauma

Liver laceration



Abdominal trauma

Biloma



Abdominal trauma

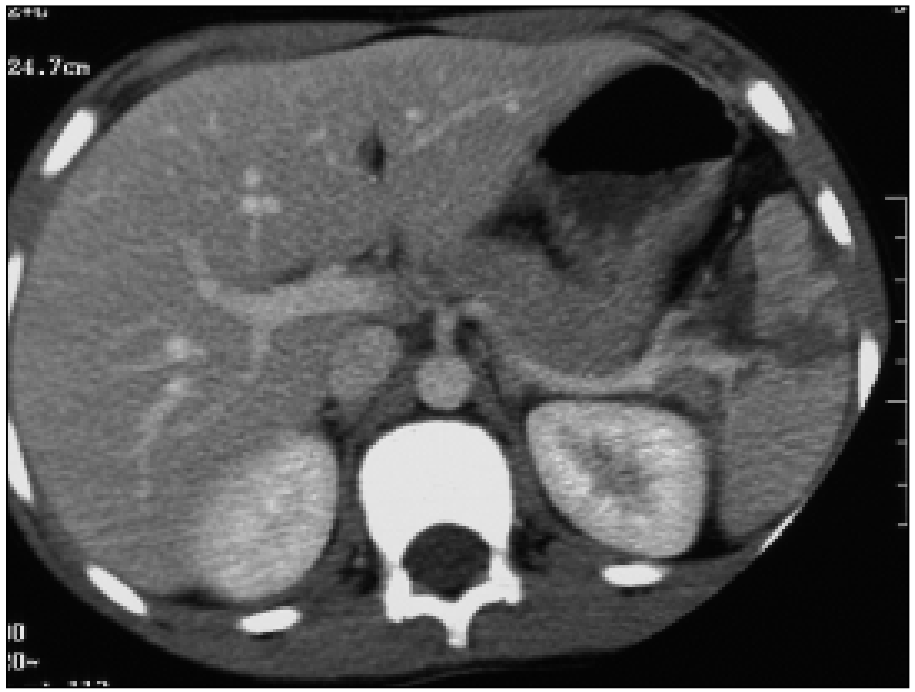
Splenic trauma

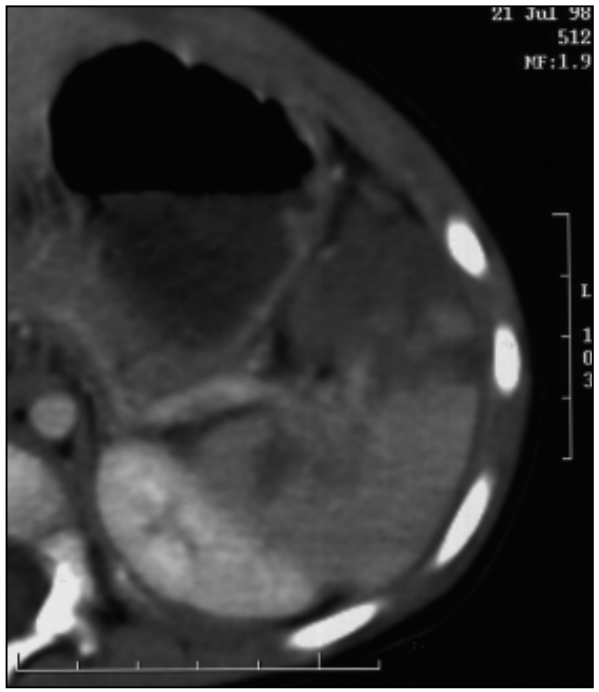
The most common splenic traumas in children are subcapsular hematoma and splenic laceration.

Splenic laceration can occur as a result of a severe trauma affecting the splenic region and can be detected using CT in the form of an interrupted contour of the organ that extends inside the splenic parenchyma and is sometimes associated with perisplenic hematic accumulation.

Abdominal trauma

Splenic laceration





Abdominal trauma

Pancreatic trauma

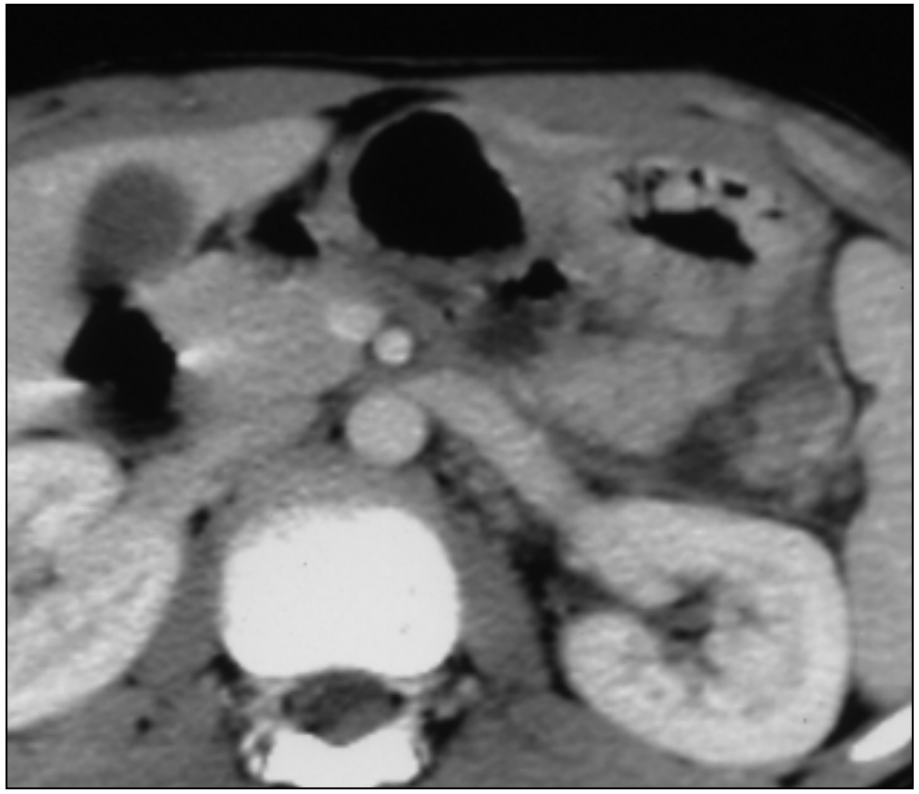
Pancreatic injuries are relatively rare in children and can be caused by direct blows to the epigastrium or seat belts in road accidents. The main cause of pancreatitis in children is trauma. CT examination is used to diagnose post-traumatic pancreatic changes.

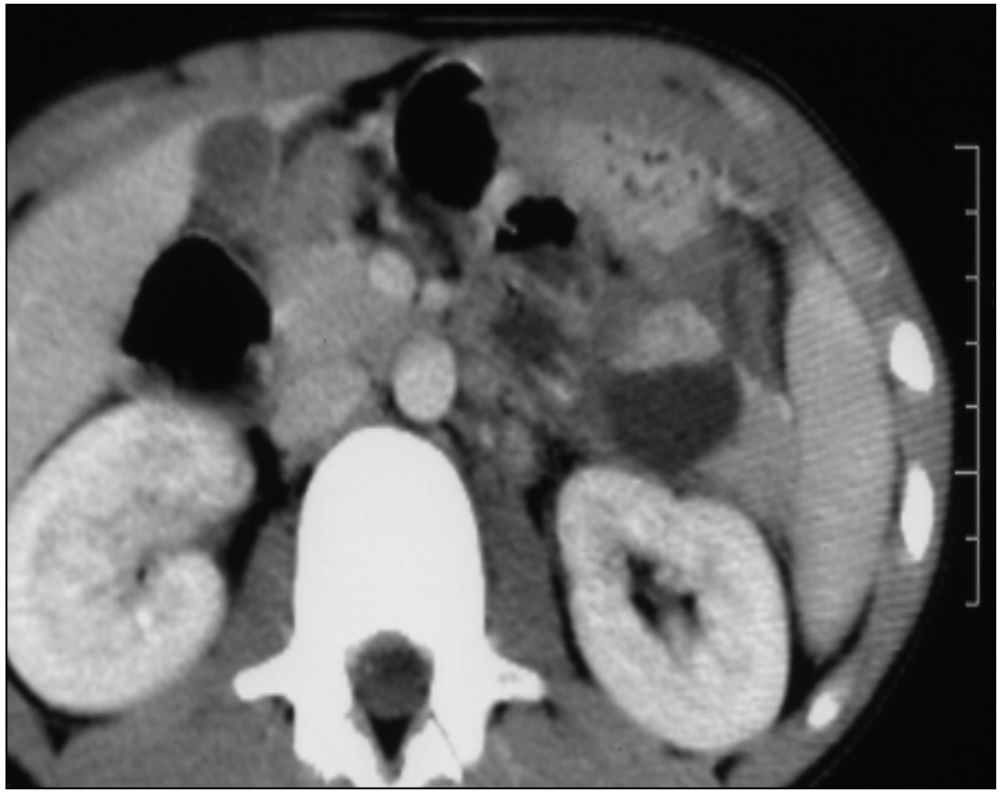
The main imaging changes detected by CT in case of a trauma involving the pancreatic region are represented by:

- pancreatic laceration - interrupted contour of the organ that extends inside the pancreatic parenchyma;
- heterogeneous uptake of the contrast substance in the pancreas;
- increased volume of the pancreas;
- pancreatic fluid collections that communicate with the pancreatic duct (pseudocyst, hematoma, etc.);
- peripancreatic fluid;
- infiltration of the peripancreatic fat.

Abdominal trauma

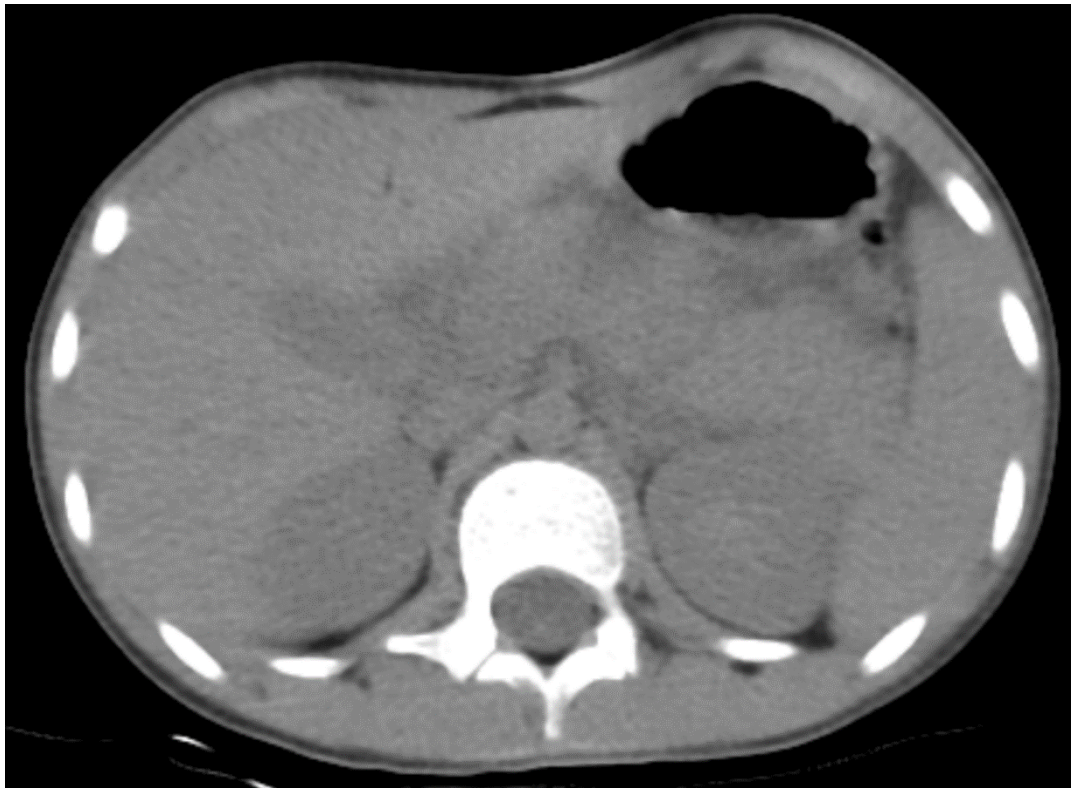
Pancreatic tail laceration

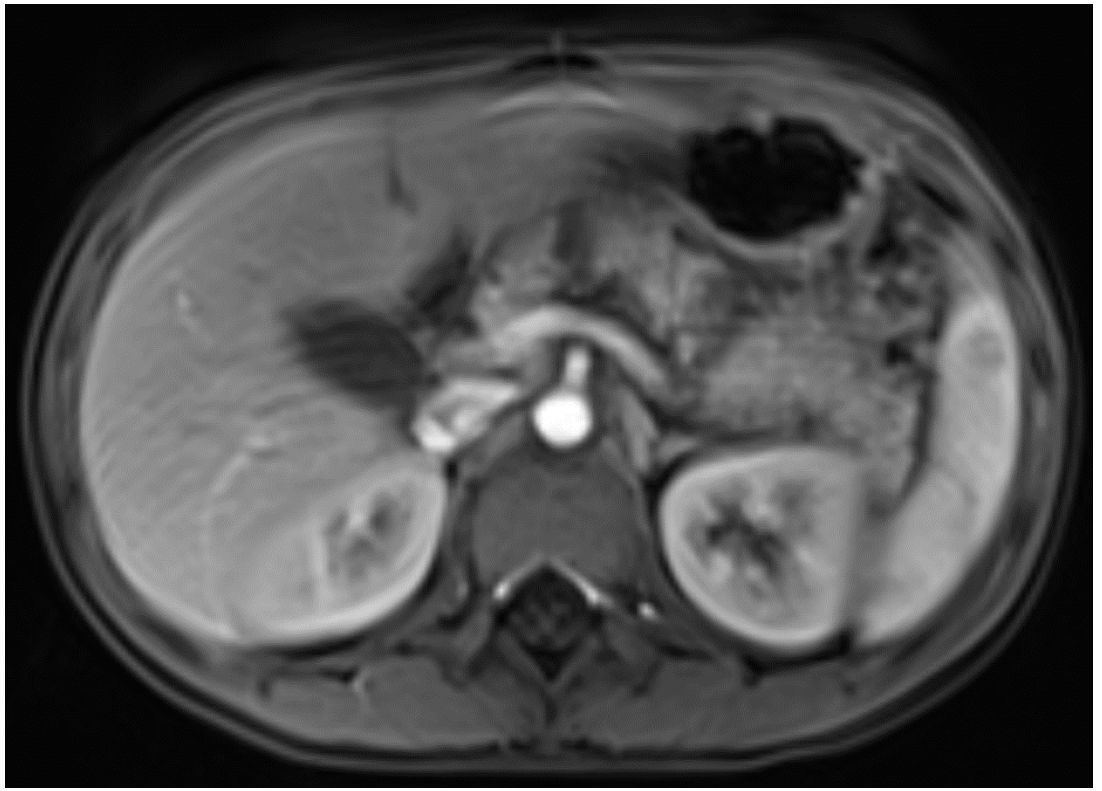




Abdominal trauma

Pancreatic body+tail laceration (CT – left, MRI – right)





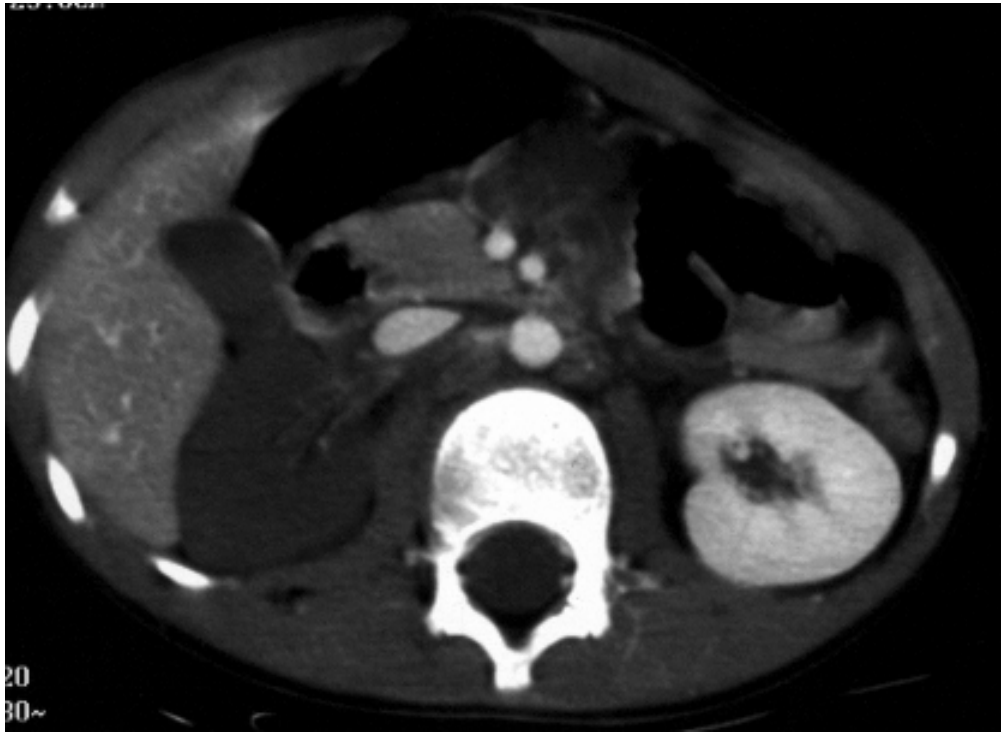
Abdominal trauma

Renal trauma

In children, the kidneys are big, mobile and exposed due to poor muscle development and perirenal adipose tissue. Among the most common kidney traumas are: contusion, hematoma, laceration, hemorrhage and avulsion of the renal pedicle. Sometimes, kidney trauma can be associated with traumatic injuries involving other abdominopelvic organs. The imaging method of choice for detecting post-traumatic renal changes is CT.

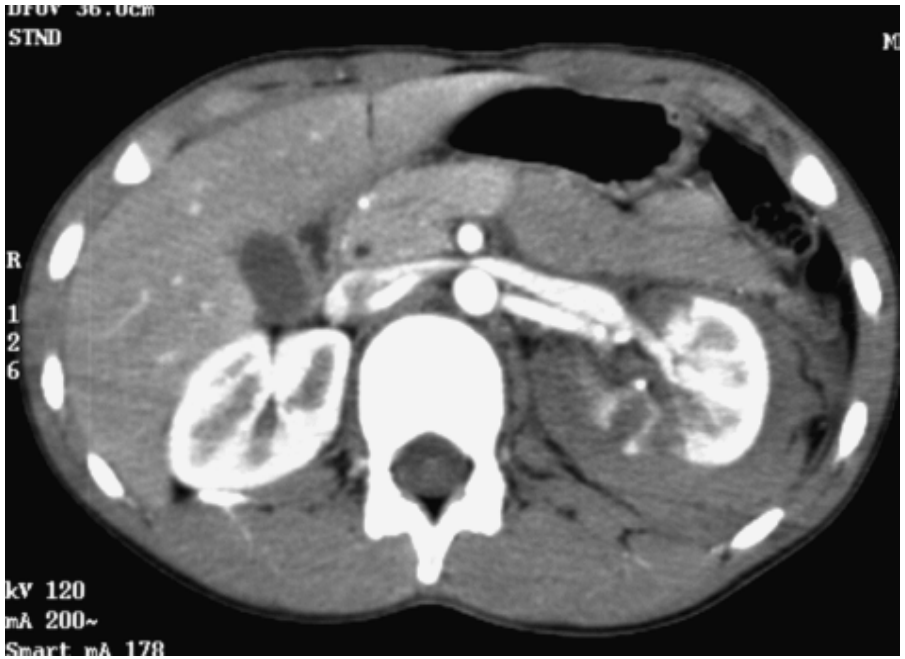
Abdominal trauma

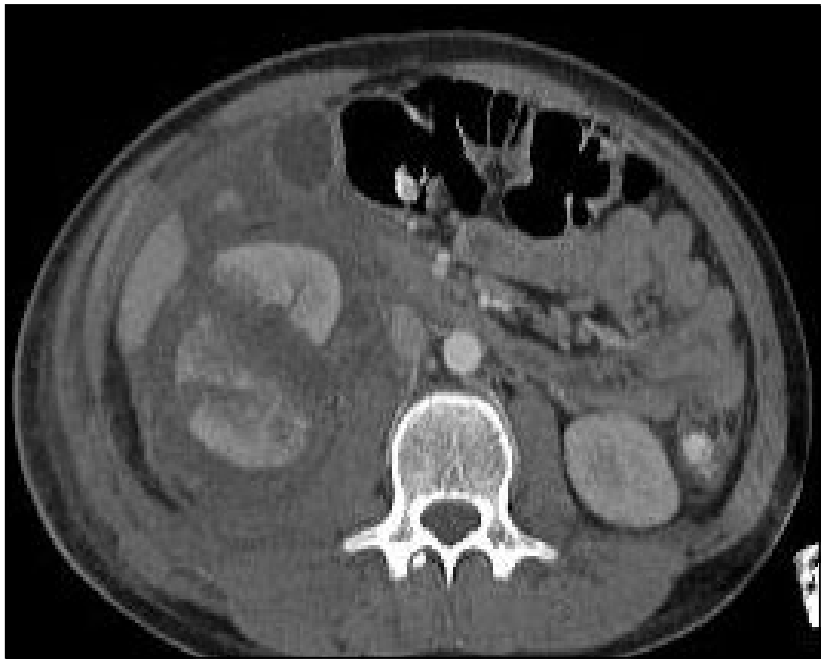
Avulsion of the renal pedicle with no renal secretion



Abdominal trauma

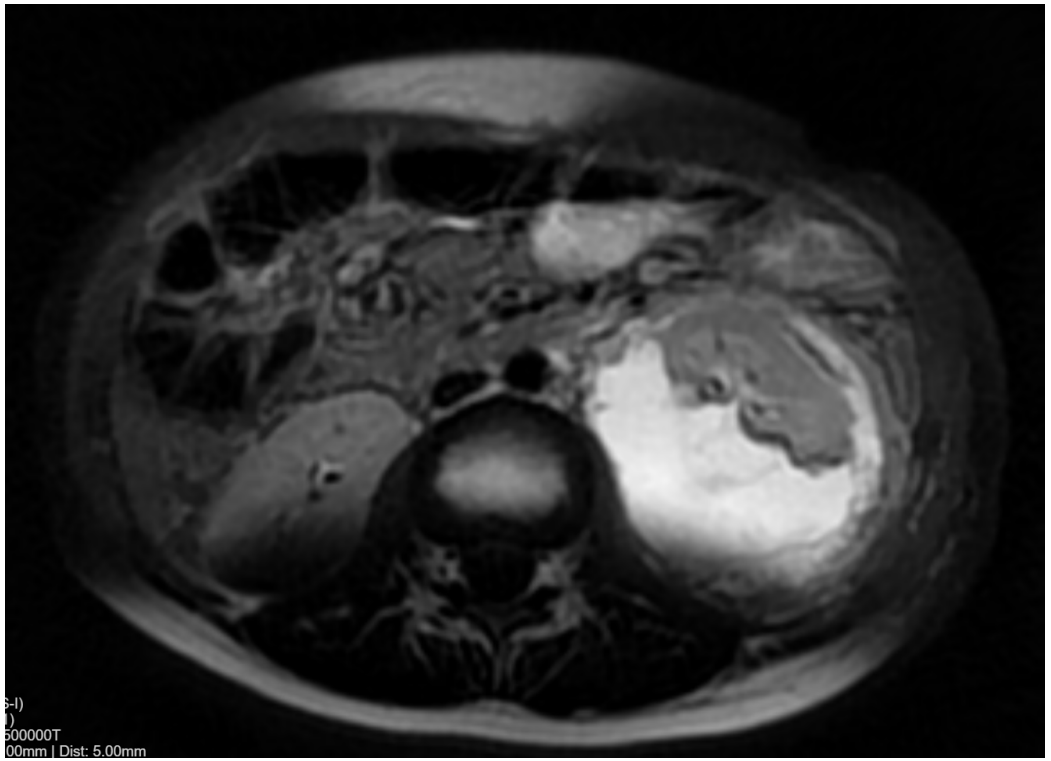
Renal laceration

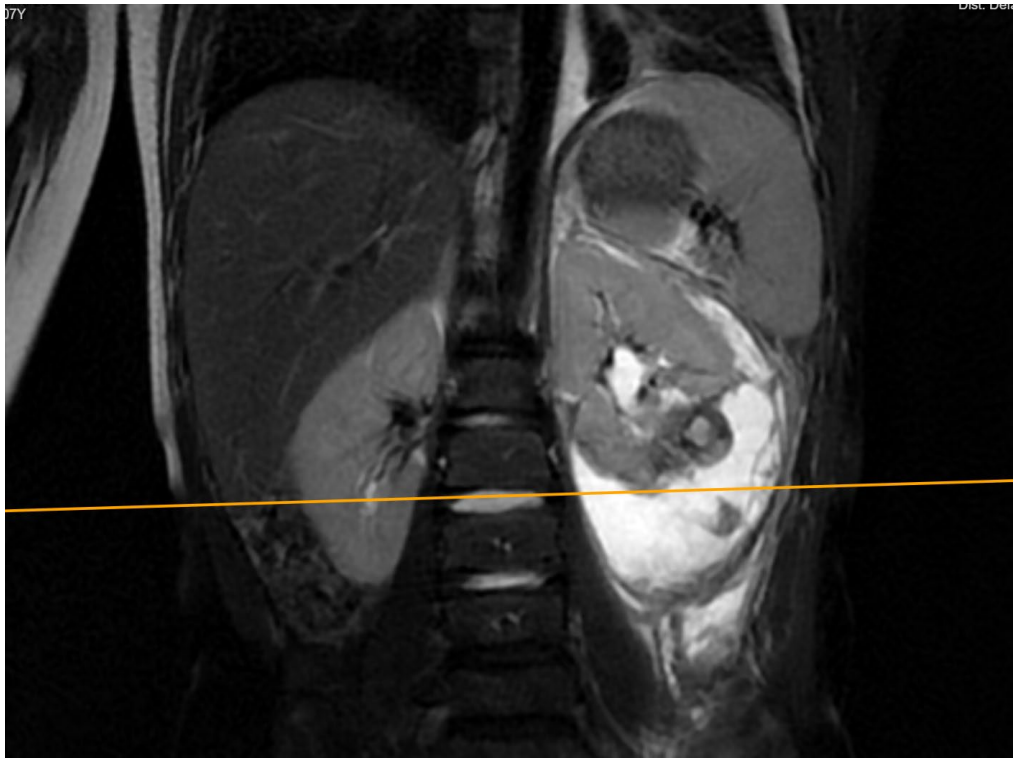




Abdominal trauma

Ruptured kidney + mixed fluid collection (urinoma/hematoma)





Osteoarticular pathology

Scoliosis is defined as the curvature in the frontal plane of the spine and can be dextroconcave (the concavity is oriented to the right), dextroconvex (the convexity is oriented to the right) or in "S" (mixed - dextroconcave and dextroconvex). Scoliosis is divided into functional scoliosis and structural scoliosis.

Functional (nonstructural) scoliosis can be caused by:

- position;
- compensatory;
- antalgic position.

Structural scoliosis can be:

- idiopathic;
- defects.

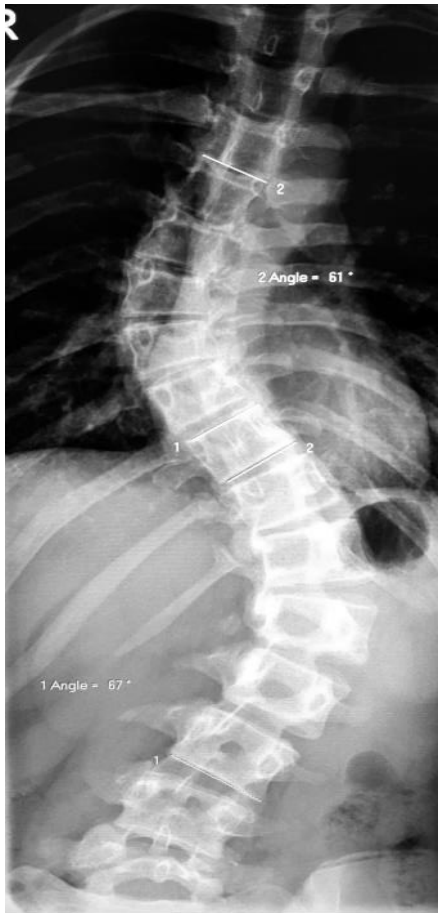
Osteoarticular pathology

Imaging diagnosis requires X-ray in antero-posterior incidence (allows assessment of the scoliotic degree) and lateral incidence (allows assessment of the associated kyphotic and lordotic changes). The orientation of the concavity or convexity for establishing the direction of scoliosis will be mentioned.

The degree of scoliosis is determined by calculating ***the Cobb angle***:

- two vertebrae are identified: upper limit vertebra and lower limit vertebra (upper limit and lower limit of scoliosis);
- two lines will be drawn - one tangent to the upper vertebral plate of the upper limit vertebra and one tangent to the lower vertebral plate of the lower limit vertebra;
- on each of the two lines a perpendicular line will be drawn, and the intersection of the two perpendiculars (towards the inside of the scoliosis concavity) determines the Cobb angle.

Osteoarticular pathology

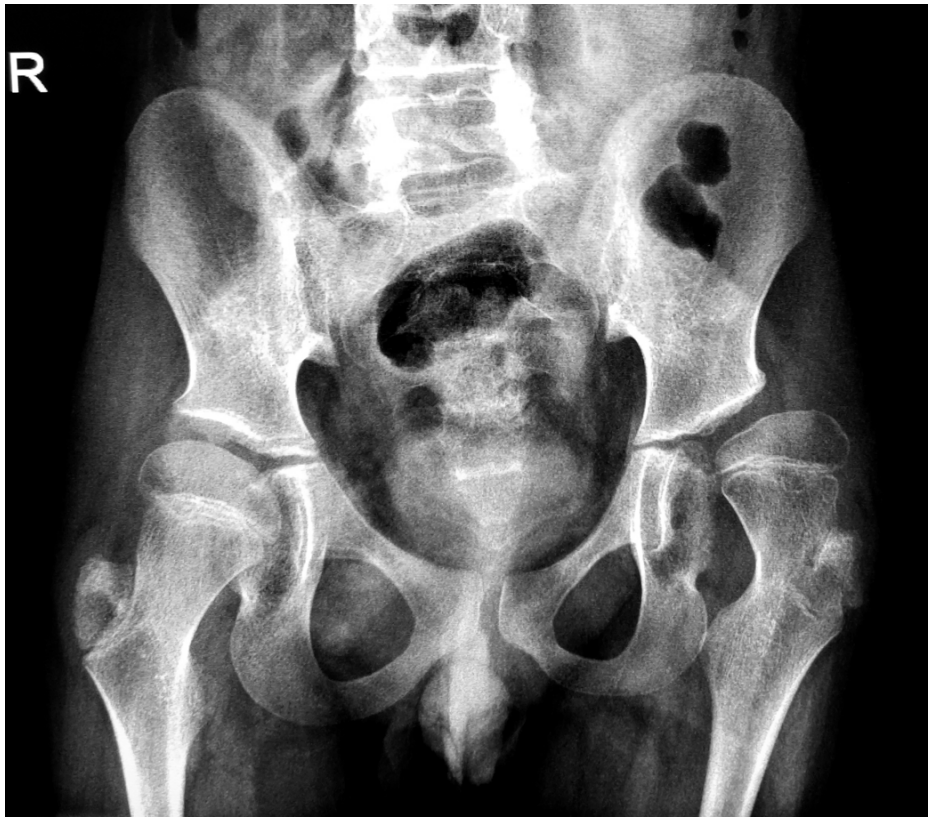


Osteoarticular pathology

Hip dysplasia is characterized by an abnormal relationship between the bone elements that form the coxo-femoral joint: the femoral head and the acetabulum. From a morphopathological point of view, the configuration of the coxofemoral joint (fixation of the femoral head in the acetabulum) is affected.

The imaging diagnosis is established through a pelvic X-ray and hip ultrasound (depending on the age of the patient - the hip ultrasound is performed in the newborn and infants, but after the maturation of the femoral head the pelvic X-ray is used).

Osteoarticular pathology



Osteoarticular pathology

An early diagnosis allows a less aggressive and much more effective therapeutic approach !!!

Hip ultrasound can be performed from the first days of life, but correlates with the clinical aspects starting at the age of 4-6 weeks, when the signs of joint instability start to appear. With the help of hip ultrasound, two angles, alpha and beta, can be calculated. In the healthy hip, the alpha angle is > 60 °. An alpha angle less than 60 ° suggests the presence of hip dysplasia. ***The smaller the alpha angle, the greater the degree of dysplasia.***

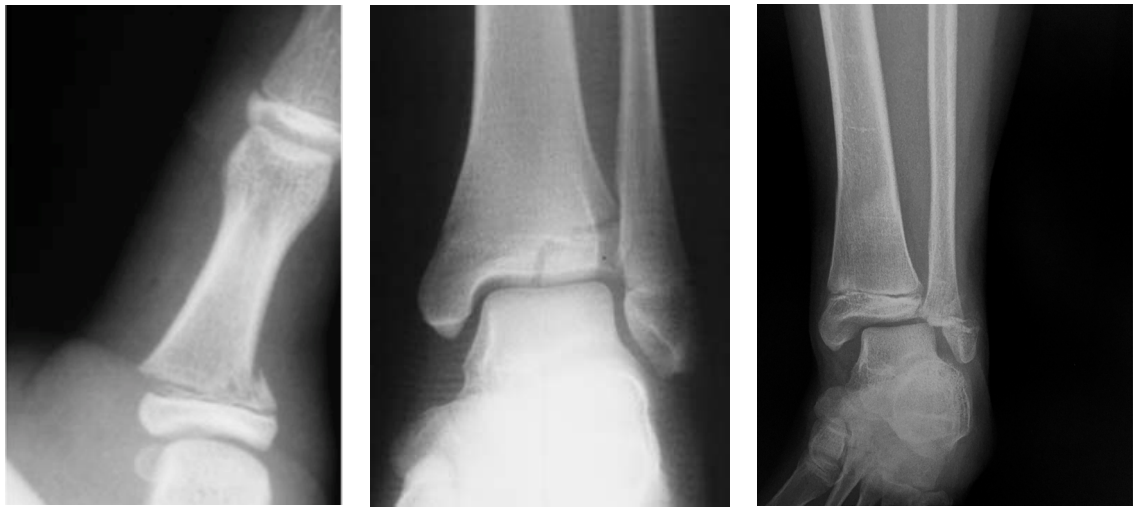
The advantages of hip ultrasound are represented by the possibility of performing this technique from the first days of life (early diagnosis, 2-3 months before radiography, the non-radiating character of the imaging technique, allows a staging of the disease, as well as monitoring the treatment).

The disadvantages of this technique are represented by the development of the ossification nucleus in the femoral head, which will create an acoustic shadow cone (with aging, it will prevent the optimal visualization of the defining elements for diagnosis).

Osteoarticular pathology

Salter-Harris fractures are the fractures in which the growth cartilage from the long bones is interested. The most commonly affected areas are radio-carpal and tibio-tarsal bones. The most common complication of this type of fracture is represented by a limited bone length growing.

In imaging, diagnosing a fracture can be performed through conventional radiography, US, CT or MRI.



Osteoarticular pathology

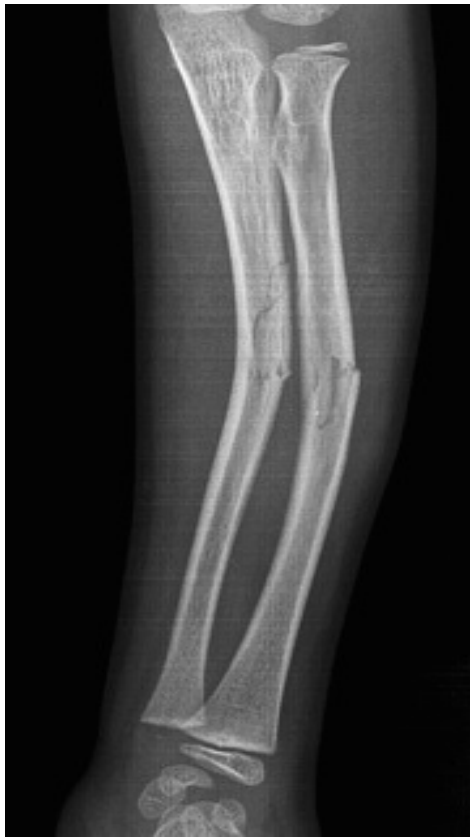
Greenstick fractures are characterized by an incomplete tear of the long bones due to elasticity (only a single bone cortex is interrupted).

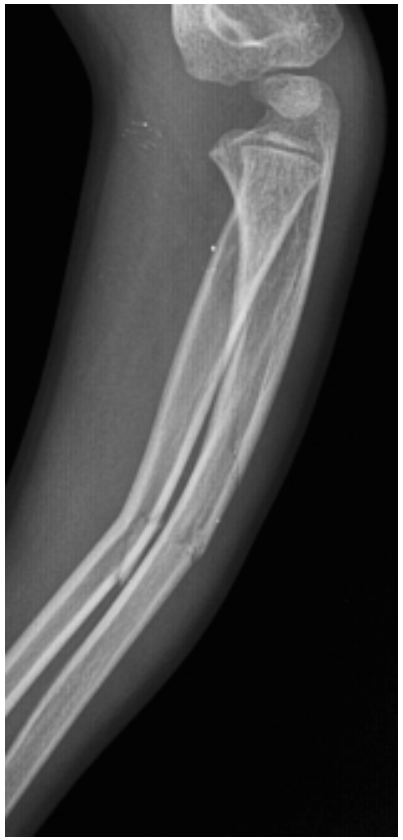
The imaging diagnosis is established using conventional radiography or US.

Conventional radiography shows the fracture that causes disruption of a single bone cortex. It is mandatory to carry out at least two x-rays in perpendicular planes and possibly to repeat the X-ray examination at 2 weeks, as the fracture can be extremely difficult to see.

Ultrasound can identify the fracture path as well as the associated lesions in the soft parts.

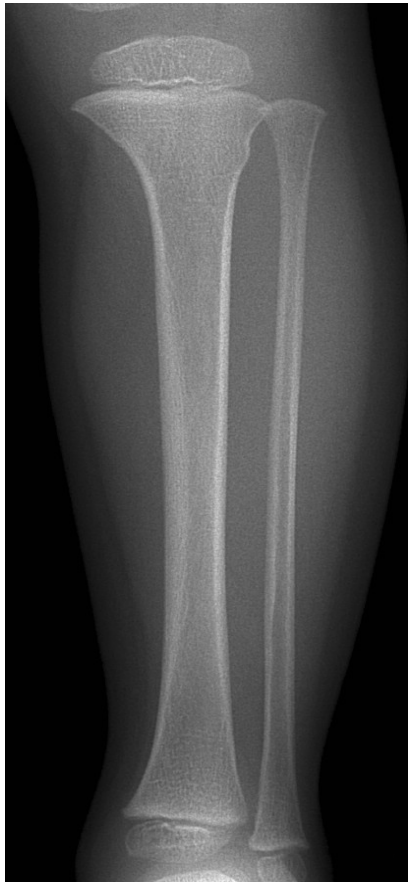
Osteoarticular pathology

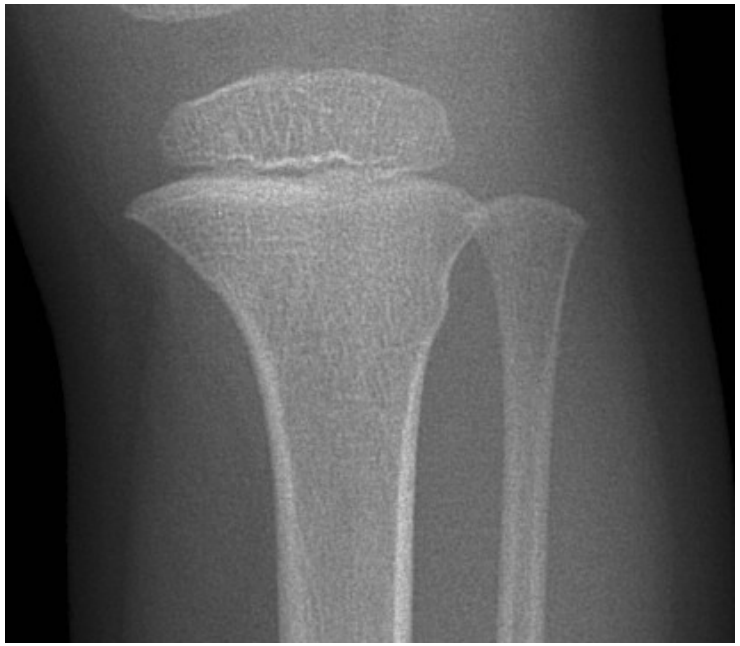




Osteoarticular pathology

Subperiosteal fractures are a particular type of fracture encountered mainly in children in which the underlying cortical bone is affected, but the overlying periosteum is intact. Also, there is no displacement of the bone fragments.





Osteoarticular pathology

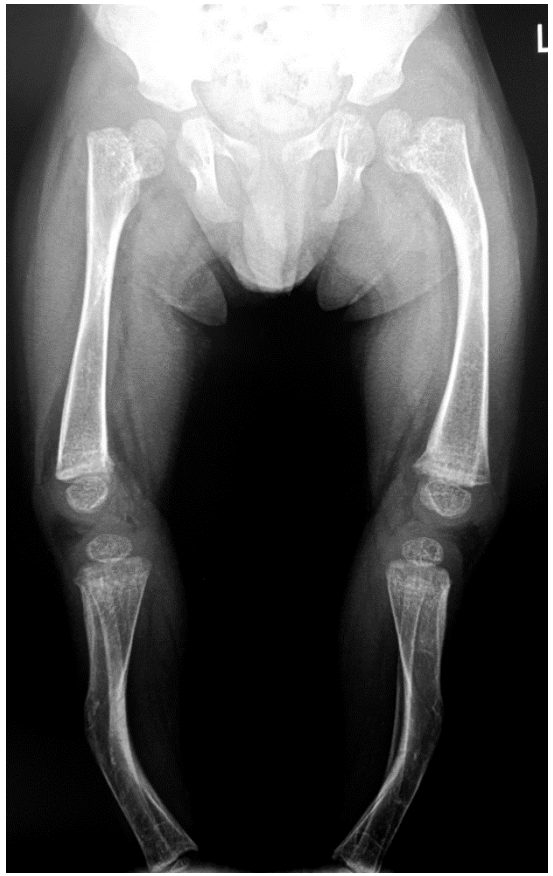
Rickets (rahitism) occurs due to vitamin D deficiency (low intake, malabsorption etc.).

Bone changes in this condition are found in all the bones that make up the skeleton: decreased intensity of bone structures (associated with an increased risk of fracture on pathological bone) and deformity of bone structures (frequently, the scoliostotic aspect is encountered in the tibia, coxa vara, coxa valga).

At the cranial level, late closure of the fontanelles and presence of frontal bumps are noted.

At the thoracic level, the enlargement of the thorax is found at the base, the sternum appears depressed or prominent, and the chondral-costal junctions develop bristles.

Osteoarticular pathology



Benign bone tumors

Characteristics of benign bone tumors:

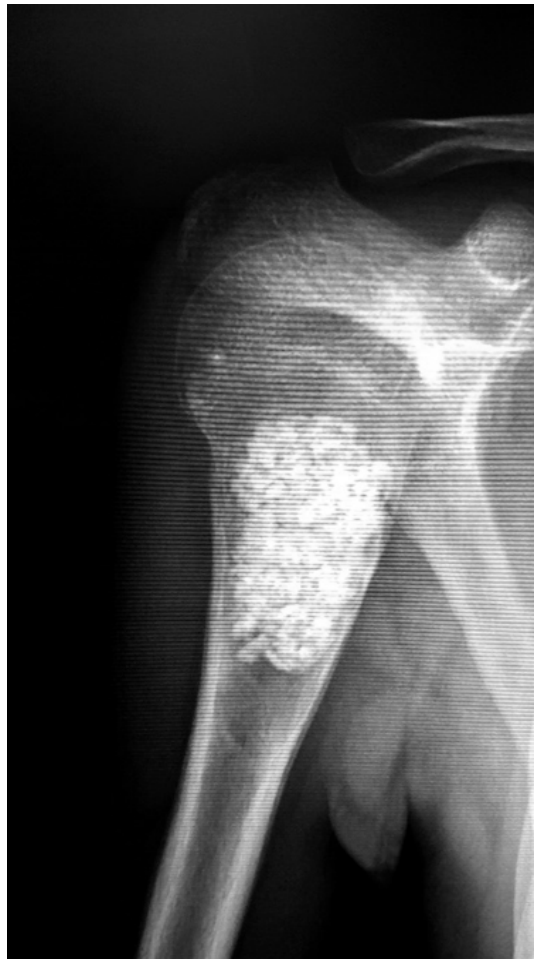
- frequently located in the metaphysis and extend to the diaphyseal level;
- well delimited by a net contour;
- do not interrupt the bone cortex;
- do not cause periosteal reaction;
- generate mass effect on adjacent soft structures, but do not infiltrate them;
- have a slow evolution over time.

Benign bone tumors

1. 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.

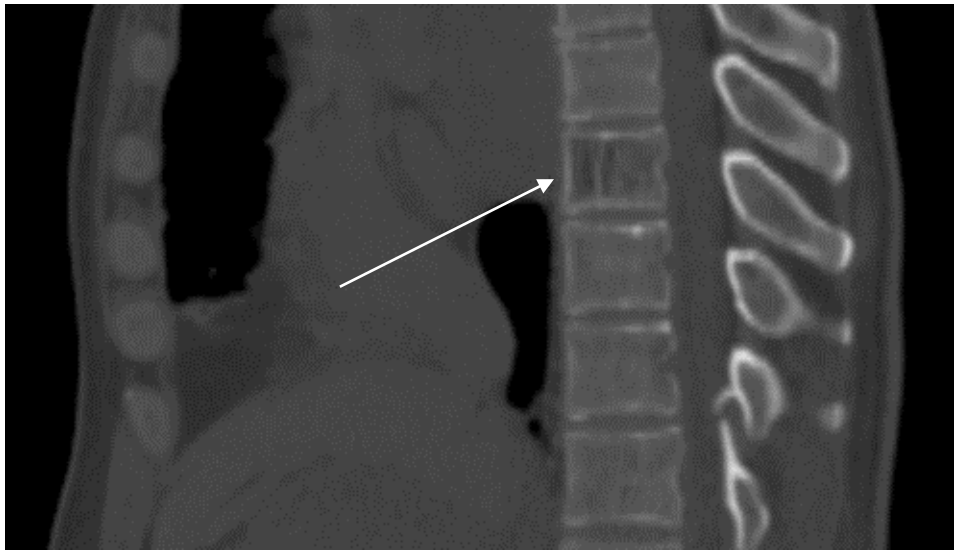
The MRI exam confirms the homogeneous, well-defined aspect of the cyst, seen in hypo T1 and hyper T2, without contrast enhancement.



Benign bone tumors

2. 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).



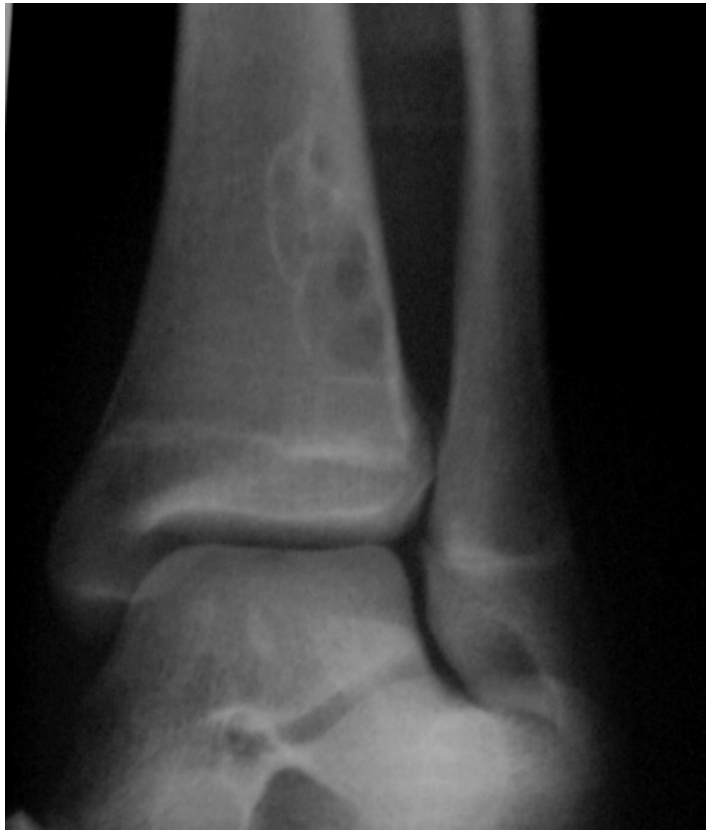
Benign bone tumors

3. 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.

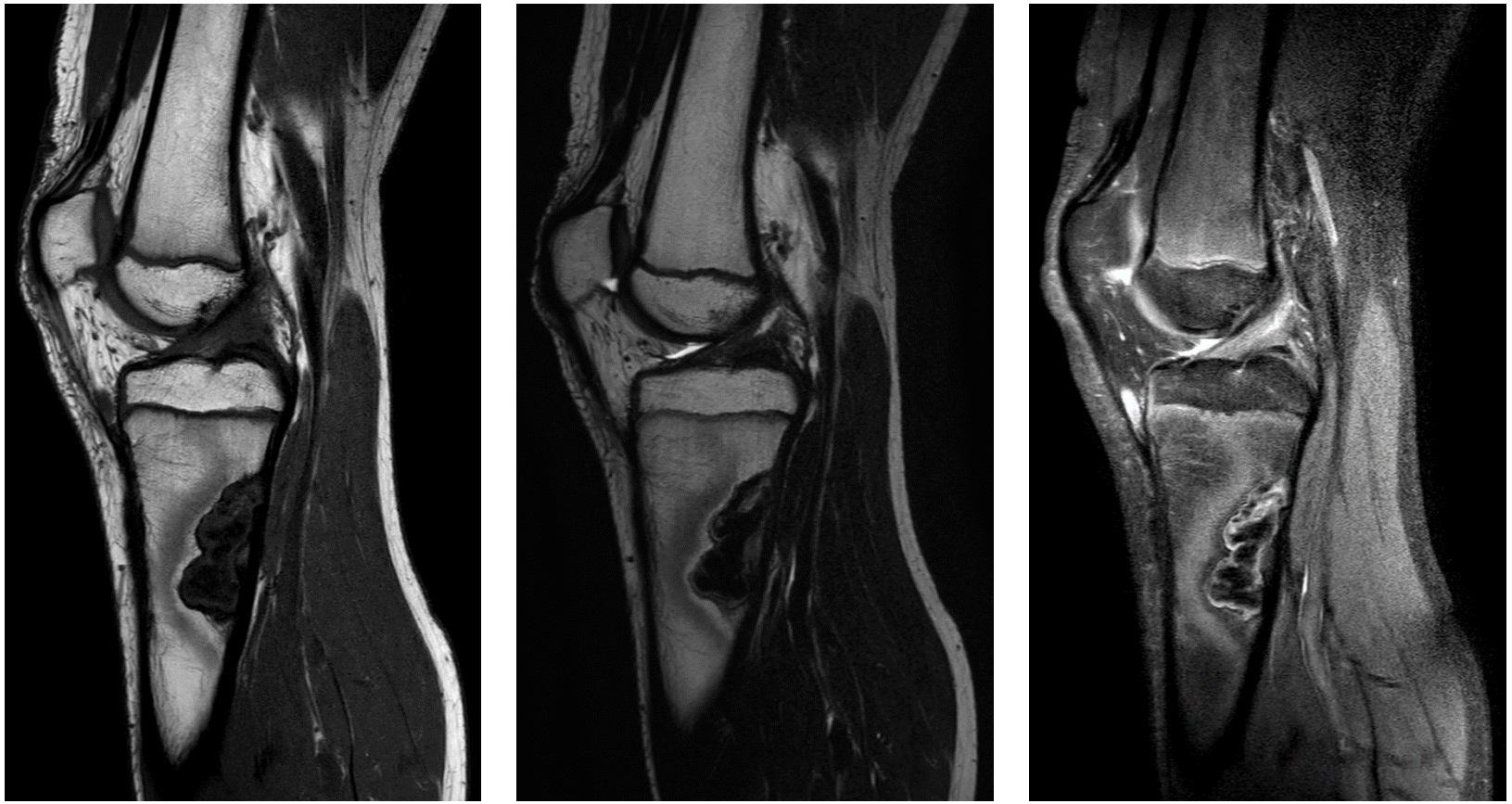
The CT examination and conventional radiology reveal a multiloculated osteolytic lesion, well delimited by an osteosclerotic rim. It usually presents an eccentric localization inside the affected bone and does not cause periosteal reaction nor does it interrupt the bone cortex.

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

3. Non-ossifying fibroma



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

Benign bone tumors

4. Osteoid osteoma

Osteoid osteoma is a benign bone-forming tumor that frequently develops in children. It is usually located in the long bones of the limbs (especially in the femoral neck and tibial shaft), but also in the phalanges and vertebral bodies.

Conventional radiography and CT can be used for diagnosis.

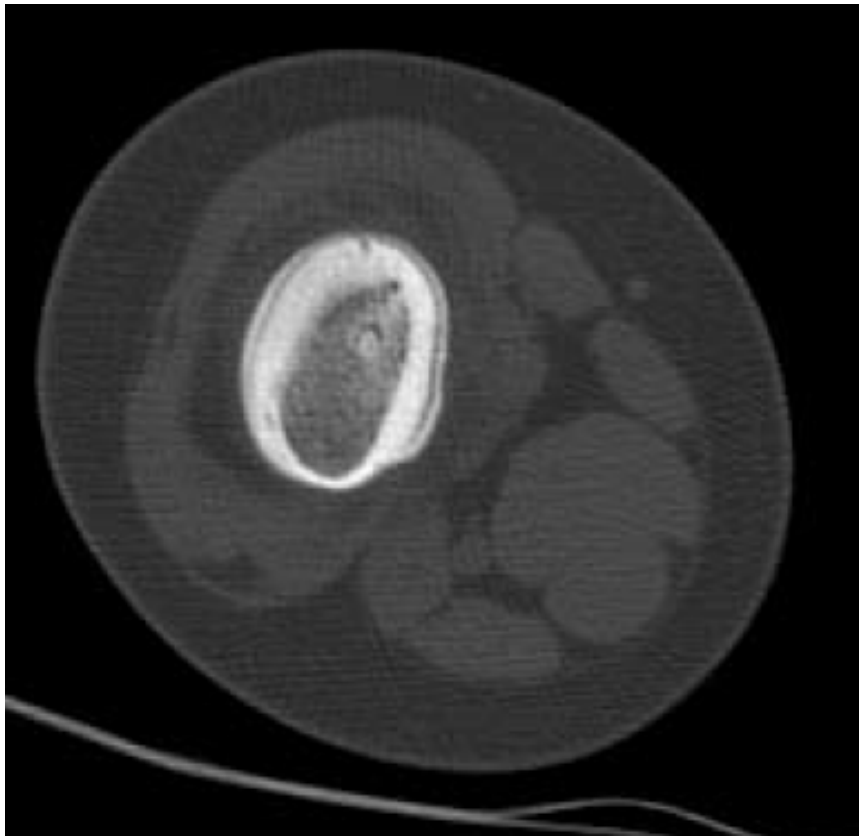
RX: is characterized by the presence of a radiolucent nidus (less than 2 cm), well delimited, round-oval in shape, accompanied by peripheral osteosclerotic reaction. Sometimes, a small osteosclerotic area can be detected inside the nidus.

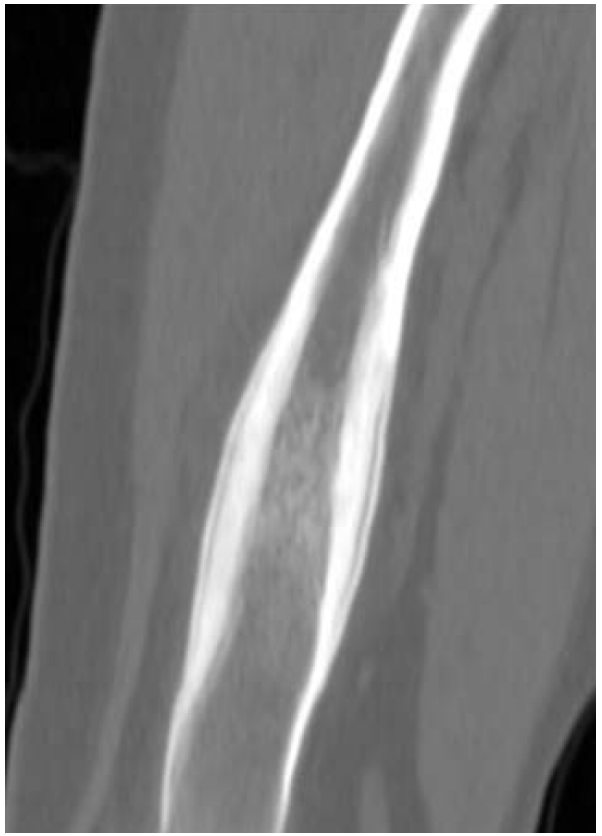
CT: changes similar to those detected by conventional radiography.

The changes highlighted by the MRI examination are nonspecific. In some cases, this examination may not reveal the nidus. Usually, the nidus has an increased variability regarding the native and postcontrast signal intensity.

Benign bone tumors

4. Osteoid osteoma





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

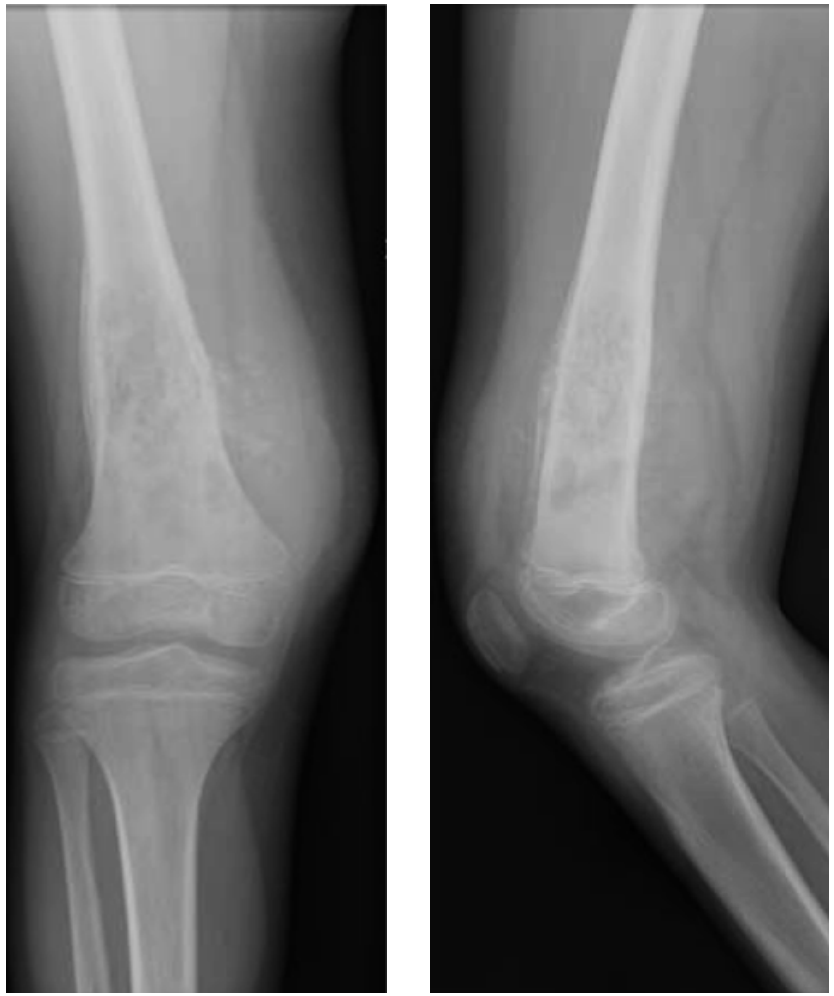
Osteosarcoma is the most common malignant bone tumor in children aged 10 to 20 years. Most commonly, osteosarcoma is located in the distal portion of the femur, proximal portion of the tibia and humerus. In order to establish the imaging diagnosis of osteosarcoma, conventional radiography, CT or MRI can be used.

Conventional radiography identifies osteosarcoma as a diffusely delimited, radio-opaque bone mass, which results in disruption of the bone cortex and infiltrates the perilesional soft parts. Also, the periosteal reaction is present.

The CT examination allows a more precise localization of the tumor and can identify secondary lesions, but ***the MRI examination*** more accurately characterizes the invasion of the malignant tumor in the adjacent soft parts.

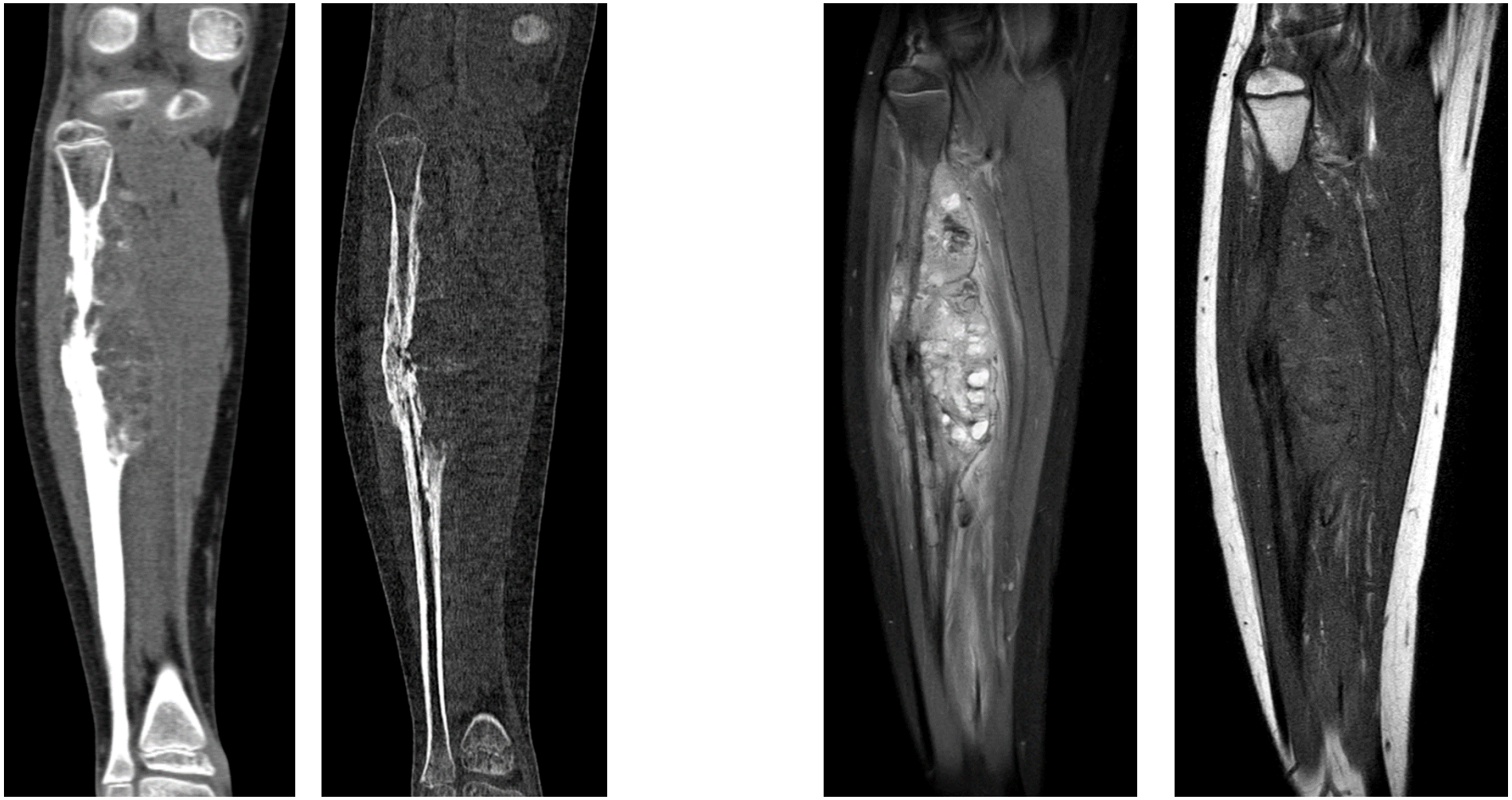
Malignant bone tumors

Osteosarcoma



Malignant bone tumors

Osteosarcoma



Malignant bone tumors

Ewing's sarcoma is the second most common malignant bone tumor in children aged 10 to 20 years. Most commonly, Ewing's sarcoma develops in the ribs, pelvis, femur and tibia. In order to establish the imaging diagnosis of Ewing sarcoma, conventional radiography, CT or MRI can be used.

Conventional radiography identifies Ewing's sarcoma as a diffusely delimited osteolytic area, which results in disruption of the bone cortex and infiltrates the adjacent soft parts. Also, the periosteal reaction is present.

The CT examination allows a more precise localization of the tumor and can identify secondary lesions, but ***the MRI examination*** more accurately characterizes the invasion of the malignant tumor in the adjacent soft parts.

Malignant bone tumors

Ewing's sarcoma