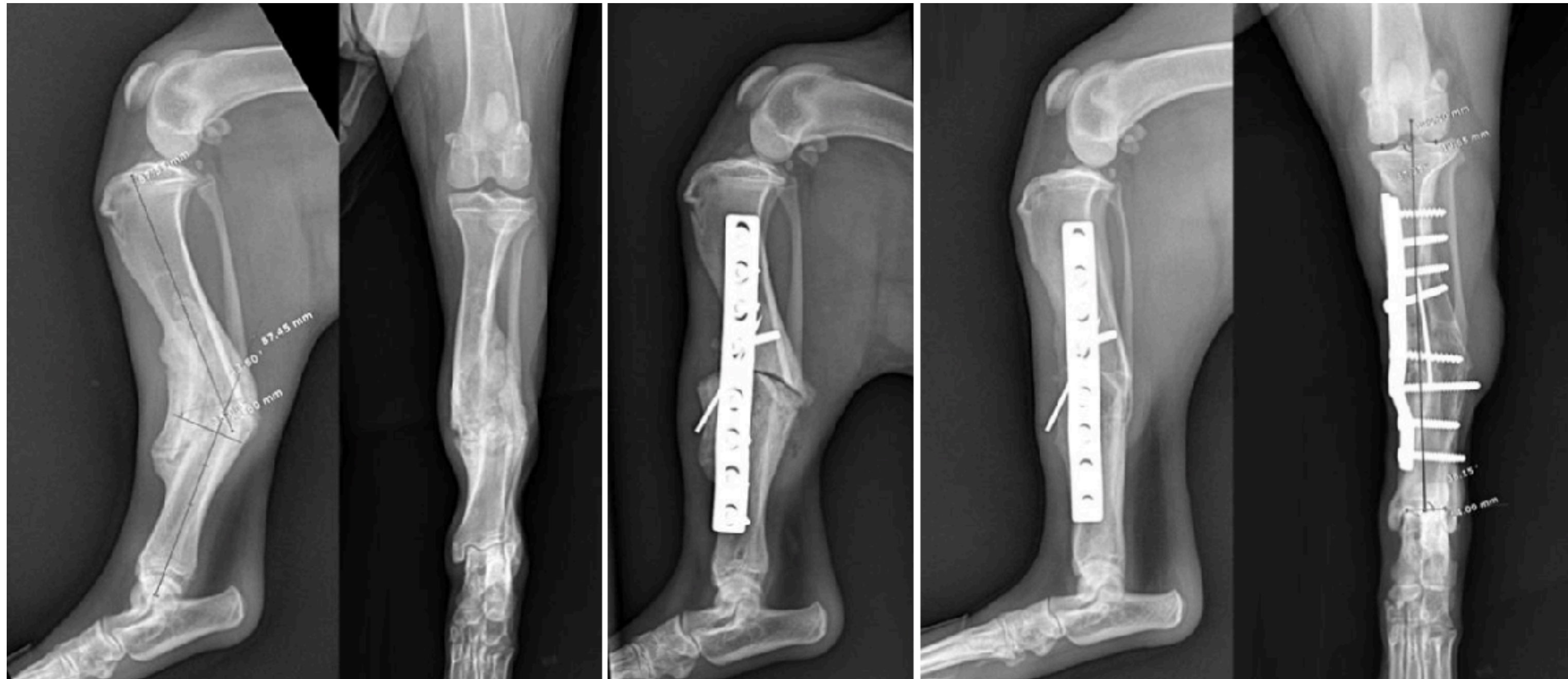


Malunions

Prevention and treatment

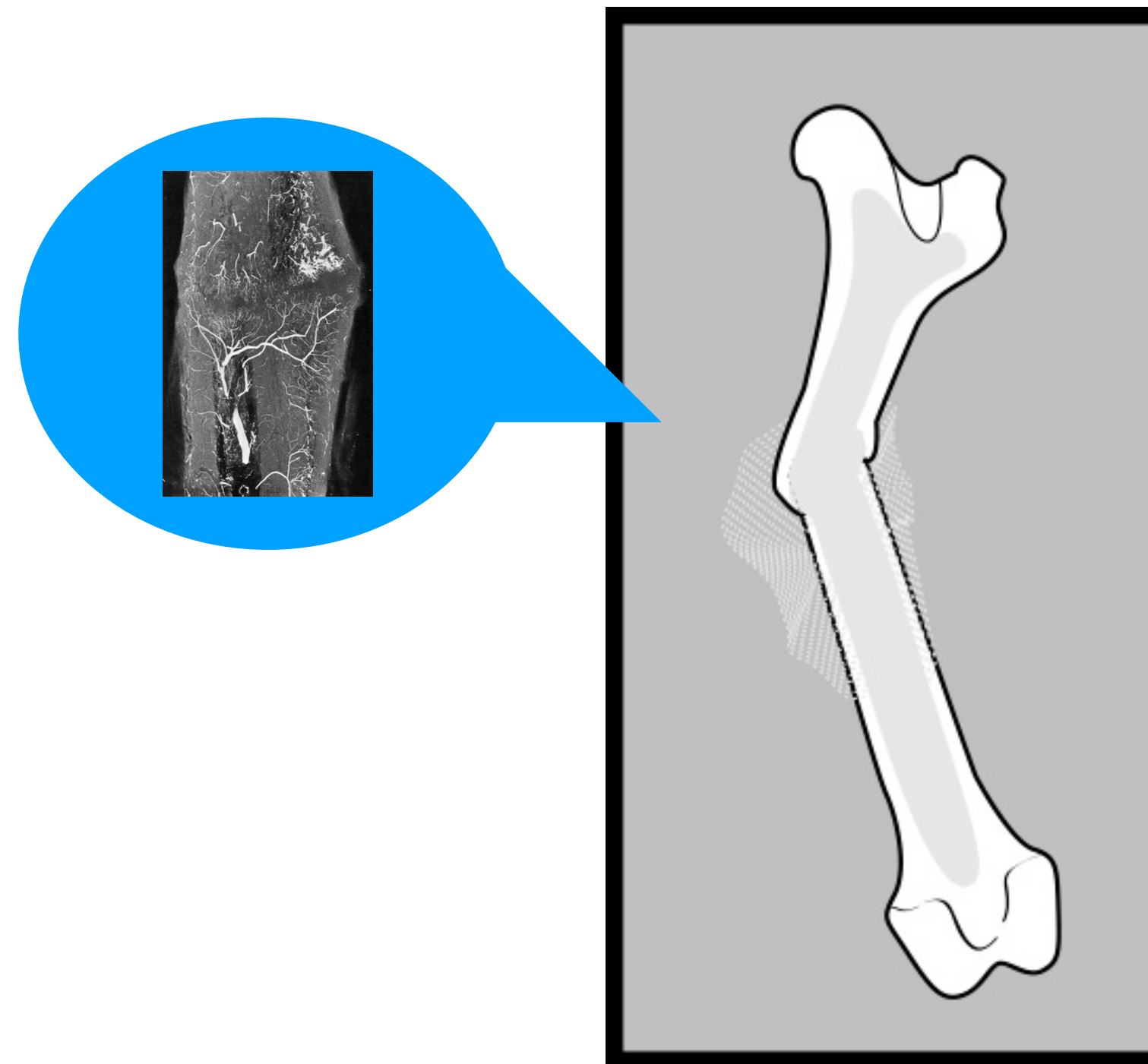


Dr. Vladislav Zlatinov
Central Veterinary Clinic- Sofia, Bulgaria



Definition

“A fracture that has healed with unacceptable amount of malalignment, impairing the ambulation or pain-free function of the limb”.



Causes?

“Natural” bone healing process..



● Inappropriate conservative management- splinting of unstable fractures



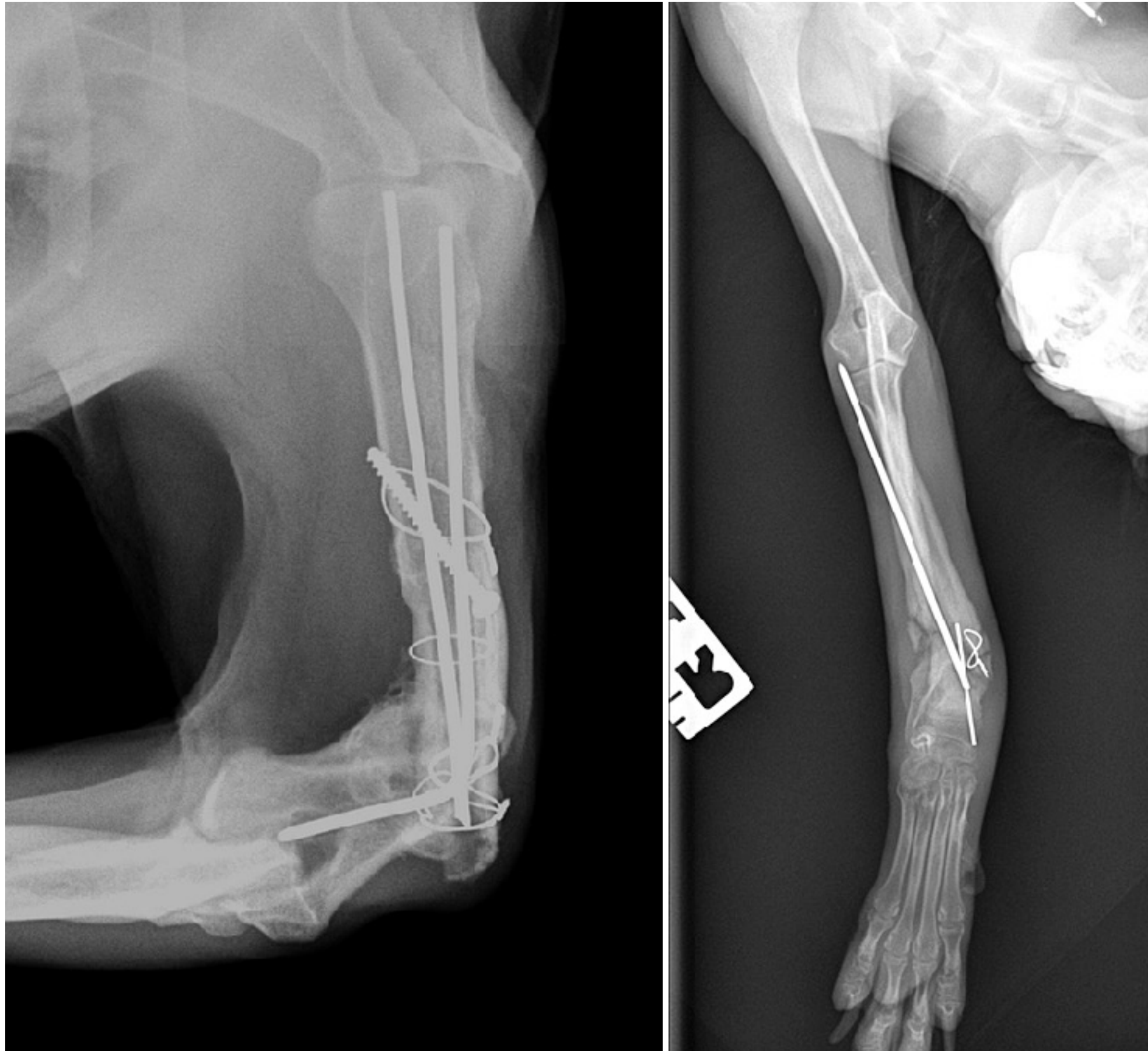
Suboptimal surgical technique



Failure of the surgical fixation or implants

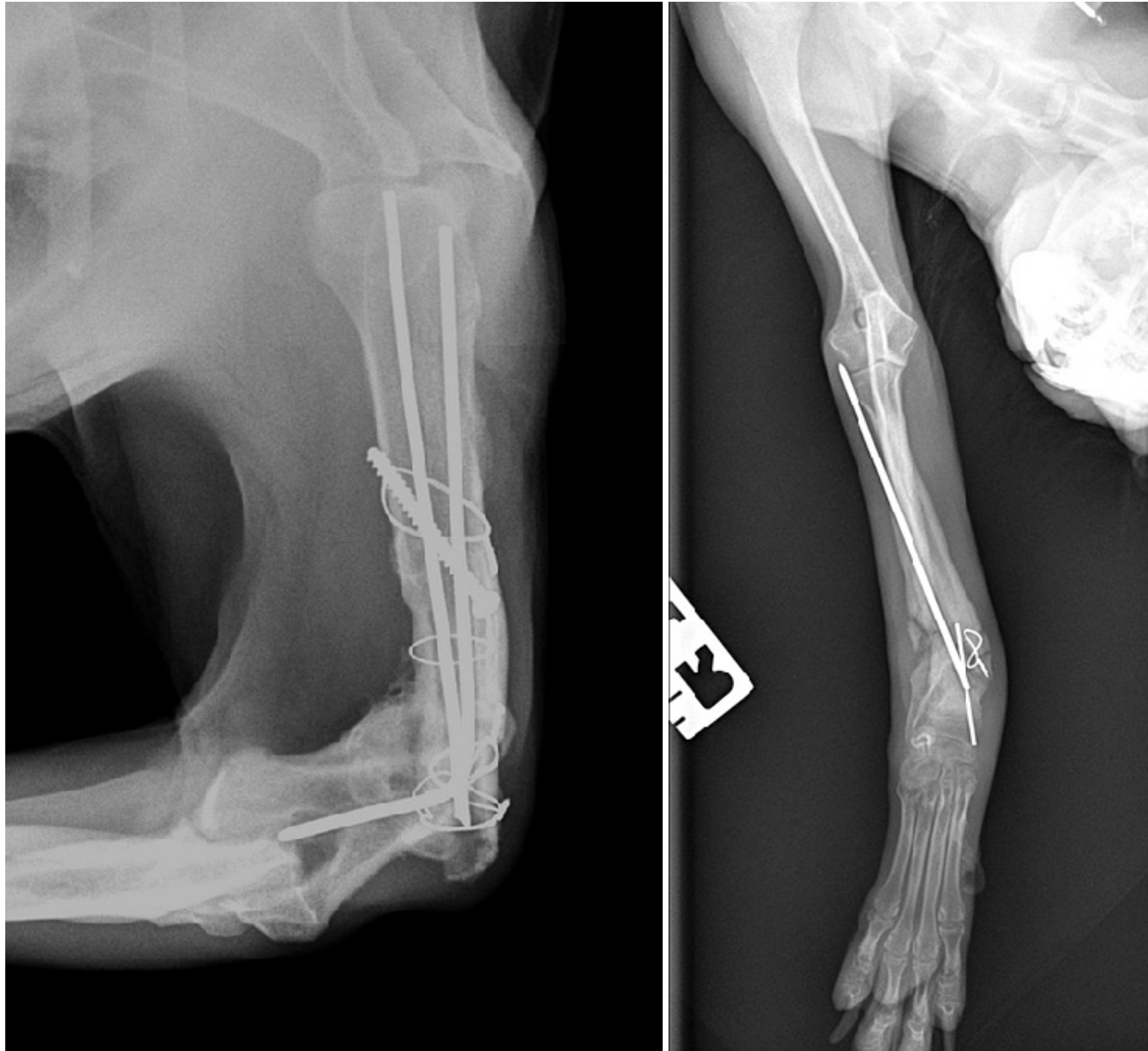


Improper repair technique

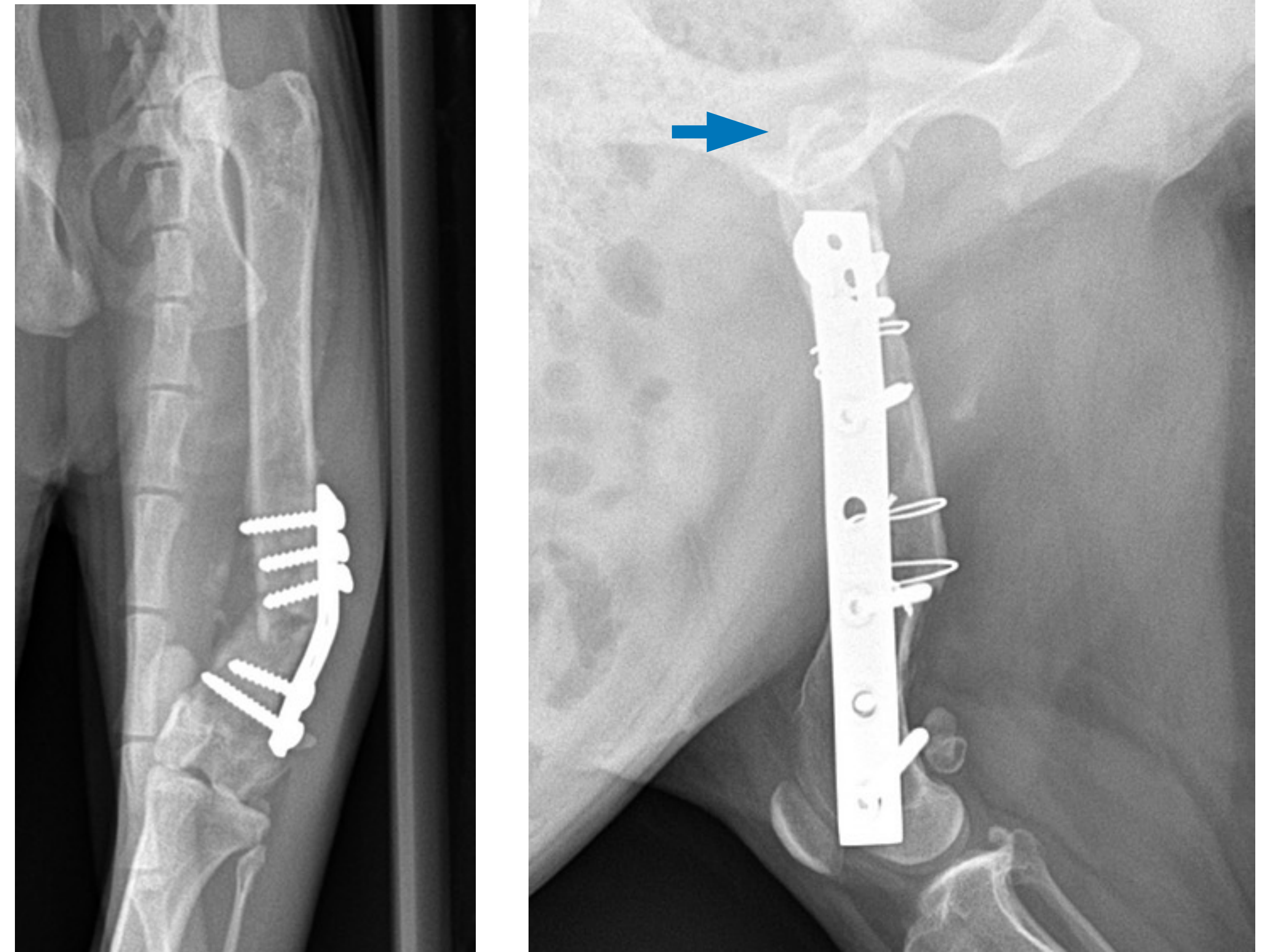


Failure of the surgical fixation or implants

Improper repair technique



Improper application of an appropriate technique



Malunions versatility

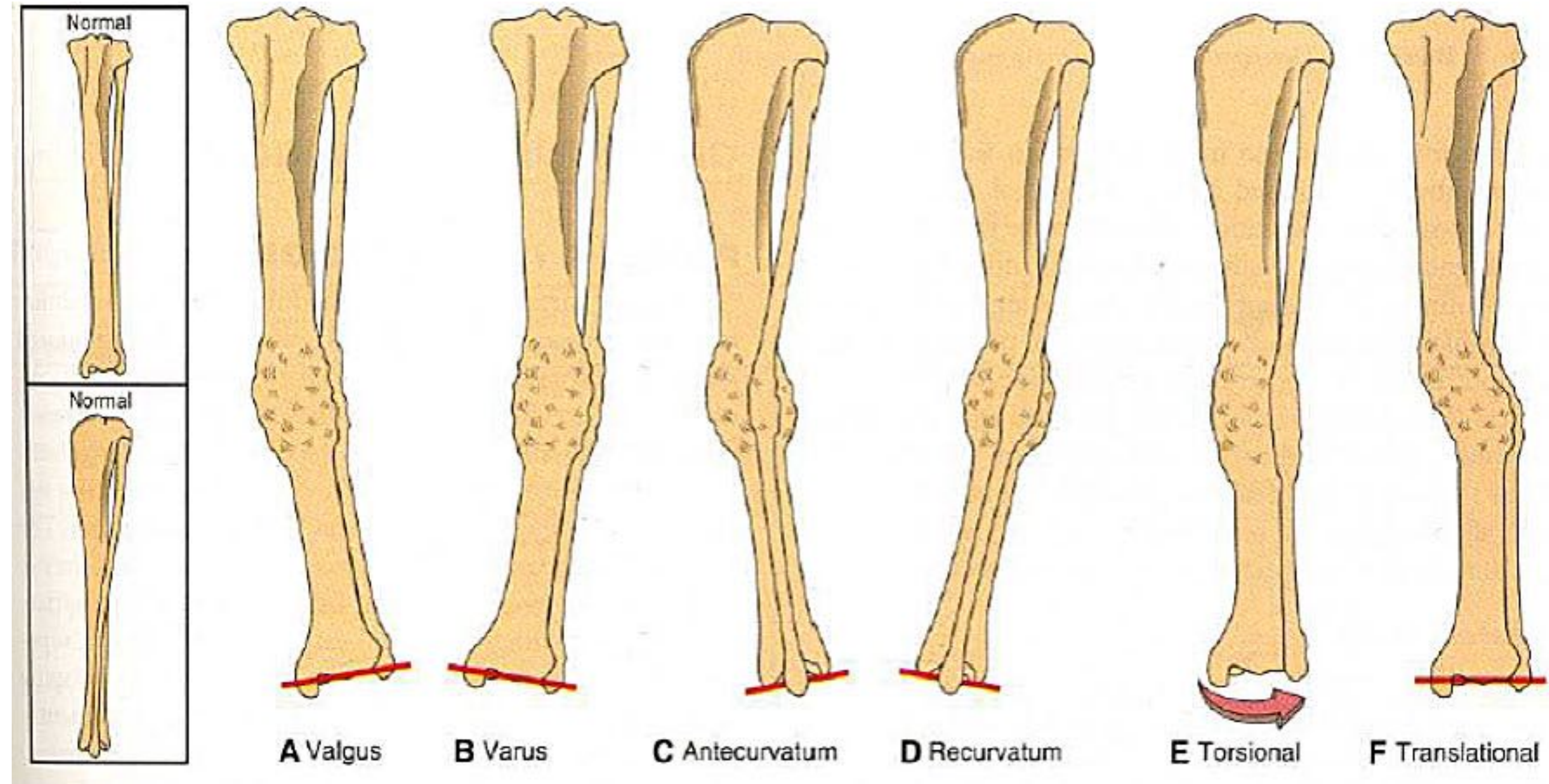
- Trauma type
- Fragments in/stability created
- Forces acting on the fracture
- Weight, age, activity..=>



Common end result is unrepeatable, diverse.

Subsequent deformities

- Shortening
- Angulation
- Rotation
- Translation

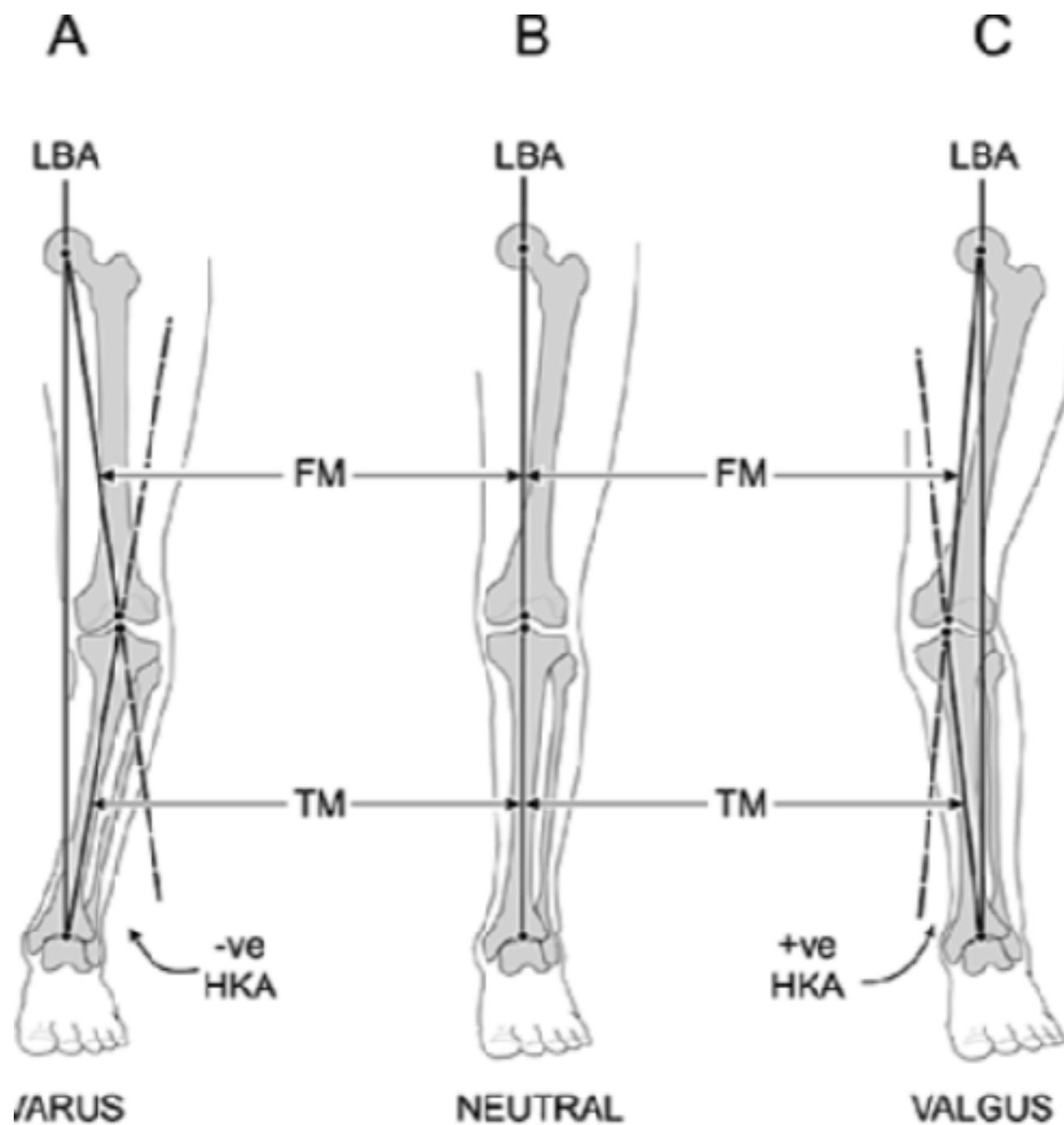


Malunion classification and grading

How much is too much?

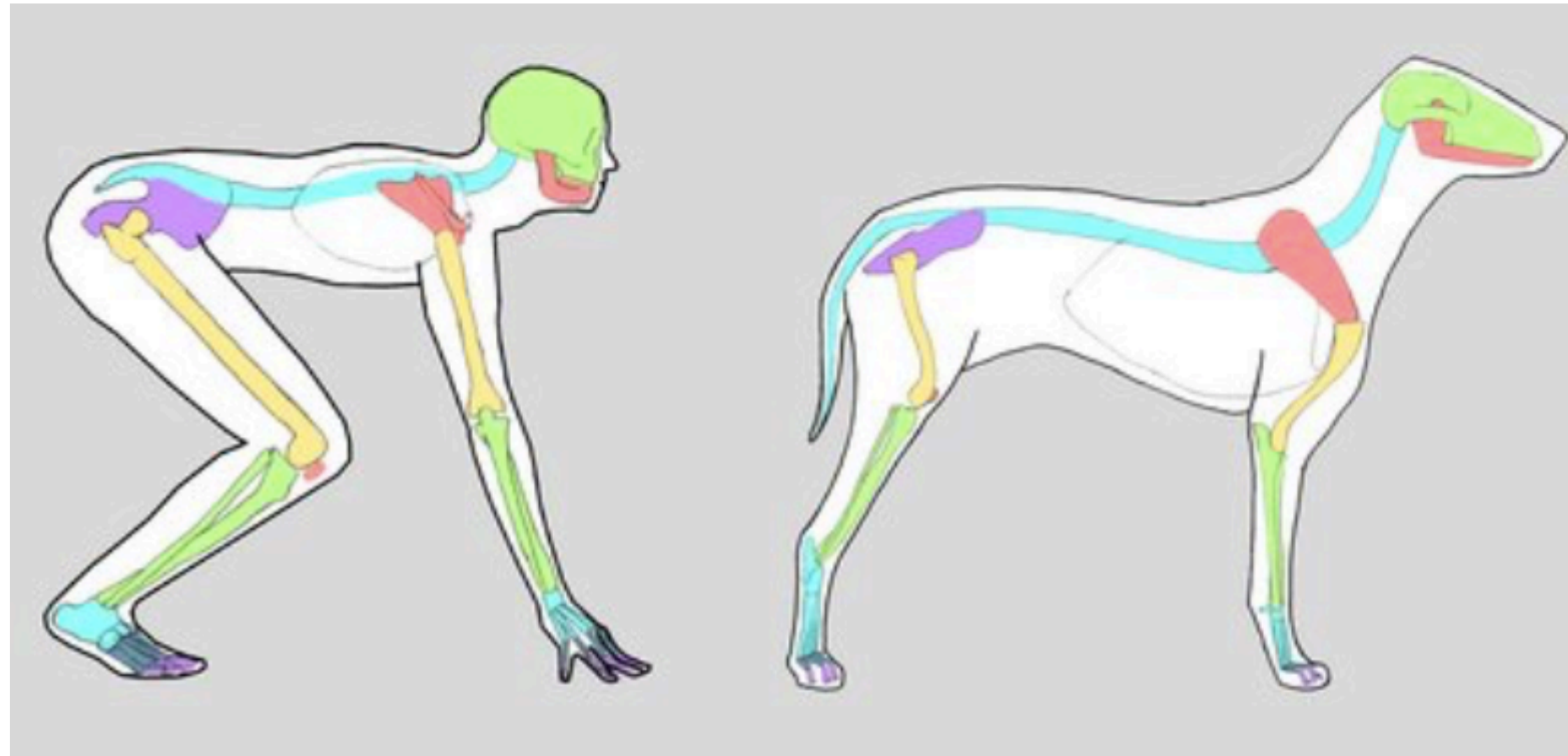
Malunion classification and grading

In humans > 5 degree of excessive tibial valgus causes stifle DJD progression.



Malunion classification and grading

What about the quadrupedals?



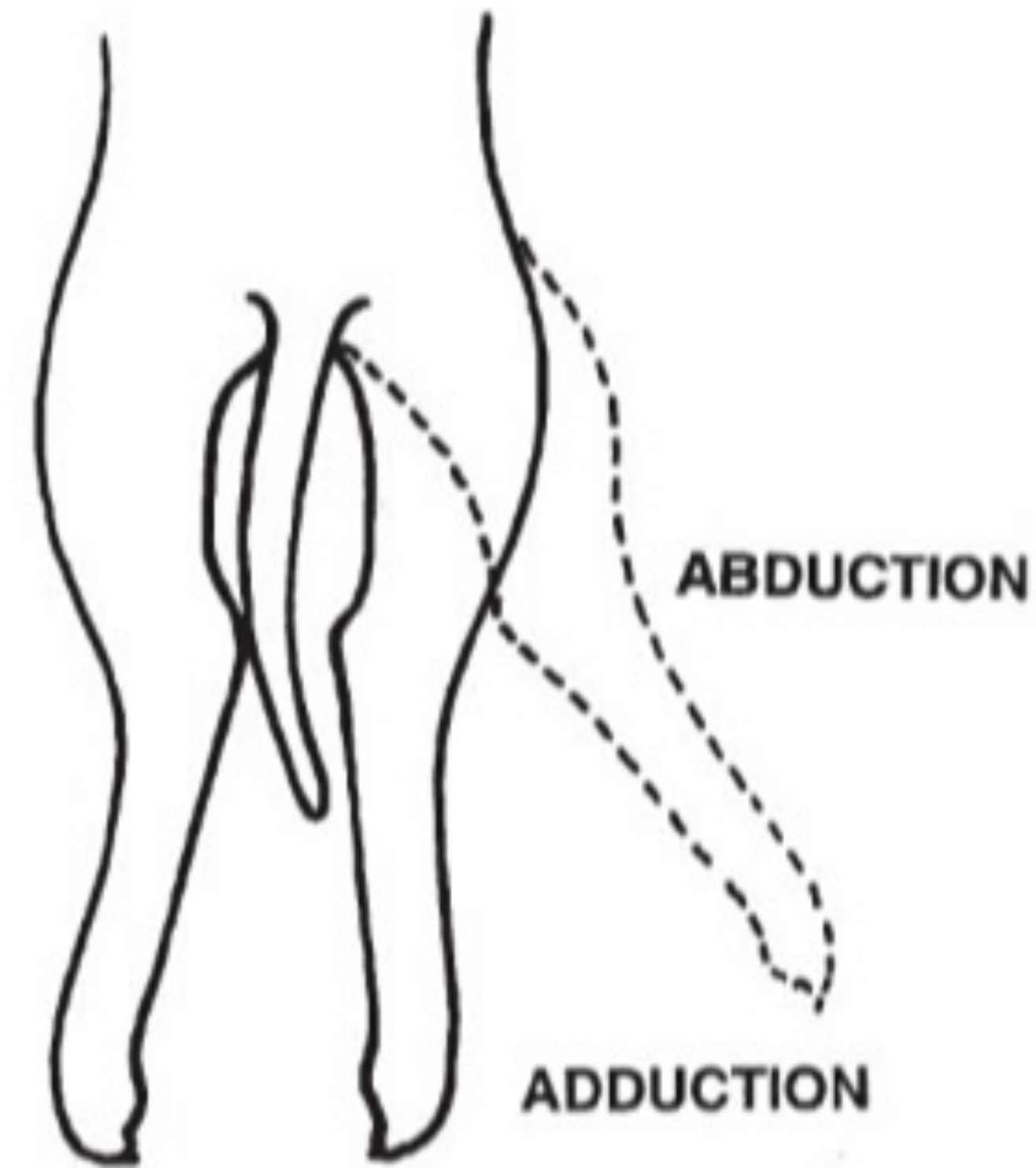
Malunion classification and grading

-**Minor angular deformities** (< 10 degrees in any plane); minor shortening (10% or less).

-**Major angular deformities** (>10 degrees in any plane); major shortening (more than 10%).

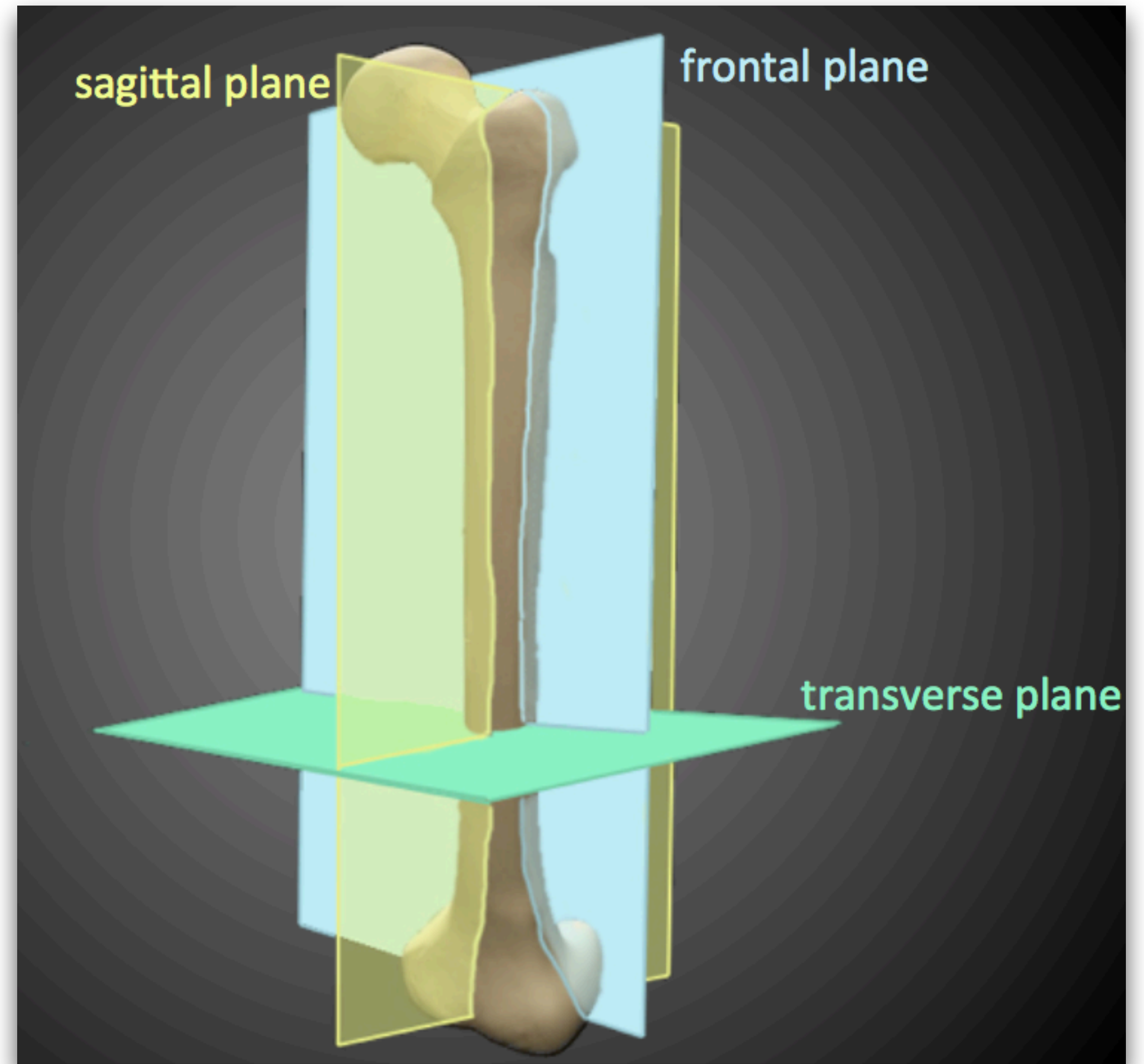
Clinical significance factors

- In which plane (frontal , sagittal , axial)
- Which bone is affected ?
- Compensatory mechanisms?



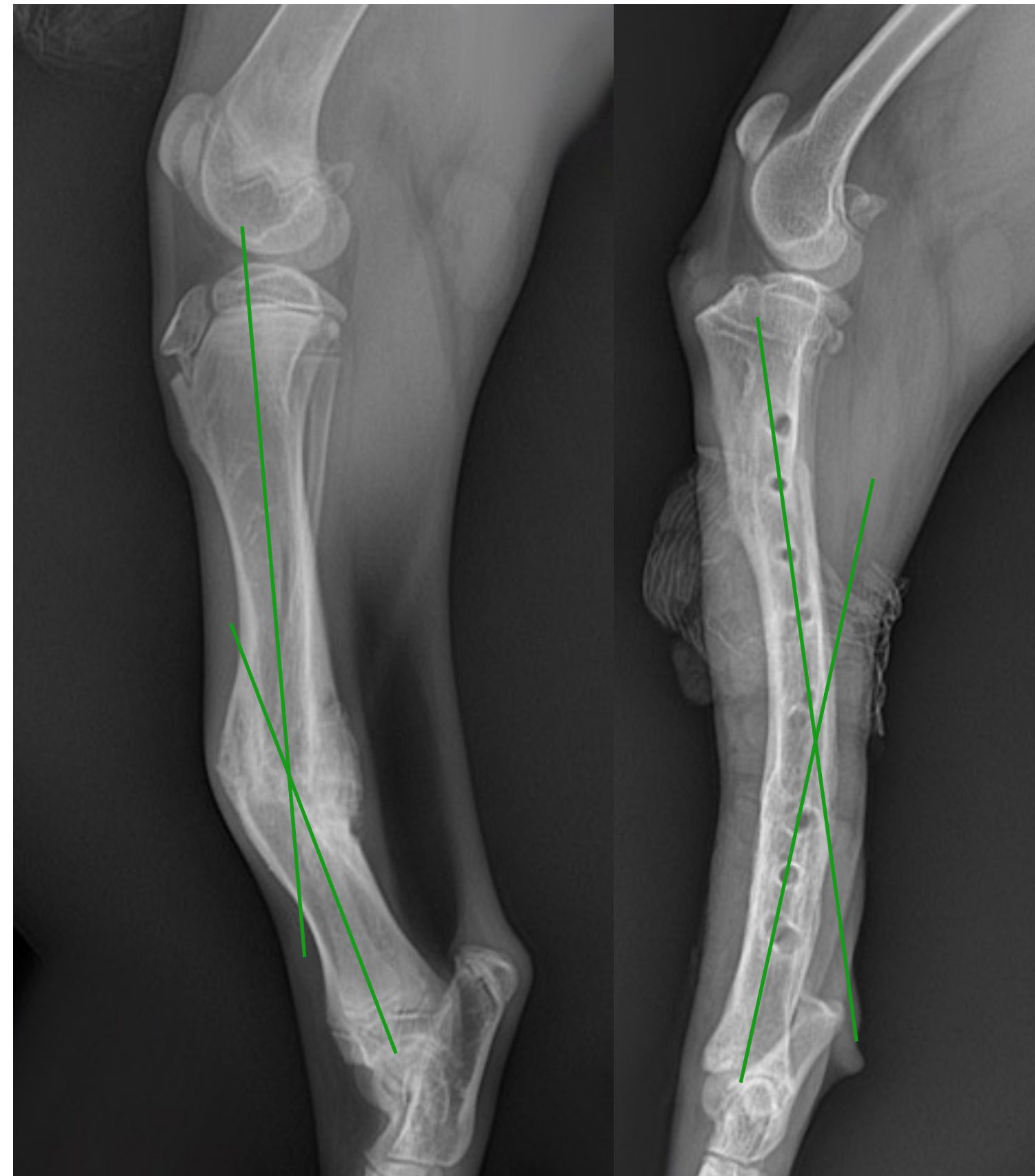
Planes

- **Transverse**
- **Frontal**
- **Sagittal**



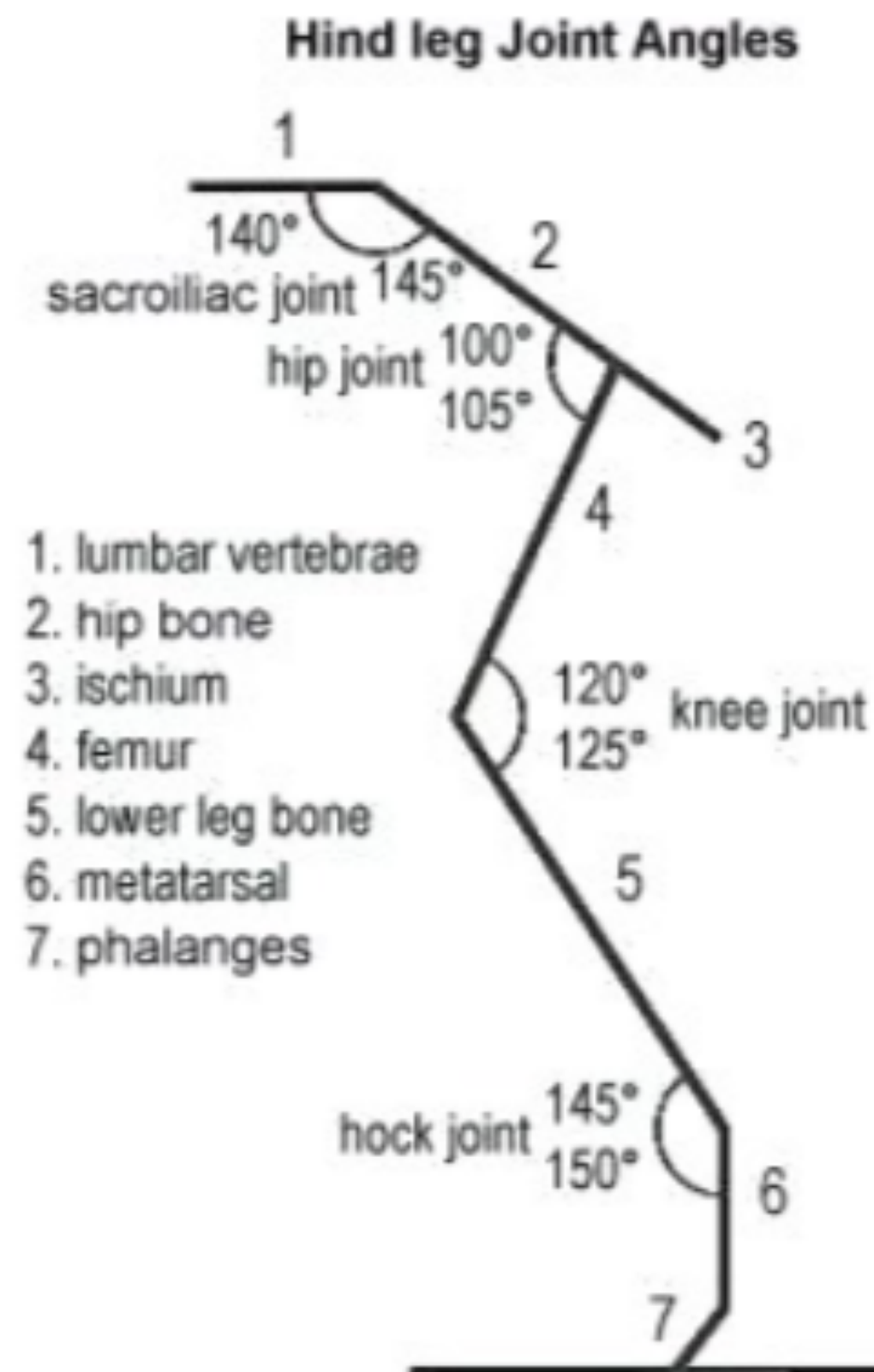
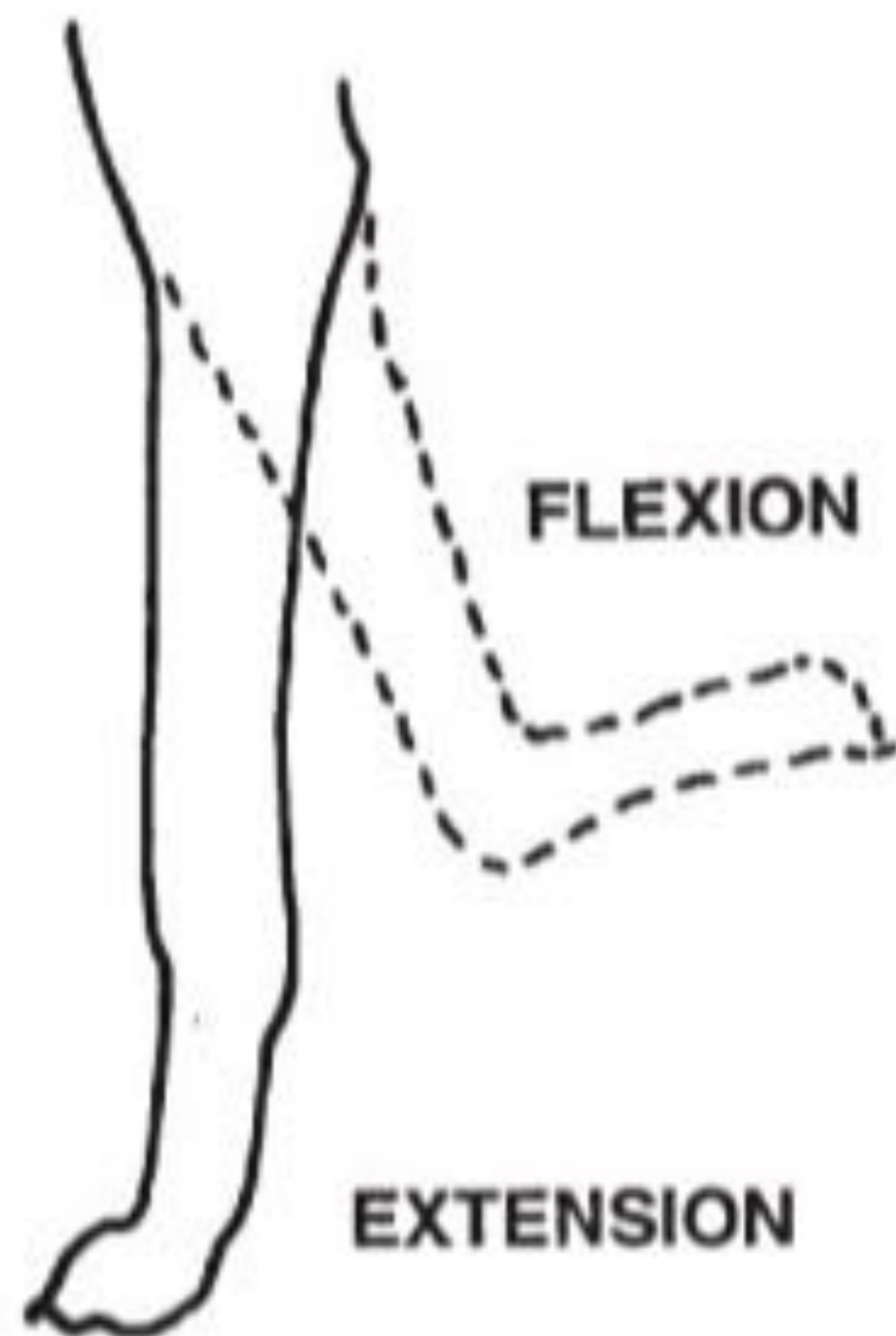
Saggital plane

- **Procurvatum/recurvatum**- the distal bone ends are deflected caudally (procurvatum) or cranially (recurvatum).



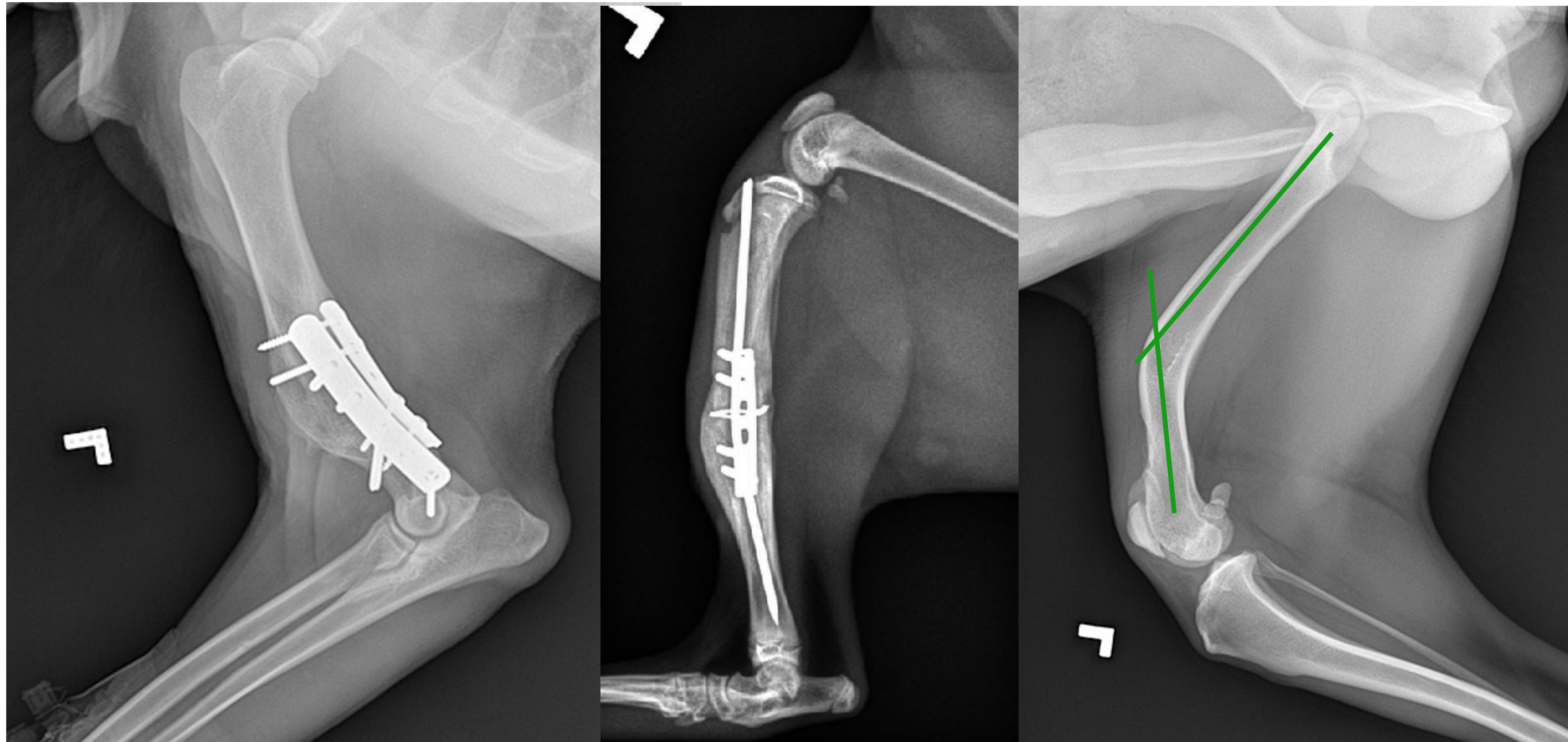
Which plane?

- **Sagittal**- the direction of primary limb motion. The flexion and extension of the joints compensate moderate angulation of the bones.



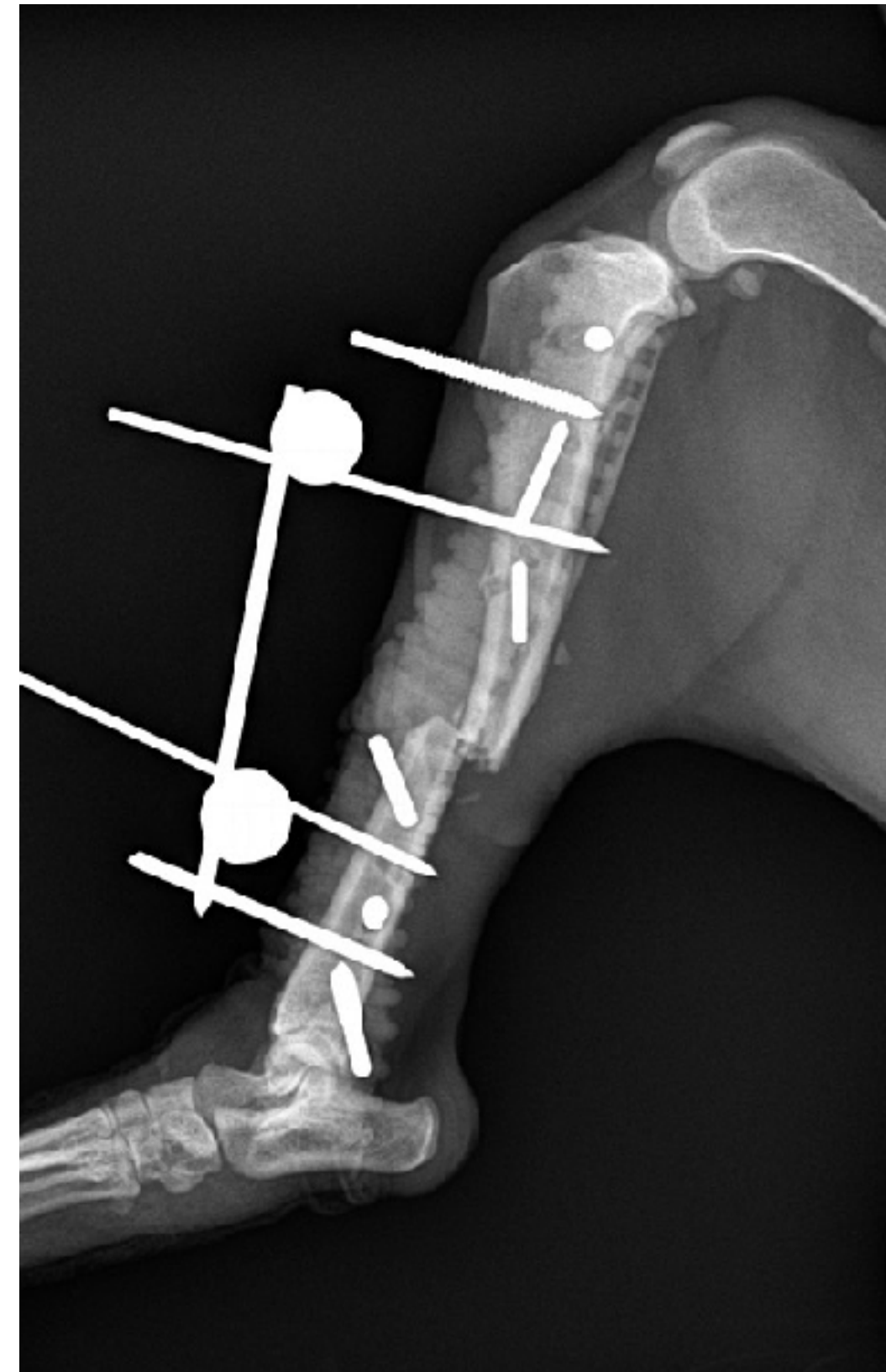
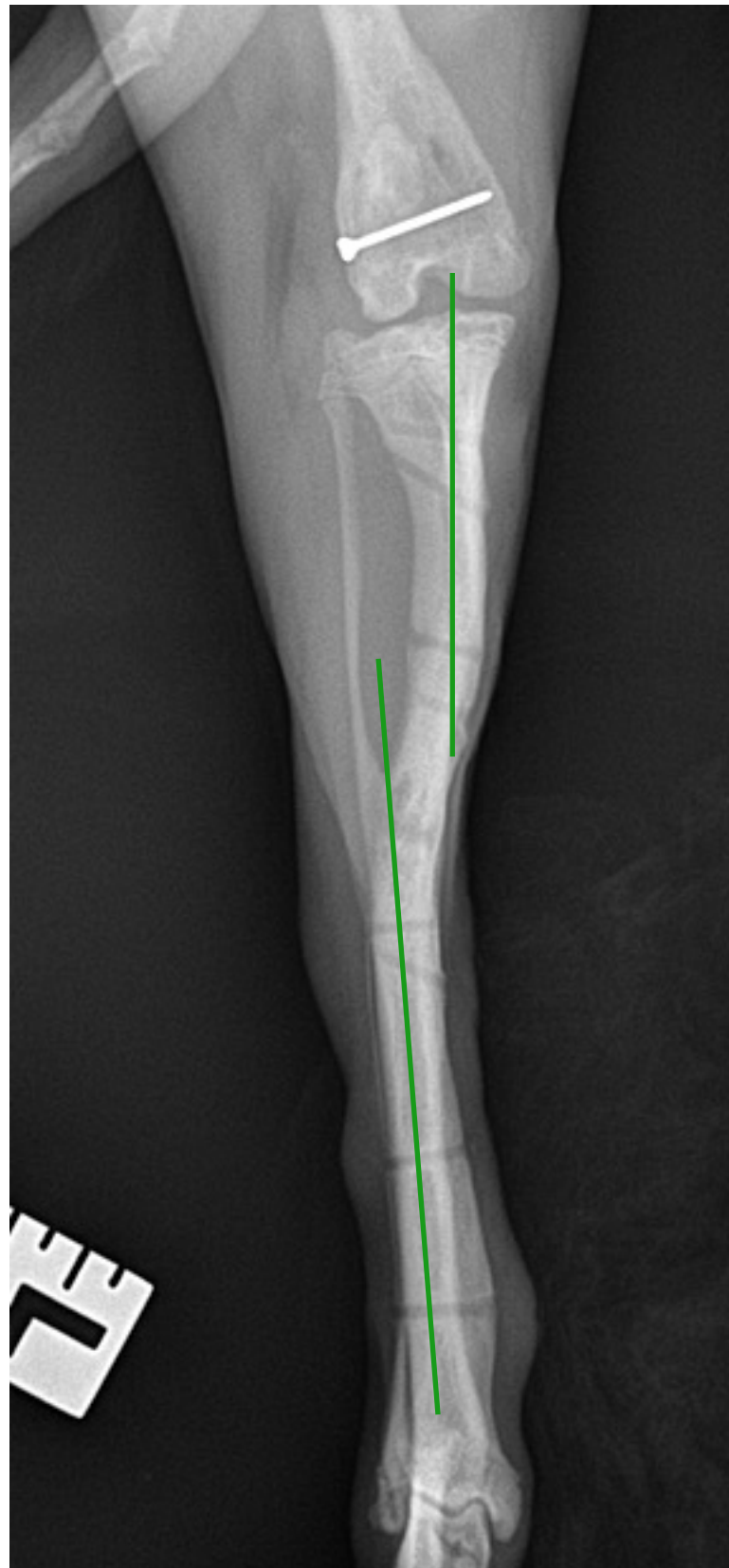
Which plane?

Well tolerated **sagittal plane** angulations.



TRANSLATION

- **Parallel displacement.**
- **Moderate degrees- tolerated**



Frontal plane

- **Valgus/ varus**- the proximal and distal bone ends are deflected inward (varus) or outward (valgus) of the sagittal median plane.

Valgus



Varus

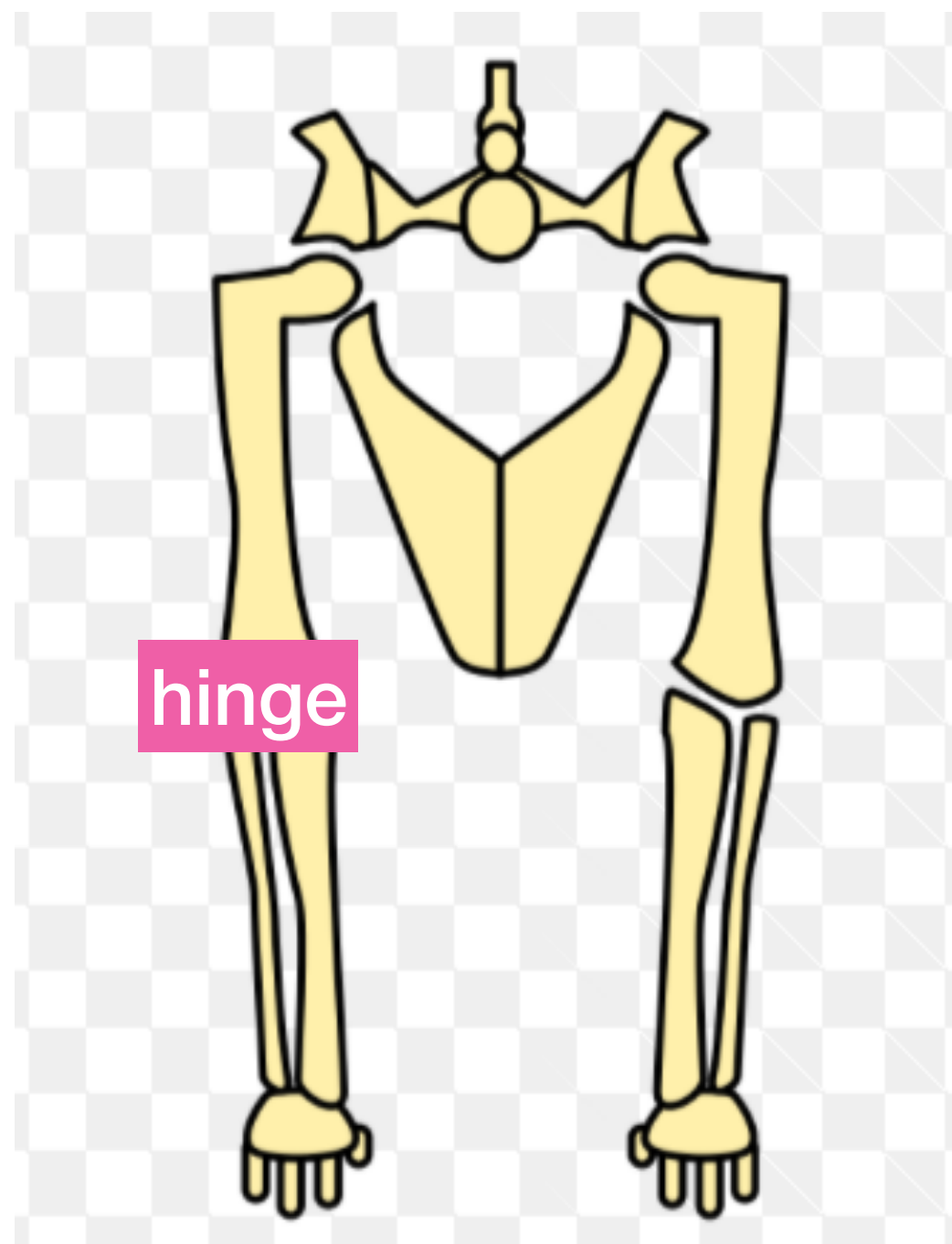


Clinical significance

Depends on which bone is affected

Which bone?

- Humeral deformities- better tolerated in the frontal plane (locate between a **ball-socket** and a hinge joint).

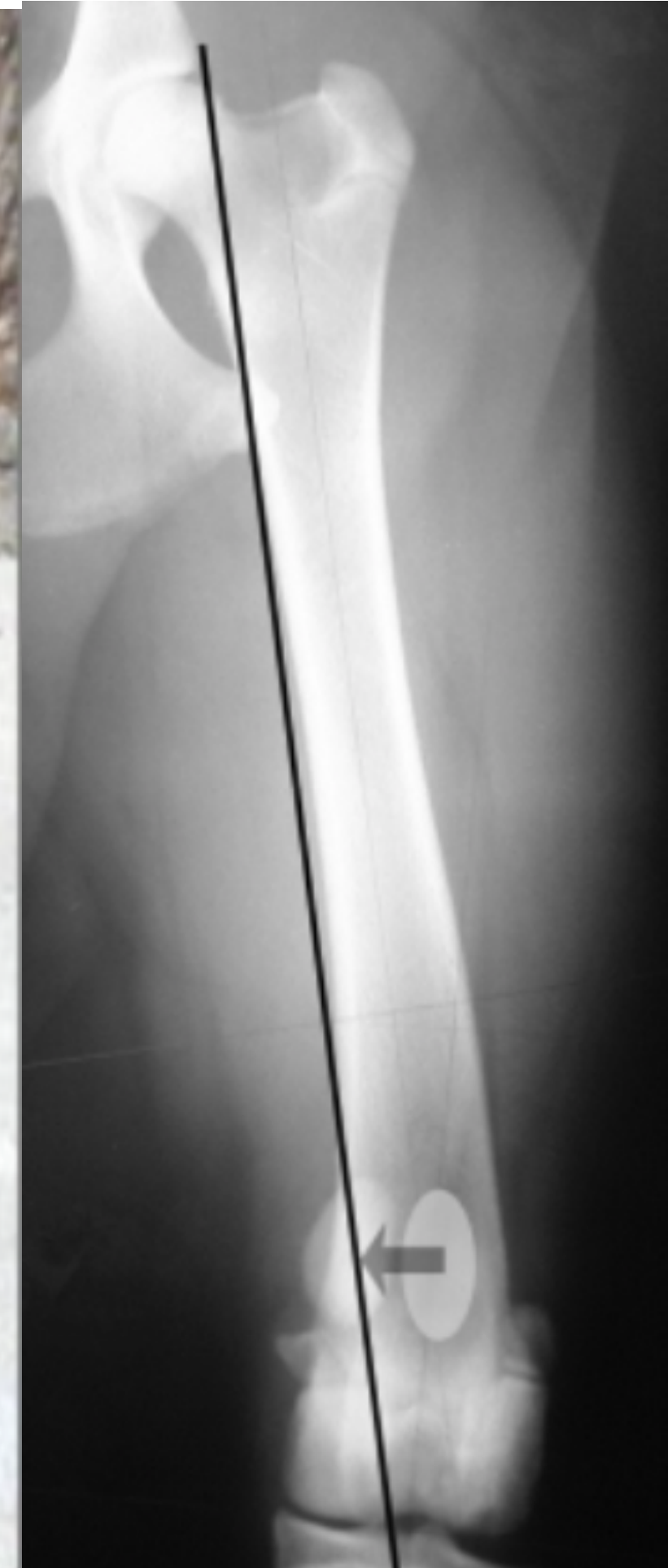


Humerus, frontal plane

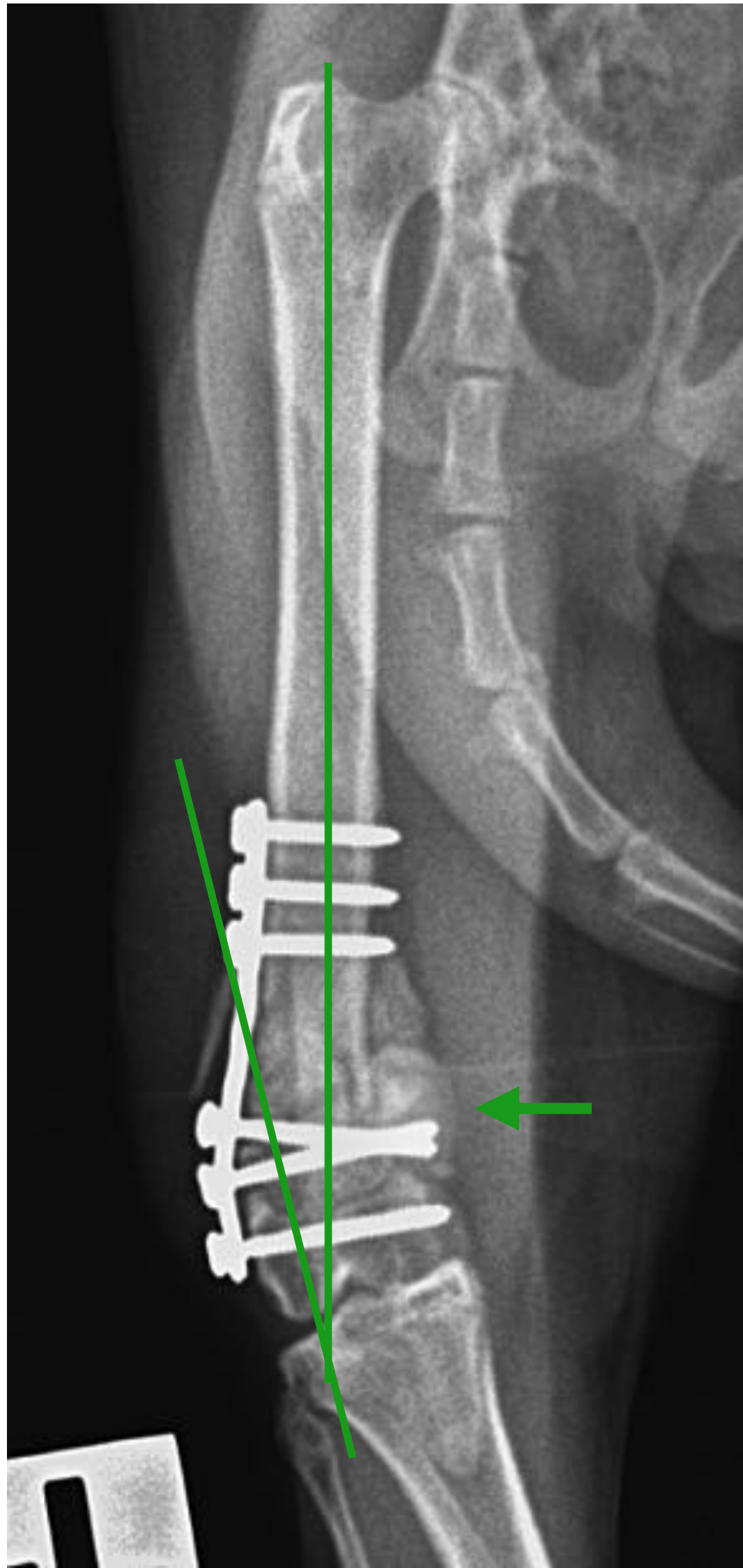


Femur, frontal plane

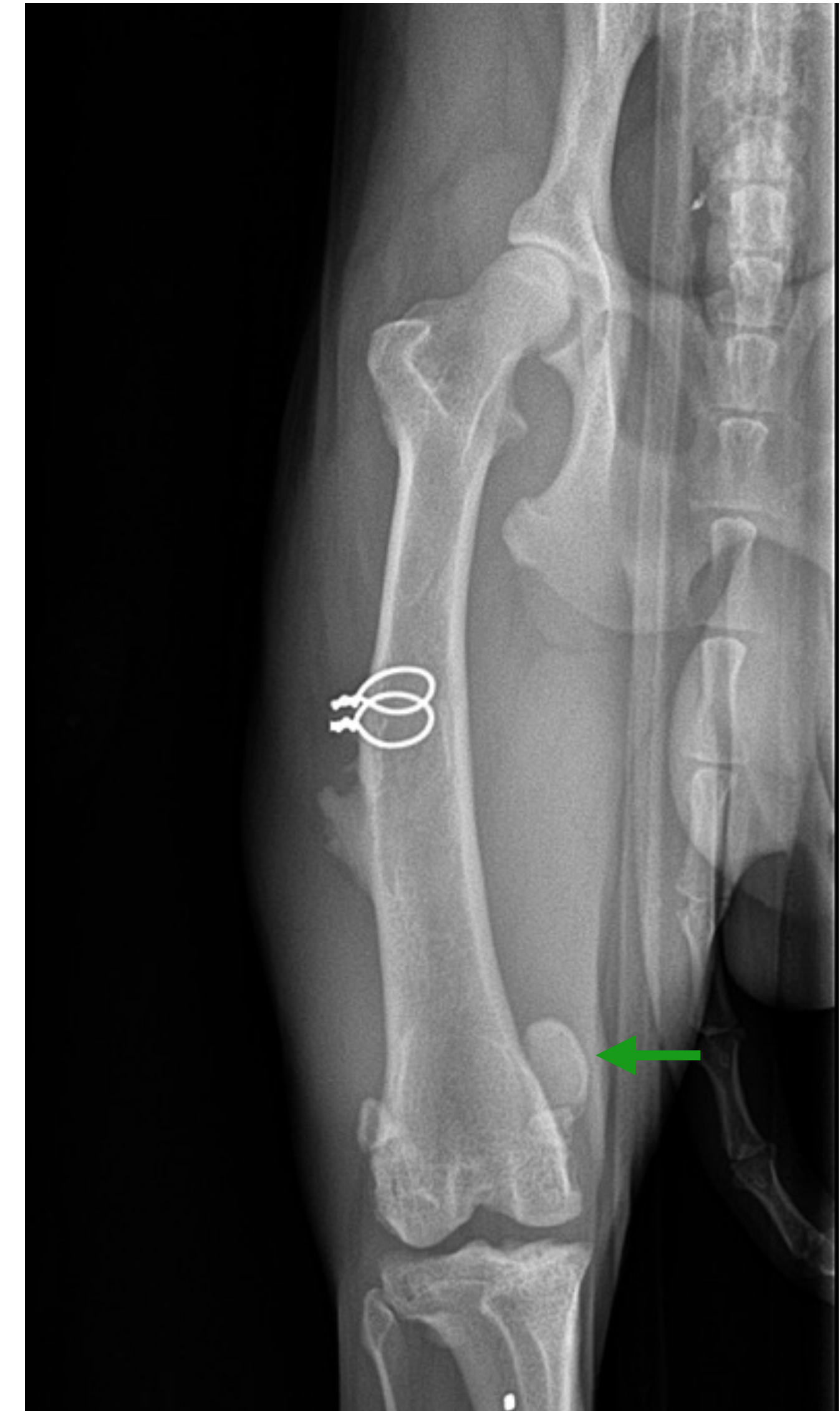
- Femoral malalignment => patela mistracking!
- Distal hinge (joint) overload



Medial patellar luxation



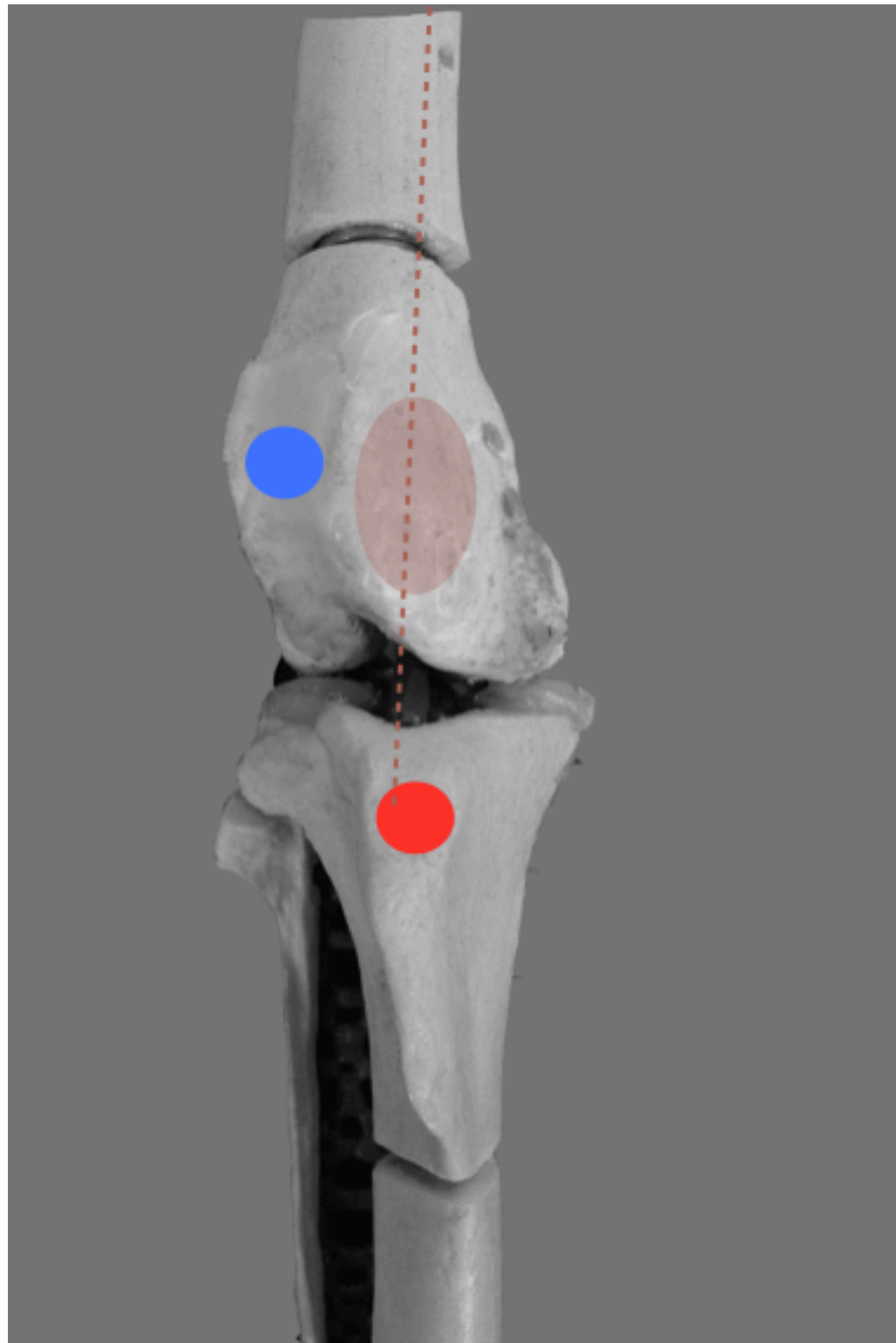
iatrogenic varus



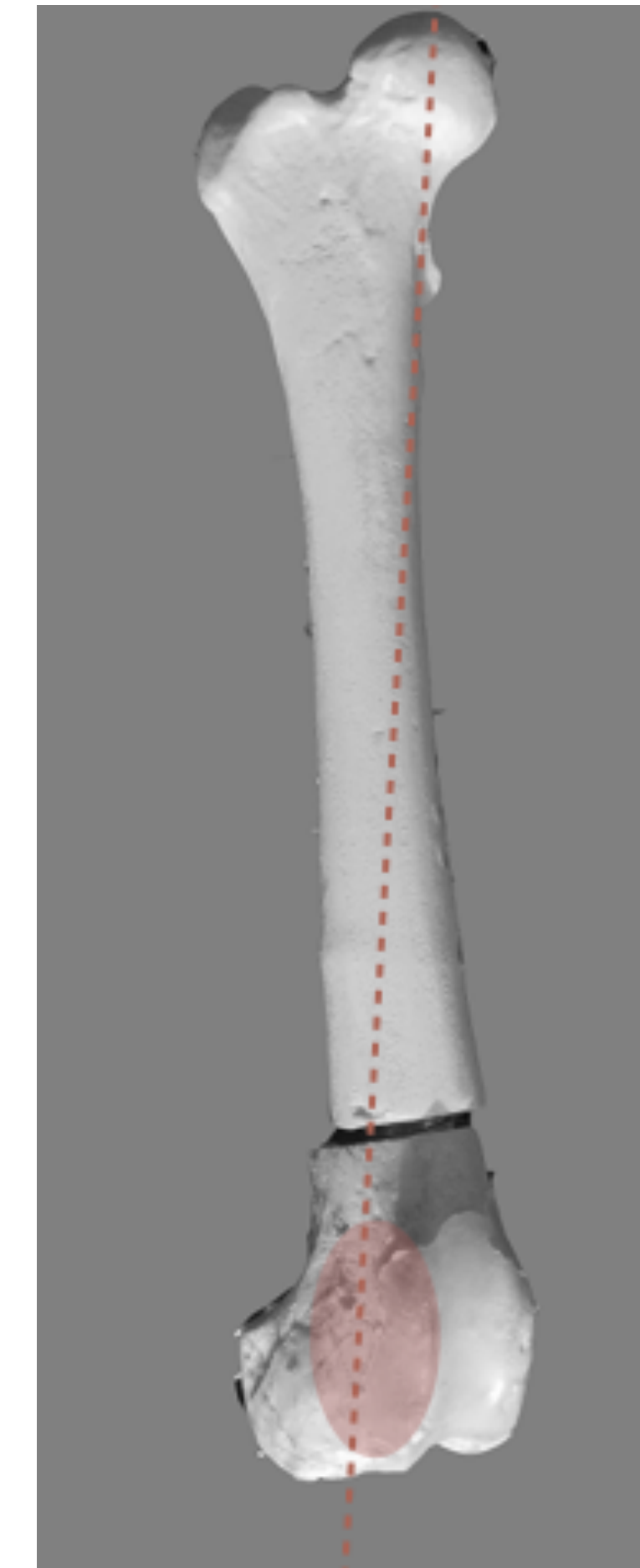
Axial plane

Torsion/rotation- deviation around the long axis of the bone/limb.

- **Rotation-** between two bones within a joint.
- **Torsion-** within a single bone;

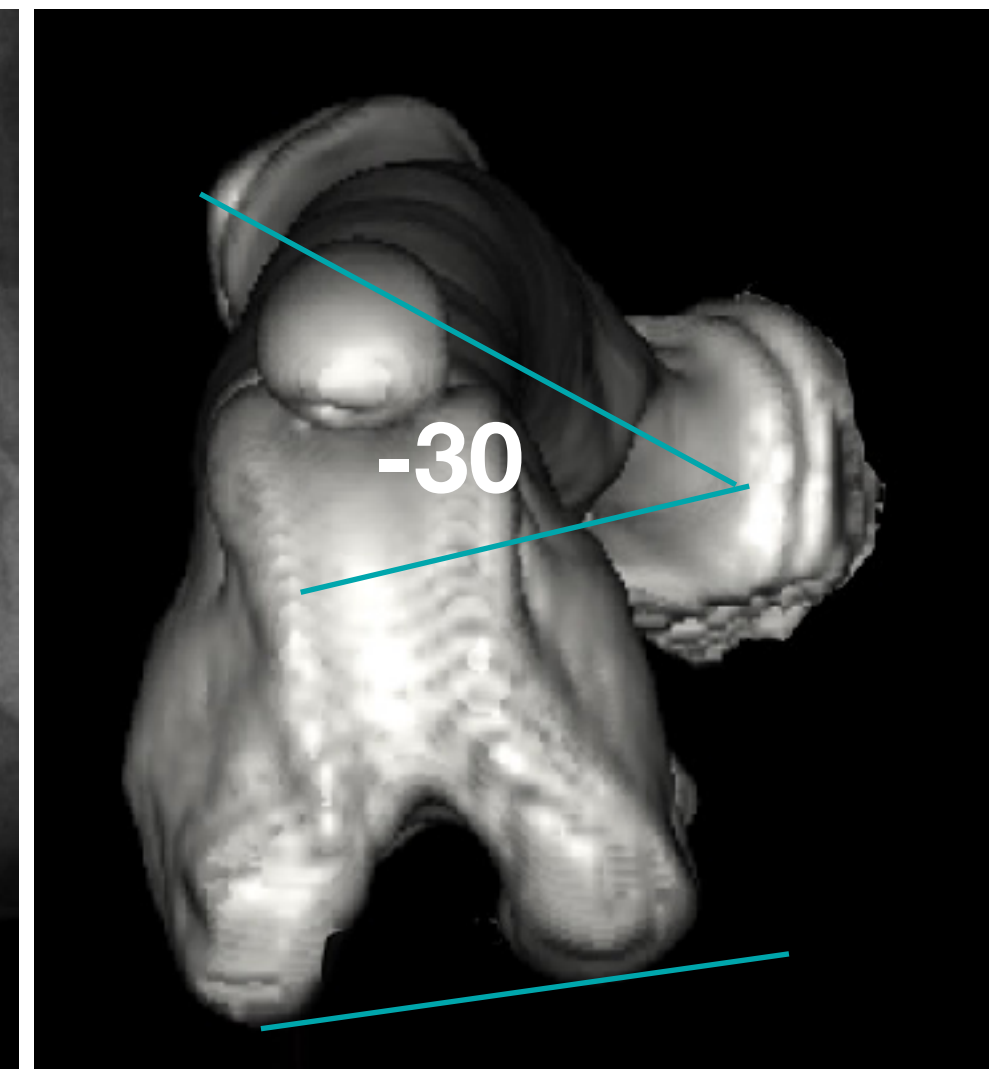
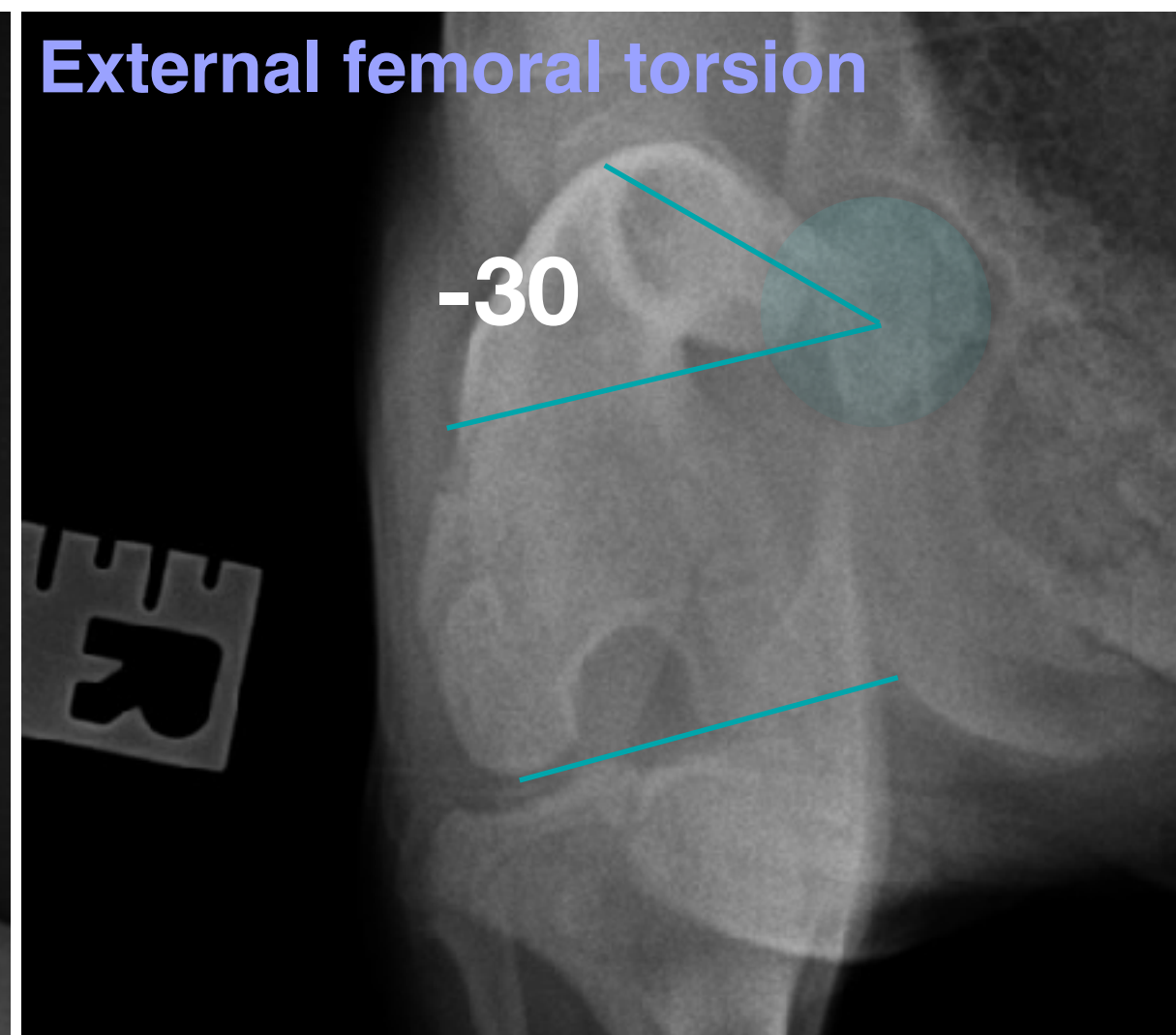


MODEL

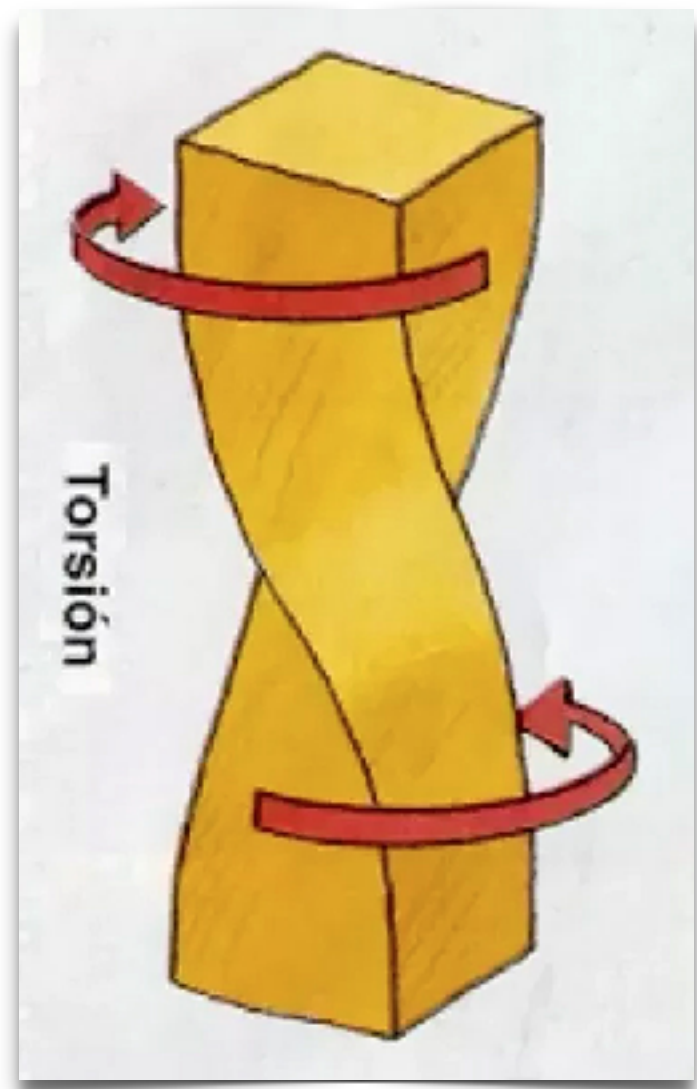


Femoral torsional angle

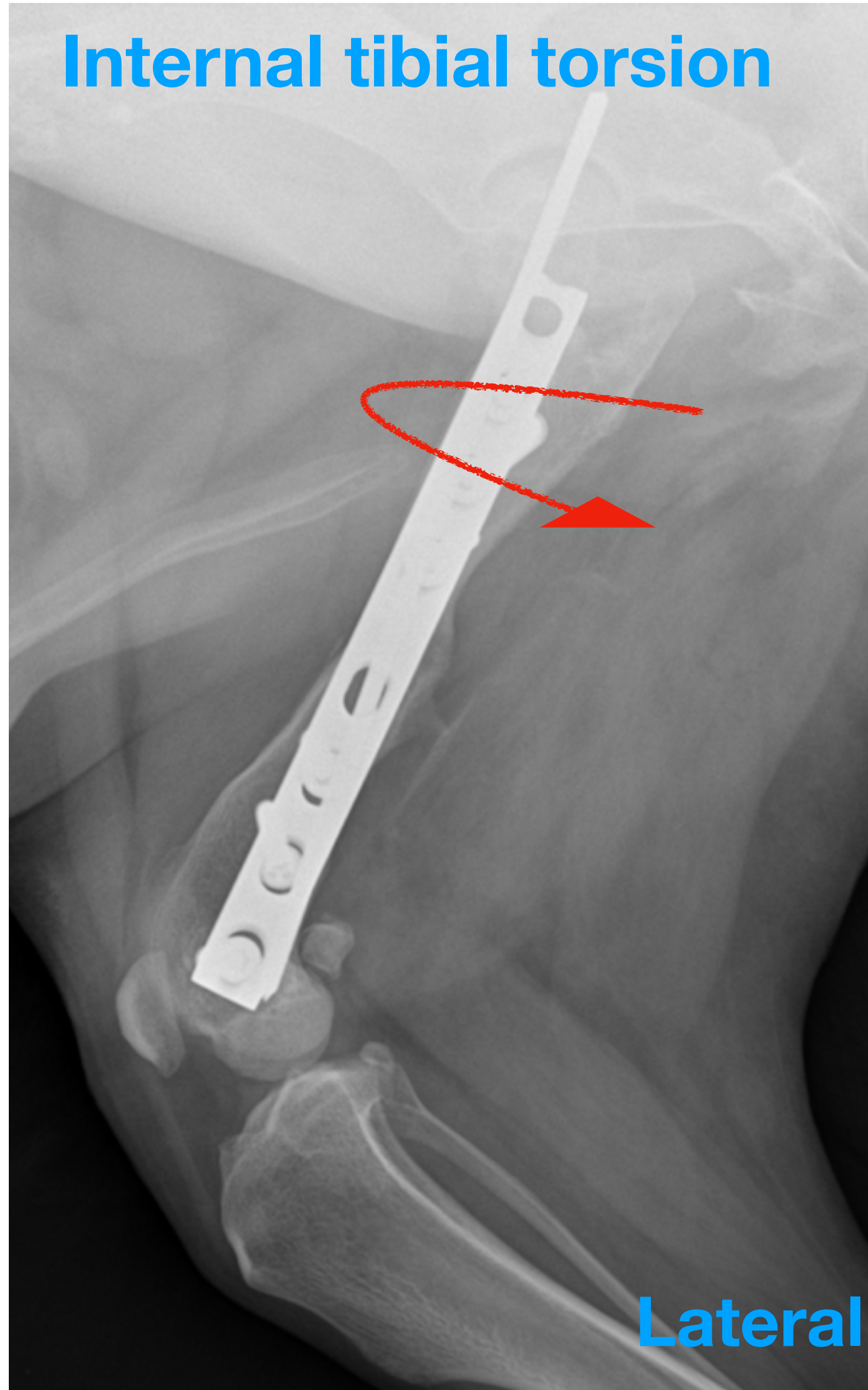
Retroversion= ext fem torsion



Major clinical significance

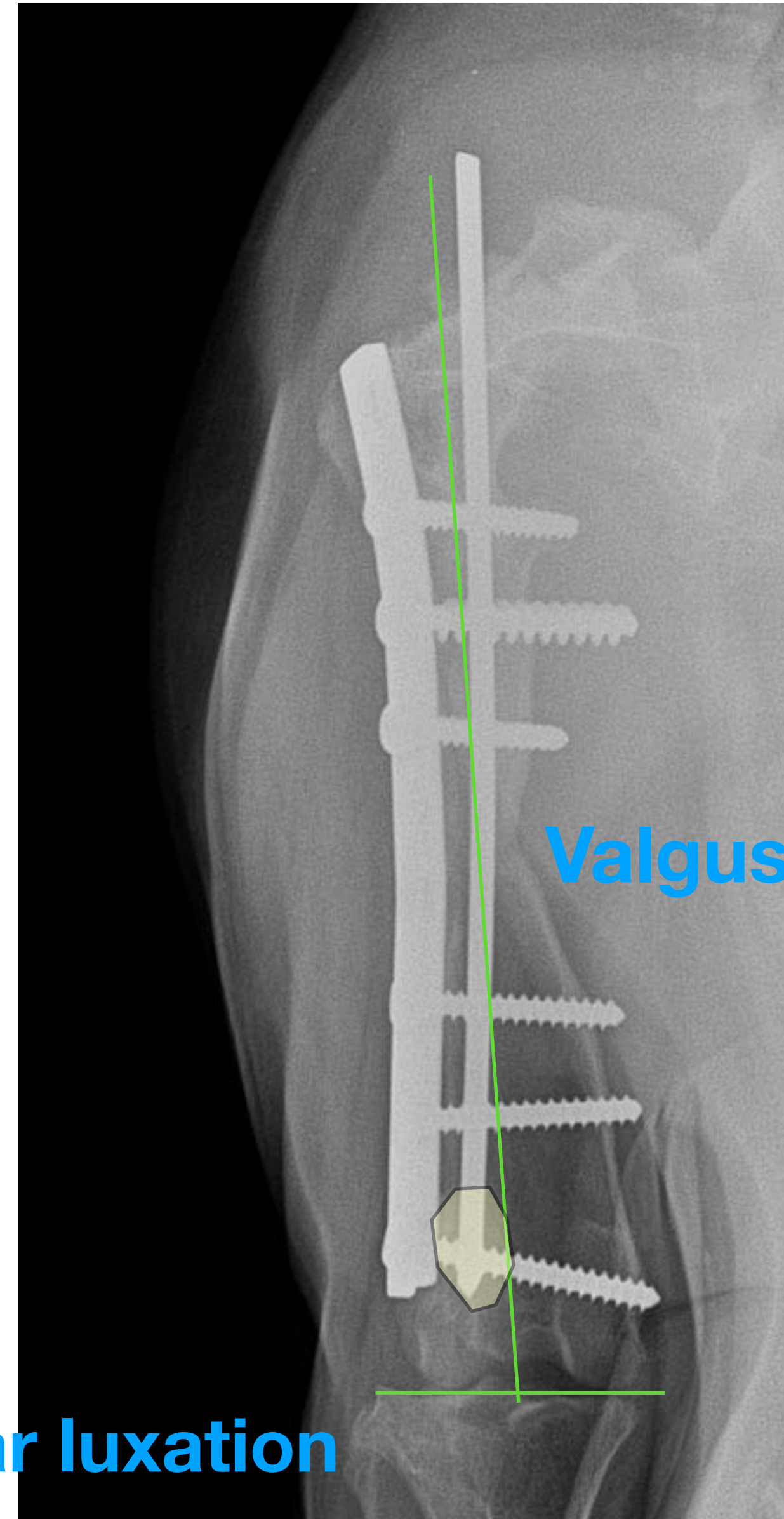


Internal tibial torsion

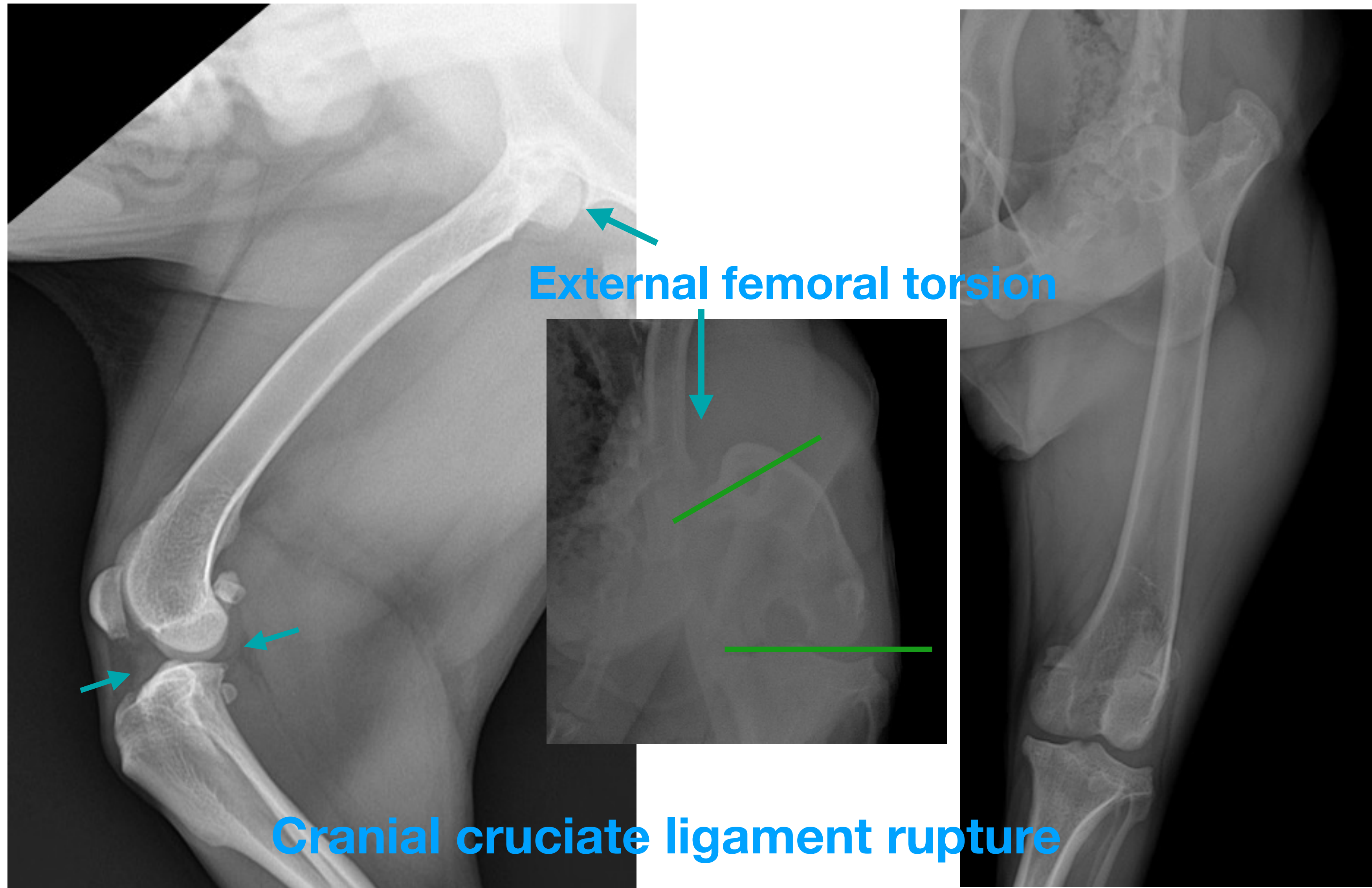


Lateral patellar luxation

Valgus



Major clinical significance

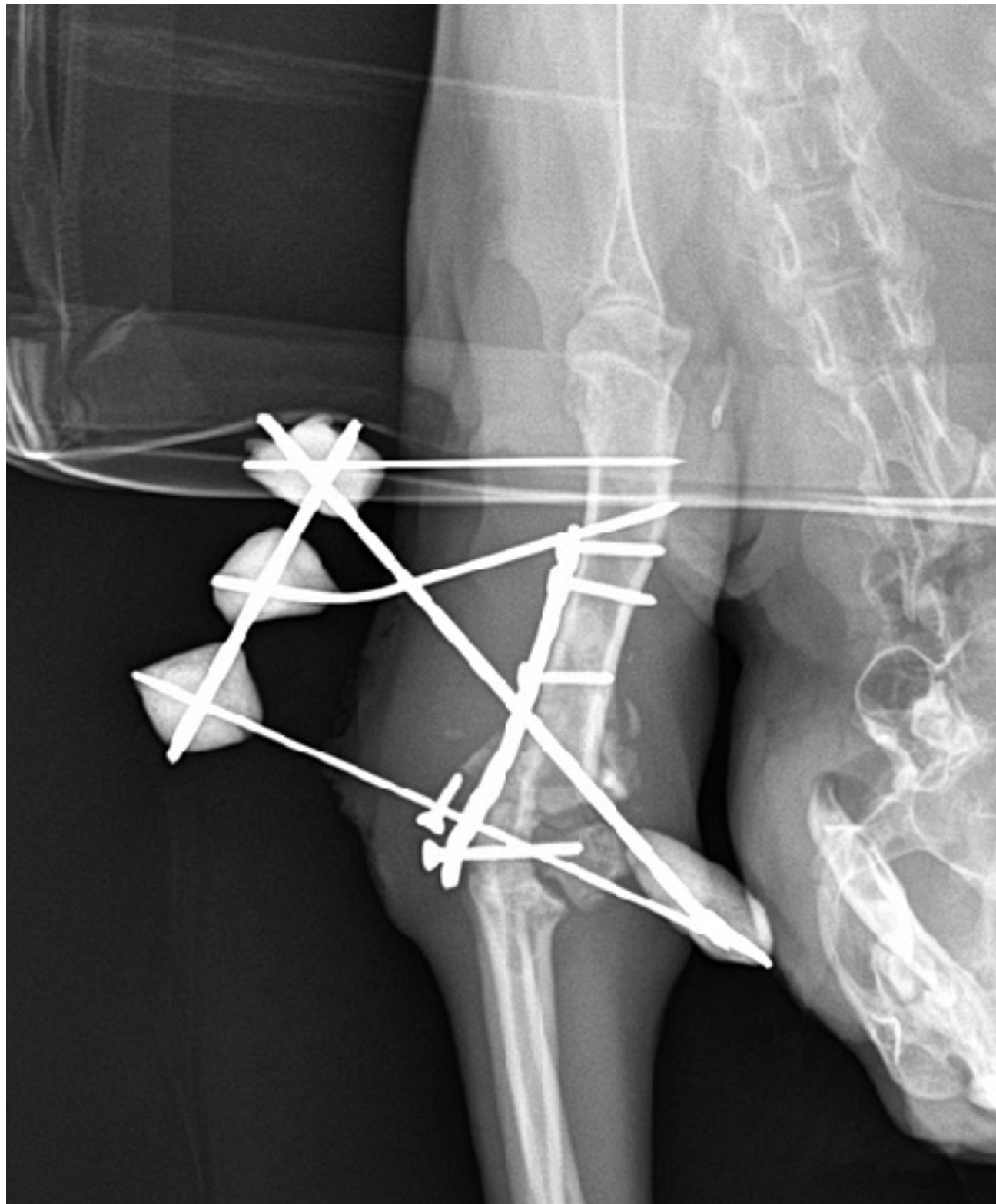


Major clinical significance

- Deformation in axial and frontal plane more detrimental effects!

Major clinical significance

- Malunions of a diarthrodial joint- always a major malalignment!



Bone shortening

Common problem

How much is tolerated?

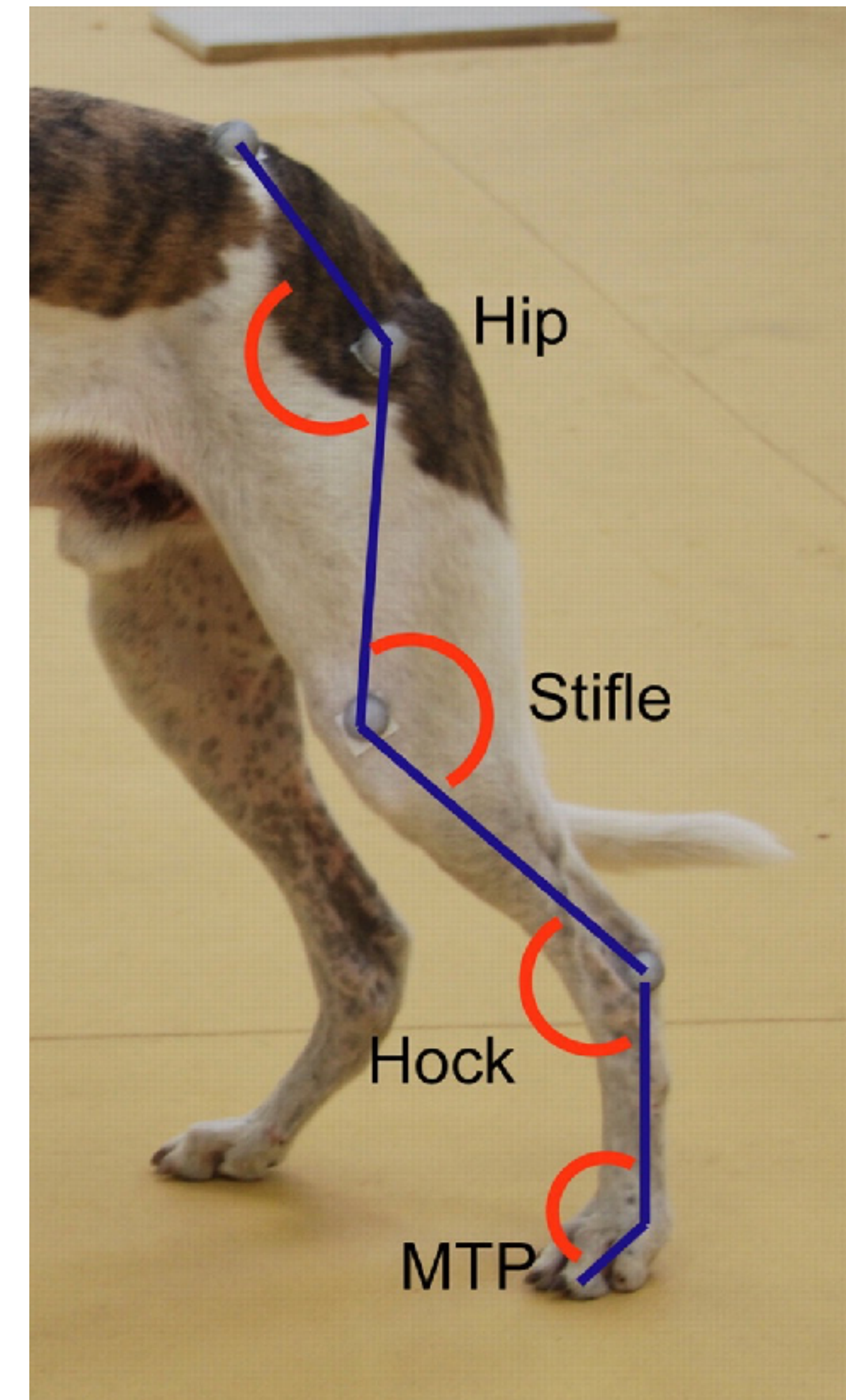


Bone shortening

Length compensatory mechanism of the quadripedal animals:

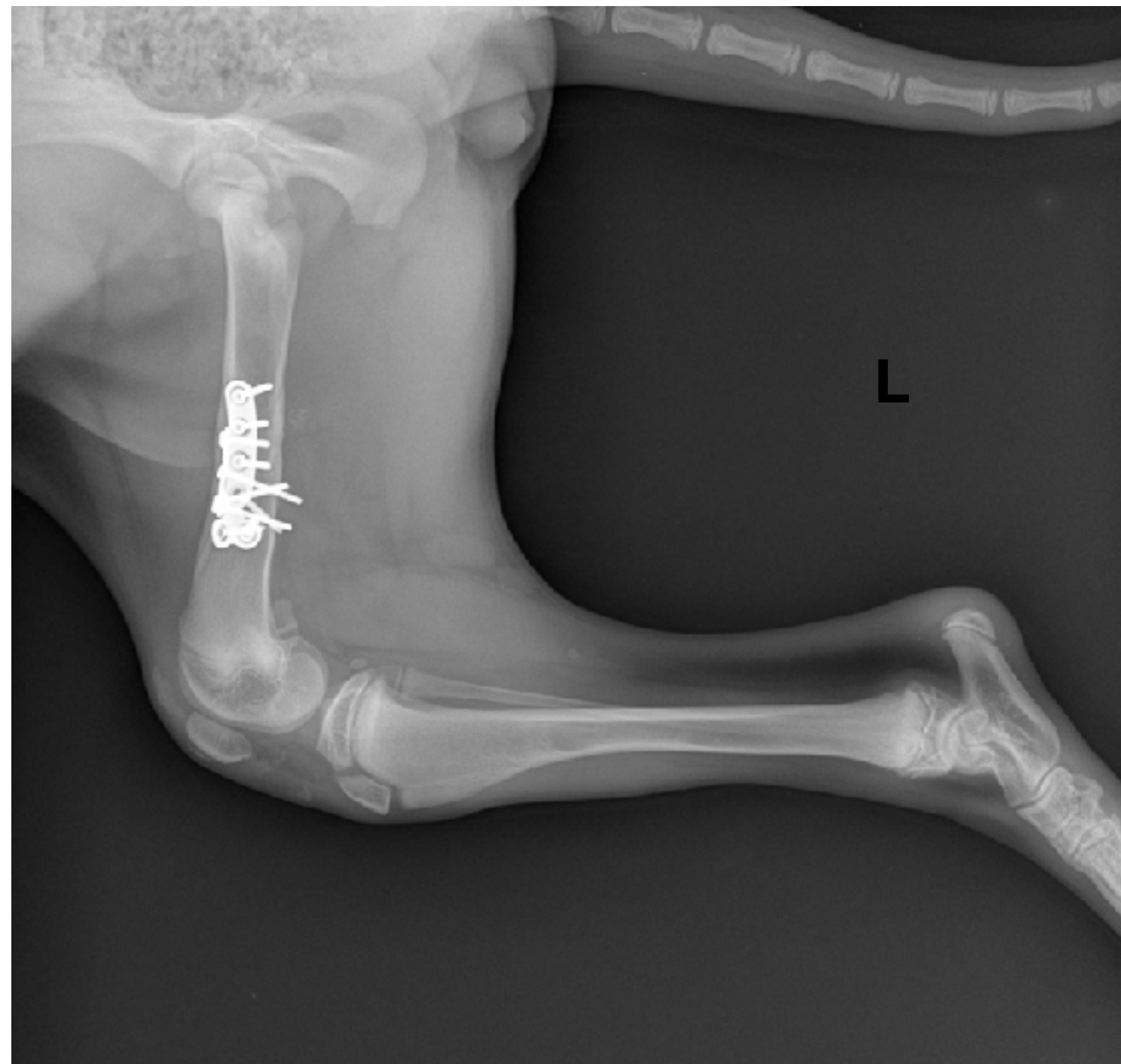
The semi- flexed standing postures

<20-25 % could be tolerated well functionally.

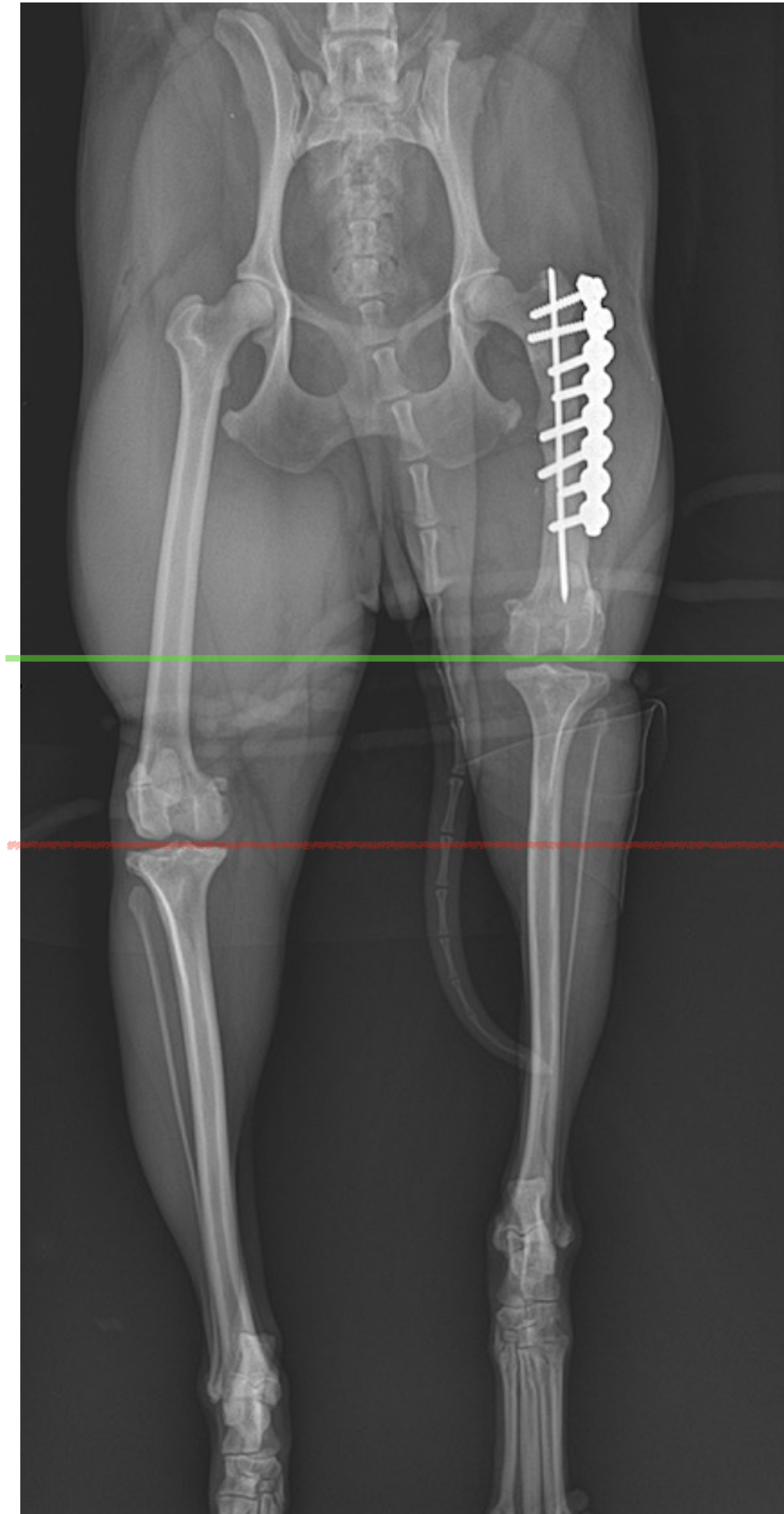


Bone shortening

Moderate shortening in 6 months old mix puppy with old femoral fracture.



Significant limb shortening



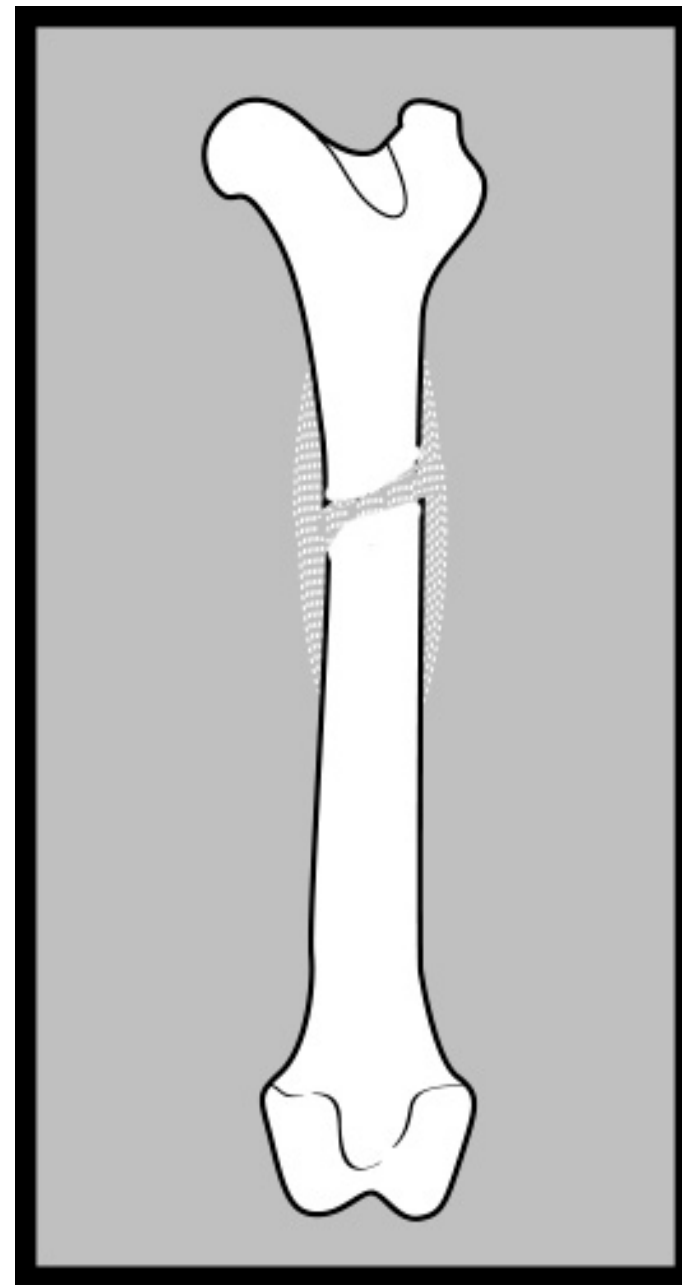
Pelvic fractures

Clinical consequence- narrowing $> 50\%$ => obstipation (especially in cats).

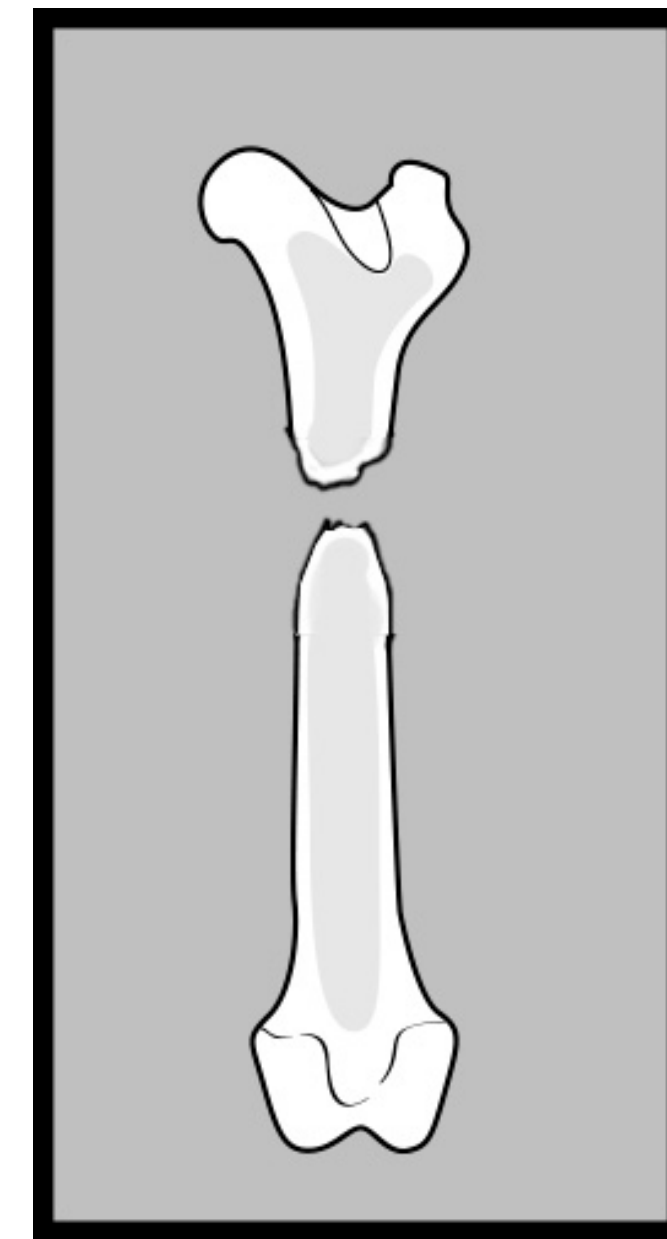


Related conditions, differentials

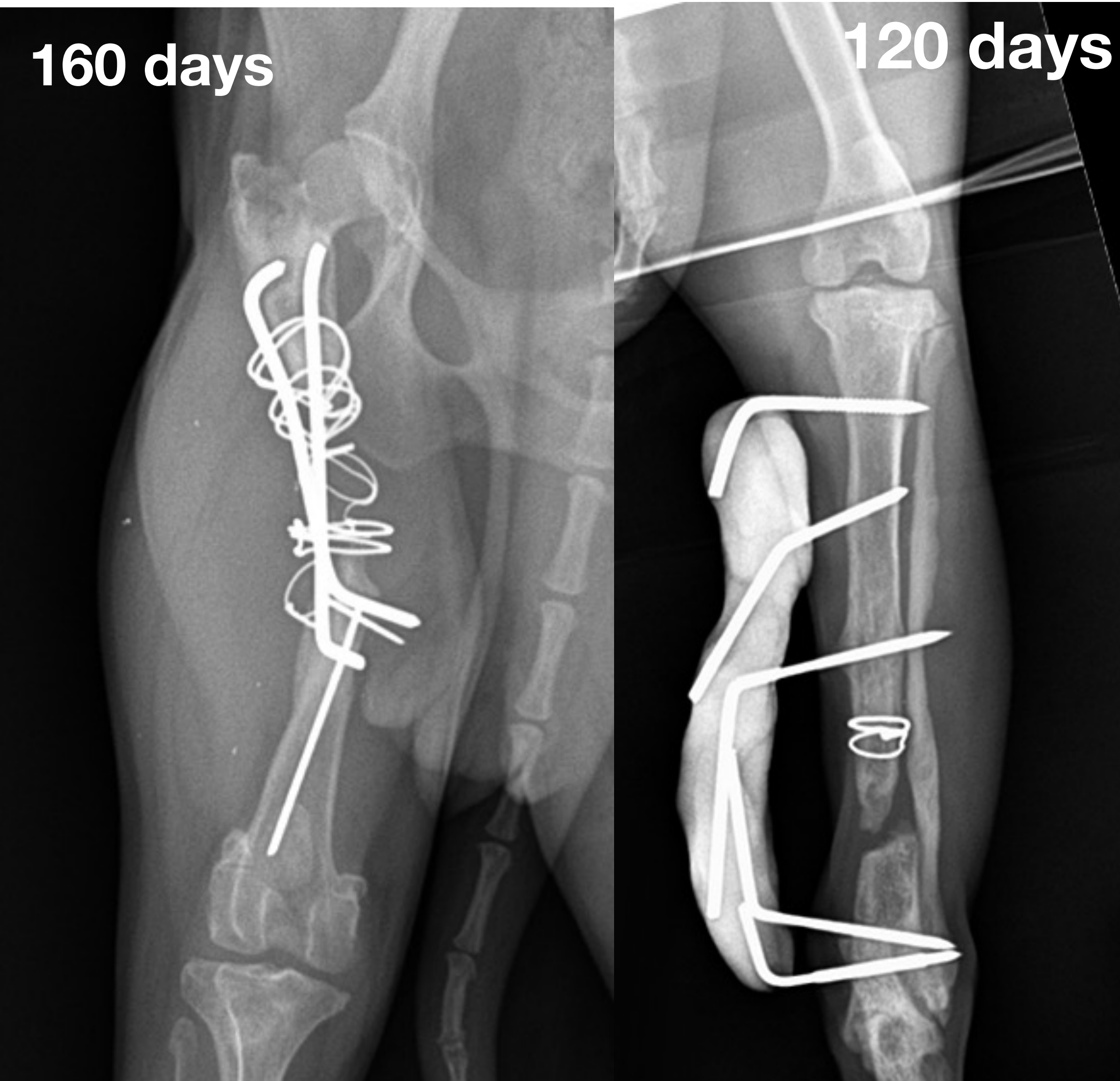
DELAYED UNIONS



NONUNIONS



Nonviable Nonunions (Atrophic)



Viable Nonunions (Hypertrophic)



Can we prevent malunions

- Surgery vs conservative- case selection.
- Proper surgery planning
- Good post op evaluation and follow up.



Fracture splinting



Choose wisely!



Fracture splinting

Avoid conservative treatment for:

- articular fractures.
- unstable ones.
- multiple trauma patients.



Fracture splinting

“**Toy-breed-** 83% incidence of **malunion** and non- union when **external coaptation** is utilized..”.

Harasen G: External coaptation of distal radius and ulna fractures.

Milovancev M, Ralphs SC: Radius/ulna fracture repair.



PRE surgery preparation

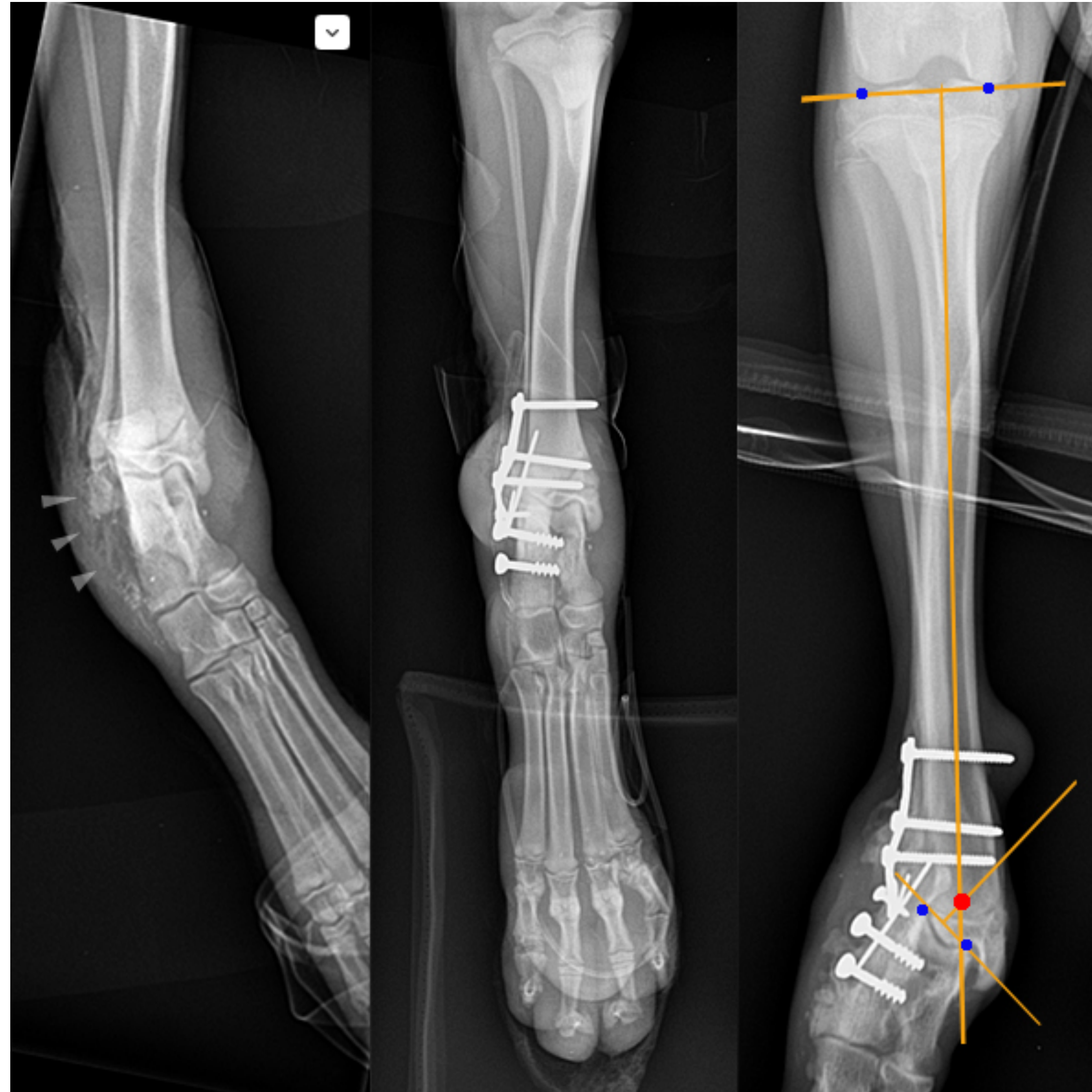
Build good surgical plan.

- Proper surgical approach and technique.
- Appropriate implants/instrumentation.
- No implant size underestimation.
- Rigid fracture stabilisation.



Intra op

Growing plates!



Intra op

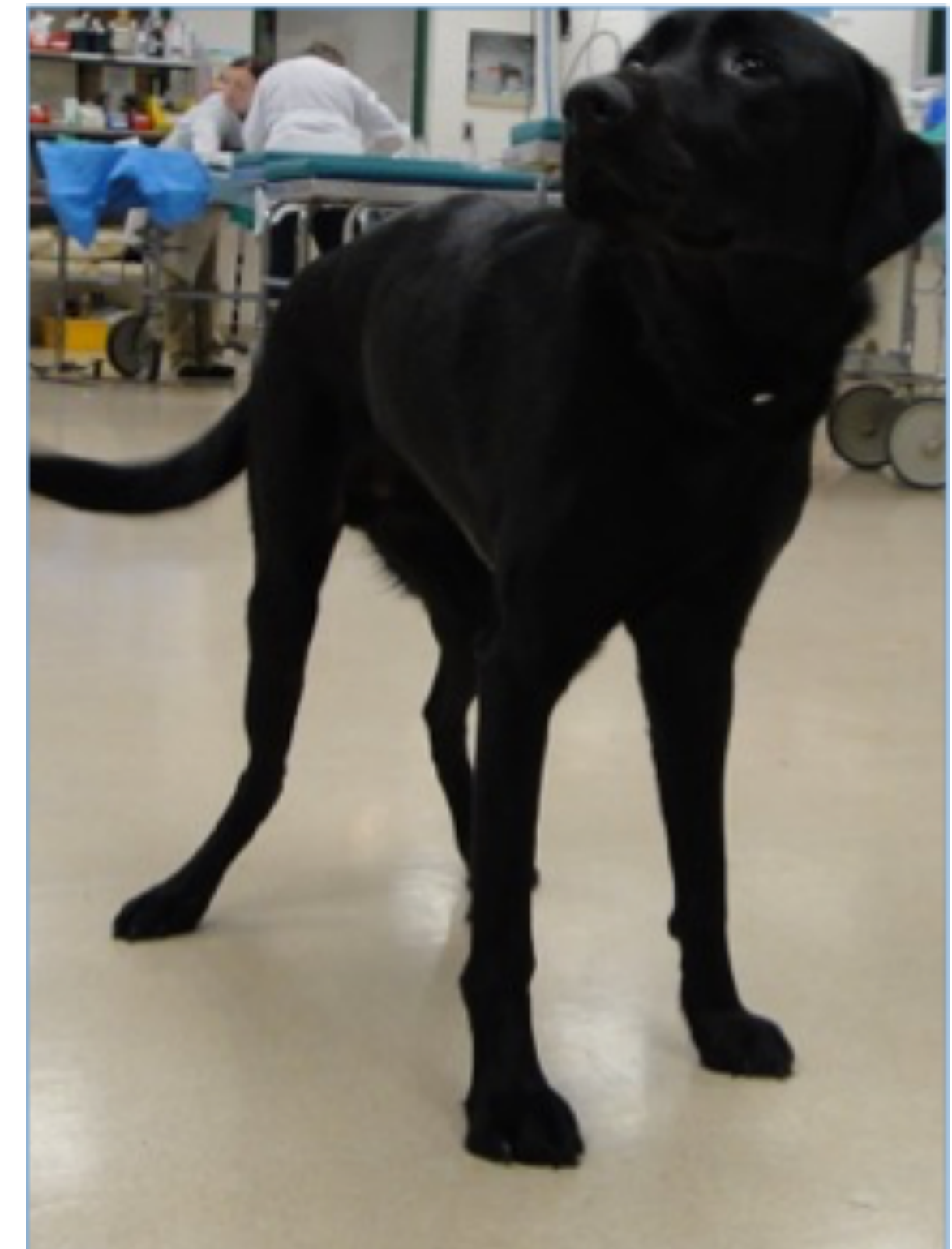
Everything BUT perfect reduction/stabilisation for
intrarticular fracture - compromise!



Kum MIPO

MIPO techniques

- Minimally invasive fracture repair => risk of malalignment and malunion.



Courtesy Dr. L. Dejardin

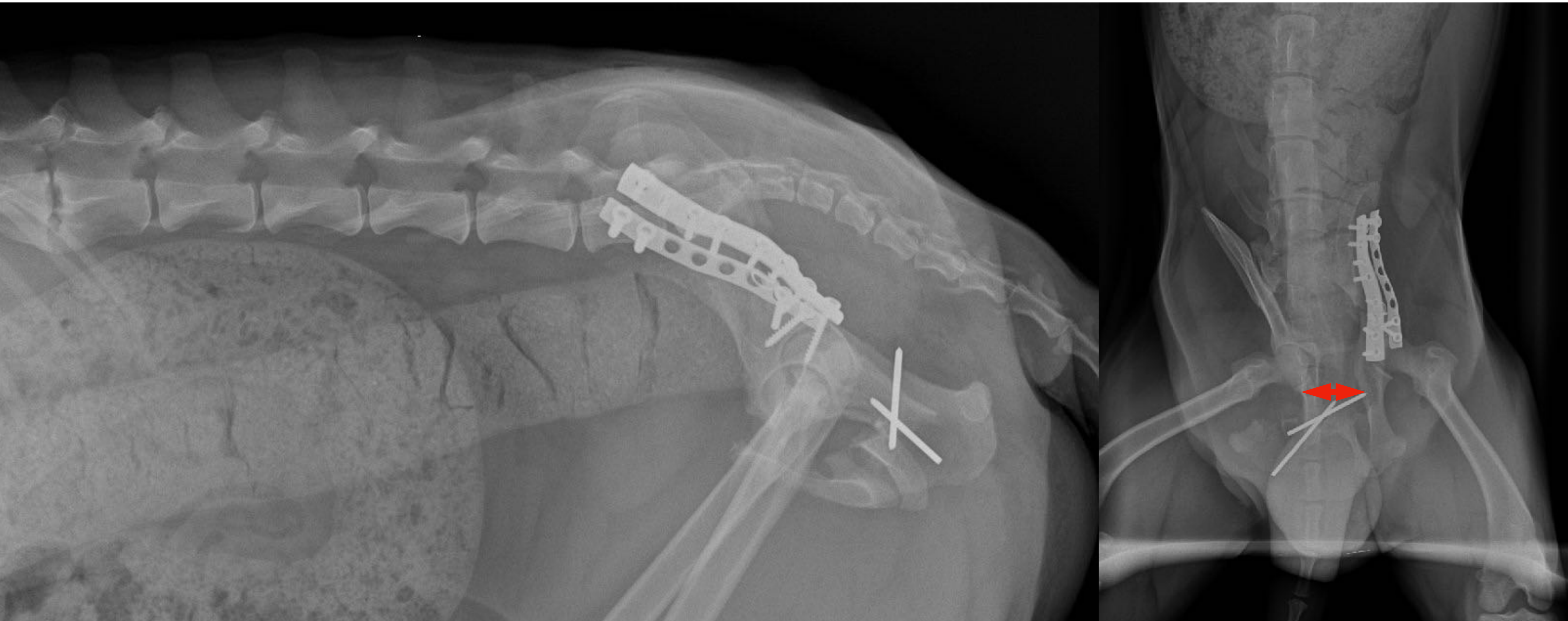
Femoral MIPPO techniques

- Complex femoral anatomy, surrounding muscles => difficult to assess.
- Axial alignment!

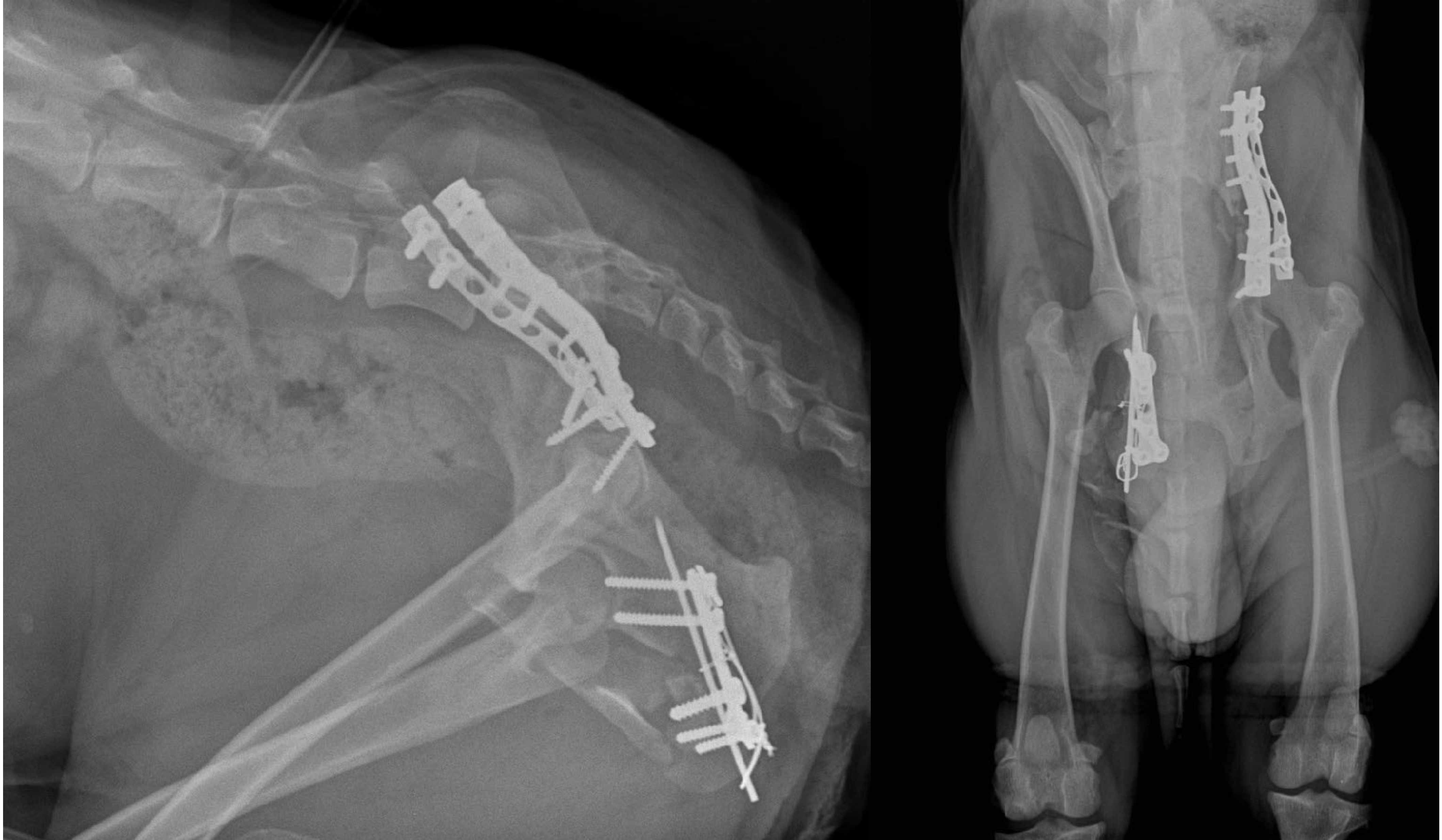


Special attention- pelvic fractures!

Narrow pelvic canal and constipation common.



Revision



Post op evaluation

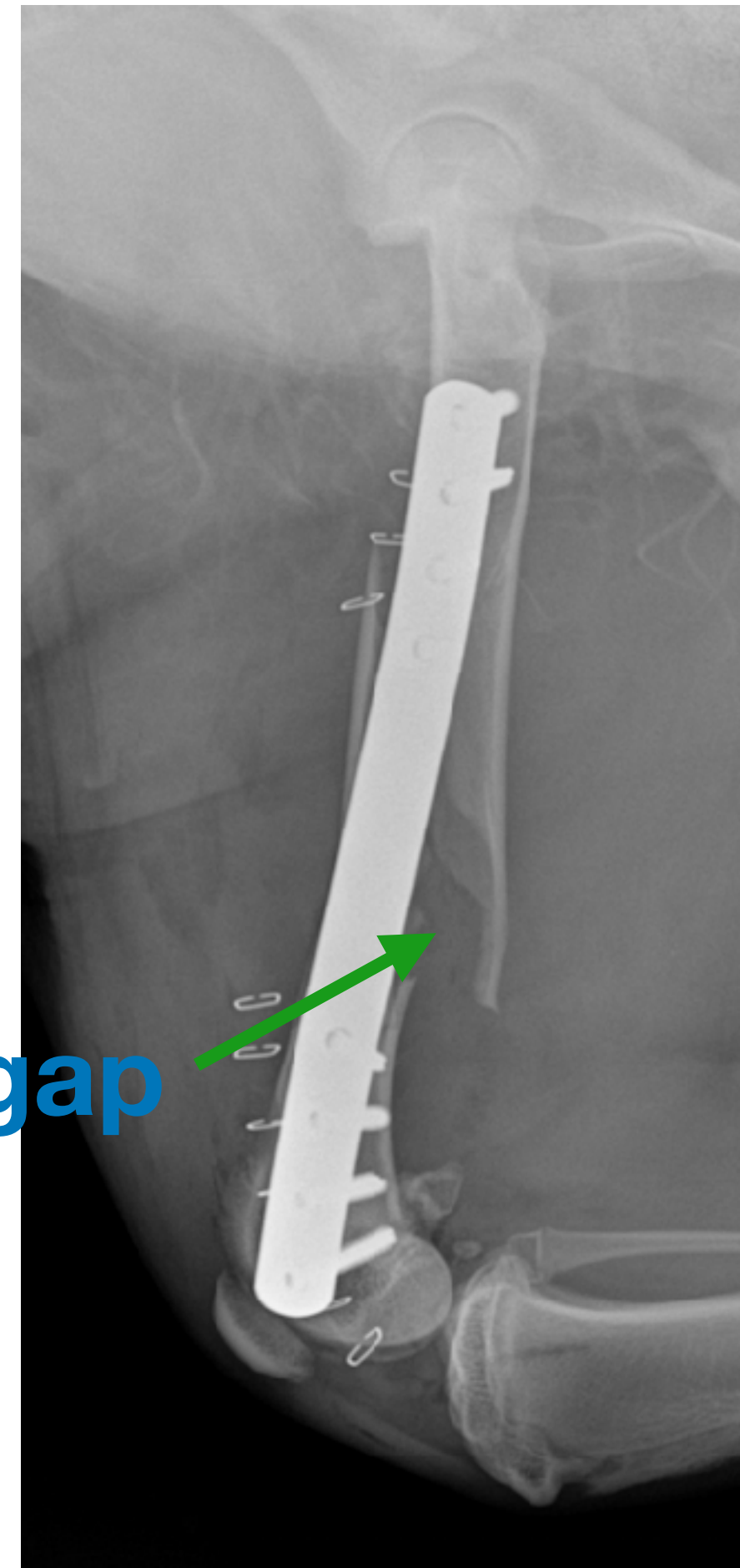
- AAAA scheme.
- Go back to surgery, before point of no return!

AAAA evaluation

Suboptimal apposition/ reduction

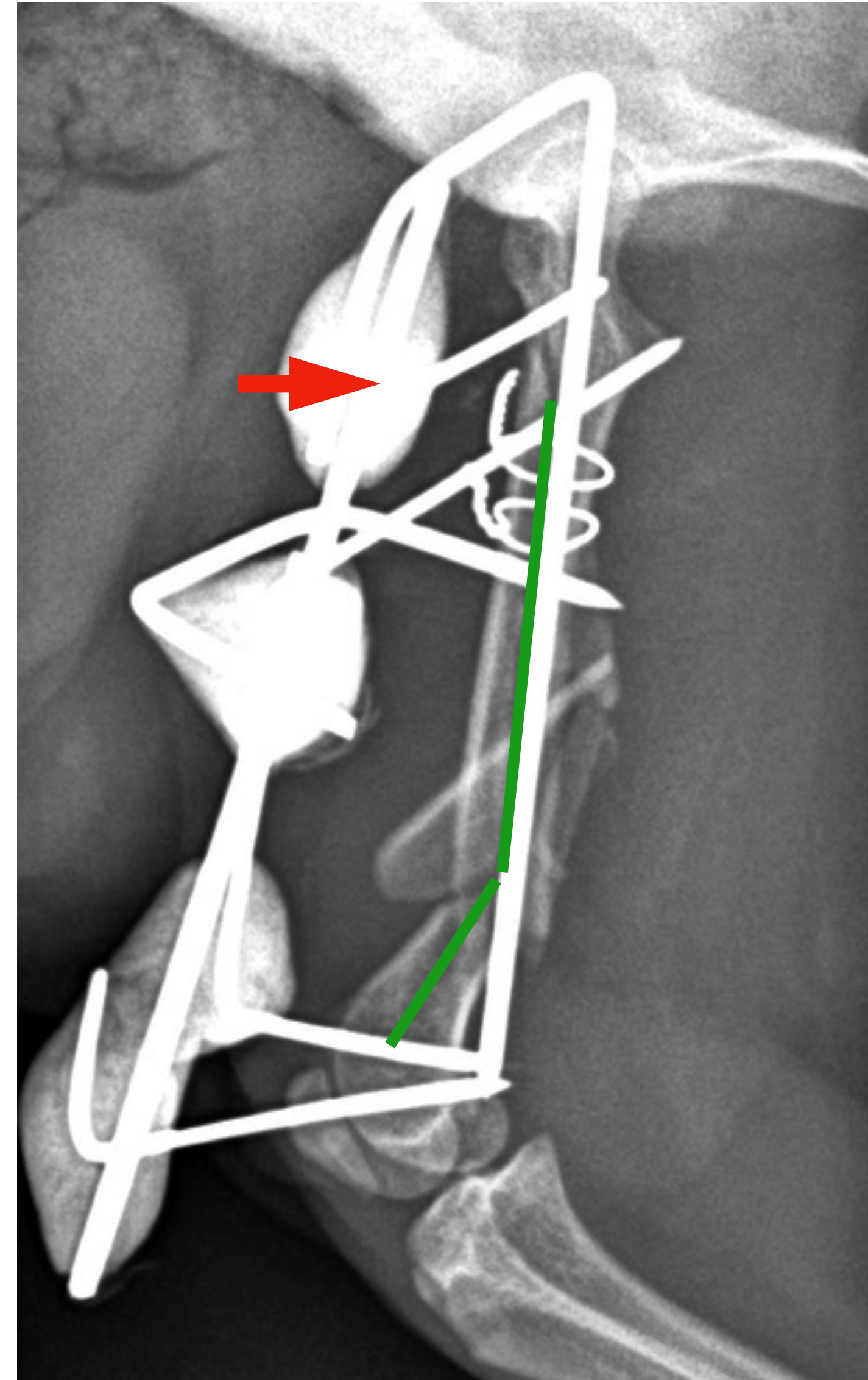
- Apposition

Fracture gap



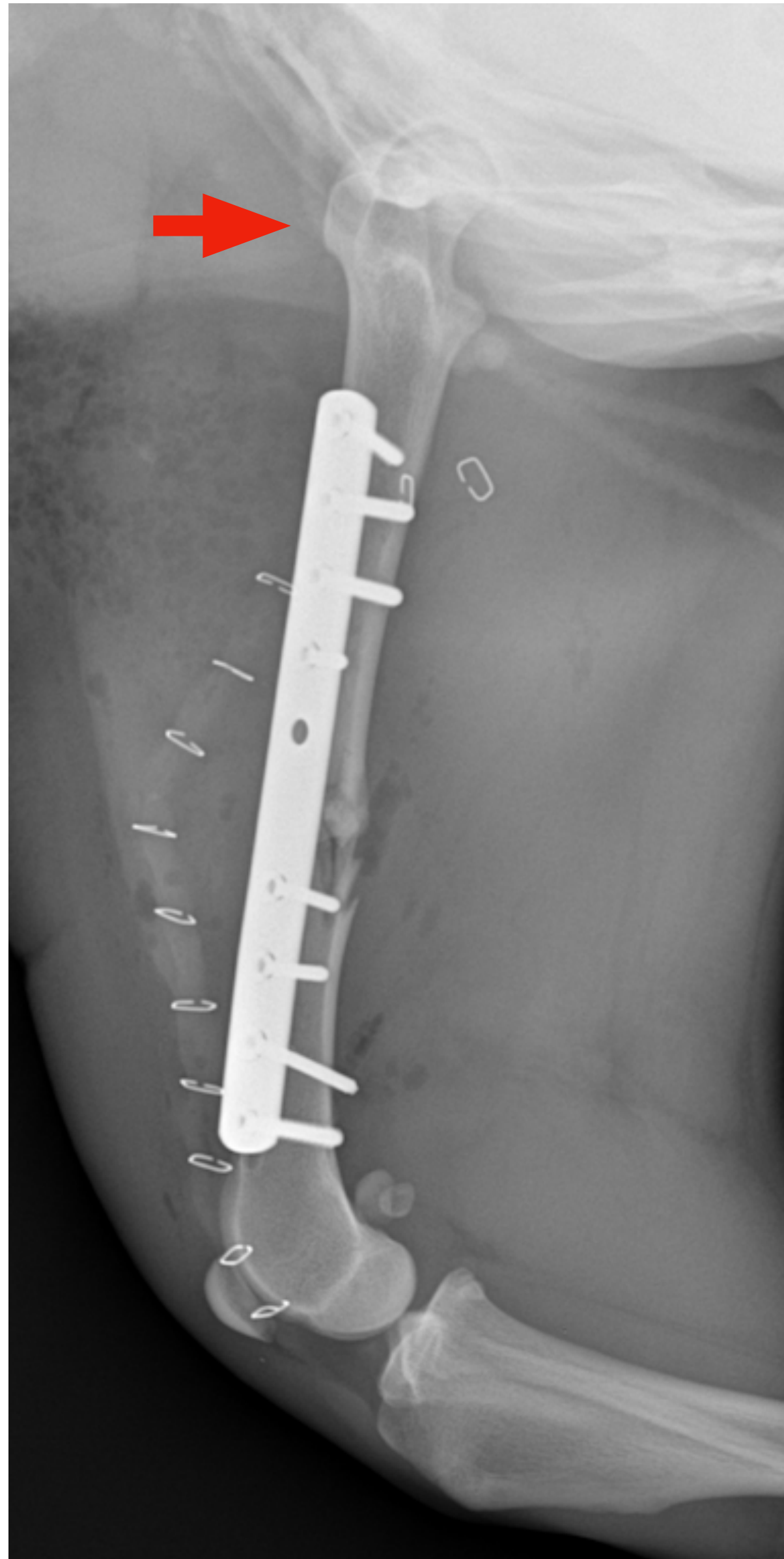
AAAA evaluation

- **Alignment**



Bad alignment

AAAA evaluation

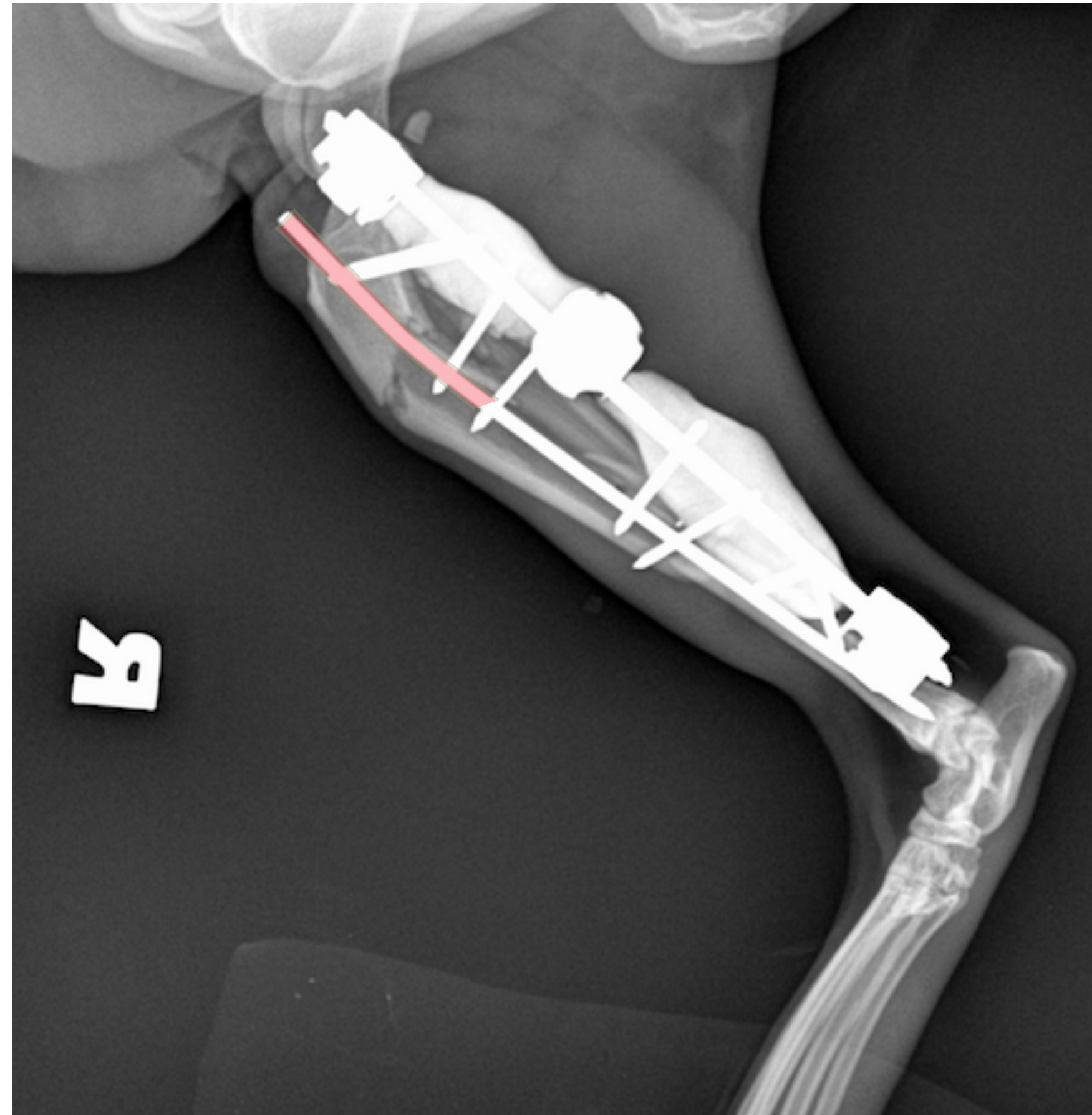


**Rotational
malalignment=>
immediate revision
surgery..**



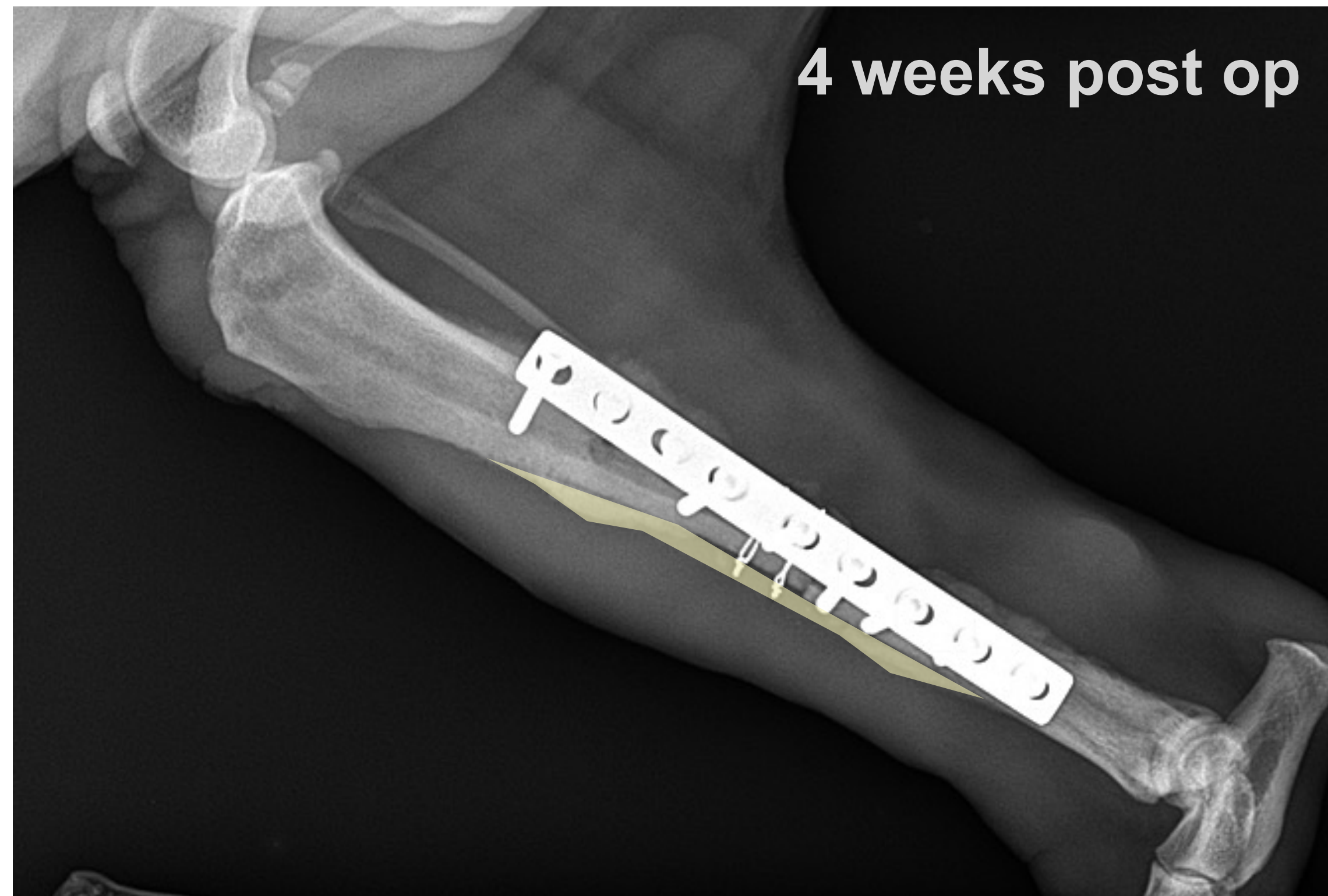
AAAAA evaluation

- Apparatus



AAAA evaluation

- **Activity**



Treatment of Malunions

Treatment of Malunions

- Huge versatility.
- Individual approach.
- Evaluation of the significance of every deformity aspects (angular, shortening..)
- Surgery planning
- Plan B

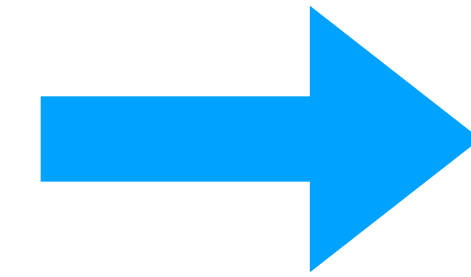
When to consider surgical correction?

- With seriously compromised limb function.
- When a long term osteoarthritis is expected

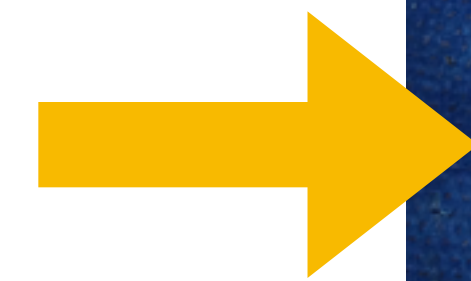


Reference marks

- Simple fracture reconstruction



- Malunions=> physical landmarks may be unavailable.



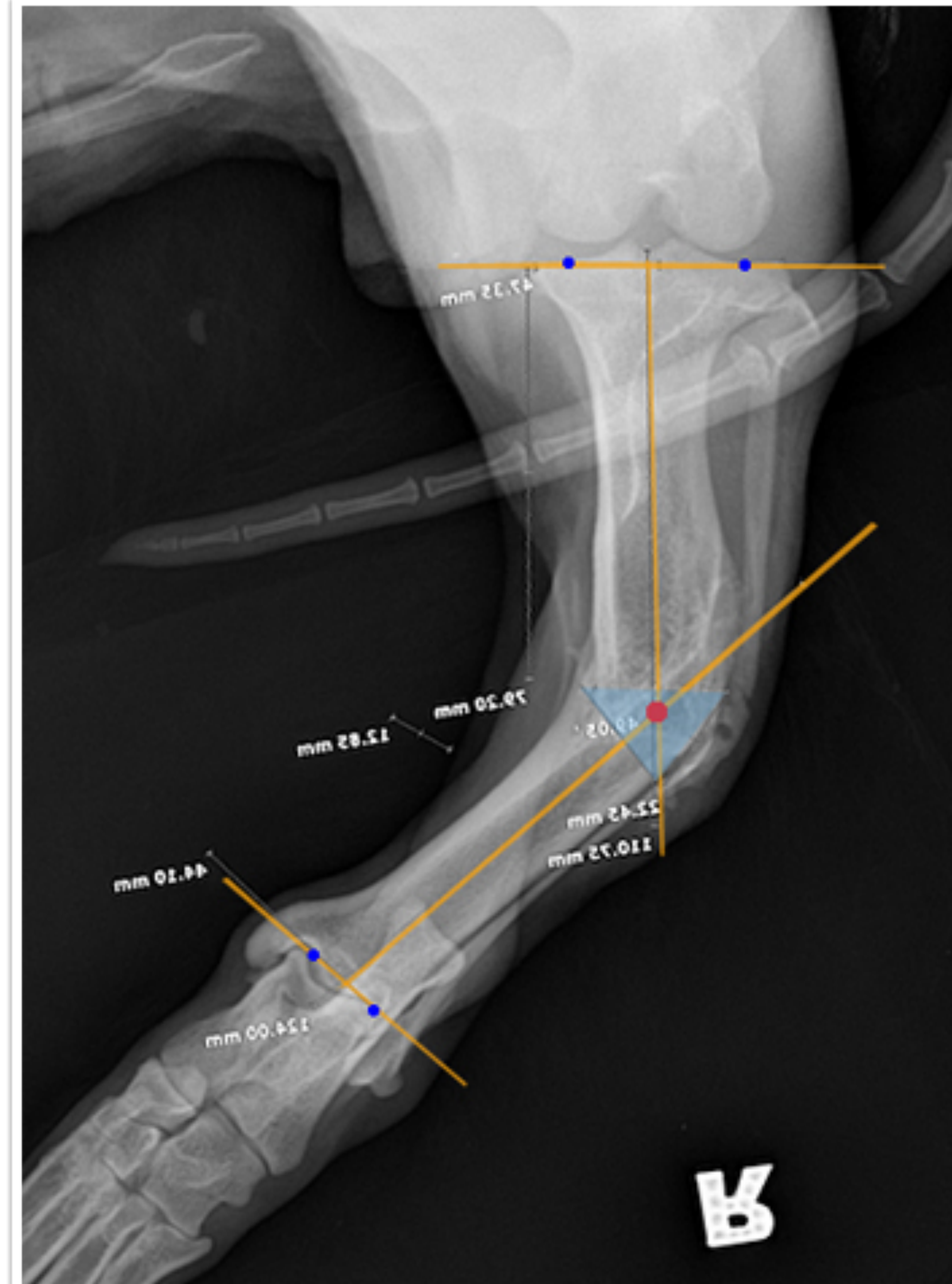
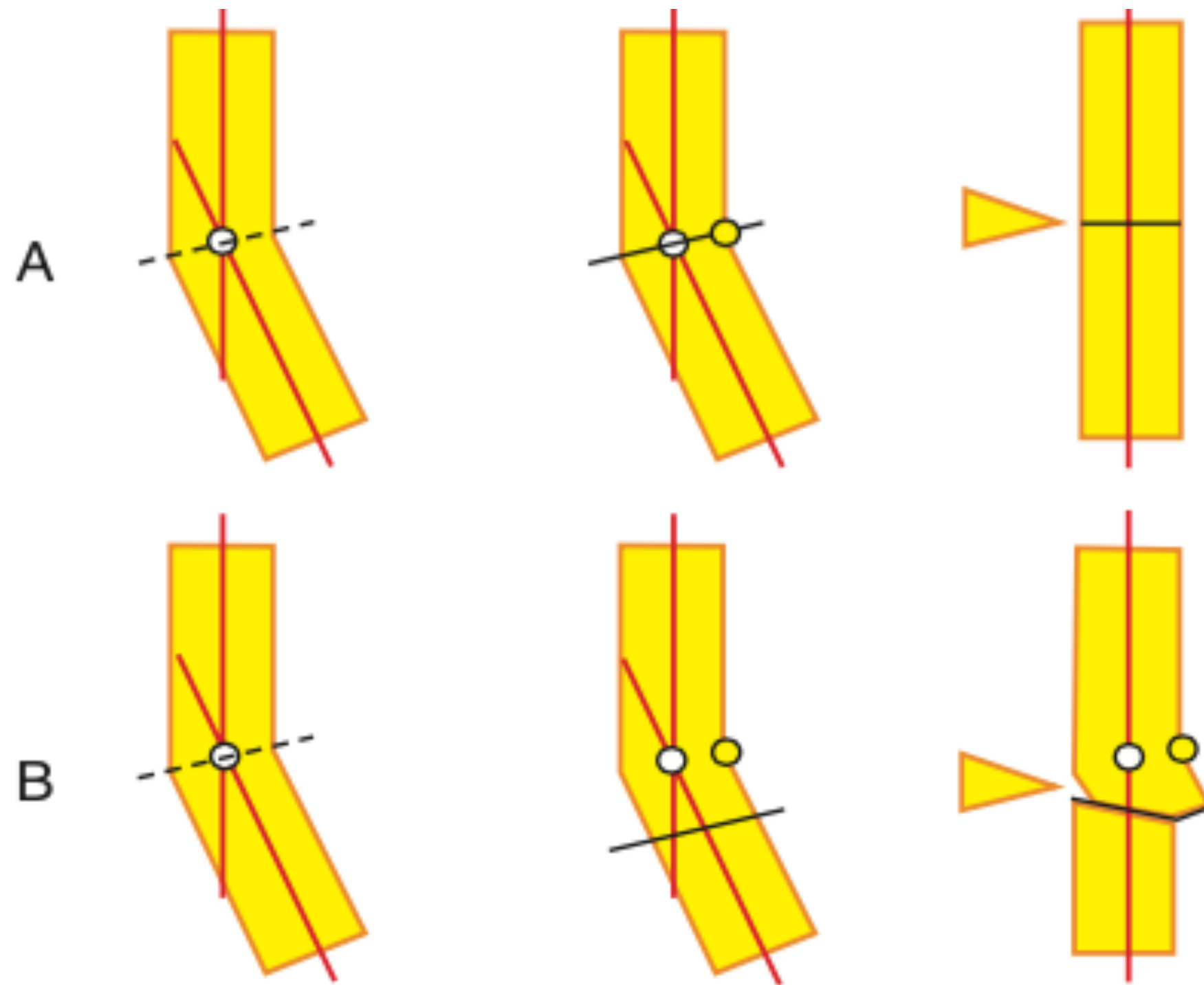
Soft tissue limitations

- Limitation of muscle, vessels, nerve acute elongation/stretching.
- Shorten....!



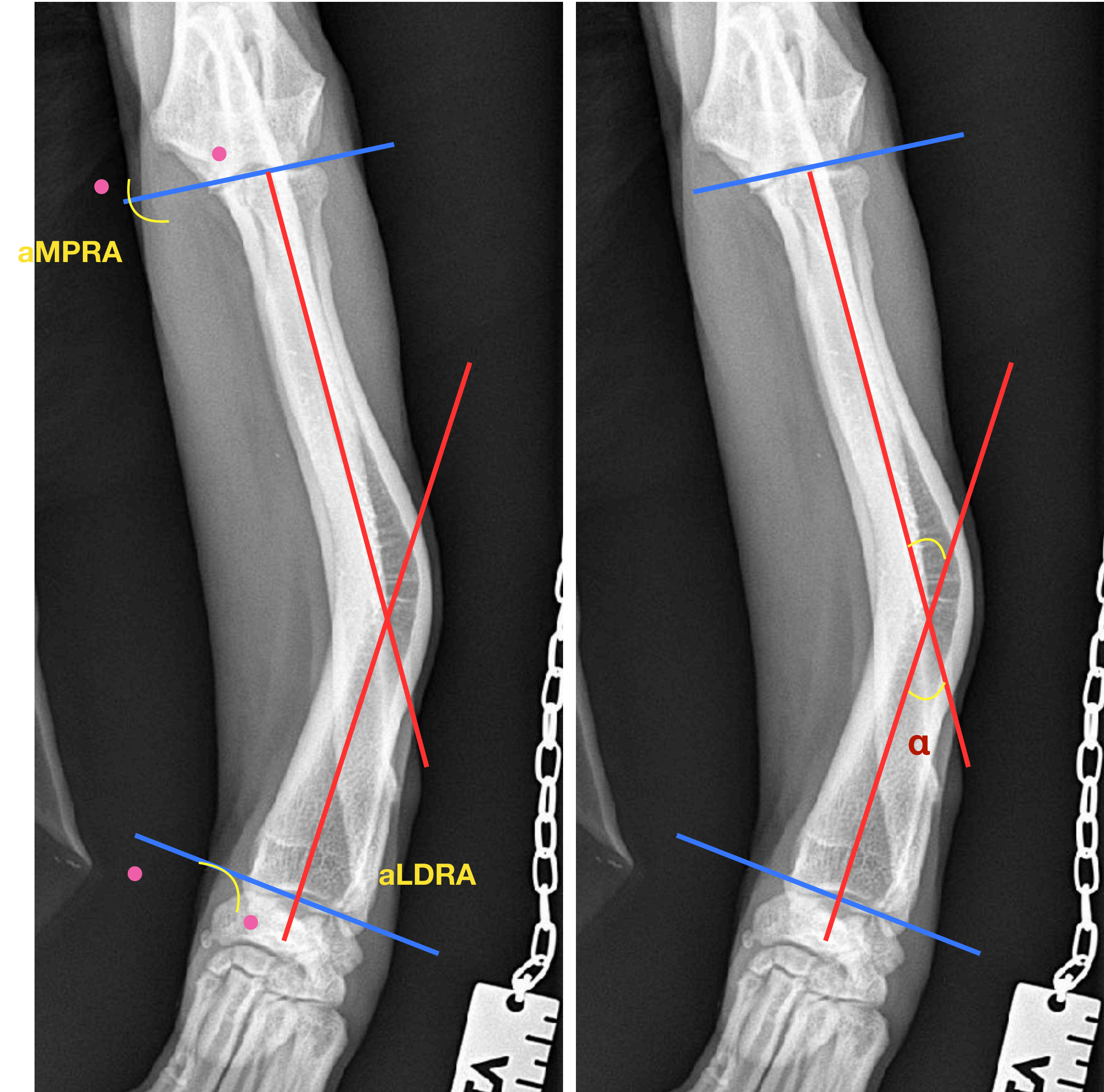
CORA concept

CORA- center of rotation of angulation.



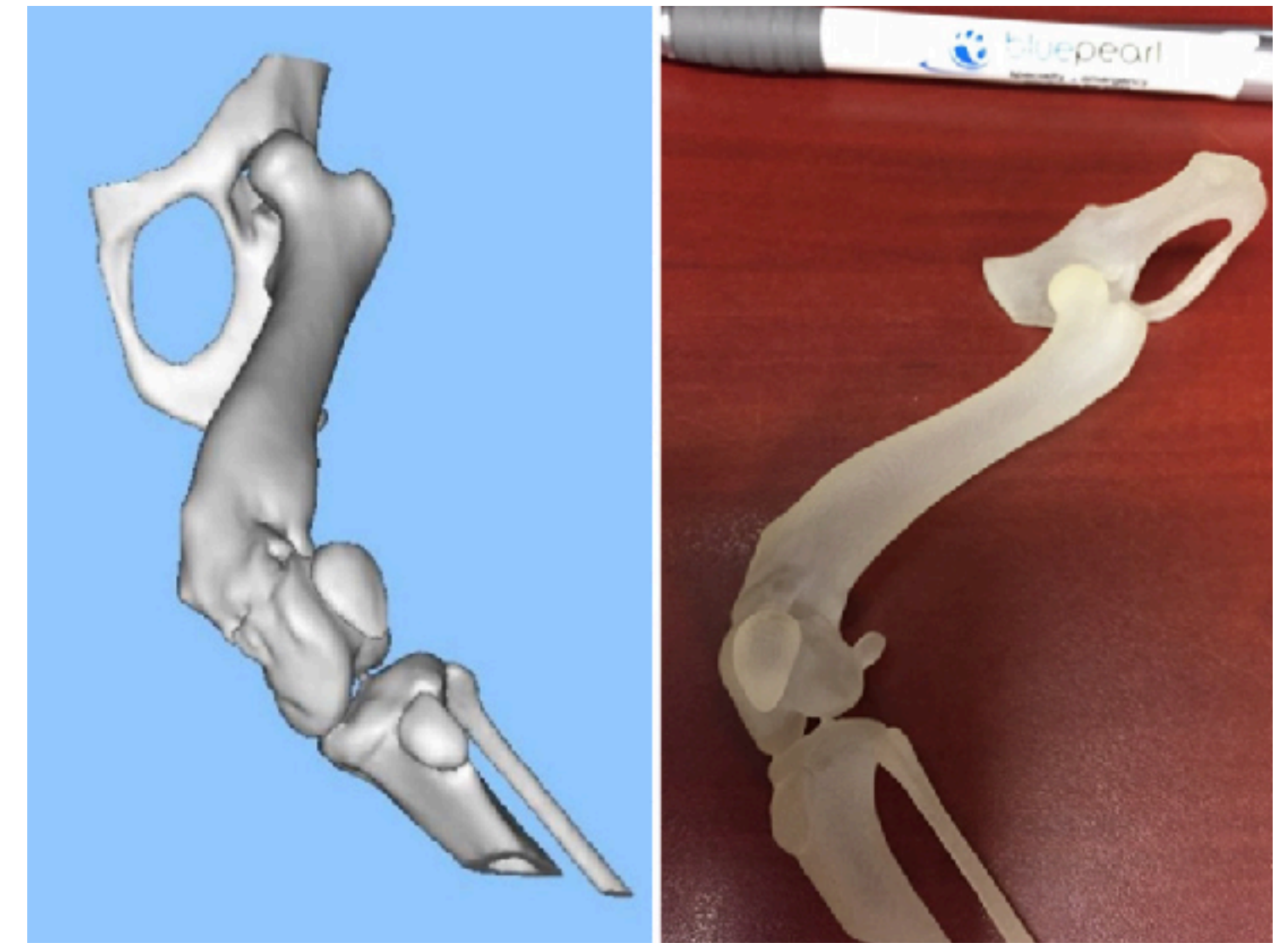
Measure deformity

- CORA location.
- CORA magnitude.
- CORA magnitude = α



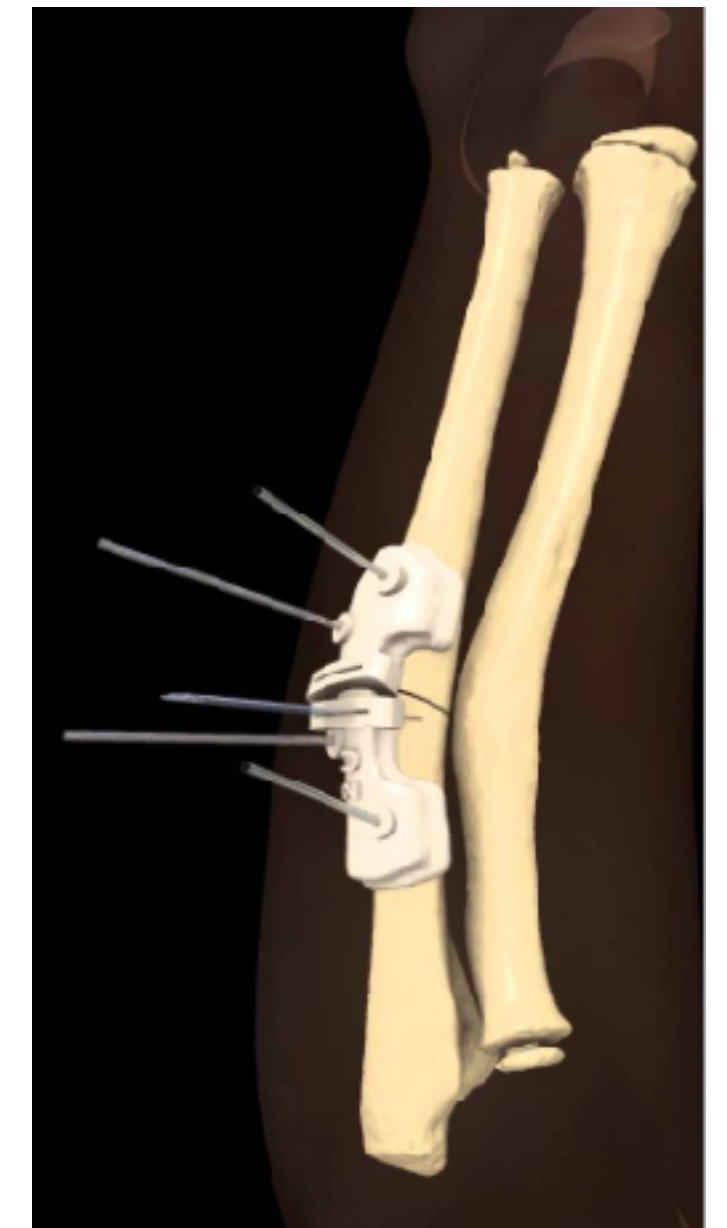
Other imaging tools

- CT with 3-D reconstruction



- Rapid prototype fabrication (3D printing);

- Intra op radiography/fluoroscopy



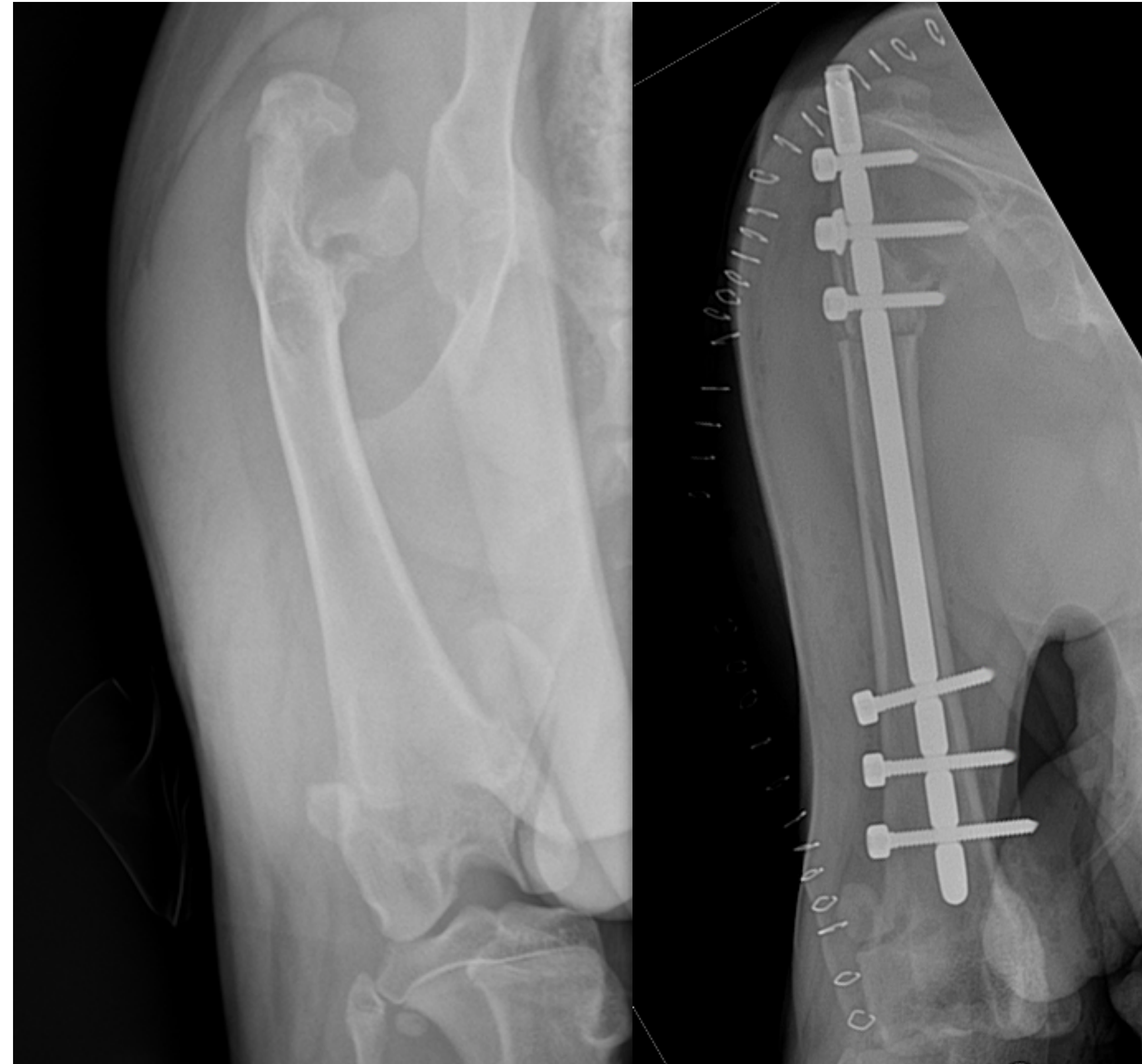
Implants

- Plate fixation- commonly in the upper bones (femur and humerus) and the pelvis.

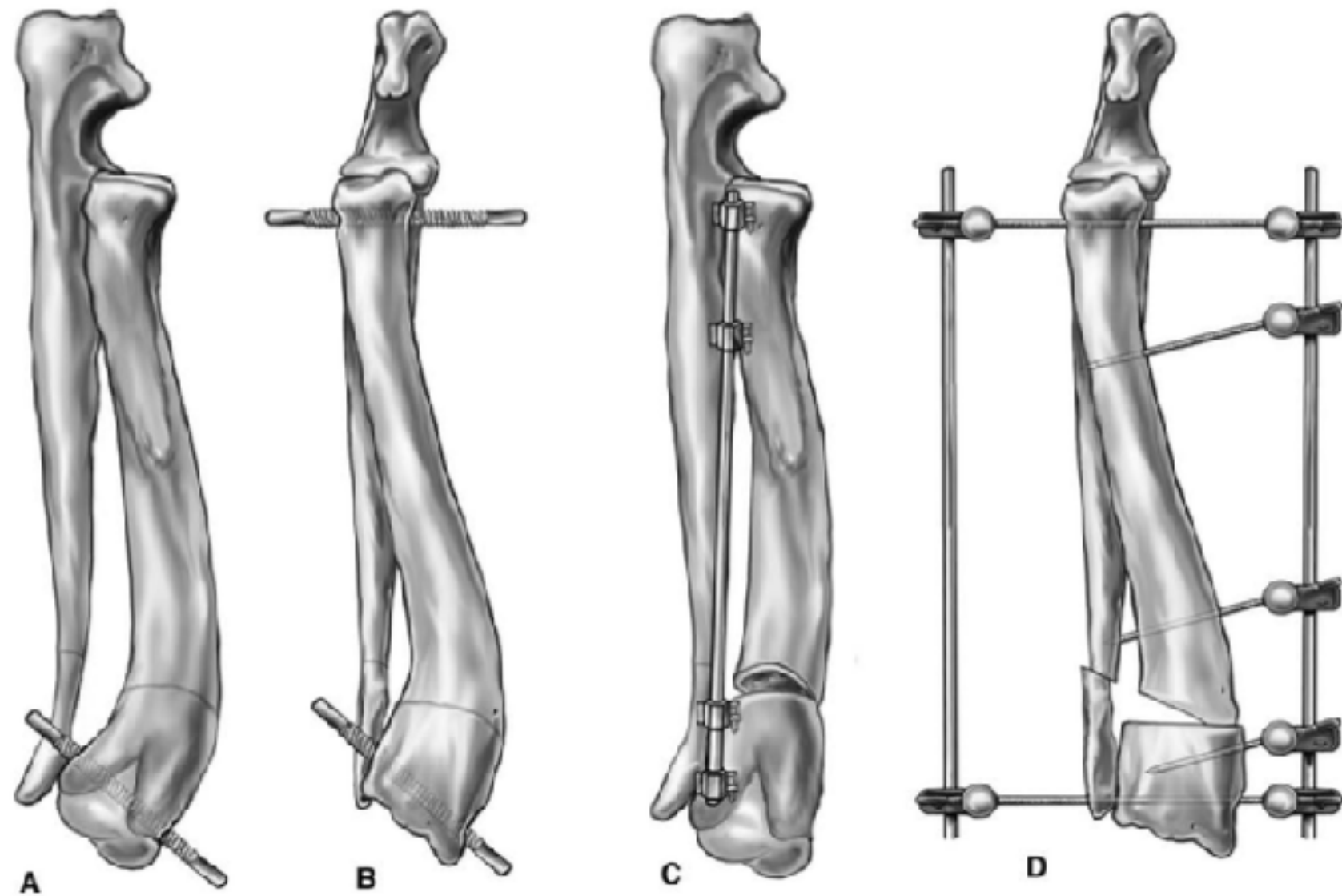


Implants

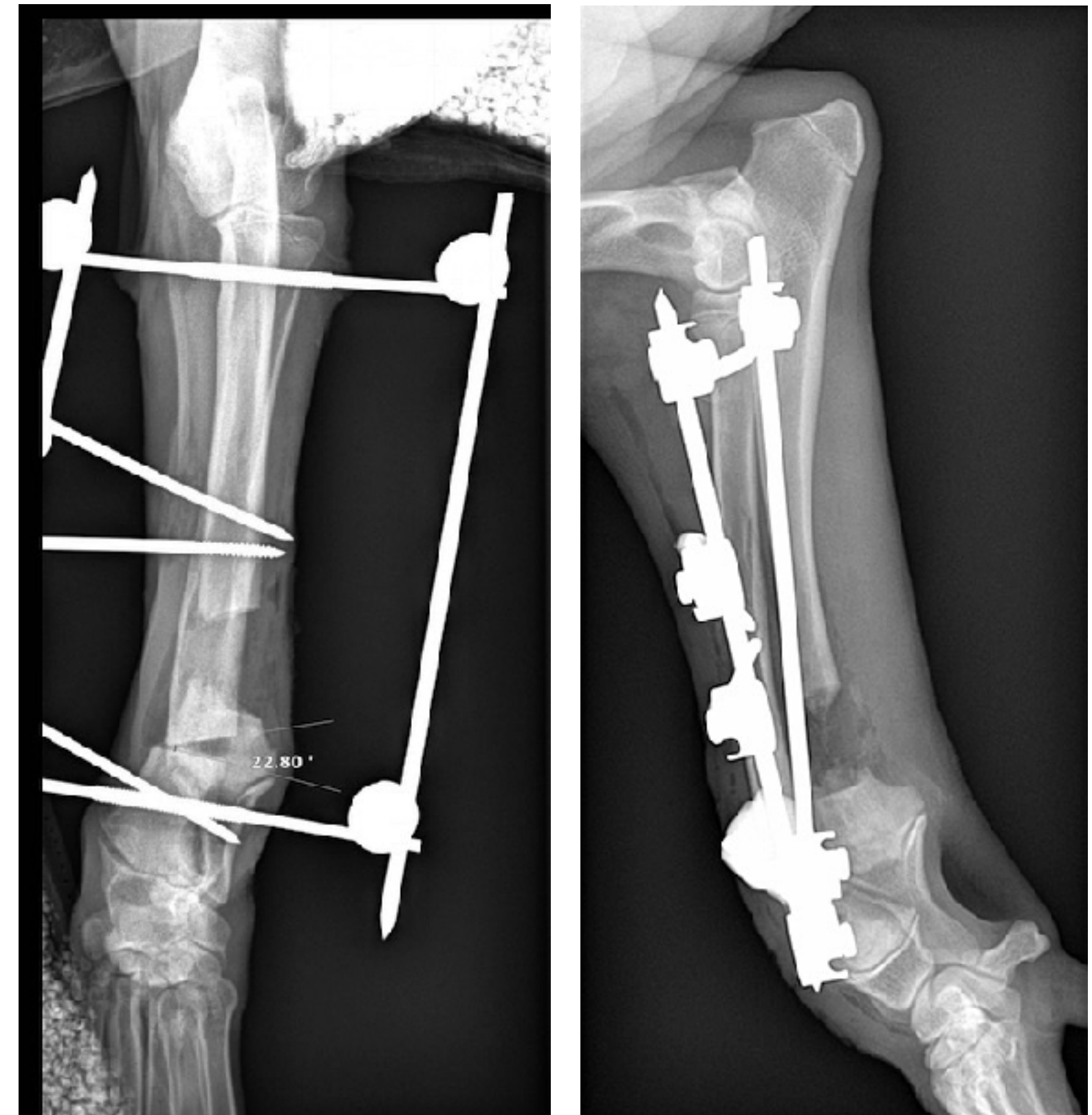
- Interlocking nails- femur, tibia and humerus.



- **External skeletal fixators**- useful in the distal extremities.
- Only for young animals

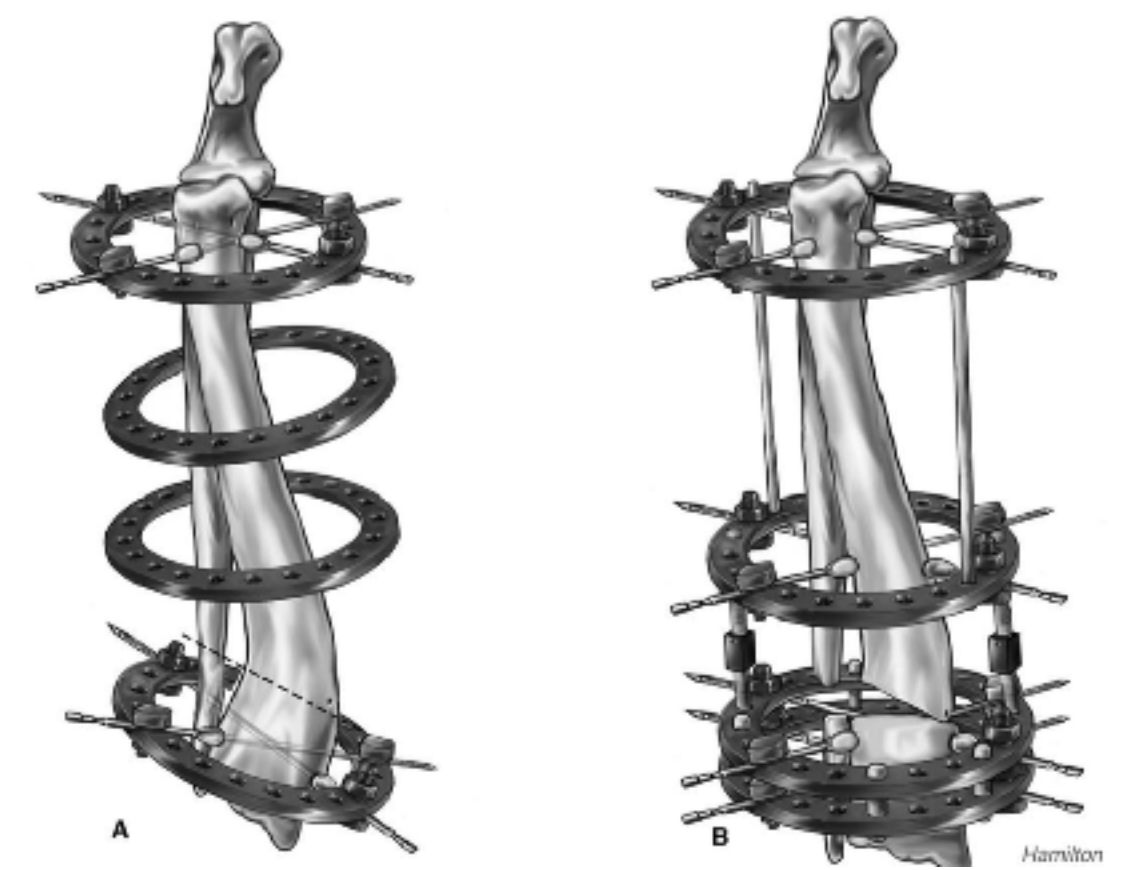


*“Current techniques in Small Animal Surgery
M. Joseph Bojrab, 5-th edition”*

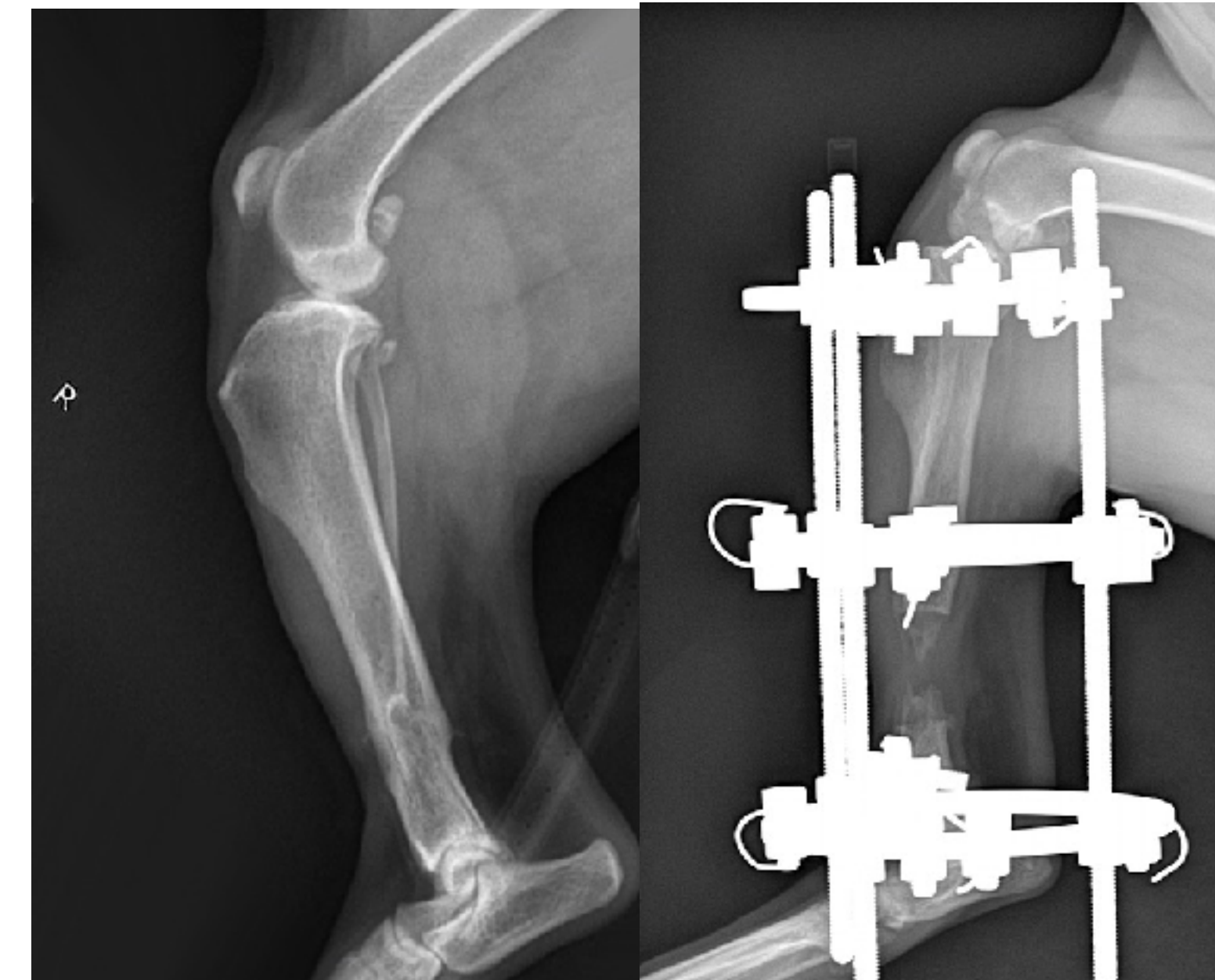


Ring external fixators-“*distraction osteogenesis*”.

Unique indication- combination of major angular deformities and serious shortening.

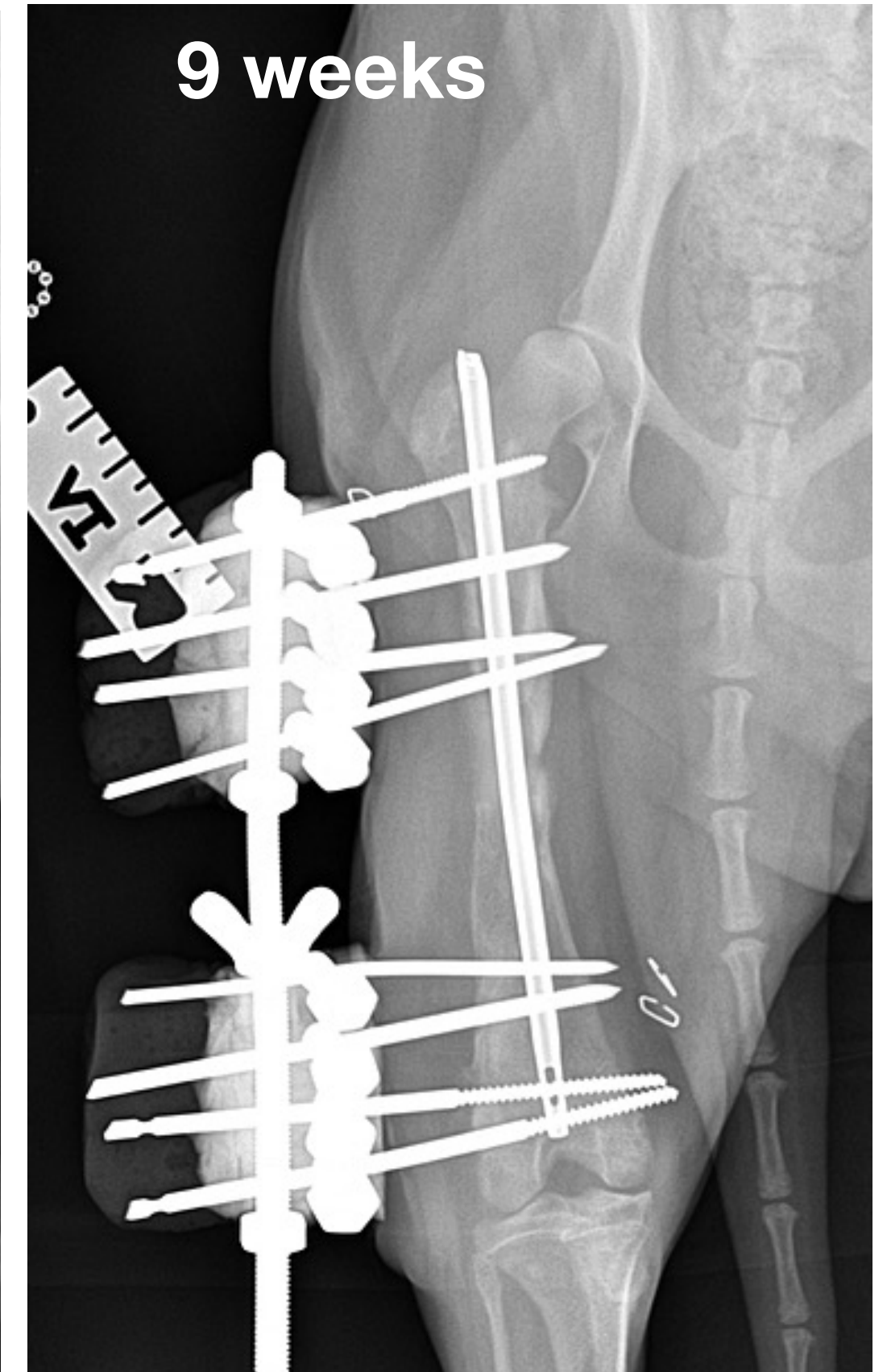
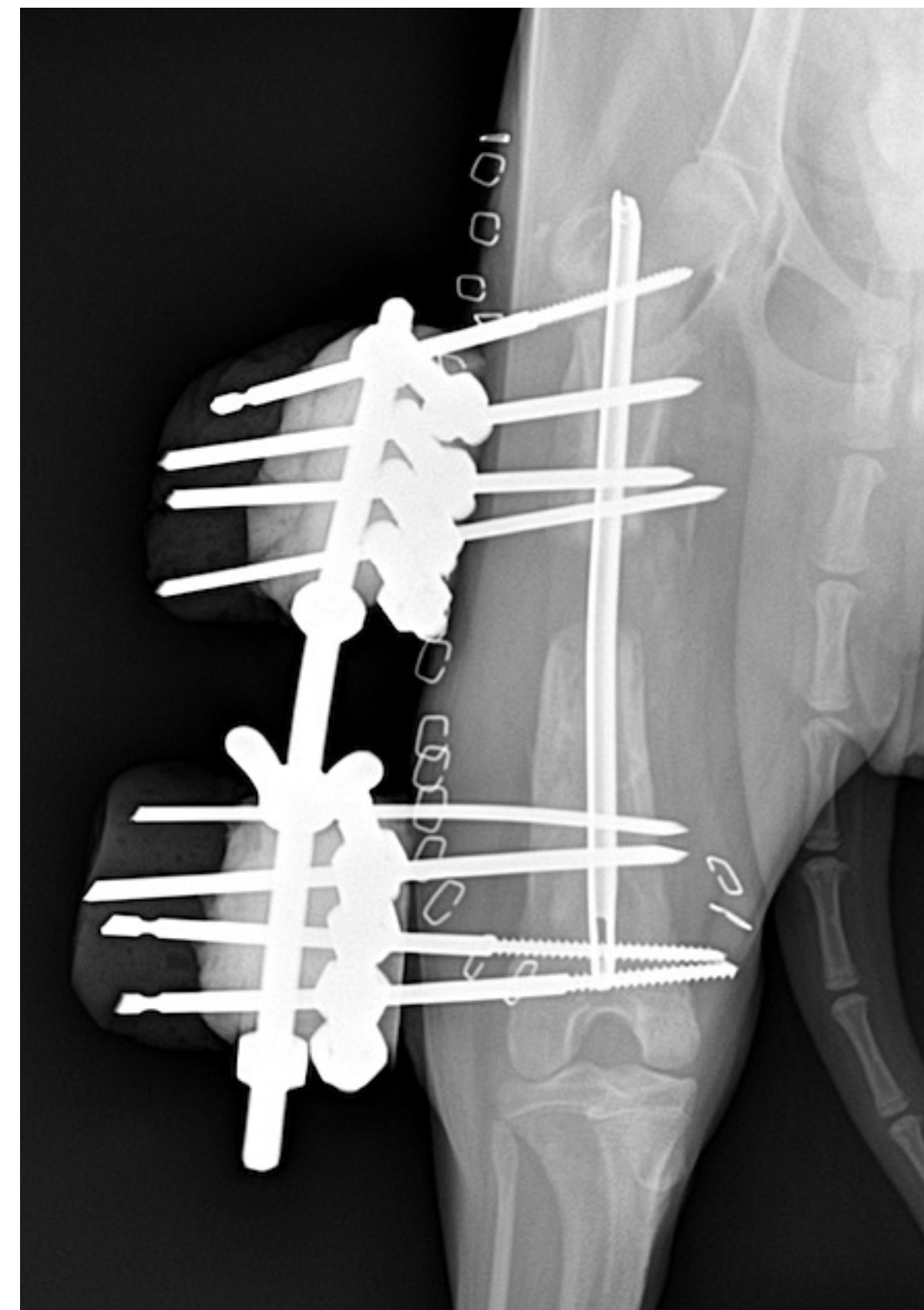
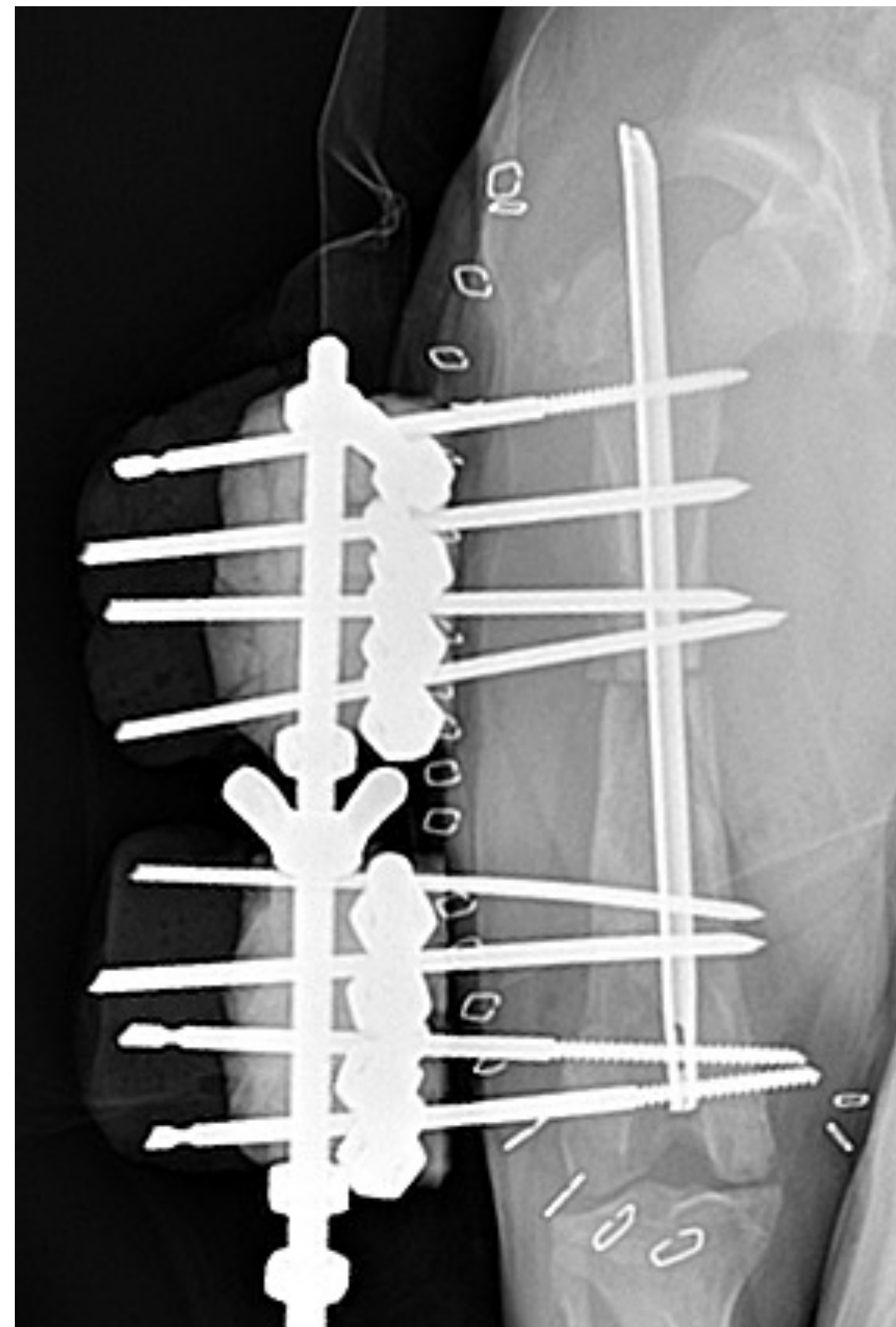


Tibial lengthening



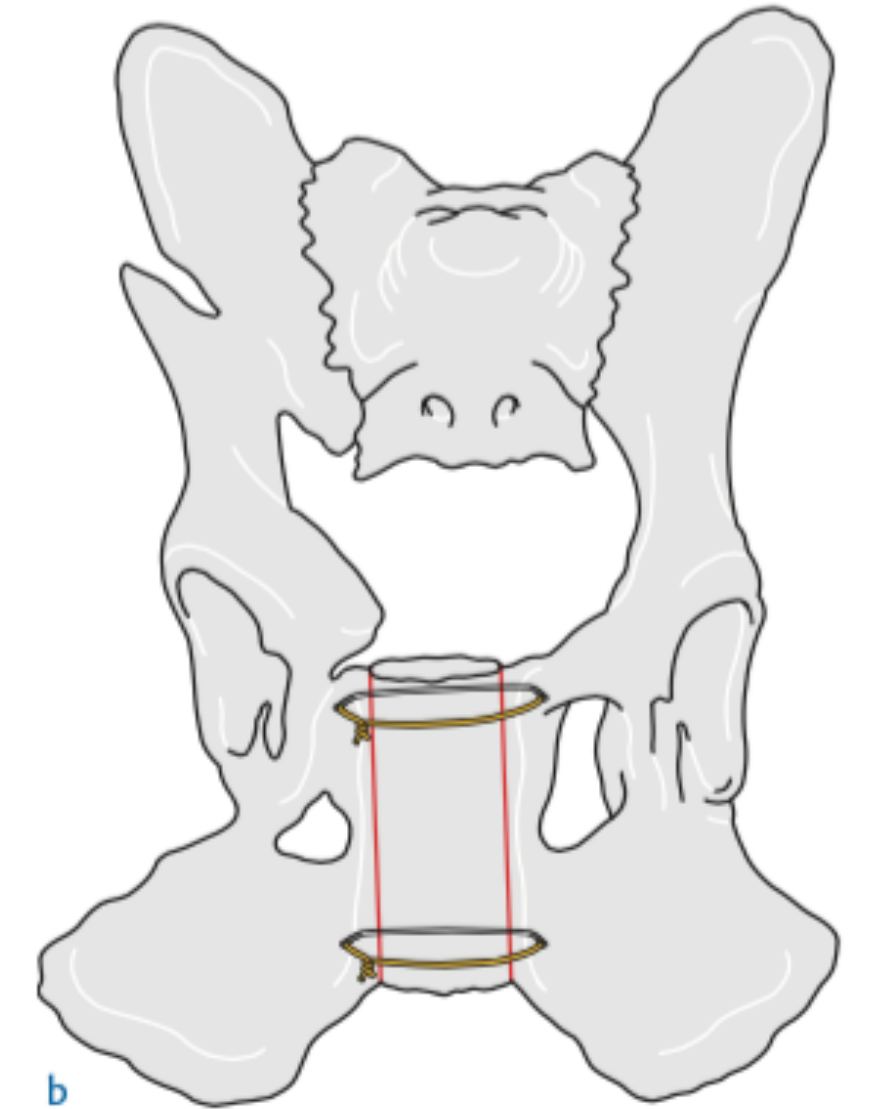
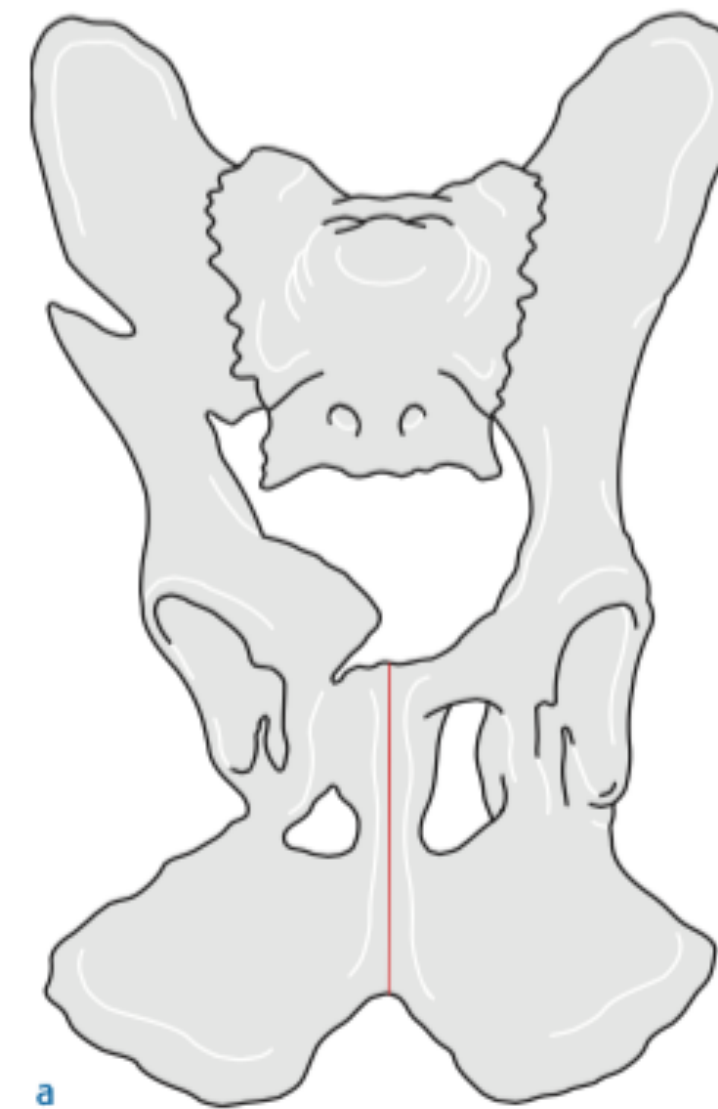
Linear dynamic distraction.

***1 y old, mix.
old femoral fracture***



Pelvic malunions

- Canal narrowing.
- Iliac osteotomy or distraction of the pubic symphysis



Thank you!

