

RADIOLOGY of HEMATOPOIETIC DISORDERS

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BLOOD

CELLS

RBCs

WBCs

Platelets

PLASMA

BLOOD

CELLS



RBCs

Sickle cell

Anemia Thalassemia

Others – nutritional, hemolysis etc.

Polycythemia

WBCs

Platelets

PLASMA

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RBCs

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Anemia Thalassemia

Others – nutritional, hemolysis etc.

Polycythemia

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Lymphoma

Leukemia

Multiple myeloma

Platelets

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Anemia Thalassemia

Others – nutritional, hemolysis etc.

Polycythemia

WBCs

Lymphoma

Leukemia

Multiple myeloma

Platelets

Bleeding / clotting disorders

PLASMA



A

Reactive increase
in red bone marrow



Expanded bone marrow in bones including long bones
of hands, feet, limbs, skull
Decreased T1 MRI signal in vertebral body bone
marrow than adjacent discs

N

New marrow areas
in potential organs



Liver, Spleen, Lymph nodes, Thymus, Paraspinal areas
with possible extension into spinal canal outside the
dura,
Kidneys, Meninges, Skin

E

M

I

A

Transfusions
Iron overload



Increased CT density (brightness) and changes in MRI
signal of liver & spleen

SCA

Infections



Pneumonias, Osteomyelitis

Infarcts



Spleen, Kidneys, Brain, Bones

Thalassemia

Decreased bone density with coarse trabeculae

Wide medullary cavity with thin cortex



Normal for comparison

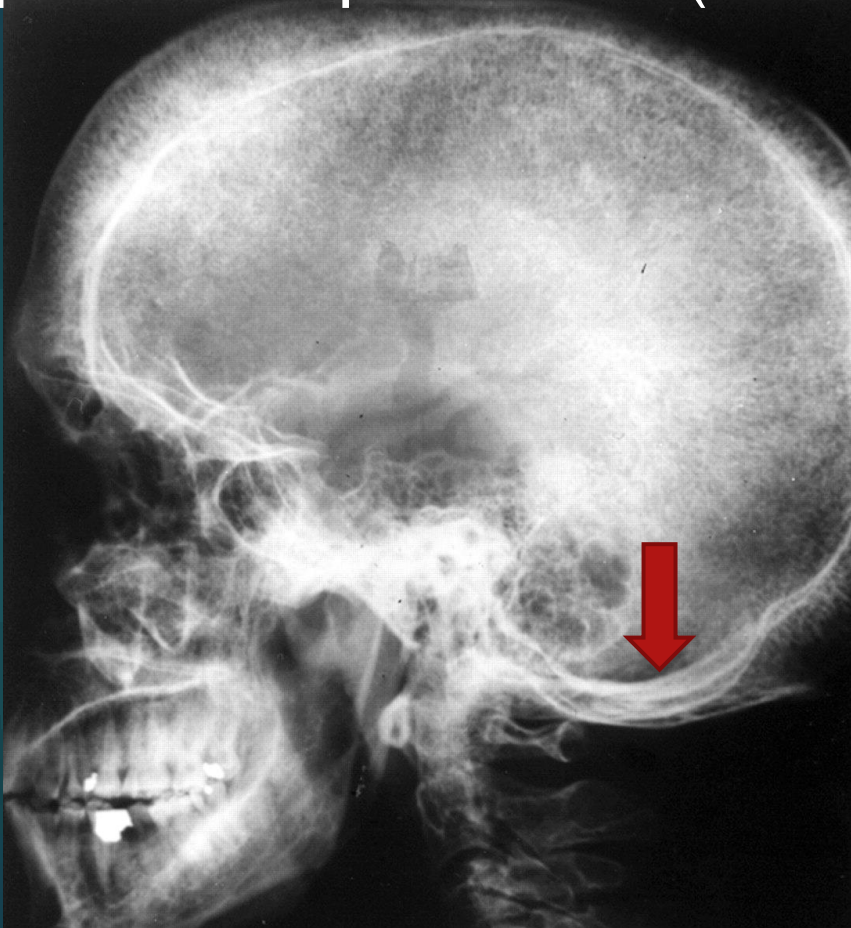


Severe chronic anemia



Normal for comparison

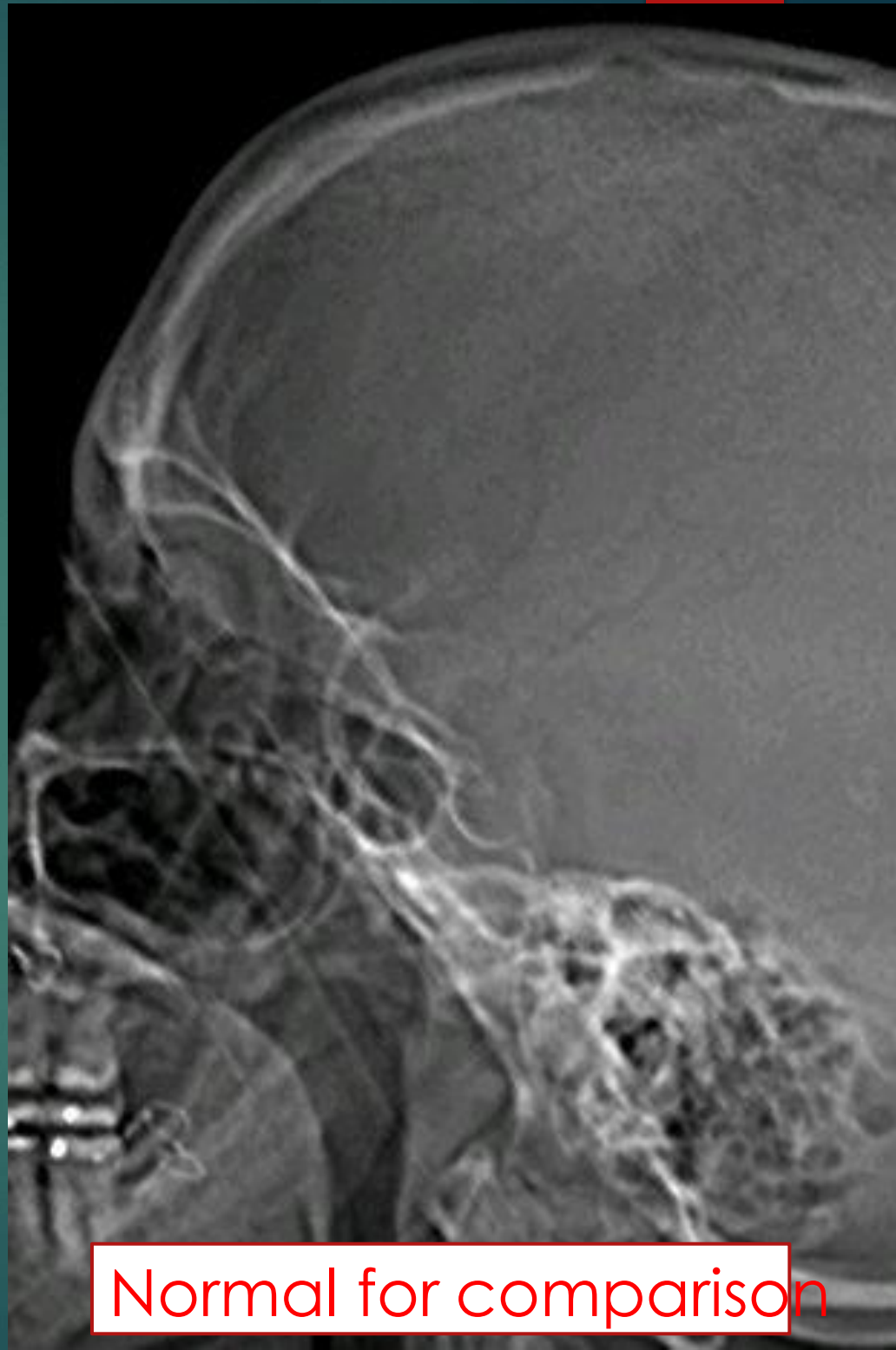
25-year-old man with β -thalassemia.
Lateral skull radiograph shows
expansion of diploic space with hair-on-end appearance
widened groove for middle meningeal artery
Spared occipital bone (arrow)



Normal for comparison

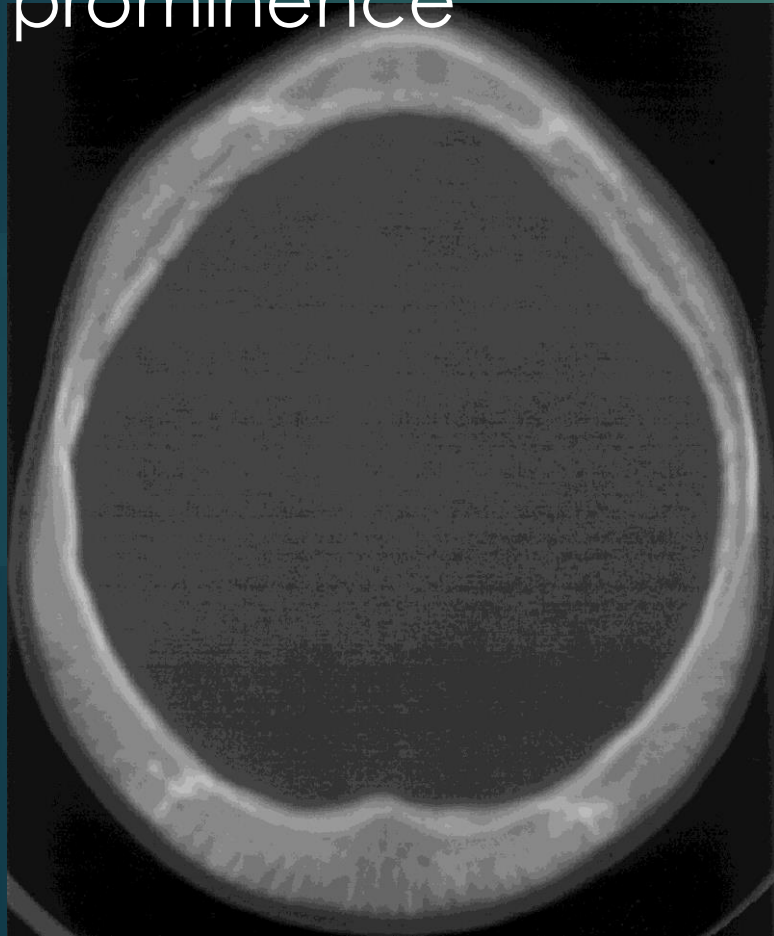


Severe chronic anemia

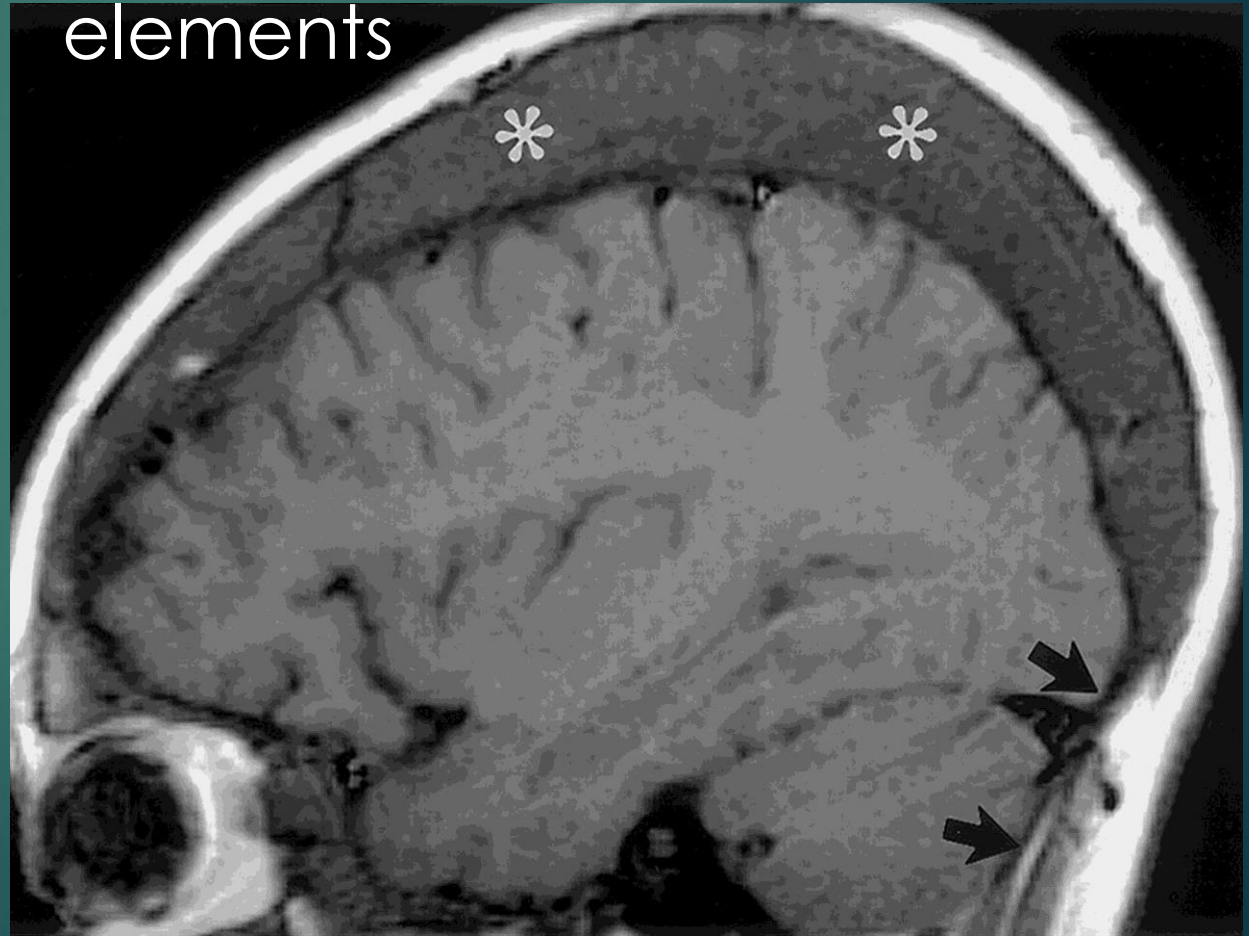


Normal for comparison

Axial CT image of upper skull (left) shows diploic space widening and trabecular prominence

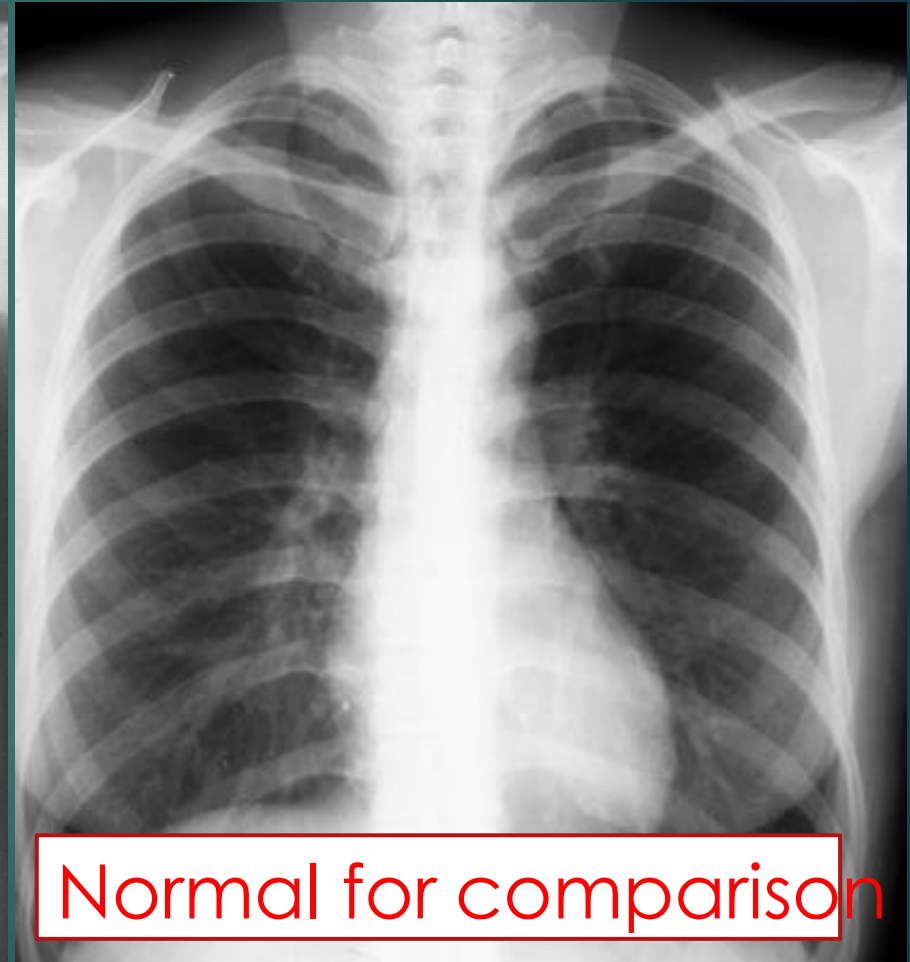
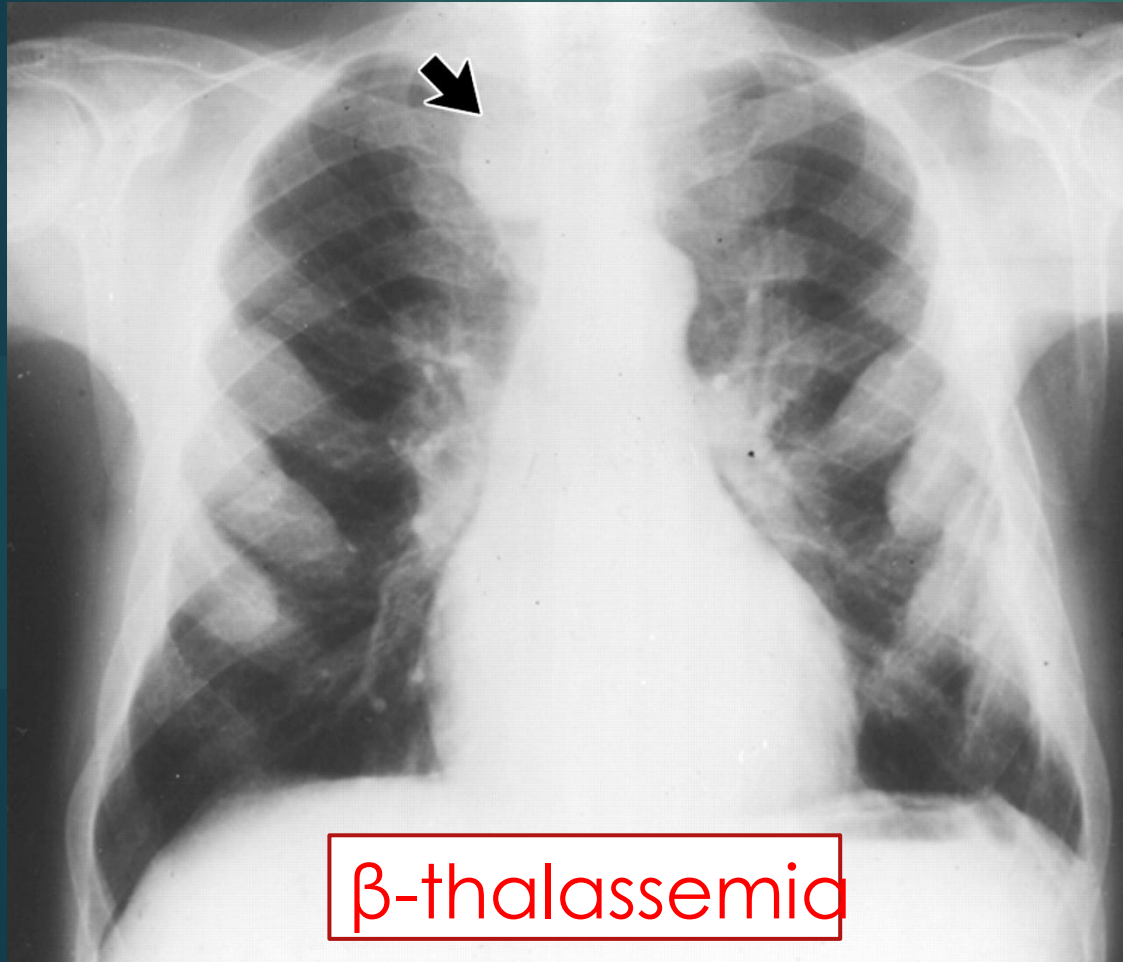


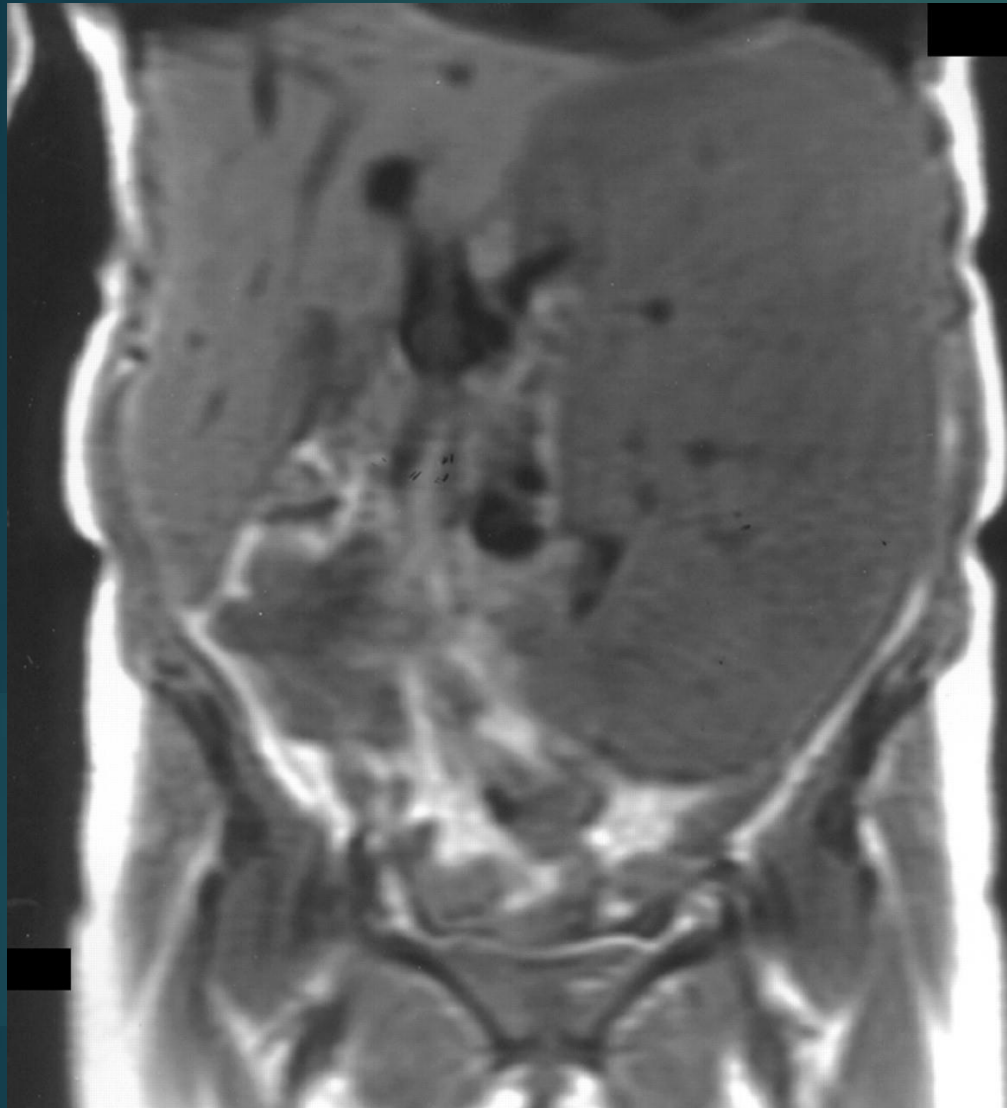
Sagittal MRI of brain (right) shows diploic space widening representing red marrow (*). Note spared occipital bone (arrows), which has no marrow elements



25-year-old man with β -thalassemia.

PA radiograph of chest (left) shows diffuse expansion of ribs and right upper paraspinal thoracic mass (arrow) compatible with extramedullary hemopoiesis.





51-year-old woman with myelofibrosis.

Coronal T1-weighted MR image shows massively enlarged spleen

Splenic biopsy was followed by splenectomy

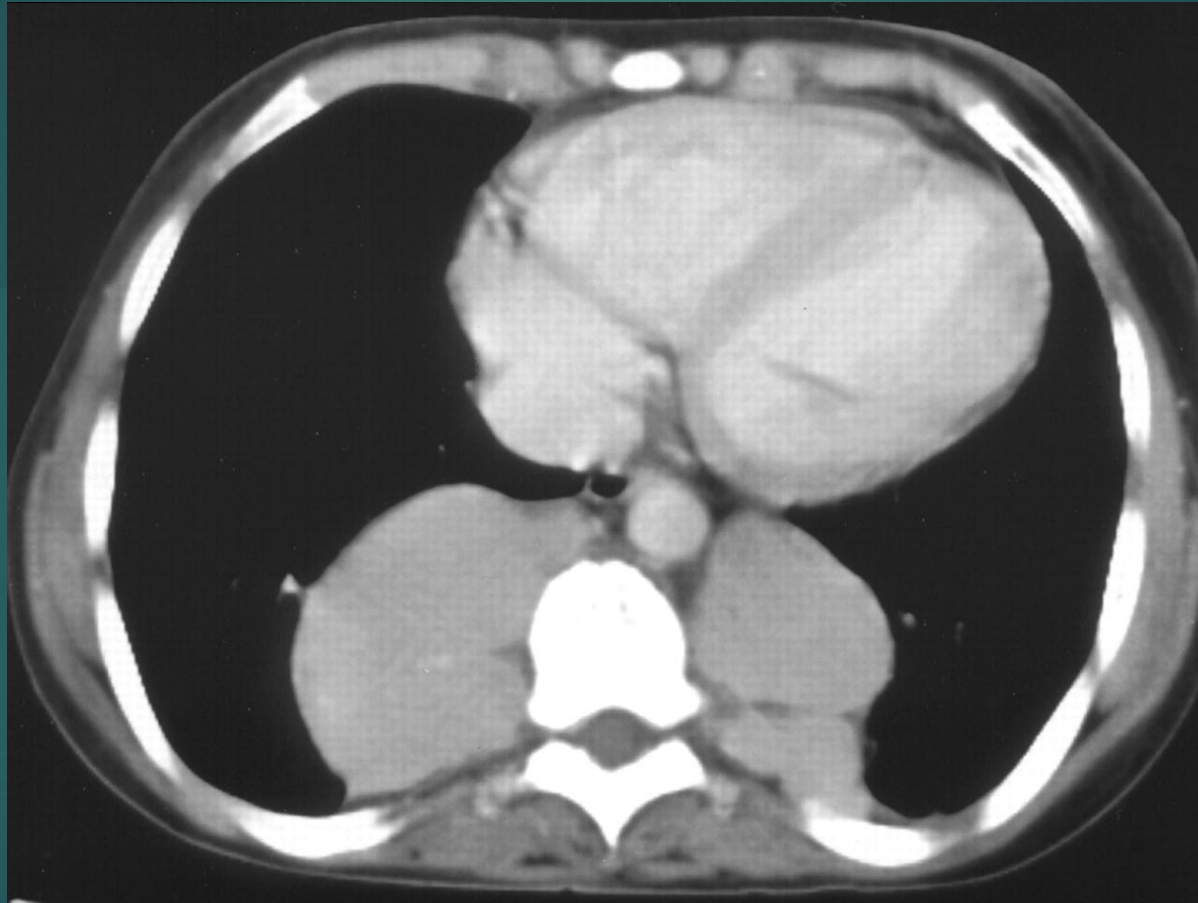
Pathologic examination revealed extramedullary hematopoiesis



23-year-old woman
with history of
thalassemia and
known extramedullary
hemopoiesis

PA chest film shows
well-marginated
bilateral, paraspinal
masses compatible
with extramedullary
hemopoietic tissue

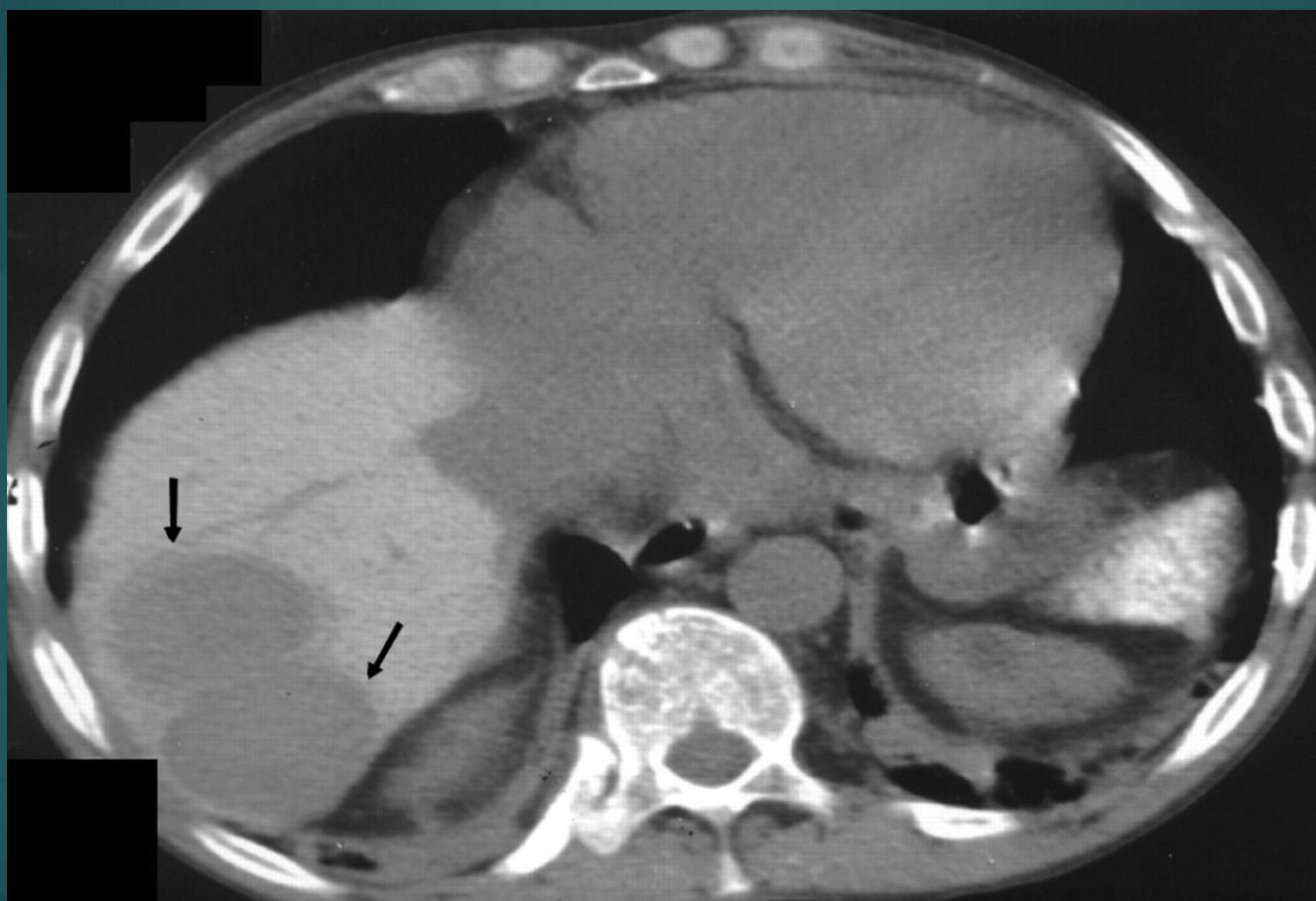
23-year-old woman with history of thalassemia and known extramedullary hemopoiesis. Axial contrast-enhanced CT scan through chest shows uniformly enhancing paraspinal hemopoietic masses with no bony erosion.



40-year-old man with sickle cell disease

Axial unenhanced CT scan at thoracoabdominal level reveals two uniformly low-attenuation (compared with liver parenchyma), well circumscribed lesions (arrows)

Percutaneous biopsy showed extramedullary hemopoiesis



56-year-old man with myelofibrosis

Axial contrast-enhanced CT scan through kidneys reveals bilaterally symmetric enhancing perinephric masses.

Biopsy showed extramedullary hematopoiesis





48-year-old man with hemolytic anemia and myelofibrosis

Axial CT scan through pelvis shows

well-margined presacral soft-tissue mass (arrow) with no bony erosion

Biopsy (not often needed) showed extramedullary hematopoiesis

Sickle cell disease may be manifested as

ANEMIA

Growth failure

Hyperkinetic heart failure

Expanded intramedullary hematopoiesis

Presence of extramedullary hematopoiesis

VASO-OCCLUSION

Infarcts in spleen, bone marrow, kidney,
bowel, brain, muscles etc.

SUPERIMPOSED INFECTION

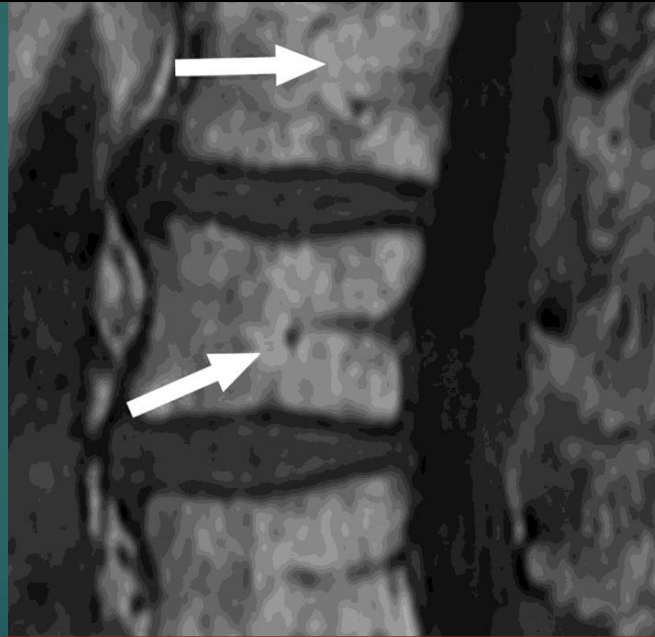
Pneumonia (*Pneumococcus*, *H. influenzae*,
Staph. aureus, *Chlamydia*, and *Salmonella*)
Osteomyelitis (*Salmonella*)

Red marrow in vertebral bodies in a 7-year-old girl with Sickle Cell Anemia.

Sagittal T1-weighted MRI of spine shows

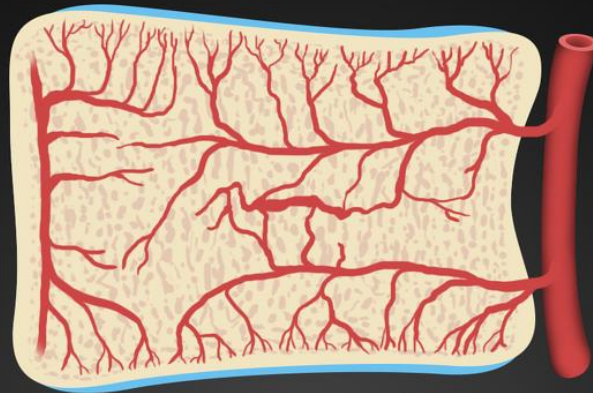
Low signal intensity in vertebral bodies compared to discs

H-shaped vertebrae (arrows in right image) due to **osteonecrosis** of vertebral endplates

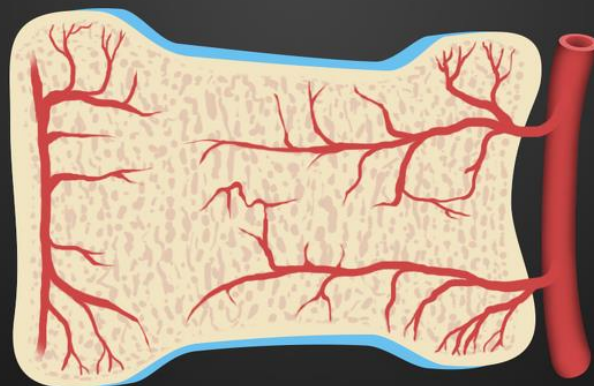


Normal for comparison





normal



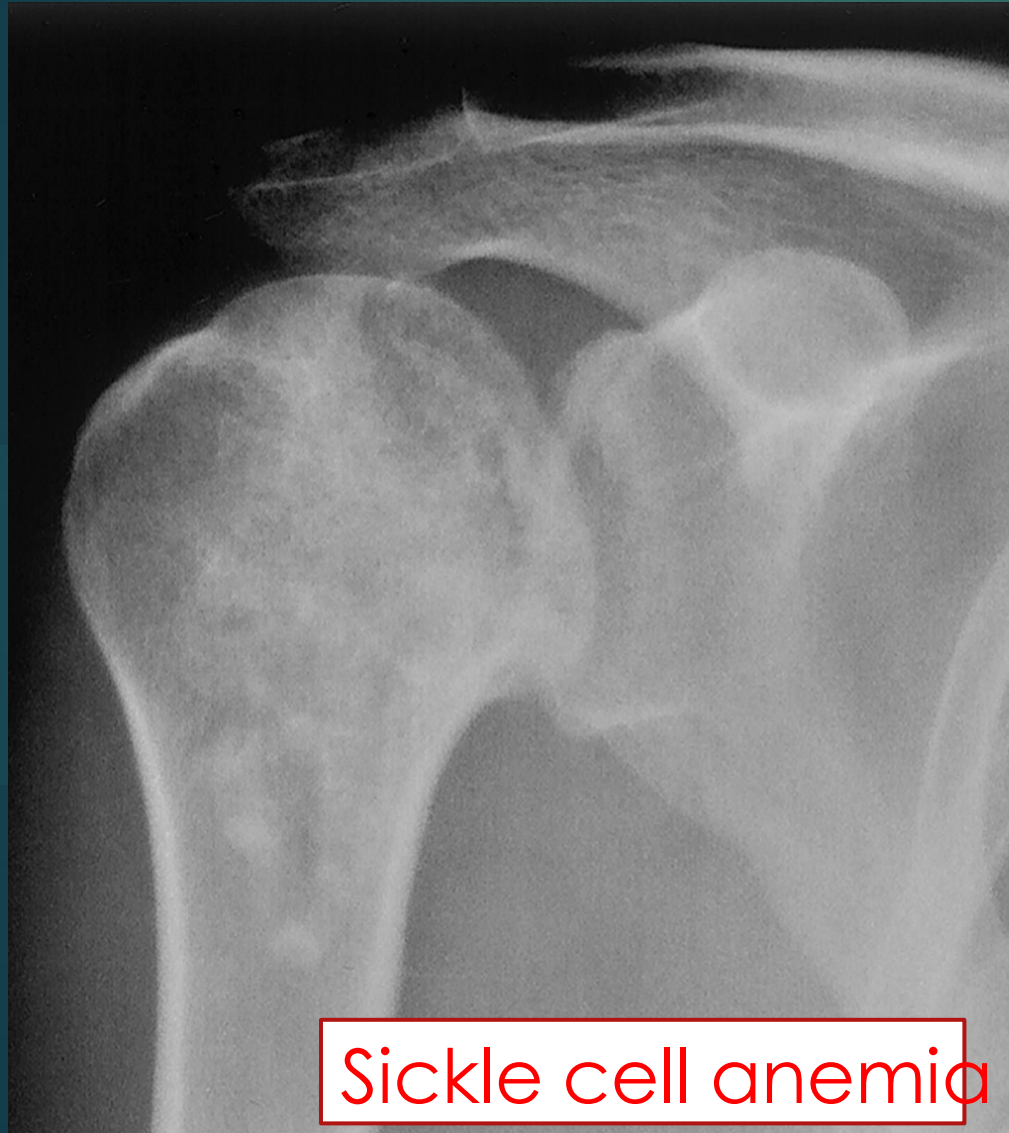
sickle cell anemia

Bone infarcts typically occur in the medullary cavities and epiphyses

Epiphyseal infarcts are frequently seen in the femoral and humeral heads, and more often bilateral than avascular necrosis due to other diseases

Medullary bone infarcts in SCA

Frontal radiograph of right shoulder in a 22-year-old patient shows an area of patchy sclerosis and radiolucency

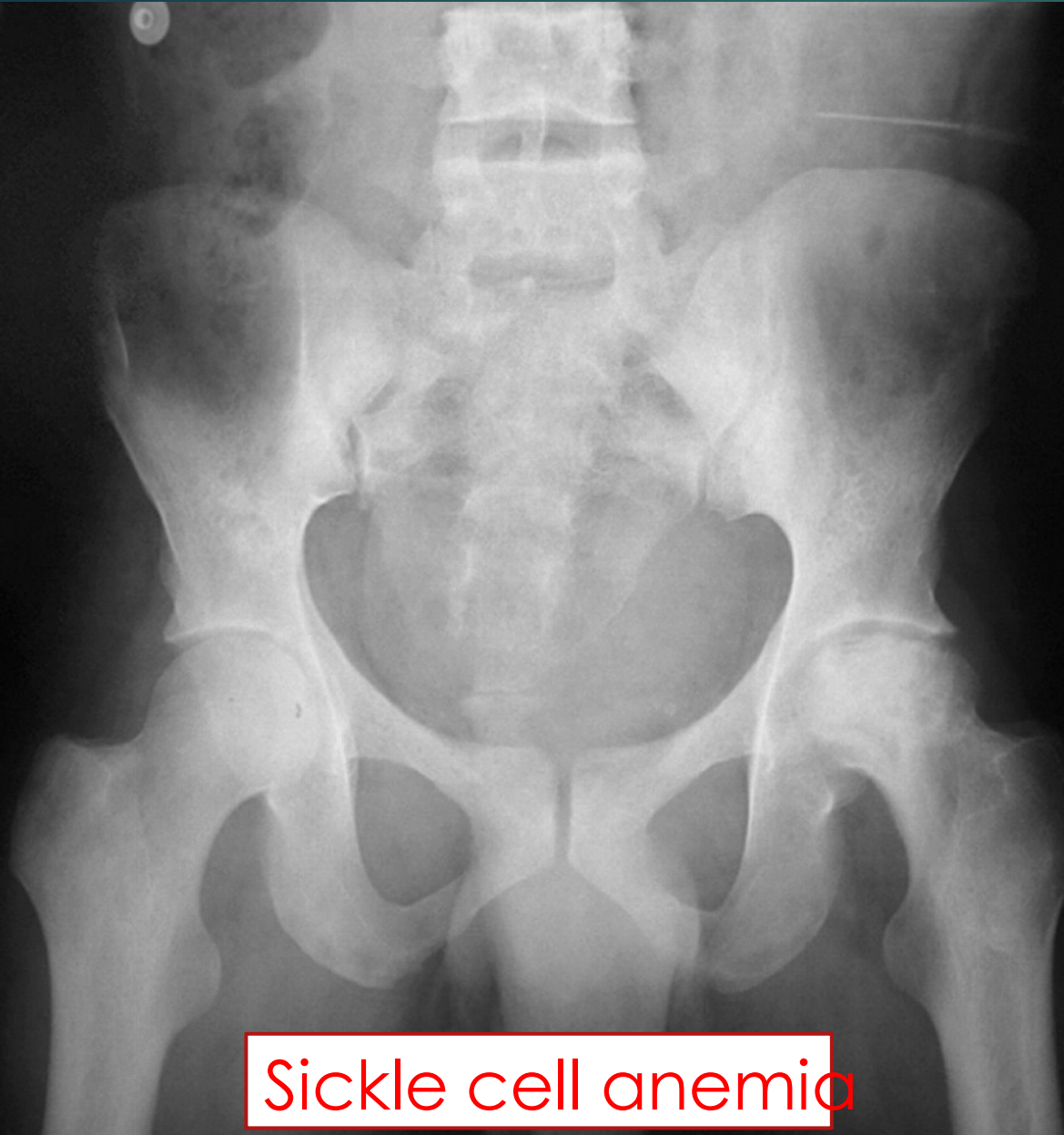


Sickle cell anemia



Normal for comparison

AP radiograph in a 44-year-old man shows advanced avascular necrosis in left hip and a normal right hip



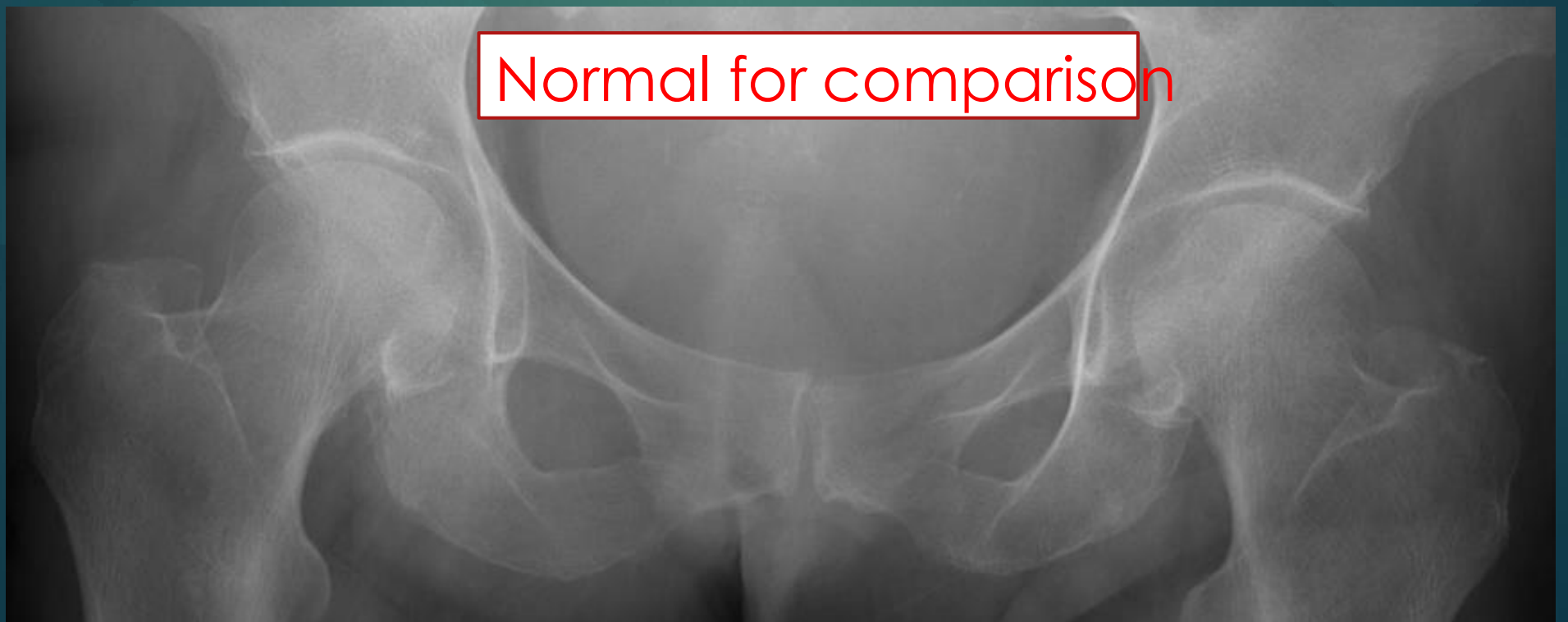
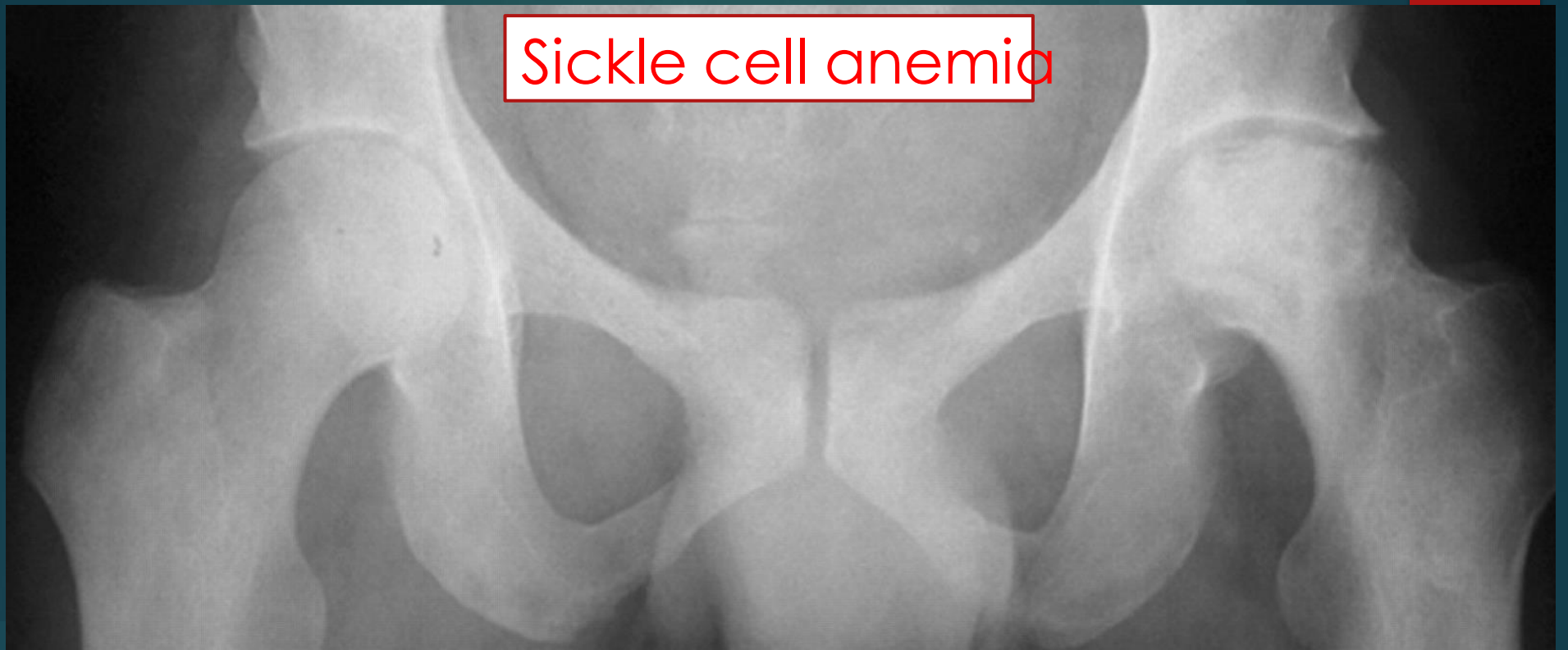
Sickle cell anemia



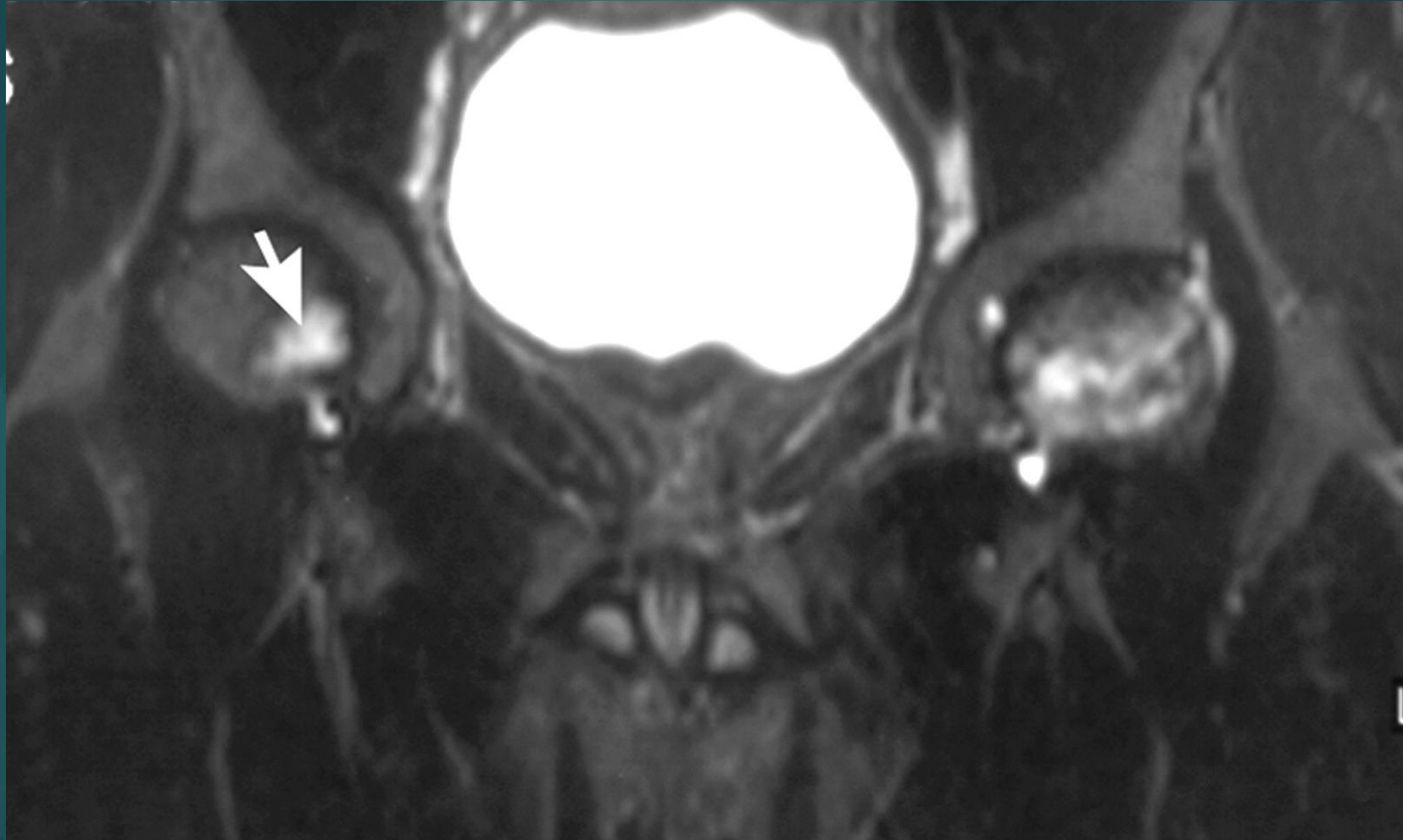
Normal for comparison

Sickle cell anemia

Normal for comparison



Coronal STIR MR image in the same patient shows stage 1 avascular necrosis in right hip (arrow) as well, in addition to advanced changes of avascular necrosis of left femoral head



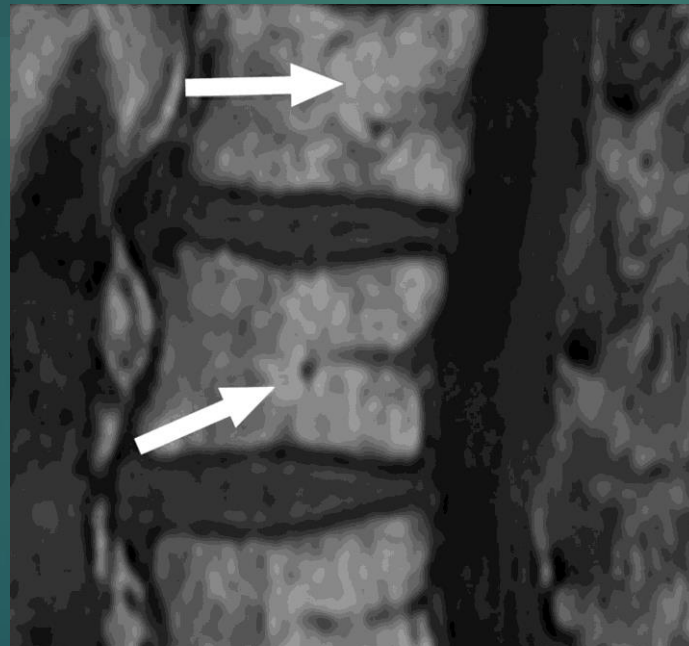
H-shaped vertebrae in a 15-year-old patient with SCA
Lateral radiograph of spine shows classic boxlike endplate depressions in middle portion (see the lowest vertebra shown) due to osteonecrosis of the vertebral endplates



Normal for comparison

Red marrow vertebral bodies in a 7-year-old girl with SCA.

Sagittal T1-weighted MRI of spine shows low signal intensity in vertebral bodies compared to discs, and H-shaped vertebrae (arrows in right image) due to osteonecrosis of vertebral endplates



Normal for comparison



Hand-foot syndrome (dactylitis) in SCA

Frontal radiograph of right foot in a 3-year-old girl shows thick periostitis and subperiosteal new bone along the metatarsal shafts



Salmonella osteomyelitis in
a 10-year-old boy with
SCA

Initial film (left) at onset of
lower shin pain and fever is
normal

Film 7 days later (right)
shows mottled lower tibial
shaft and diffuse periostitis
of the lower diaphysis



Bone infarcts and osteomyelitis are difficult to differentiate on history, clinical examination and plain x-ray images but are very important to avoid complications of osteomyelitis

MRI findings of

- Cortical defects in bone

- Adjacent **fluid collections** in soft tissue

- Bone marrow enhancement

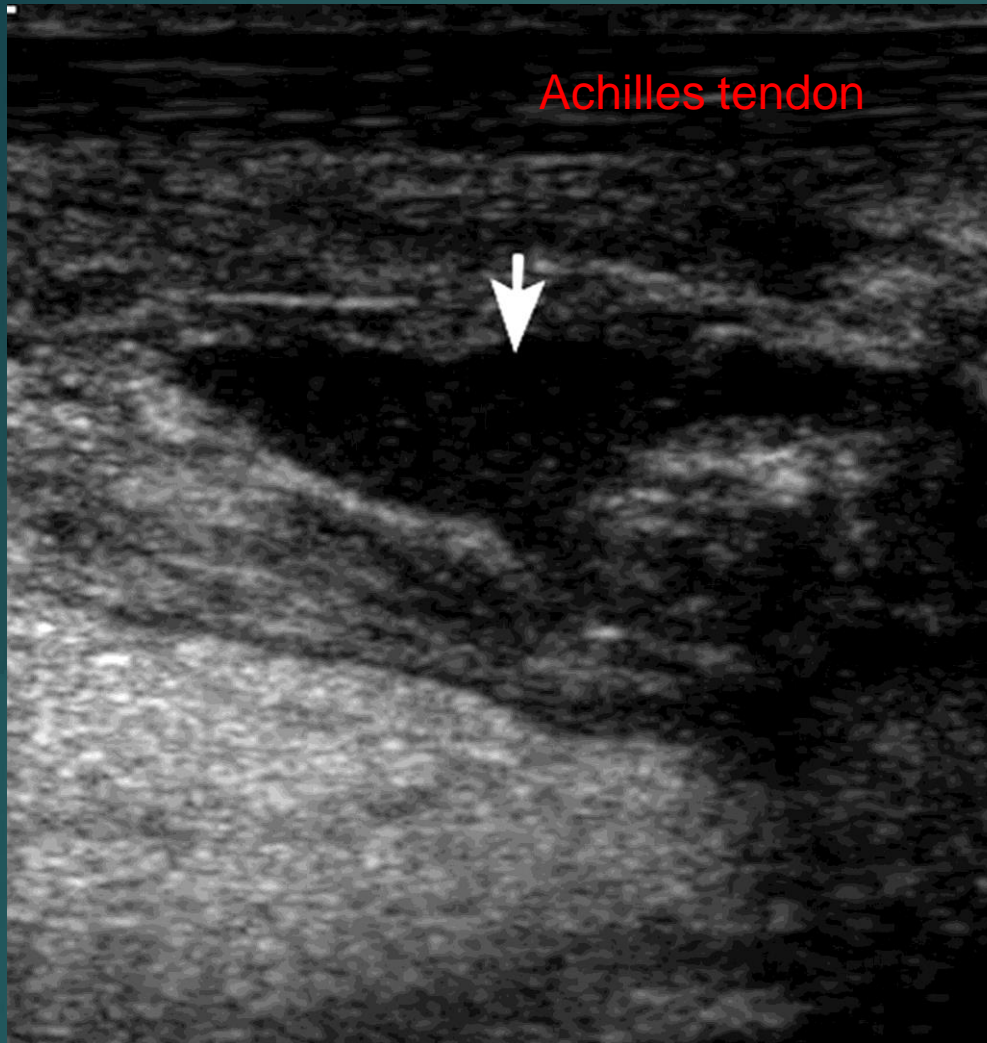
are highly suggestive of infection

Ultrasound guided aspiration of fluid collection around the involved bone can be confirmatory

Osteomyelitis of femur in a 24-year-old patient with SCA

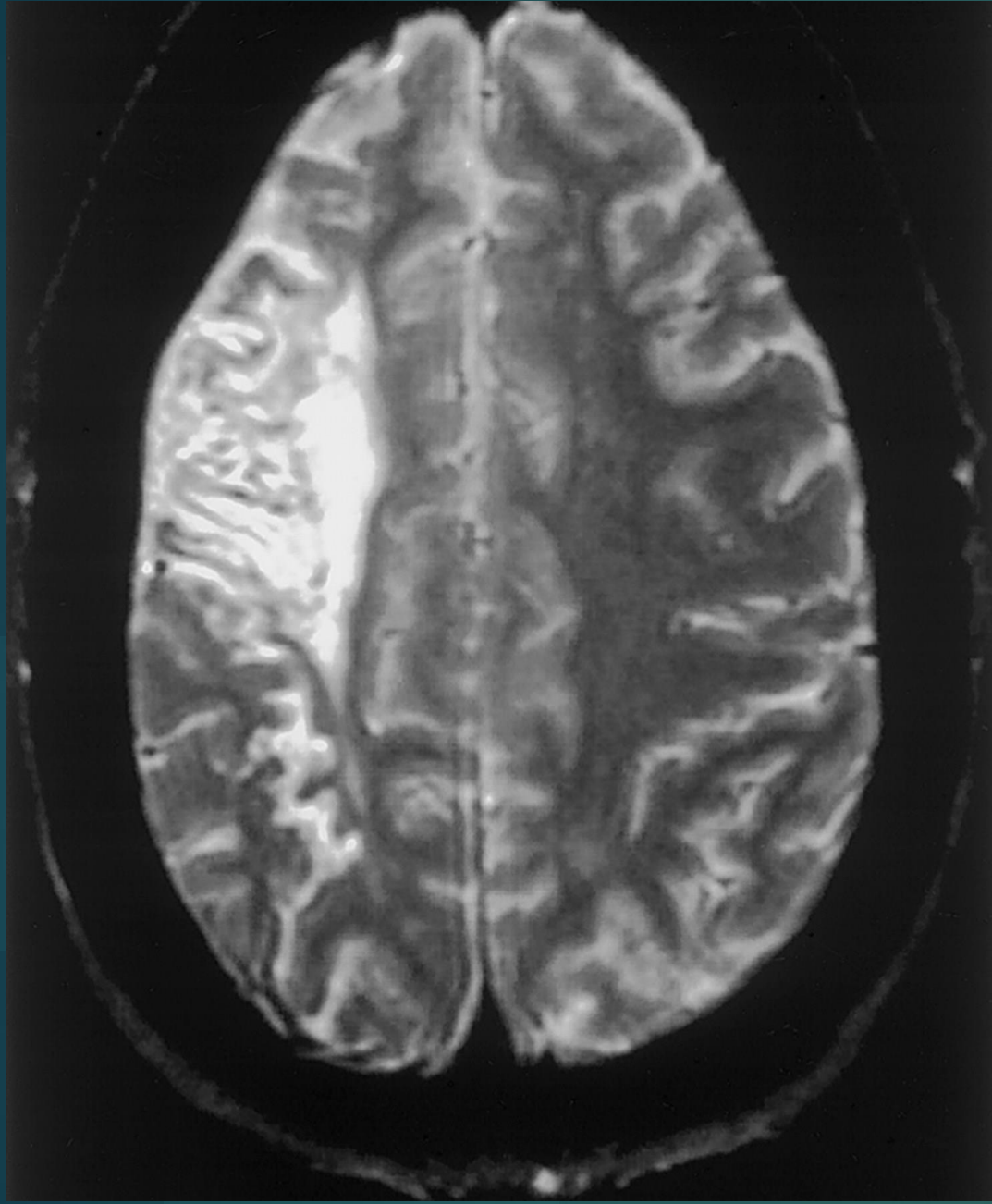
Axial T1-weighted MRI after contrast shows heterogeneous enhancement of marrow cavity, a rounded low-signal-intensity area adjacent to the shaft that is non-enhancing (fluid collection), and enhancement of the soft tissues around the shaft and of the adjacent musculature. Areas of enhancement are likely infected





Soft-tissue infection in a 52-year-old man with homozygous sickle cell disease.

Longitudinal high-resolution ultrasound image of left ankle shows a hypoechoic (dark) fluid collection (arrow) deep to Achilles tendon. Thick pus was aspirated from this area under ultrasound guidance



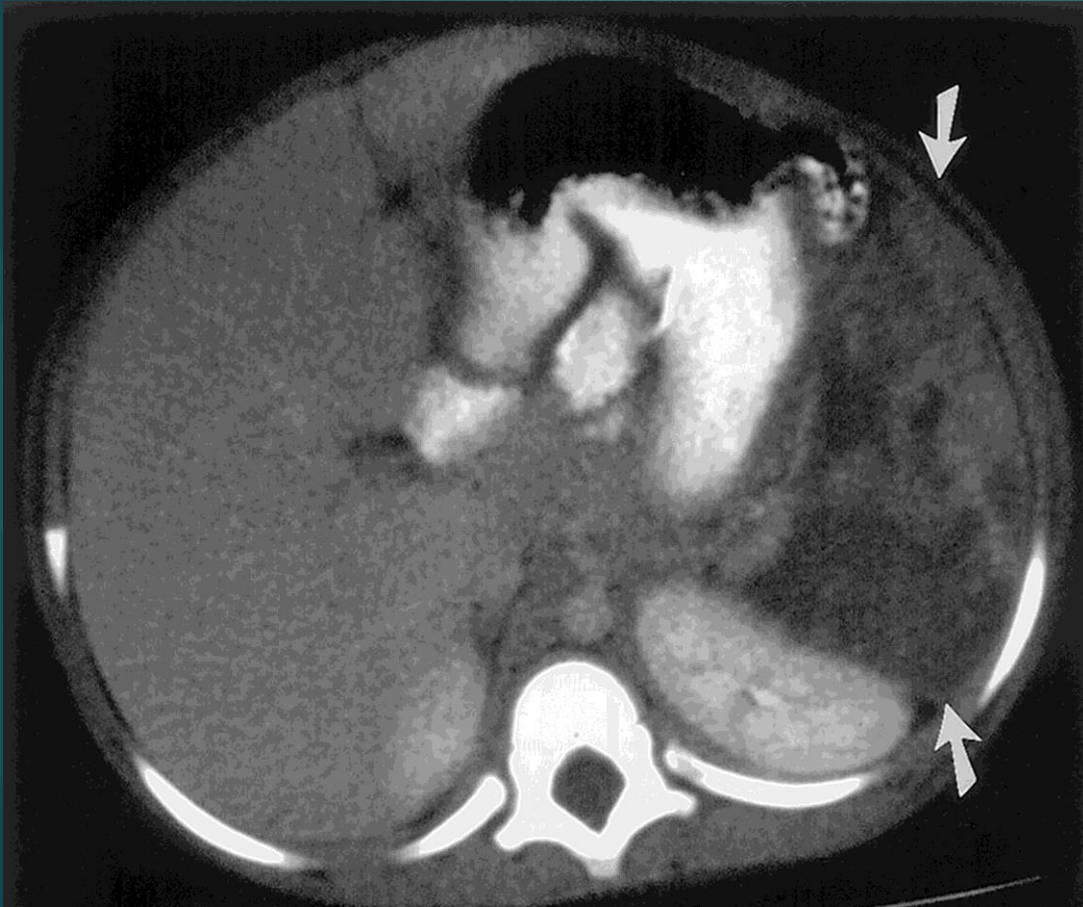
Chronic infarct in a 19-year-old patient with SCA and longstanding mild left sided weakness

Axial T2-weighted MRI shows an area of high signal intensity and enlargement of overlying CSF spaces, compatible with chronic infarction and atrophy

Sequestration syndrome with splenic infarction in SCA

Axial CT after contrast shows enlarged spleen that enhances heterogeneously and minimally with large non-enhancing areas (arrows)

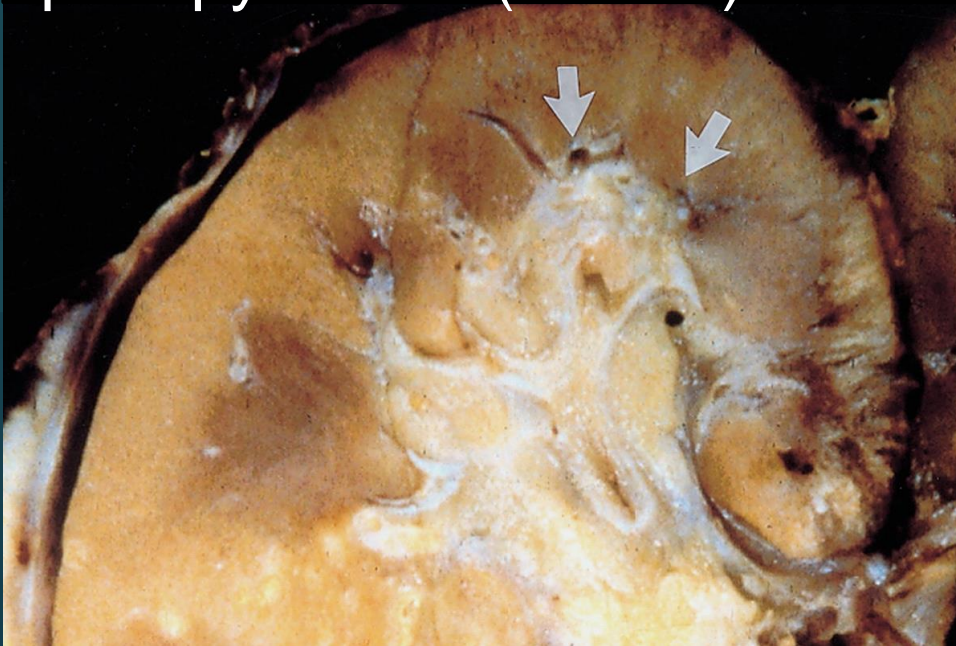
Photograph of spleen in a different patient shows areas of congestion and central necrosis



Papillary necrosis in SCA

Frontal view of kidney during excretory urography in a 32-year-old man with SCA shows a small, round collection of contrast material in a missing papillary tip (arrow)

Photograph of a kidney from a different patient shows loss of papillary tips in some upper pole pyramids (arrows).





Growth disturbance in distal radius in a 12-year-old girl

Anteroposterior (AP) radiograph of left wrist shows epiphyseal shortening and a cup deformity of adjacent metaphysis.

Also changes of old bone infarct in distal radius.

LYMPHOMA

Hodgkin's Disease

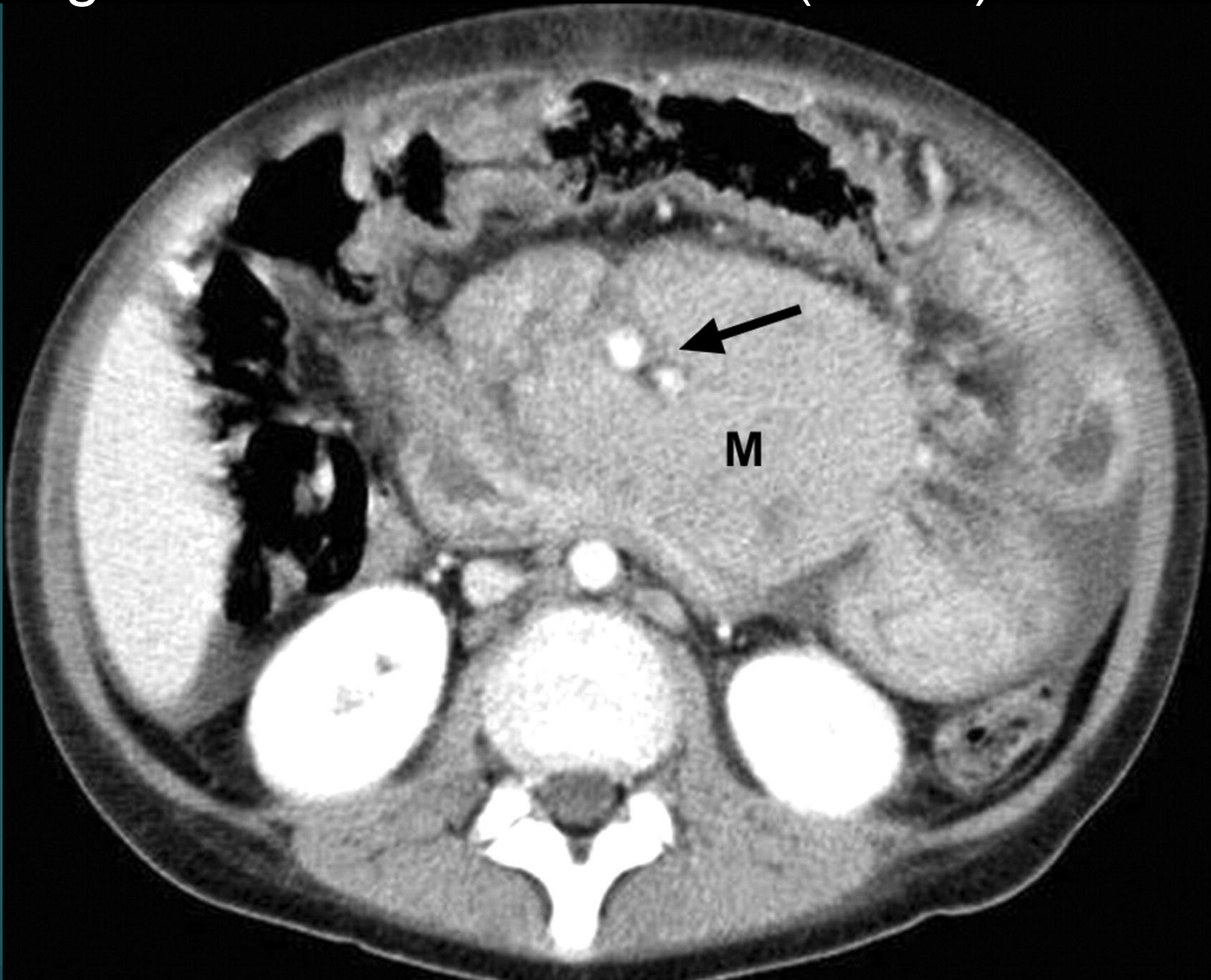
- Lymphocytic predominance
- Mixed cellularity
- Lymphocytic depletion
- Nodular sclerosis - the most common

Non Hodgkin's Lymphoma

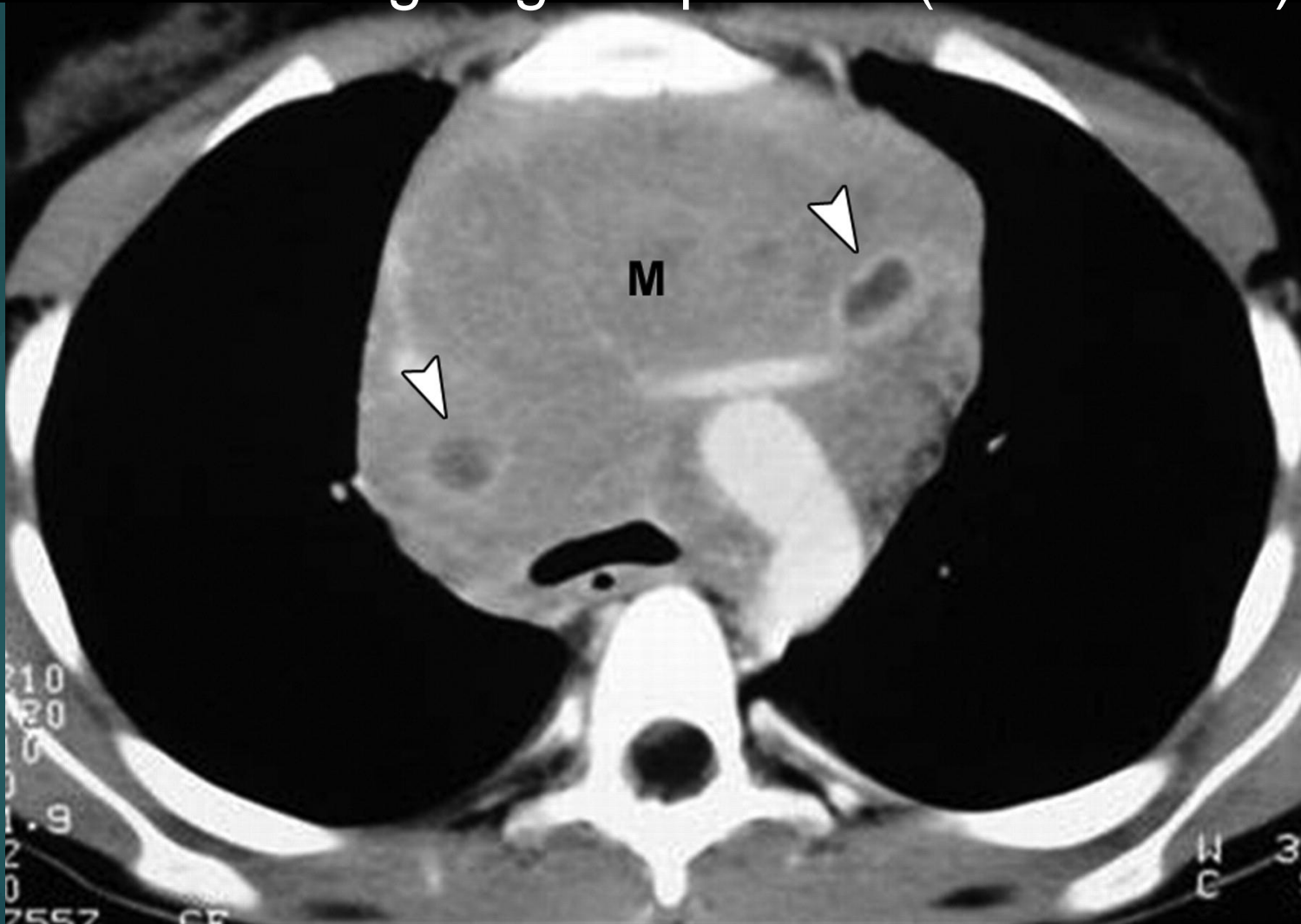
- Burkitt lymphoma (jaw and abdomen)
- Burkitt-like lymphomas (abdomen and nodes)
- Large B-cell lymphomas (abdomen and nodes)
- Lymphoblastic lymphoma (Mediastinum, nodes, bone marrow)
- Anaplastic large cell lymphoma (Nodes, skin, soft tissue, bone)
- Other peripheral T-cell lymphomas
- MALT lymphoma

Lymphoma can present as mass anywhere in the body

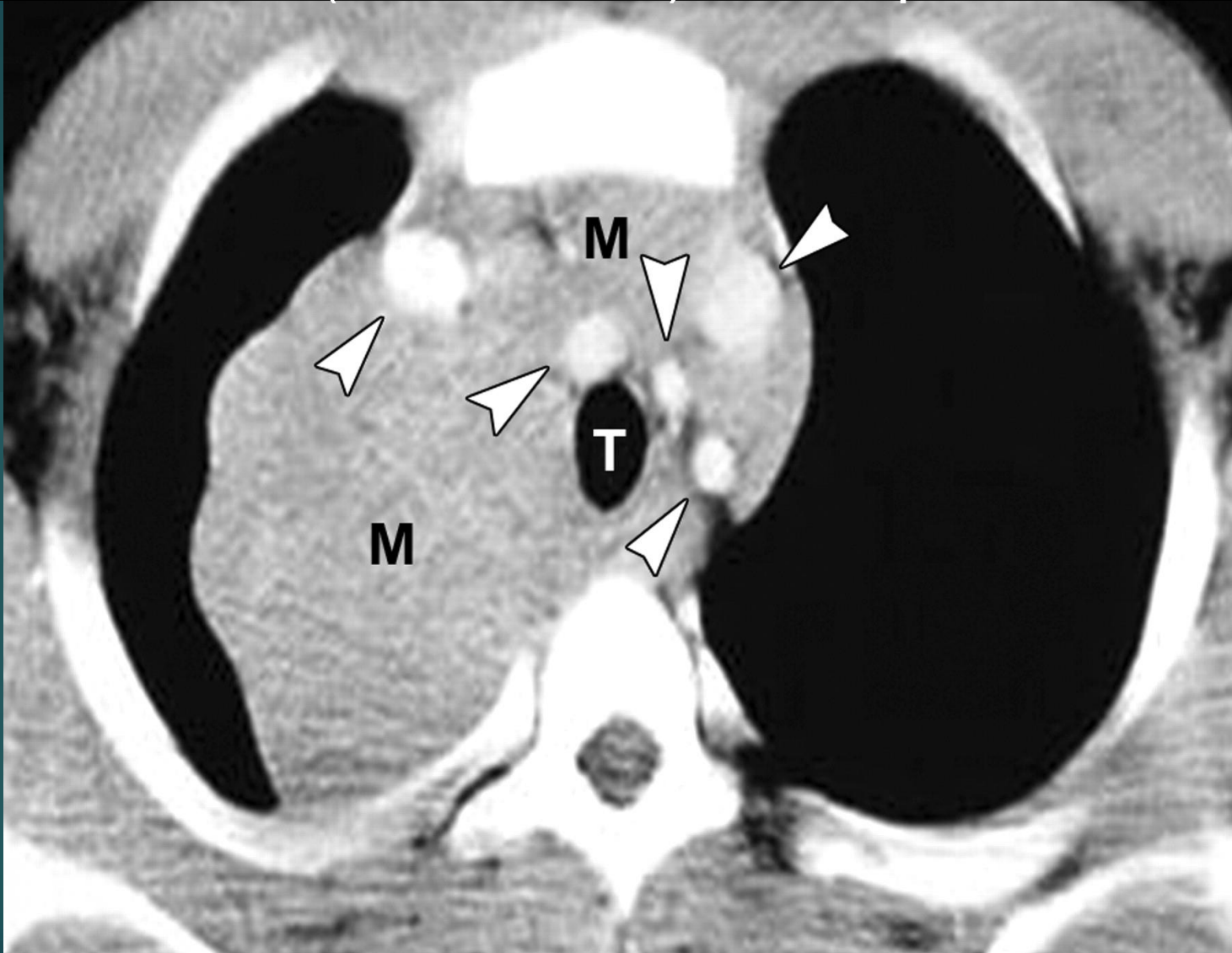
NHL in an 11-year-old boy.
Axial CT scan shows a large lymphomatous mass (M)
encasing the mesenteric vessels (arrow)



NHL in a 14-year-old boy. Contrast-enhanced CT scan shows a large anterior mediastinal mass (M) that originates from thymus. A few cysts with central low attenuation and a peripheral enhancing ring are present (arrowheads).

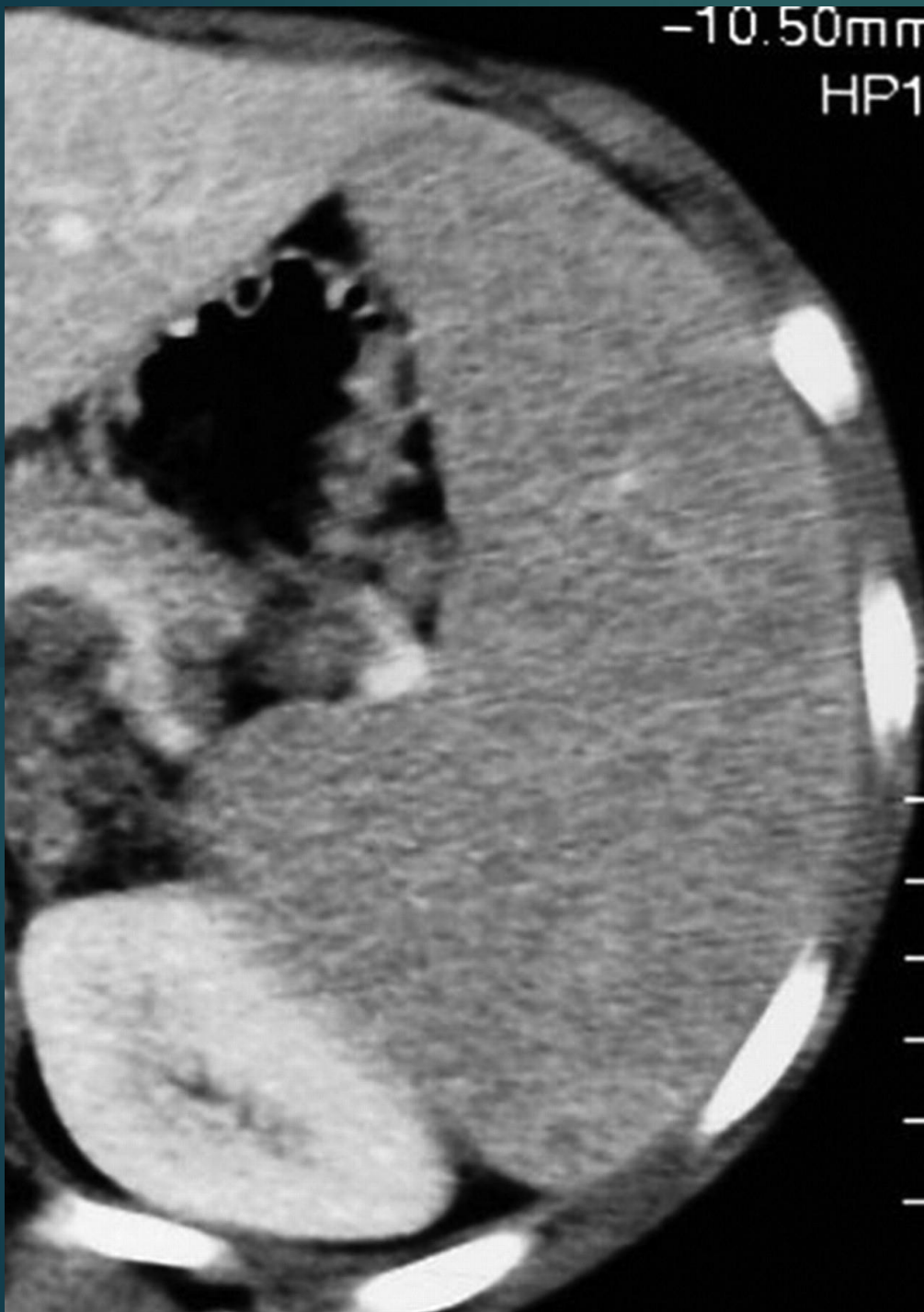


HD in a 17-year-old boy. Contrast-enhanced CT scan shows a large mediastinal mass (M). Trachea (T) is compressed, and great vessels (arrowheads) are displaced



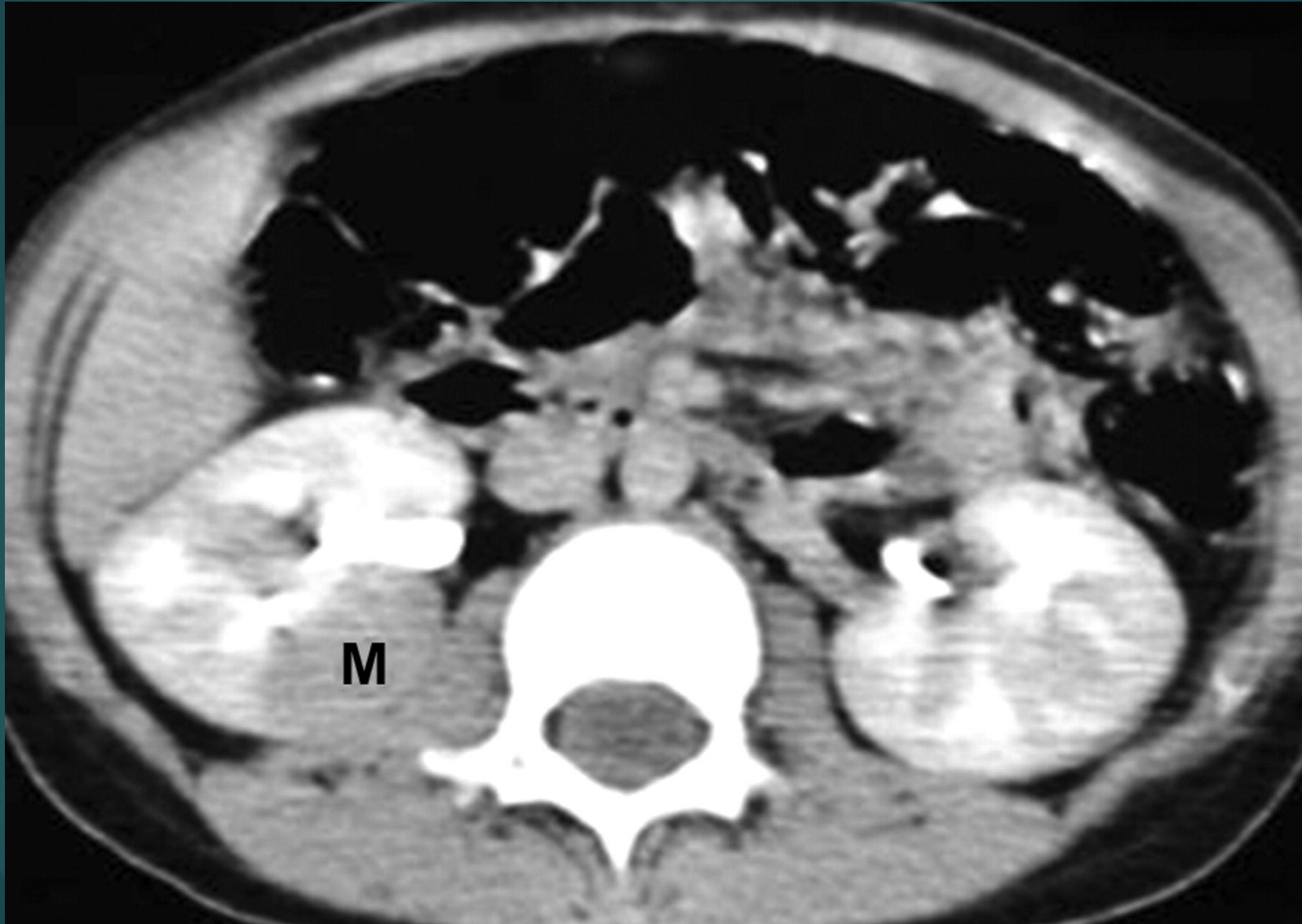
NHL in a 16-year-old girl. Contrast-enhanced CT scan shows low-density lesions (arrowheads) in both hepatic lobes, with small nodules in spleen and right kidney.





HD in a 12-year-old girl
Contrast-enhanced CT scan shows an enlarged spleen with a diffusely inhomogeneous appearance.

NHL in a 14-year-old boy. Contrast-enhanced CT scan shows single well-defined, low density mass (M) in right kidney



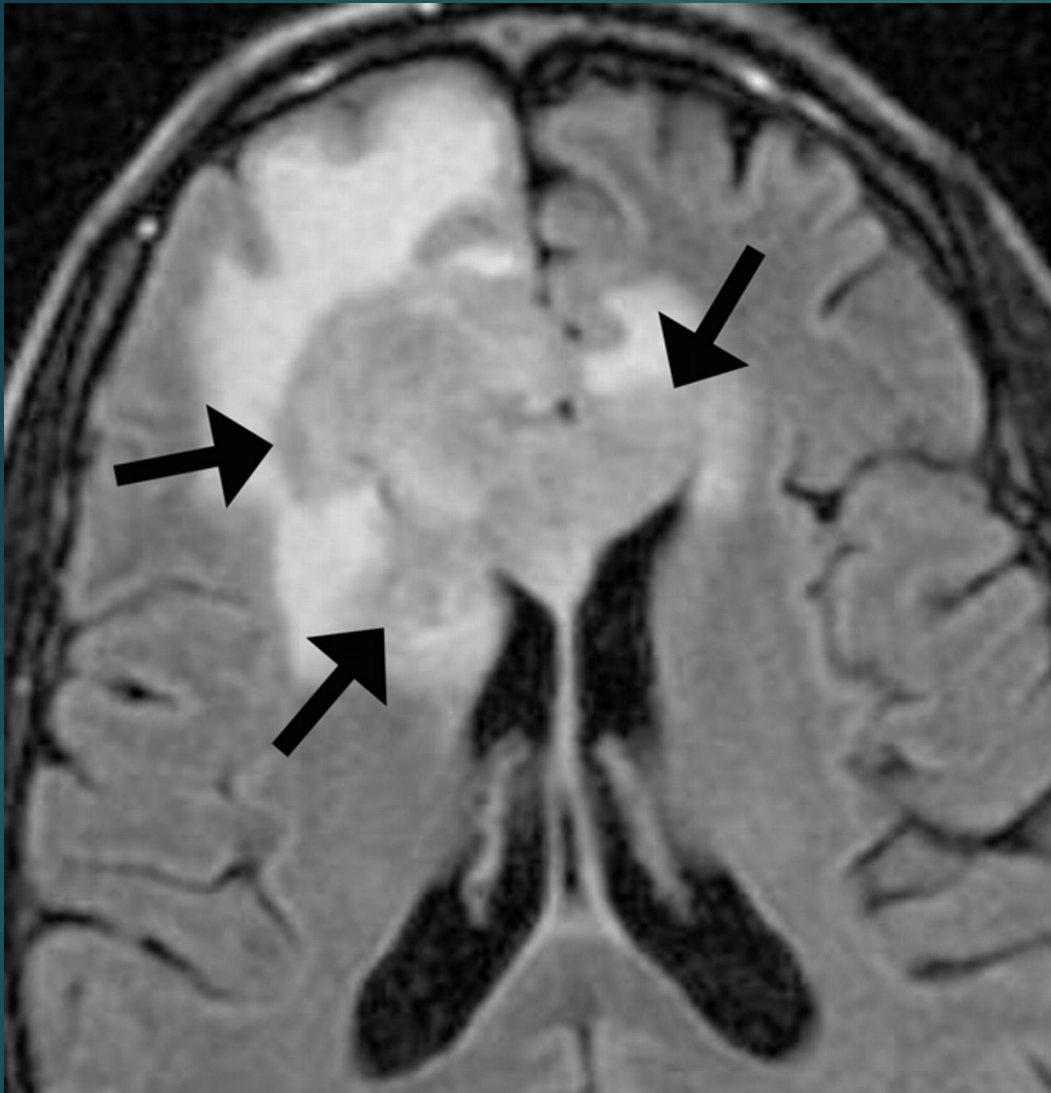
Diffuse hepatosplenic involvement in lymphoma
Axial CT scan shows multiple round, homogeneous, low density nodules (arrows) in liver and spleen





72-year-old immunocompetent woman with primary CNS non-Hodgkin's B-cell lymphoma

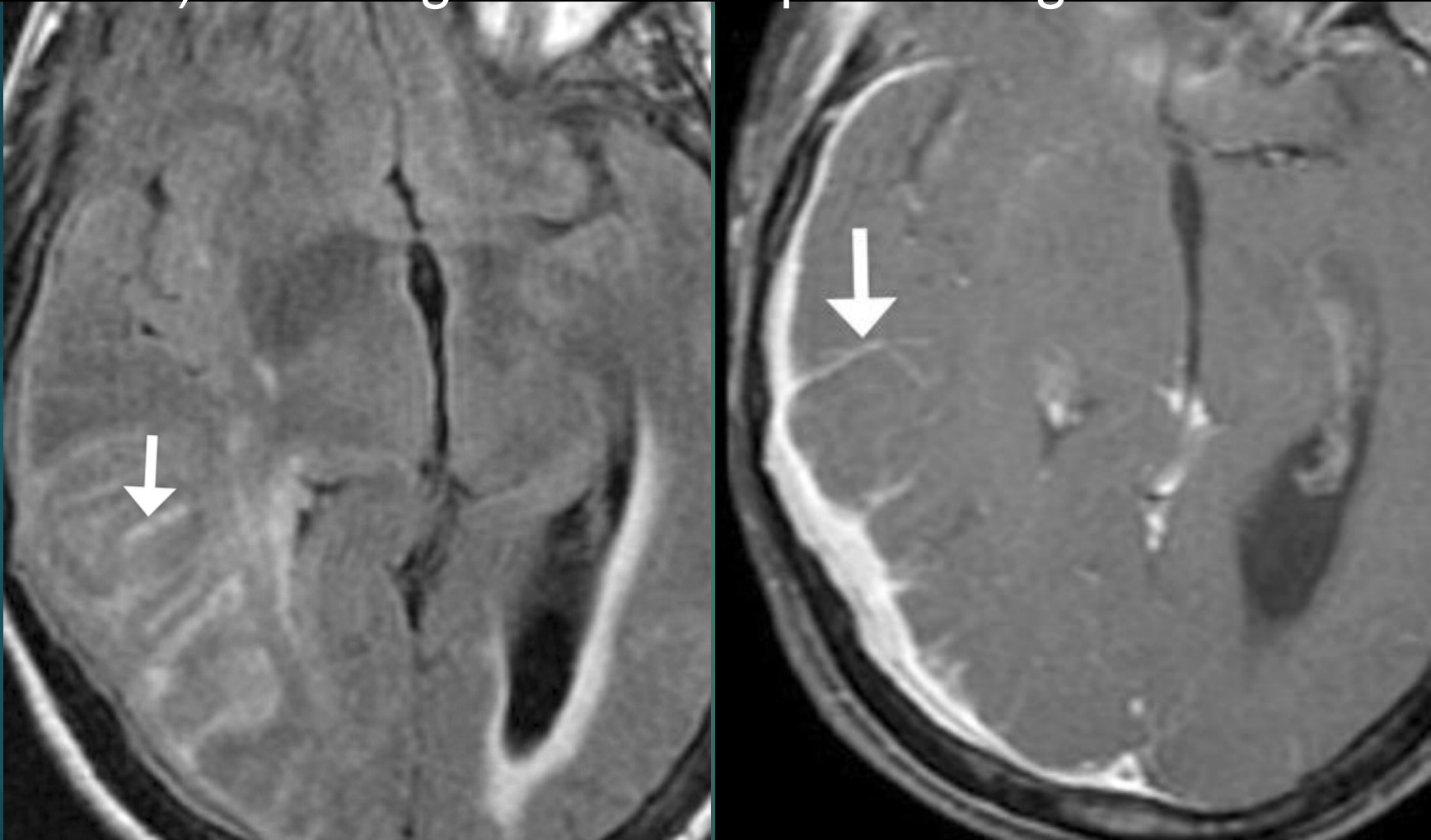
Unenhanced CT image shows classic hyperdense masses involving deep white and gray matter.



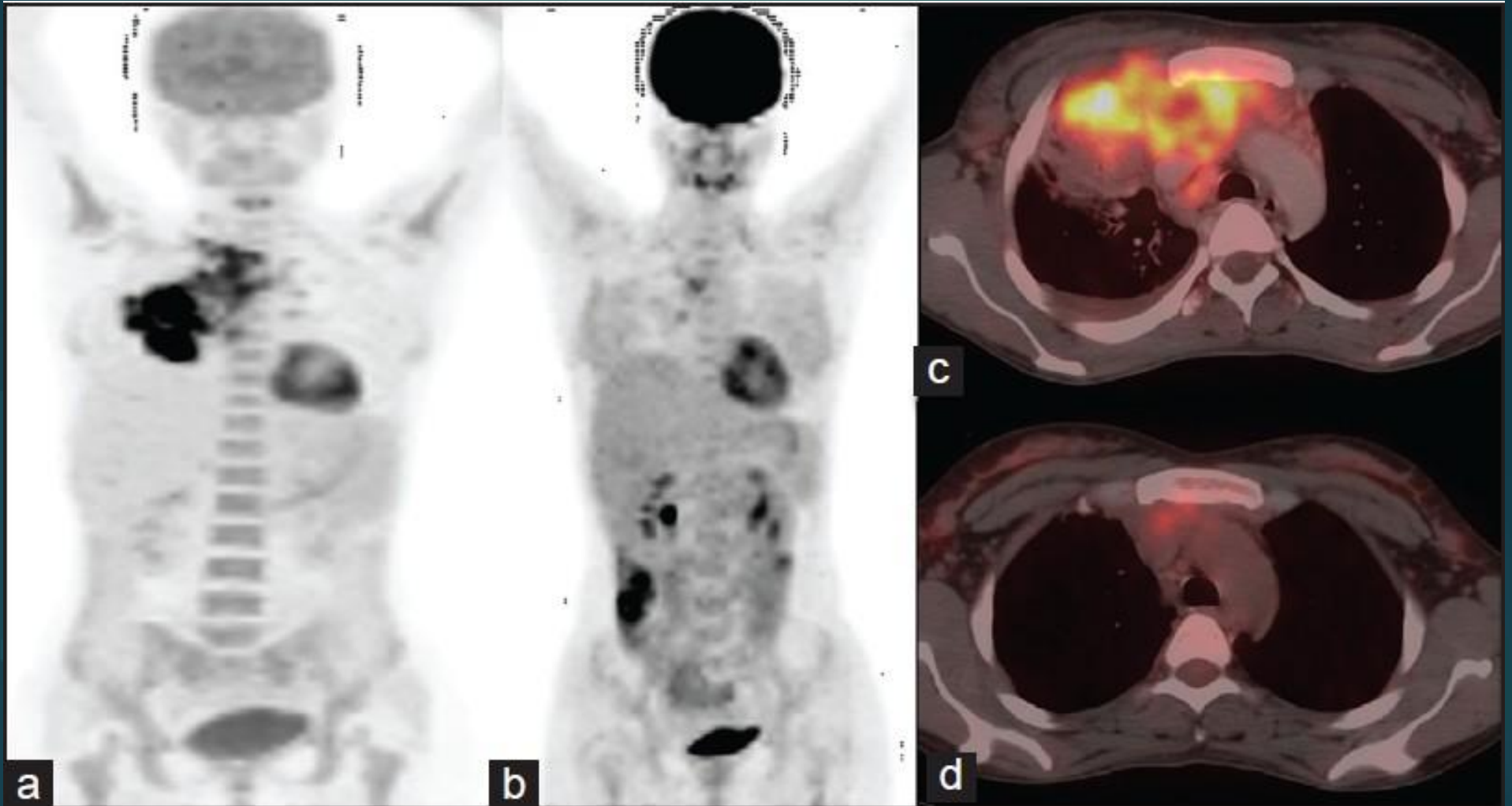
44-year-old HIV-positive woman with primary CNS non-Hodgkin's B-cell lymphoma

Axial FLAIR MRI shows lesion isointense to gray matter (arrows).

63-year-old woman with primary meningeal lymphoma
Axial FLAIR (left) and post contrast T1 weighted (right)
MR images show hyperintensity and enhancement
(arrows) involving sulci and leptomeninges

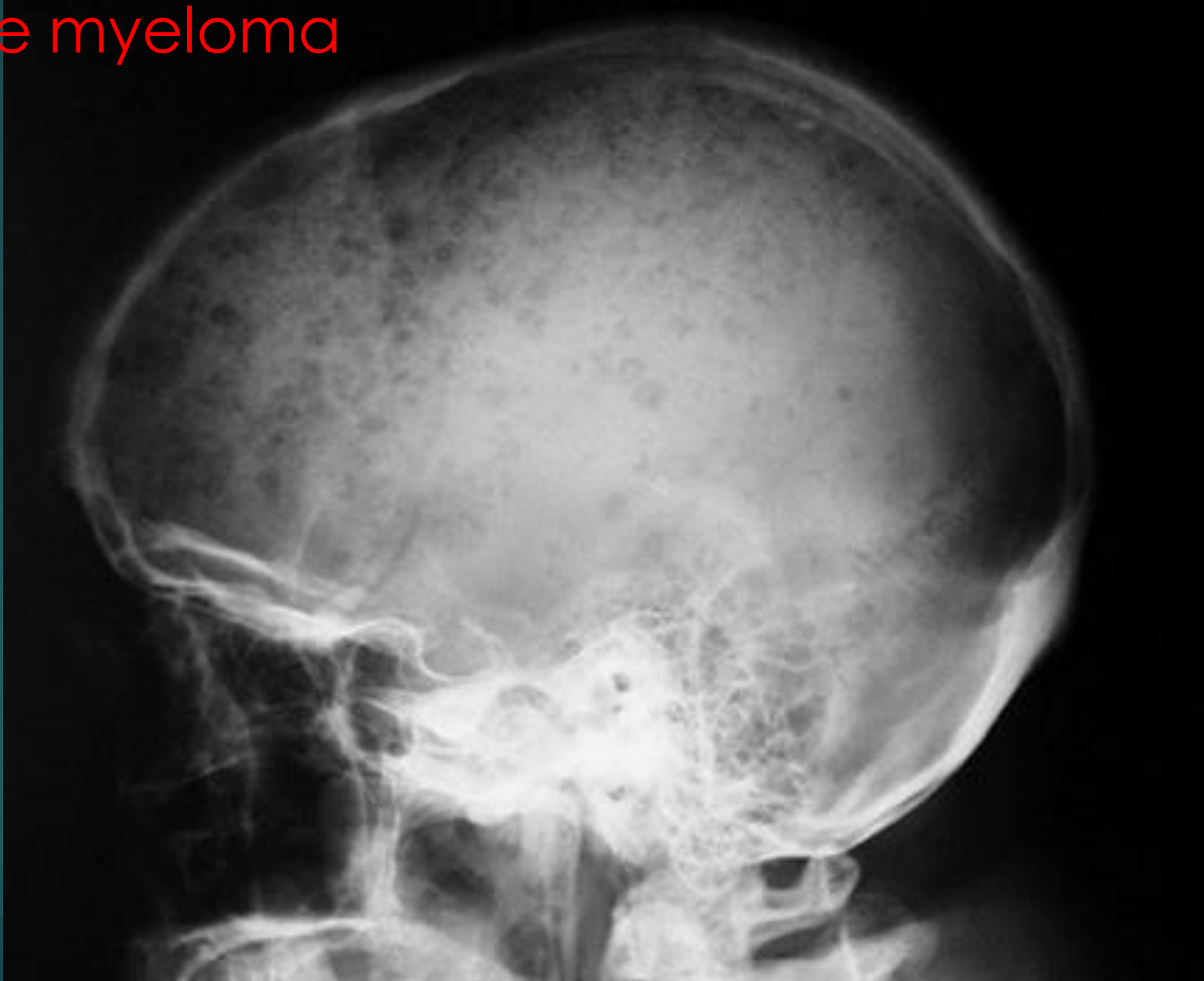


PET-CT scan is the gold standard imaging modality to diagnose and F/U lymphoma



Lateral skull radiograph showing multiple very sharply outlined (punched out) lytic lesions of

multiple myeloma



Findings shown here can be seen in

1. any severe chronic anemia
2. thalassemia
3. Sickle cell anemia
4. Lymphoma
5. Lymphoma



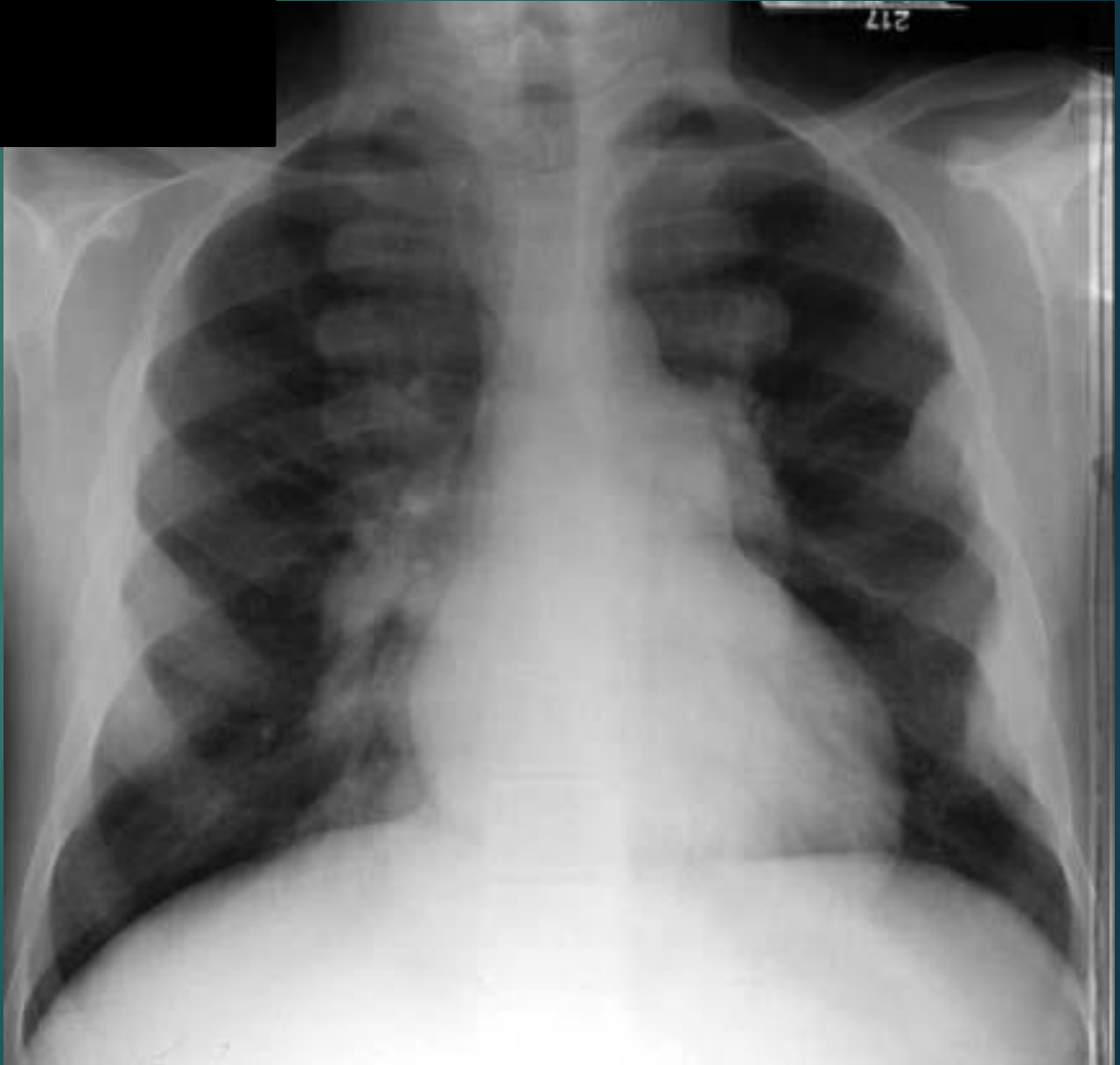
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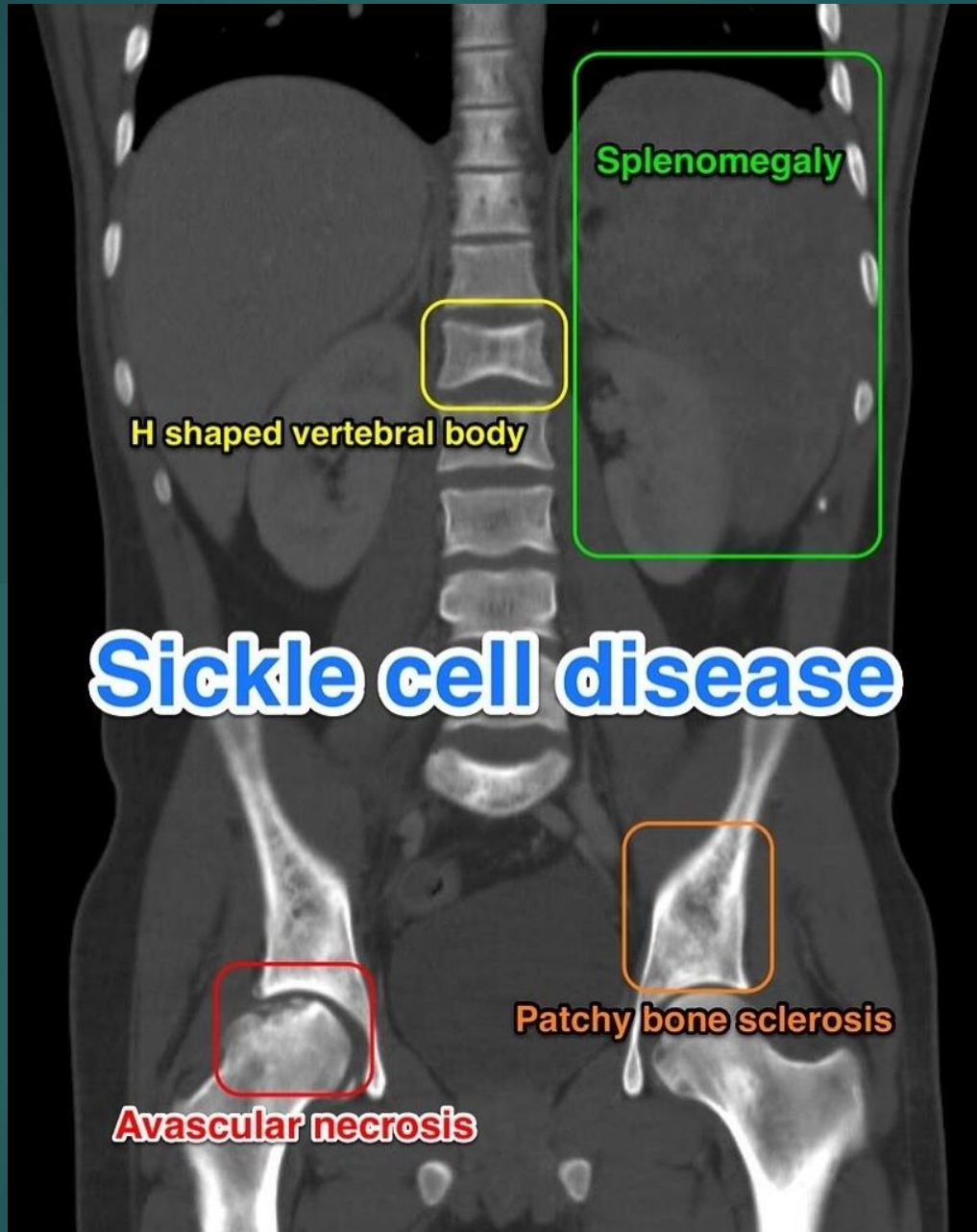


Findings shown here can be seen in

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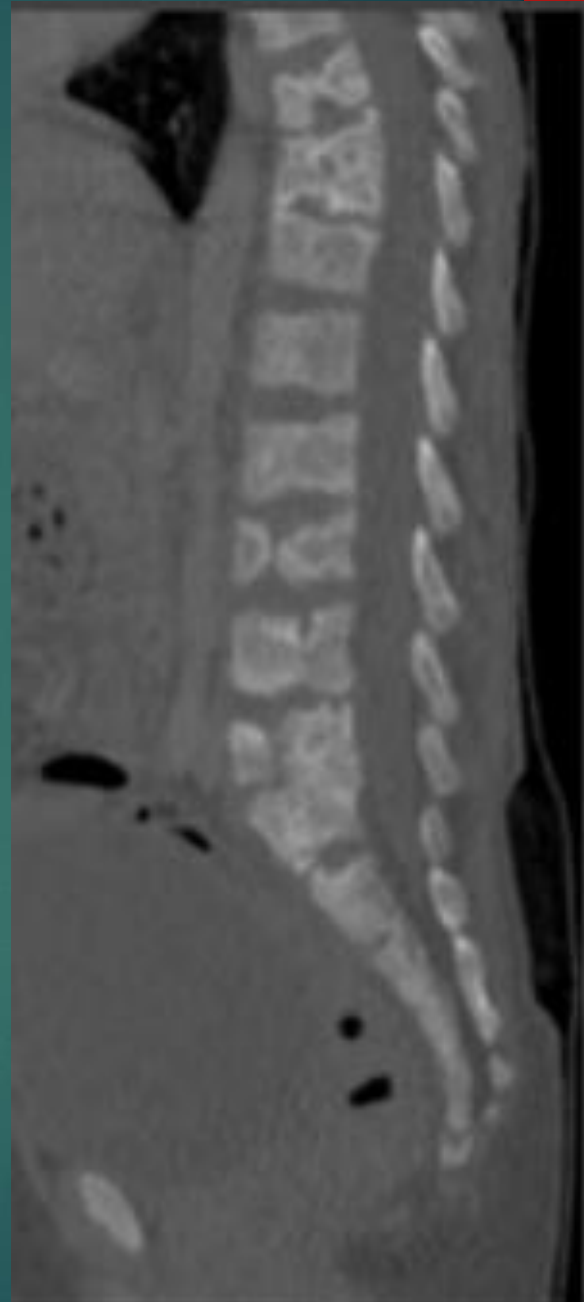






Sickle cell disease





INTRA medullary hyperplasia can be seen in Thalassemia, Sickle cell anemia, Iron deficiency anemia, Any severe chronic anemia except bone marrow failure

Signs of INTRA medullary hyperplasia include

- Expanded bone marrow in bones including long bones of hands, feet, limbs, skull
- Decreased T1 MRI bone marrow signal than adjacent discs

EXTRA medullary hematopoiesis can be seen in ALL SEVERE CHRONIC ANEMIAS

Sites of EXTRA medullary hematopoiesis include Liver, Spleen, Paraspinal areas with possible extension into spinal canal outside the dura, Kidneys, Meninges, Skin, Lymph nodes, Thymus

EXTRA medullary hematopoiesis appears as homogeneous soft tissue masses on imaging

INFARCTS and INFECTIONS are additional findings in Sickle cell anemia

Bone infarct vs infection is important to diagnose early so that antibiotics can be started early to prevent complications. MRI with contrast and ultrasound /CT guided aspiration of fluid collections are very helpful if imaging is unable to differentiate these two

Multiple myeloma produces punched out lytic lesions in bones with background bone appearing normal. Opposite to bony metastases, myeloma more often involves intervertebral discs and mandible, and less often involves pedicles.

Lymphoma can produce a mass anywhere in the body. CT is often used to scan whole body to evaluate the disease extent (staging), and to do CT-guided biopsy to make tissue diagnosis if not already diagnosed. Rest is all by laboratory and clinical based.

THANKS