USMF
„NICOLAE TESTEMIŢANU"

Radio-imaging methods and imaging evaluation in medical rehabilitation

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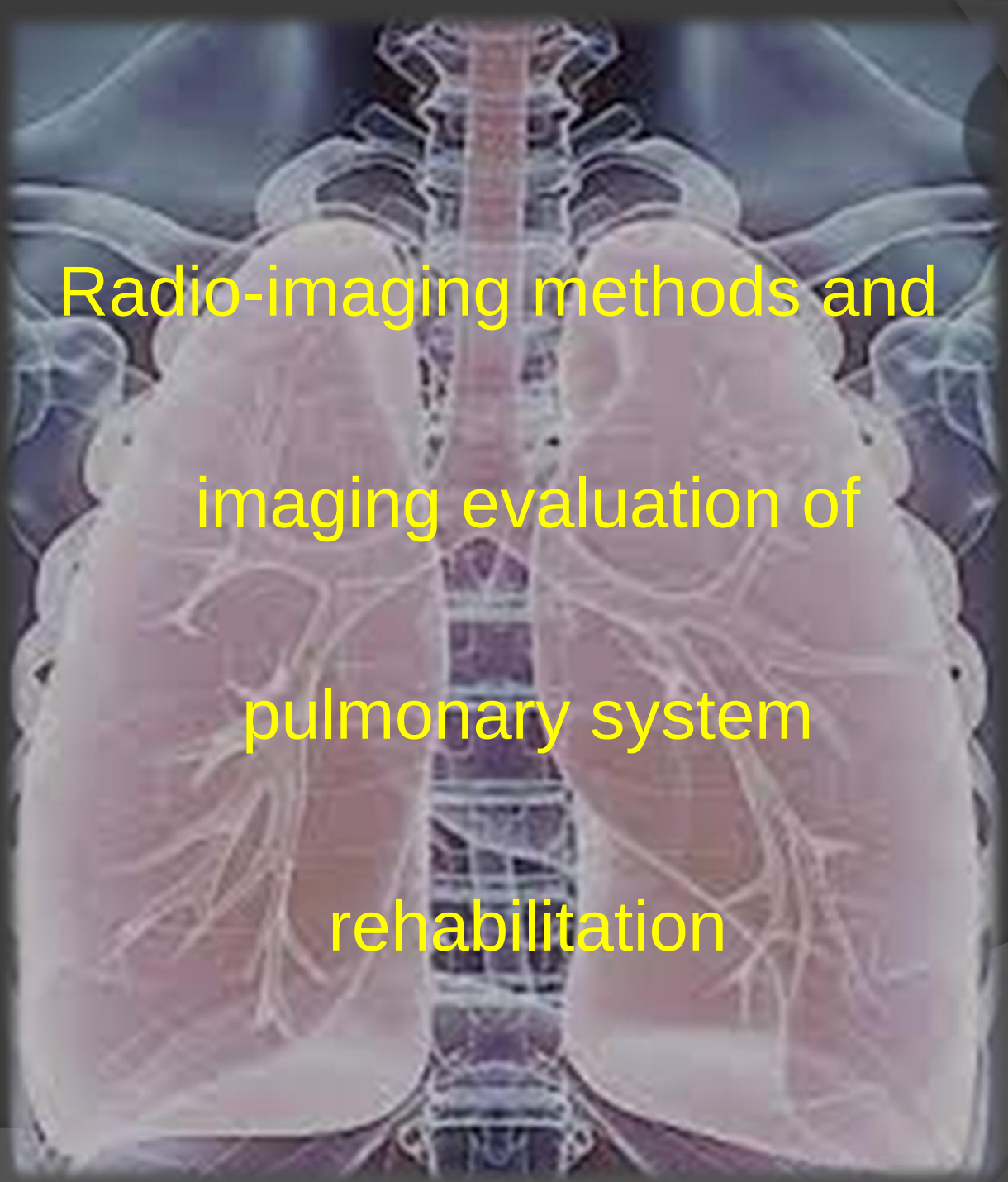


Radio-imaging methods and

imaging evaluation of

pulmonary system

rehabilitation

Pulmonary rehabilitation

is an integral part of the clinical management and maintenance of the health of those patients with chronic respiratory disease who remain symptomatic or continue to have respiratory problems despite medical treatment.

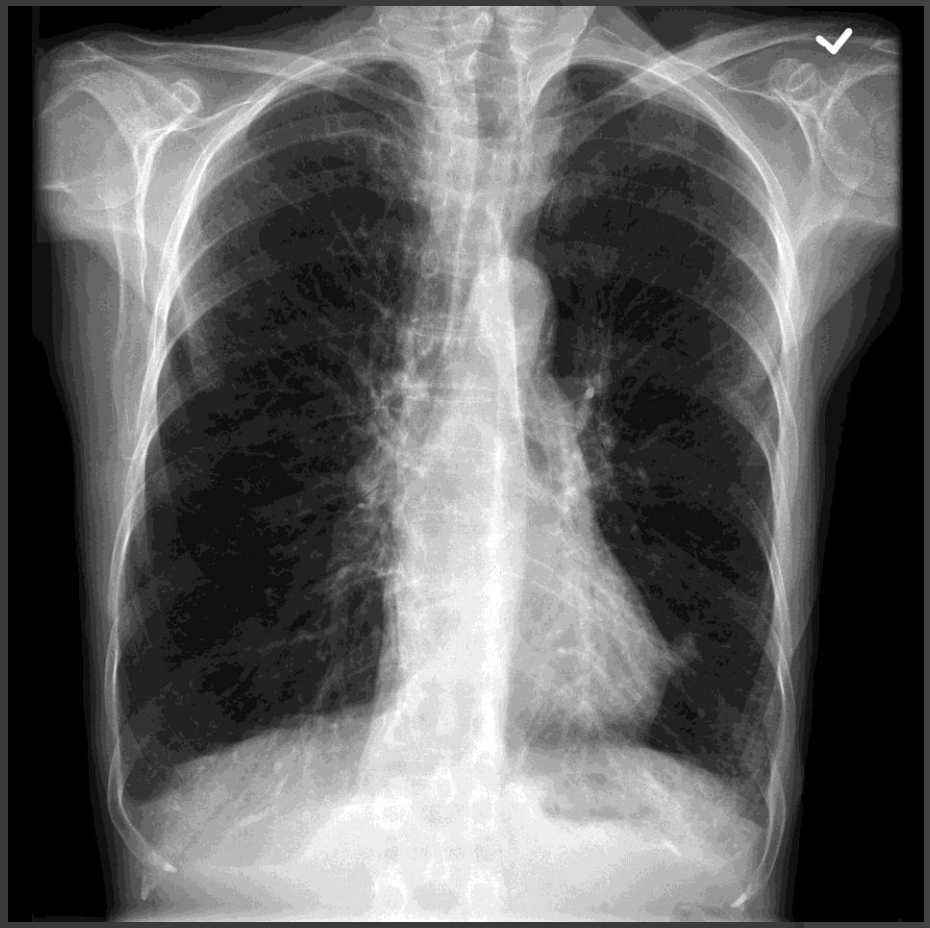
Chronic lung disease has a negative effect on many patient-centered outcomes. Of these, dyspnea, and quality of life are the most relevant.

The analysis of these factors gives research efforts to identify effective interventions for this patients. As defined by the American Thoracic Society and the European Respiratory Society, pulmonary rehabilitation is an evidence-based, multidisciplinary and comprehensive intervention for patients with chronic respiratory disease who are symptomatic and often have a low ability to participate in activities of daily living.

Integrated into the individualized treatment of these patients, pulmonary rehabilitation is designed to reduce symptoms, optimize functional status, increase participation, and reduce health care costs by stabilizing or reversing systemic manifestations of the disease.

Chronic lung disease

- Chronic bronchitis
- Pulmonary emphysema
- Bronchiectasis with pneumosclerosis
- Diffuse interstitial pneumonia (PID) - sarcoidosis; bronchiolitis; idiopathic pulmonary fibrosis



Simple chest radiograph (PA incidence)

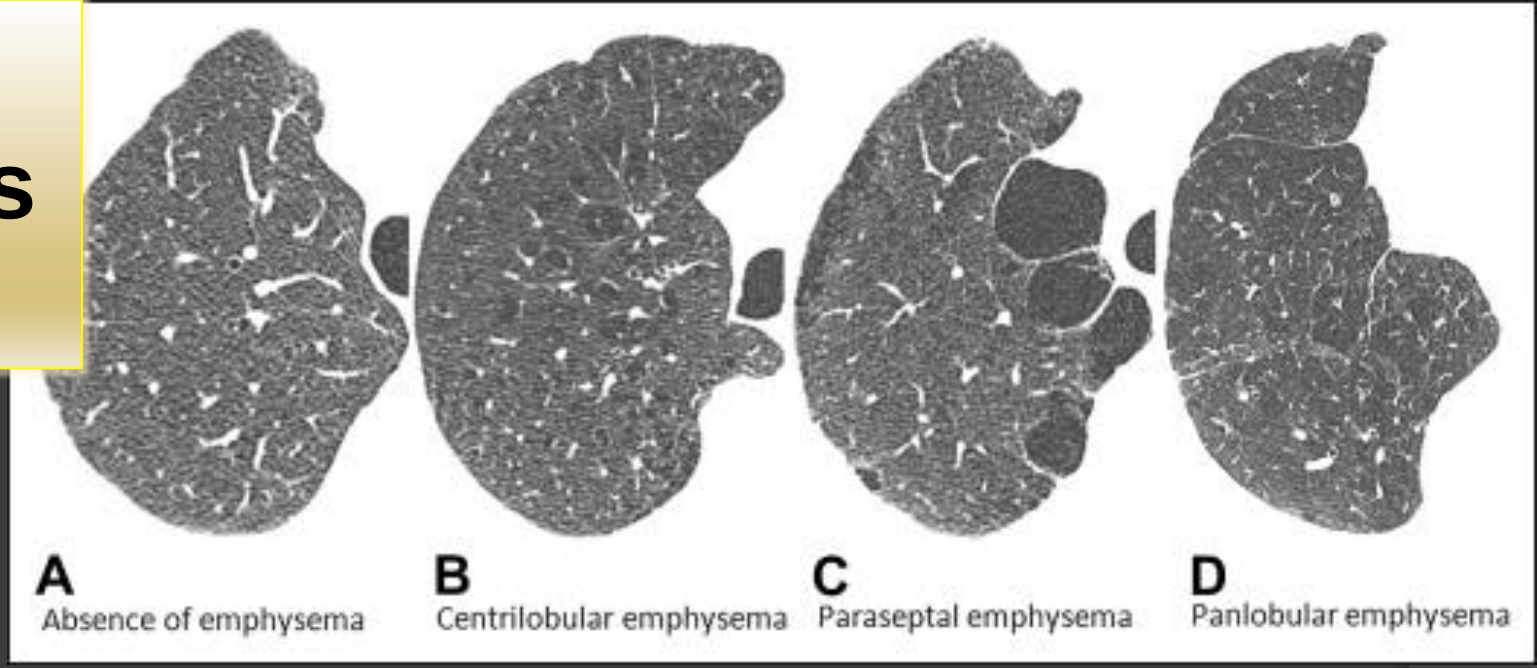
The findings of chronic bronchitis on chest radiograph are nonspecific and include deformed bronchovascular lung pattern and sometimes cardiomegaly.

Emphysema manifests as pulmonary hyperinflation with flattened hemidiaphragms, a small heart, and possible lung bullaes. An X-ray can show a "barrel chest" with an enlarged anterior-posterior diameter.

CT
Chronic bronchitis

In chronic bronchitis, can be observed the thickening of the bronchial wall, sometimes already calcified. Repeated inflammation can lead to scarring with bronchovascular irregularities and fibrosis.

CT Emphysema



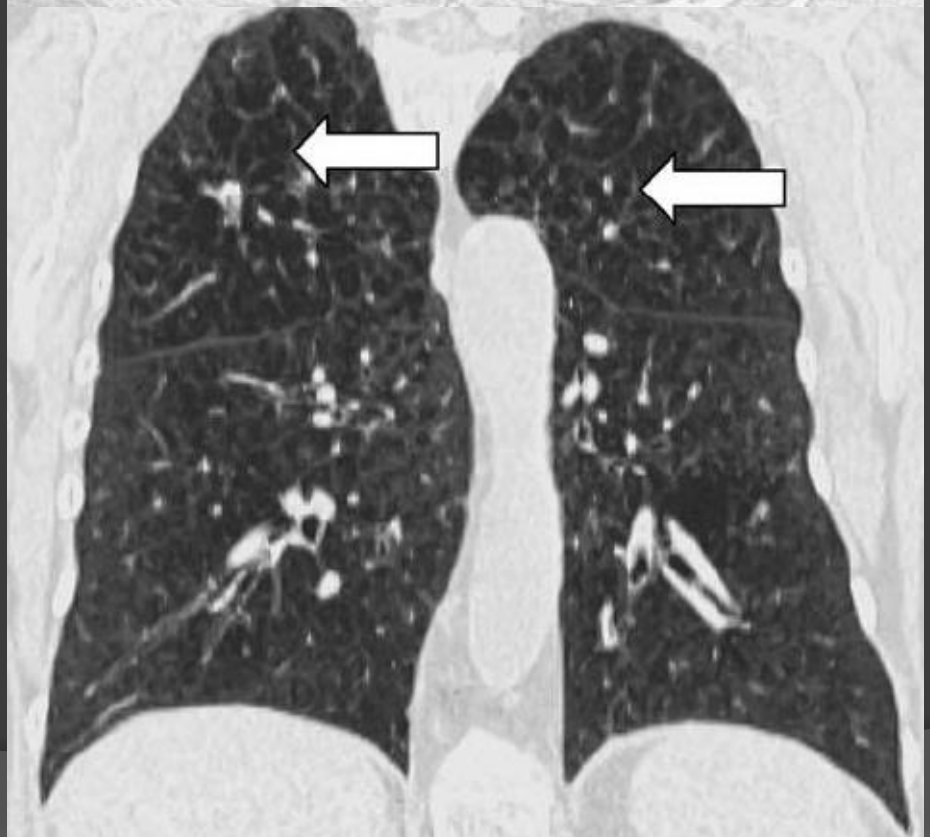
is diagnosed by destroying the alveolar septum and enlarging the airspace, which can occur in a variety of distributions.

Centilobular emphysema: Focal regions with low attenuation, surrounded by normal lung attenuation. As the severity increases, the vessels appear "cut" and the regions with low attenuation increase. It is observed predominantly in the upper lobes

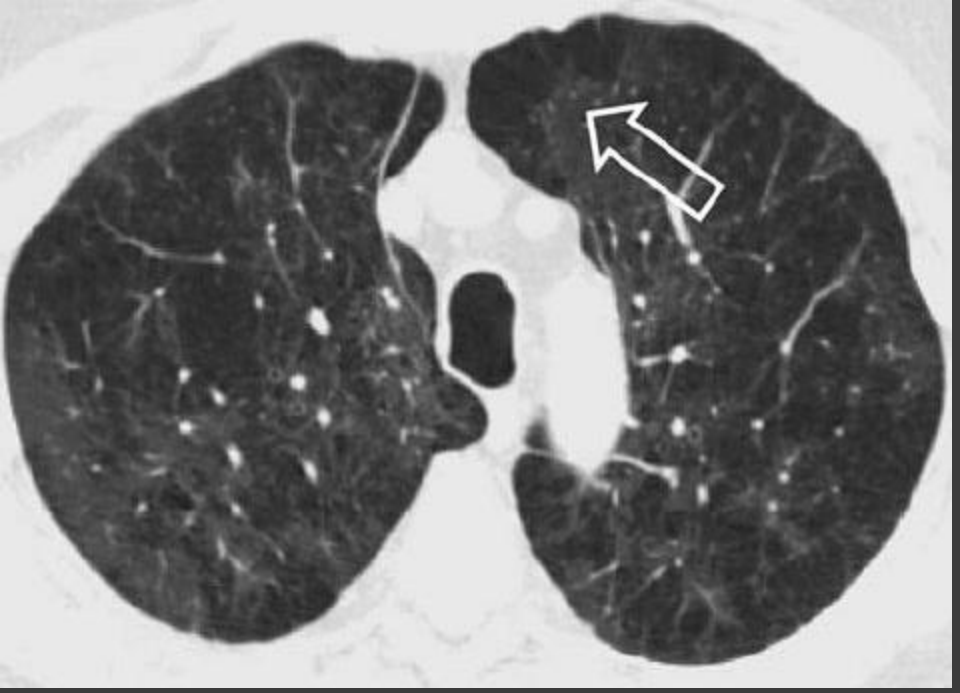
Panlobular emphysema: diffuse regions with low attenuation involving entire secondary pulmonary lobes. As the severity increases, the deficit of peripheral vessels increases.

Paraseptal emphysema: Low attenuation regions adjacent to the visceral pleura (including fissures). It tends to appear near the fissures of the lungs and the pleura. The formation of giant **bullaes** can lead to compression of the mediastinal structures, while their rupture can cause spontaneous pneumothorax / pneumomediastinum**.**

Mild centrilobular emphysema.
CT section through the upper lobes shows areas of lung attenuation limited to the secondary lung lobes (arrows). The structure of these lobes is intact, including the central structures. Such subtle emphysema will often go undetected on conventional chest x-rays.

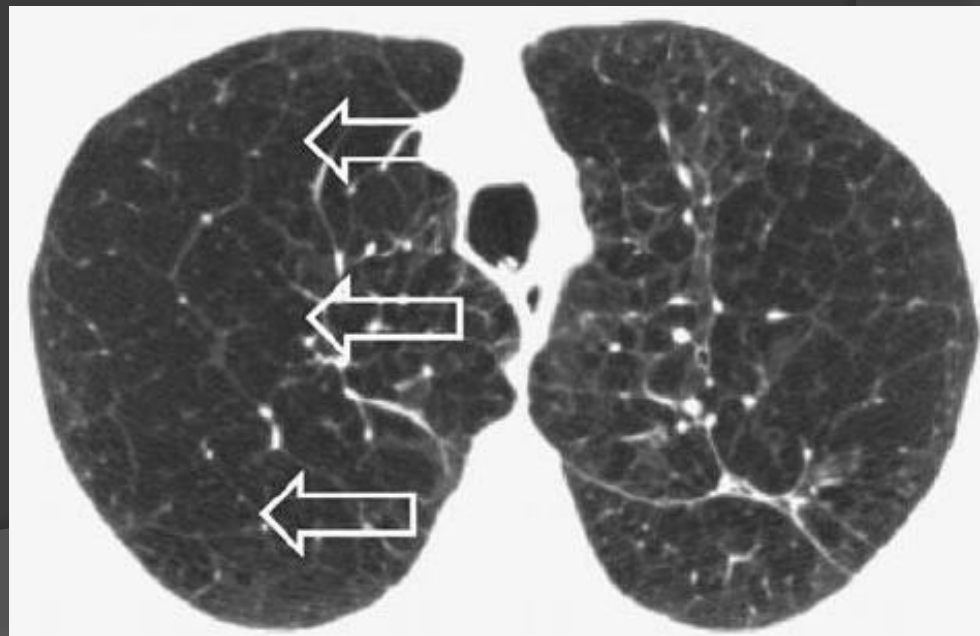


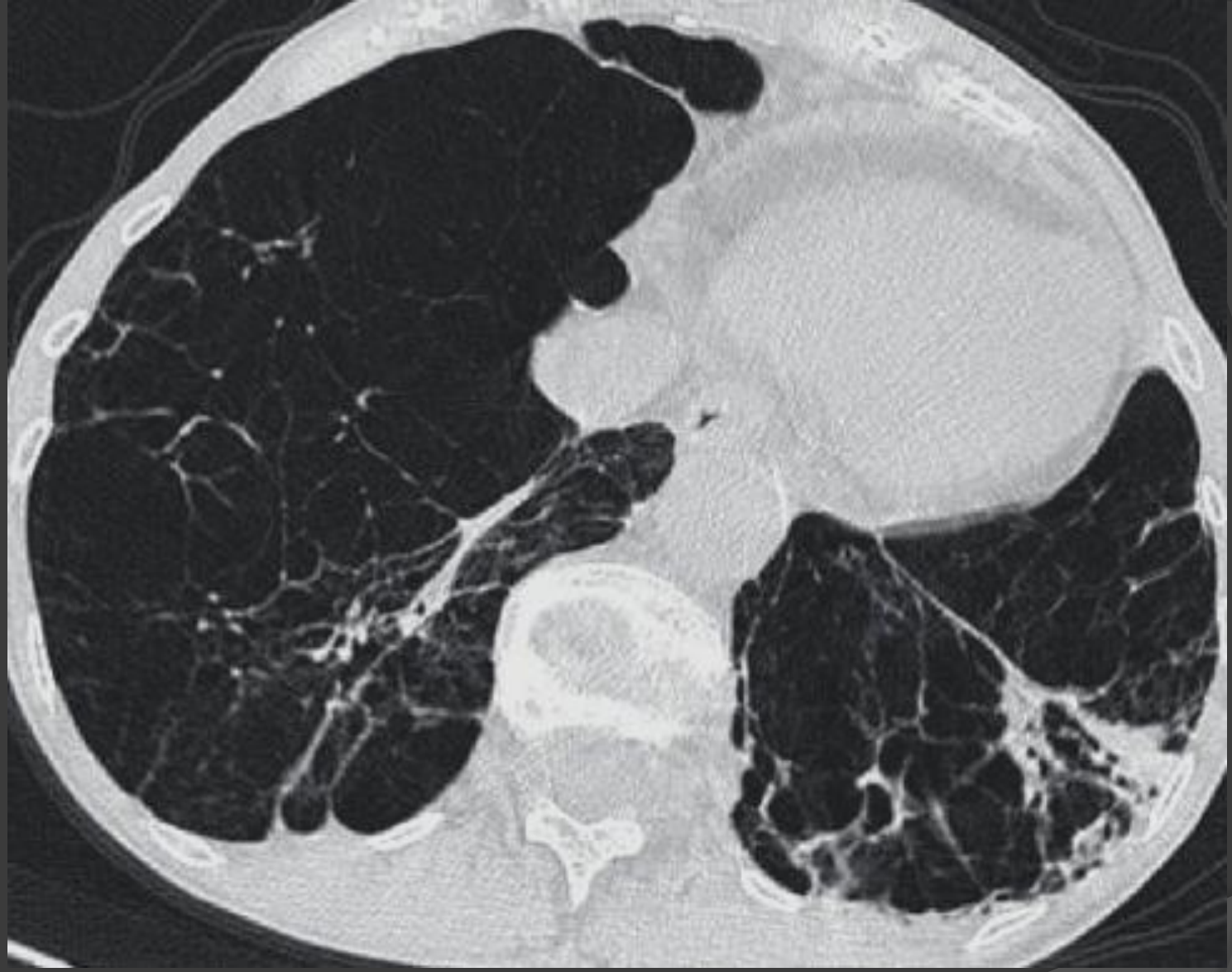
Centilobular emphysema.
Coronary reconstruction of the dorsal lungs shows the apical predominance of the disease and the typical well-defined focal areas of attenuation (arrows), with the morphology of the secondary lung lobe remaining visible.



Paraseptal emphysema.
The CT section through the upper lobes shows areas of lung attenuation that predominate in the subpleural regions of the lungs.

Diffuse panlobular emphysema.
The CT section through the upper lobes shows diffuse areas of lung attenuation, the structure of the secondary lung lobe is no longer visible

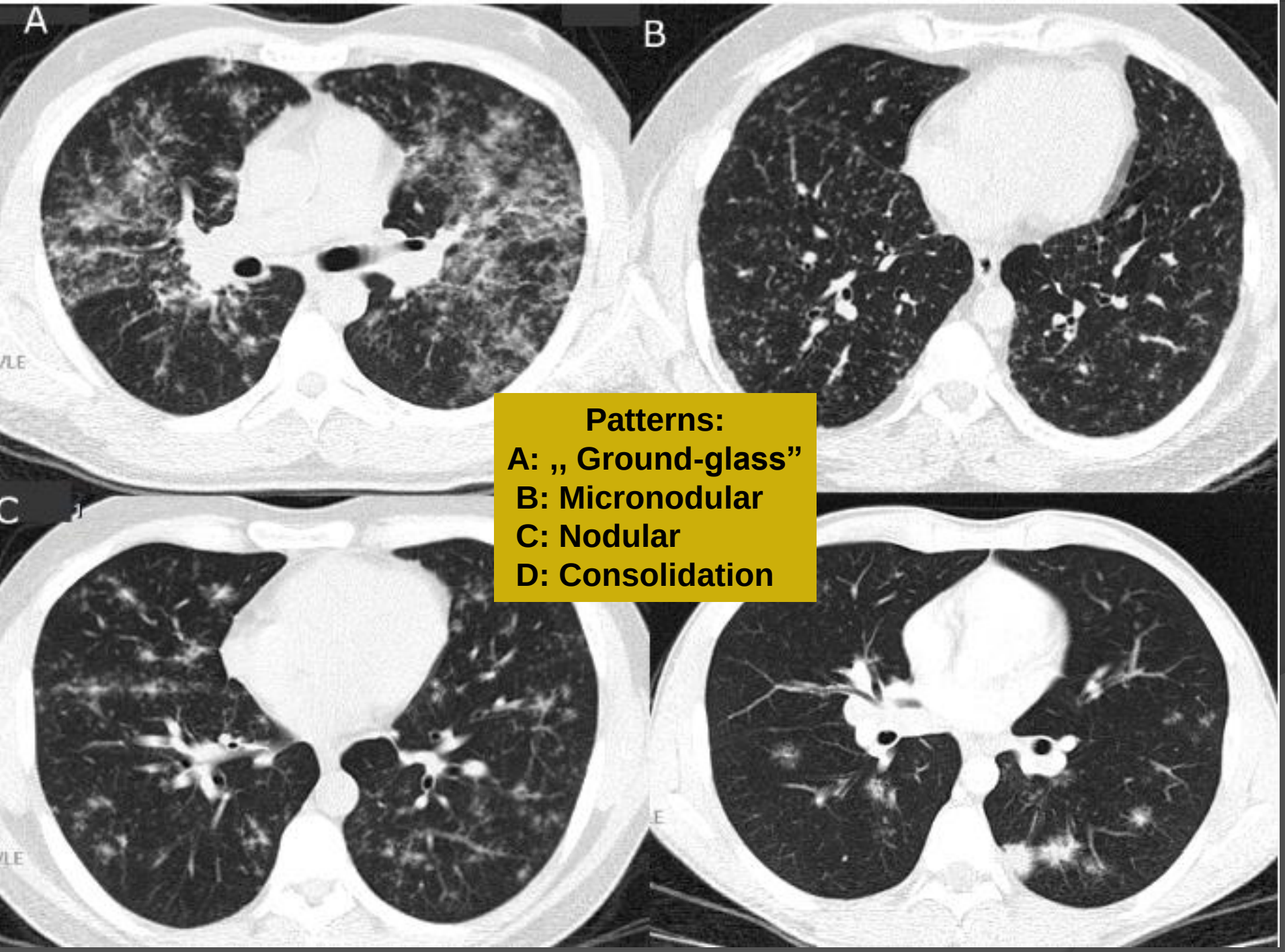




Diffuse panlobular emphysema. CT section through the lower lobes. There is a general attenuation of the lung parenchyma with the deformation of the lung pattern. Bronchiectasis is more prominent in the lower left lobe and coexists with areas of irregular consolidation (inflammatory process)

Sarcoidosis

- systemic pathology of unclear genesis, affecting young and middle-aged adults, usually presents with bilateral hilar lymphadenopathy, pulmonary infiltrates.
- The organs that may be involved are: liver, spleen, peripheral lymph nodes, salivary glands, heart, nervous system, musculoskeletal system
- Sarcoidosis is the great imitator. Fibrosis in sarcoidosis usually has a predominance of peribronchovascular changes in the middle to upper lung area, with architectural distortions and traction bronchiectasis, reticular changes "honeycombing sign". Initially with hilar and bilateral mediastinal lymphadenopathy, in the late fibrotic stage of the disease, the lymph nodes are usually normal in size and calcified.


A
B
C
Patterns:
A: „ Ground-glass”
B: Micronodular
C: Nodular
D: Consolidation

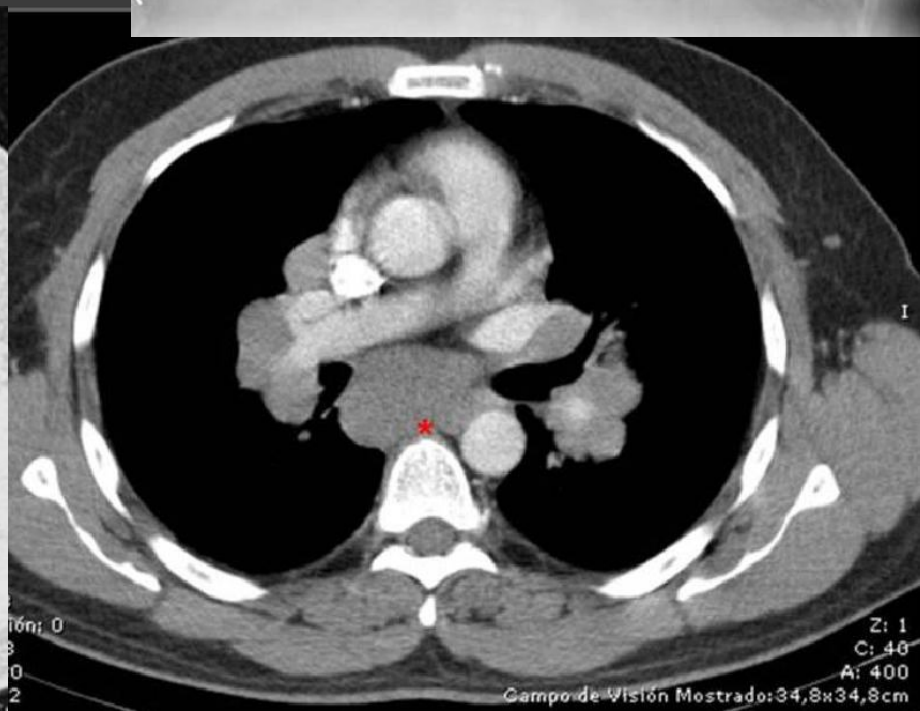
Sarcoidosis: **Stage I**

Chest X-ray (AP)

Bilateral dilation of the hilum with a clear polycyclic contour - lymphadenopathy is determined

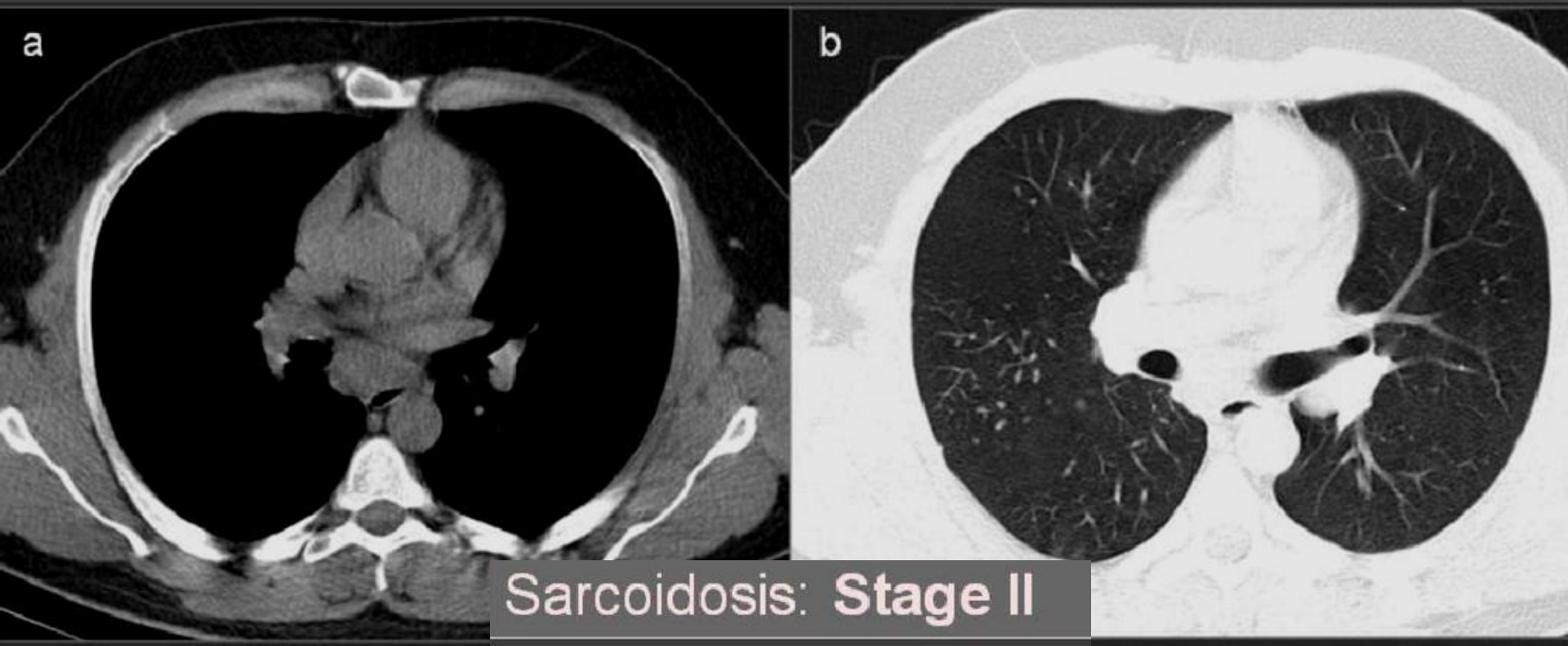
Contrast chest and mediastinal CT

Bilateral and mediastinal supracentimetric hilar lymphadenopathy is determined without affecting the lung tissue.



CT chest and mediastinum without contrast

Hilar and supracentimetric mediastinal lymphadenopathy is determined with lung tissue damage by perilmphatic regional micronodular pattern



Sarcoidosis: Stage III

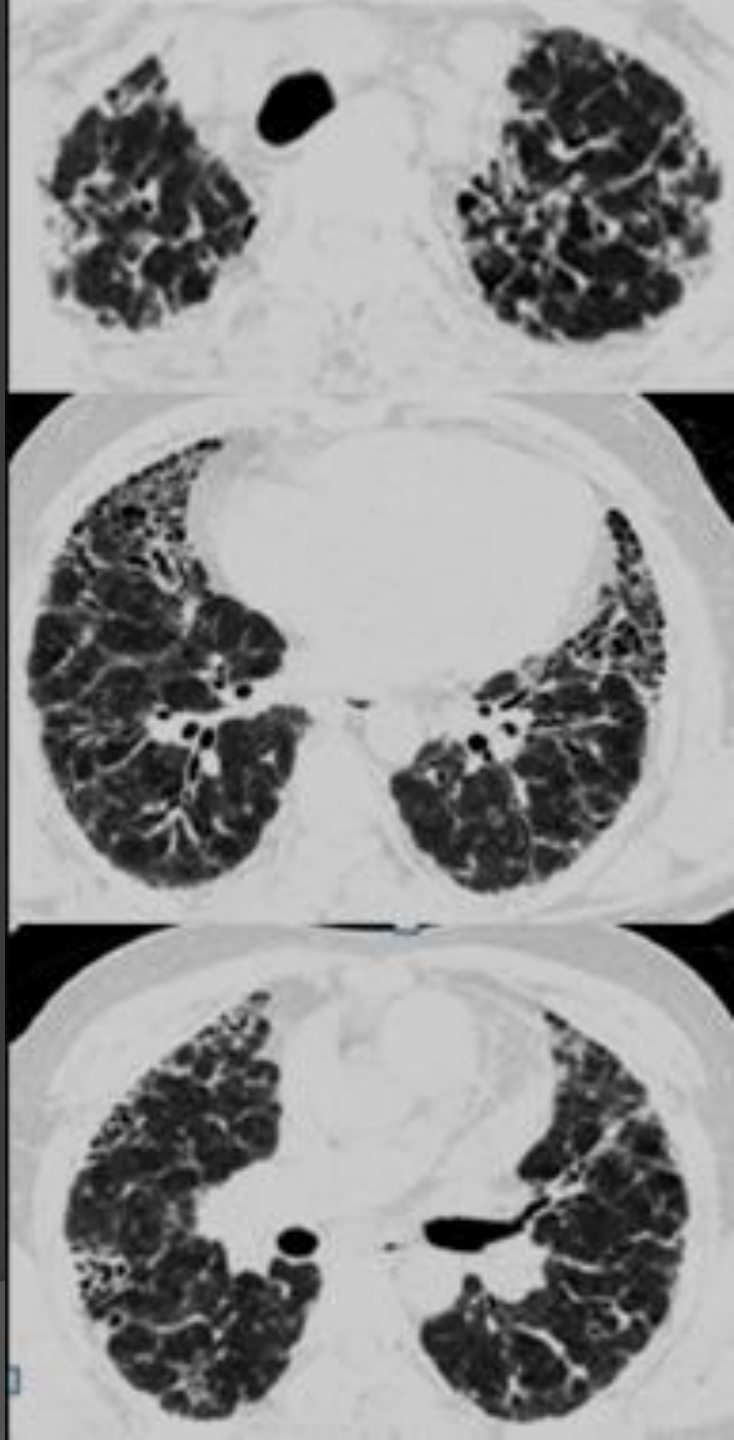
Chest X-ray (PA) and chest CT and mediastinum without contrast

Hilar lymphadenopathy is determined with interstitial lung changes by diffuse nodular pattern and consolidation sectors

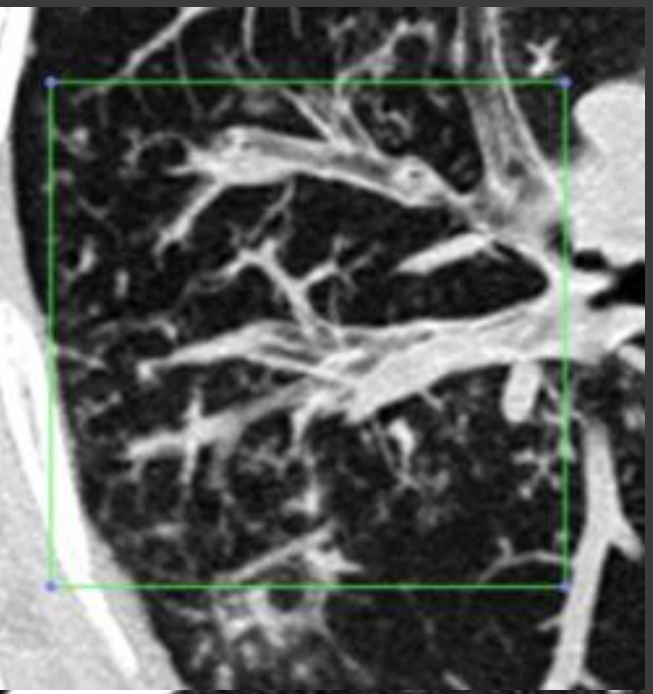
Sarcoidosis: Stage IV

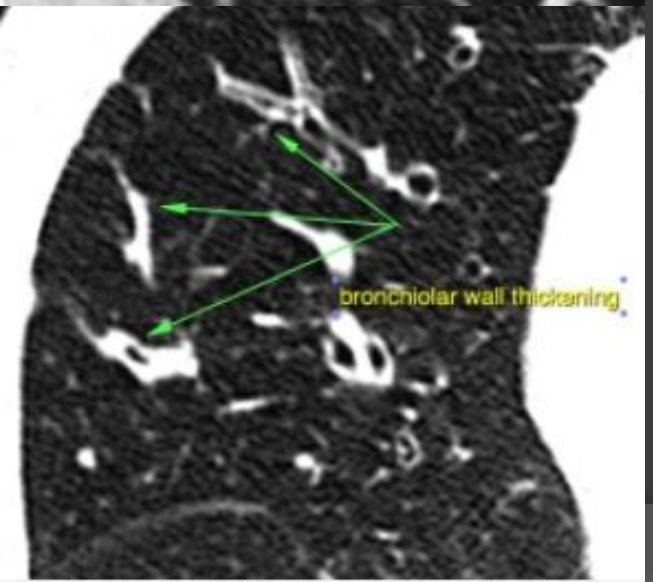
Chest X-ray (PA) and chest CT and mediastinum without contrast

Diffuse pulmonary fibrosis is determined, which on CT shows reticular interstitial lung changes, "honeycomb" pattern distributed more subpleurally in the middle and upper areas.



is an acute infectious disease, predominantly viral, of the respiratory tract, which is the consequence of an inflammatory obstruction in the small airways.





Bronchiolitis

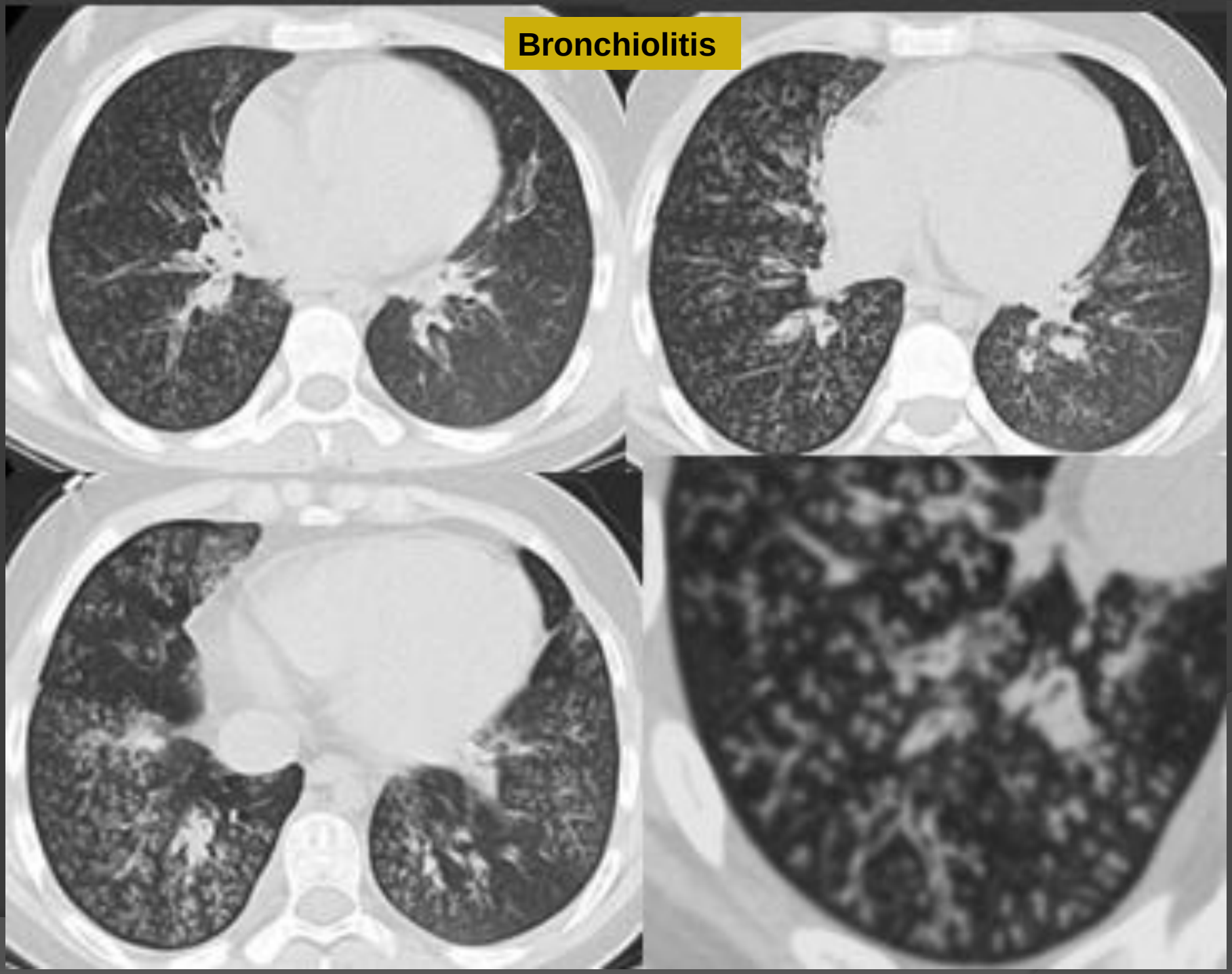
Simple radiography

It is usually not detected on chest x-ray, but may be manifested by nonspecific findings, such as indefinite small or blurred nodules or hyperlucency areas.

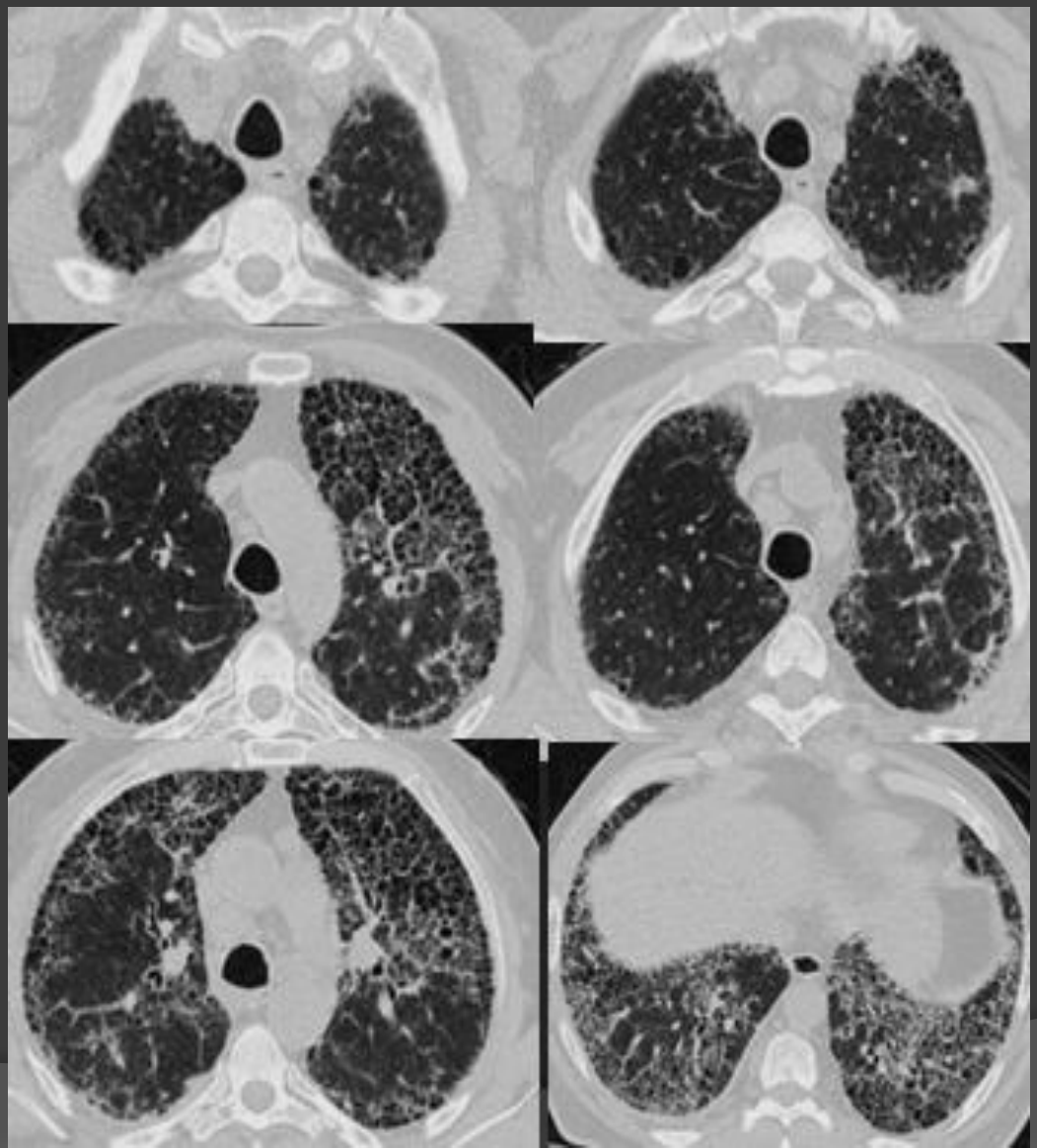
The presence of bronchiolitis is best assessed by CT.

CT features include a combination of centrilobular micronodules („tree in bud" pattern), thickening of the bronchial wall, bronchial dilation (called bronchiectasis).

Bronchiolitis



is defined as a specific form of chronic fibrosis interstitial pneumonitis of unknown cause, affecting mainly the elderly, with exclusively **interstitial lung changes**, with slow evolution to pulmonary parenchyma fibrosis and irreversible distortion of lung architecture, associated with lung biopsy with histological manifestation common for interstitial pneumonia



The classic model of interstitial pneumonia: Reticular changes with a "honeycomb" pattern are present in the lower areas of the lungs. Architecturally small sections of normal lung parenchyma remain with increasing pneumatization, due to the physiological redistribution of preferential blood to areas of normal parenchyma.

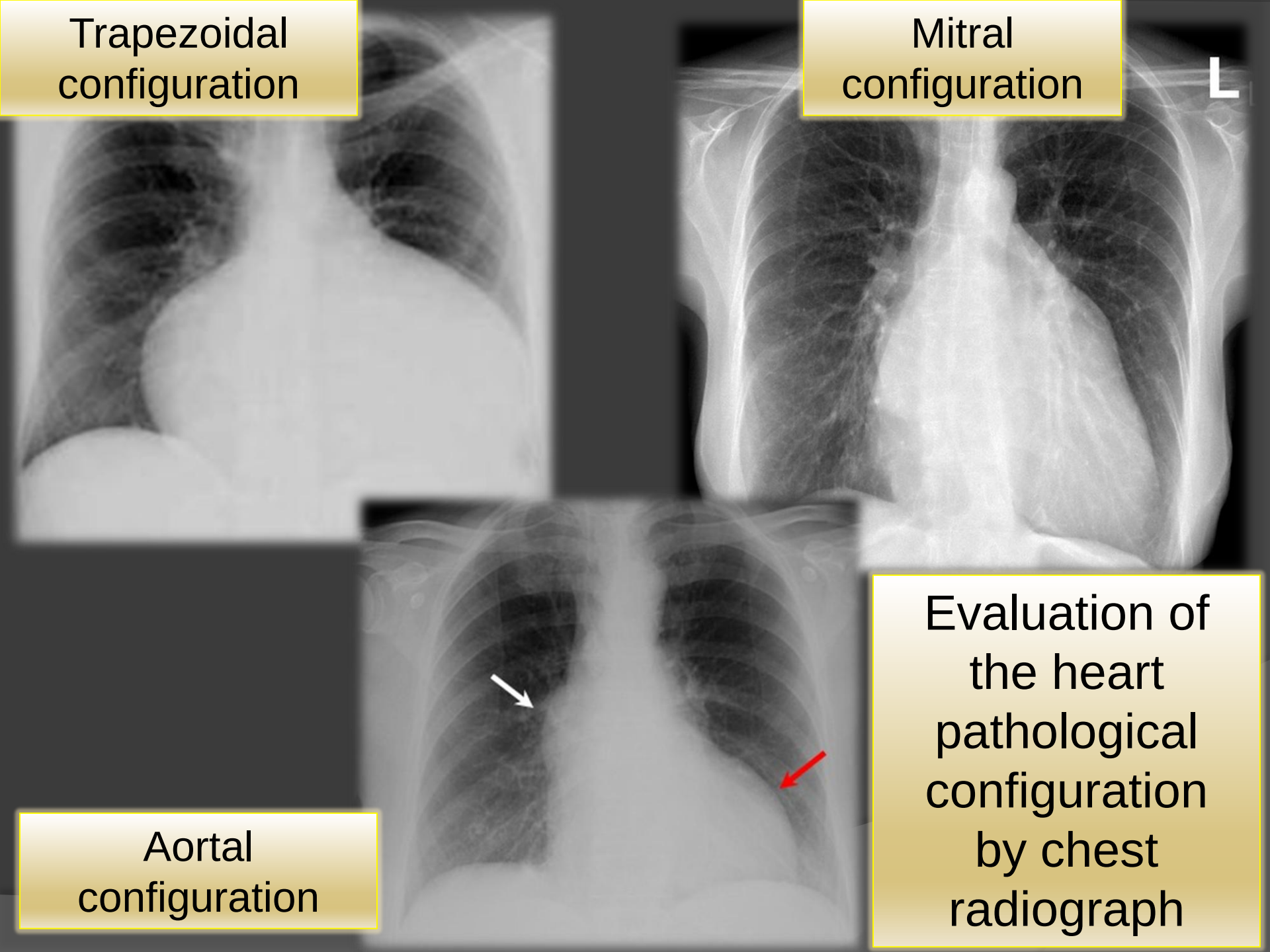
Idiopathic Lung Fibrosis (IPF)

Imaging evaluation of rehabilitation therapy in heart failure

Cardiac rehabilitation (CR) - a multidisciplinary and multifaceted intervention that improves functional capacity, recovery and psychological comfort

RC means long-term comprehensive programs that involve medical evaluation, exercises, modification of cardiovascular risk factors, education, designed to limit the physiological and psychological effect of heart disease, reduce the risk of sudden death and repeated myocardial infarction, control heart symptoms, stabilize or slow down the atherosclerotic process

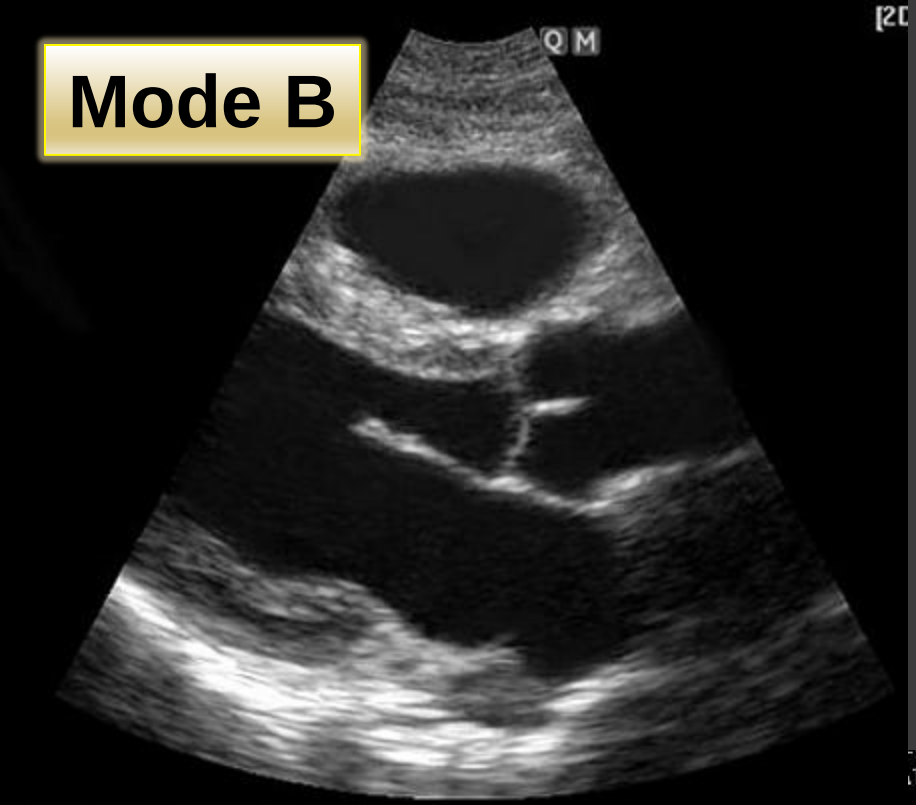
Cardiac imaging has made significant progress; it now serves as a diagnostic and prognostic tool. Patients with heart failure require constant follow-up with basic imaging, such as Heart Ultrasound, AngioCT coronary arteries; Cardiac MRI and nuclear medicine. Imaging guides the treatment as well as the intervention procedures for the patients with heart failure.


Trapezoidal configuration
Mitral configuration
L
Aortal configuration
Evaluation of the heart pathological configuration by chest radiograph

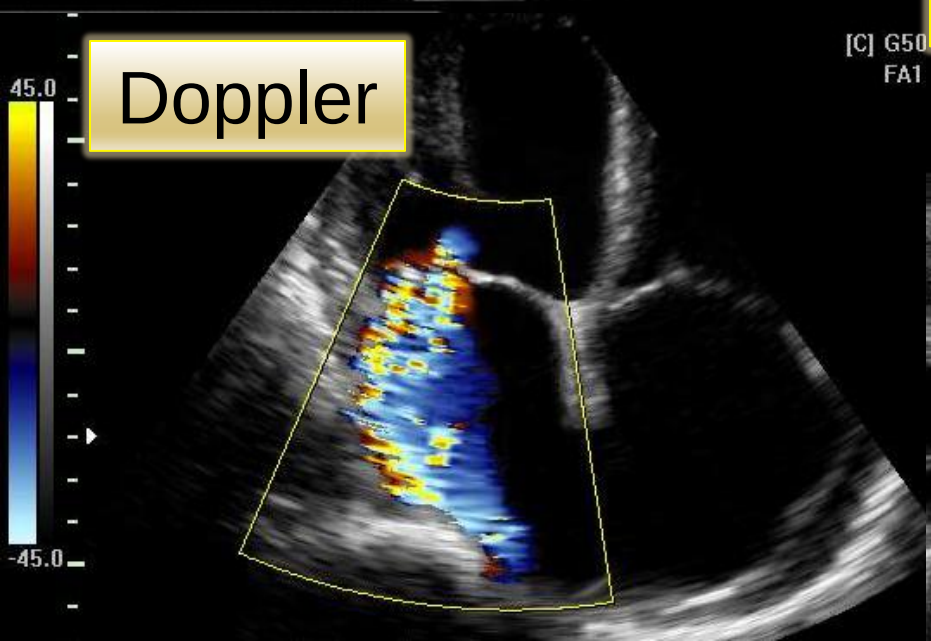
Echocardiogram

is a main tool for diagnosing heart failure patients and assessing prognosis

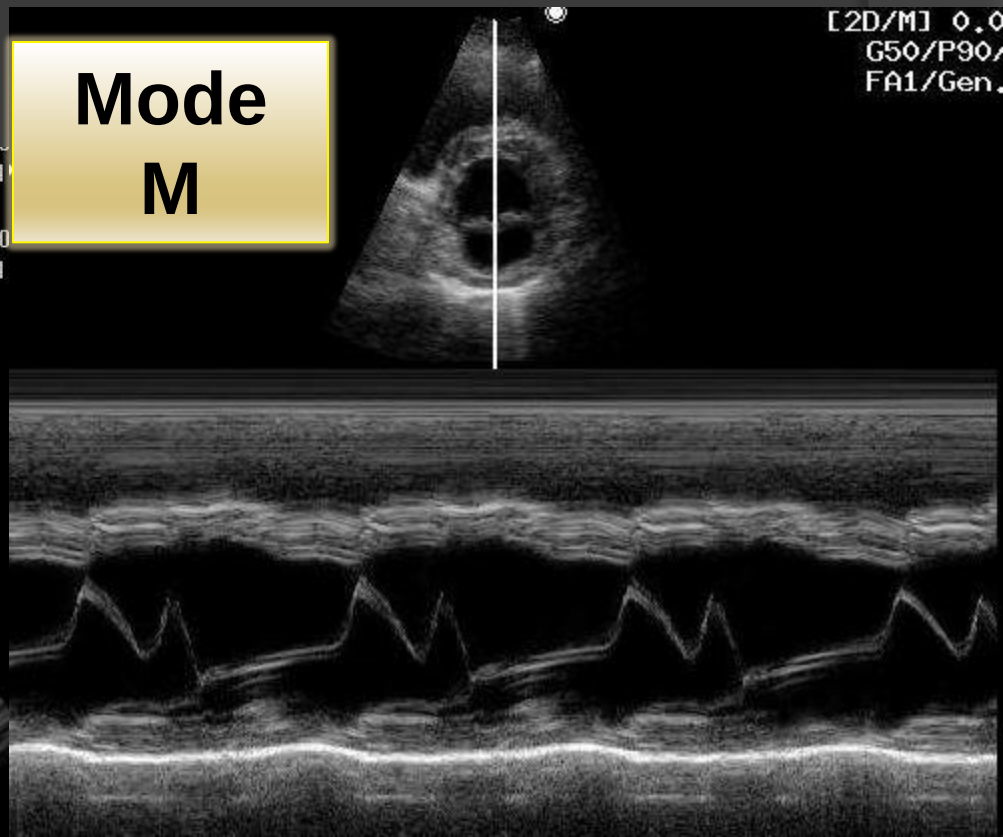
Mode B



Doppler

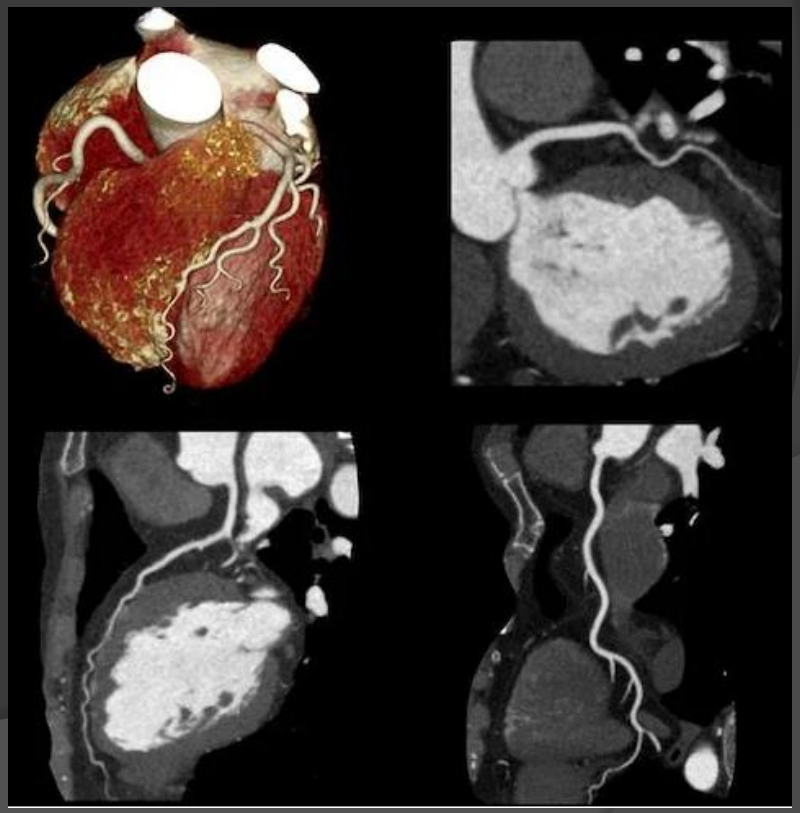


Mode M



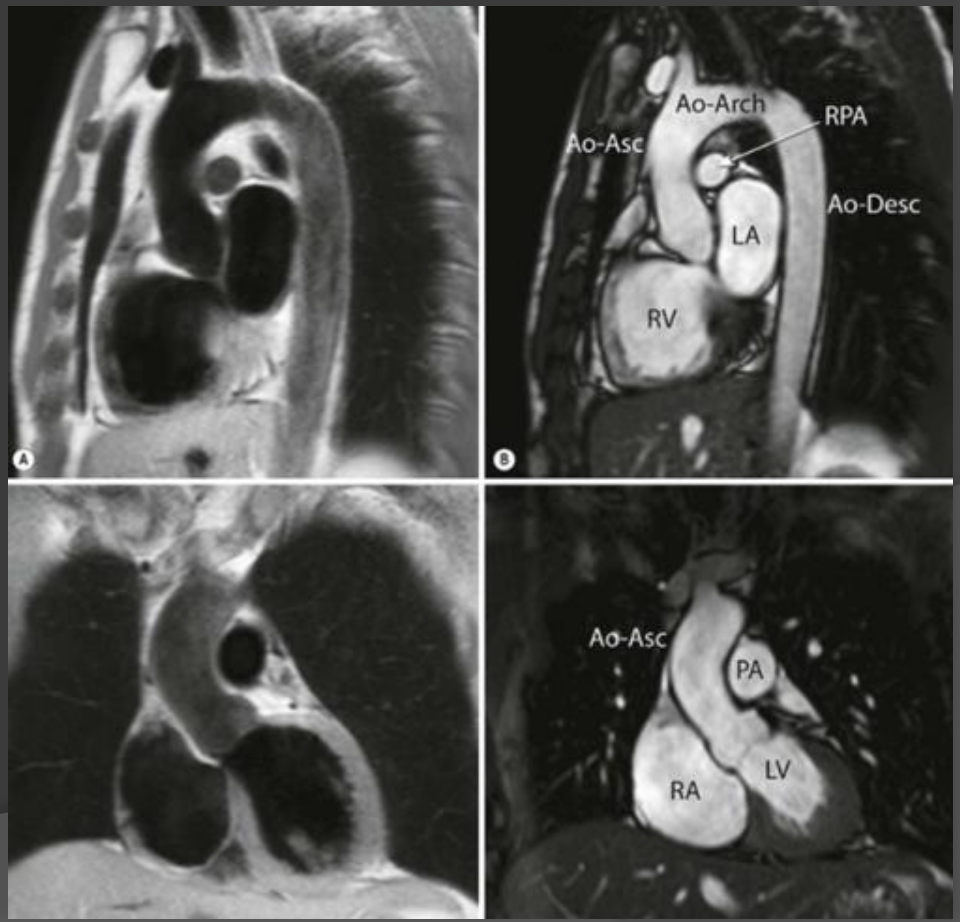
Heart CT

aims to use the latest technology together with US to reduce scanning time and radiation exposure. CT will be able to measure the size of the infarction with a precise correlation with the measurements obtained by cardiac MRI and may be a valuable alternative in patients with non-MRI conditioned pacemakers or conditioned defibrillators.



Heart MRI

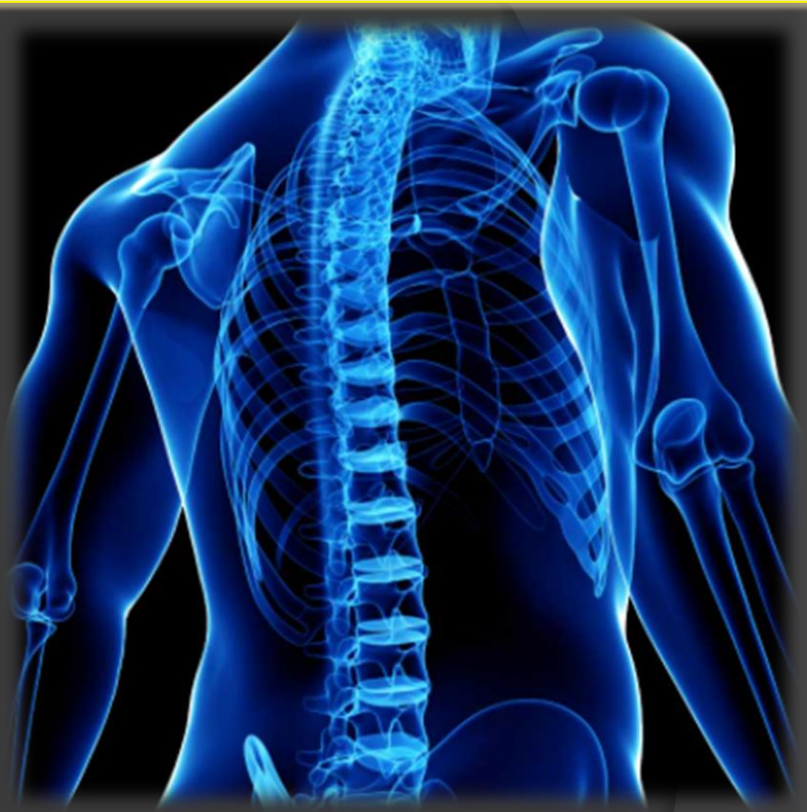
it is a superior imaging modality in the non-invasive assessment of heart failure, when conventional imaging modalities such as echocardiography fail to specify the etiology. Due to the accuracy, higher visual field, lack of radiation and the ability to characterize myocardial tissue allows the assessment of ventricular size and function to determine the cause of heart failure, determine the infusion and viability of the myocardium and to assess pericardial disease. It is recognized as the gold standard for quantifying ventricular volumes.



Radio-imaging methods and their influence in osteo-articular rehabilitation

Overview

- Radiography is the method of choice and indispensable for the examination of the osteoarticular system.
- A good bone x-ray must have contrast, sharpness in the structure, to see the bone trabeculae.

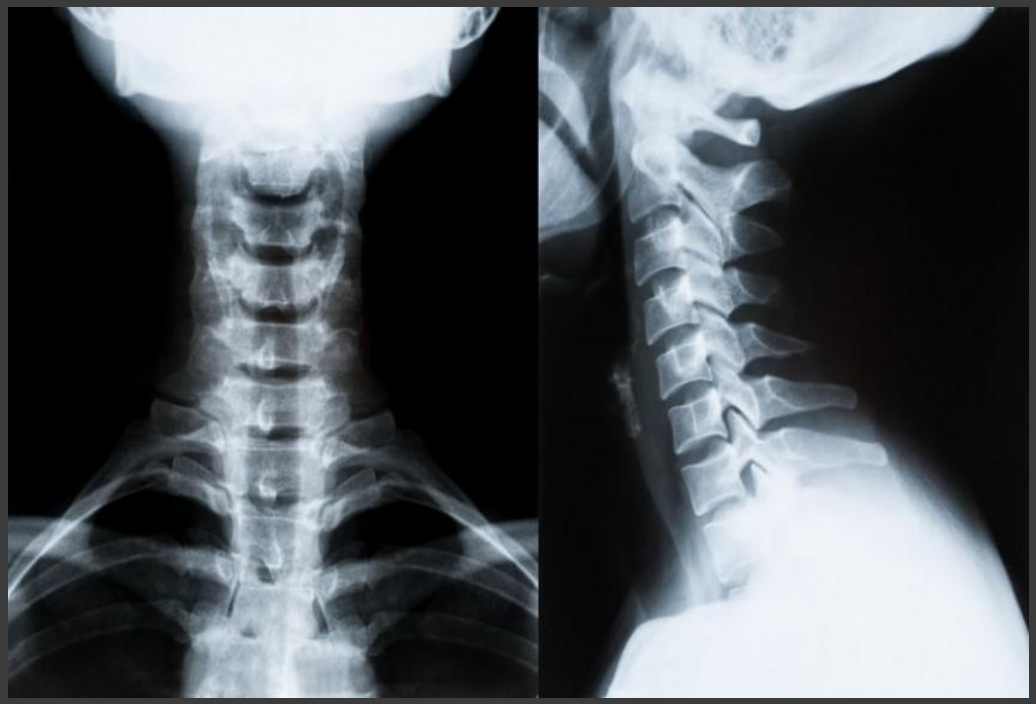


❑The radiological examination in fractures not only aims to verify the diagnosis, which can often be established clinically, but also specifies whether or not there is a dislocation of the fragments and in which direction it occurred.

❑Specifies whether the fracture occurred in a healthy bone or with a pathological process.

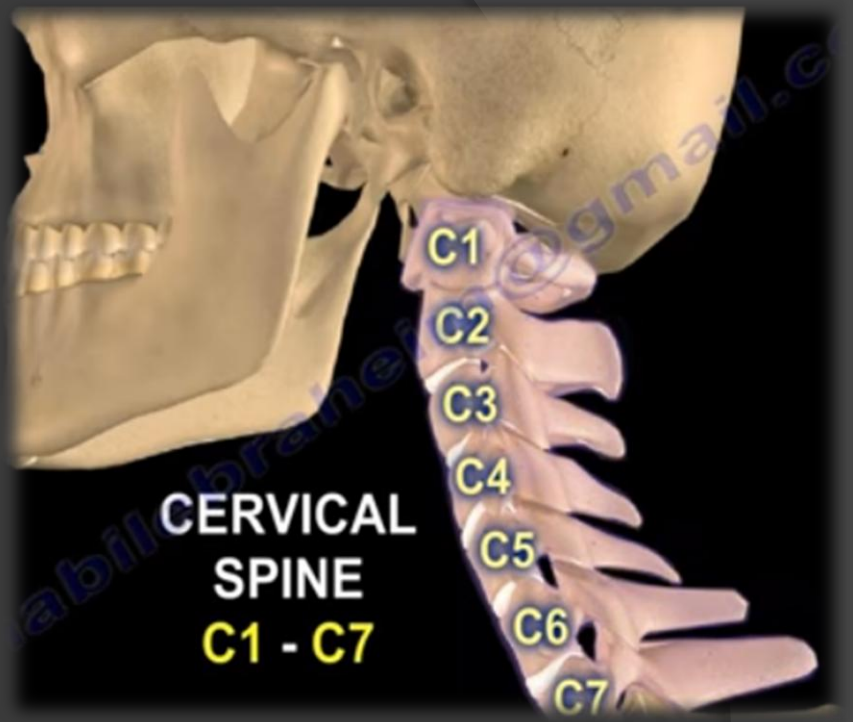
❑It helps to establish the treatment and follows the evolution and healing.

General criteria for obtaining best radiography



- We need to see each vertebra and each intervertebral space separately.
- The spinous process must be in the middle of the spine and in the lateral profile to be seen in its entirety.
- In the lateral projection we must see a single contour of the posterior faces of the vertebral bodies.
- The bodies of the lumbar vertebrae are clearly determined, including the Th 12 vertebra and the first S1 sacral vertebra.
- The sacroiliac joints are determined when performing lumbar X-ray

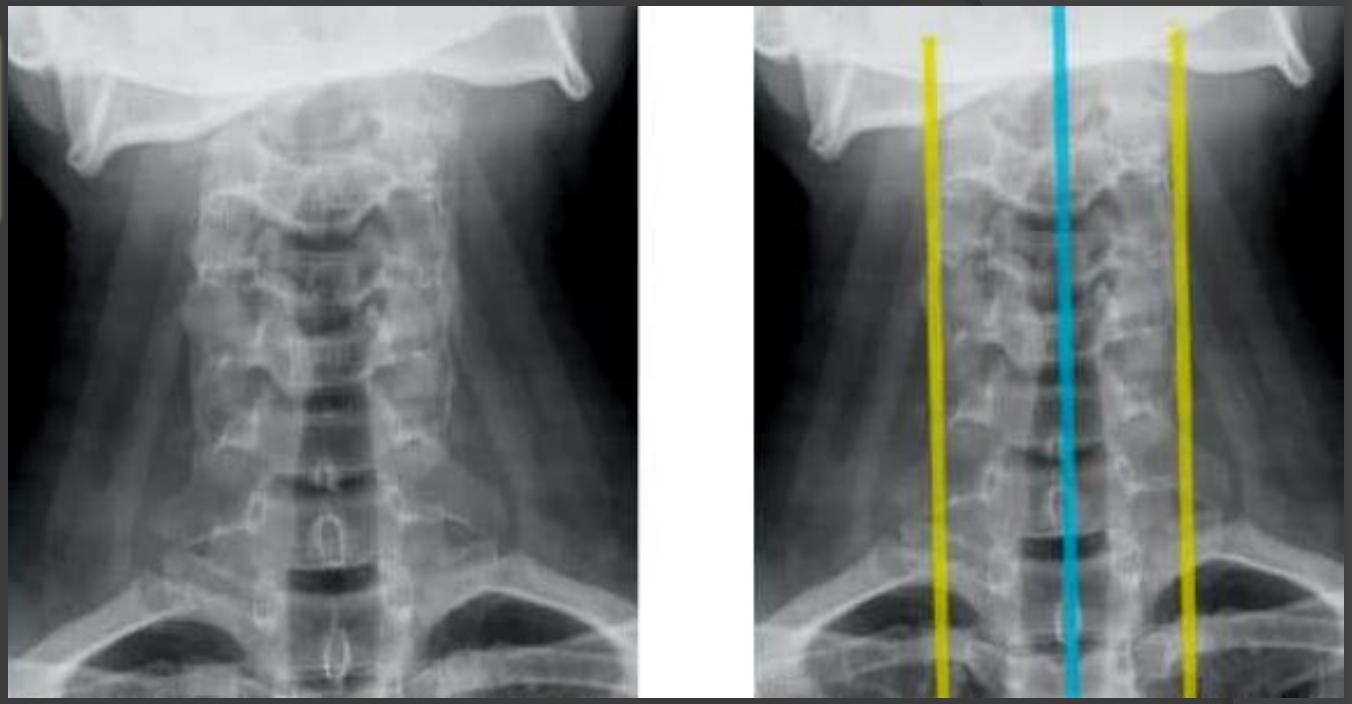
Cervical spine



is performed in the projections:

1. AP
2. open mouth- aimed for C1-C2
3. Lateral with functional tests (flexion and extension)
4. oblique (anterior and / or posterior)

Cervical spine
AP projection

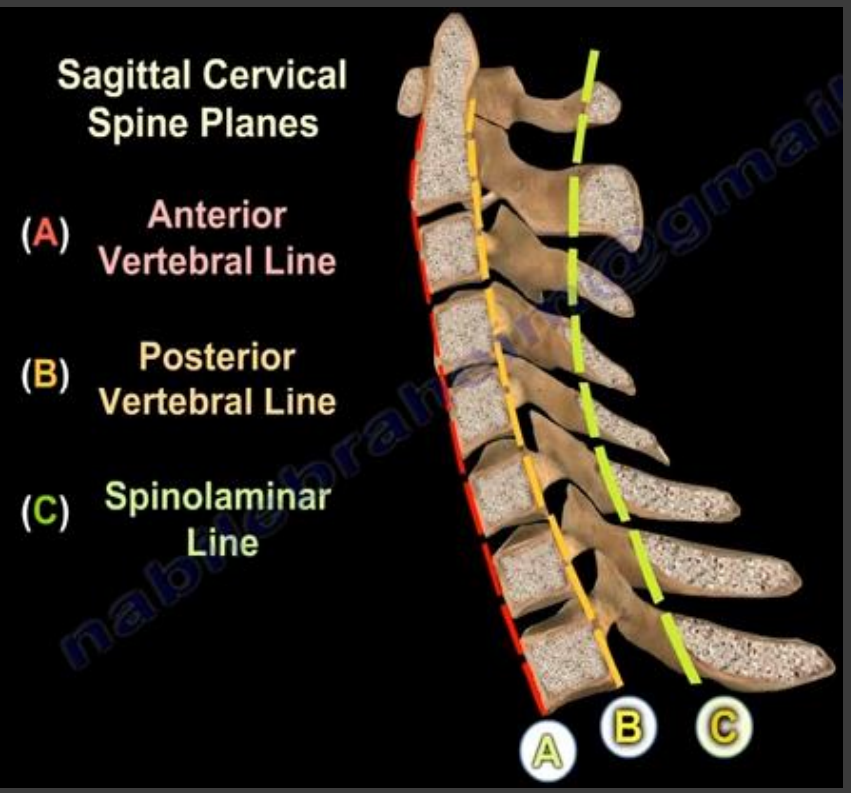


The two lateral lines in the AP projection go on each side of the vertebral body (represented by the yellow lines).

The line at each spinous process from C1 to C7 runs through the middle (represented by the blue line)

Cervical spine Lateral projection

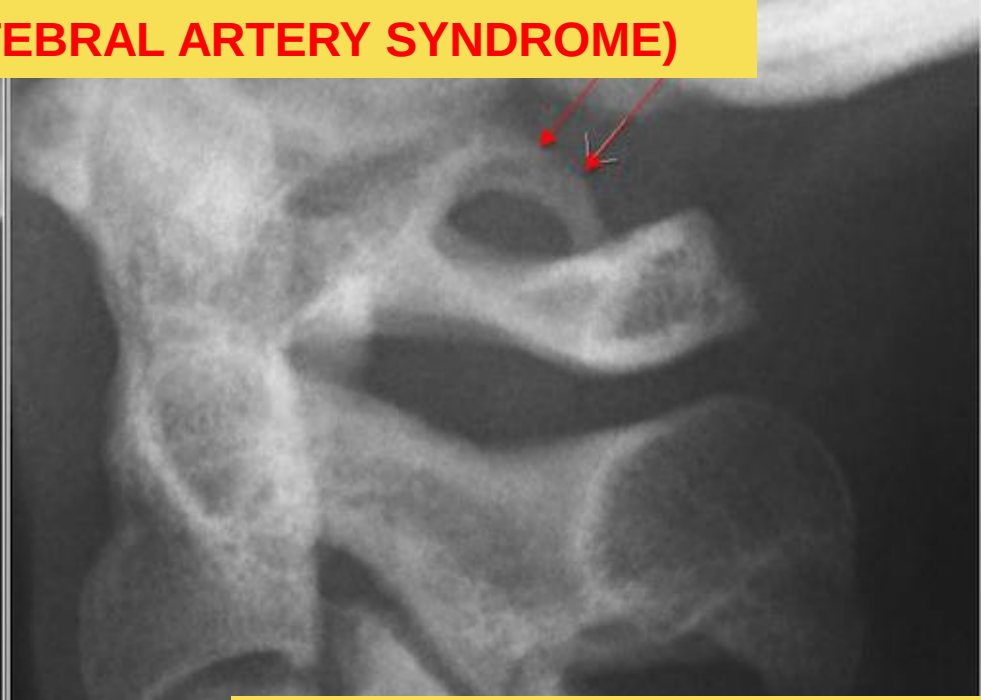
The anterior longitudinal line runs along the anterior surface of the vertebral bodies. **The posterior longitudinal line** passes along the posterior surface of the vertebral bodies. **The spinolaminar line** runs along the anterior edge of the spinous process (at the junction of the spinous process and the laminae).



Flat neck spine (or TEXT NECK, known in the international literature "Turtle Neck posture" or "Anterior Head Syndrome"or smartphone disease)

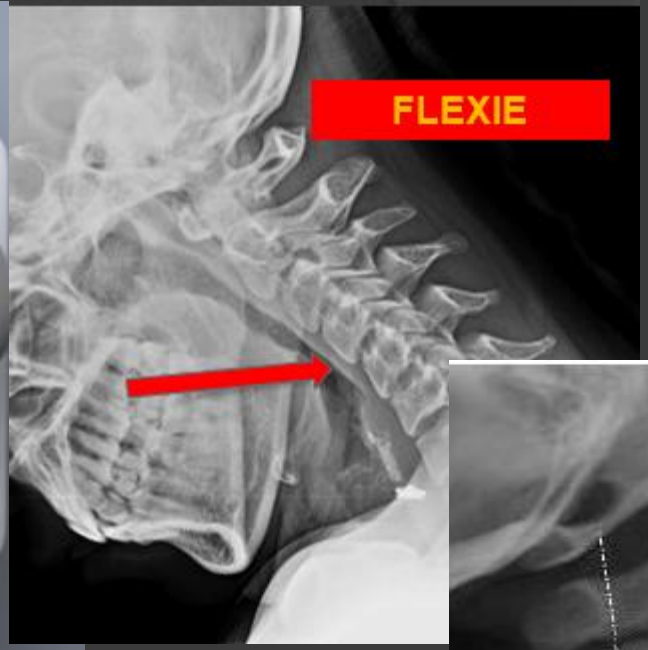
Cervical instability (anterolisthesis)

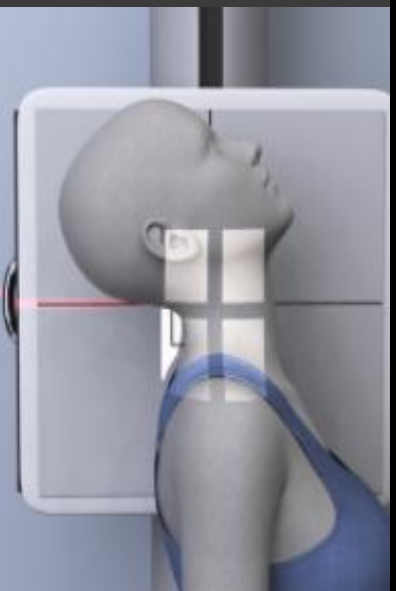
KIMMERLE ABNORMALITY (OR VERTEBRAL ARTERY SYNDROME)



12-30% of people, it is not a disease, but an anatomical variant of the first cervical vertebra, produced by the complete or incomplete ossification of the atlanto-occipital posterior ligament over the vertebral artery groove, resulting in the formation of an arched foramen (additional bony arch) which contains the vertebral artery and the posterior branch of the spinal nerve C1, and which may limit the movement (flow) of the vertebral artery, causing its mechanical compression syndrome.

Cervical spine functional tests (flexion and extension)

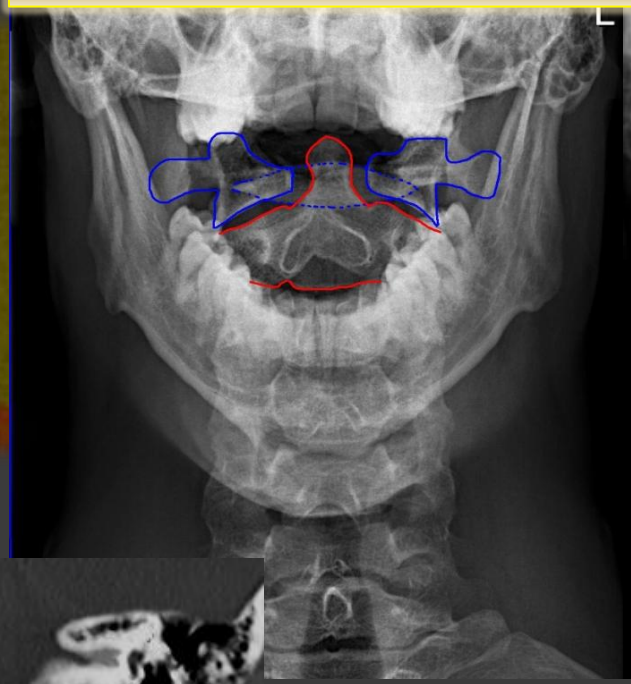


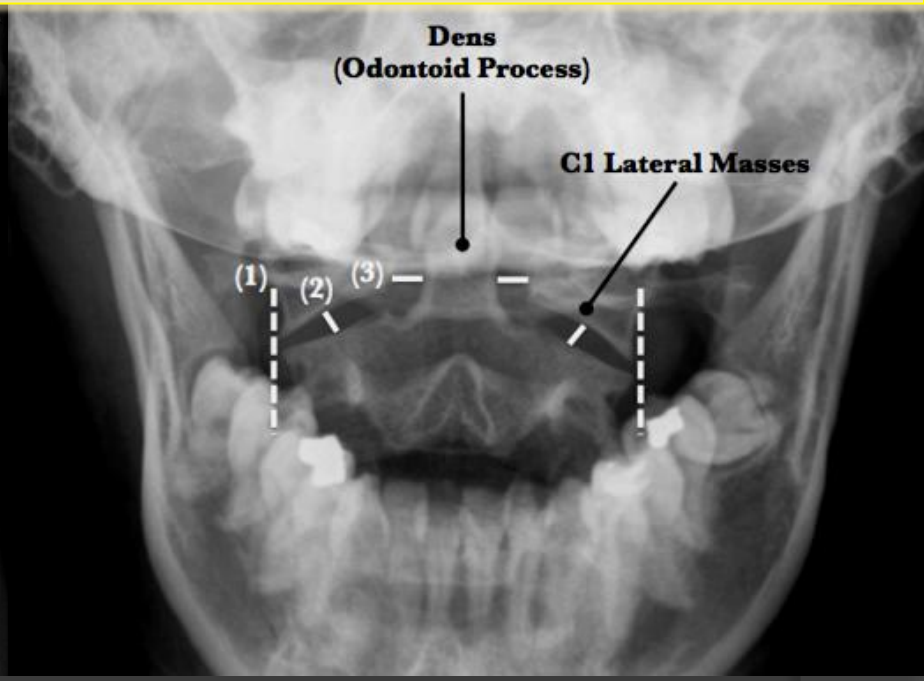


flexion images should demonstrate well-separated spinous processes

extension images should demonstrate the congestion of thorny processes

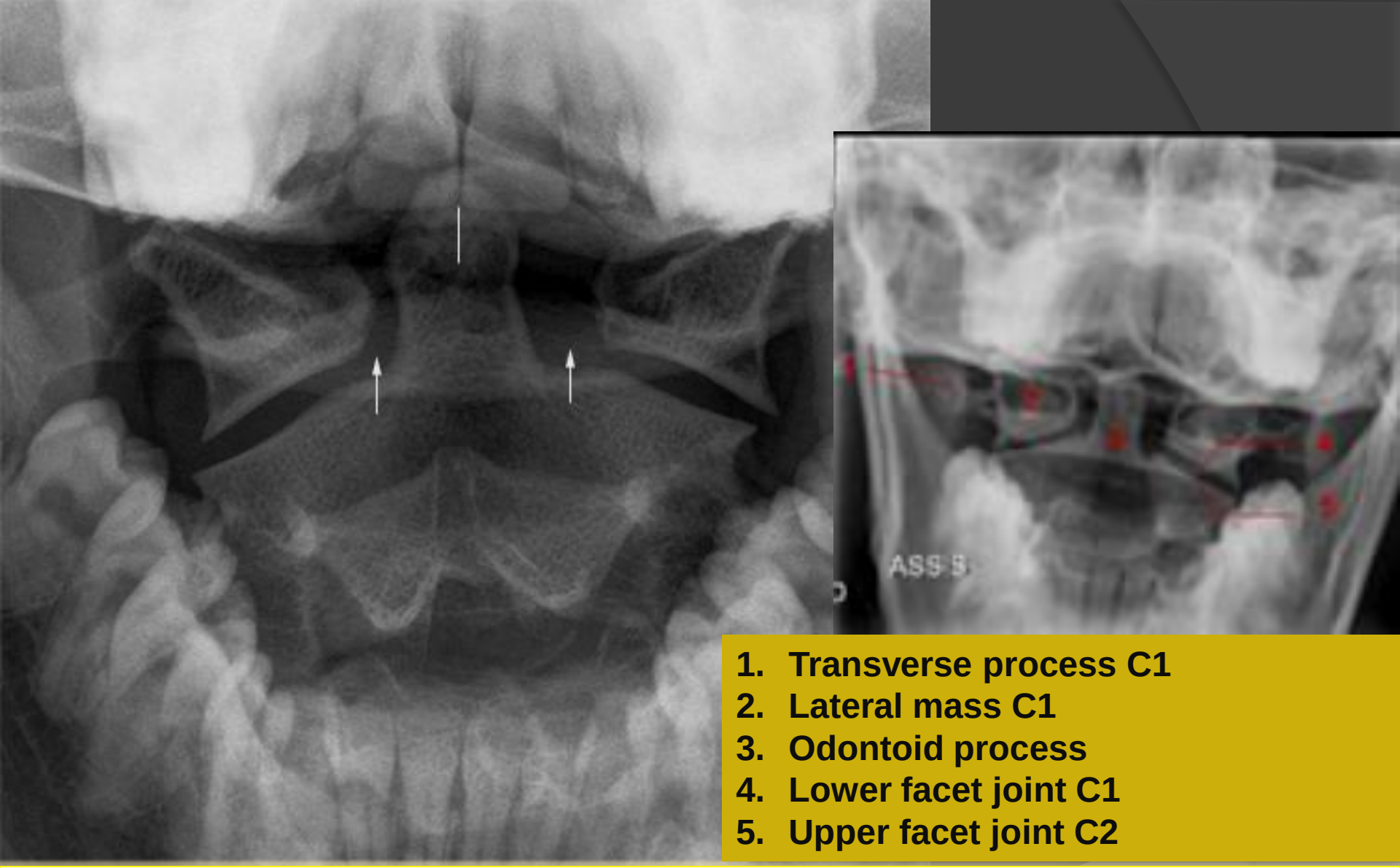
Cervical spine: open mouth projection





the odontoid process is clearly determined, not overlapping.The x-ray shows the I-II cervical vertebra through the open mouth. The median and lateral atlanto-axial joint are well delimited

Cervical spine: CT



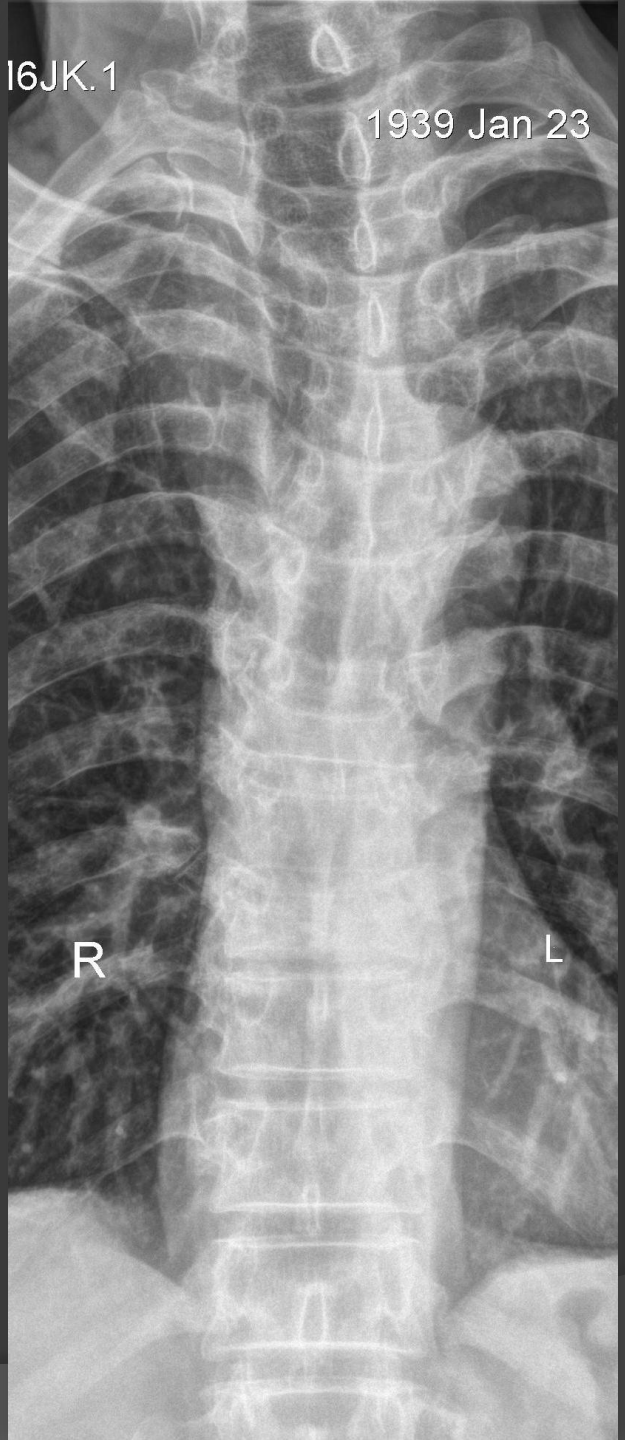
1. **Transverse process C1**
2. **Lateral mass C1**
3. **Odontoid process**
4. **Lower facet joint C1**
5. **Upper facet joint C2**

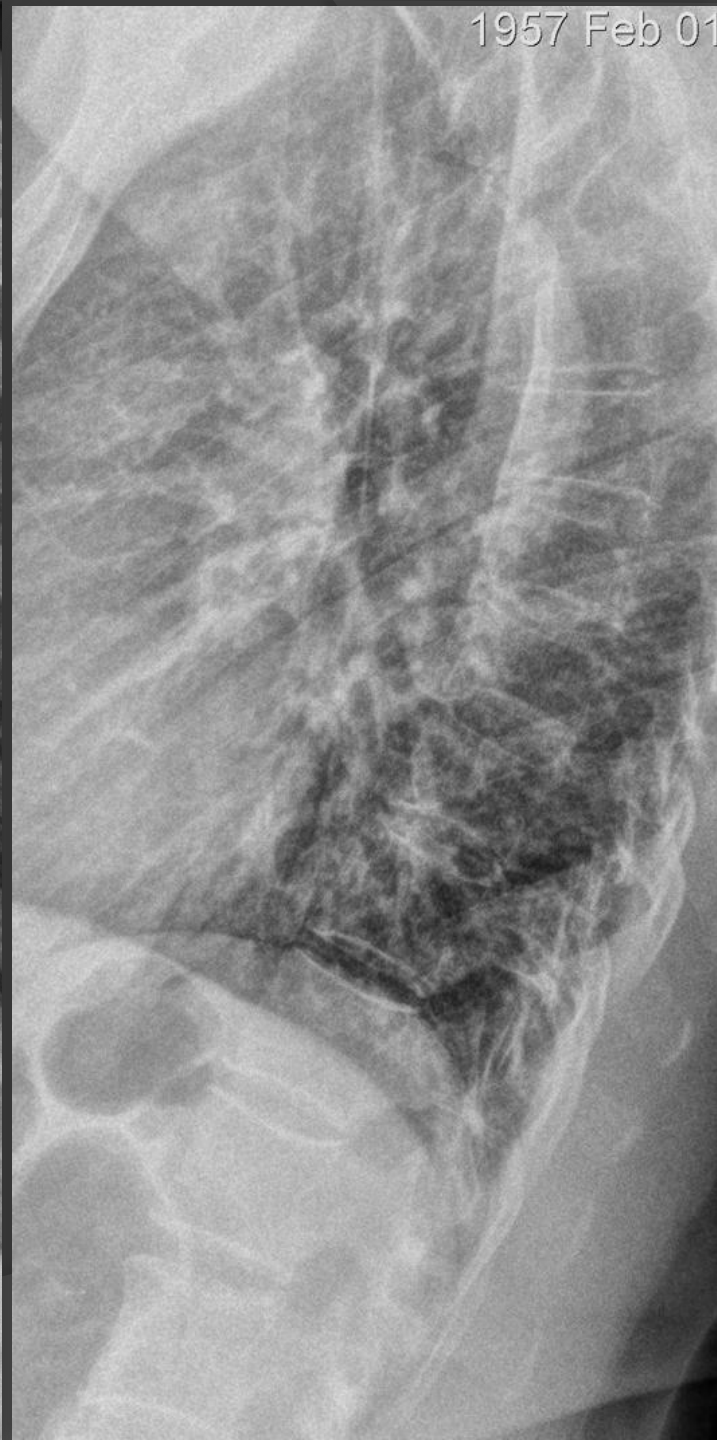
Instability in the median atlanto-axial joint, moved to the right (asymmetry of the articular space between the lateral masses of C1 and odontoid process; R<L)

Thoracic spine

It is performed in the projections:

1. AP
2. lateral

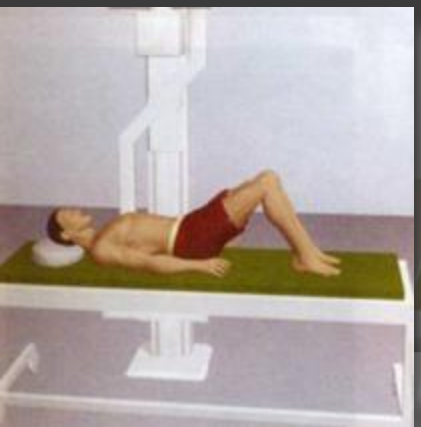


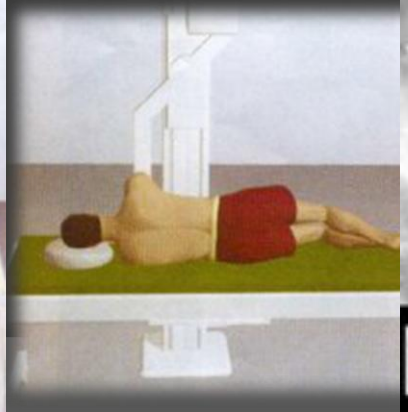


Lumbar spine

It is performed in the projections:

1. AP
2. Lateral
3. functional tests (flexion and extension)
4. oblic

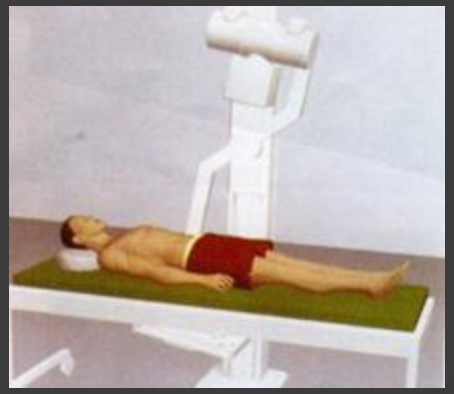




Sacrococcygeal Region

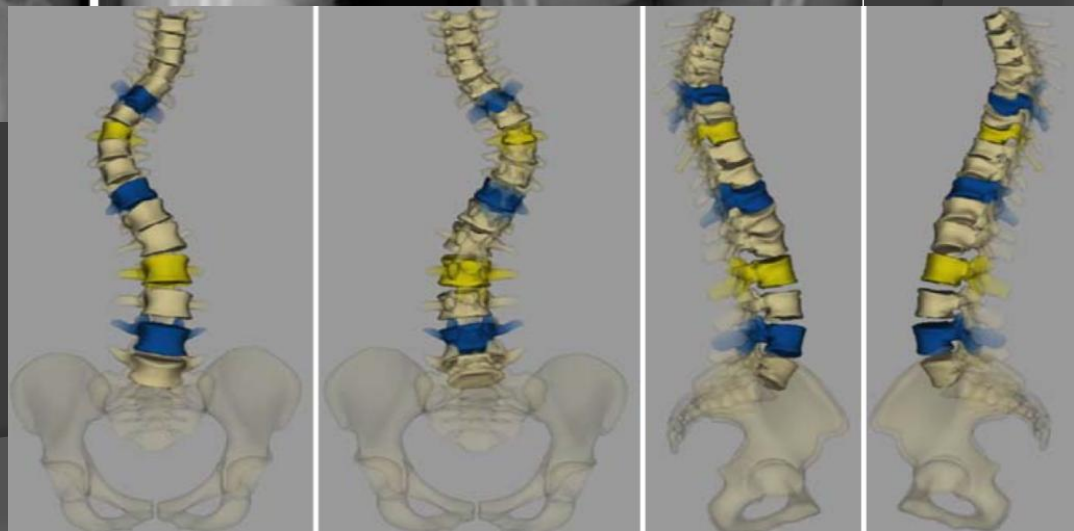
It is performed in the projections:

1. AP
2. lateral



= imaging diagnostic system that allows the simultaneous acquisition of two Xray images (AP and lateral), in conditions of significant reduction of the degree of irradiation of the patient

EOS system

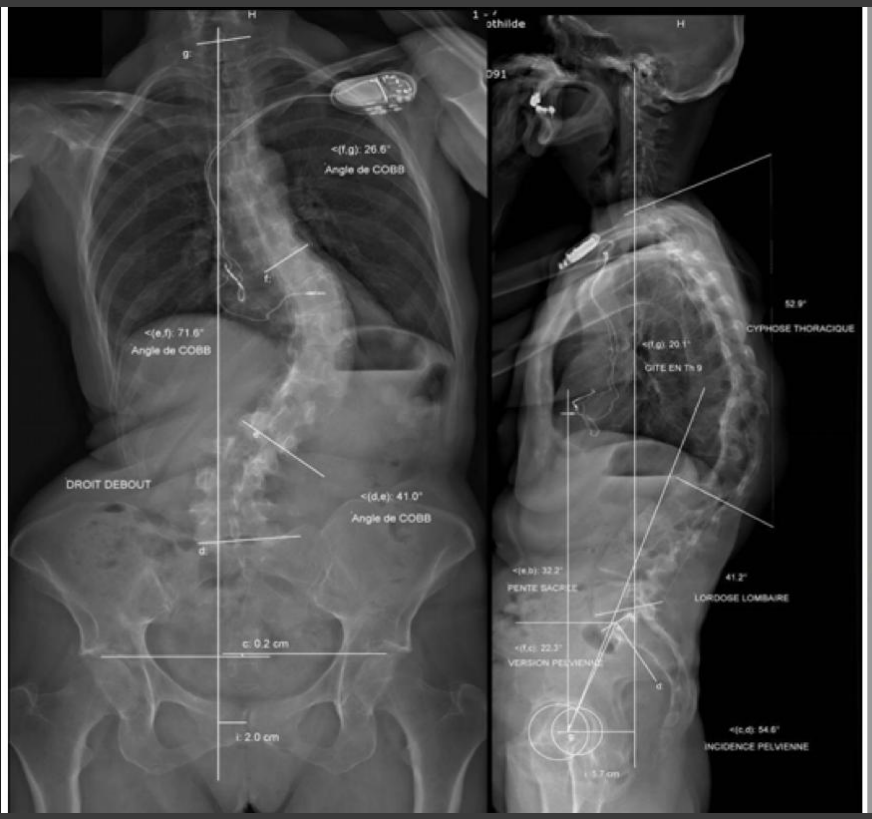


Possibility of 3D modeling of the obtained images and real-world interpretation of the values of the static indicators of the osteo-articular system

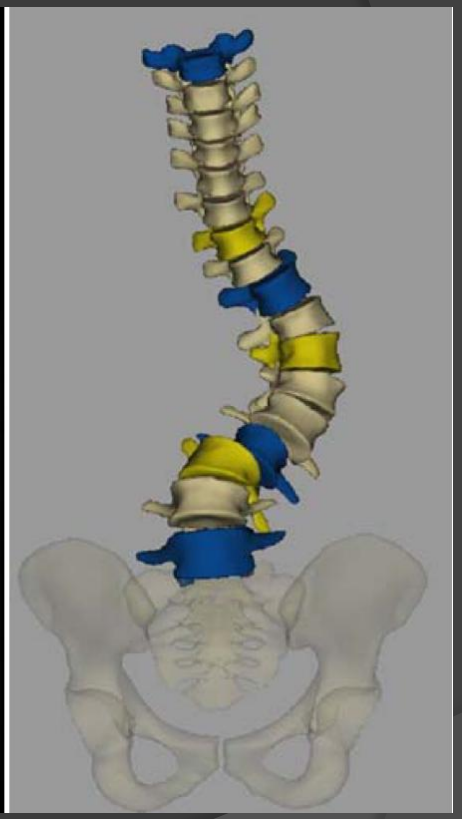
Possibilities of EOS imaging evaluation in skeletal pathology

Female, 66 years old, Diagnosis - Degenerative lumbar scoliosis

Simultaneous acquisition of images in two planes



Magnification of the image on the segment of clinical-imaging interest and evaluation of the radio-imaging diagnostic landmarks



3D modeling frontal view

Possibilities of EOS imaging in the axial deviations of the inferior limb)

Woman, 60 years old. Diagnosis: Left lower limb shaft abnormality

Simultaneous acquisition of frontal and sagittal plane images in orthostatism.

Right - 2^{o} genu valgum,
Left - 2^{o} genu varum,

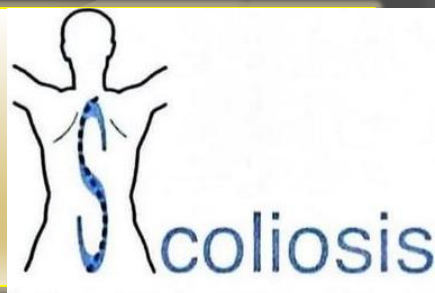
General indications for spine radiographs

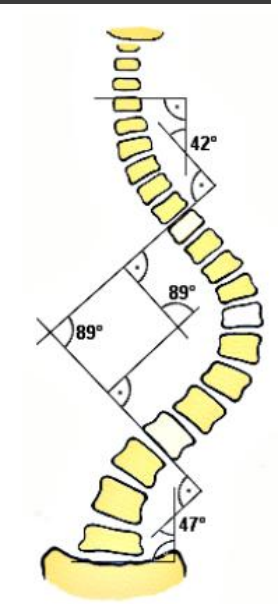
1. Bone degenerative changes (osteoarthritis)
2. Vertebral alignment changes (congenital / acquired)
3. Acute changes (due to trauma that causes stress fractures and changes the position of the vertebrae)
4. Pathological changes (caused by a bone disease)
5. Postoperative changes

Vertebral alignment changes
Types of scoliosis

Types of scoliosis depending on:

1. Affected area
2. Column deformation mode: "C" shape and "S" shape
3. Direction of scoliosis: dextro- or levoscoliosis

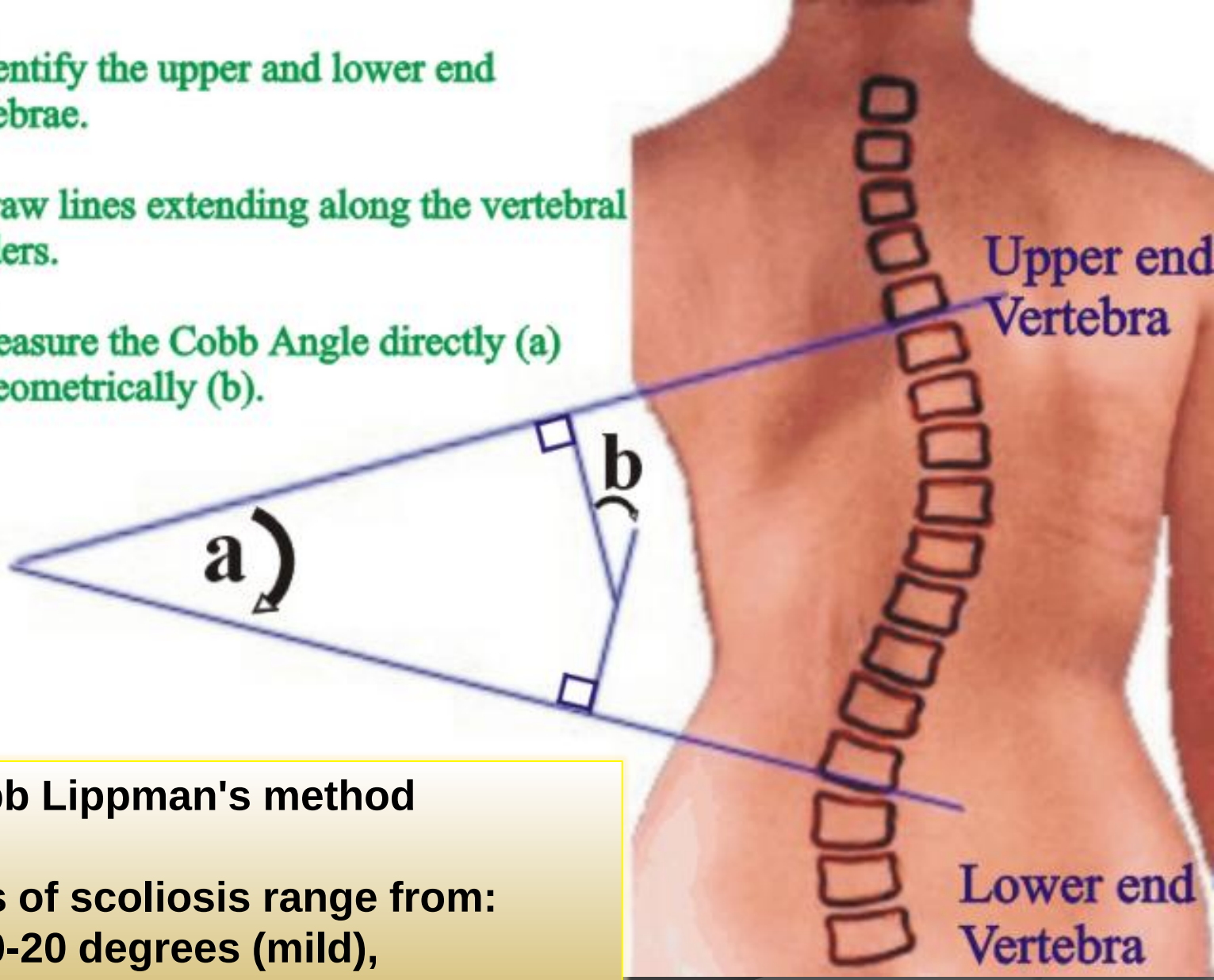




1. Identify the upper and lower end vertebrae.

2. Draw lines extending along the vertebral borders.

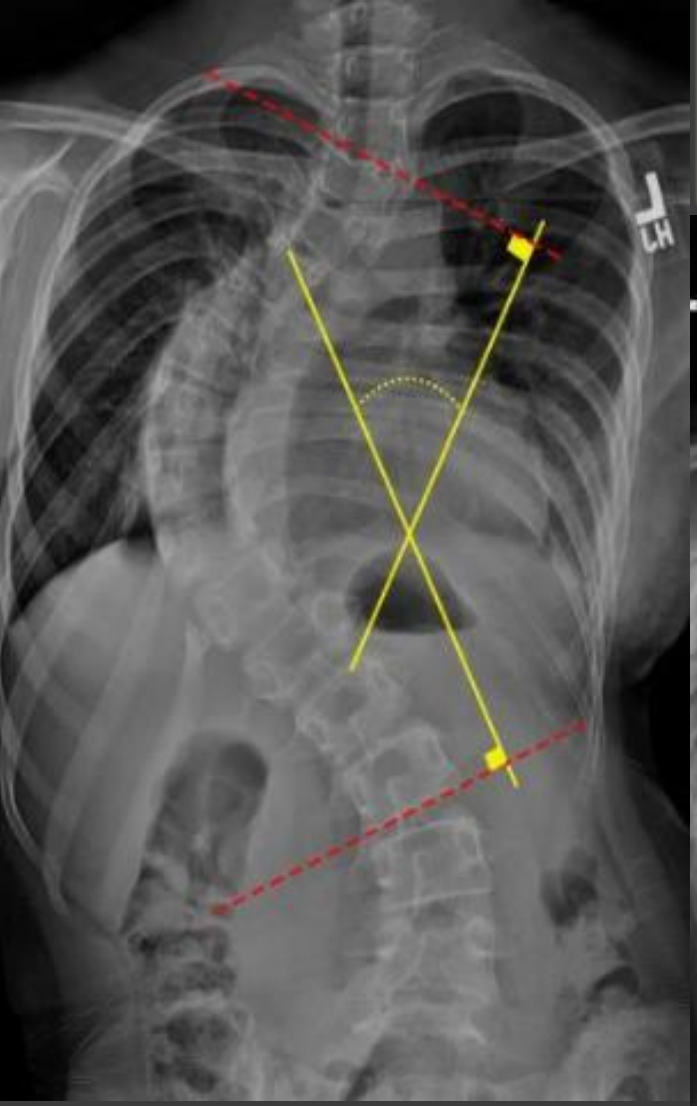
3. Measure the Cobb Angle directly (a) or geometrically (b).



Cobb Lippman's method

Degrees of scoliosis range from:
10-20 degrees (mild),
20-50 (moderate)
severe (greater than 50 degrees)

Cobb angle evaluation

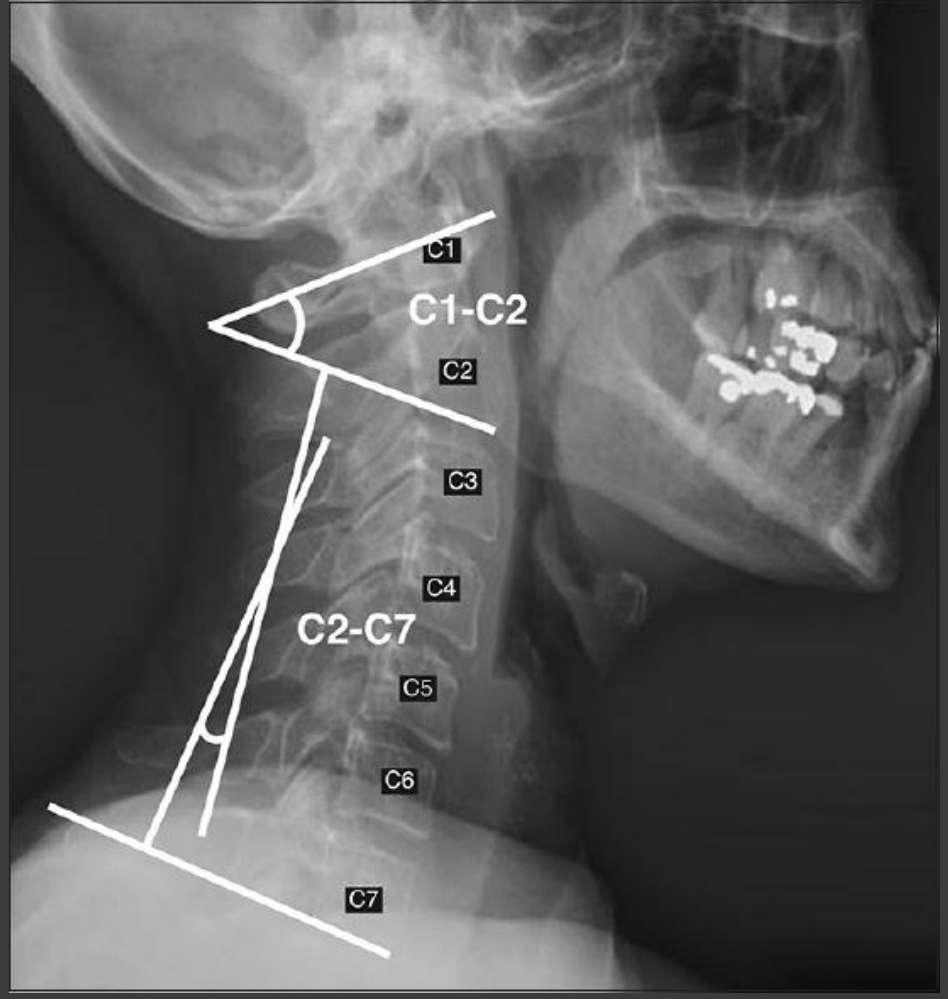


Assessment of pelvic tilt

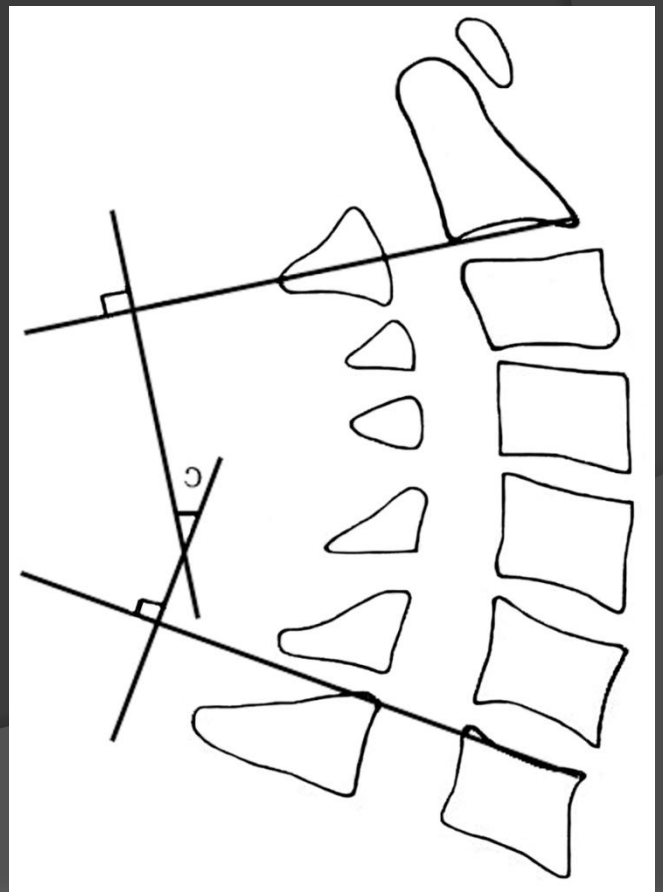
An inclination of ~ 5 ° of the pelvis to the left can be observed

Scoliosis surgical treatment


SĂNĂTOS
LORDOZĂ
CIFOZĂ
Kyphosis

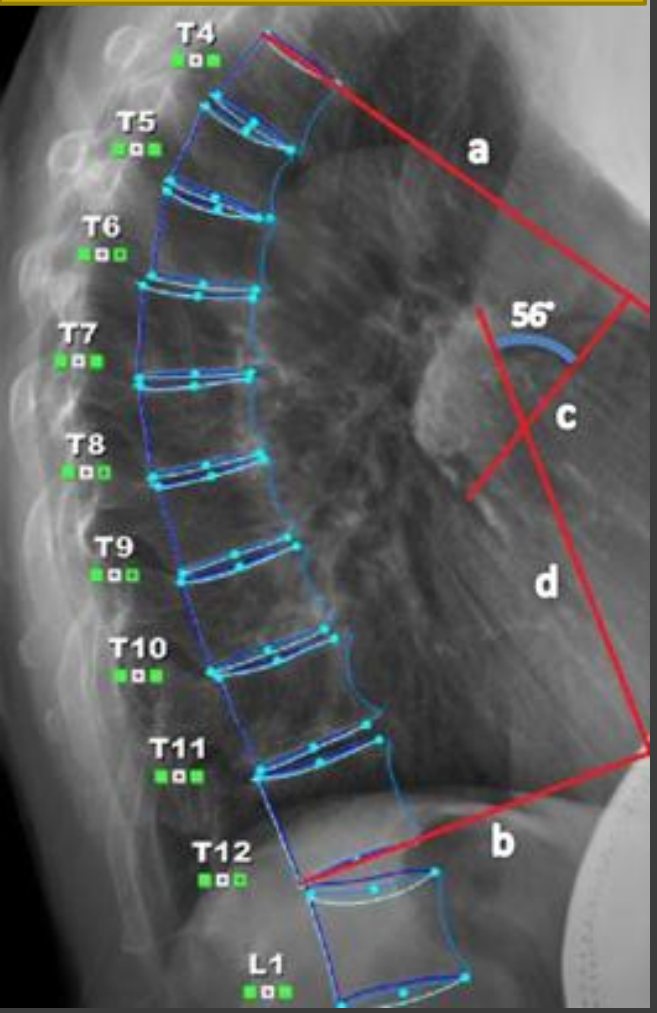


Lateral cervical spine radiographs
Angles C1 - C2 (upper cervical lordosis) and C2 - C7 (lower cervical lordosis - by Cobb technique) are indicated



Cobb method for measuring cervical lordosis. The lordotic cervical angle is measured according to Cobb's method on a lateral neutral radiograph: the angle (c) consists of the two lines perpendicular to the two lines parallel to the edges of the vertebral bodies C2 and C7. When the C7 vertebra is not well visualized on the lateral radiographs, C6 is used

Cobb's method of measuring thoracic kyphosis



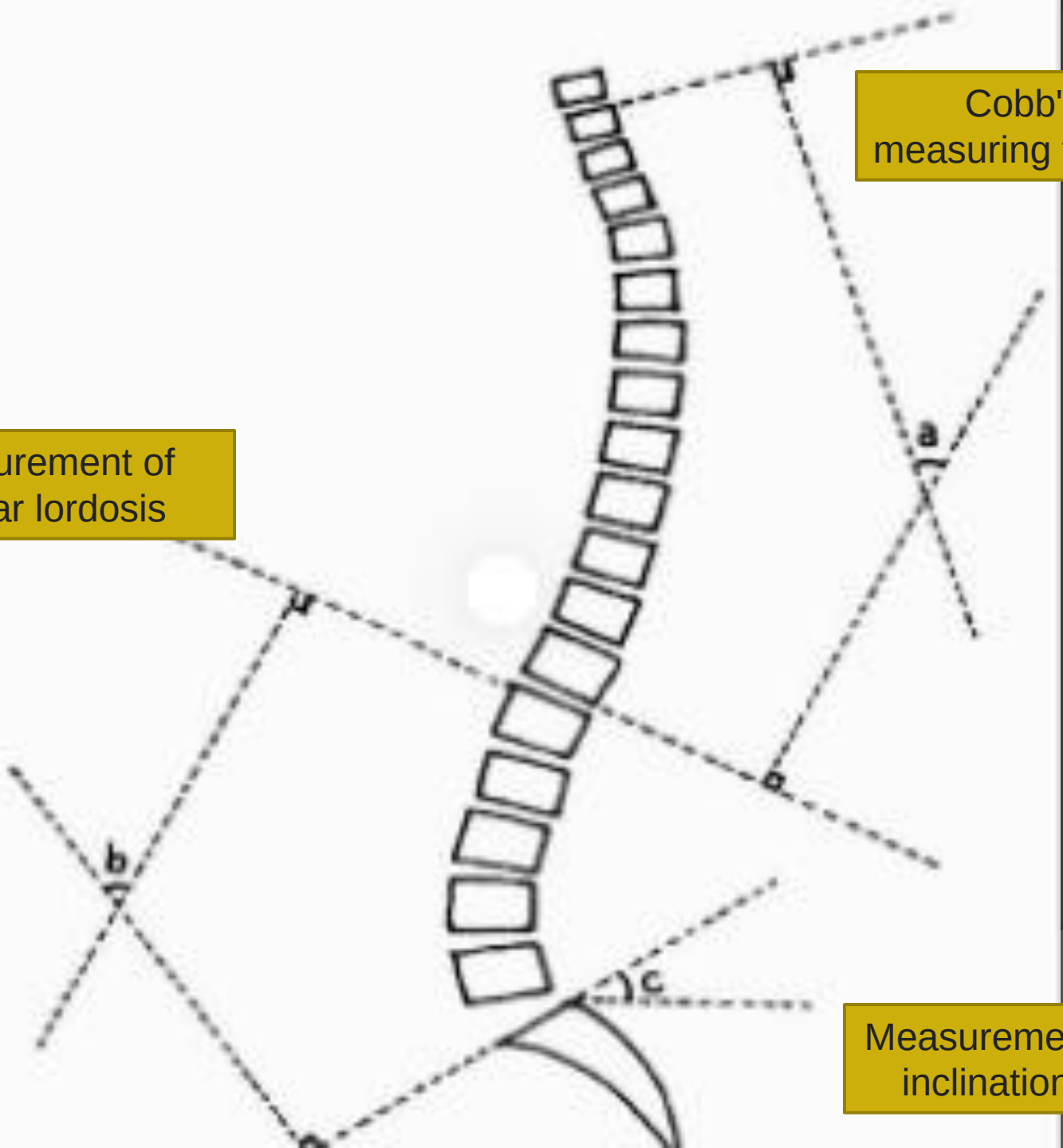
Normal kyphosis angles range from 20 ° to 40 ° in young people; 48 ° to 50 ° in women and about 44 ° in men in older populations

Measurement of lumbar lordosis

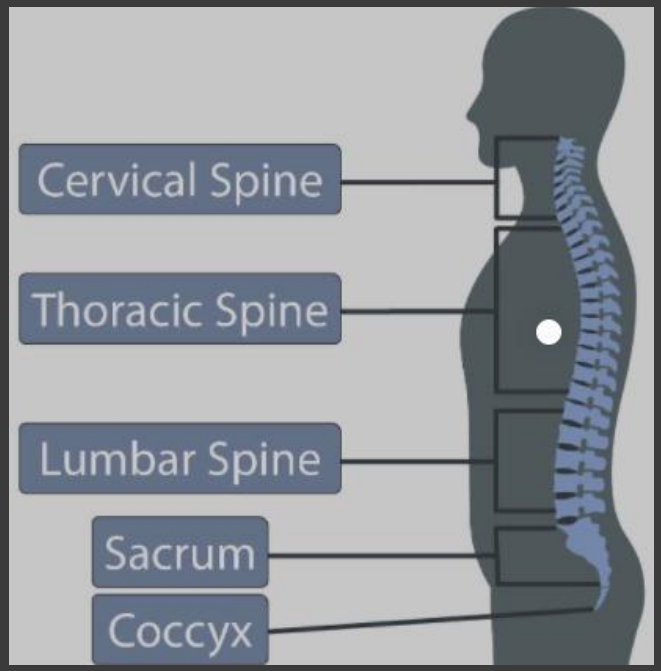
Lumbar lordosis is defined by the angle between the upper plane of the lumbar vertebrae L1 and the upper plane of the sacral vertebrae S1; normal lordosis is in the range of 31-50 °, excessive lordosis (hyperlordosis) is over 70 °, lumbar kyphosis is less than 10 °

Cobb's method of measuring thoracic kyphosis

Measurement of lumbar lordosis



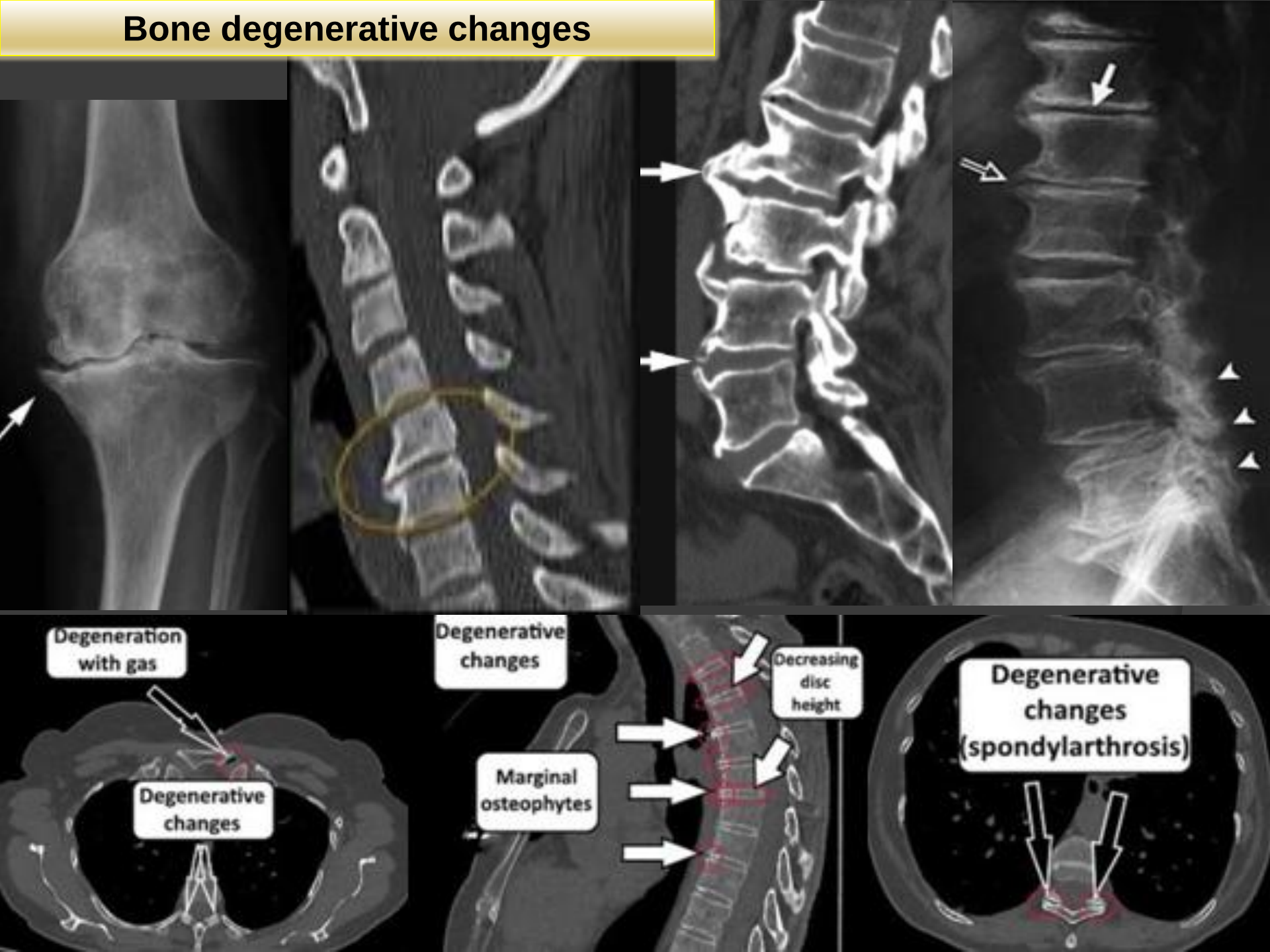
Measurement of the angle of inclination of the sacrum



Evaluation of sagittal and coronal balance

The sagittal and coronary balance are both in the normal range, the lines drawn in the middle of the C7 vertebra pass through the midline at S1 on the frontal incidence and at a distance of 2 cm from the posterosuperior corner of S1 on the lateral incidence

Bone degenerative changes



VERTEBRAL INSTABILITY

Analyzing:

1. **Anterior vertebral line**
2. **Posterior vertebral line**
3. **Spino laminar line**

Spondylolysis and Spondylolisthesis

= are conditions that affect the mobile joints of the spine that help keep the vertebrae aligned one above the other.

Spondylolysis is a weak spot or fracture in one of the bone bridges that connects the upper and lower secondary joints. It can occur at any level of the spine, but usually occurs in the fourth (L4) or fifth (L5) lumbar vertebra. This can cause the vertebrae to slip out of their normal position, a condition called spondylolisthesis.

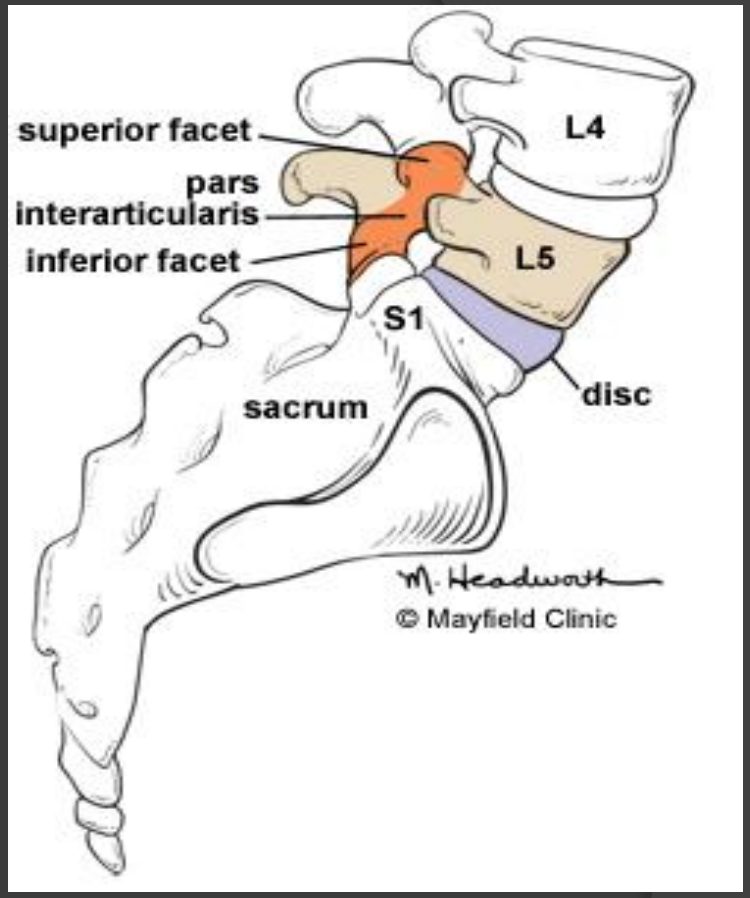
So they are separate conditions, but connected !!!

Spondylolysis usually occurs first, but not always. The term comes from "spondylum", which means spine, and "lysis", which means to divide. Spondylolysis can occur on one side (unilaterally) or on both sides (bilaterally)

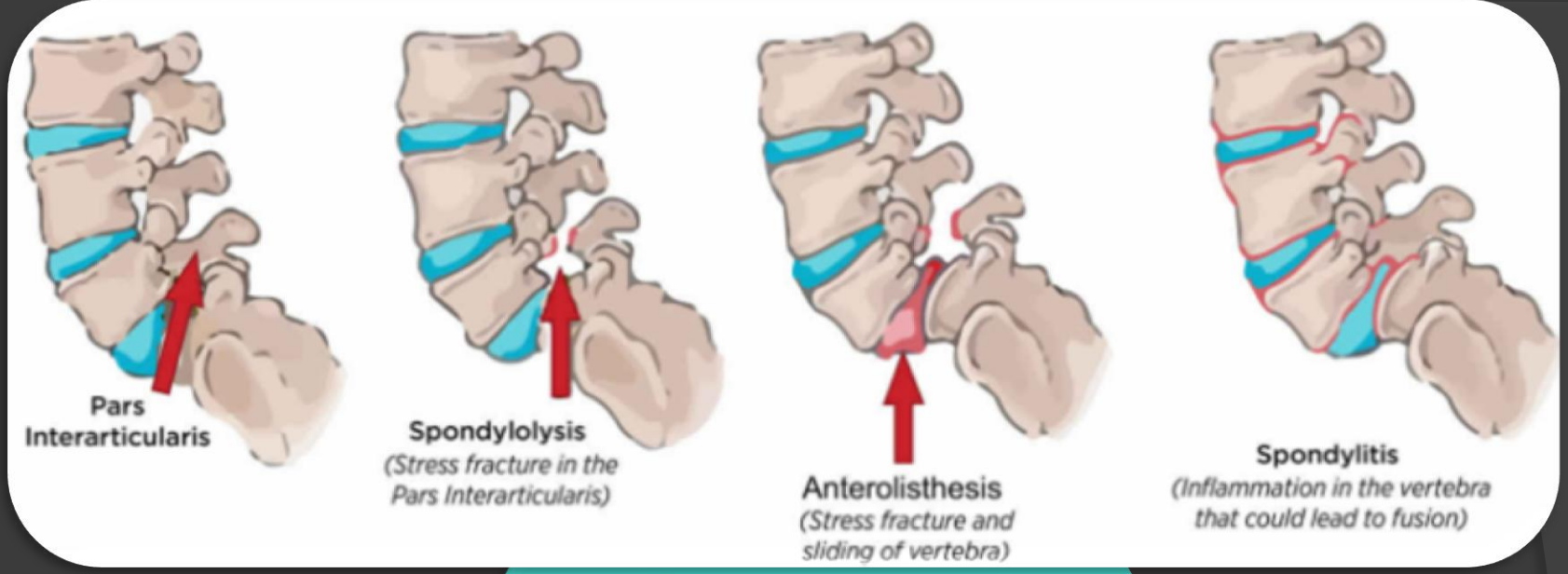
Treatment options include physical therapy to strengthen the muscles around the area. Sometimes the patient is placed in a locking device. In severe cases, surgery is also an option.

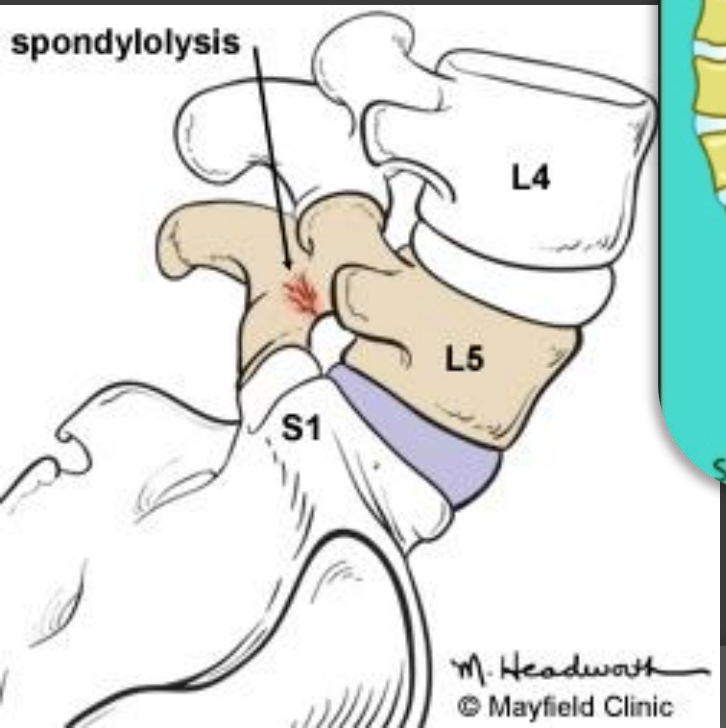
Facial joint anatomy

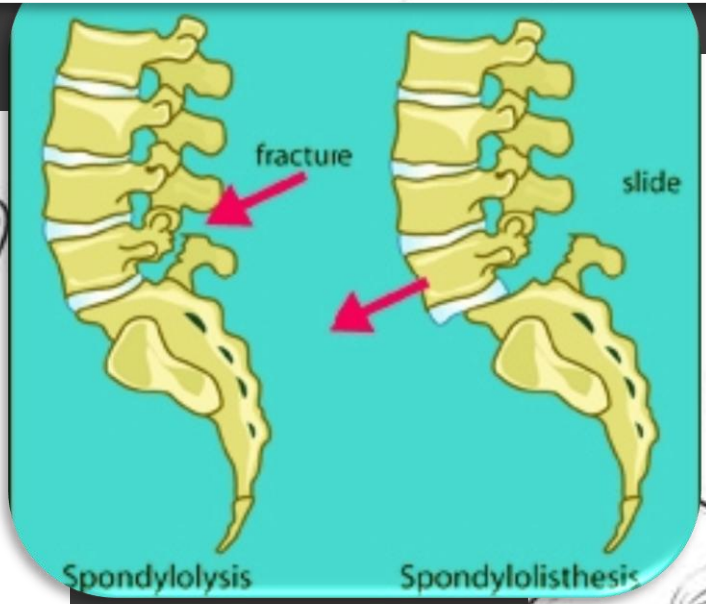
The spine is made up of 24 moving bones called vertebrae that provide the main support for your body, allowing you to move. Each of the vertebrae is separated by a gel-like disc. The vertebrae are connected and held together by ligaments and joints, called facet joints.

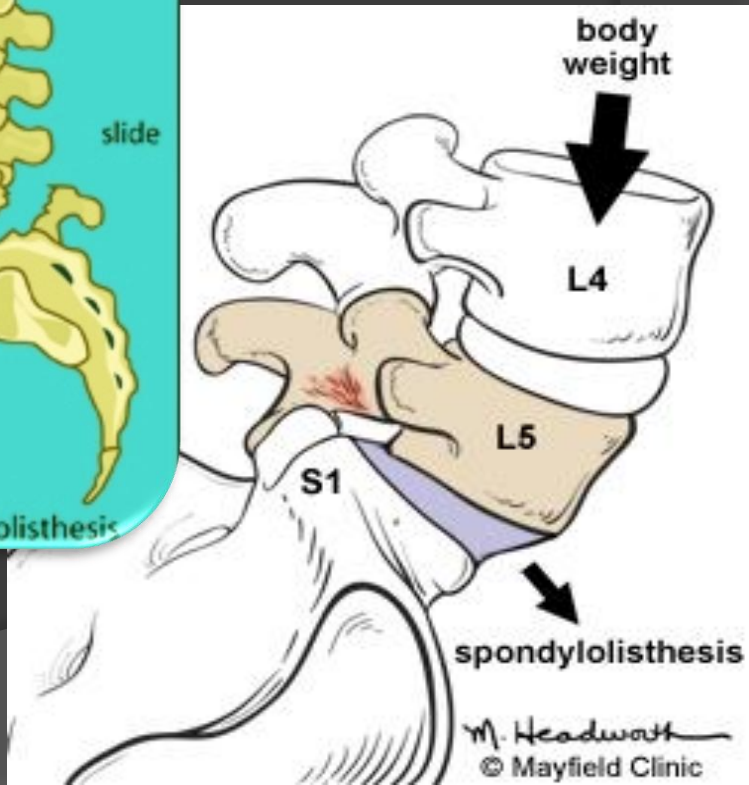


The upper and lower facet joints are connected by a narrow bridge called the **vertebral pedicle.**


Pars Interarticularis
Spondylolysis
(Stress fracture in the Pars Interarticularis)
Anterolisthesis
(Stress fracture and sliding of vertebra)
Spondylitis
(Inflammation in the vertebra that could lead to fusion)


spondylolysis
L4
L5
S1
M. Headworth
© Mayfield Clinic


fracture
slide
Spondylolysis
Spondylolisthesis

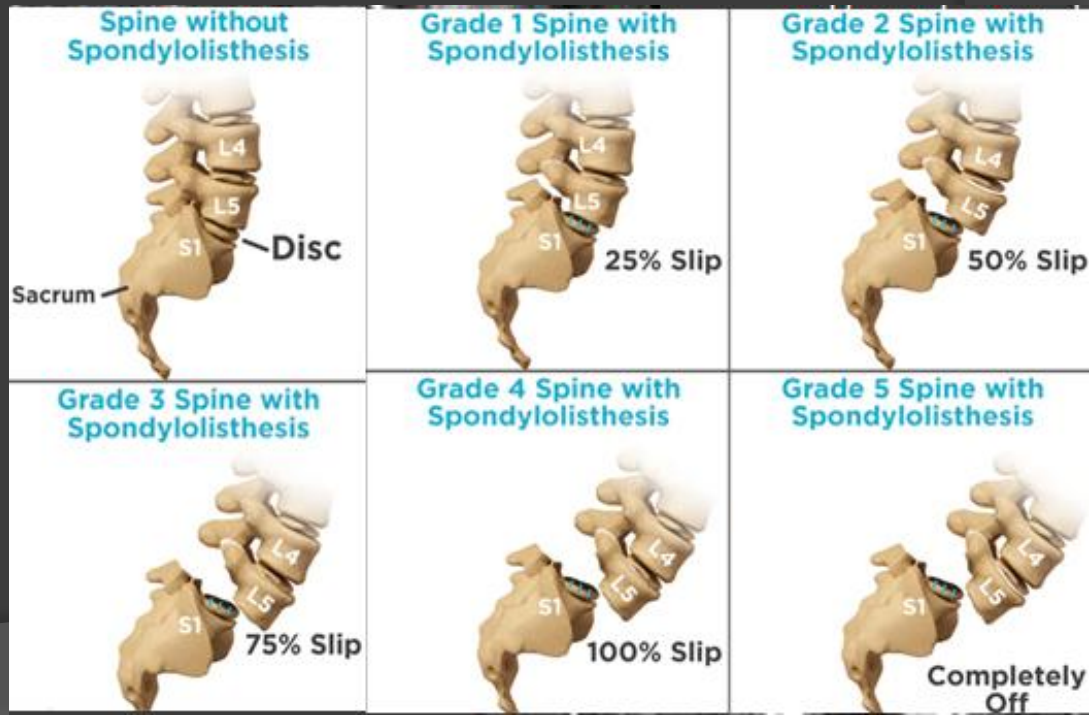

body weight
L4
L5
S1
spondylolisthesis
M. Headworth
© Mayfield Clinic

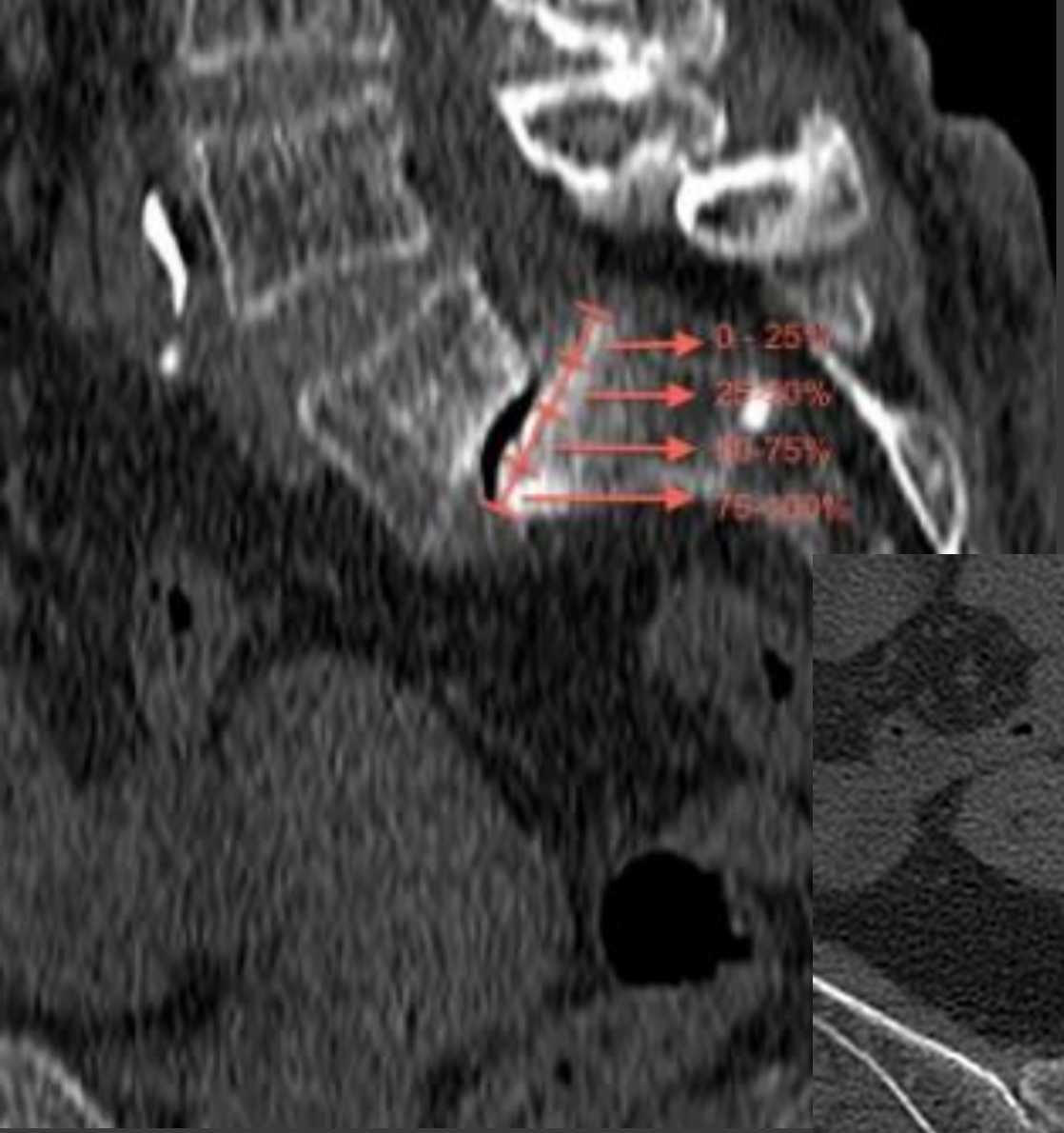
Spondylolisthesis

represents the sliding of a vertebra from the lower one, with the production of a subluxation or dislocation, being able to cause pain, instability and neurological changes

Depending on the direction of the dislocated vertebra from the underlying one, it is classified into **anterolisthesis** (sliding to the front - most common), **retrolisthesis** (sliding to the back) and **laterolisthesis** (sliding to the side). All cause spinal cord compression

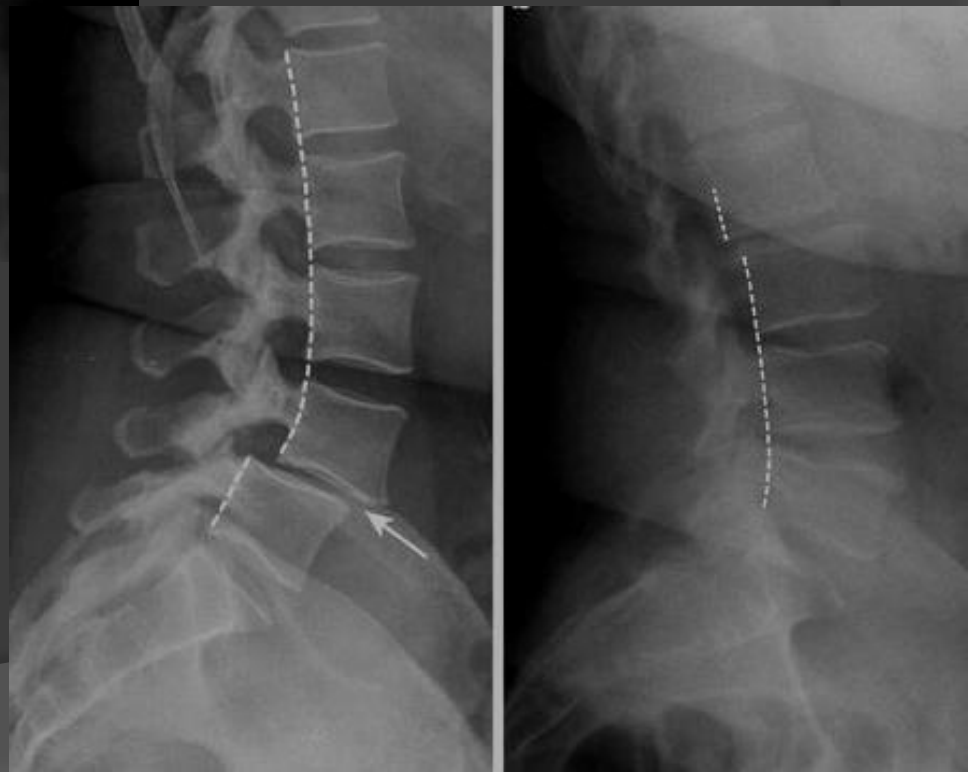
Depending on the percentage of sliding of the affected vertebral surface compared to the underlying one, spondylolisthesis can have 5 degrees of staging, from 25% to 100% and over (causing the vertebrae to collapse anteriorly - spondyloptosis).



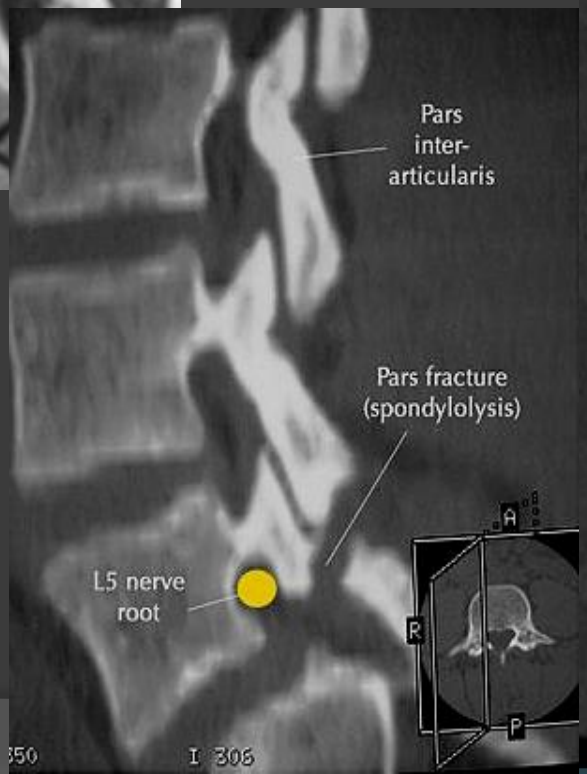


Spondylolisthesis (anterolisthesis) L5 / S1 grade II with degenerative changes (vacuum effect) of the pars interarticularis with spondylolysis.

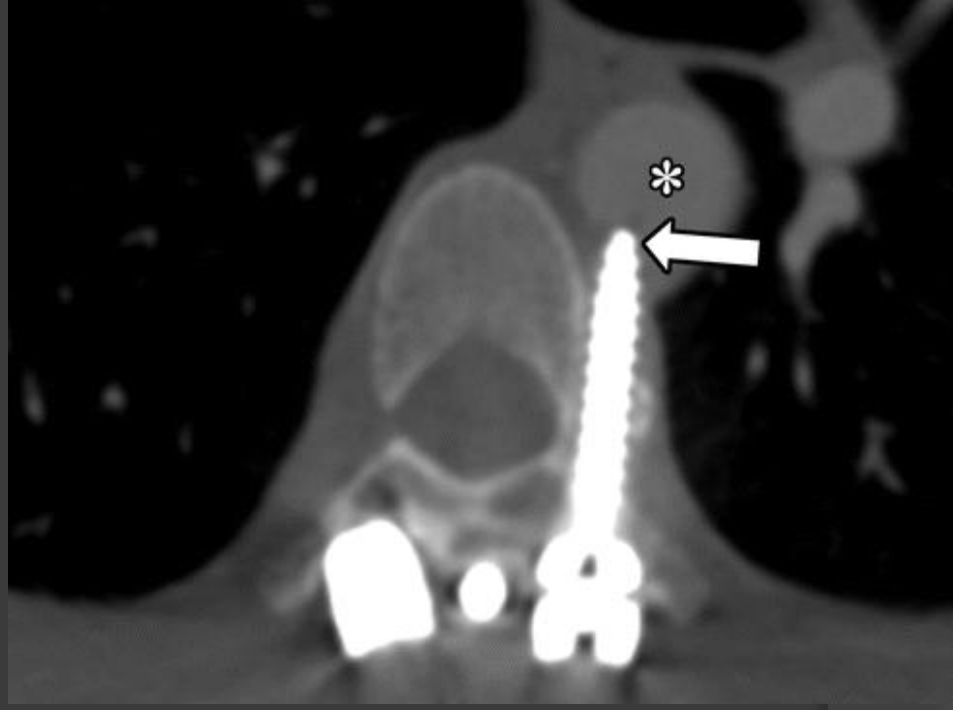
Spondylolysis or Spondylolisthesis

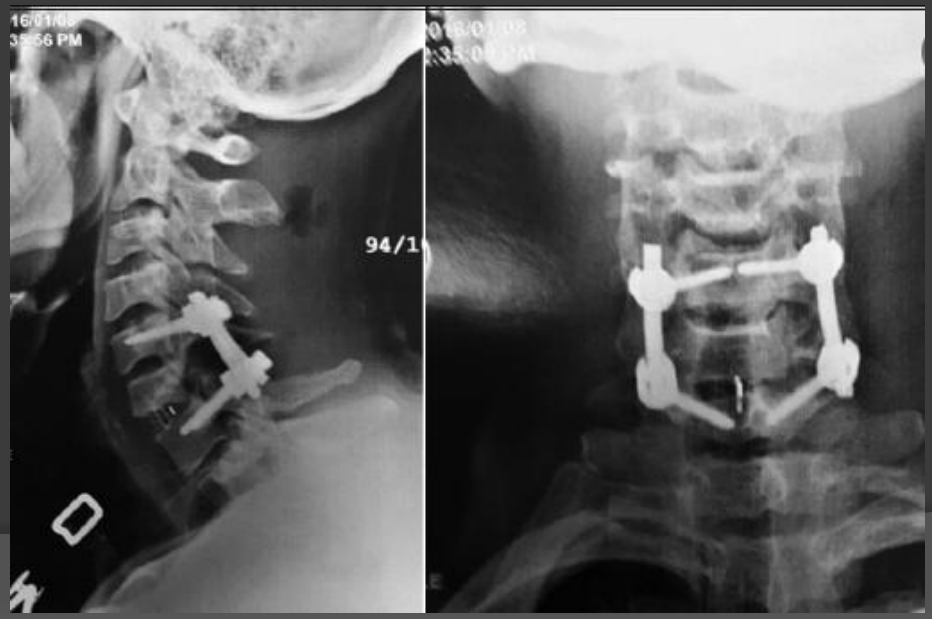


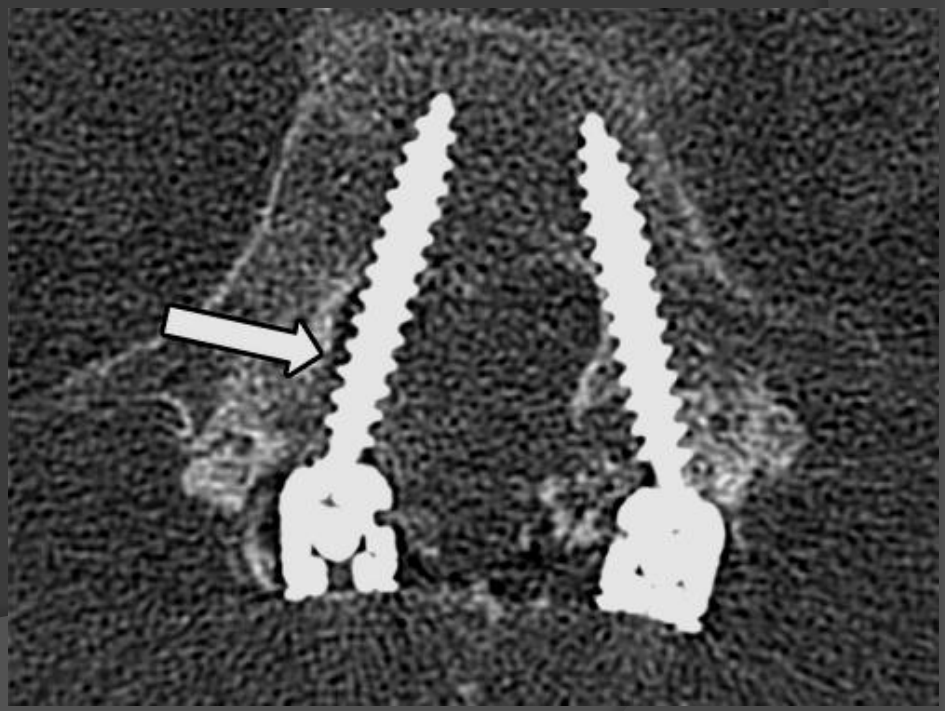
Spondylolysis or Spondylolisthesis or…?

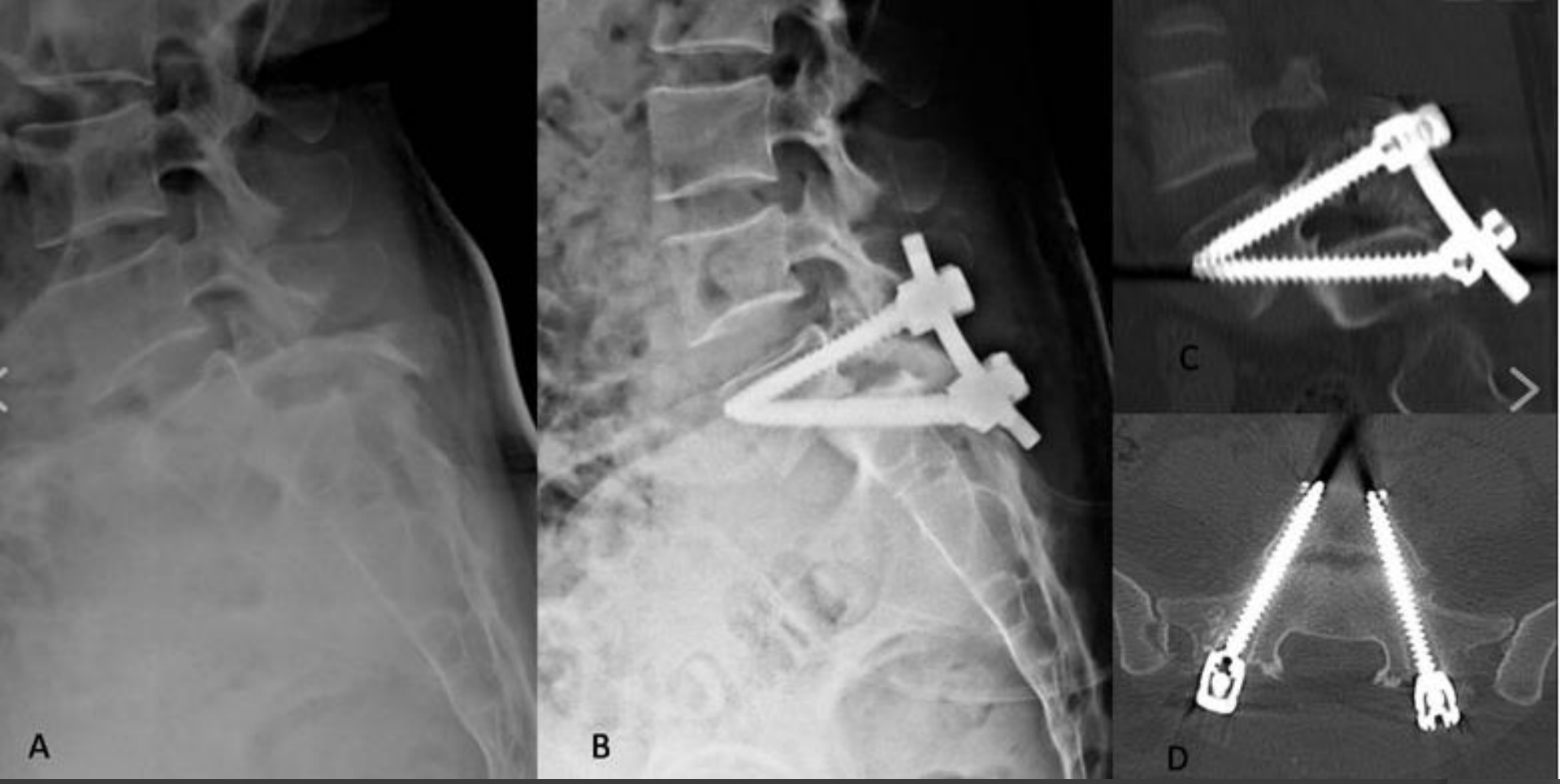


The screws and rods that were placed to realign the vertebrae on top of each other and create spinal fusion.









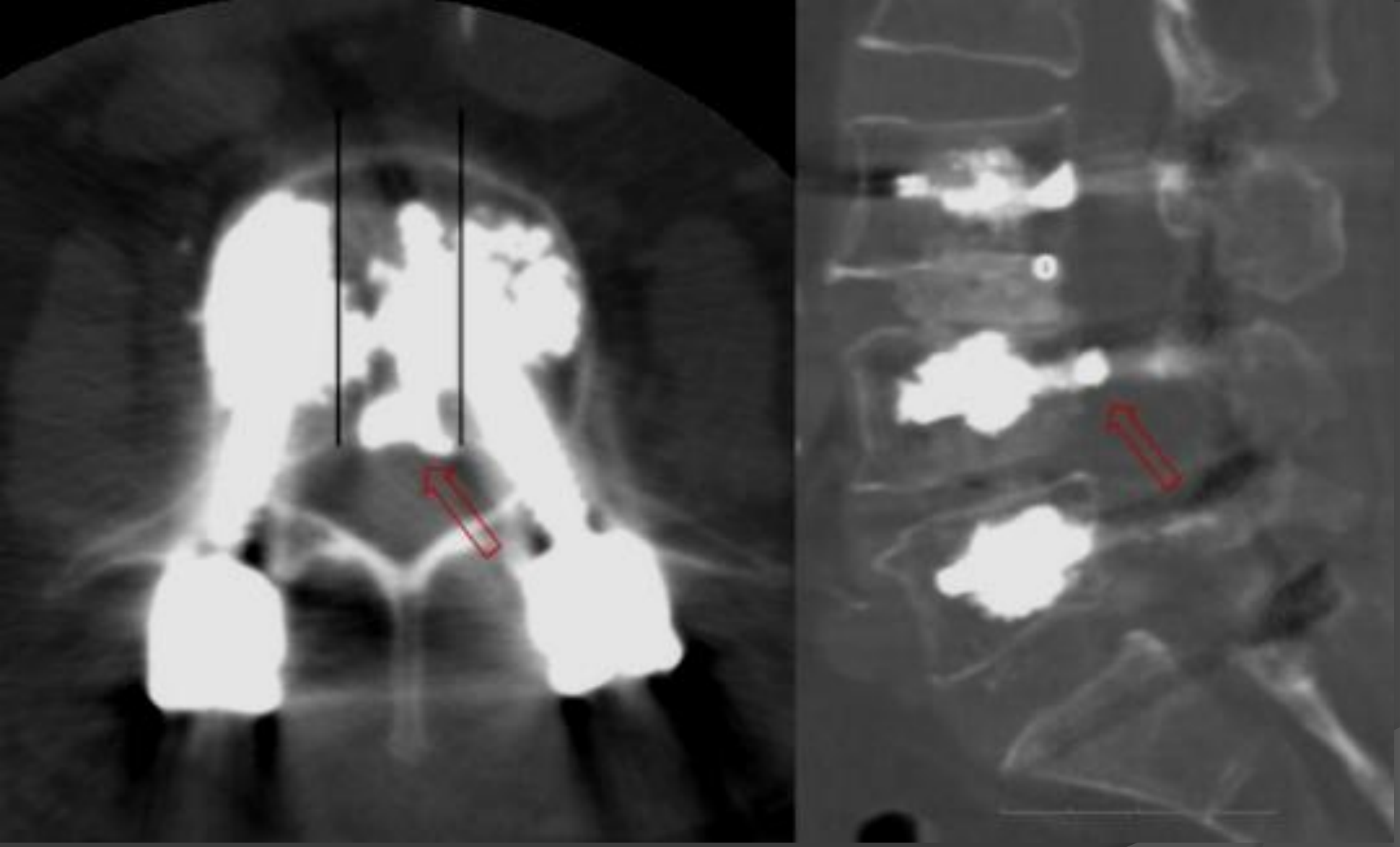
(A) Preoperative radiograph of a grade 3 spondylolisthesis, (B) Postoperative radiograph showing the position of the L5-S1 trans-sacral screw and (C and D) CT images of the trans-sacral screw fixation.

This is a 14-year-old gymnast who presented with chronic back pain without radicular symptoms.

(A) MRI in T2 and (B) simple lateral lumbar radiography shows a grade III spondylolisthesis, in addition to the slight inclination of L5 and deformation of the upper edge S1.

(C) L5-S1 axial T2 MRI imaging describes severe deformation at this level.

(D) Patient undergoing Transforaminal Lumbar Interbody Fusion (TLIF) at L4-5 and L5-S1



Vertebro-plasty with L3-L5 transforaminal lumbar interbody fusion

Postoperative CT scans illustrate the injection of bone cement into the inner part of the vertebral body with ventral epidural leakage of bone cement.

Ankylosing Spondylitis: Spinal Hallmarks

"Bamboo" Spine
extensive syndesmophytic ankylosis

"Dagger" Spine
ossification of the Posterior Longitudinal Ligament

Fusion of the **Sacroiliac joints** is again seen

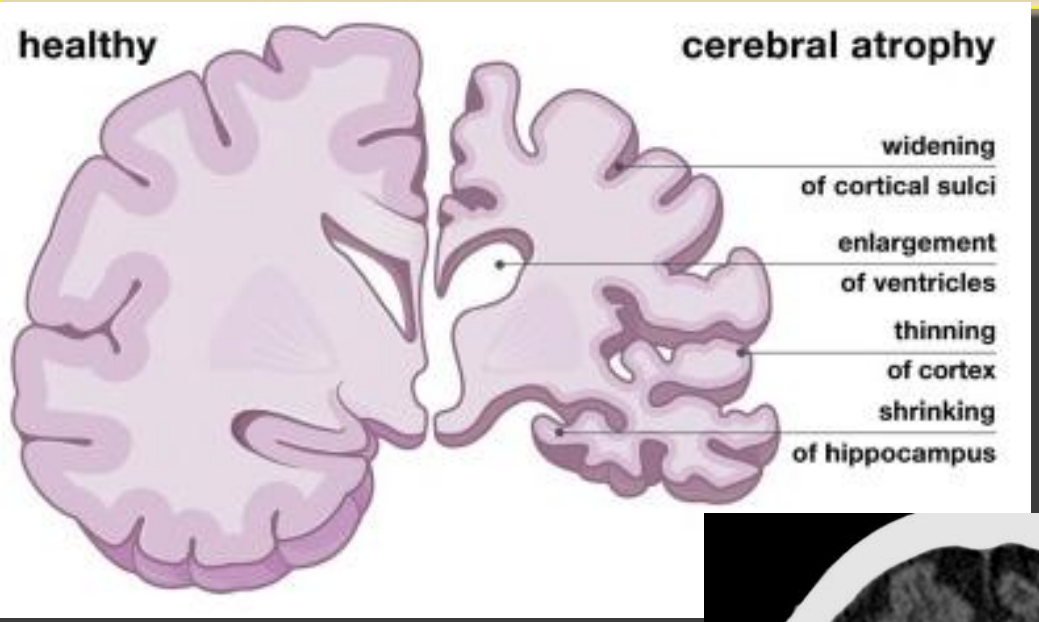
The influence of radio-imaging on neurological rehabilitation

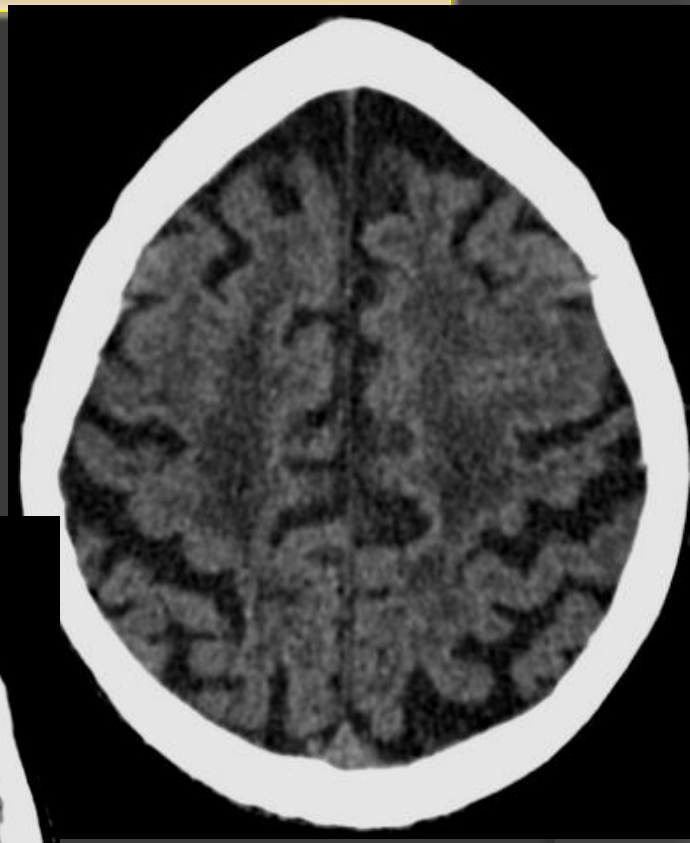
Some of the chronic conditions that can benefit from neurological rehabilitation may include:

1. Structural or neuromuscular disorders, such as brain or spinal cord tumors (after surgery)

2. Degenerative disorders such as changes after ischemic or haemorrhagic stroke; post-traumatic results, Parkinson's disease, multiple sclerosis, Alzheimer's disease and Huntington's disease

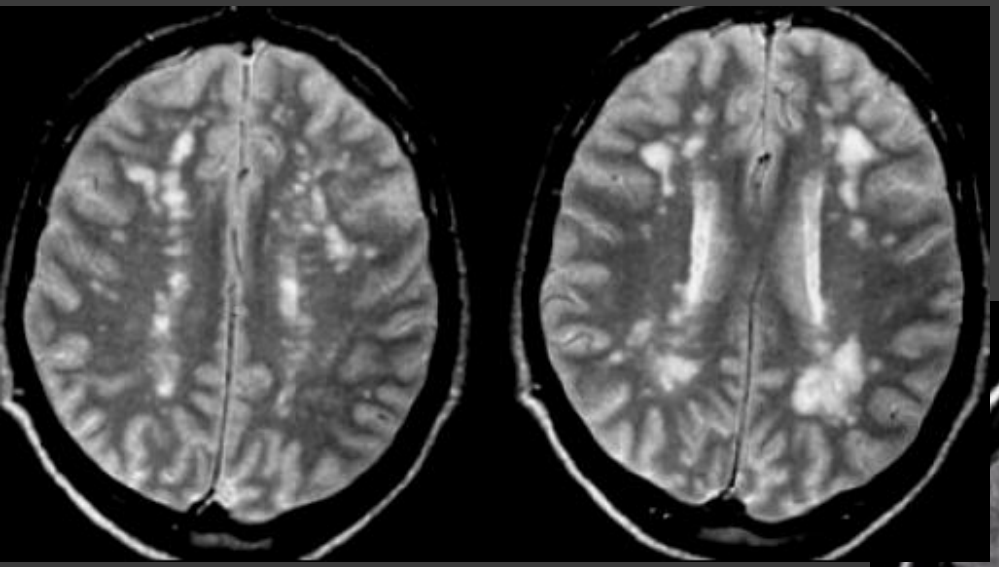
Generalized age-related brain atrophy

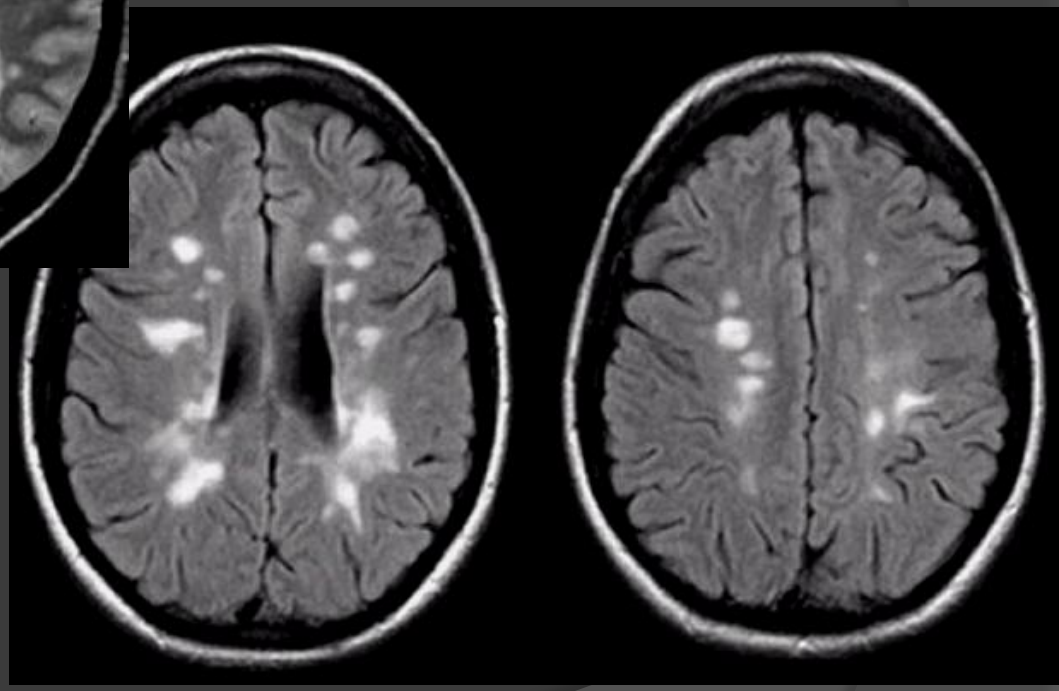




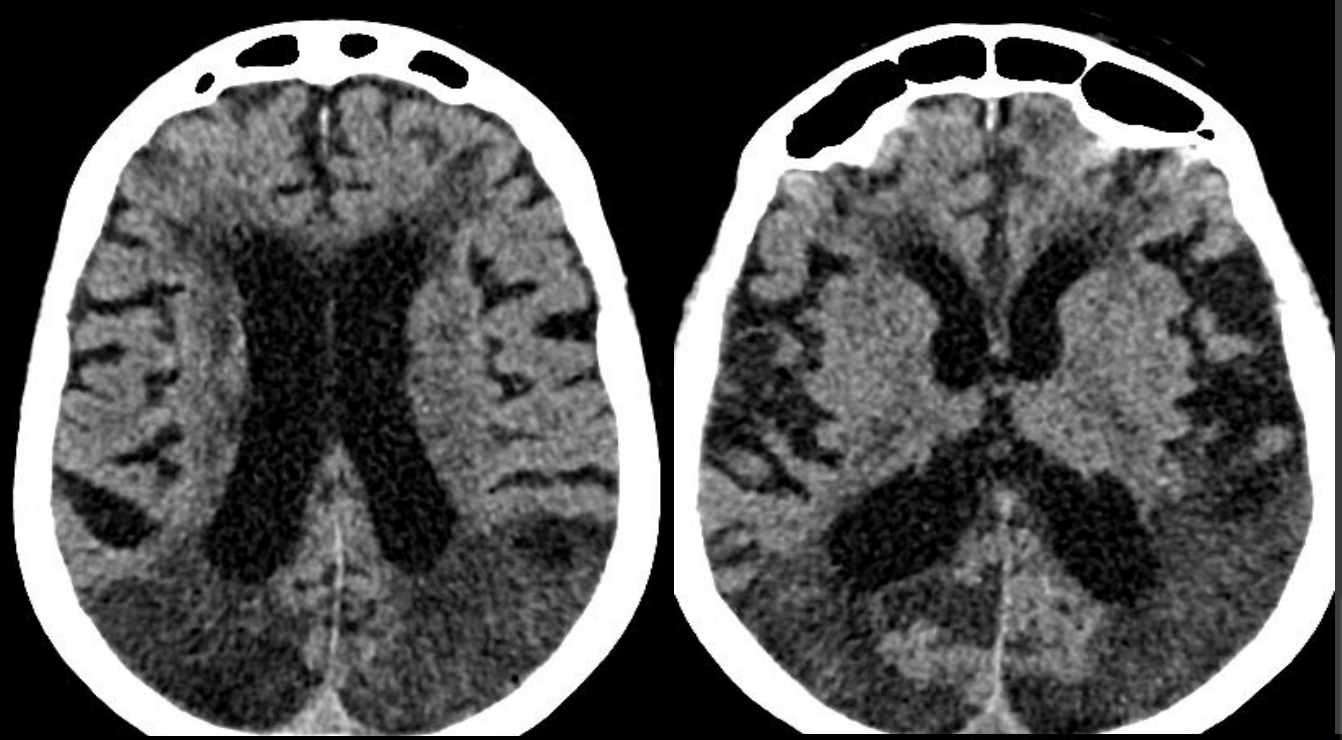
MULTIPLE SCLEROSIS

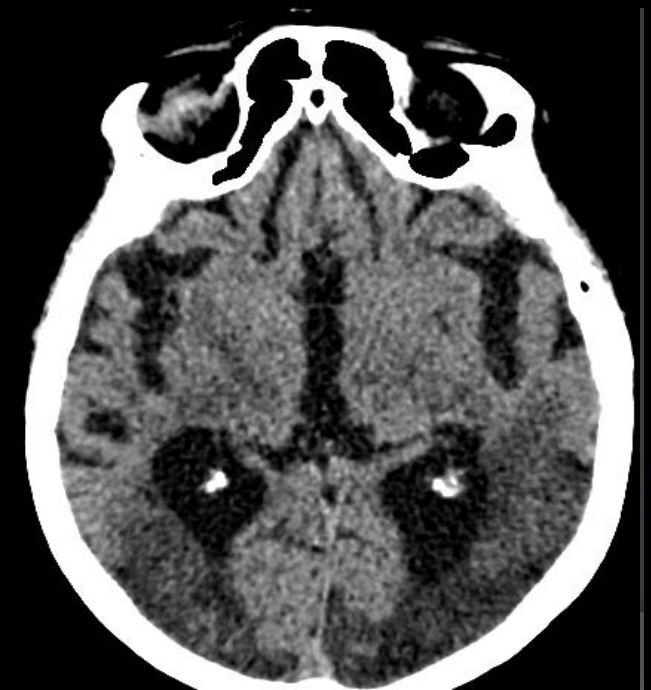
MRI imaging is the most important paraclinical tool for diagnosing and monitoring MS

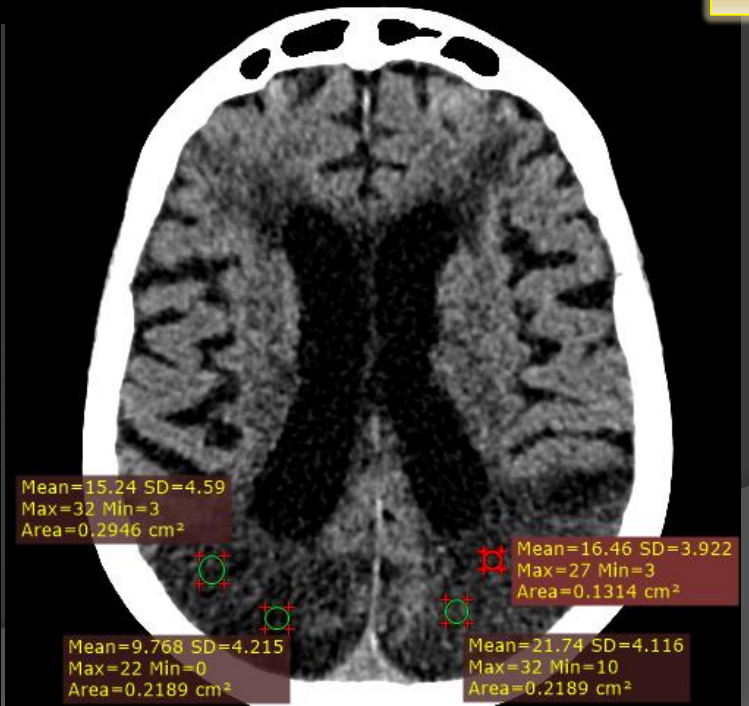




Can be seen the numerous demyelinating lesions in several areas of the white matter. Most lesions are near the ventricles. Several are aligned perpendicular to the ventricles, a sign that is often seen in MS and commonly referred to as "Dawson's fingers". Over time, demyelinating lesions may become confluent.

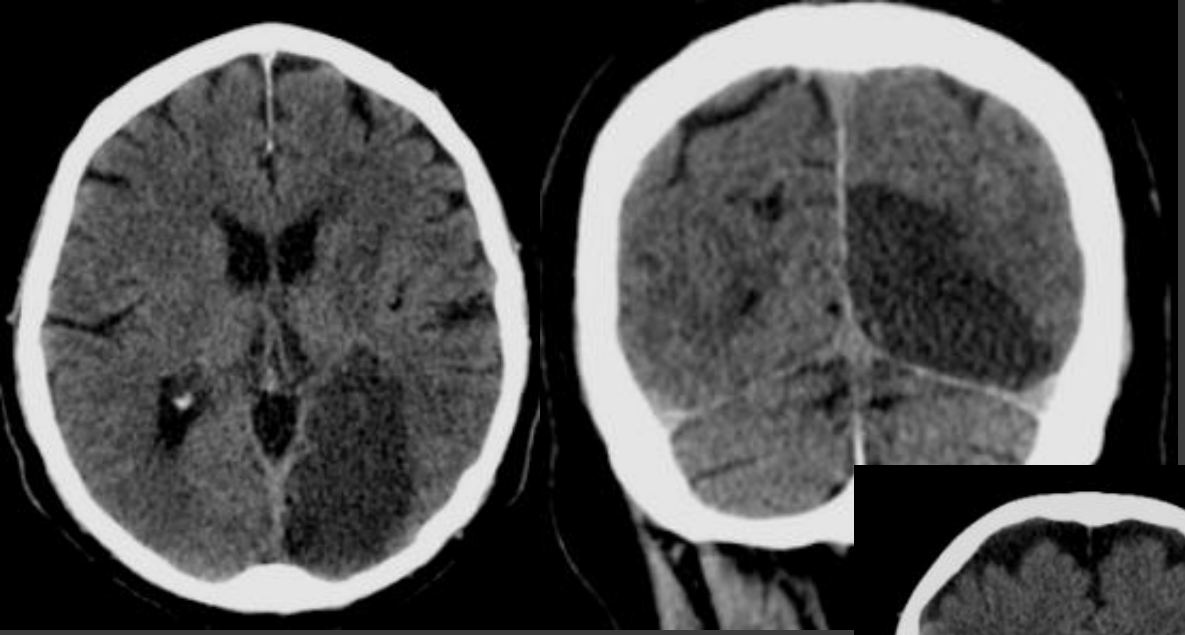


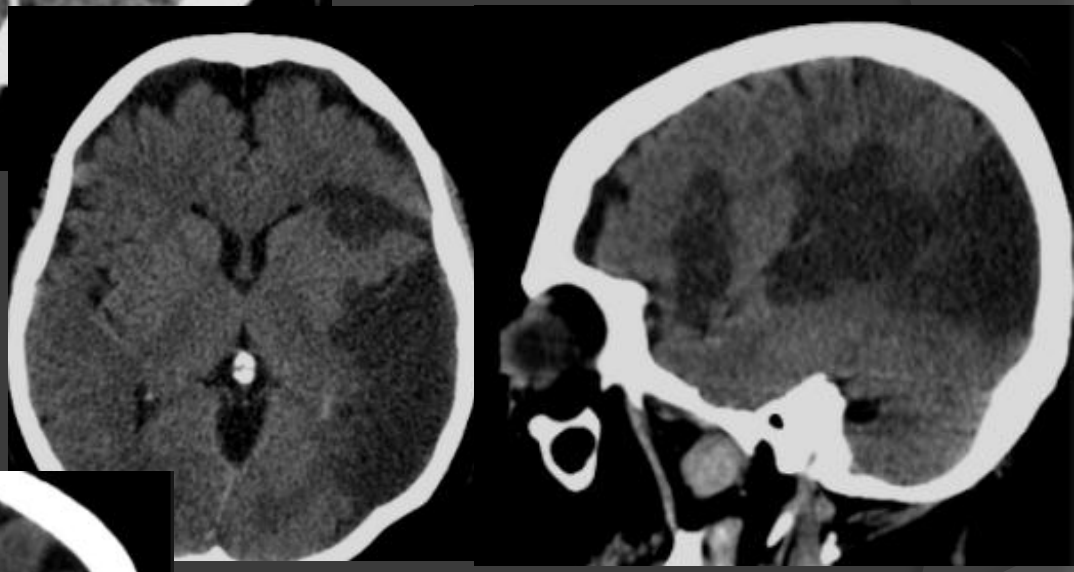


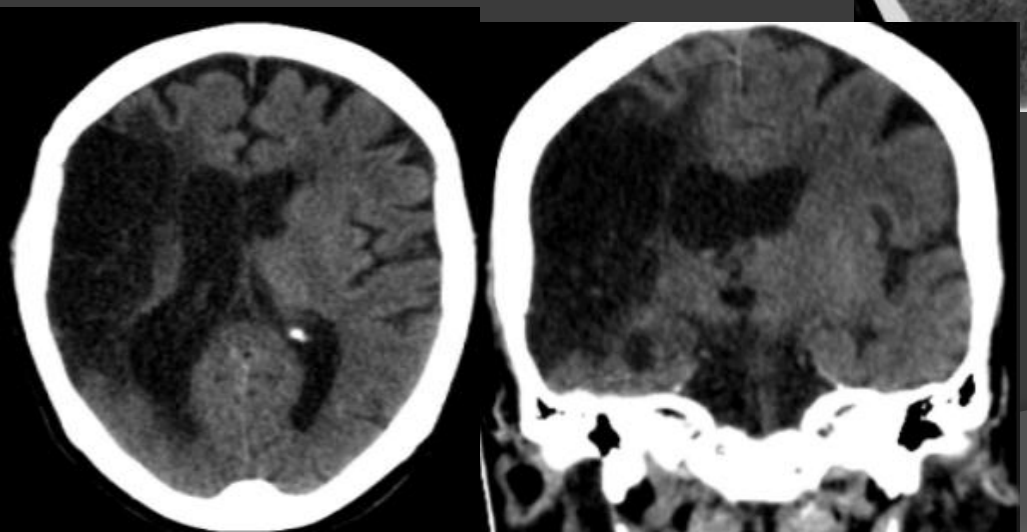


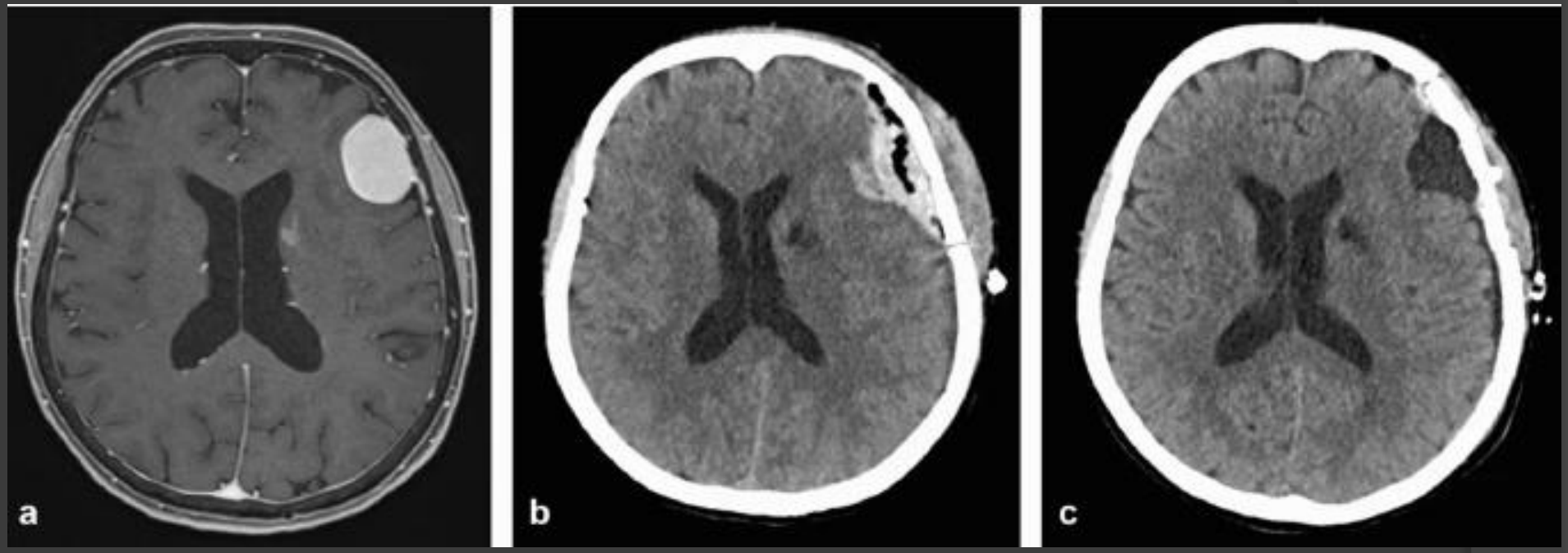
Old ischemic stroke changes

Old ischemic stroke changes









(a) A 71-year-old patient underwent surgery for a left frontal convex meningioma.

(b) On the fourth postoperative day, the emergency CT scan showed a relevant epidural hematoma, which was surgically removed.

(c) Postoperative CT scan after removal of the epidural clot.

Thank you for your attention !!!