MSK MSCT Imaging

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MSCT is a powerful modality for evaluation of the MSK system, particularly when coupled with volume-rendering reconstruction techniques.

In cases of trauma, subtle fractures (particularly those oriented in axial plane) are better seen on VR images.

Complex injuries can be better demonstrated with VR images, and complicated spatial information about the relative positions of fracture fragments can be easily demonstrated.

Evaluation of infectious or neoplastic disease is also aided by including VR imaging.

The extent of disease can be thoroughly evaluated.

Postoperative studies in patients with orthopedic hardware also benefit from VR imaging which eliminates most streak artifact and produces high-quality images.

Trauma

Roles Of MSCT in trauma

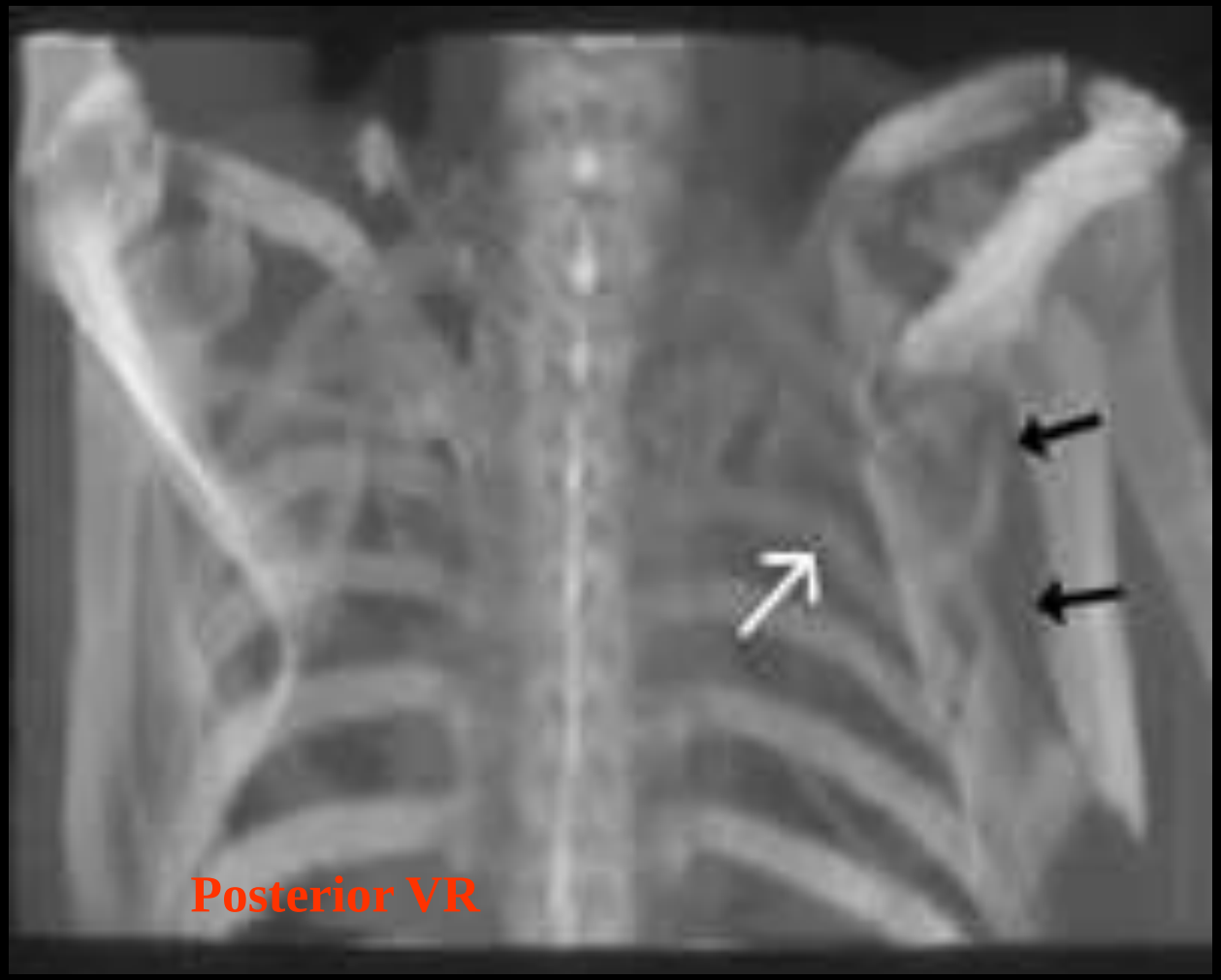
(a) To define or exclude a fracture that was equivocal at plain radiography.

(b) To determine the extent of a previously diagnosed fracture and thus provide guidance for therapy.

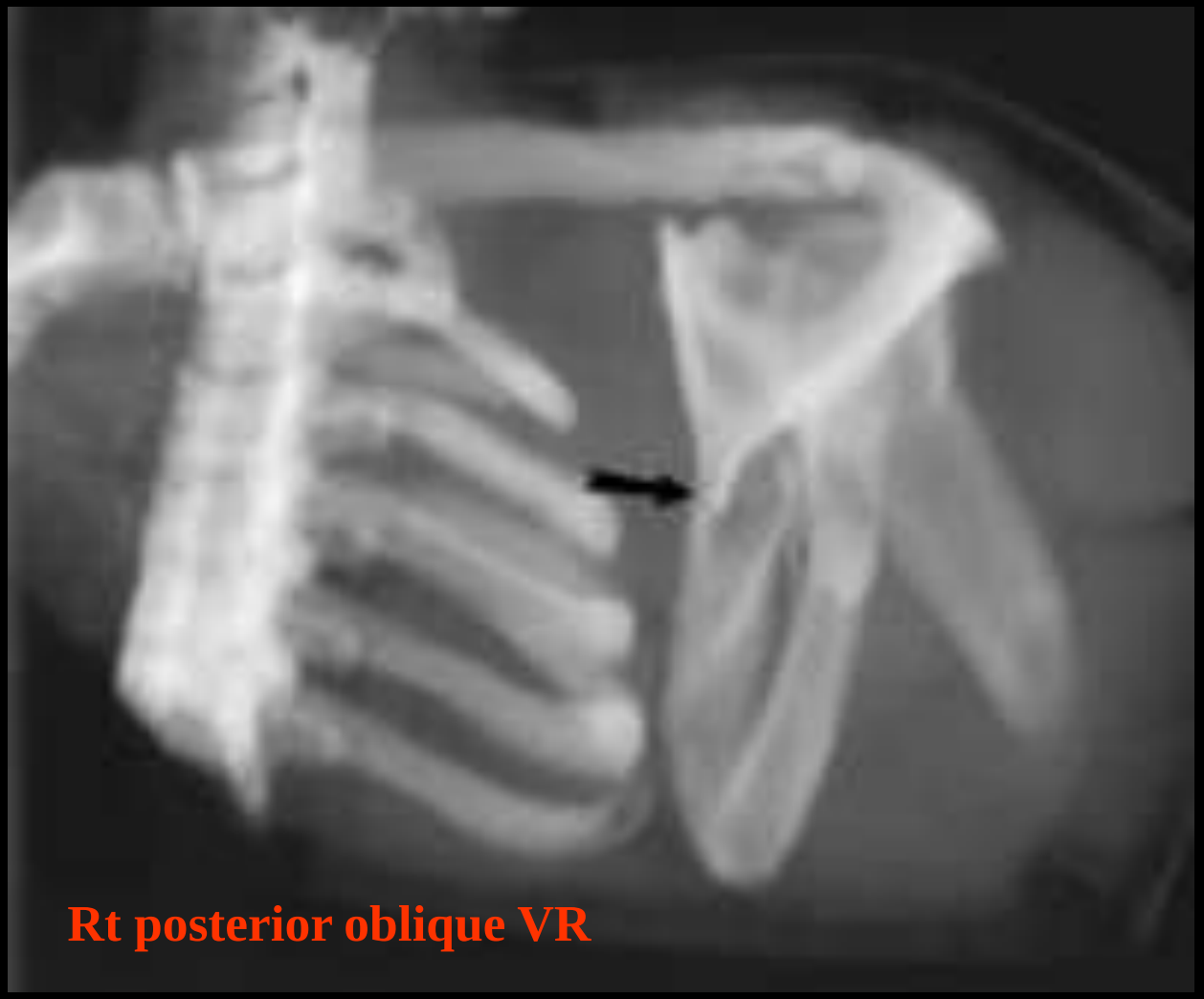
(c) To provide additional information about soft-tissue abnormalities and osseous anatomy, especially in anatomically complex areas (as pelvis, scapula & spine).

(d) VR images can display the spatial relationships of fracture fragments.

Scapular fracture

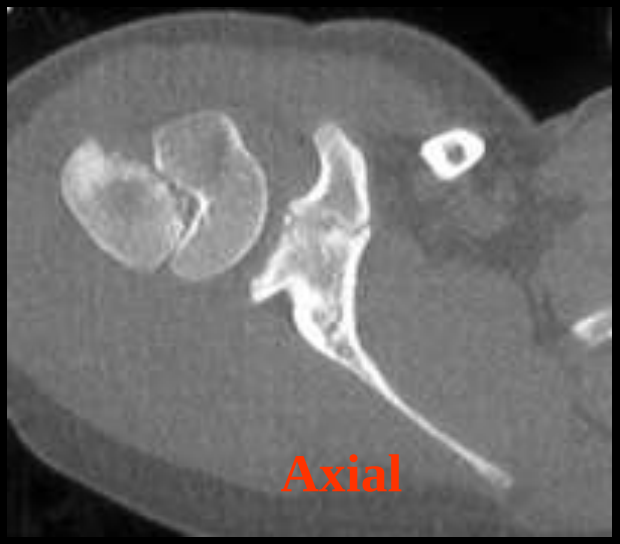


Complex fracture of Rt shoulder. The scapular body is shattered (black arrows), scapular spine is separated from the remainder of the bone. An associated ipsilateral rib fracture is also seen (white arrow).



Scapular fracture

Comminuted fracture of scapular body (arrow). The scapular spine, coracoid process & ACJ are intact.



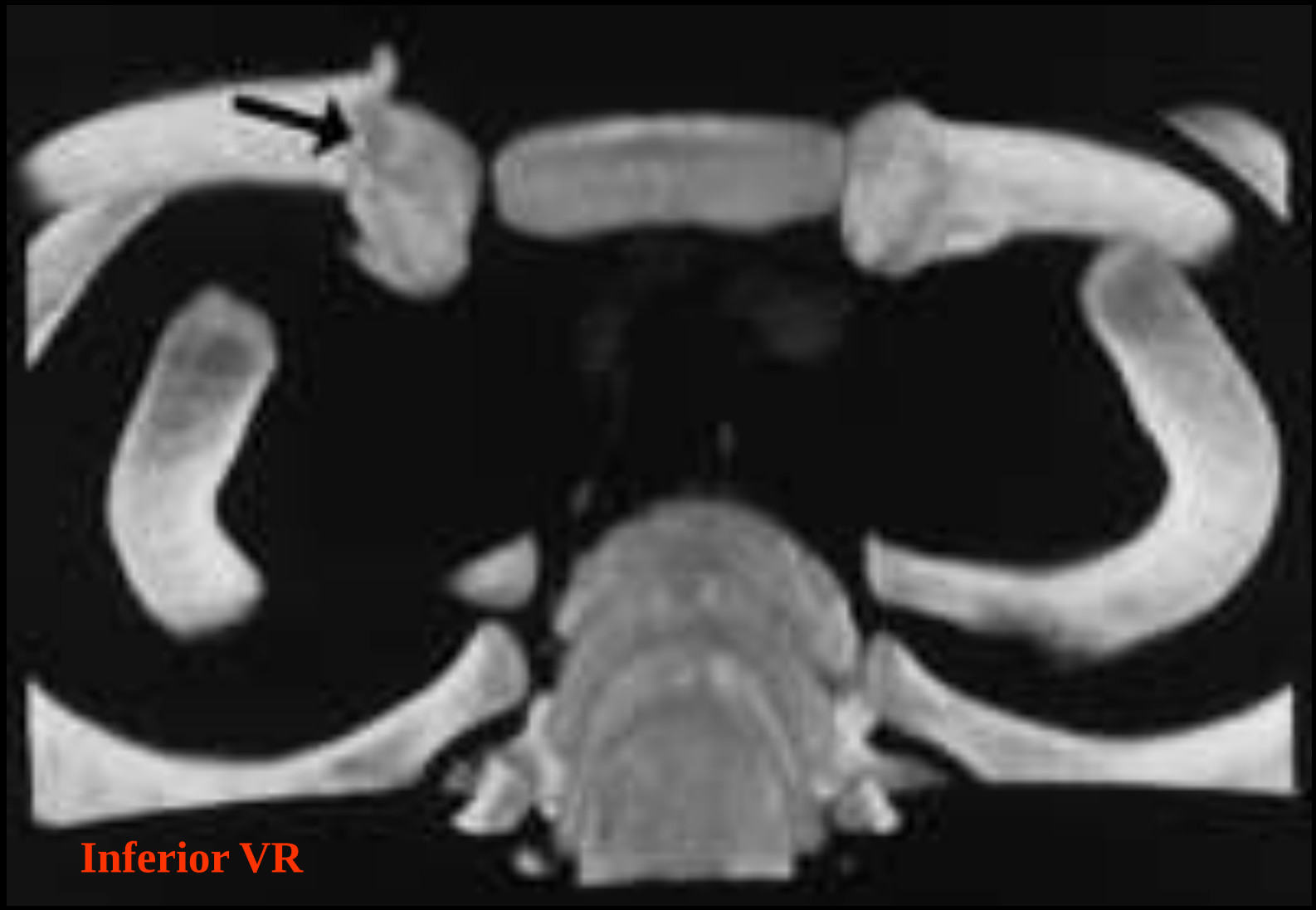
Slipped humeral epiphysis

Multiplanar & 3D imaging are valuable in imaging examination of the sternoclavicular joint.

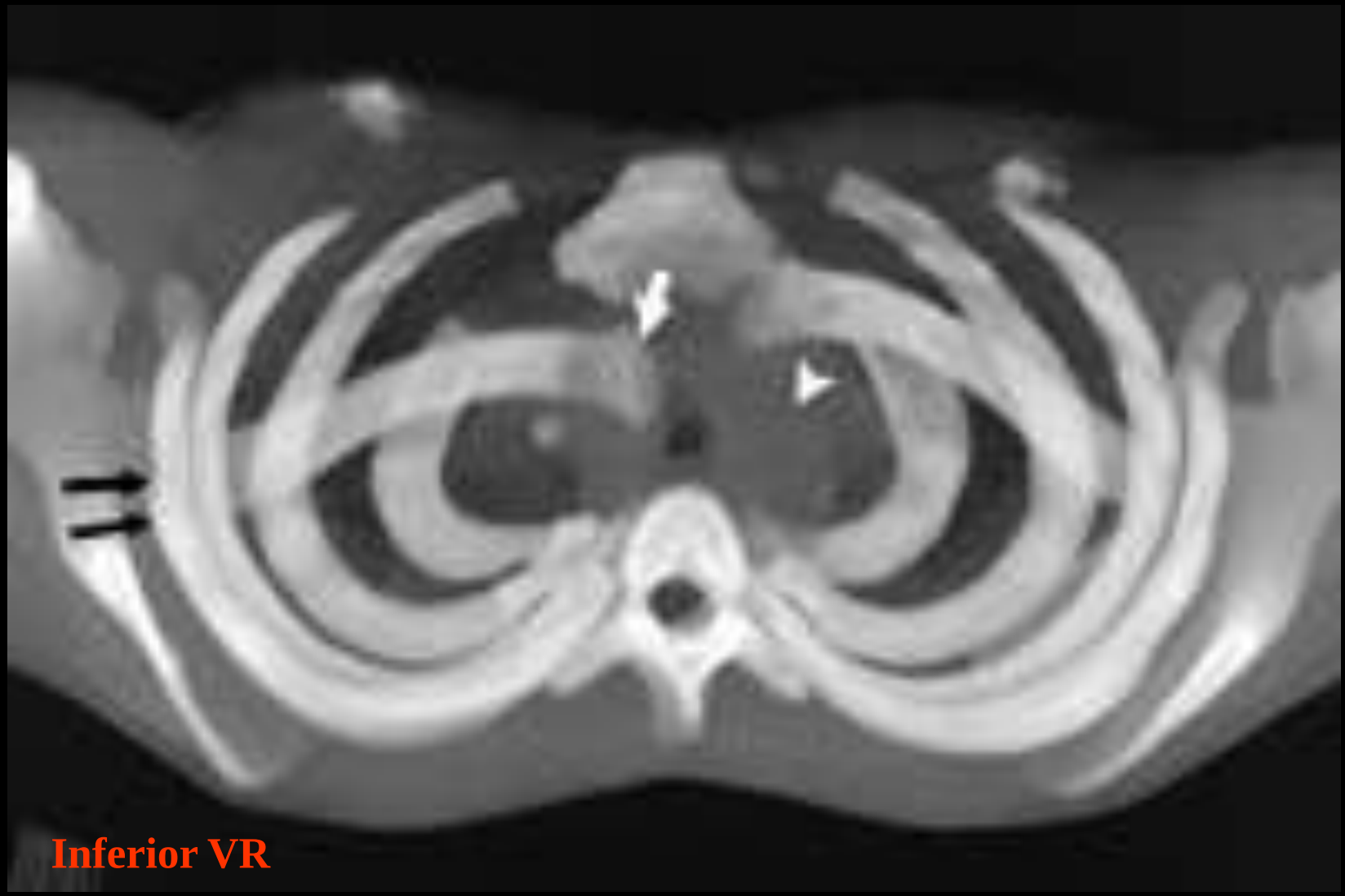
The sternum is best evaluated on coronal and coronal oblique images.

VR images are optimal for evaluating the orientation of SCJ dislocations.

These images are most useful after nearby bone structures, such as the rib cage and spine, have been edited.



Comminuted fracture of medial Rt clavicle (arrow) which is displaced posteriorly. The Rt SCJ is disrupted (widening of joint space).



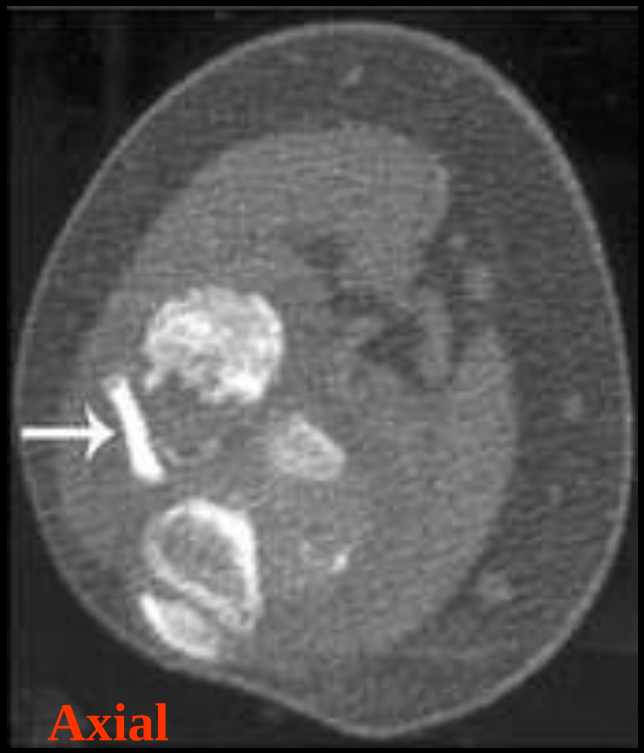
Posterior dislocation of Rt SCJ (white arrow). A mediastinal hematoma is present (arrowhead). An associated fracture of Rt 4^{th} rib is seen (black arrows).

CT of the elbow is indicated for fracture detection when plain radiographs are equivocal or it shows a complex injury.

In such cases, VR images are ideal for anatomic evaluation and for displaying the inter-relationships of fracture fragments.

2-mm collimation with a 1-mm reconstruction interval is needed to obtain satisfactory detail.

Comminuted intra-articular fracture of the olecranon (arrow).



Elbow fracture

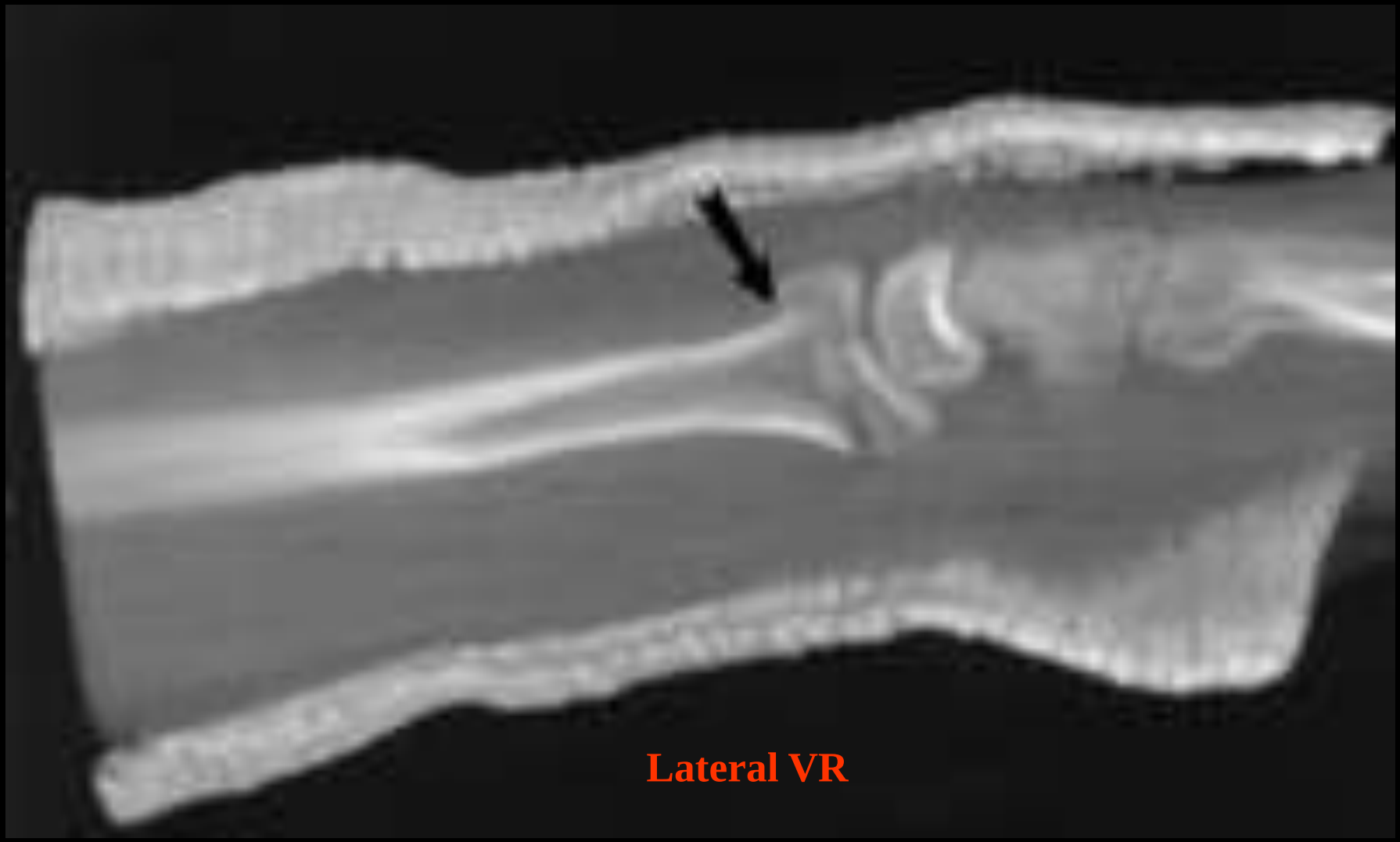
(a) Fracture of Rt proximal radius with postero-lateral displacement of a fracture fragment (arrow). **(b)** Fracture dislocation of radial head (arrow). **(c)** Posterior displacement of the fracture fragment (thin arrow). Note the remaining preserved epiphysis (thick arrow).

The wrist is best evaluated with a narrow section thickness (1–2 mm) and reconstruction at 1 mm.

VR CT is indicated in clinically suspected fractures not seen on plain radiographs and complex fractures that require further evaluation.

Although direct coronal scanning can eliminate the need for multiplanar imaging in this important plane, VR allows evaluation of the wrist from any perspective.

Unlike plain radiography, VR CT can be done through cast material without significant image degradation



Impacted comminuted intra-articular fracture of distal radius with dorsal angulation of the distal fracture fragments (arrow).

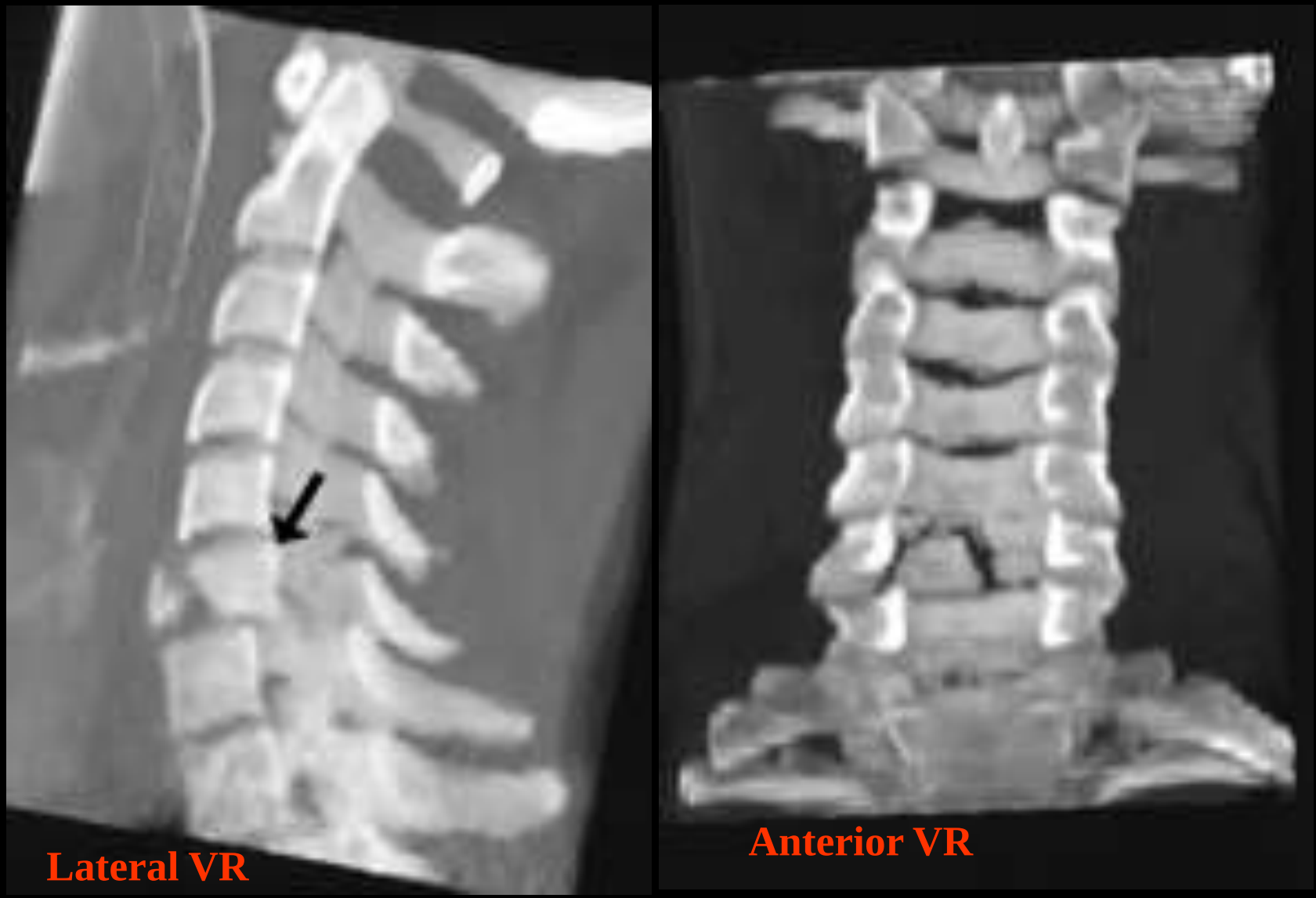
Impacted fracture of distal radius (thin arrows) associated with fracture of distal ulna (thick arrow). A small fracture fragment of the radial styloid process is also seen (arrowhead). The image was obtained through a cast, which would limit the usefulness of plain radiography.

Spinal trauma can be evaluated with a combination of axial CT & VR images.

Specific applications include identification of fractures, subluxation & localization of foreign bodies and fracture fragments.

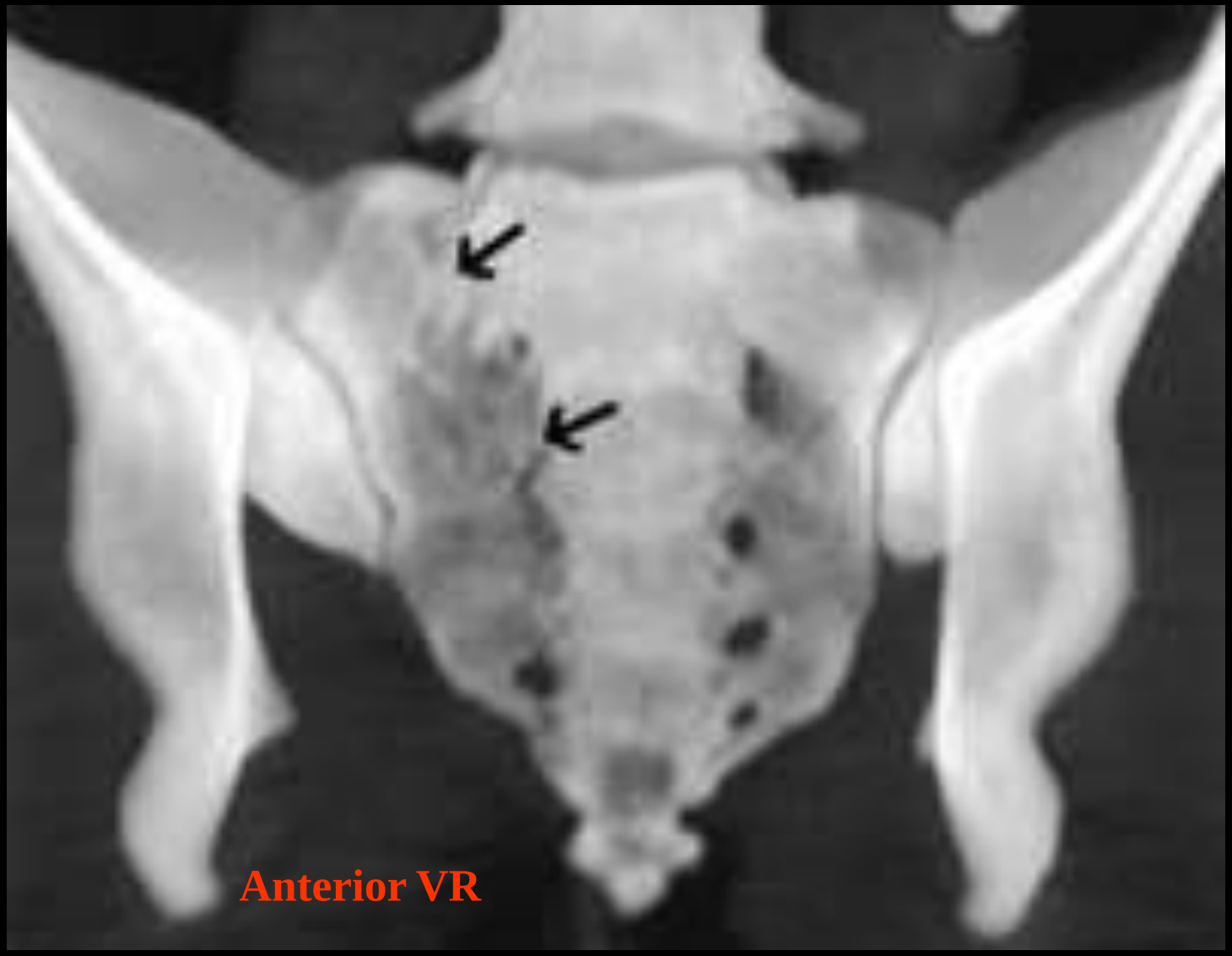
VR CT is especially valuable in the detection of subtle sacral fractures, which are often missed on plain radiographs. The relationship of the fracture to sacral foramina is well seen on 3D views.

Spinal fracture 2ry to a gunshot wound. Inferior VR CT shows an impacted bullet at the pedicle with extradural extension of both bullet & bone fragments (arrow). Streak artifact is minimal.



(a) Flexion teardrop fracture of C6 with posterior displacement of posterior portion of vertebral body (arrow). **(b)** Shows the full extent of involvement.

Sacral fracture



Pubis & ischium removed by editing shows fracture of Rt hemisacrum that extends through neural foramina of S1-S4 (arrows).

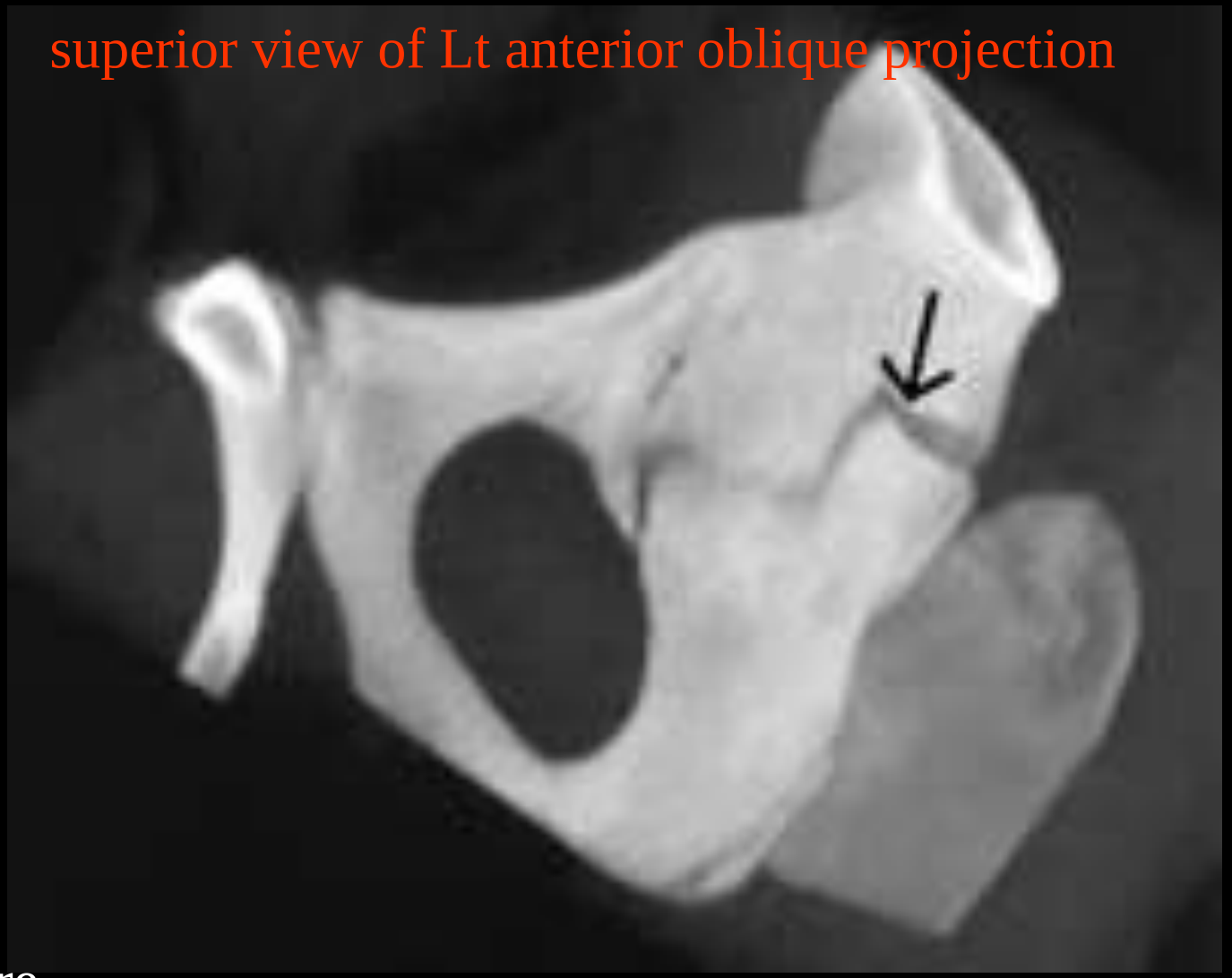
Sacral stress fracture. The fracture lines extend through both Lt & Rt foramina of S1 & S2 (arrows).

Axial CT data coupled with VR allow visualization of the entire pelvis through any plane.

Any inlet or tangential view desired may be created, thus eliminating the need for time-consuming radiographic series.

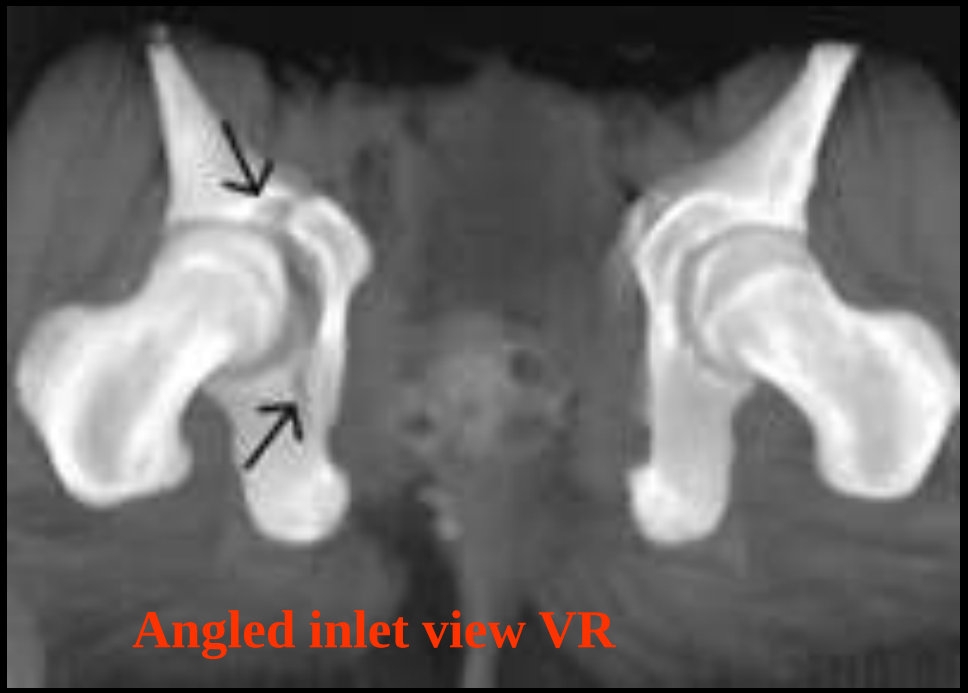
The data set may be edited to isolate the fracture, and in selected cases, the femur may be disarticulated from the acetabulum.

Concurrent sacral and sacroiliac injuries may also be identified.



Acetabular fracture

VR CT shows the extent of an acetabular fracture (arrow).



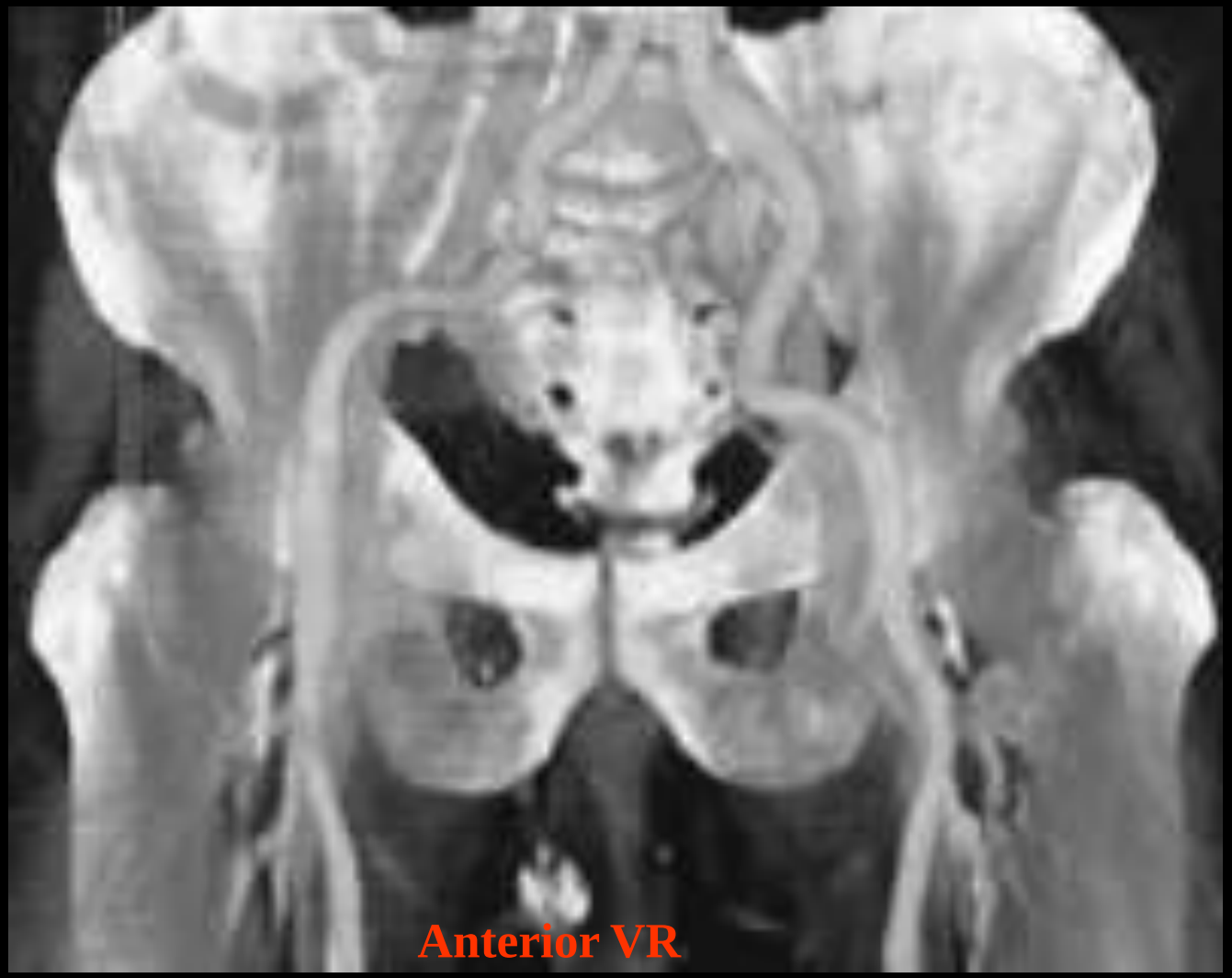
(a) Shows the extent of a Rt acetabular fracture (arrows). (b) Shows the orientation of the fracture lines and the acetabulum.

Pelvic fracture with an intra-articular fragment

Posterior acetabular fracture (curved arrow). An intra-articular bone fragment is seen (straight arrow).

Acetabular fracture

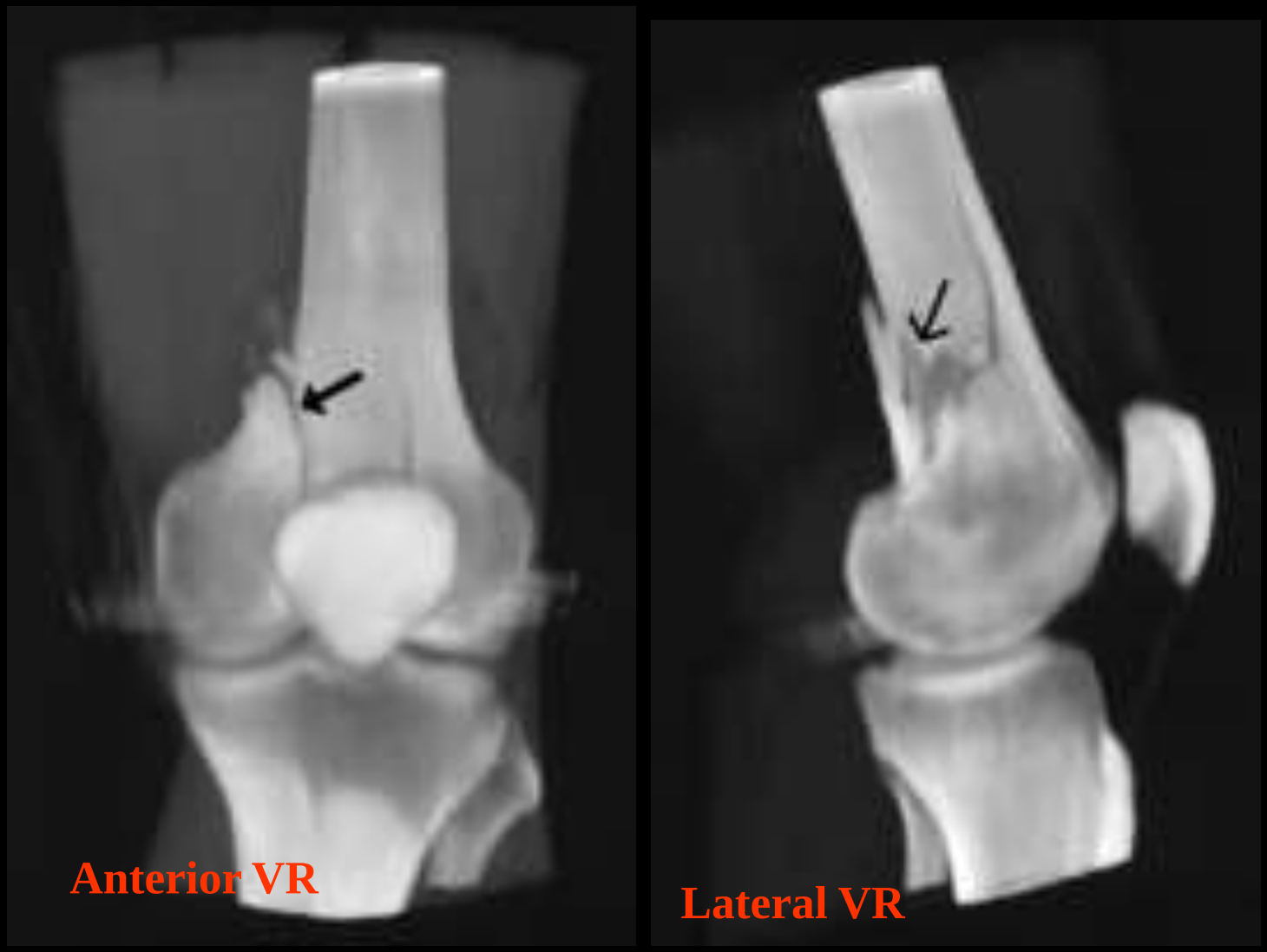
(a) Shows asymmetry of the acetabula with a possible fracture on Rt (arrow). **(b)** clearly shows the fracture of posterior acetabular wall.



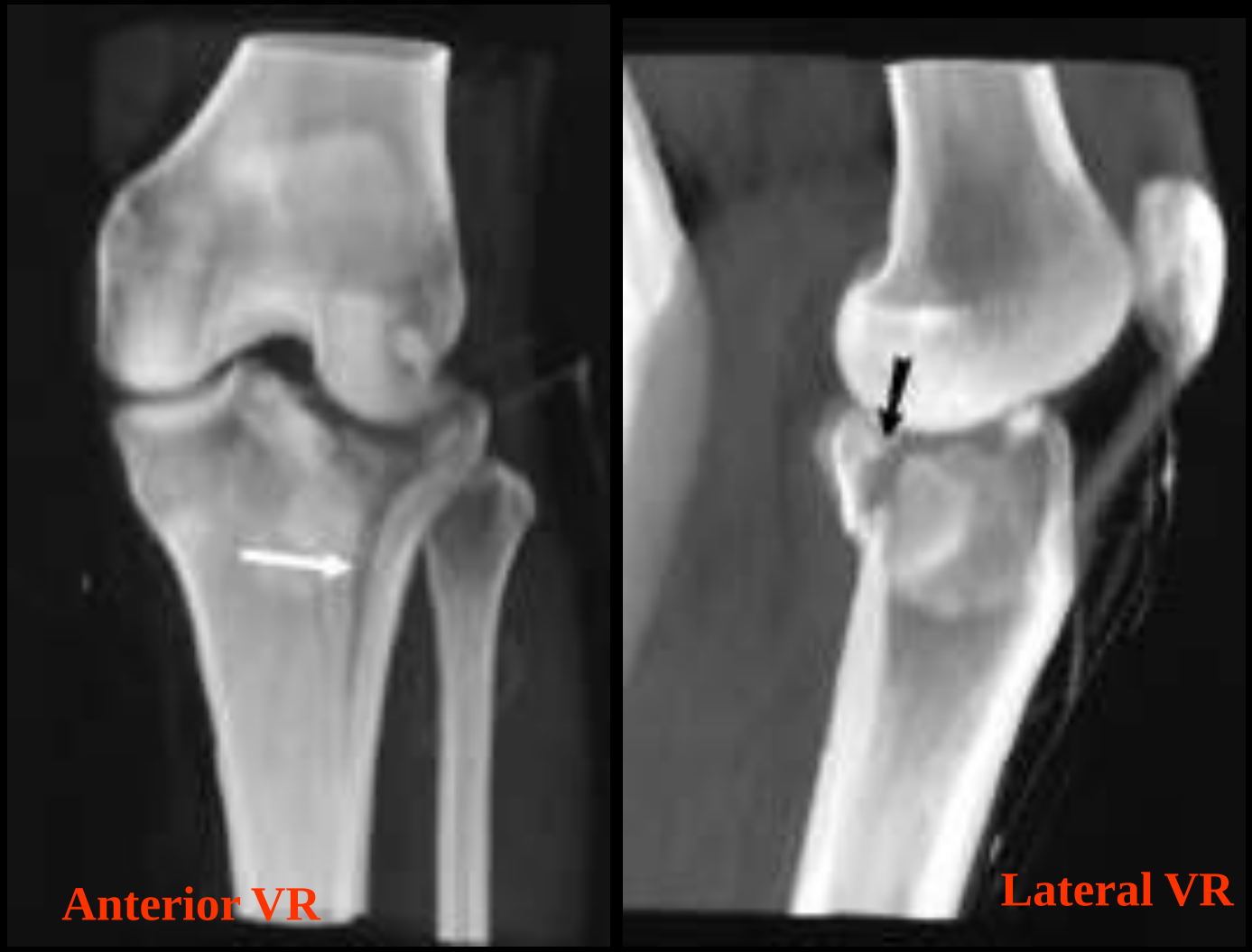
Shows that the osseous and major vascular structures are normal. In this trauma case, evaluation of the aorta and major pelvic vasculature was performed at the same time as evaluation of the osseous pelvis.

Although MRI is the preferred modality for evaluating the ligaments and menisci of the knee, CT with multiplanar reconstruction and VR is ideal for evaluating the osseous structures.

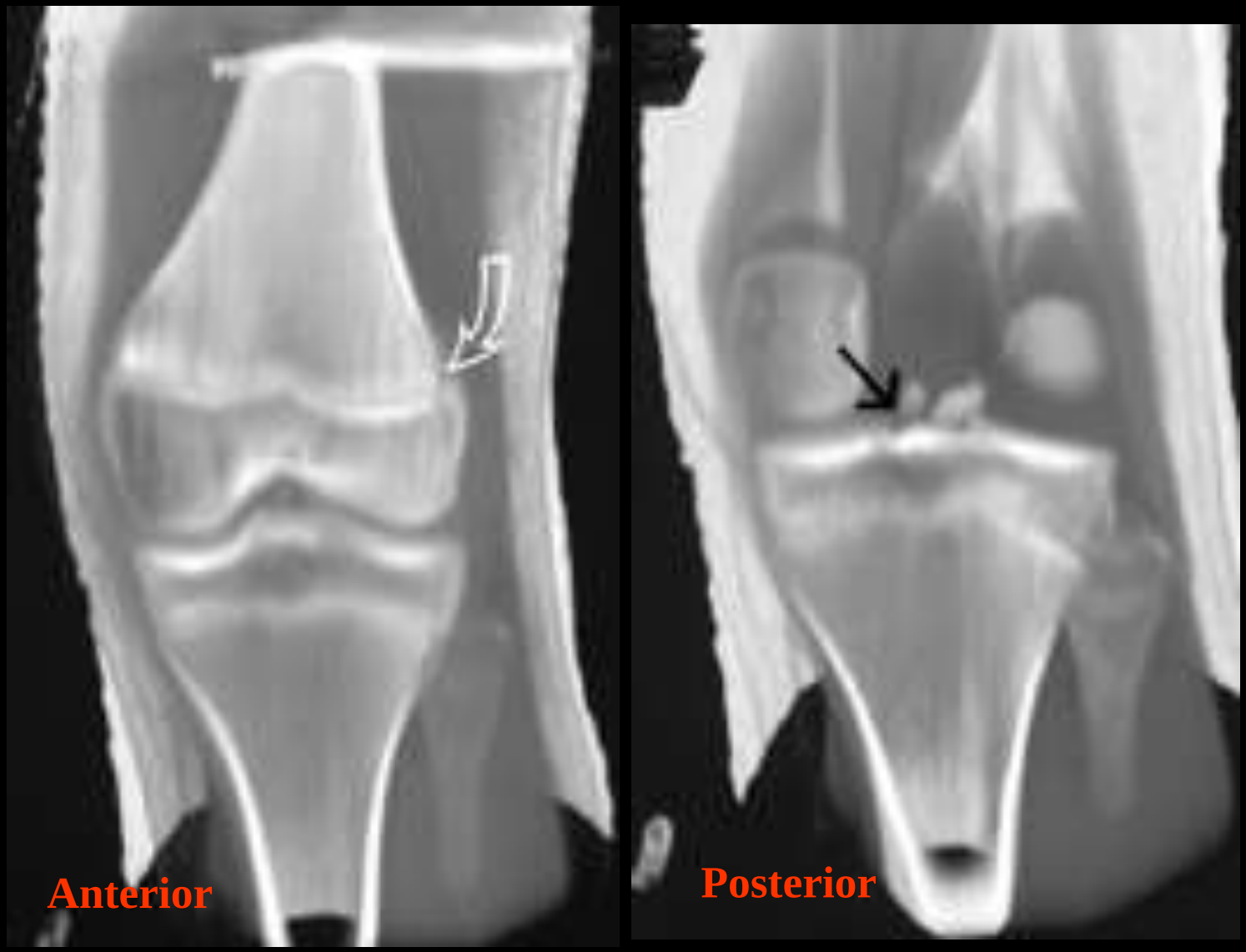
The reconstructed images can show the quantitative depression of tibial plateau, even if the knee cannot be easily positioned for conventional radiography.



Comminuted fracture of the distal femur (arrow).



Comminuted fracture of tibial plateau (arrow). The examination was limited with plain radiography due to the presence of cast.



Fracture of the lateral aspect of distal femur (arrow in **a**). Avulsion of the tibial spines is best seen on the posterior view (arrow in **b**).

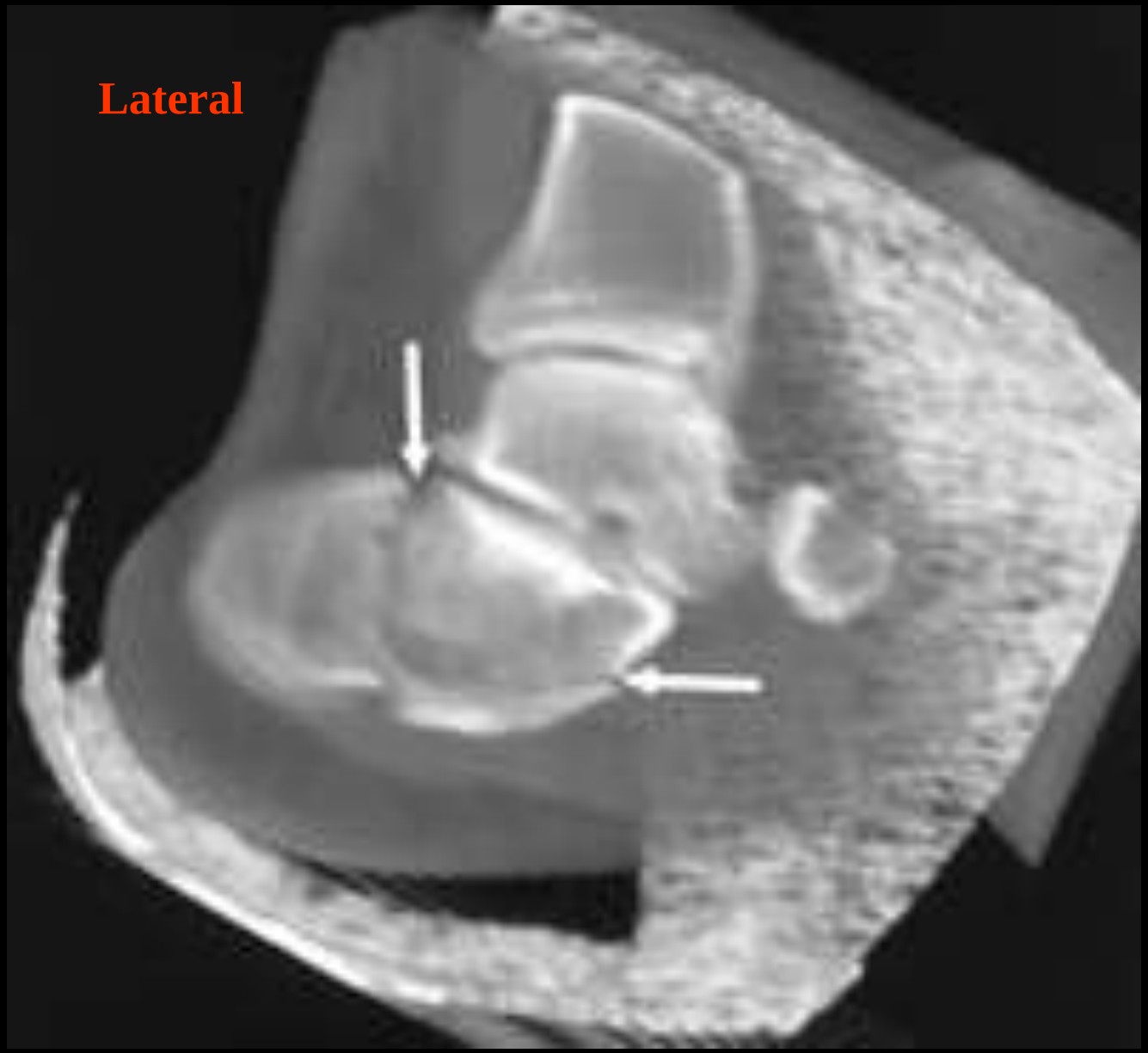
Routine fractures of the ankle do not require CT. However, in complex intra-articular fractures of the distal tibia, the added information provided by CT and VR imaging are more valuable.

Talar and calcaneal injuries can also be easily evaluated, 3D mapping can be done for preoperative planning.

Data acquisition done in a single plane parallel to the foot or in two planes with direct coronal imaging.

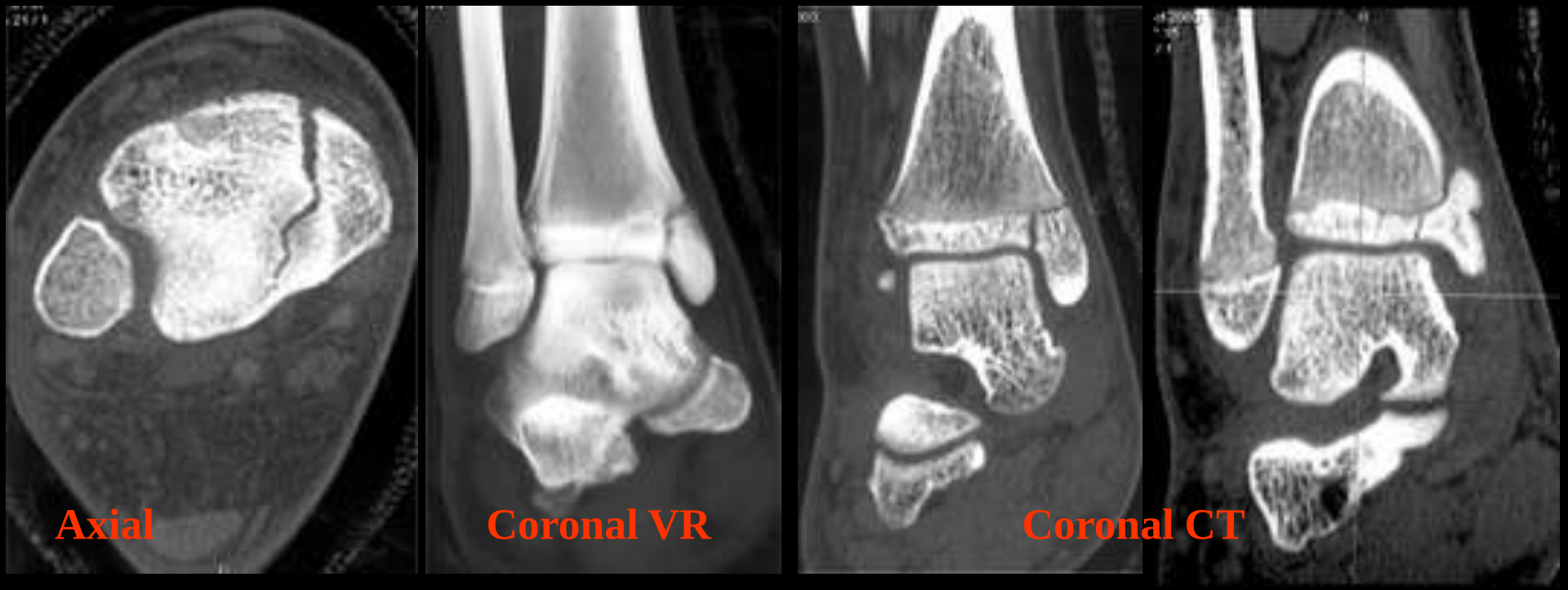
Comminuted impacted fracture of distal tibia in cast.

Fracture of distal tibia (arrows in **a**, solid arrow in **b**) with considerable anterior and lateral displacement and angulation of distal fracture fragments. The anterior view clearly shows an associated fibular injury (open arrow in **b**).



Comminuted fracture of the calcaneus (arrows).

Comminuted calcaneal fracture (arrow) in cast. The intraarticular nature of the fracture (arrow in **b**) is best seen in the posterior projection.



Tibial fracture

(a) Fracture of distal tibia. The relationship of the fracture to the physis is not clearly demonstrated. **(b, c & d)** show the fracture extending into the joint space.

Congenital

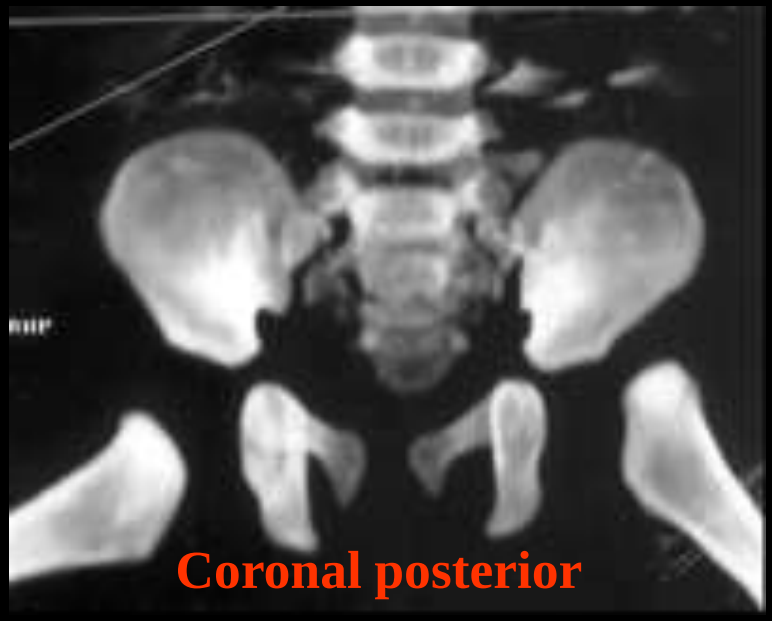
Developmental Dysplasia Of Hip

It is due to an abnormal position of the femoral head in the acetabulum, which results in abnormal growth patterns in both proximal femur and the acetabulum.

In most cases, femoral head is located superior and lateral to its normal location.

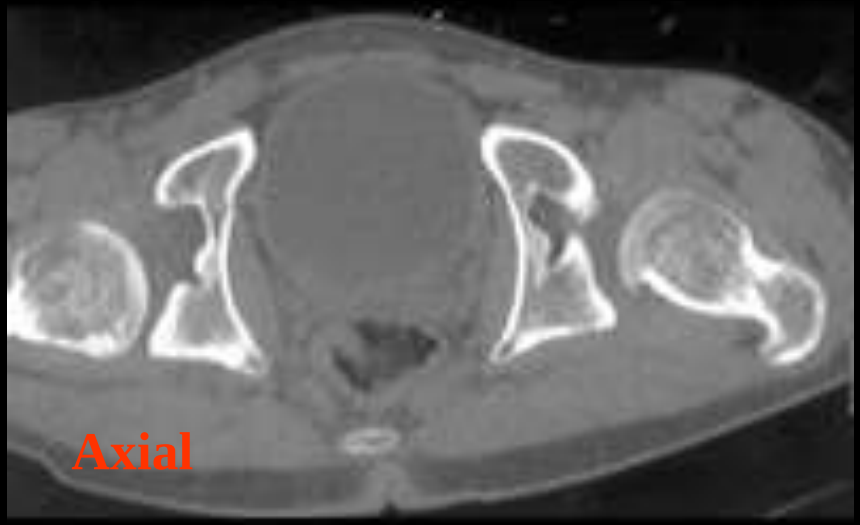
It is more common in girls.

Diagnosis is typically made by physical examination & plain radiography, however CT can be used in most difficult cases or as an imaging alternative.



(a) Axial CT does not clearly show the location of Lt femoral head. **(b, c & d)** show superolateral displacement of Lt femoral head.

(a,b) Obtained in two slightly oblique orientations show dysplasia of Rt hip with a shallow acetabulum and flattening of Rt femoral head. **(c)** Shows identical findings.



(a) Shows that the femoral heads are uncovered bilaterally. **(b)** Shows bilateral shallow acetabula and uncovering of the femoral heads (more on Lt side). **(c)** Shows the deformities and displacement of the femoral heads.

Slipped Capital Femoral Epiphysis

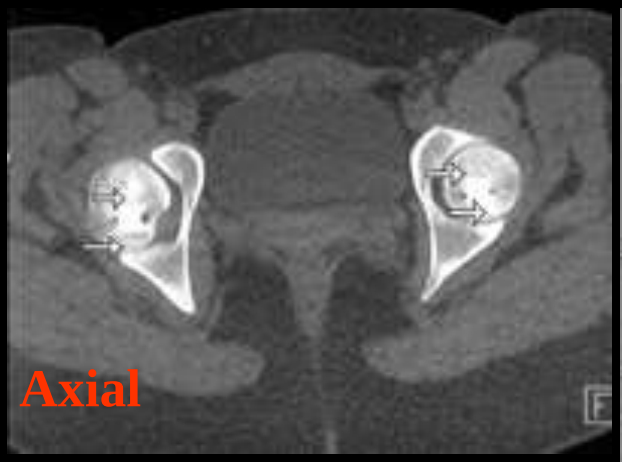
It is a condition in which the femoral epiphysis typically slips posteriorly, medially & inferiorly.

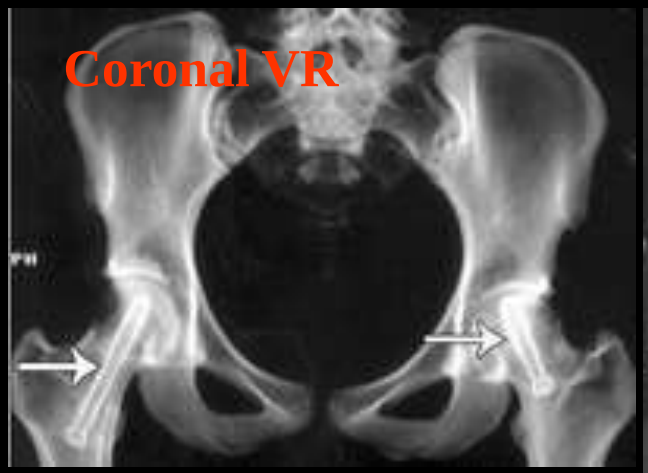
It is a bilateral condition in up to 35% of cases and is most common between the ages of 8 and 17 years.

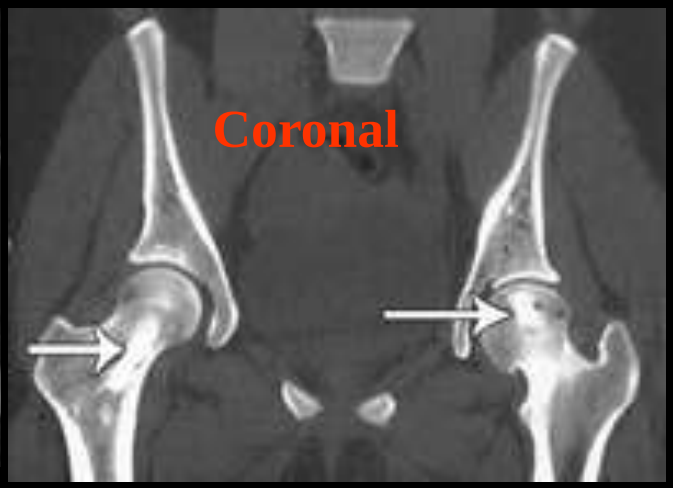
Boys are more frequently affected than girls.

The abnormality is more detected by plain radiography, however, CT with coronal & sagittal reconstruction is more useful in cases where the diagnosis is equivocal.

MRI show physeal changes earlier than plain radiography & CT.







Evaluation of surgical screws after hip fixation for bilateral SCFE.

(a) Bilateral intramedullary surgical screws with streak artifacts (arrows). **(b)** Streak artifacts are eliminated. **(c)** Shows the intramedullary screws (arrows). The alignment is satisfactory.

Legg-Calvé-Perthes Disease

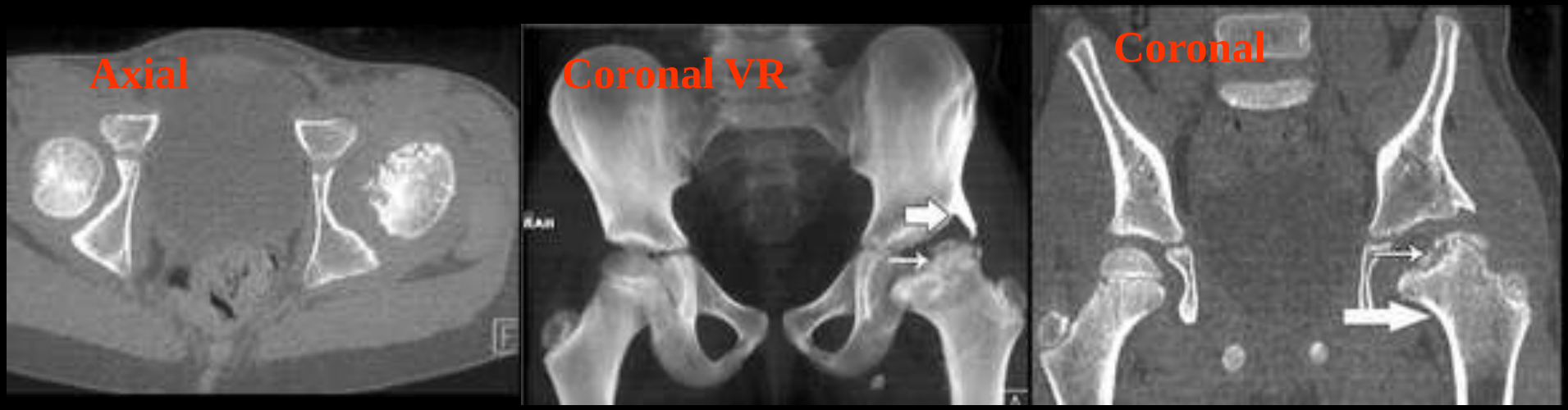
Also known as *idiopathic avascular necrosis of the hip*.

It occurs between 4–8 years & is common in boys.

MRI & multidetector CT are commonly used now.

The findings of asymmetric femoral epiphysis & joint effusion can be defined on coronal CT or VR images.

Later-stage disease with fragmentation or irregularity of the epiphysis, as well as deformities of the femoral neck, are well documented on 3D CT.

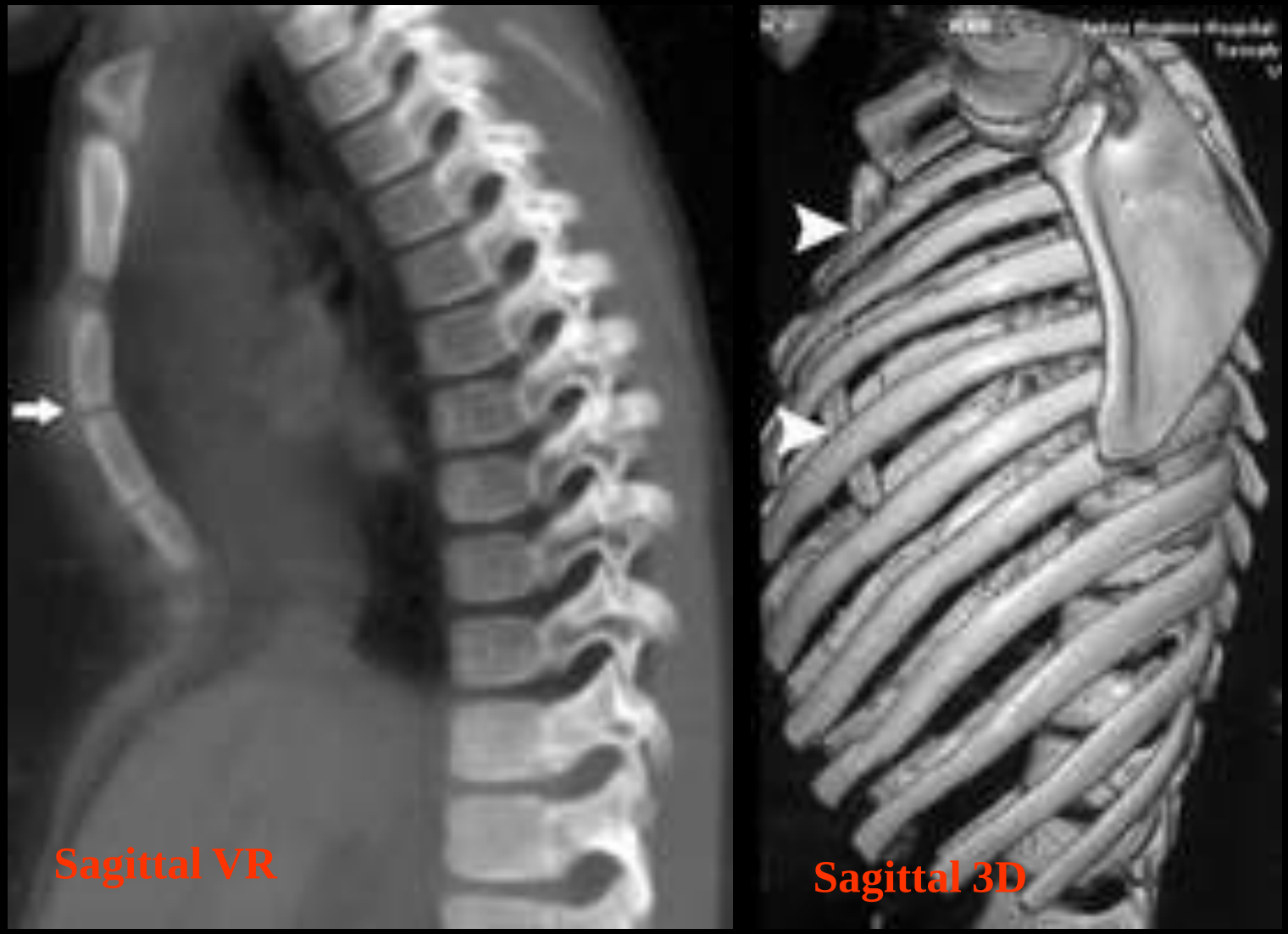


(a) Remodeling of Lt femoral neck. The epiphysis is difficult to evaluate on axial source images. **(b)** Fragmentation of Lt femoral epiphysis (thin arrow). The patient has undergone Lt acetabuloplasty (thick arrow). **(c)** Fragmentation of epiphysis (thin arrow) & remodeling of femoral neck (thick arrow).

Pectus Excavatum

In most patients, CT is not necessary to determine the extent of disease or for surgical planning, as chest radiography is sufficient.

However, in patients with more severe deformities or in cases where initial repair was unsuccessful, CT with 3D mapping of the chest is valuable.



(a) Pectus excavatum & narrowing of the AP diameter of the chest
(b) Shows the deformed sternum (arrowheads).

Pectus excavatum.

Tarsal Coalition

They may be osseous / nonosseous (fibrous / cartilaginous).

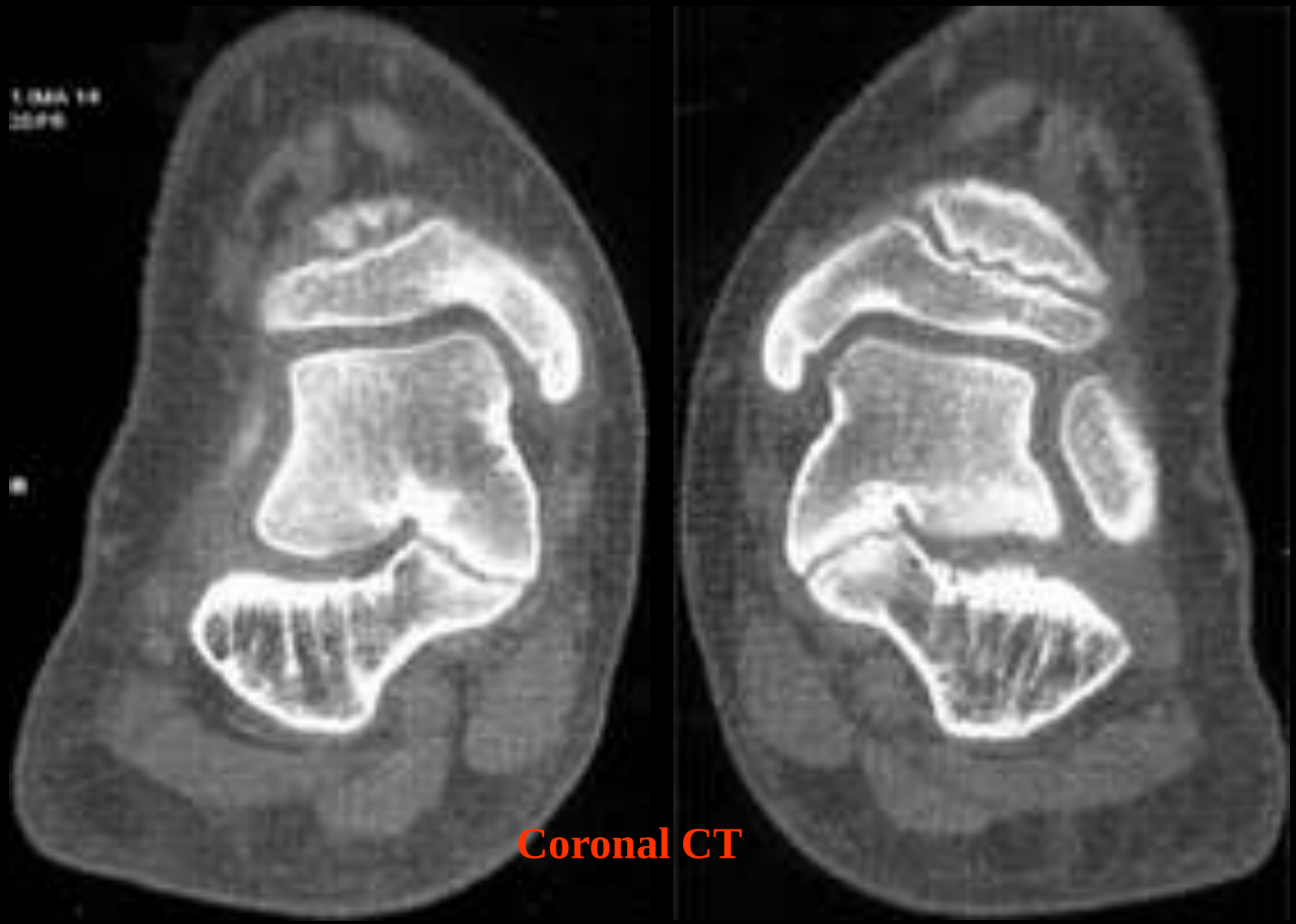
Talo-calcaneal and calcaneo-navicular are the most common forms of tarsal coalition.

The diagnosis can be overlooked by plain radiography. CT is the study of choice for evaluation of these patients.

With 16-section MDCT and isotropic data sets, acquisition in only one plane is required and subsequent reconstruction to other desired planes can be performed.

In general, to detect a coalition between two bones, a plane perpendicular to the articulation is needed. (ex., for a talo-calcaneal coalition, the coronal plane is favored).

Shows proximity of the anterior process of the calcaneus to navicular bone with surrounding sclerosis (arrow) (indicative of a non-osseous calcaneo-navicular coalition).



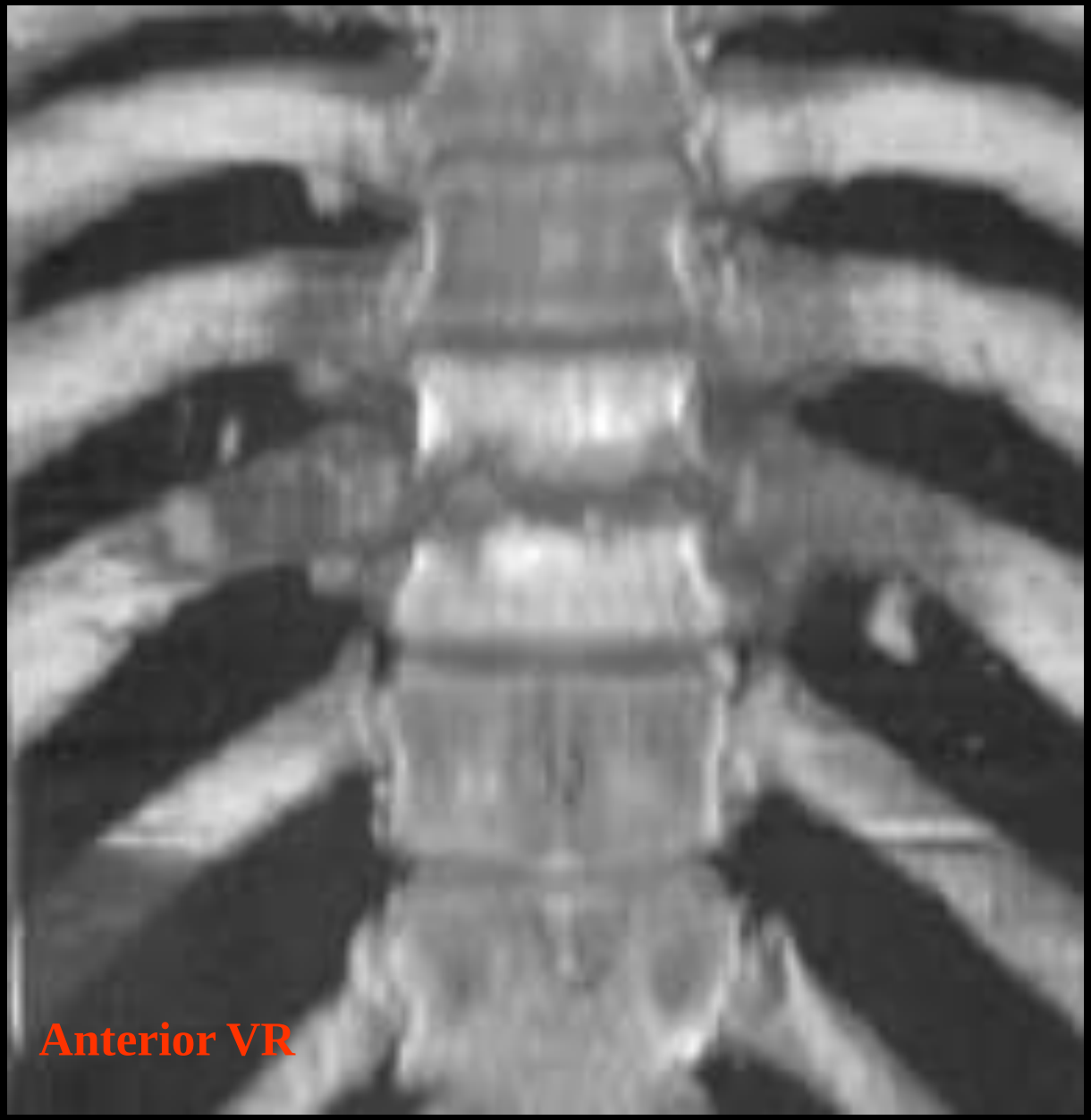
Bilateral nonosseous talocalcaneal coalitions.

Infection

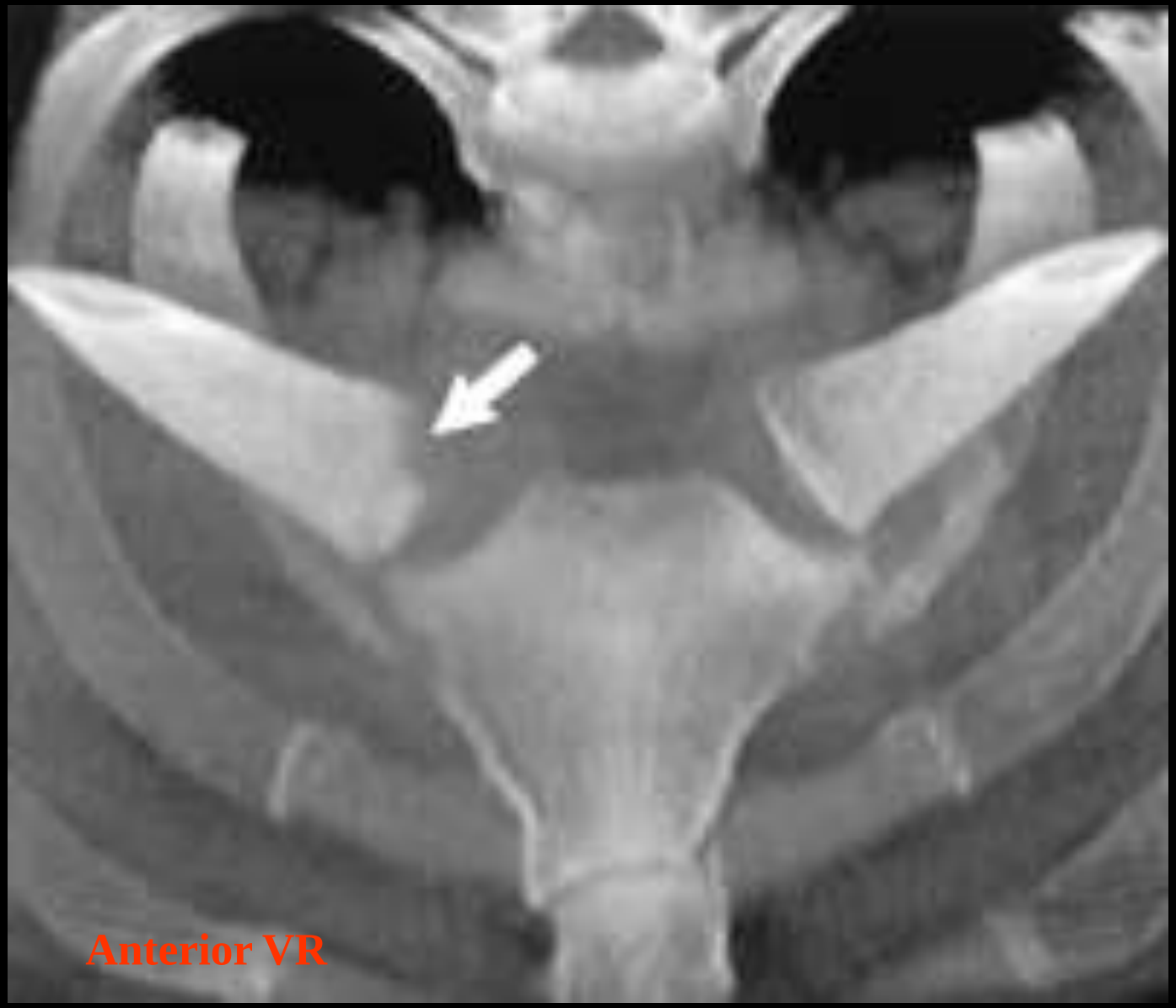
VR CT is valuable in detecting infection and in determining which compartments are involved (subcutaneous tissue, fascia, muscle, bone) and the extent of the process.

IV contrast material is necessary for defining the extent of disease.

Definition of the vascular anatomy is also helpful in these cases, and 3D CTA may be performed if needed.



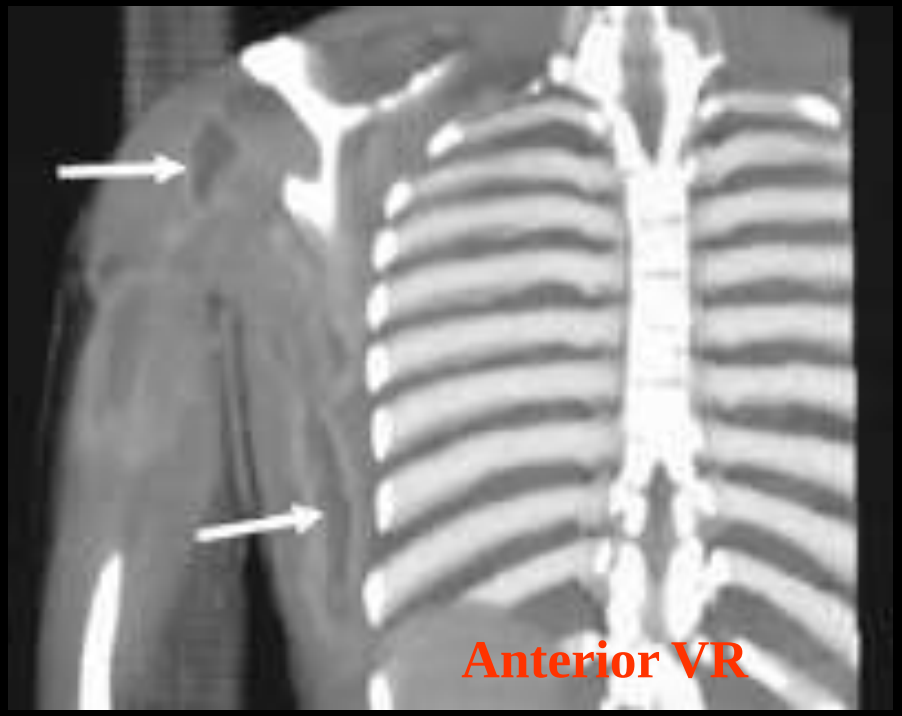
Vertebral osteomyelitis

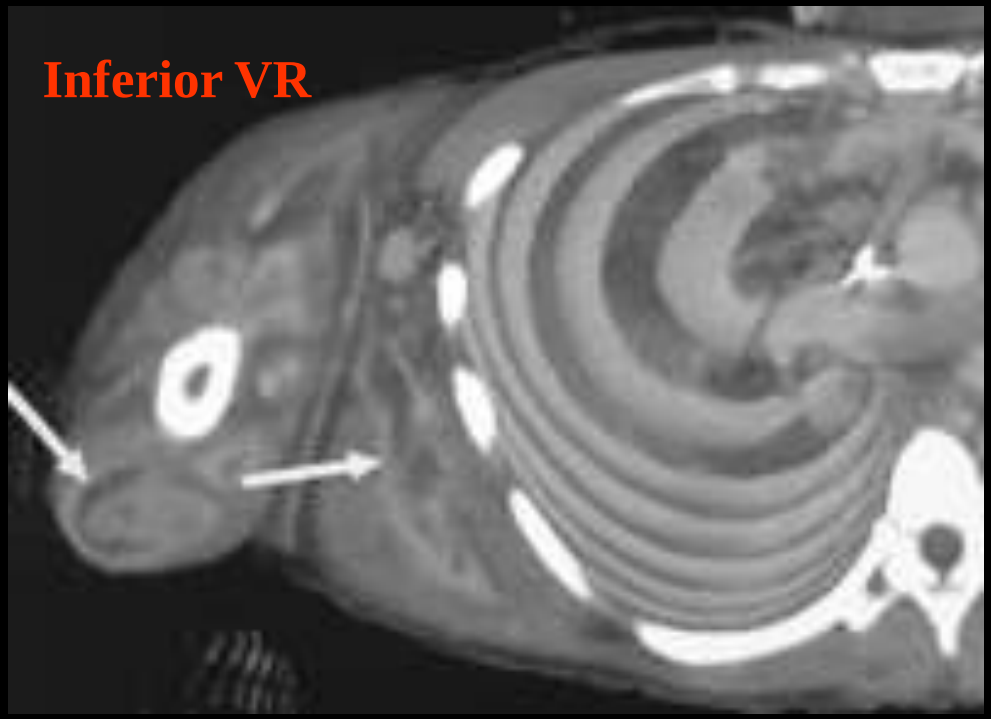


Osteomyelitis with erosion of the proximal Rt clavicle & manubrium (arrow).

Soft-tissue abscess

CT after IV contrast show a large abscess involves Rt shoulder. The full extent of the abscess is seen, including involvement of the supraspinous (arrowheads), infraspinous (solid arrow) & teres minor (open arrow) muscles.





Soft-tissue abscesses

CT after IV contrast show multiple hypodense rim enhancing abscesses in Rt arm & chest wall (arrows).

Tumors

For bone tumors, plain radiography remains the mainstay of lesion detection and D.D.

Although MRI has become the leading modality for evaluating the extent of bone and soft-tissue neoplasms, many studies found that CT is effective.

CT remains superior to MRI in the detection of cortical destruction and lesion calcification.

VR CT is useful in defining the full extent of bone tumors.

3D images are especially valuable in anatomically complex areas as ribs, pelvis, shoulder & spine

Large lytic lesion involving superior aspect of sacrum (arrow) (giant cell tumor).

D.D. include 2ry, chordoma & neurofibroma.

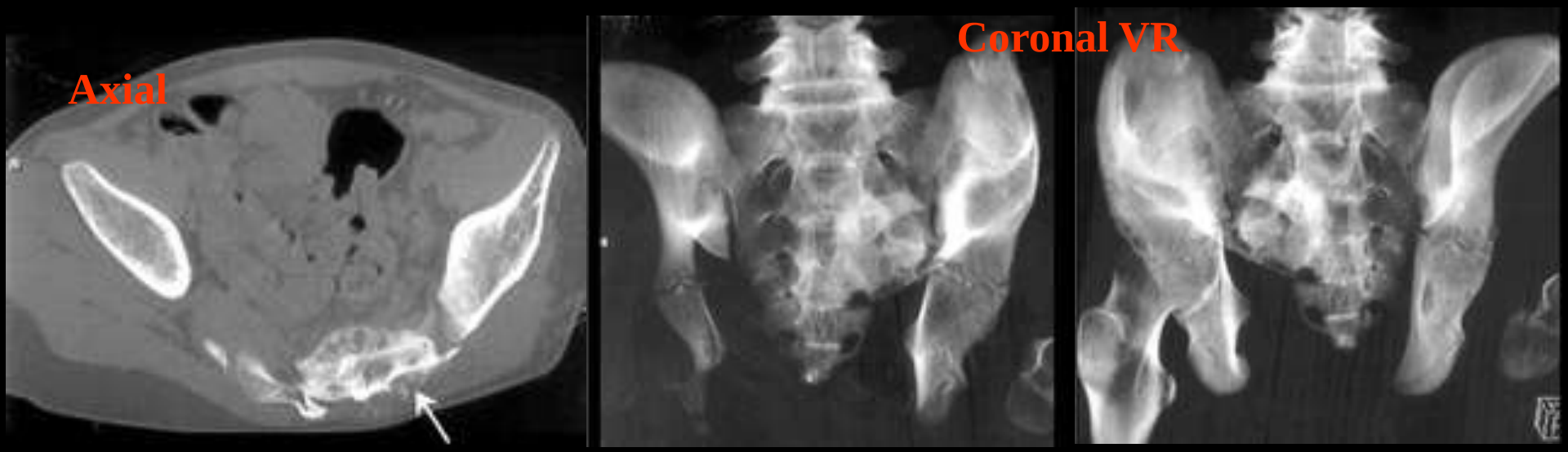
Metastasis from breast carcinoma.

Sclerotic metastasis to Lt ischium (arrow).

Sclerotic lesion in Lt aspect of L5 vertebral body (arrows). (Ewing sarcoma).

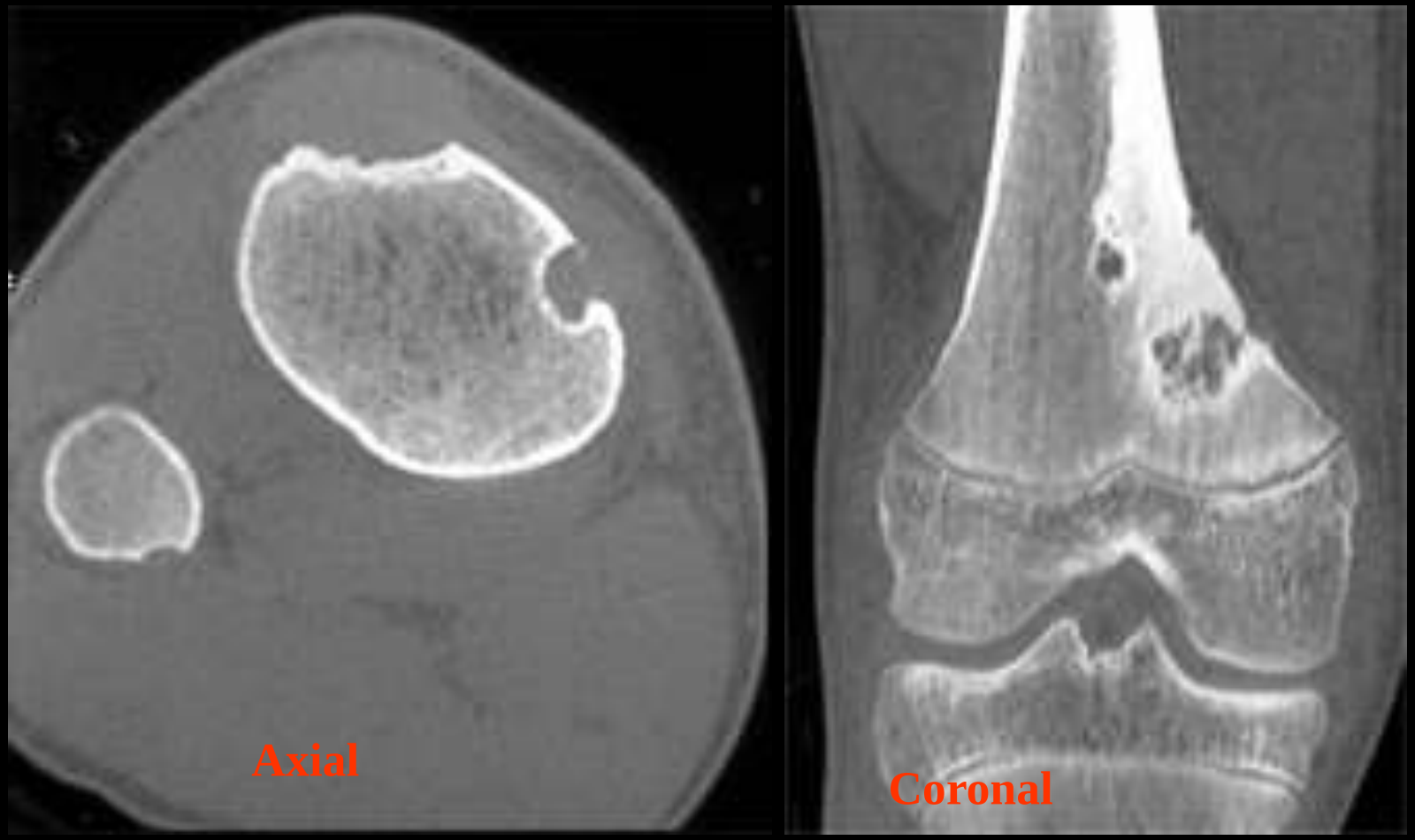
Destructive midline lesion of the sacrum (arrow) (chordoma).

Extensive replacement and destruction of the scapula by multiple myeloma.



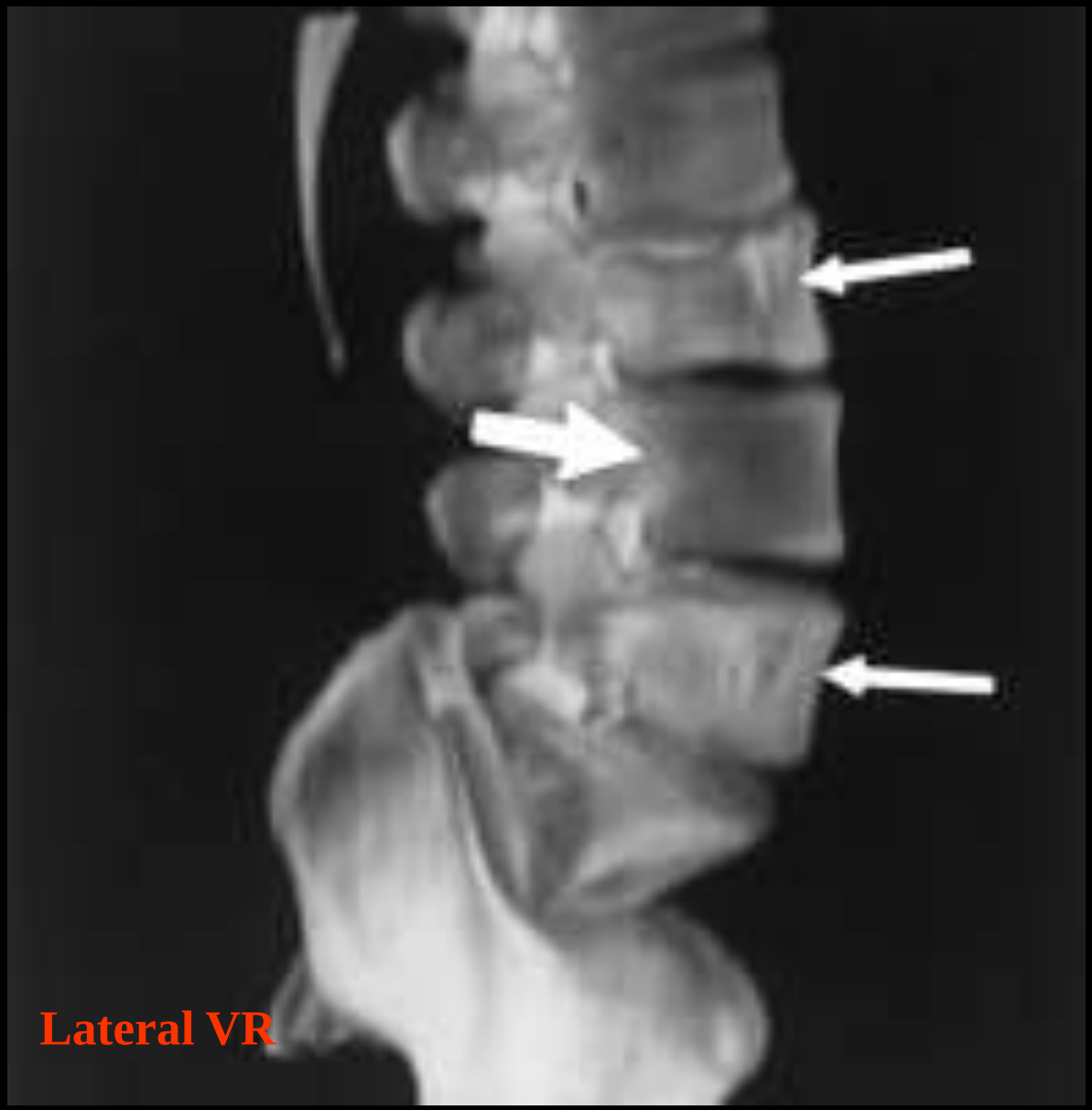
Sacral osteosarcoma

(a) Lt sided sacral lesion (arrow) that contains osteoid matrix and is associated with a soft-tissue mass. The relationship to the posterior S.I.J. is not clearly demonstrated. **(b)** The sacral lesion abuts the S.I.J. and involves the lower sacral foramina. **(c)** More posterior, shows the sacral lesion



Nonossifying fibroma

(a) Eccentric lytic lesion in the cortex with a probable very thin rim of overlying periosteum. **(b)** Multiple eccentric, well-defined, lobulated, low density lesions with sclerotic borders (compatible with nonossifying fibromas).



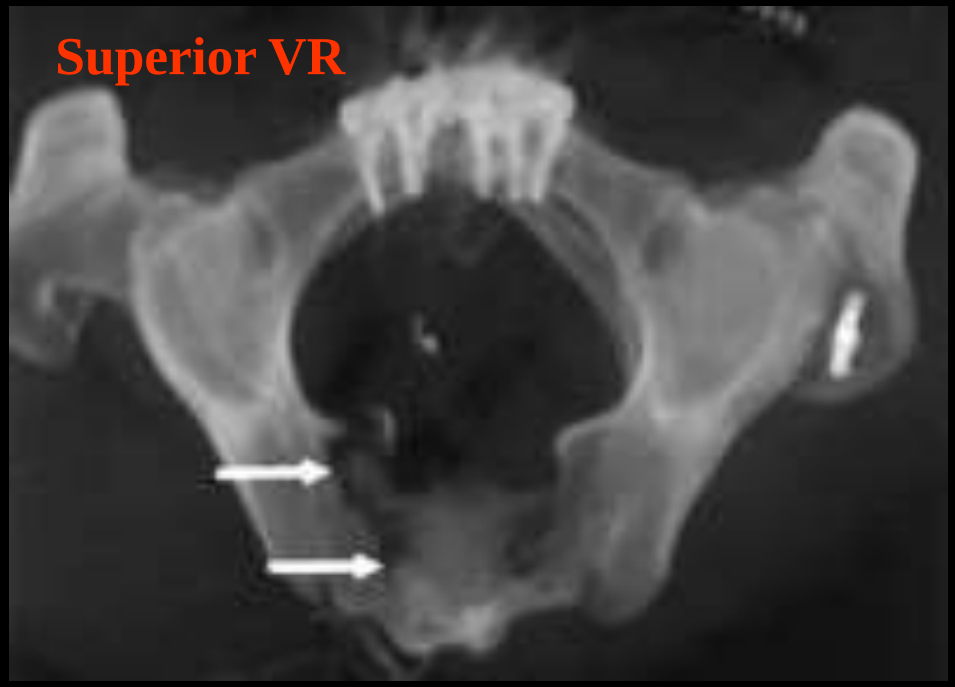
Mixed sclerotic (thin arrows) & lytic (thick arrow) lesions in lumbar spine (lymphoma).

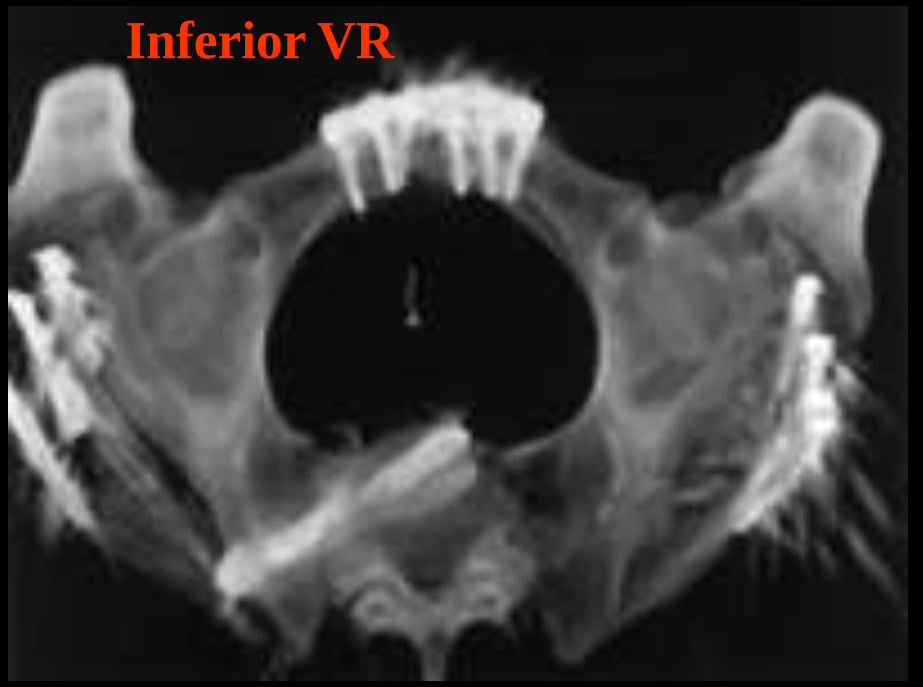
Post Op. Imaging

When plain radiography fails to answer the clinical question in a postoperative orthopedic patient, CT or MRI is performed.

In such patients, CT is often markedly limited 2ry to extensive streak artifact from implanted hardware and MRI is limited by susceptibility artifact.

VR CT is often able to compensate for streak artifact, and studies are usually quite successful despite the presence of metal plates, pins or prostheses.

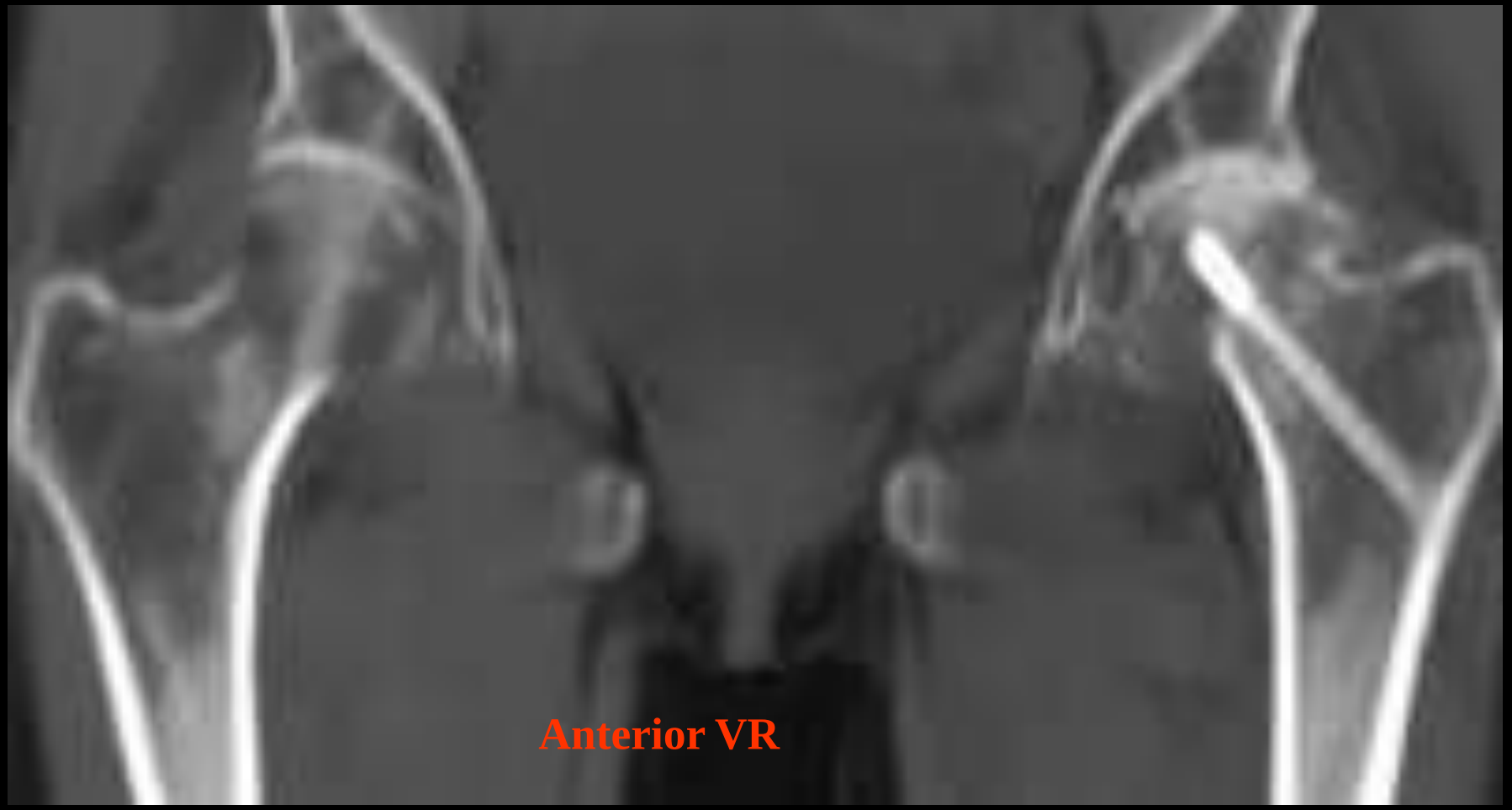




Complex pelvic injury after reduction

CT was done to determine if the reduction was successful.

Despite extensive metal artifact due to plates and screws in the pubic symphysis, both iliac crests, and the sacrum, VR CT show specific details with little artifacts.



Shows a pin inserted through an impacted fracture of Lt femoral neck. No streak artifact from the pin is seen.

Failed Rt hip prosthesis which is superiorly displaced relative to the osseous acetabulum.

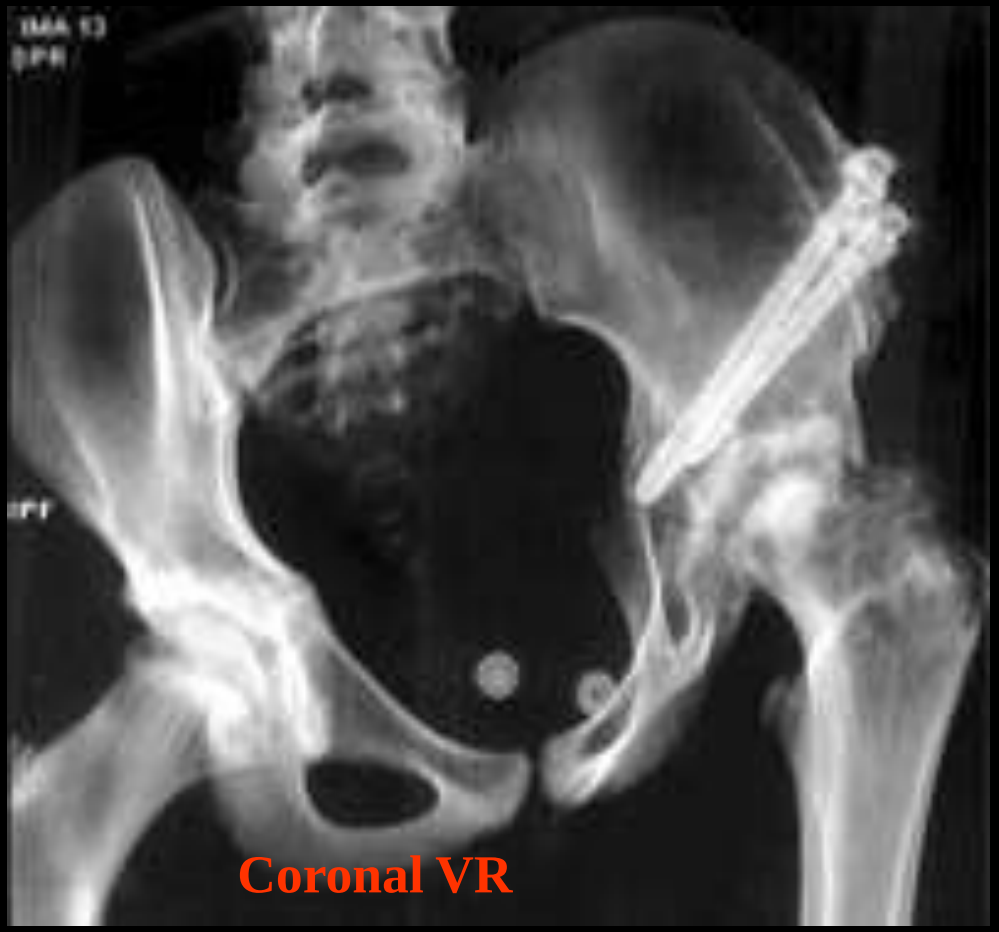
Several cerclage wires are broken.

Coronal VR

Coronal CT

Orthopedic hardware in polyostotic fibrous dysplasia. She underwent osteotomy with placement of a dynamic hip screw and a lateral plate.

(a) Varus deformity of Rt hip with orthopedic hardware. **(b)** Shows the metallic hardware. **(c)** Extensive streak artifacts related to the orthopedic hardware.



Orthopedic hardware in boy with Legg-Calvé-Perthes disease after Lt hip osteotomy

(a)Surgical screws at the osteotomy site. Note the deformed femoral head. **(b)** Shows streak artifacts related to one of the surgical screws.

Coronal oblique VR

Orthopedic hardware in girl with multiple fractures.

Surgical screw traversing a fracture of the anterior column of the acetabulum.

Conclusion

CT is a powerful modality for the evaluation of MSK system, particularly when coupled with VR.

In trauma cases, subtle fractures, complex injuries & complicated spatial information about the relative positions of fracture fragments are better seen on VR images.

The use of IV contrast material also allows simultaneous evaluation of vascular structures within the affected area.

Evaluation of infectious or neoplastic disease is also aided by VR 3D imaging as disease extent can be thoroughly evaluated.

Postoperative studies in patients with orthopedic hardware benefit from VR imaging by eliminating streak artifact.


Thank You