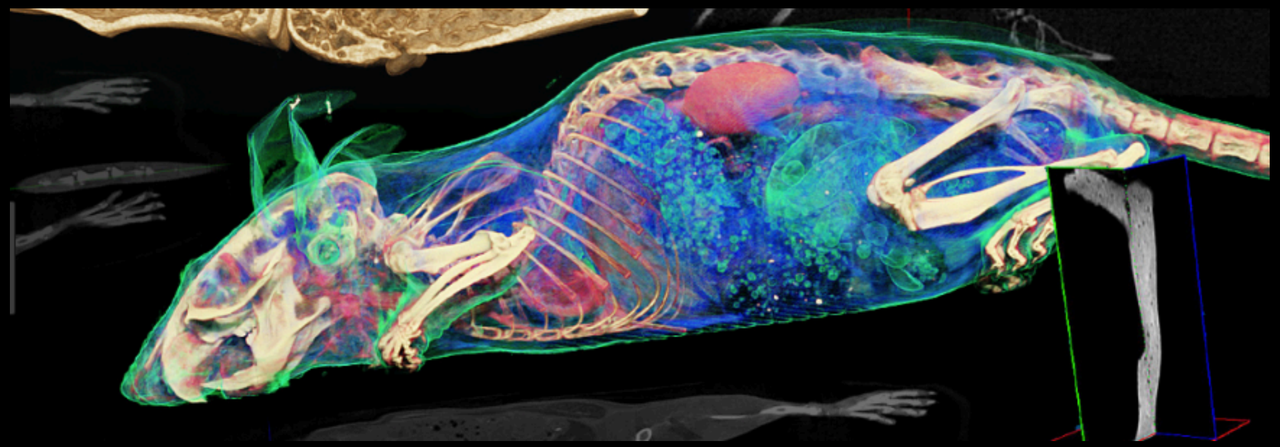
Imaging techniques for orthopedists

How to get the best of them?



CONGRESO VETERINARIO DE LEÓN

Dr. Vladislav Zlatinov
Central Vet Clinic - Sofia, Bulgaria

The successful treatment demands right diagnosis.

Not like MEDIUMS, vets need diagnostic tools

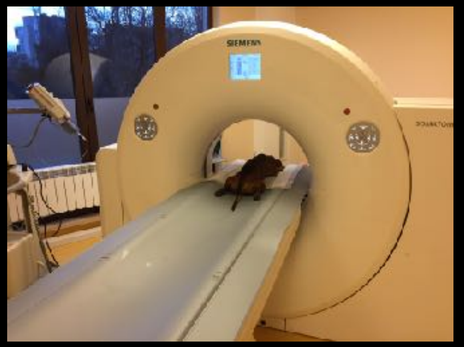
Doctors are not mediums, just curious guys :)

Medical imaging evolution..

Imaging of the musculo-skeletal systems includes

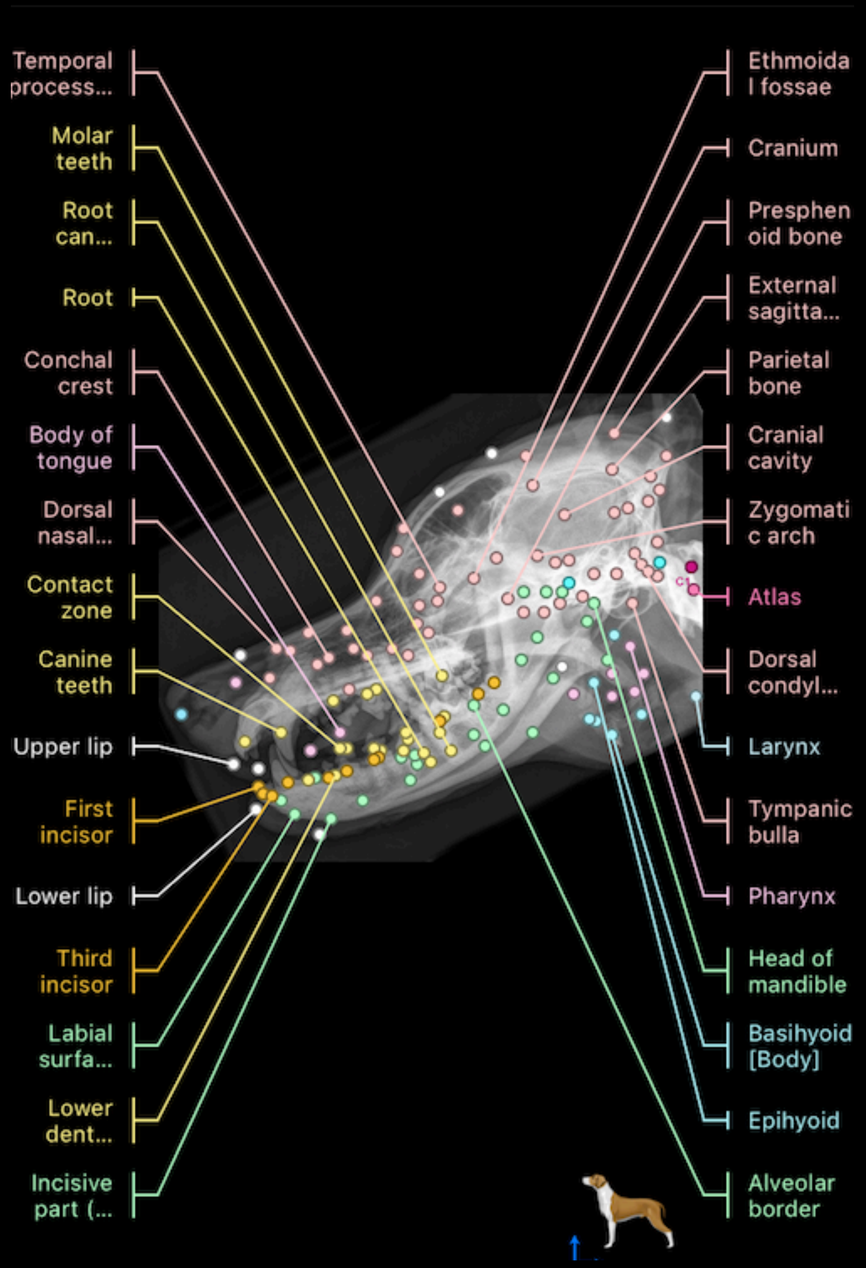
- ★ Radiographic study
- ★ Echographic study
- ★ Computer tomography
- ★ Magnetic Resonance study
- ★ Scintiography
- ★ Arthroscopy

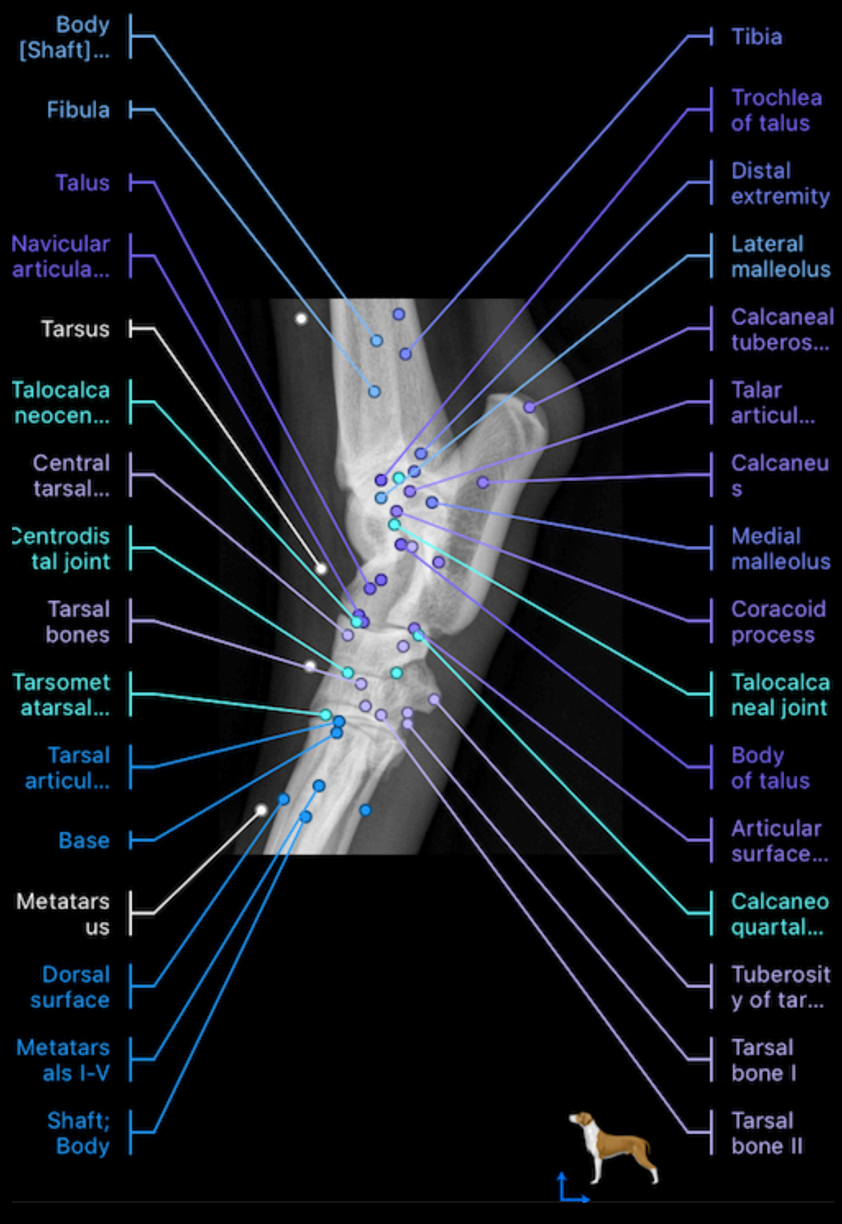
- Contrast enhancement.



Radiographic study

Do you know all of them?

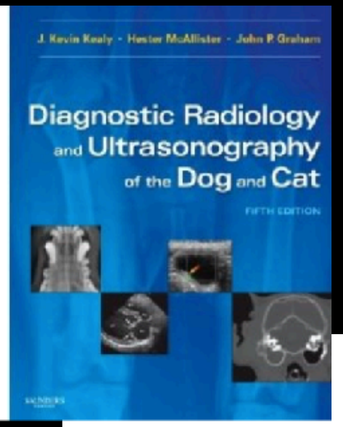




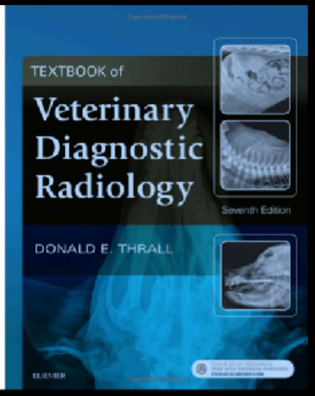
The lecture is not about “knowing them”

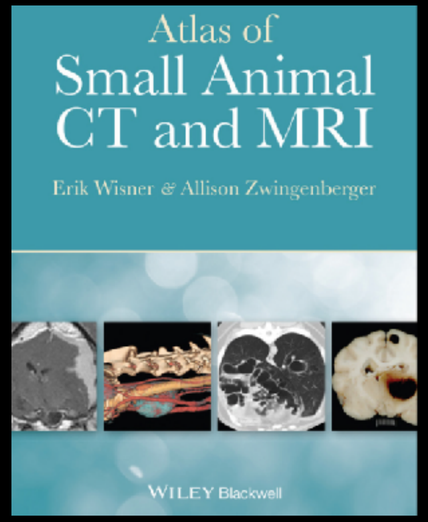
The lecture is not about “knowing them”

Kealy JK, McAllister H: Diagnostic radiology and ultrasonography of the dog and cat. 5th ed. Saunders, 2010

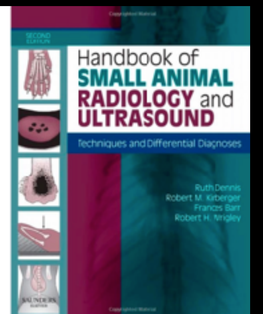


Thrall DE. Textbook of Veterinary Diagnostic Radiology, 7th Ed, Saunders Elsevier, 2018.



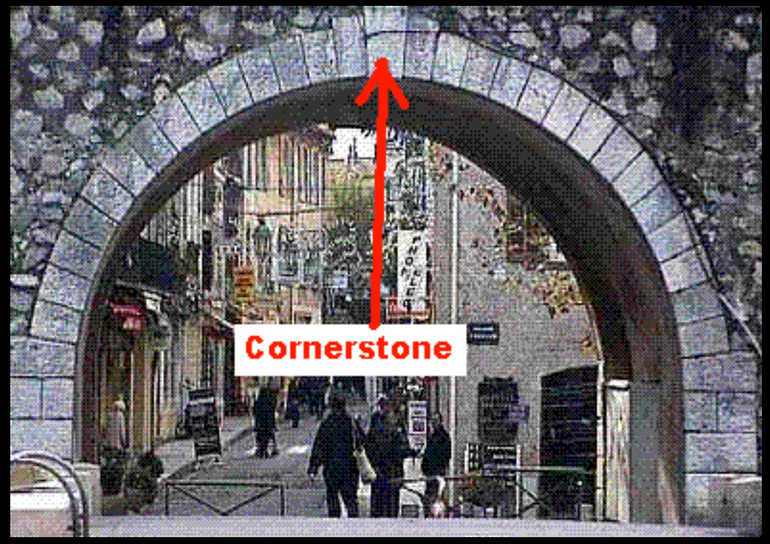


Dennis R, Kirberger RM, Wrigley RH, Barr F. Handbook of Small Animal Radiology: Techniques and Differential Diagnoses for Radiology and Ultrasonography, Saunders Elsevier, 2010



Radiographic study

- Corner stone



- Wide spread and well known

- Image/s containing **document**, option for pro and retrospective analysis.

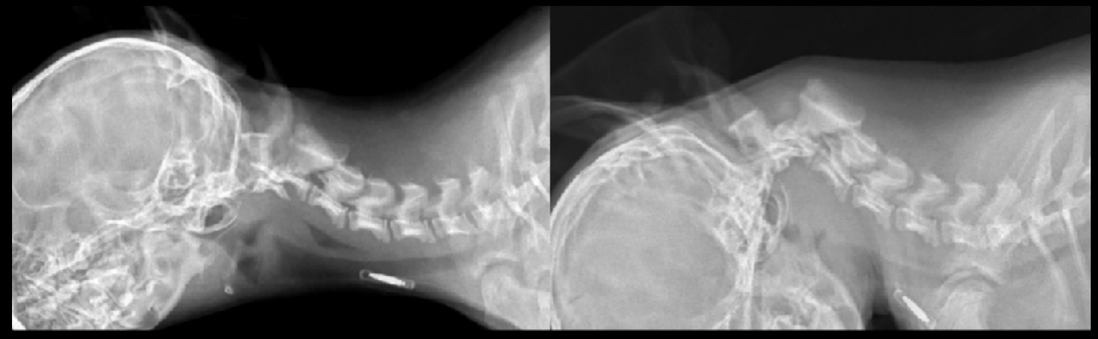
Radiographic study

- Wide spread and well known **but**

  still many pitfalls

Advantages

- Very good toll of study of **bones**
- Relatively good tool for **joint surfaces**
- Fast diagnostic tool

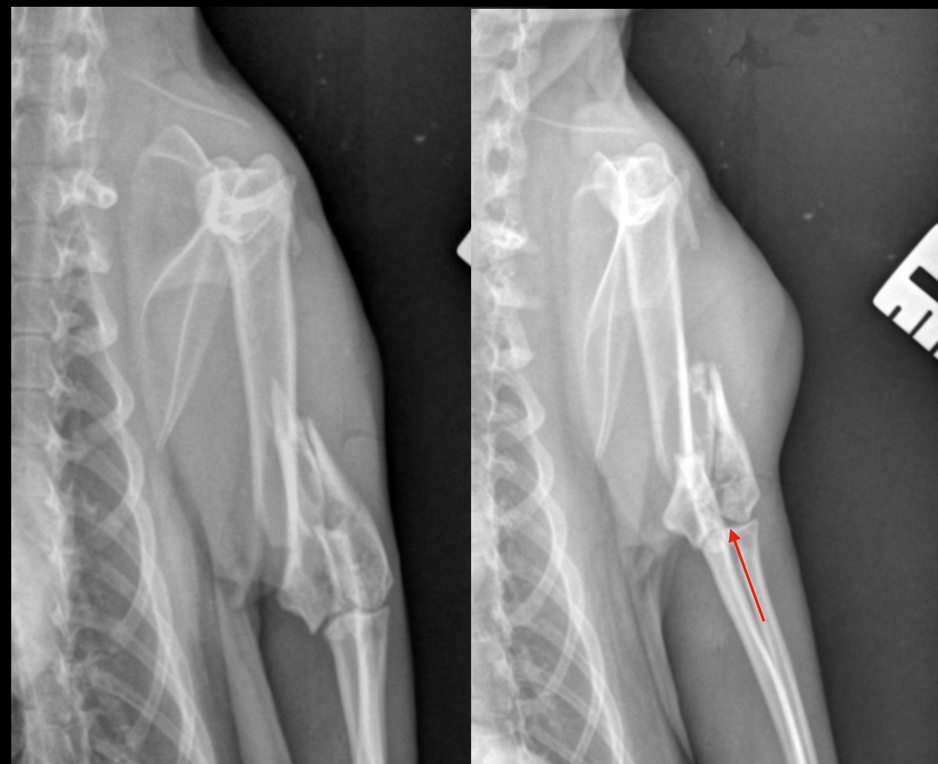


Disadvantages

- Poor specificity when study soft tissues, including CNS structures.
- Position dependent
- Radiation hazard

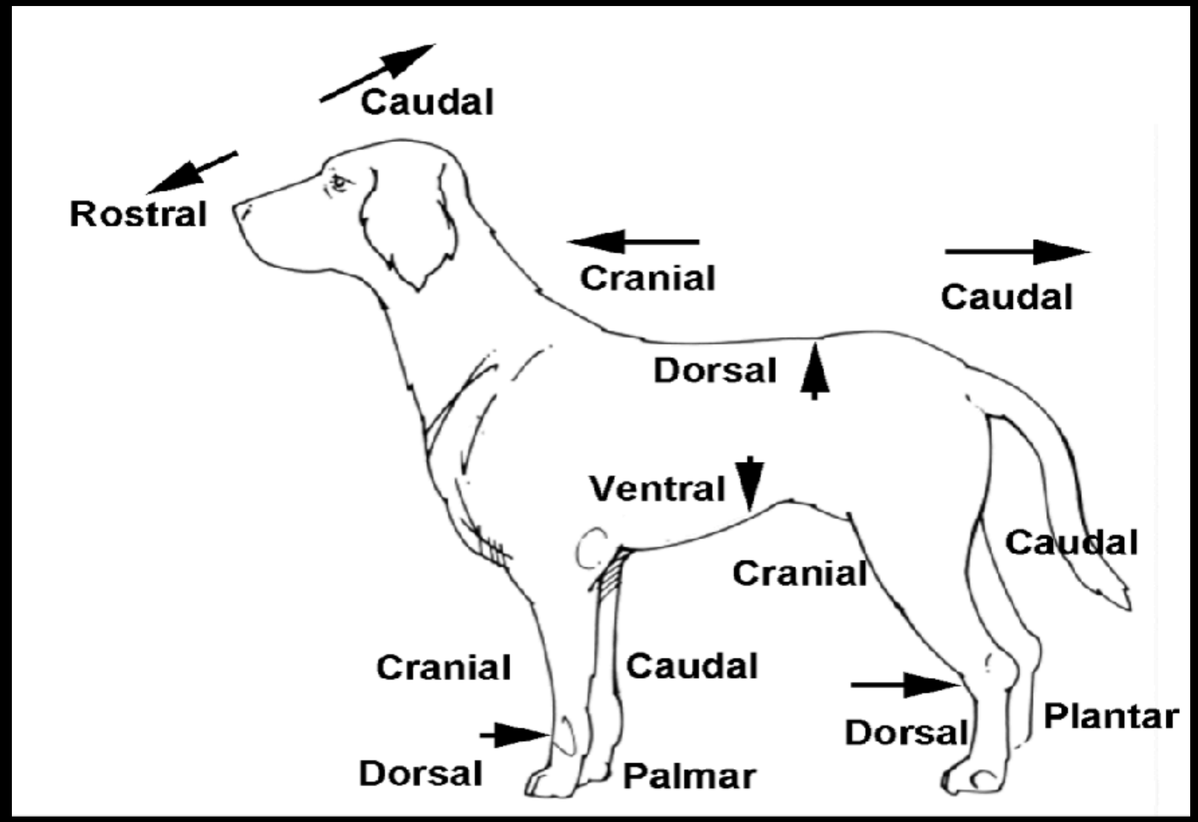
Disadvantages

- Poor specificity when study soft tissues, including CNS structures.
- Position dependent
- Radiation hazard



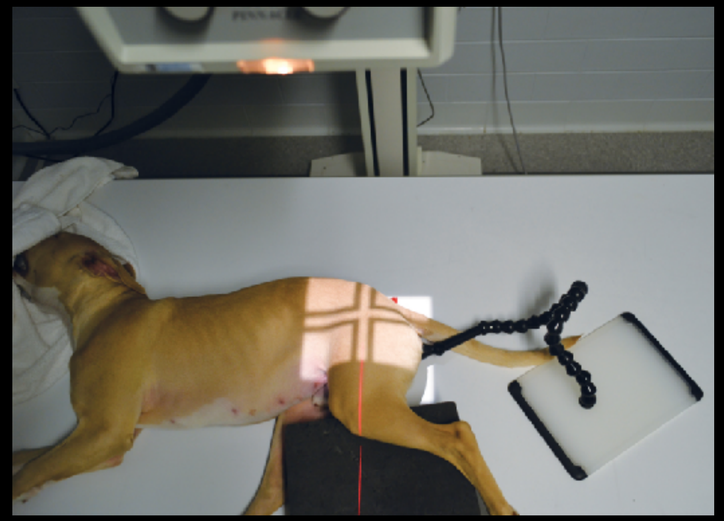
Terminology

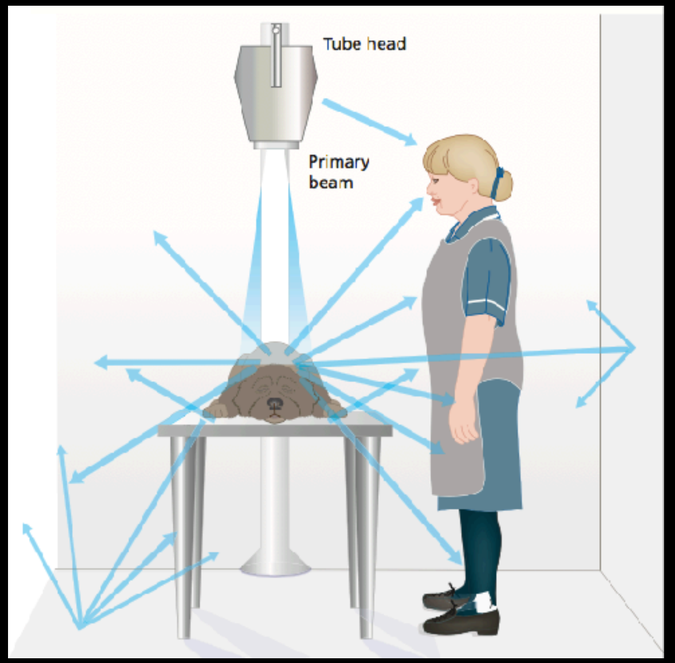
- Standrards in directions
- Human medicine difference



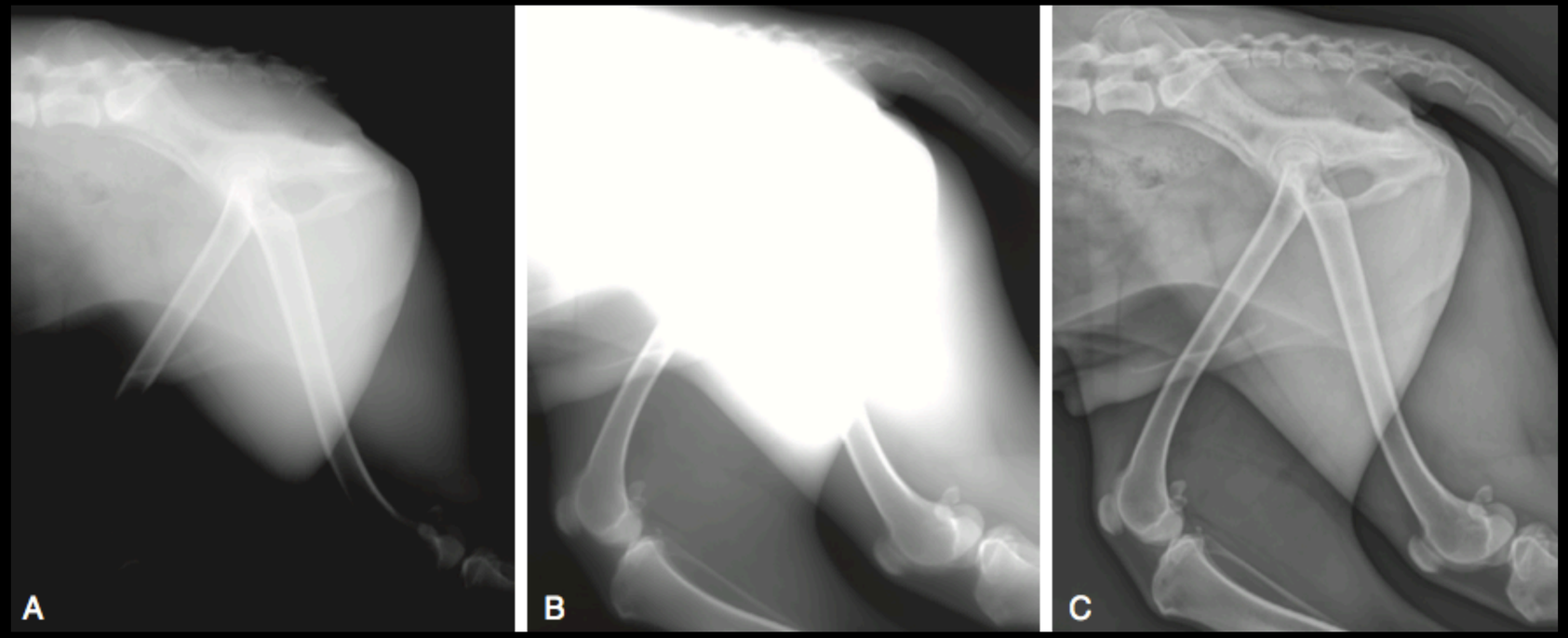
Basic principles of good X ray practice

- Right exposition
- Right labeling
- Orthogonal views
- Right positioning
- Right collimation
- Safety



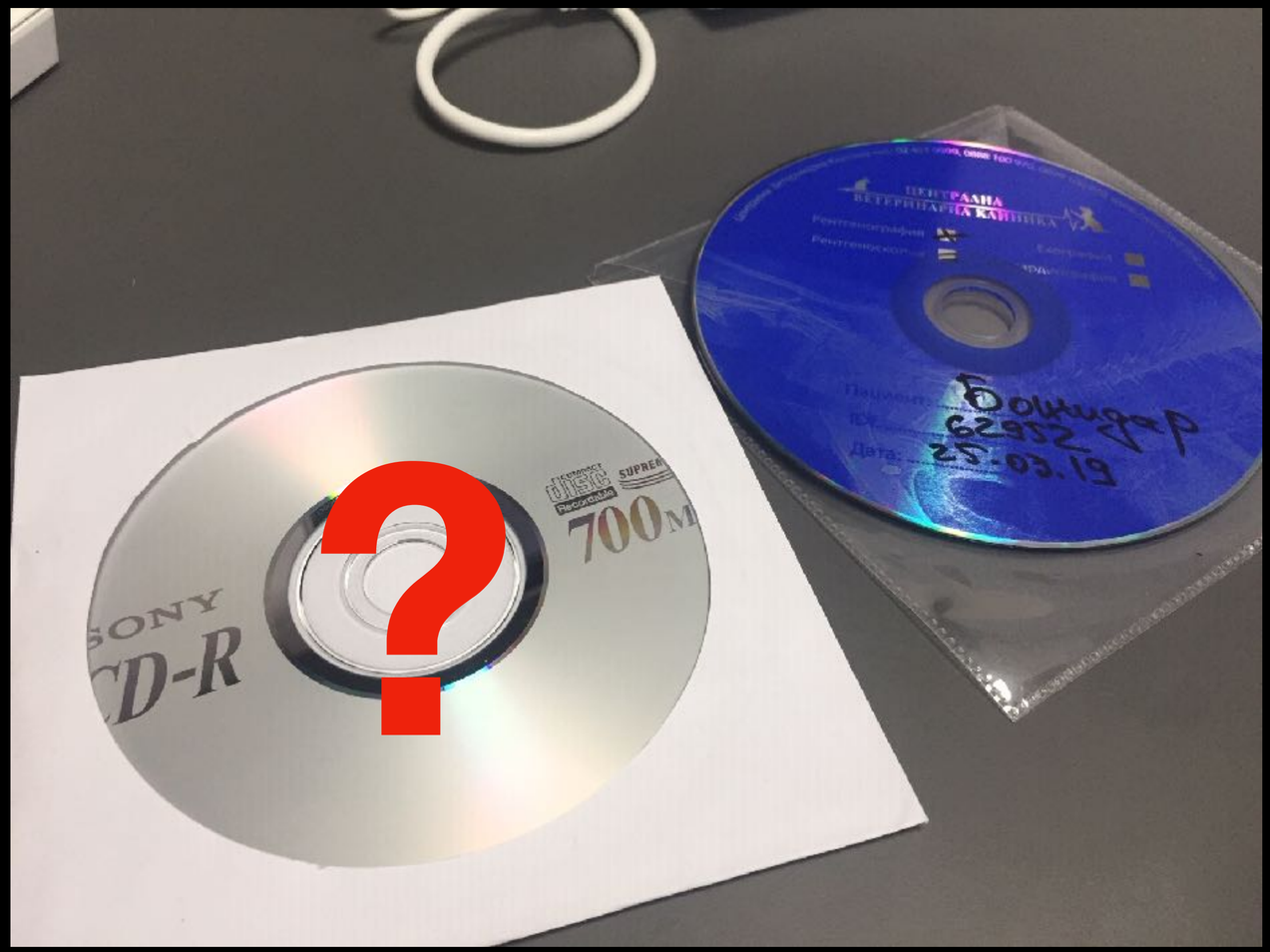


Right exposition



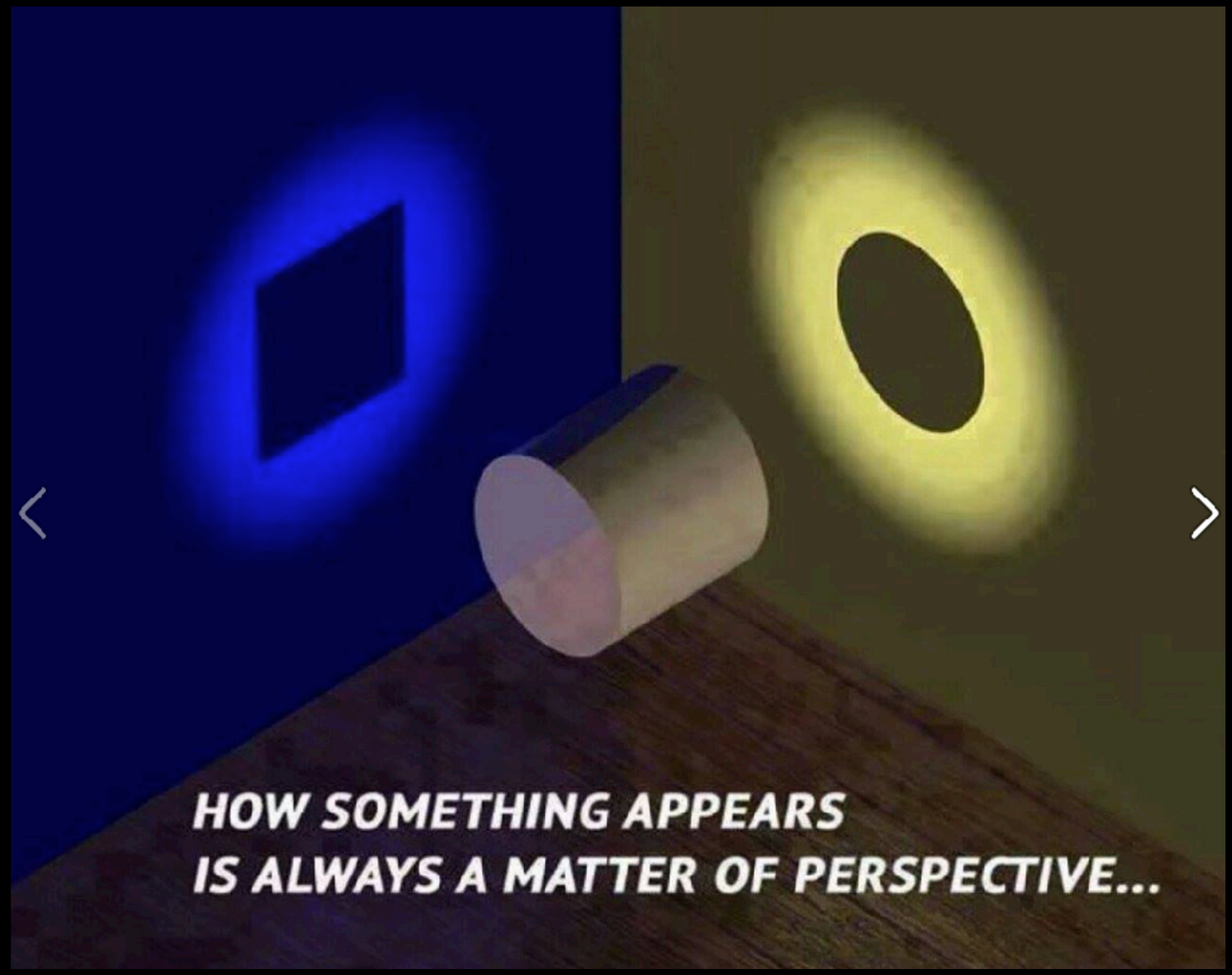
Thickness of patient (cm)	kVp	Abdomen/thorax/ proximal limbs (mAs)	Spine/pelvis (mAs)	Distal limbs/skull (mAs)	Grid required?
7	58	3.2	5	1.3	No
8	60	3.2	5	1.6	No
9	62	3.2	5	1.6	No
10	64	3.2	6.4	2.5	Yes
11	66	3.2	6.4		Yes
12	68	3.2	6.4		Yes

Right labeling



Orthogonal views

- ★ ORTHOPEDIC STANDARD!



Orthogonal views

★ ORTHOPEDIC STANDARD

Reducible?

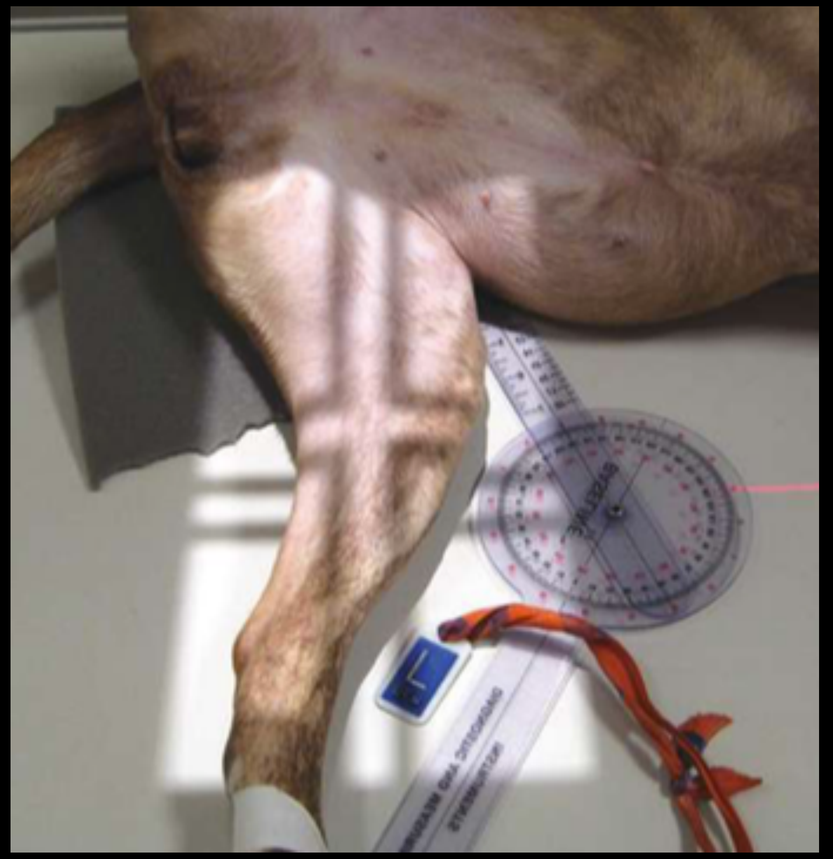
Orthogonal views

Points of view :)

Appropriate positioning

Several aspects:

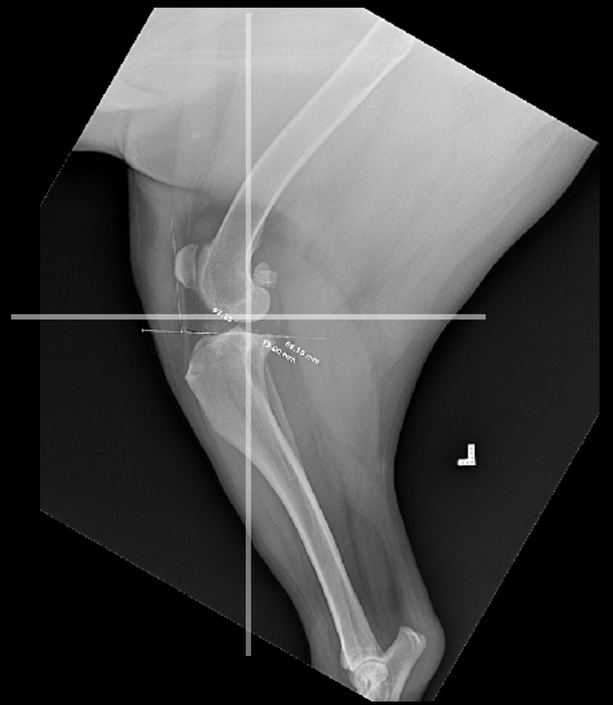
- Centering the object
- Collimation of the object
- Orientation of the object



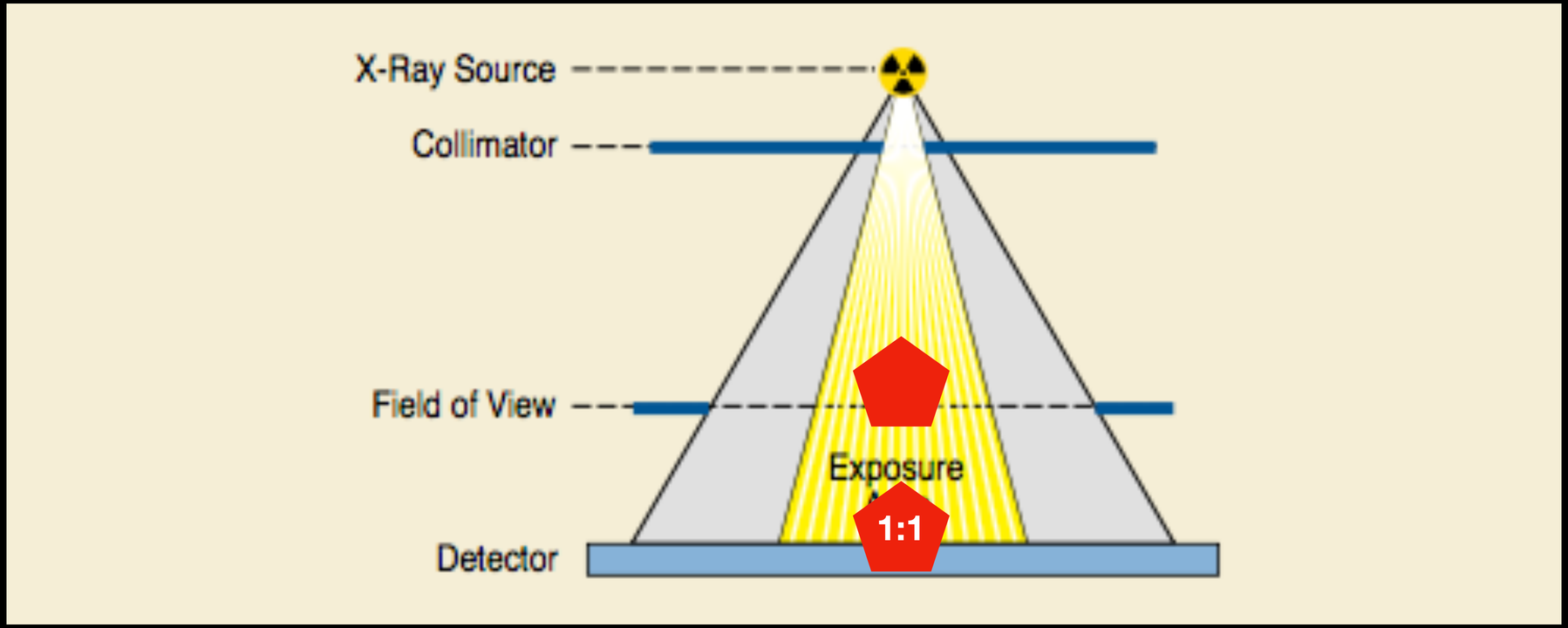
Centering the object

- Ro of a bone- collimation of the upper and lower joints

- Ro of a joint- collimation of the upper and lower bones



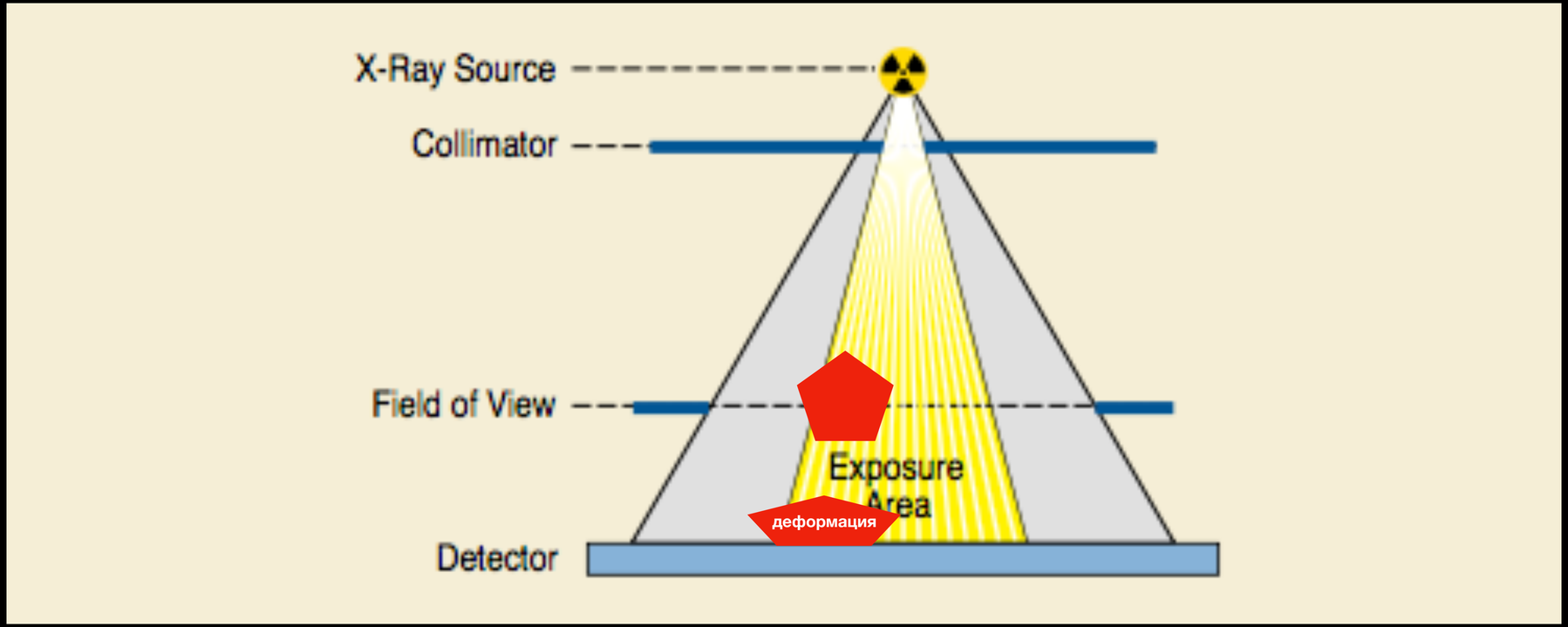
Centering the object



Centering the object

X- ray beam difusion:

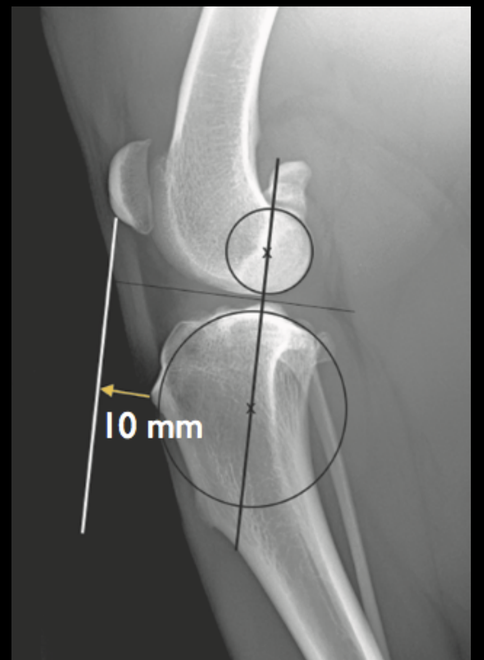
- ★ image deformation
- ★ less penetration=>not optimal exposure



Linear measurements

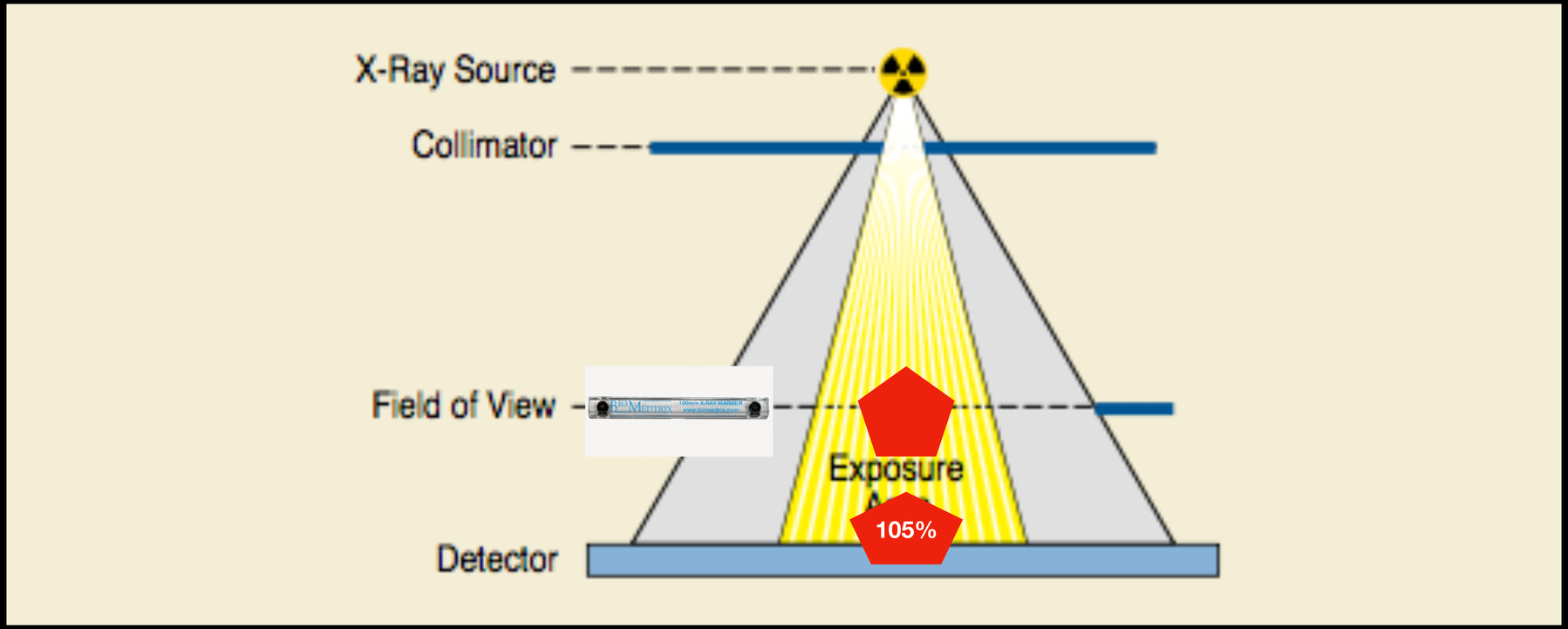
Linear measurements

- Folio “templating”
- THR, TTA, TPLO…



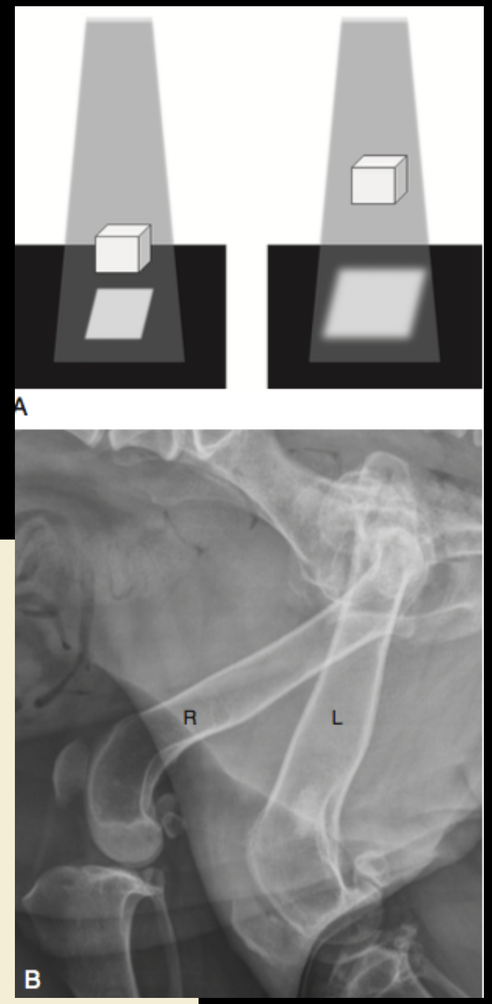
Linear measurements

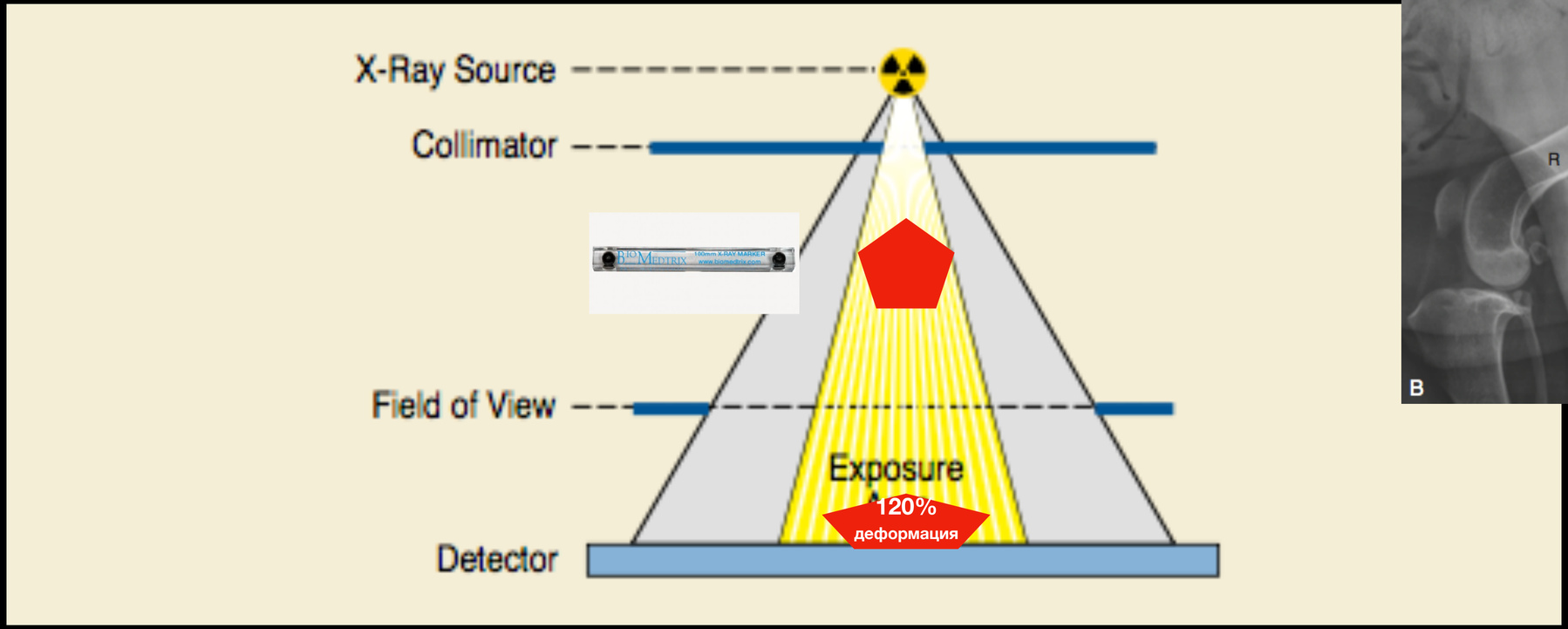
- Use of calibrators
- Magnification calculation



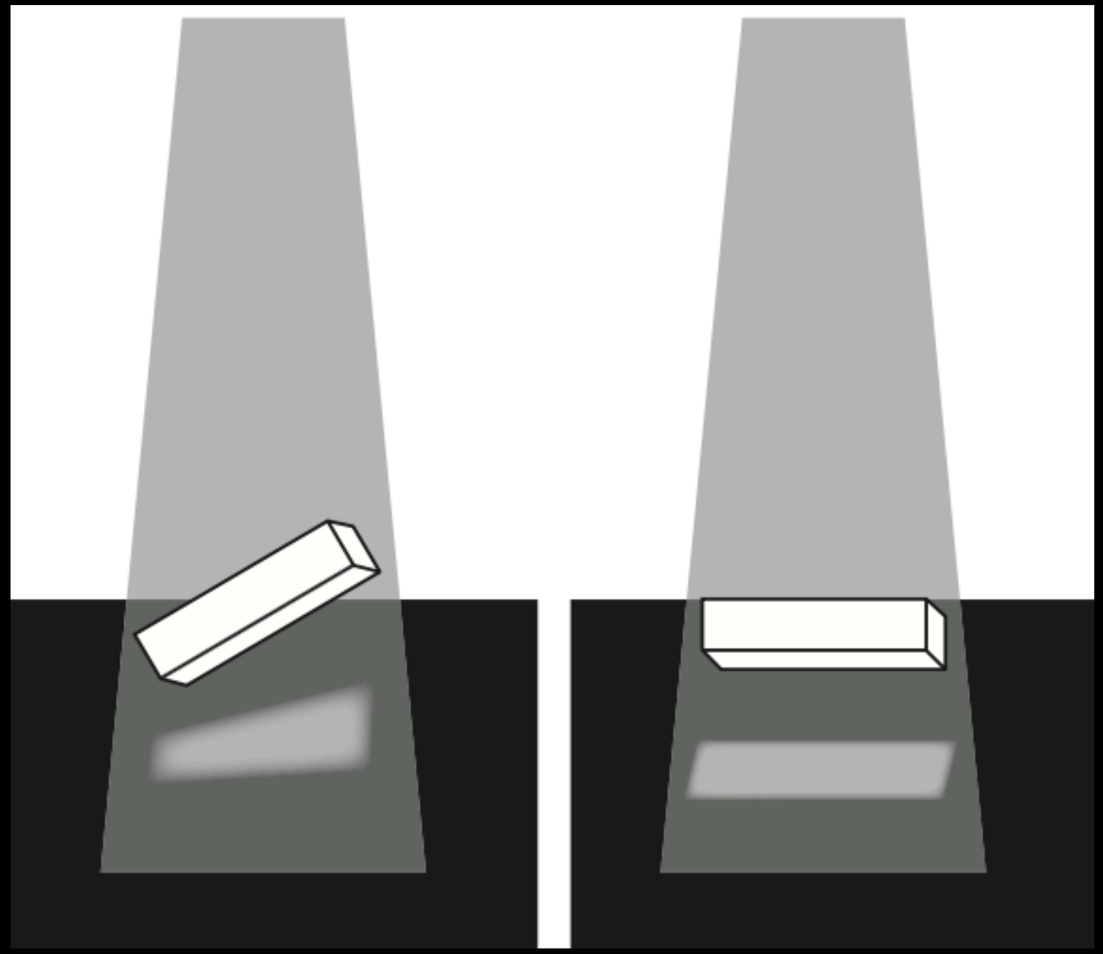
Linear measurements

- Magnification calculation



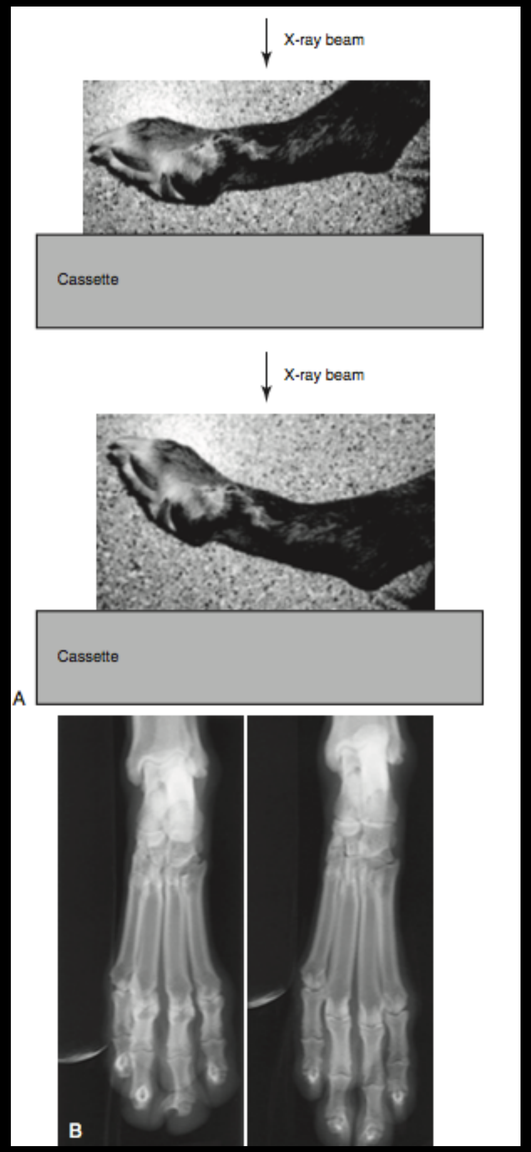


Object orientation/ Avoiding artifacts



Good centering, bad orientation

Good centering, good orientation

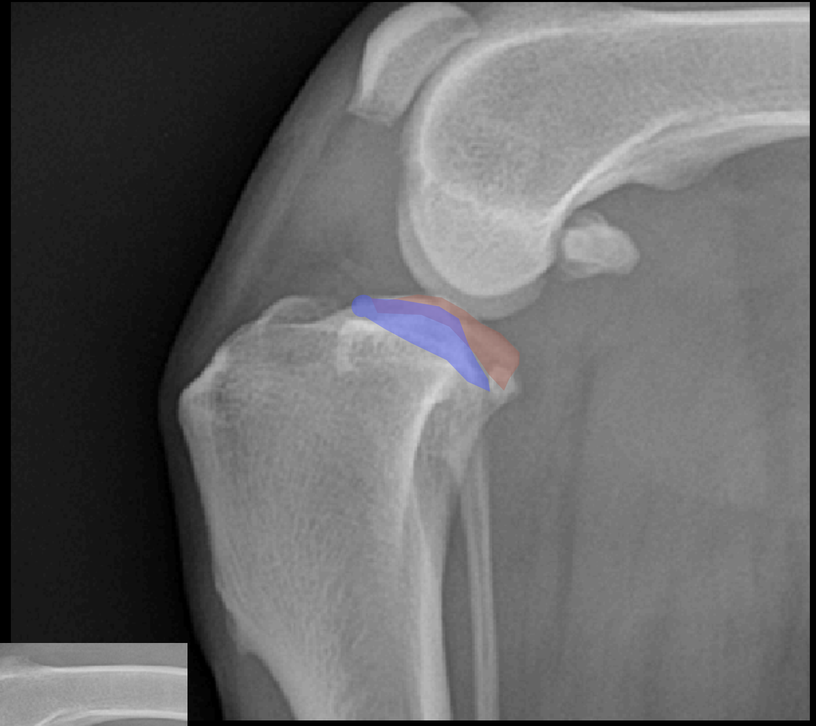


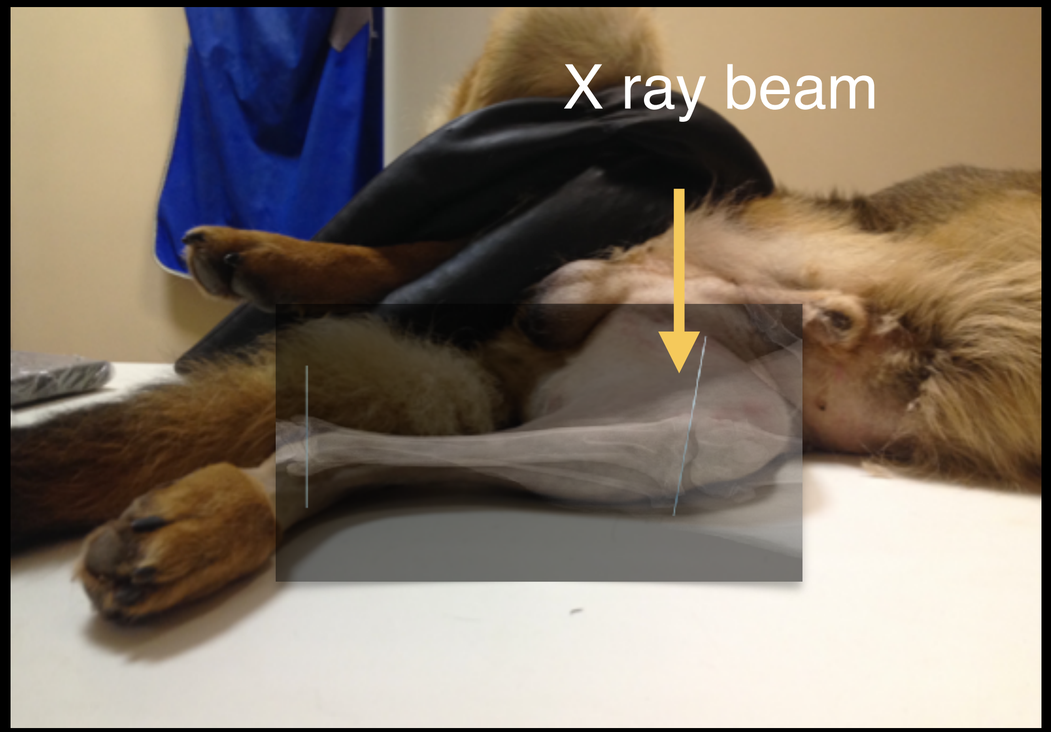
Watching the details

- Knowedge make the evaluator more critical to image quality

- Having a context may precise the study

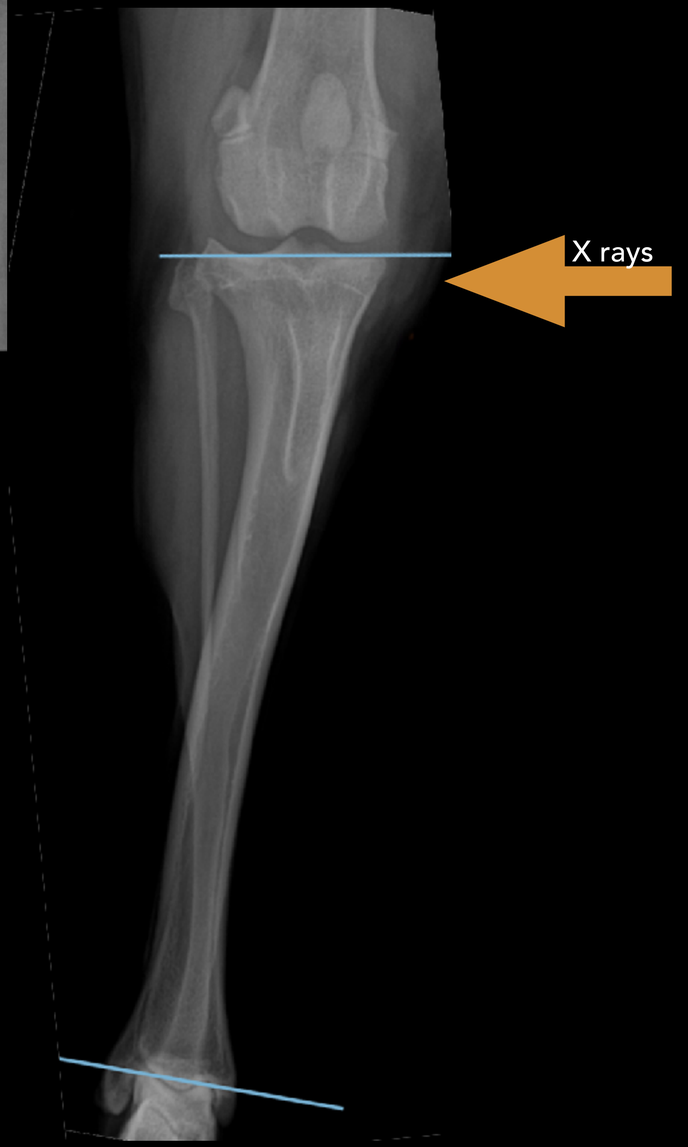
- Latarel stifle Ro,
- Cranial cruciate ligament rupture?

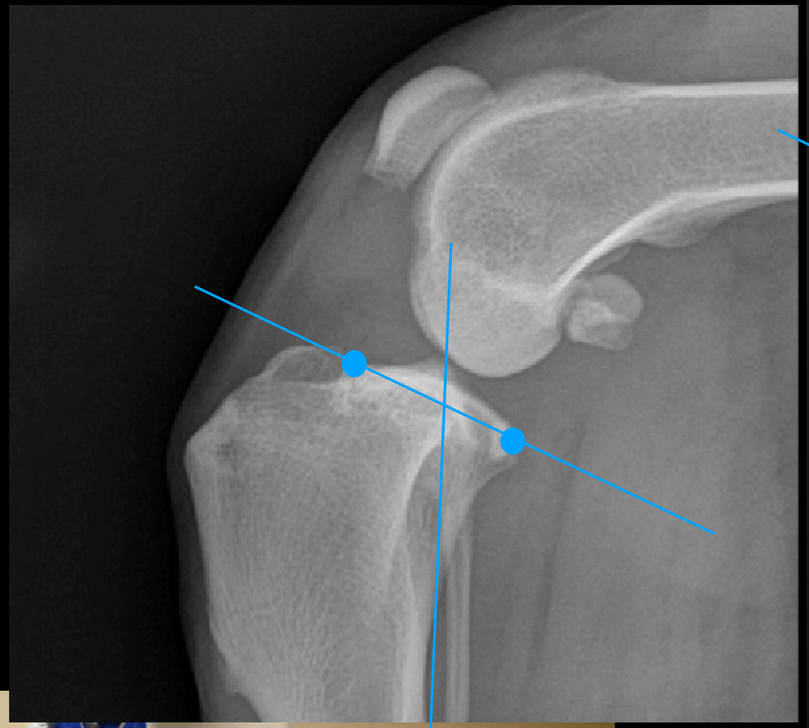


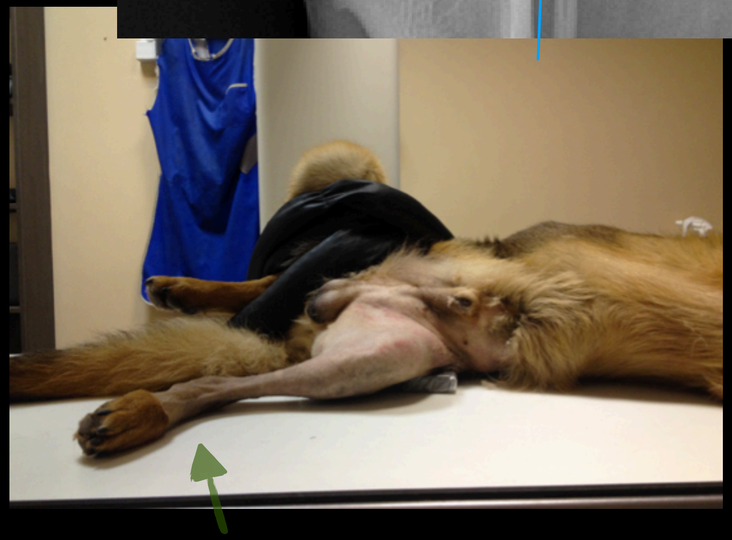

X ray beam

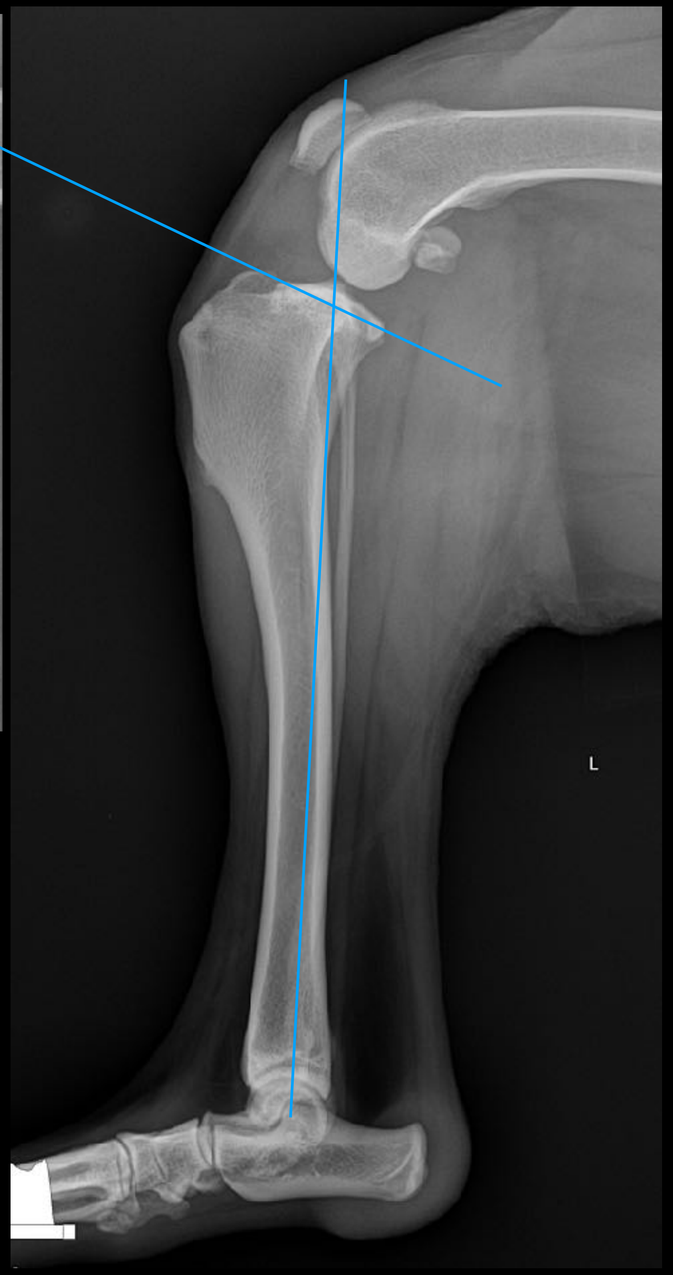

x ray


X ray beam


X rays



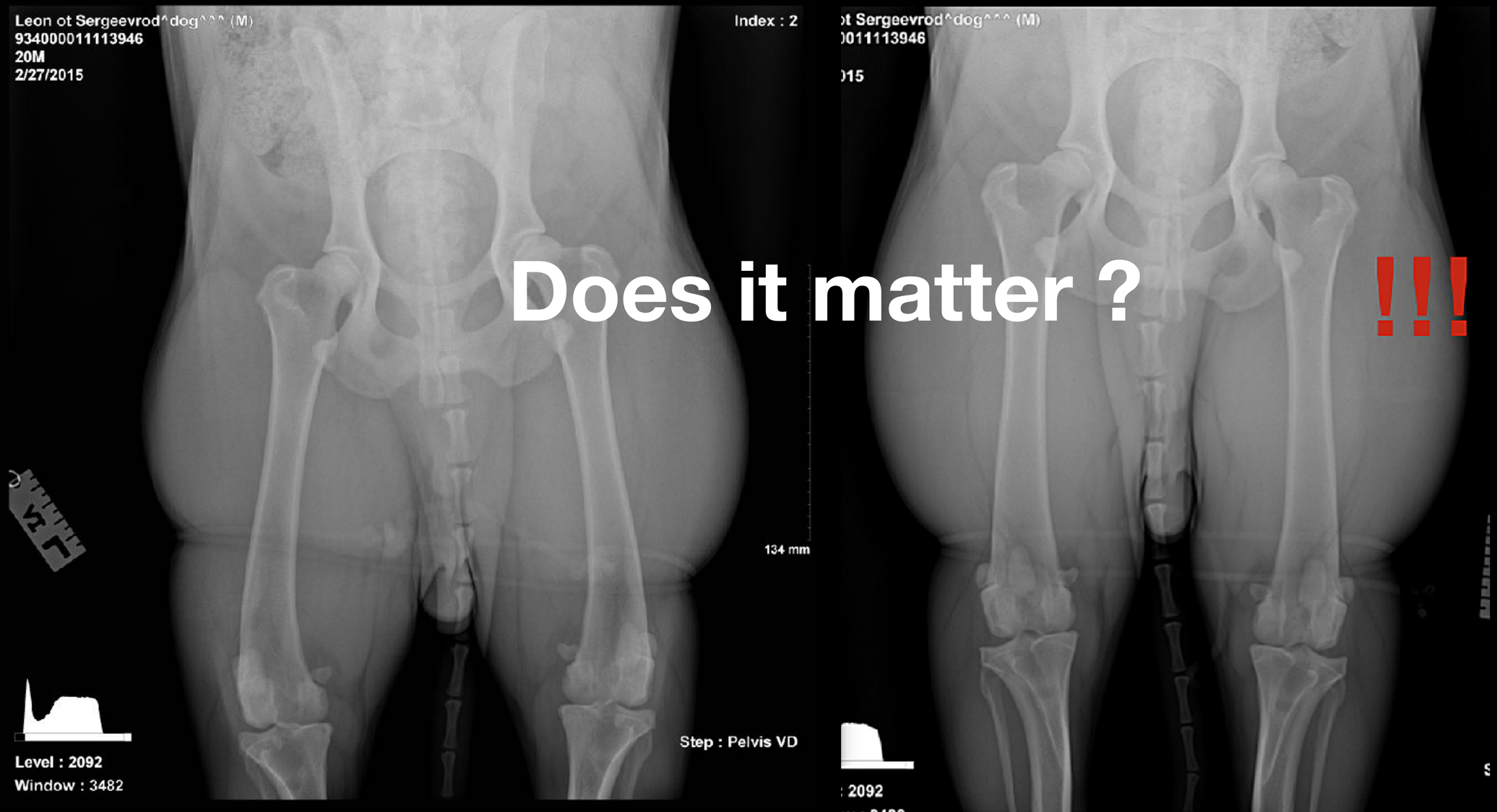



L

Extended VD view of the hips

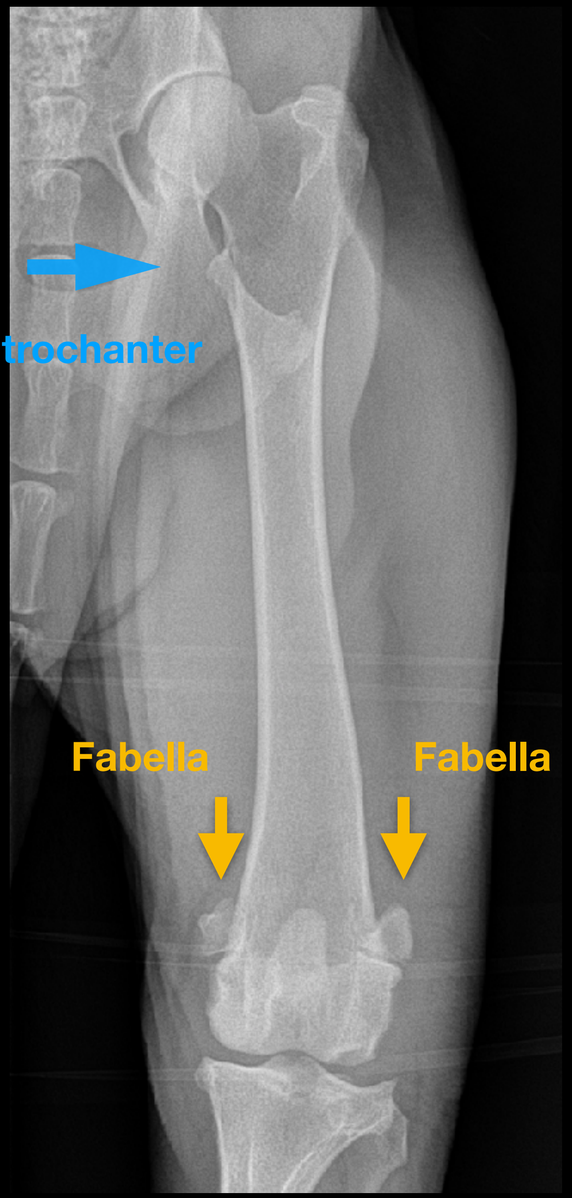
Extended VD view of the hips

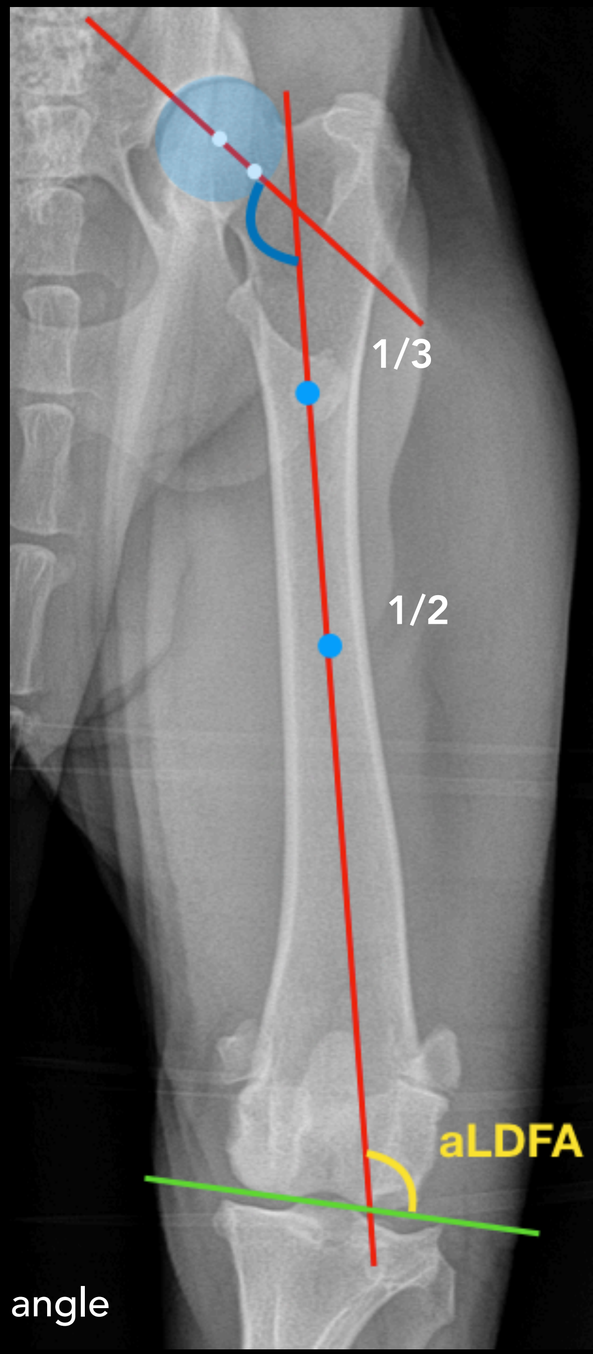
The same patient



Does it matter ? !!!

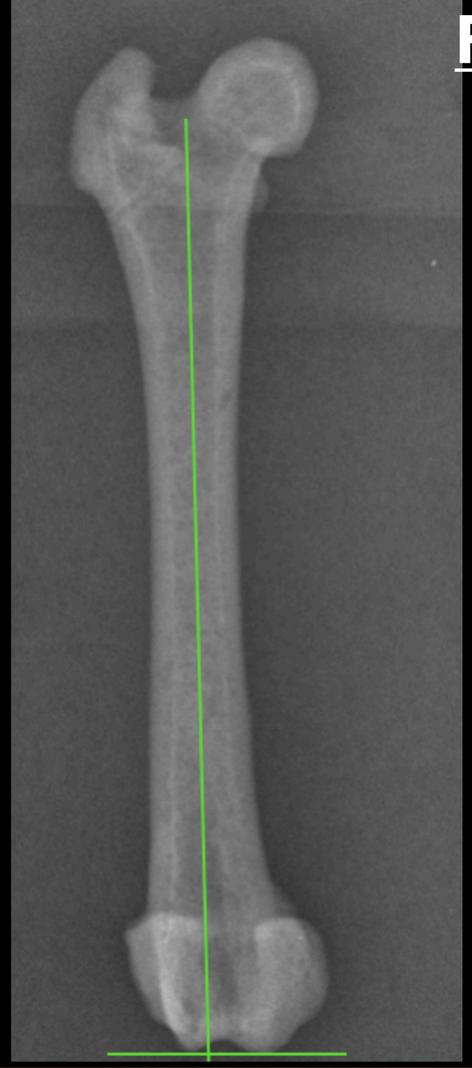
Femoral Anatomic Axis

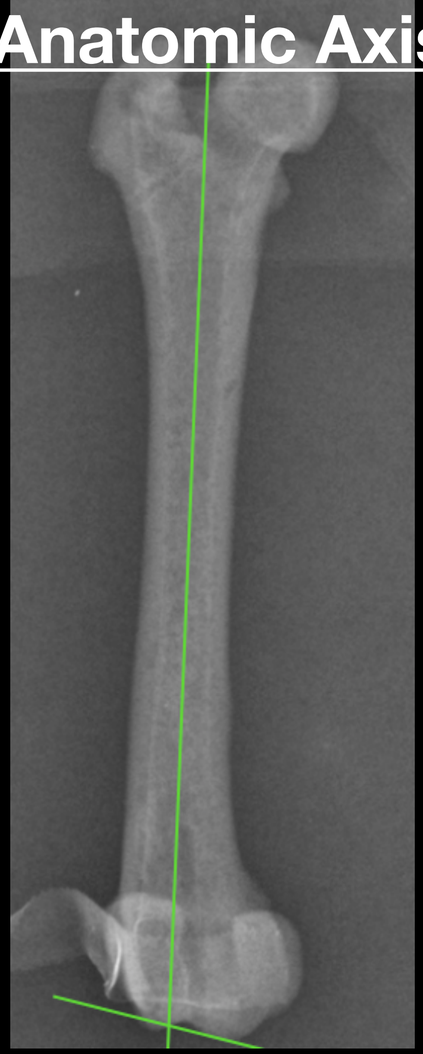


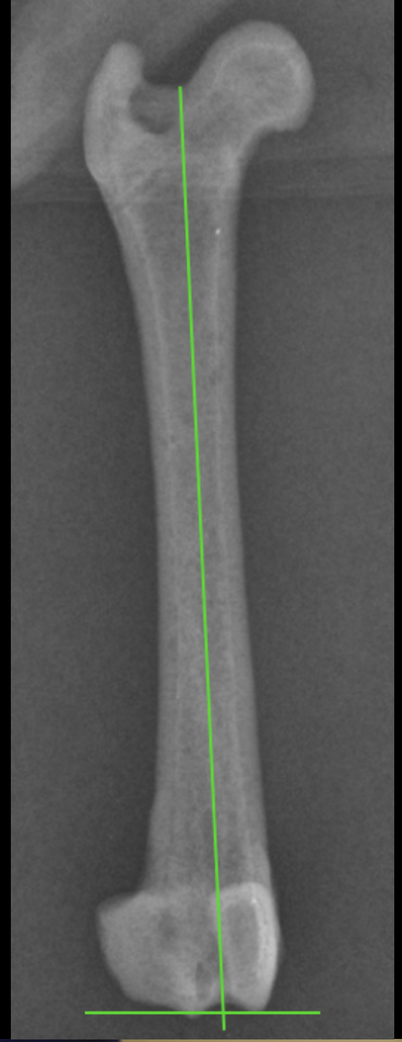


aLDFA- anatomical lateral distal femoral angle

Femoral Anatomic Axis

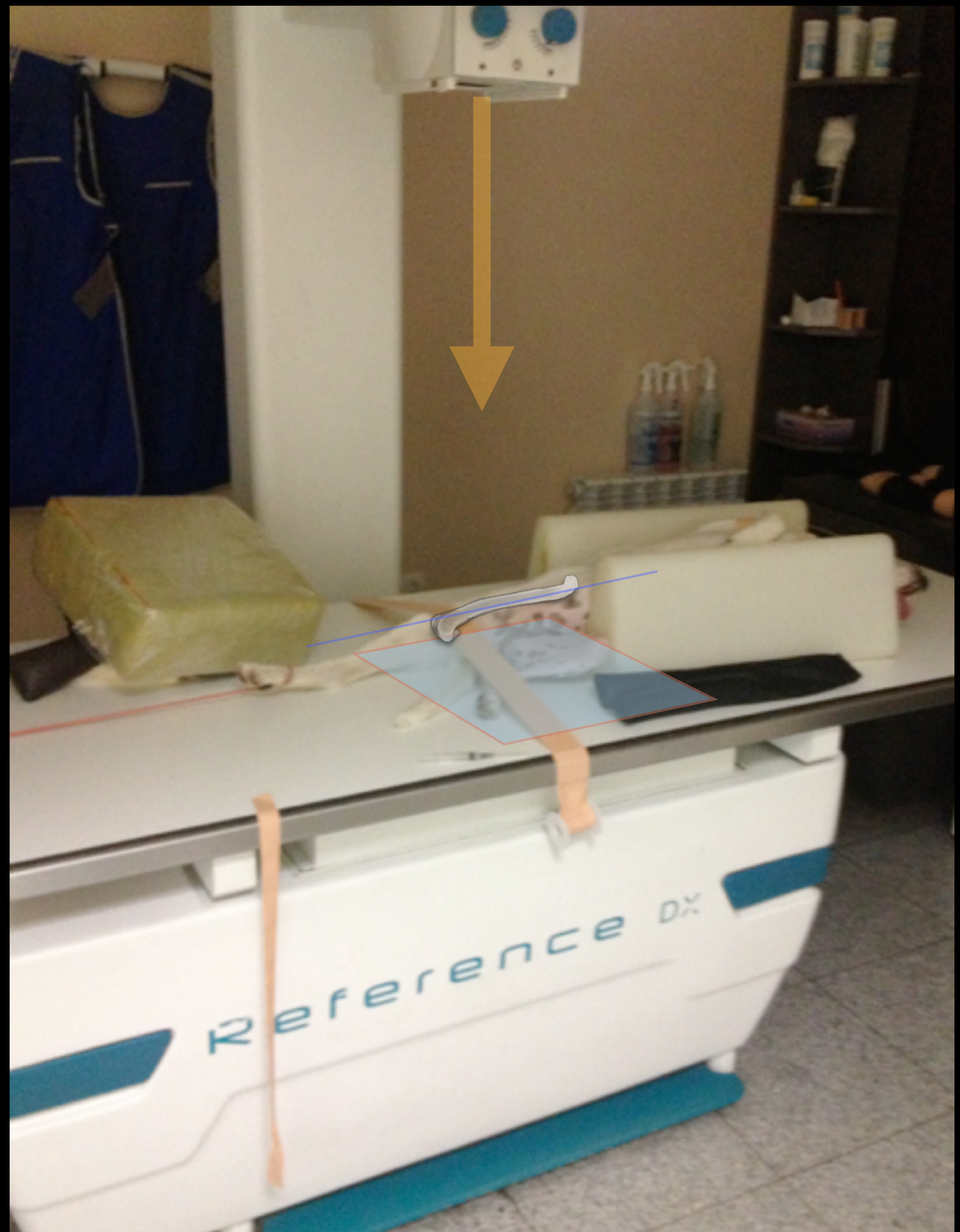






Femoral Anatomic Axis

Positioning technique



Positioning technique

- Difficulties in complex pathologies

Positioning technique

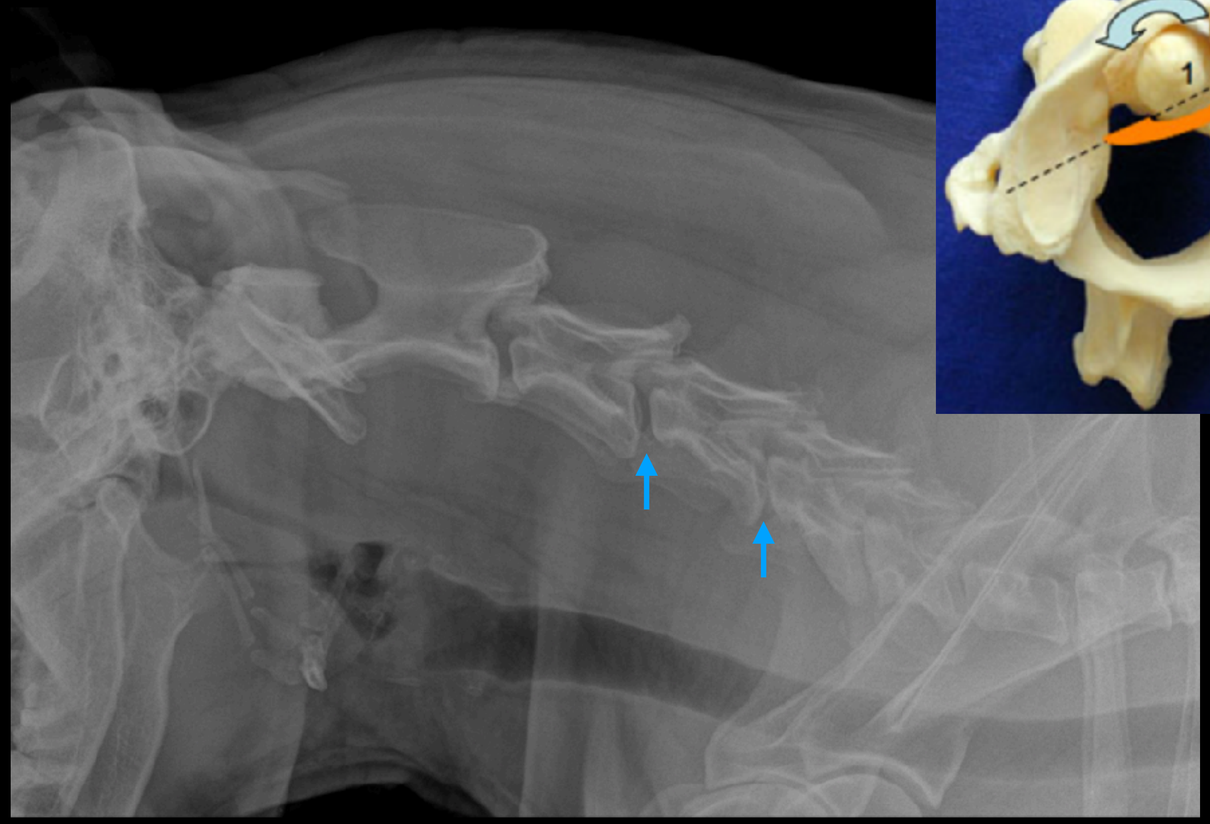
- Difficulties in complex pathologies

Spine

Sensitive in positioning

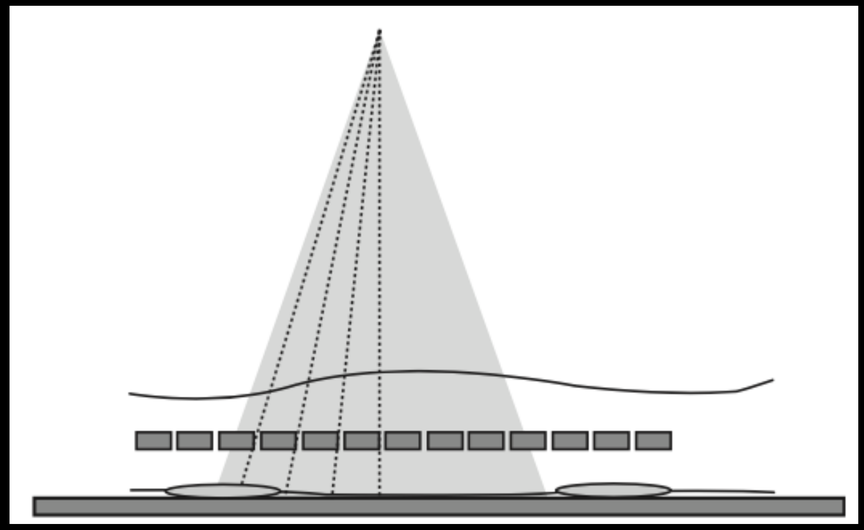
Spine

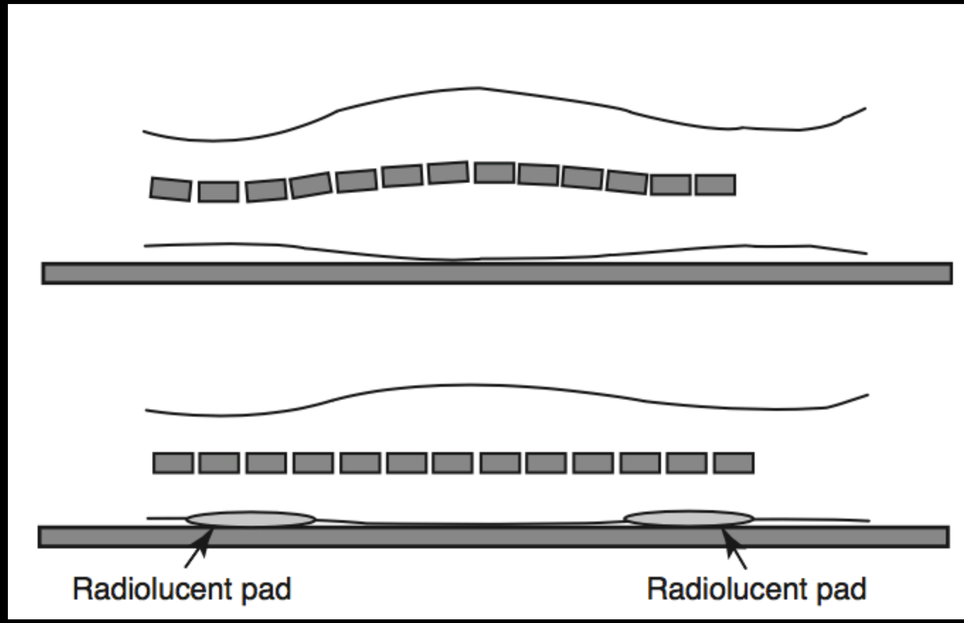
Sensitive in positioning



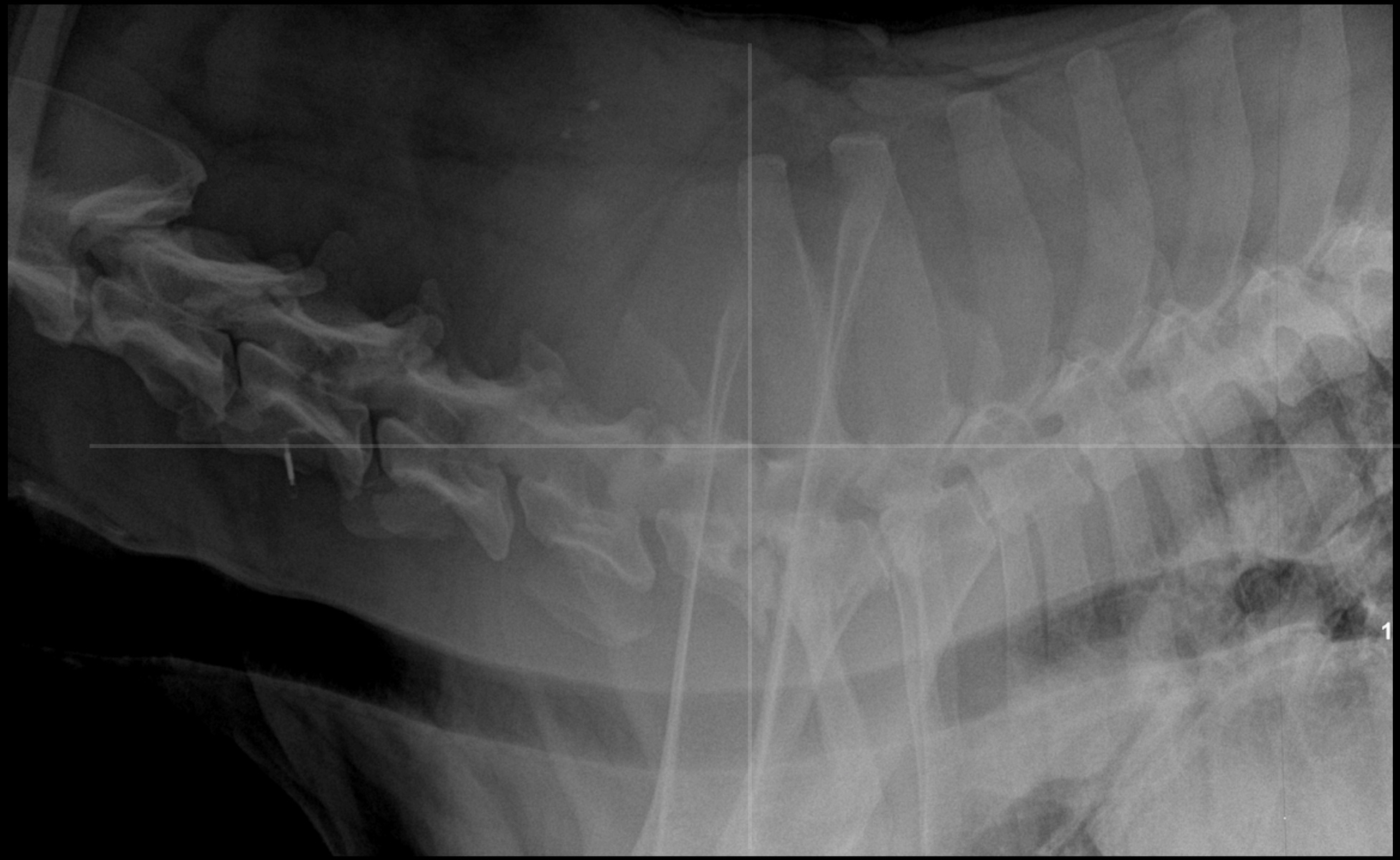
Spine

- Centering
- Anti-rotational pads
- Muscle relaxation- sedation





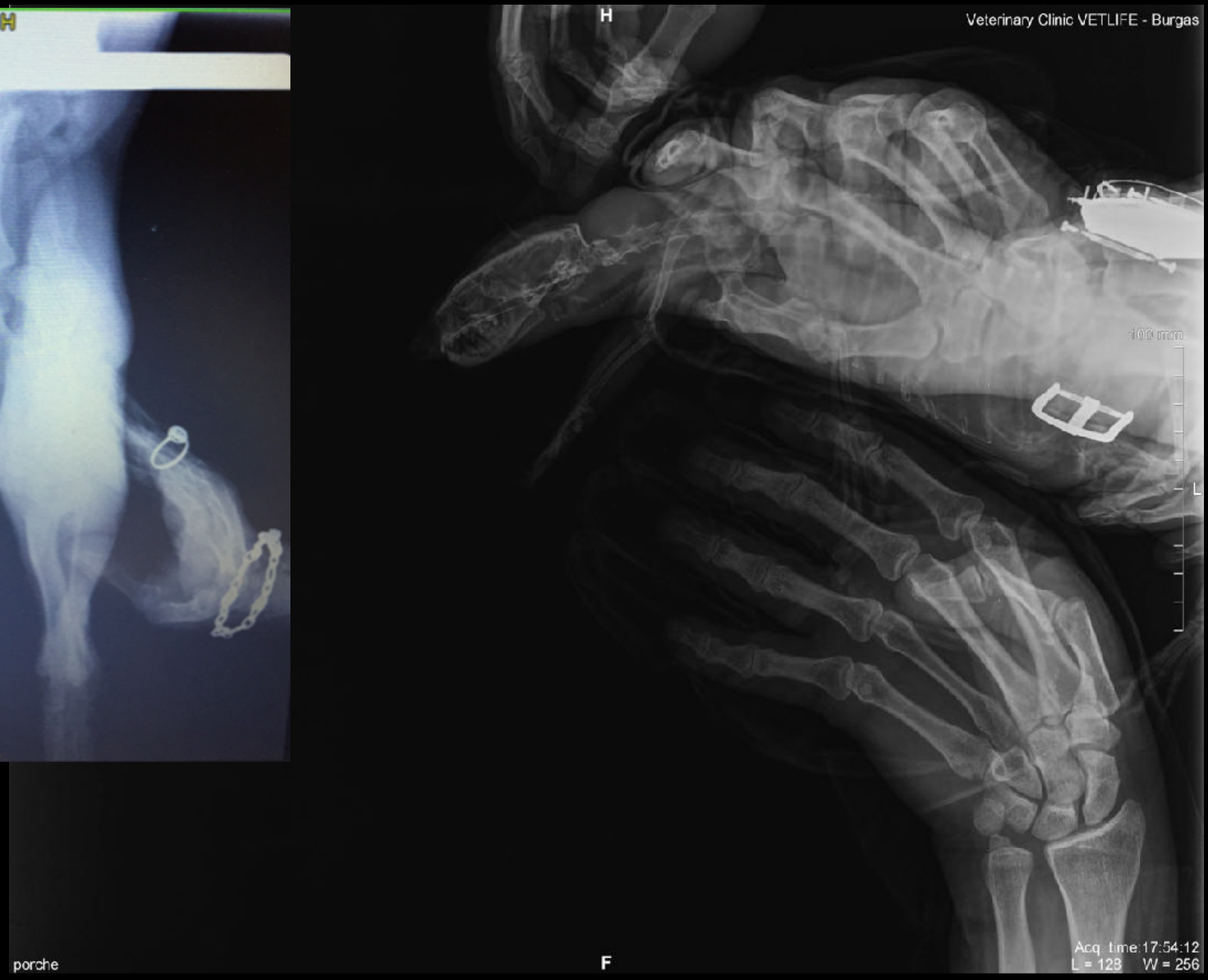

134 m



Acurate colimation / Safety

“WALK OF SHAME…..”

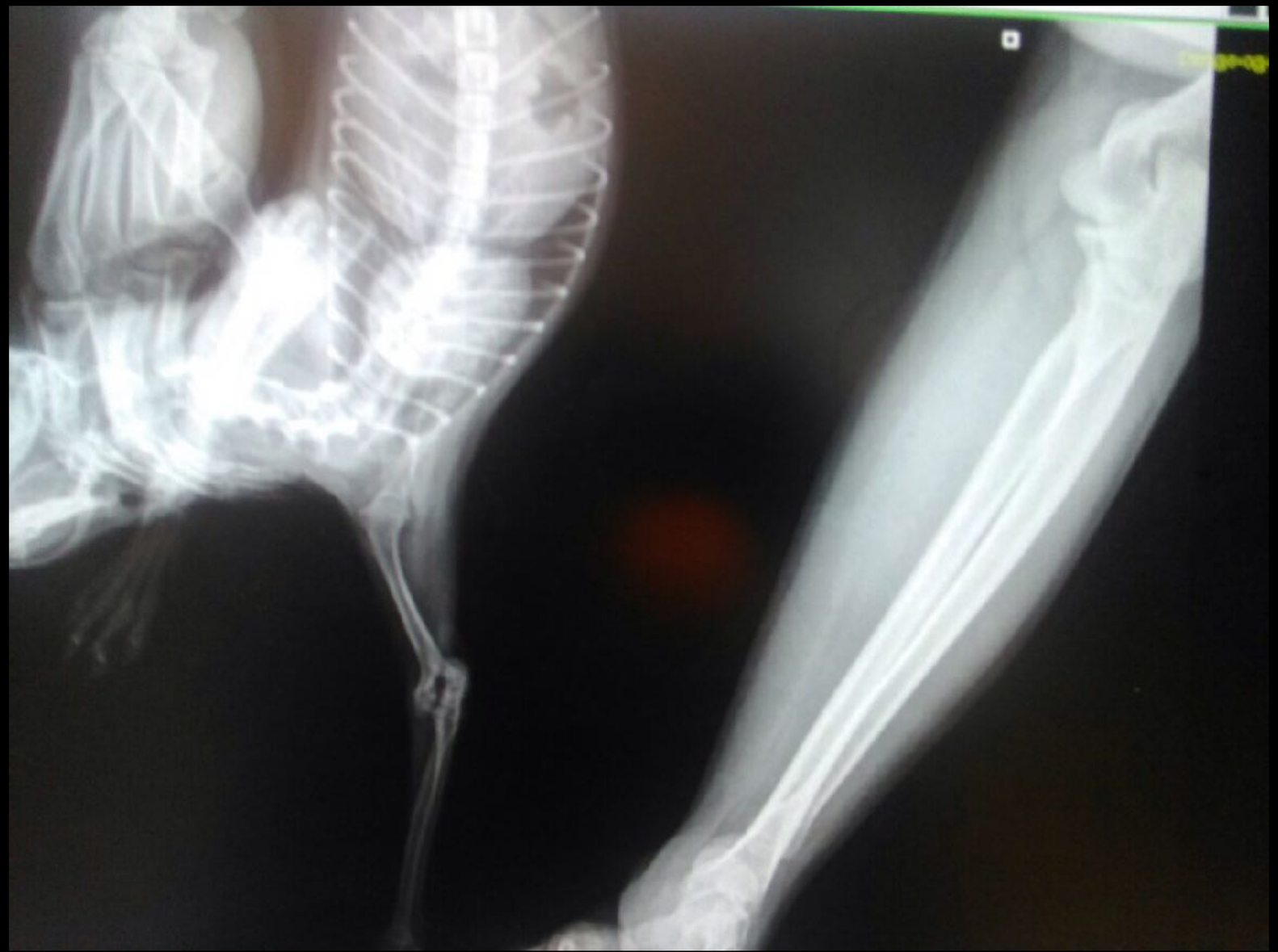
Acurate colimation / Safety



Acurate colimation / Safety

Acurate colimation / Safety

Acurate colimation / Safety



Acurate colimation / Safety

Unhealthy “SELFIE” mania

Radiation detection

Patient immobilisation

- Physical
- Chemical (sedation, anaesthesia)
- Combination

“Free hands technique”

vs

“Free hands technique”

Tool accessories- X- ray negative wedges, tubes, pads, sand bags.

“Free hands technique”

Advanatges:

- Low radiation exposition
- Better quality-no **subconcious** resistance to exposition repetition.
- Fixed position-> **referral starting point** for correction.
- Allows **passive** stress views.

“Free hands technique”

Disadvanatges:

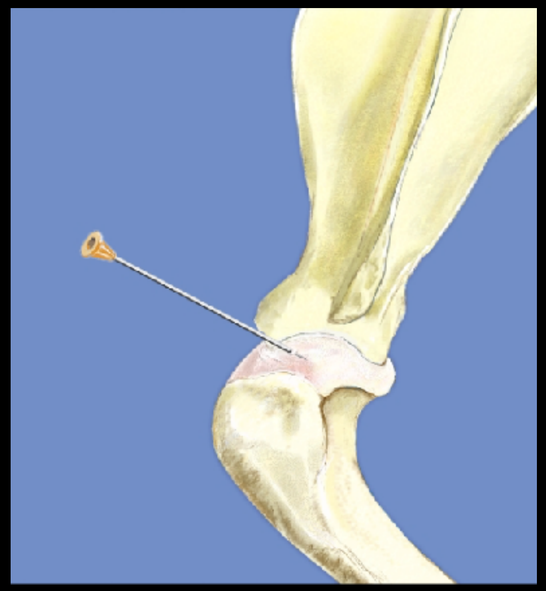
- Takes time- **relative!**
- Learning curve.
- Demands patience and careful manipulation.

“Free hands technique”

https://www.youtube.com/watch?v=glFlEbKKAho

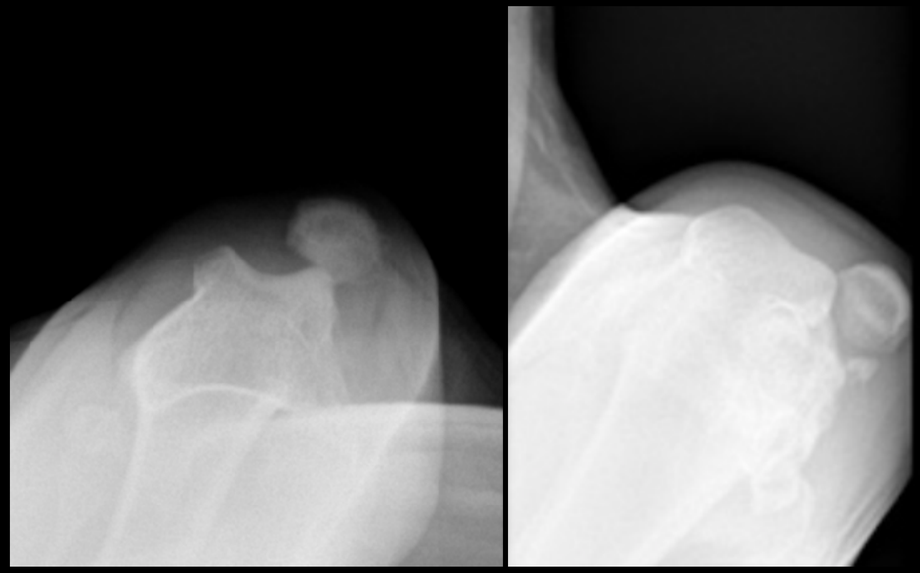
Special methods

- Special views
- Stress views
- Ro + contrast



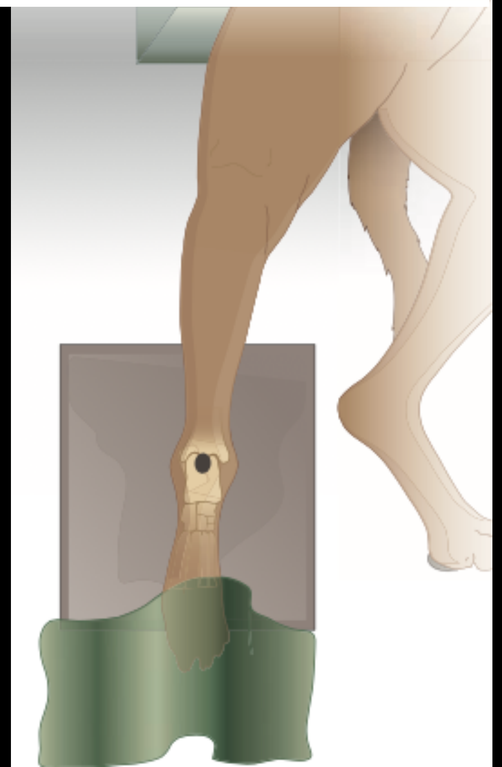
“Sky line view”

- Stiffle trochlea
- Talus, hock joint
- Intertubercular sulcus

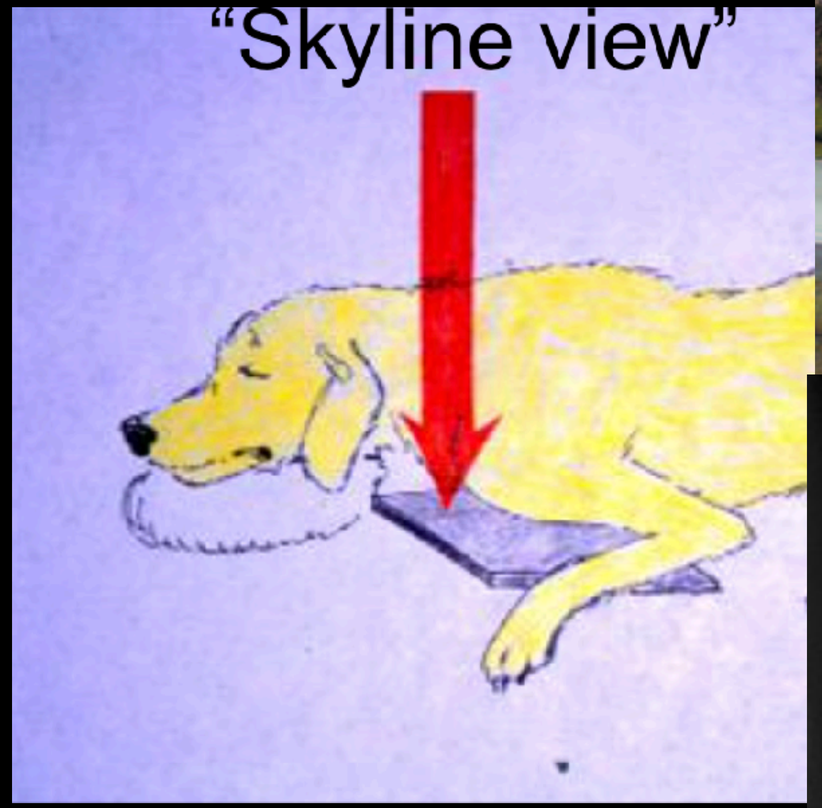


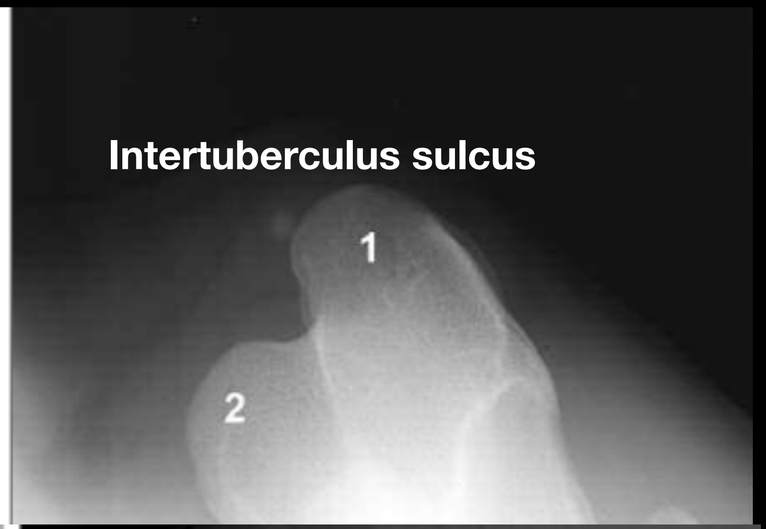
"Sky line view"

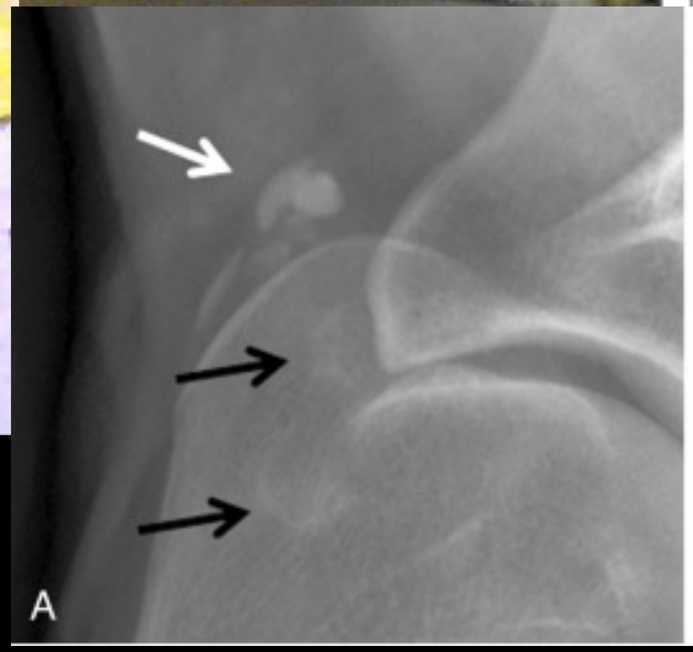
- Talus, hock joint

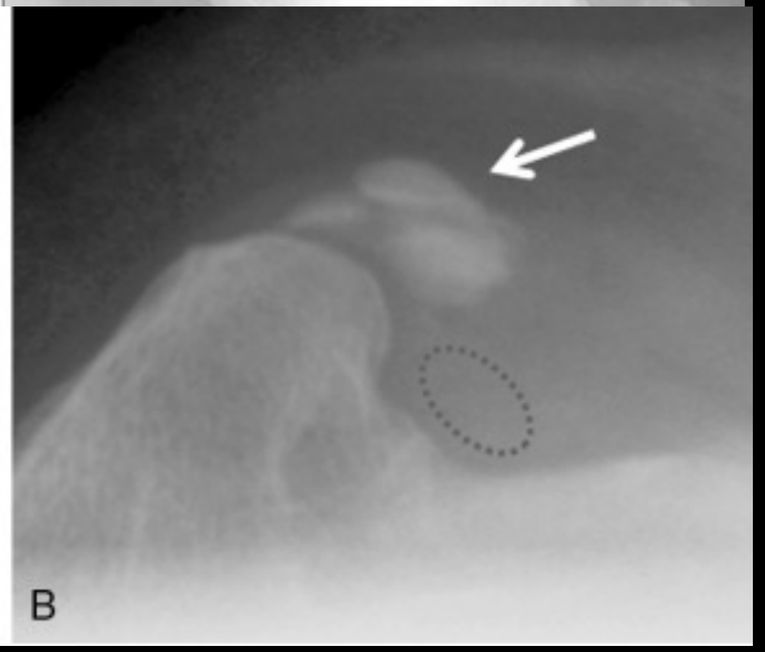


“Sky line view”

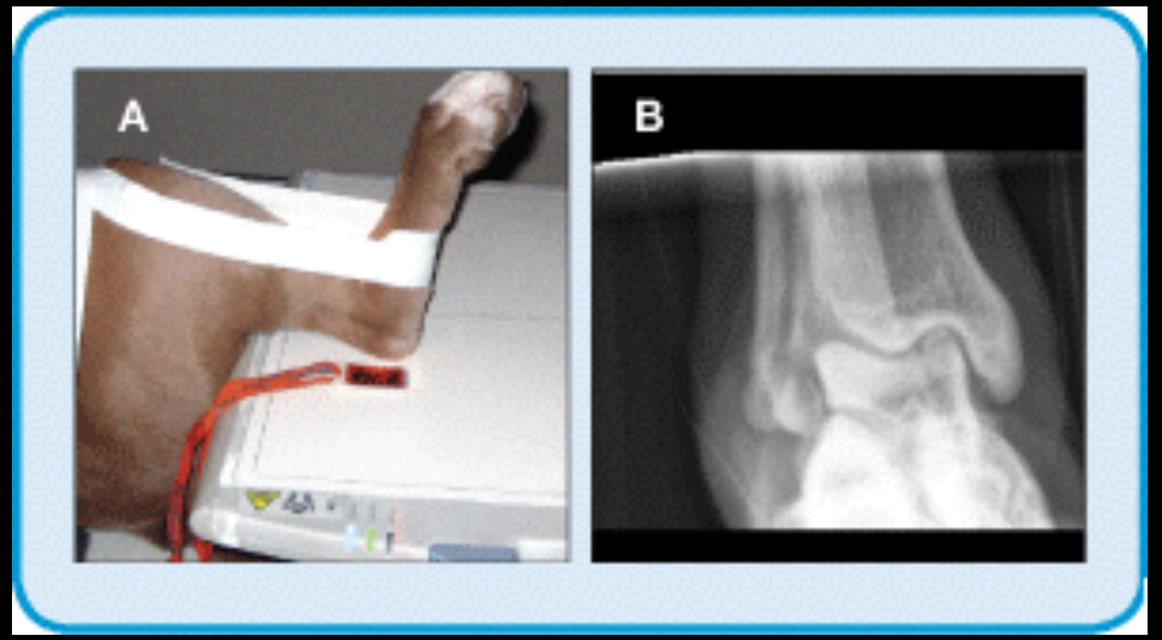


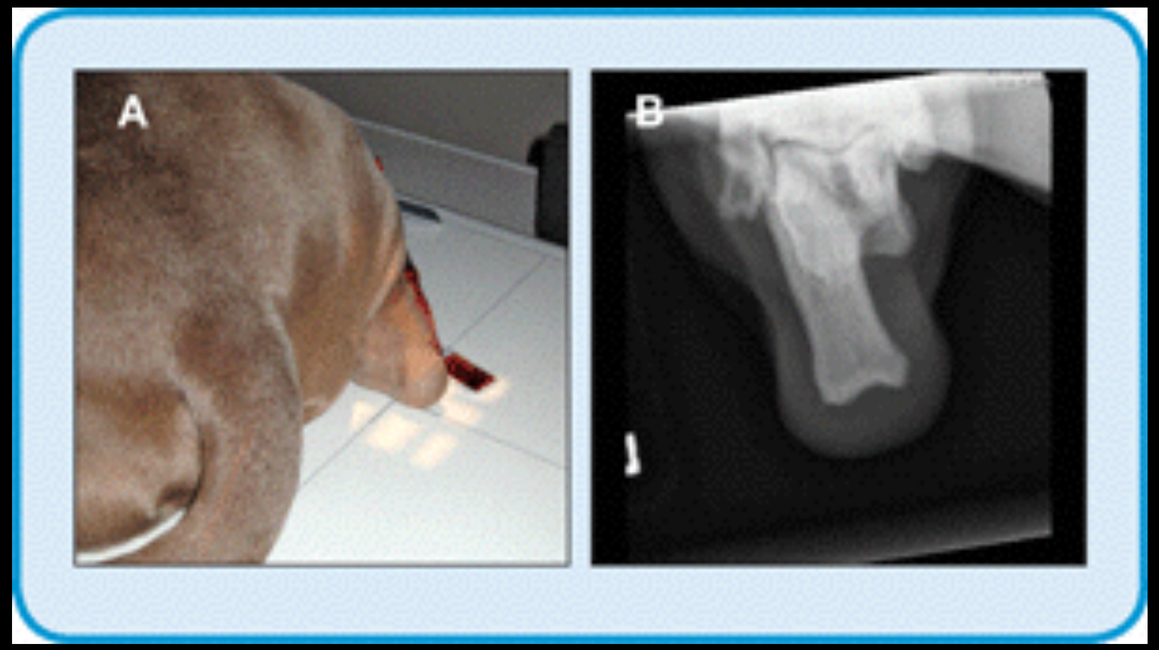




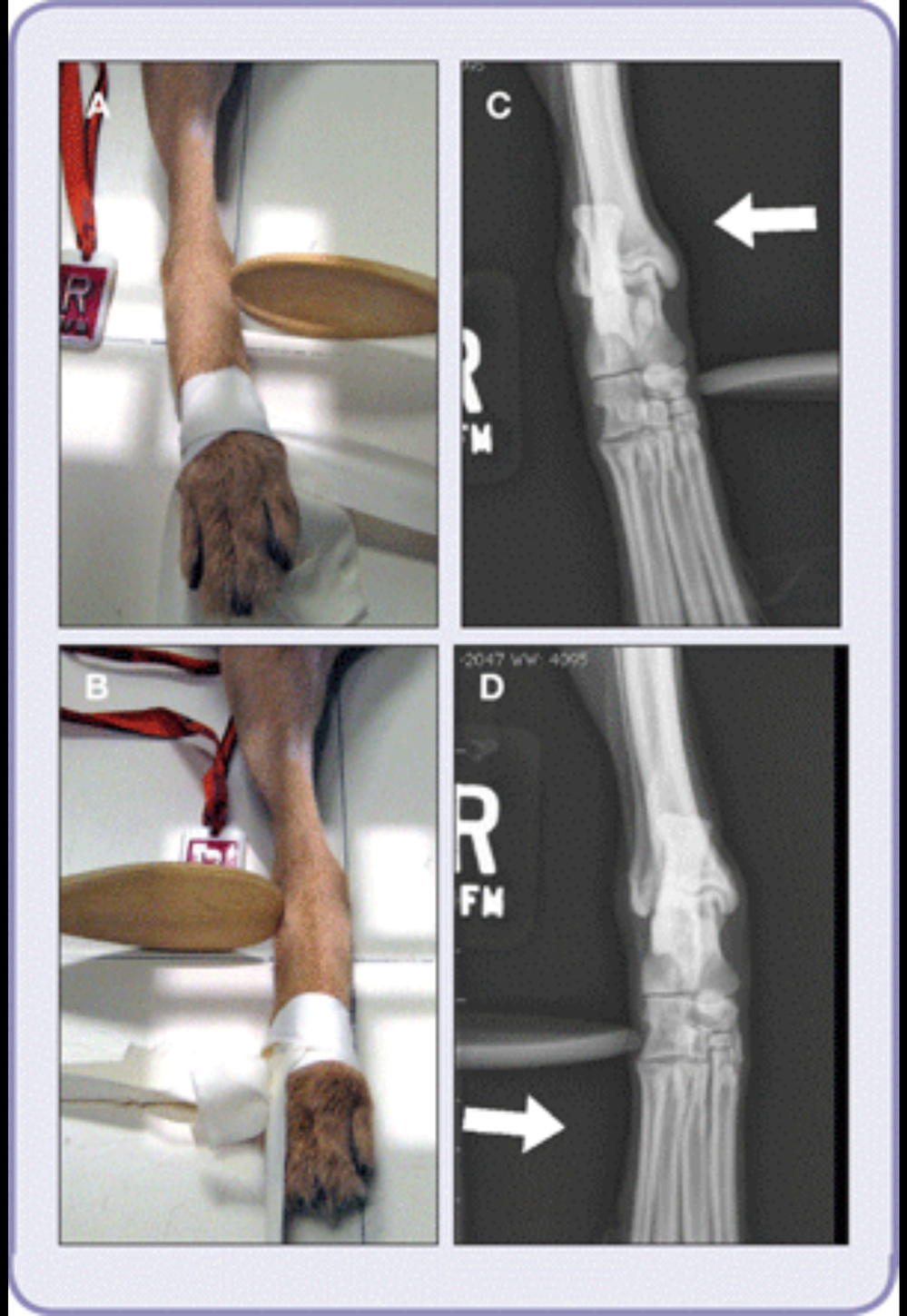


“Sky line view”

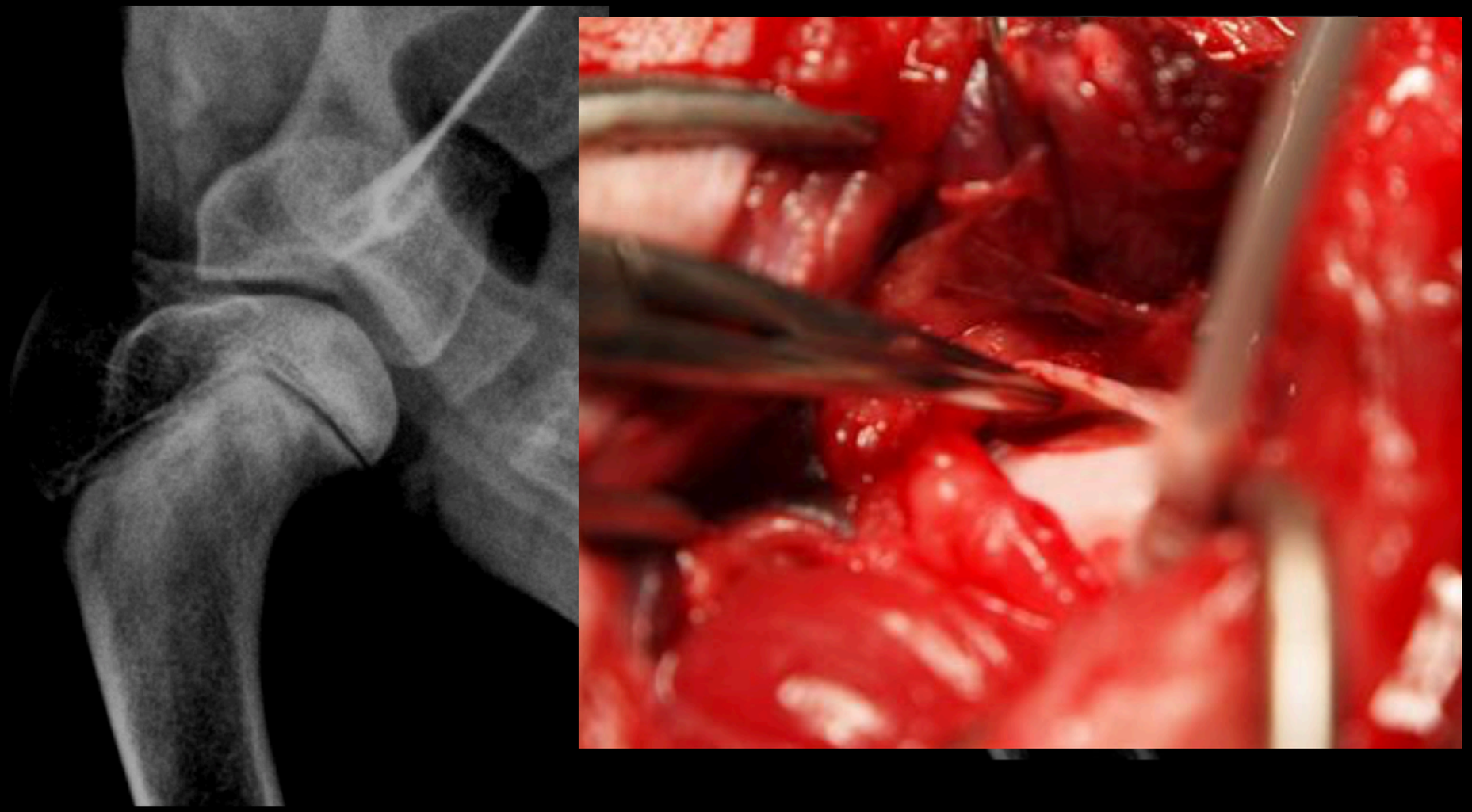




Stress views



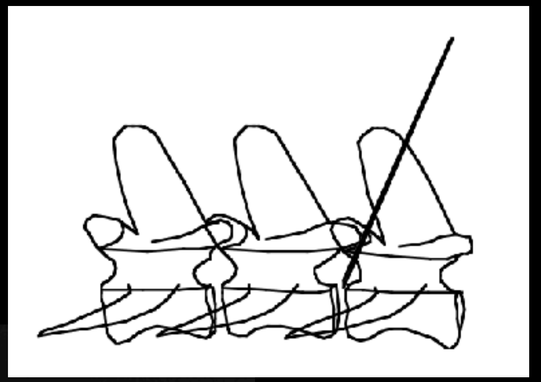
Contrast arthrography

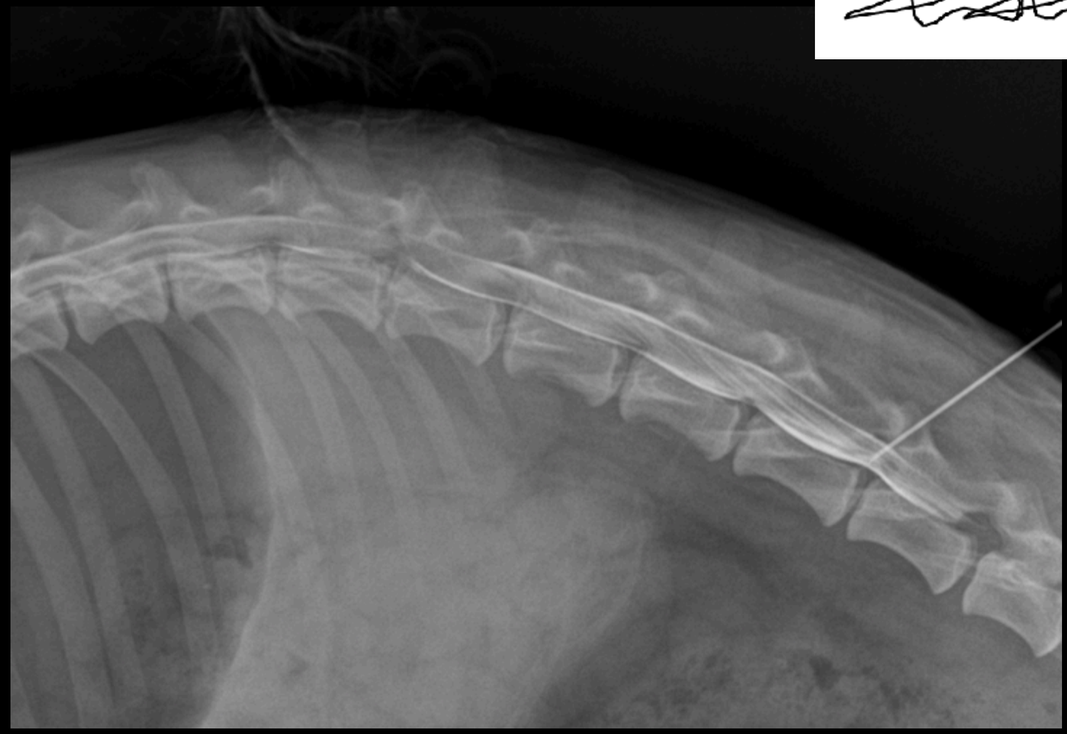


Myelogram

Myelogram

- Enhance spinal compression visualisation.
- Contrast subaharchnoidal
- 86-97% accuracy





Myelogram

Disadvanatges

- Bad contrats filling:

-diffuse edema, great distance

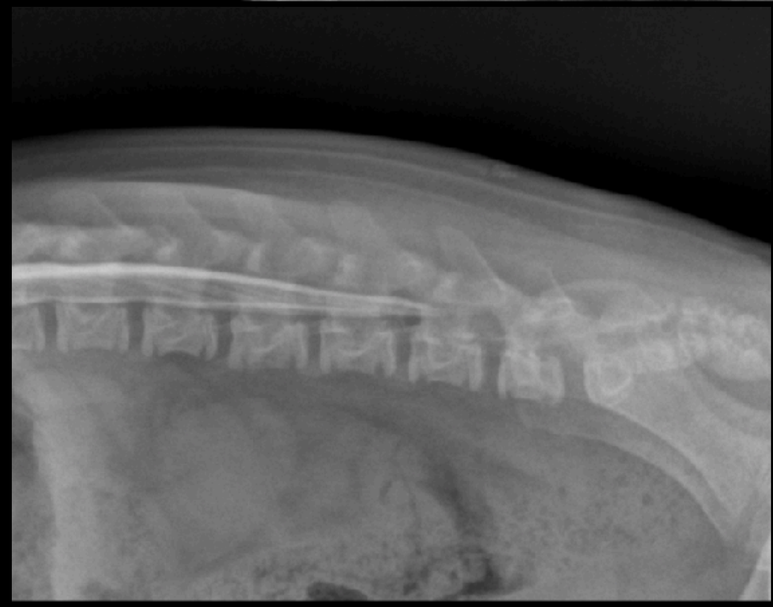
-Cervical injection

- Inappropriate method for L-S Space:

-The dural sack ends before L-S

-large dogs-L6

-Small dogs, cats- L7-S1



Myelogram

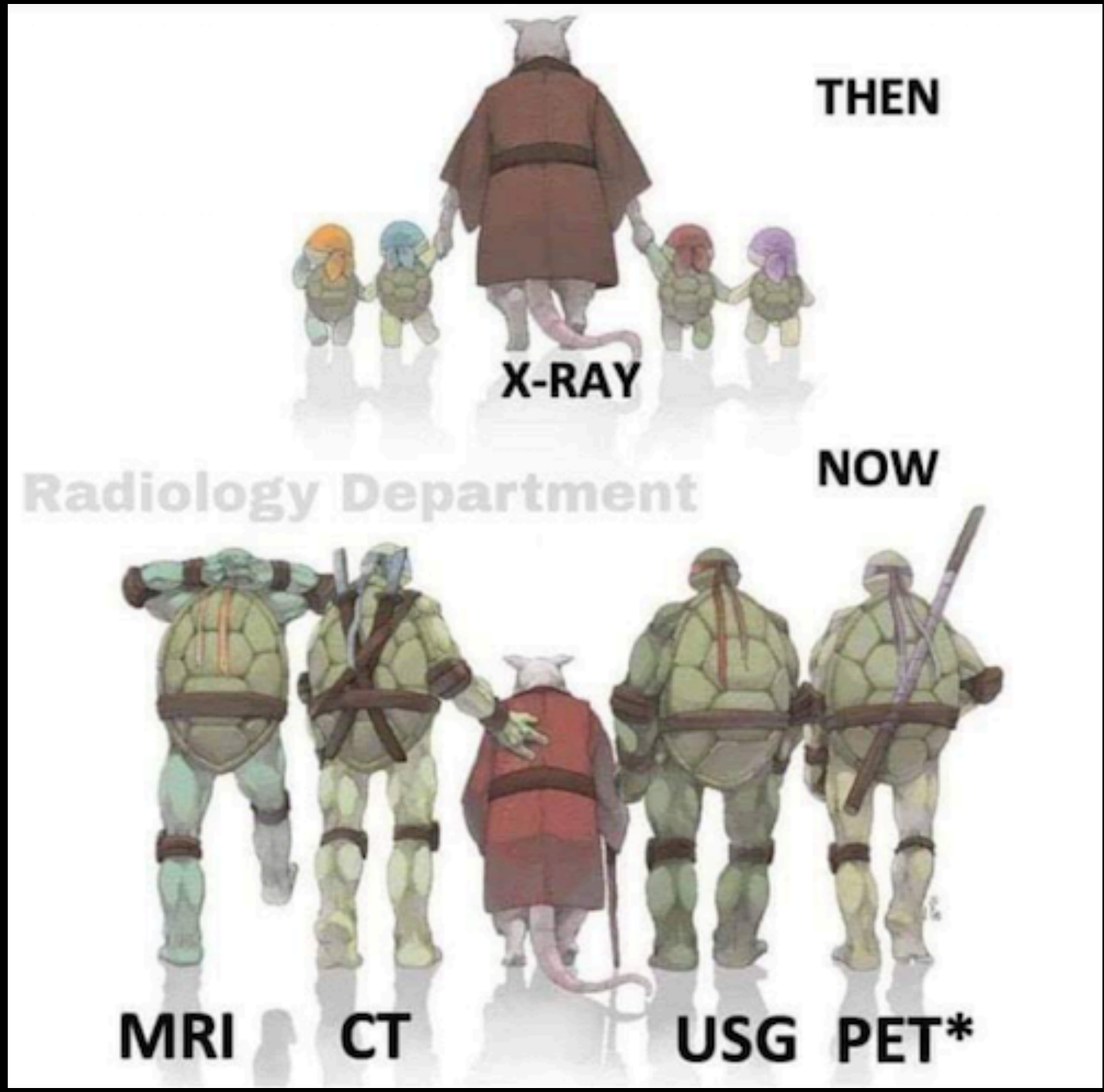
Disadvantages

- Invasivity
- Seizures

-large dogs, cervical.

- Neuro status deterioration
- Bad intramedular lesions visualisation

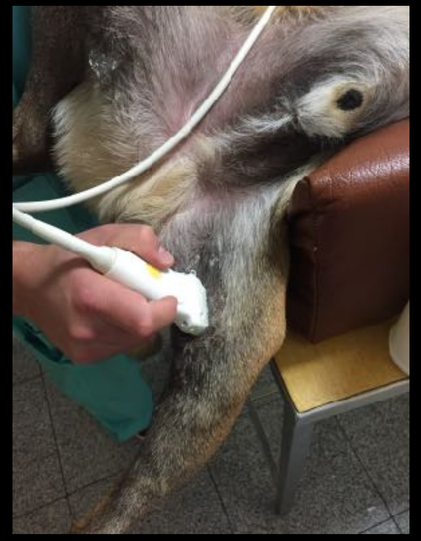
- Echographic study
- Computer tomography
- Magnetic Resonance study
- Scintiography
- Arthroscopy



Ultrasound

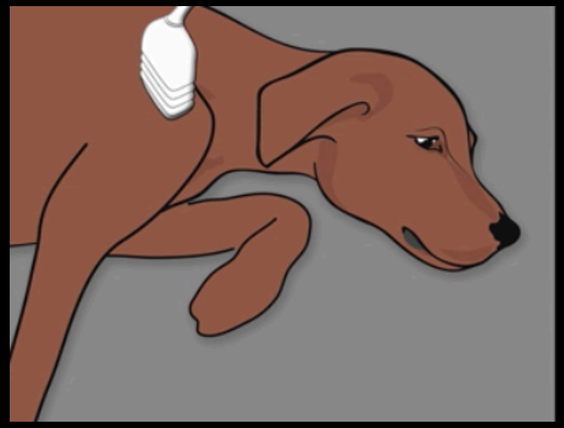
Ultrasound

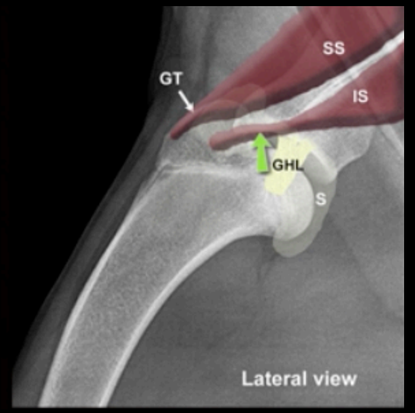
- Un popular (underestimated) method in orthopaedy.
- Bones- high acoustic impedance-> weak penetration.
- Mainly for study of muscles and tendons
- Potential for study of - menisci, intervertebral discs, CNS.

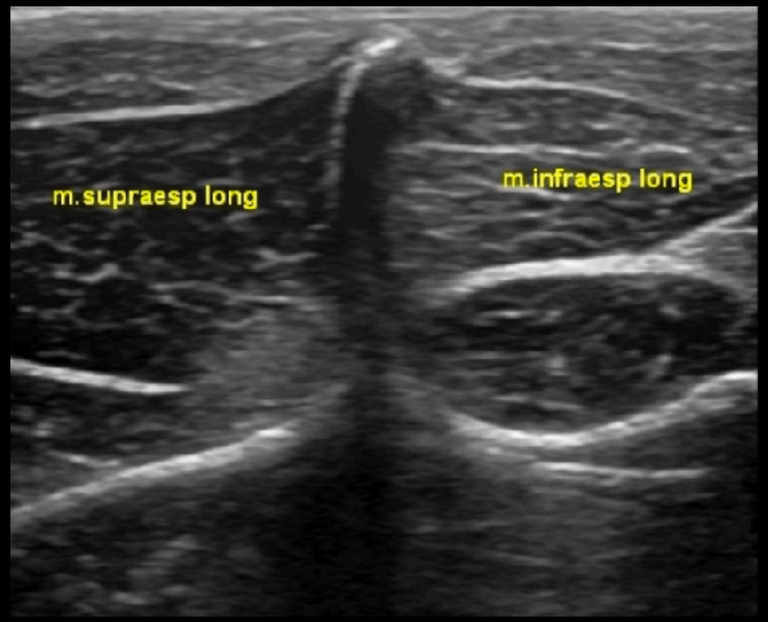


Ultrasound

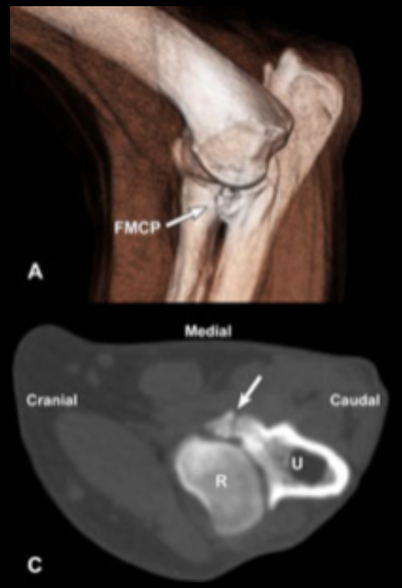
- Useful for the big diarthroidal joints- shoulder, knee.







Ultrasound



- **Publications for study of the medial coronoid:**

-Norm- sharp edges

Fig 10. Ultrasound image of a normal medial coronoid process. Note the sharp margins of the coronoid process (arrow).

-pathology- uneven edges or fragmentation

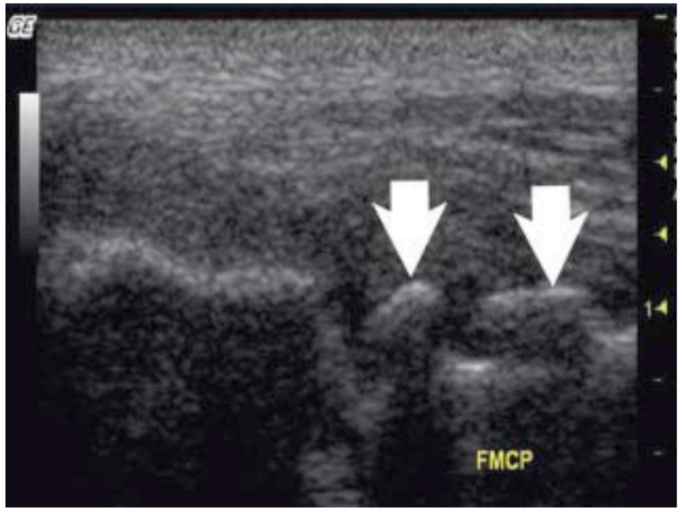
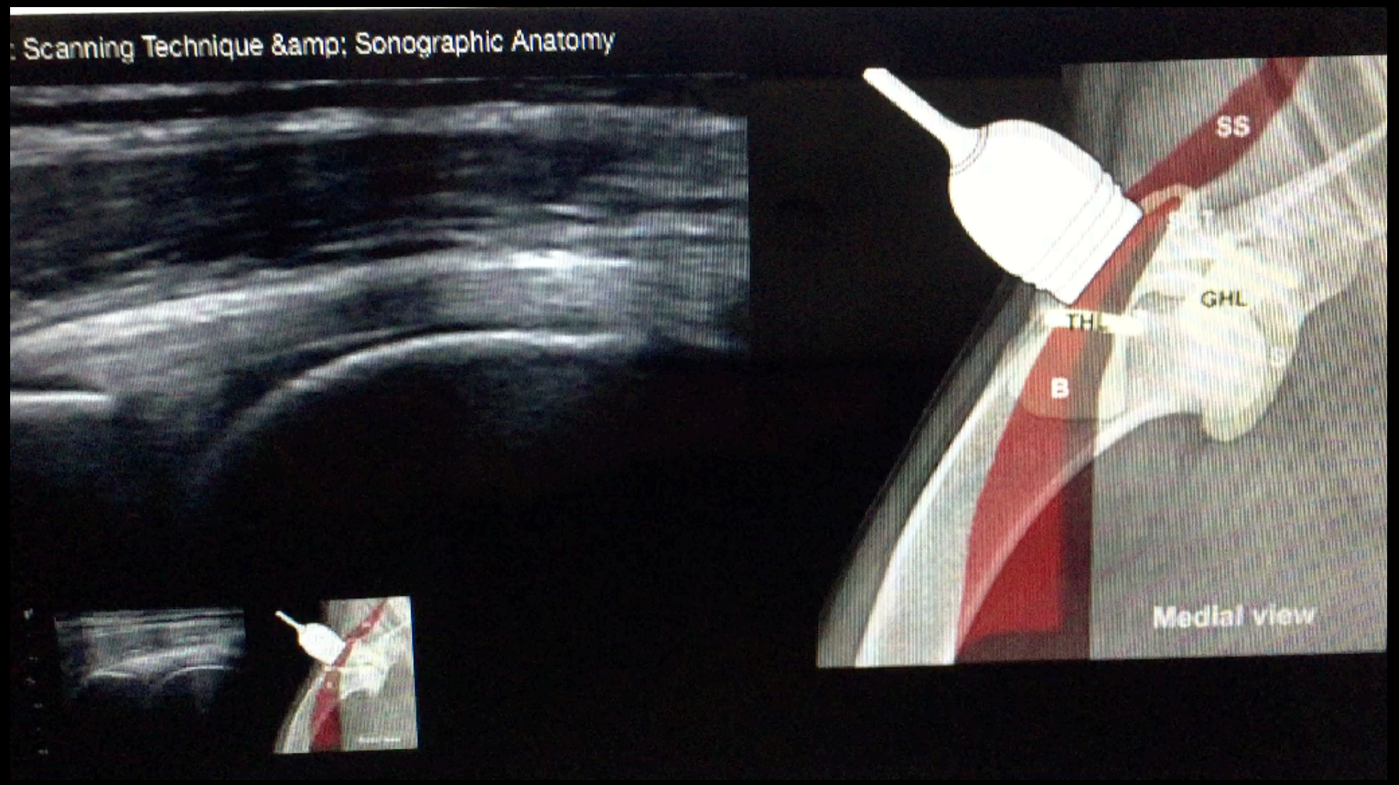


Fig 11. Ultrasound image of irregular margins of the medial coronoid process (arrows), consistent with a fragment of the medial coronoid, which was confirmed on arthroscopy.

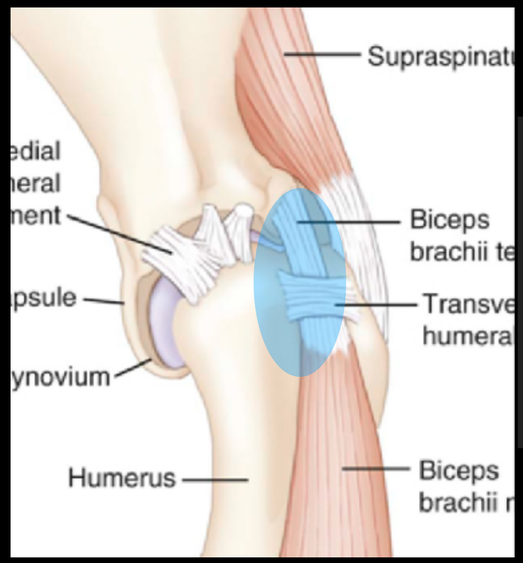
Bicipital tendon

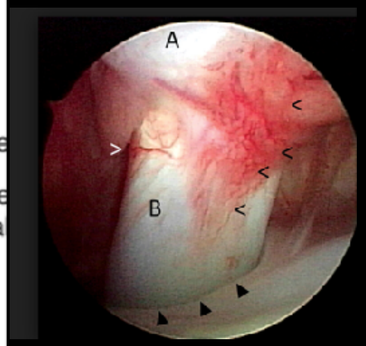
Norm

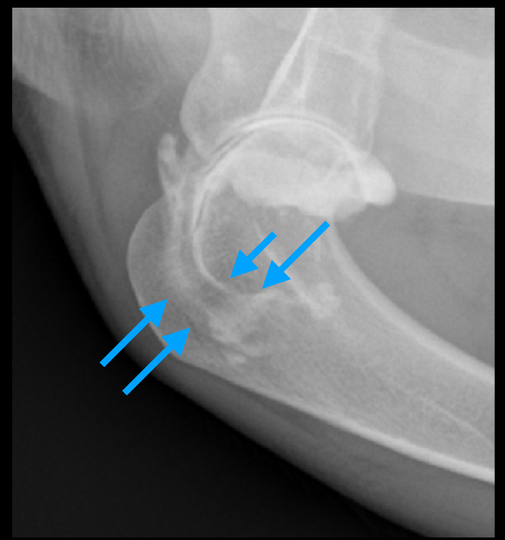


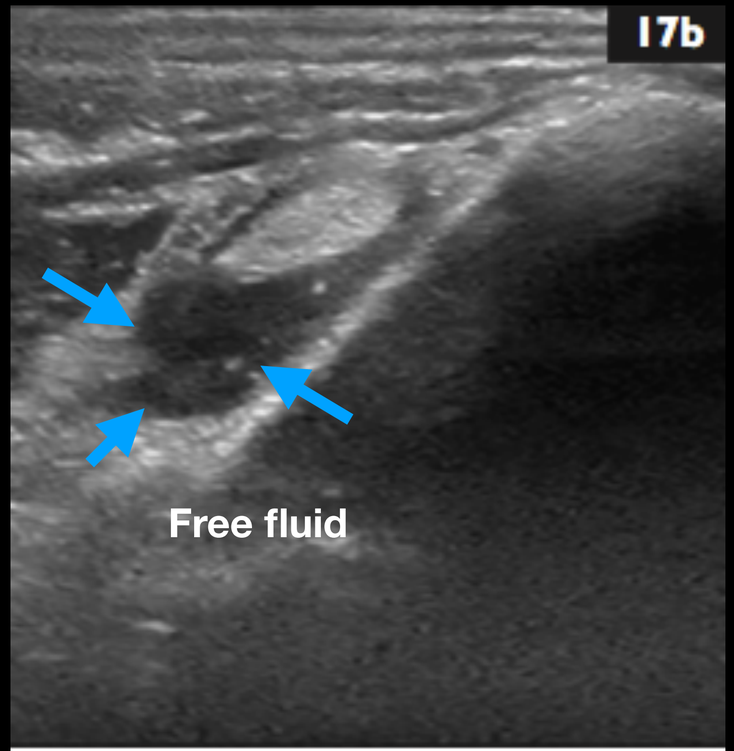
https://smallanimalultrasonography.com

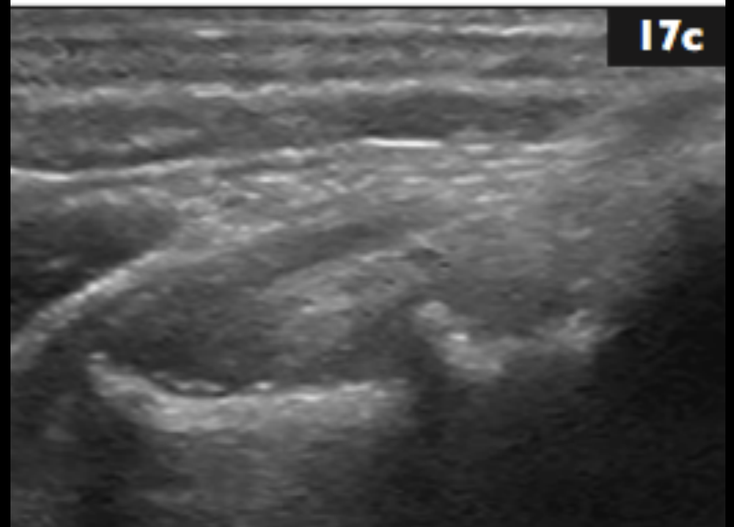
Bicipital tenosynovitis



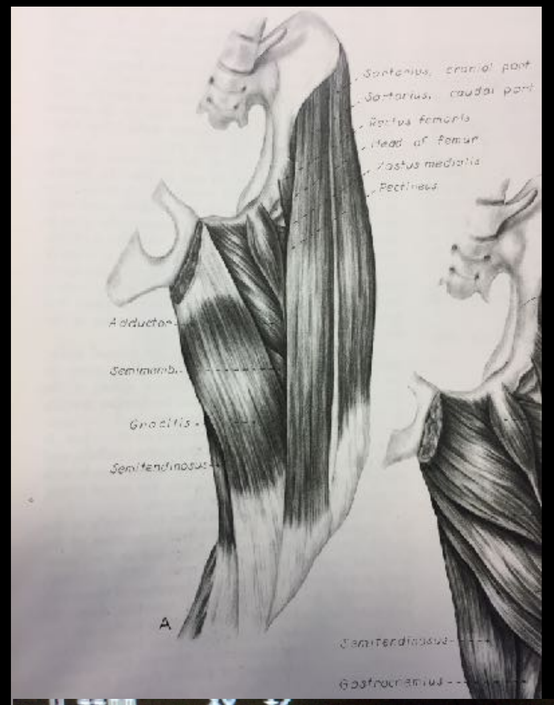


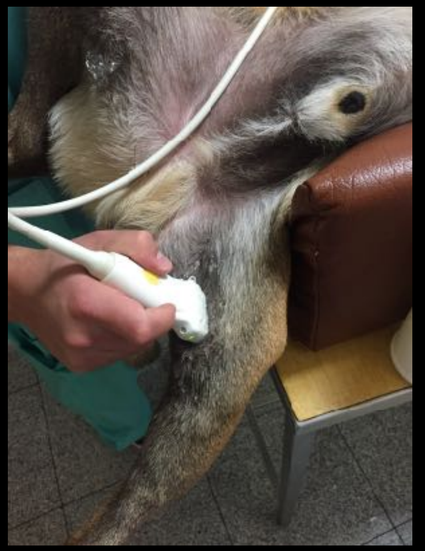


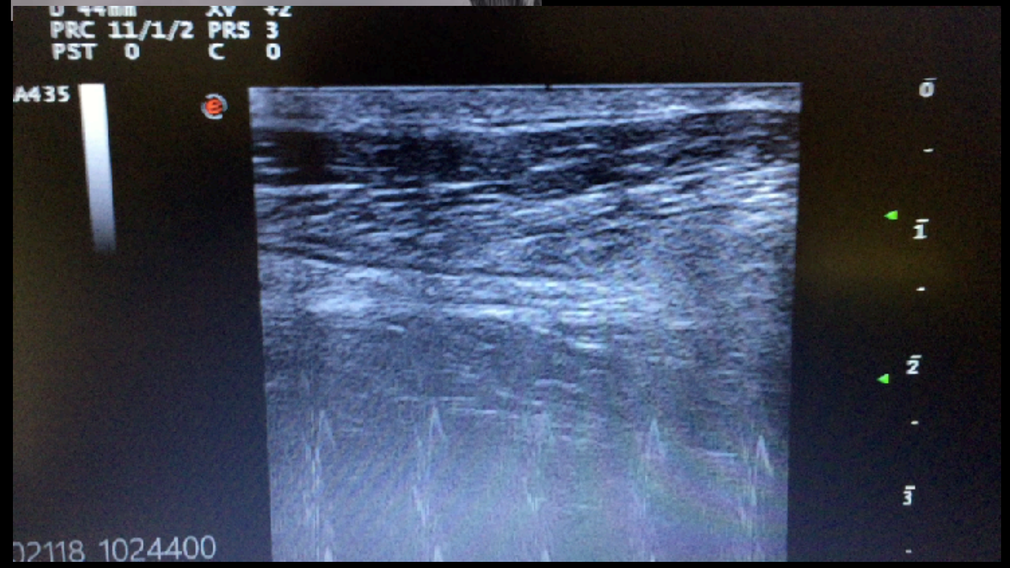




M. semitendinousos tendinopathy





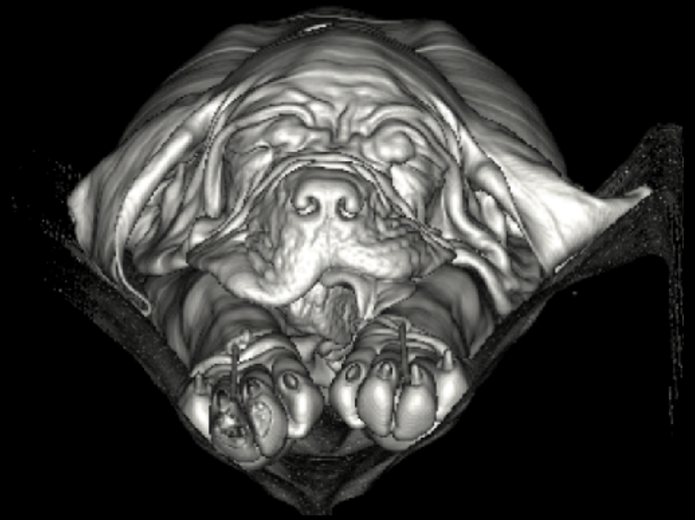


Neoplasia, long digital extensor m.

Echography

- Ultrasound guided OS biopsy

Computer tomography

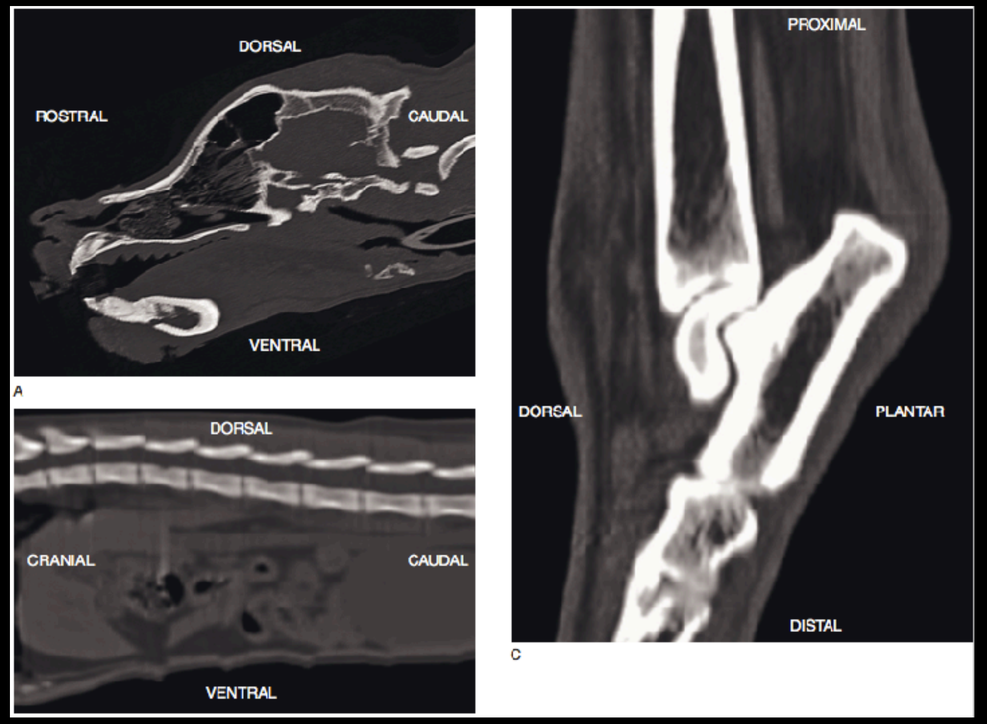


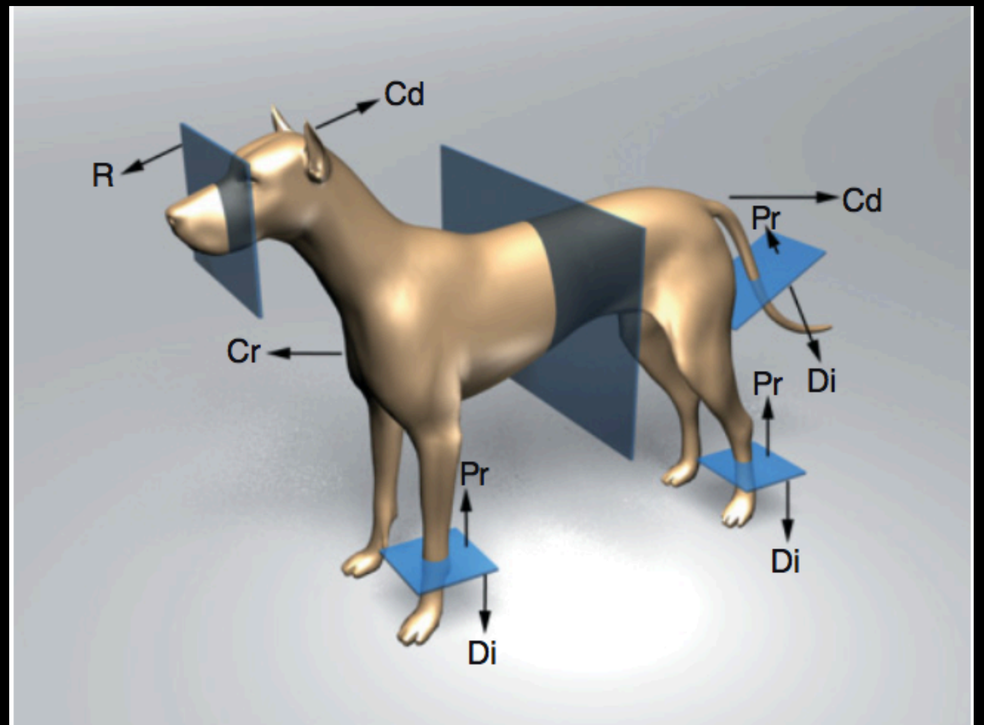
CT principles

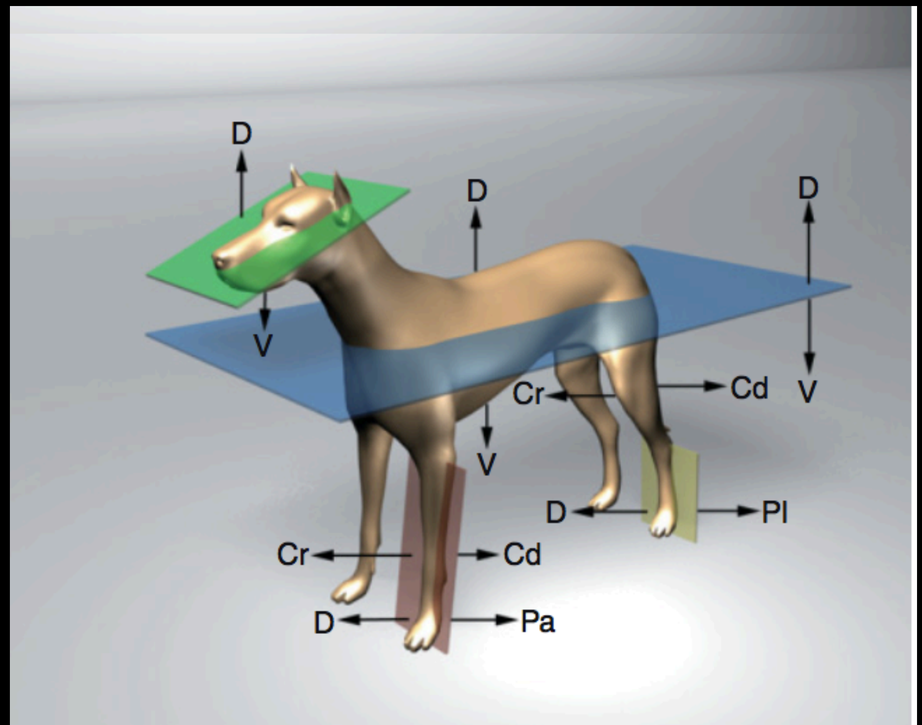
- Transverese X-rays beams
- Computer re
  images
- Four generat
- Spiral (Helica

Performance characteristics for a CT scanner in 2010.	
Power	60–100 kW
Rotating time per 360°	0.33–0.4 s
Slice width	0.5–0.6 mm
Simultaneously scanned slices	64
Data per helical scan	200–4000 MB
Image matrix	512 × 512
z-coverage per rotation	20–40 mm
Scan times 'whole body'	10–30 s
Scan range	>1000 mm
Isotropic spatial resolution	0.4–0.6 mm
Contrast resolution	3 HU
Effective dose	1–20 mSv

Terminology

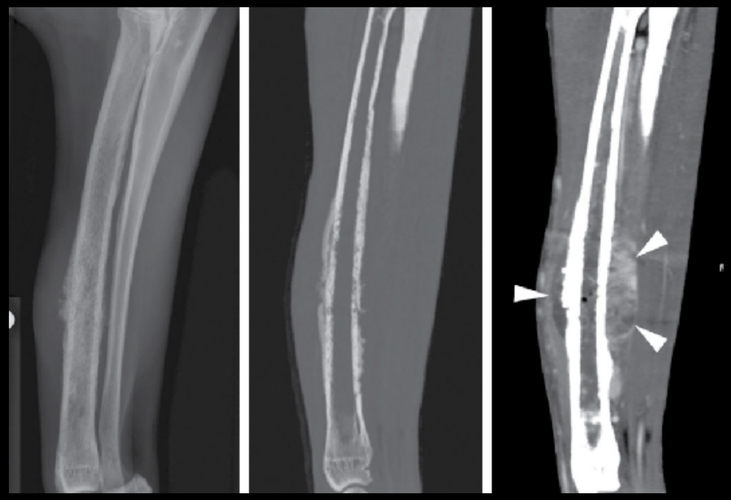


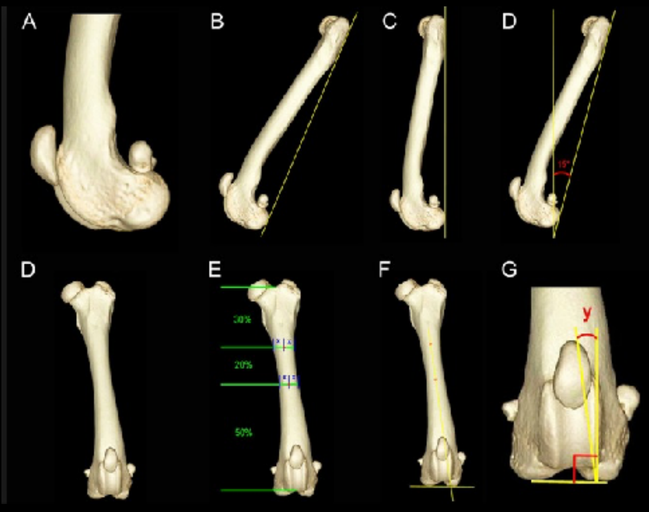




Advantages

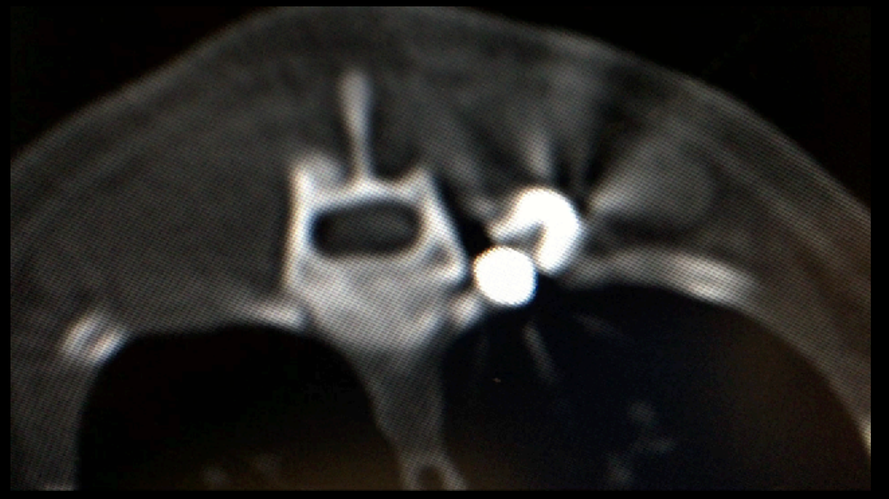
- No structures overlapping
- Relatively fast study
- Perfect bone details
- Options for different 3D Reconstructions





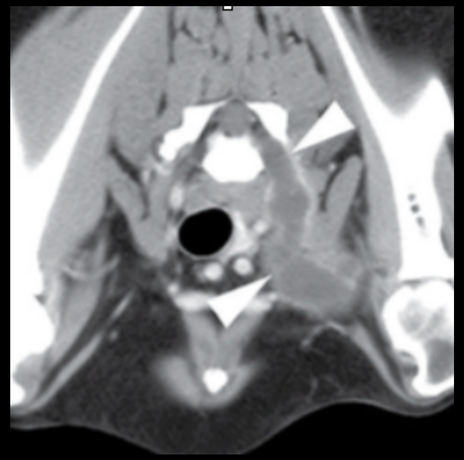
Disadvanatges

- Limited soft tissue resolution, including the nerve tissue.
- Radiation risks.
- Metal artefacts (implants)

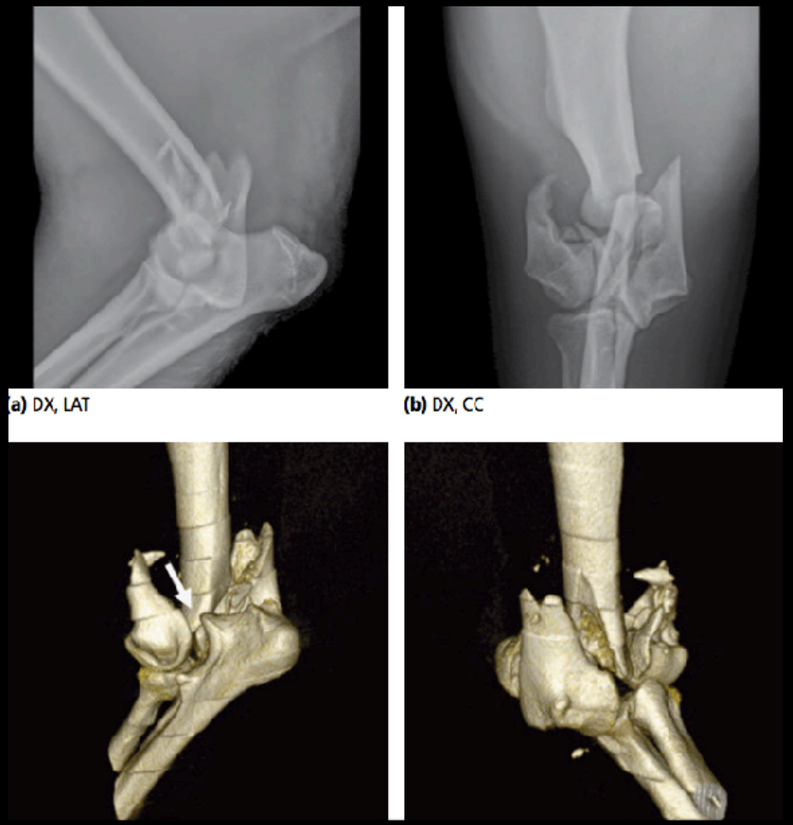


Indications

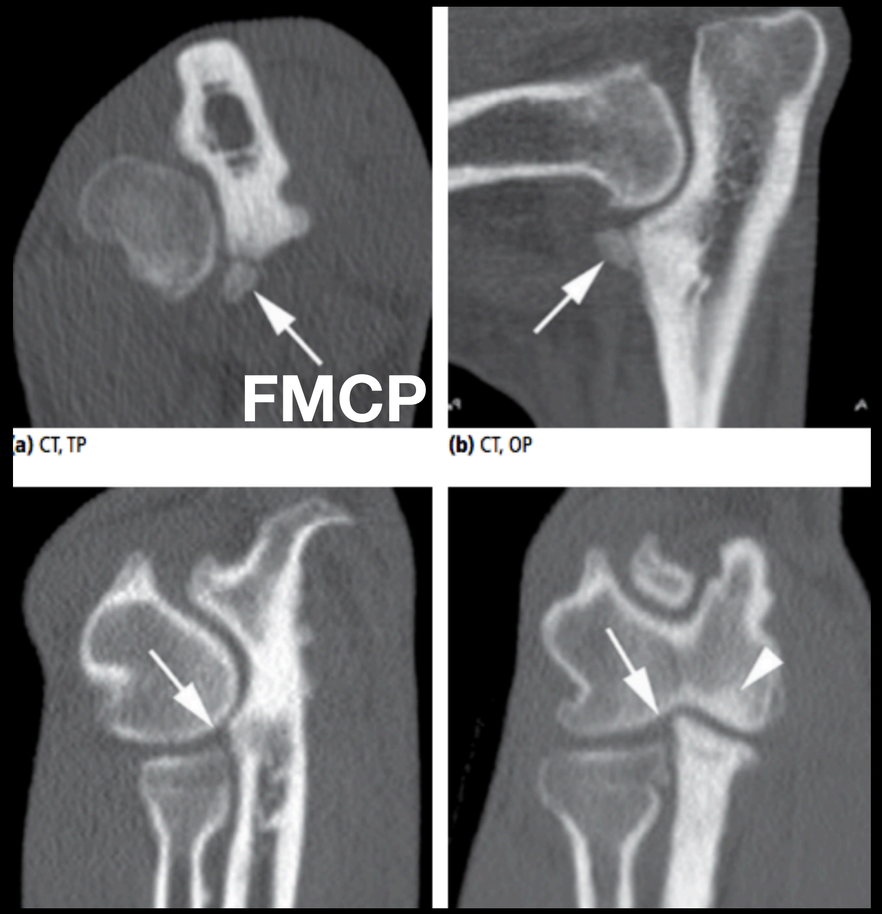
- Bone studies
- Spinal compression- disc hernias, veretebra fractures..
- Oncology

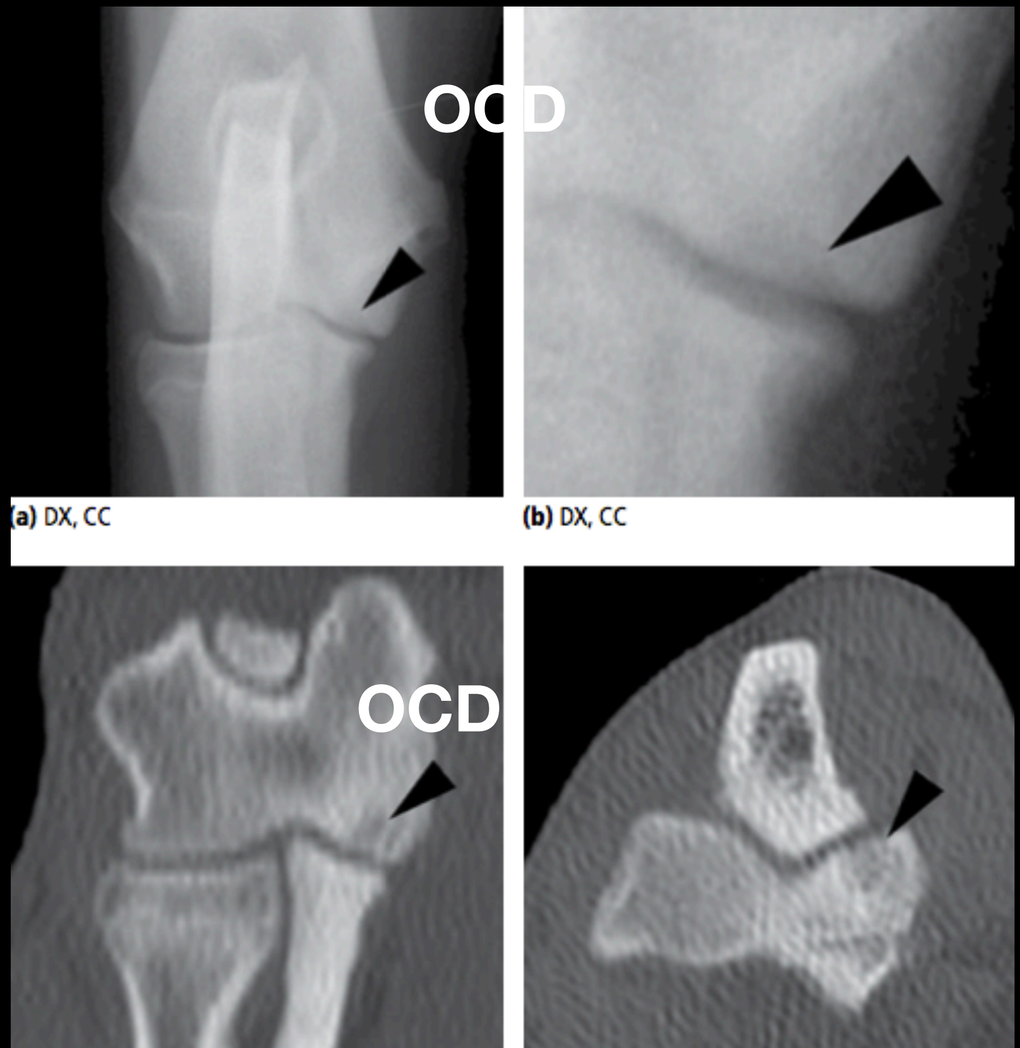


- Specific fractures- articular, pelvic, maxilofacial.

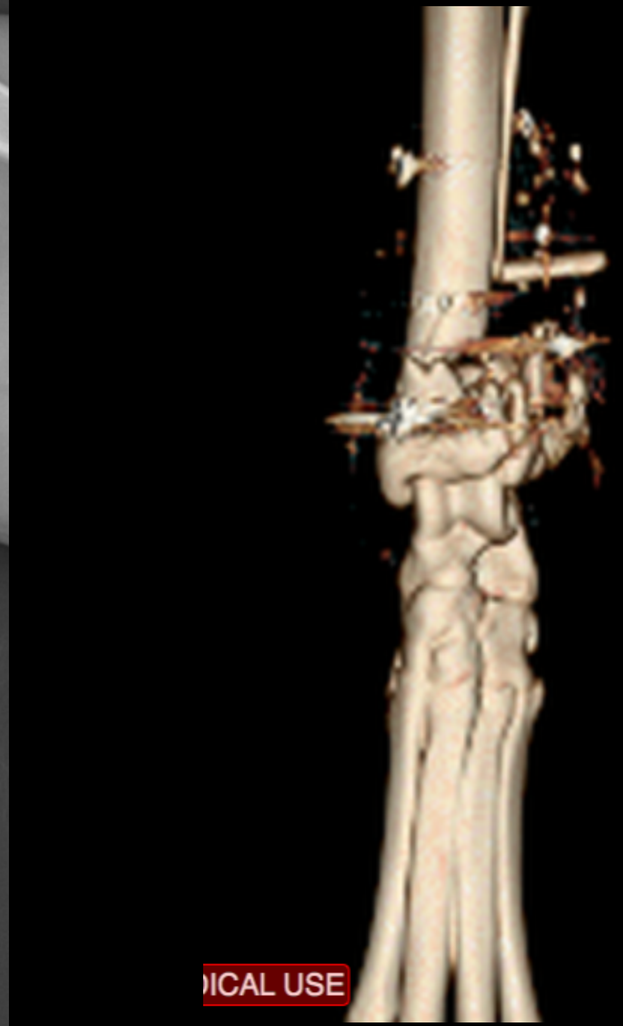


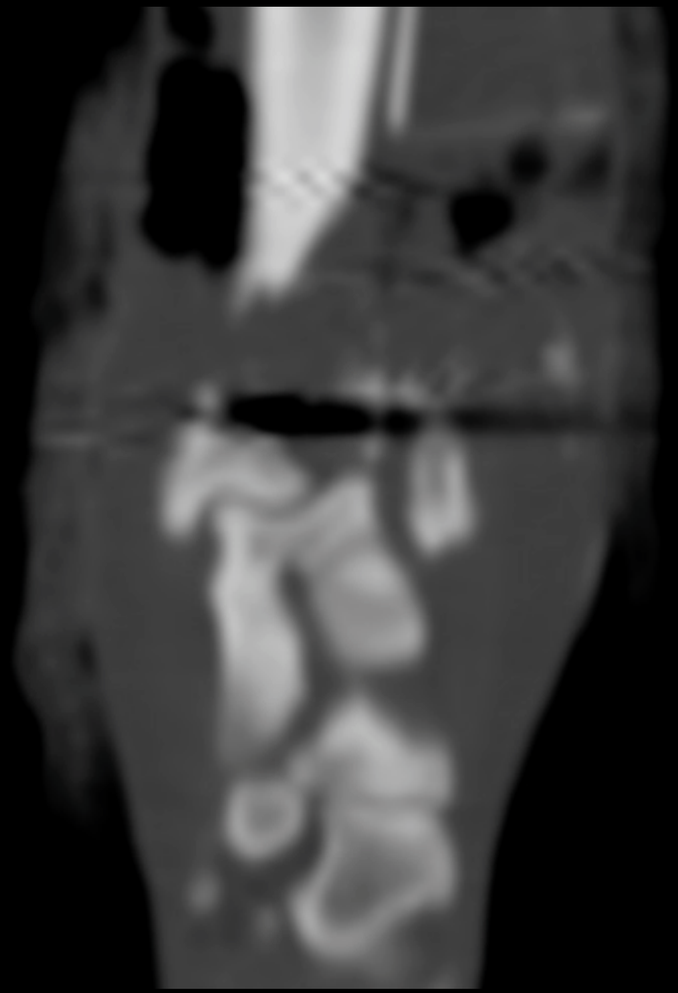
Elbow dysplasia



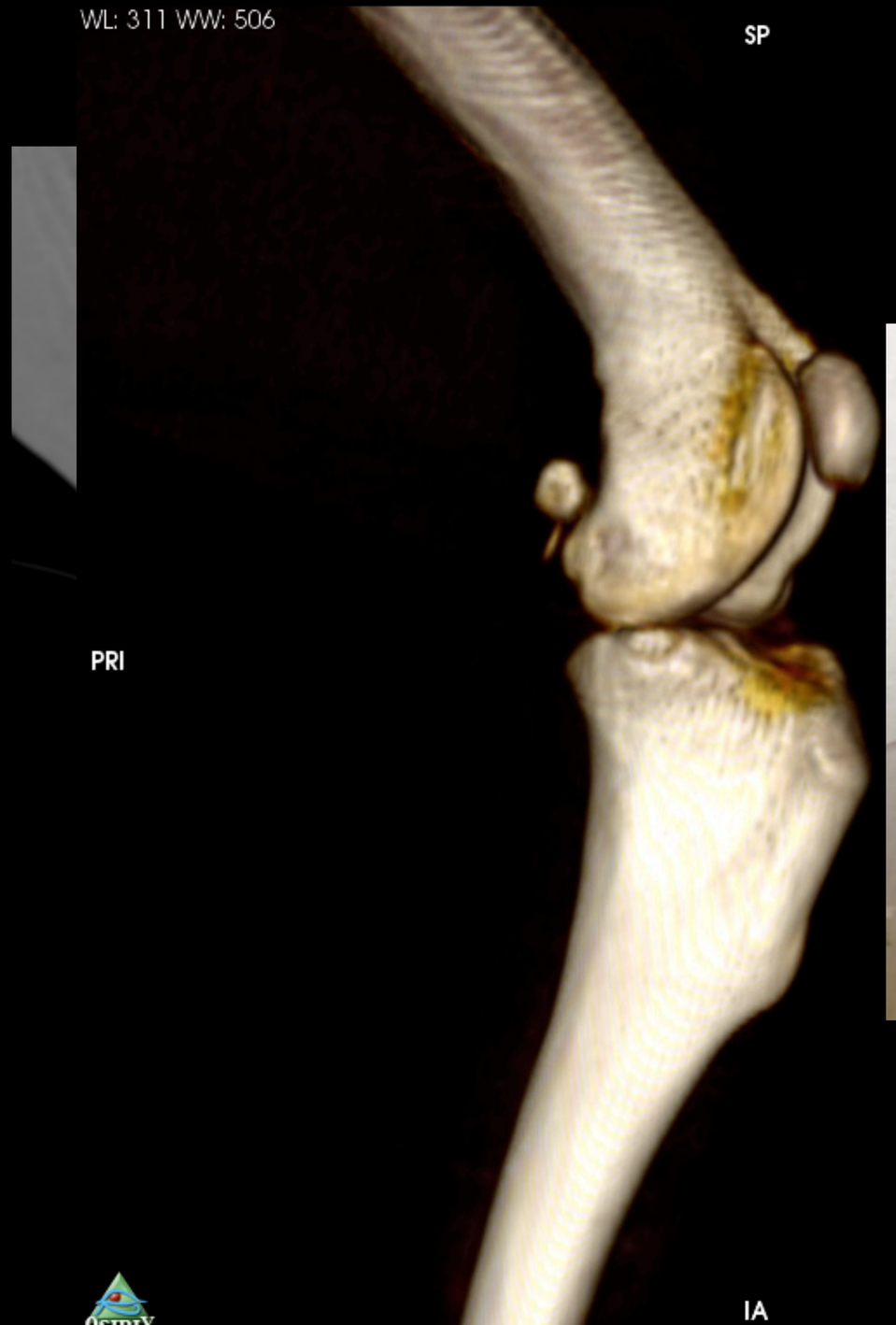


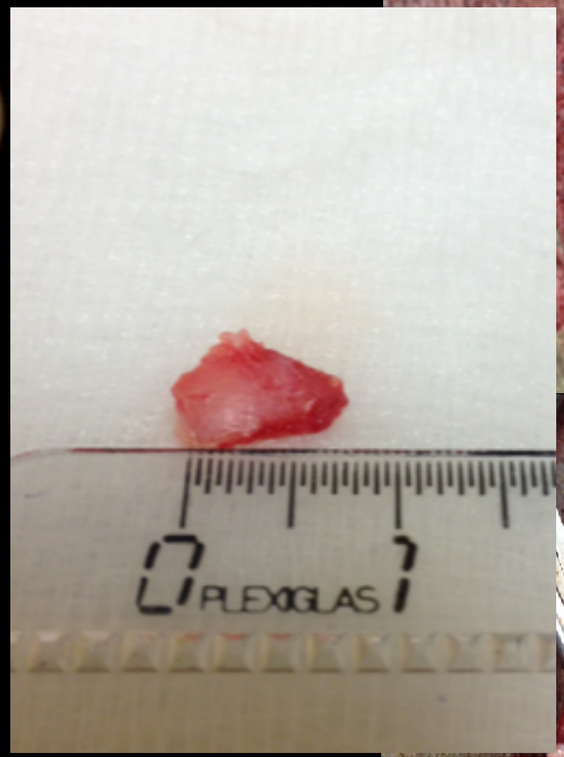
Articular fractures

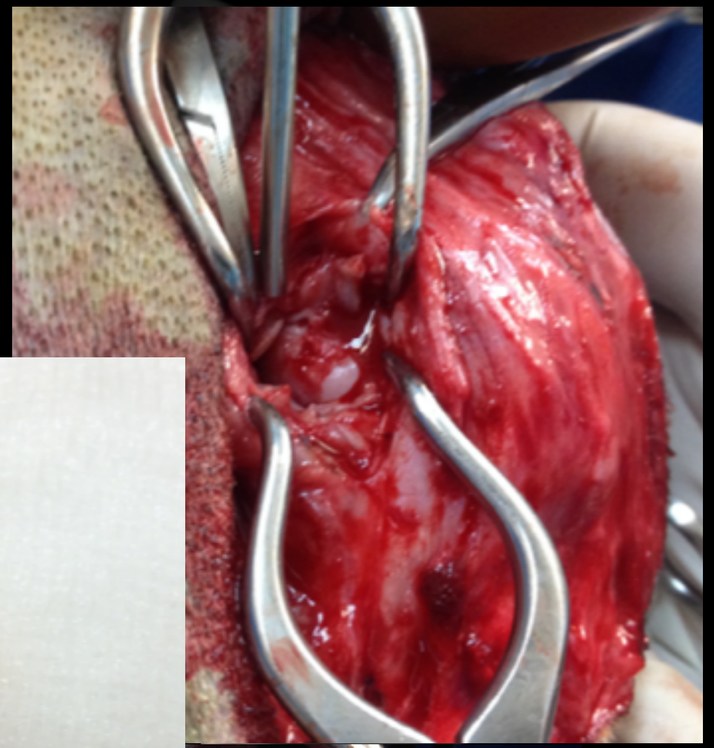


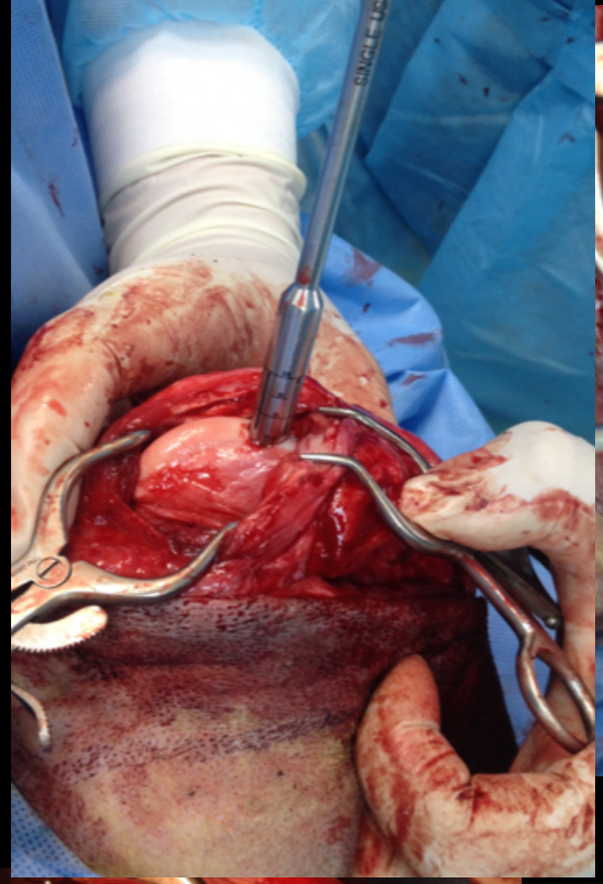
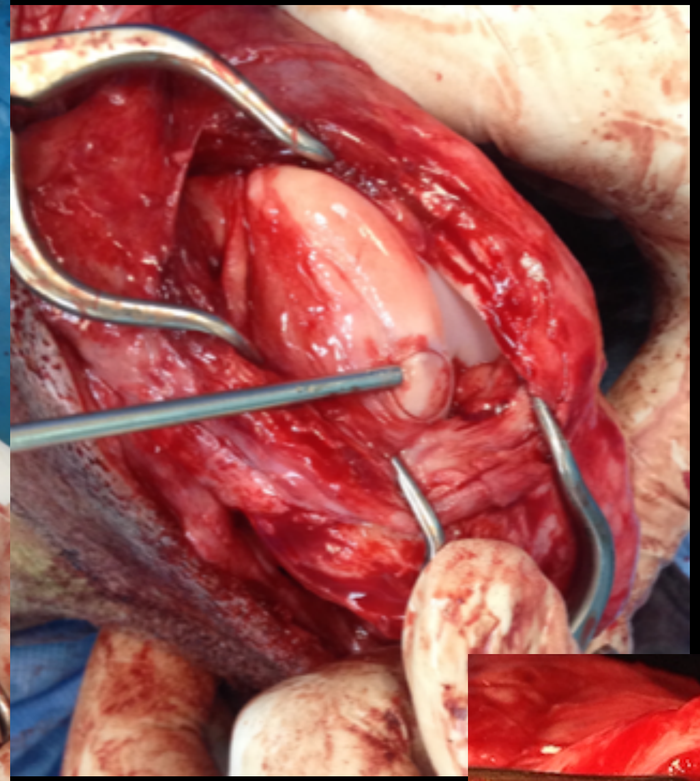
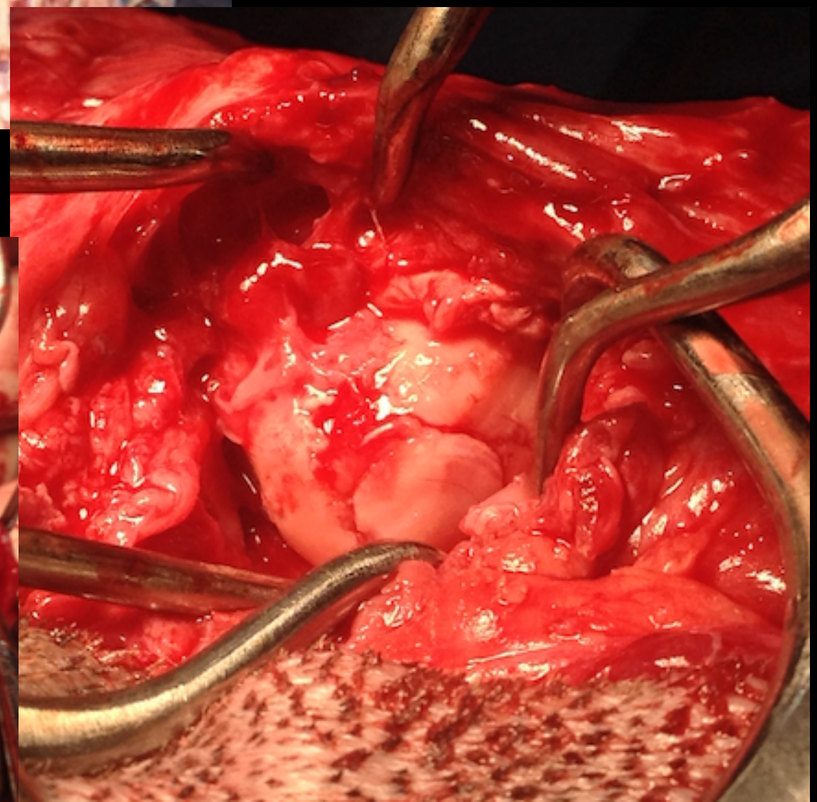
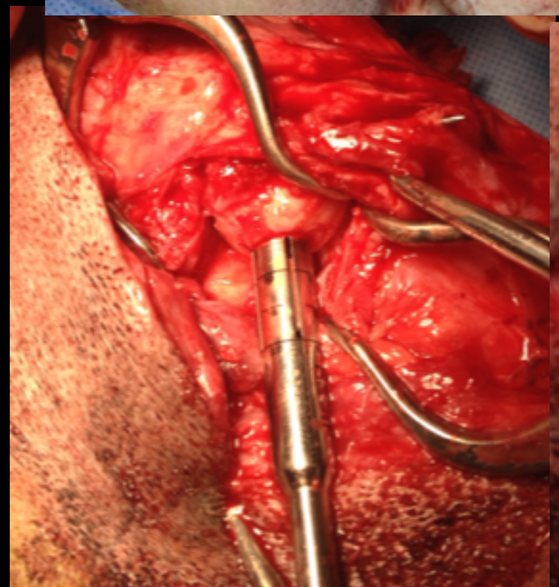
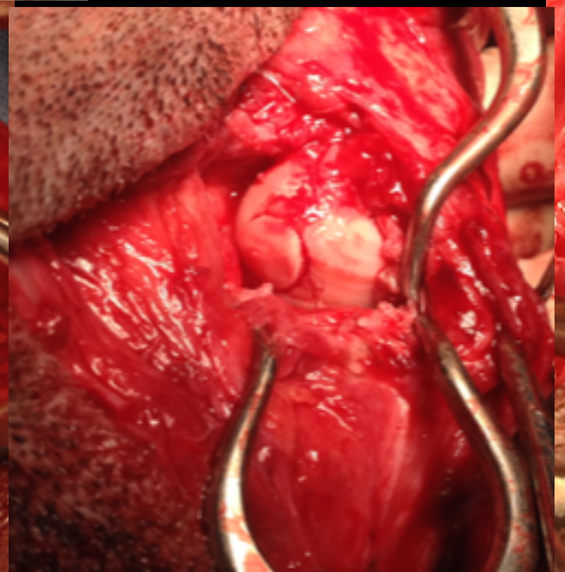


Articular fractures

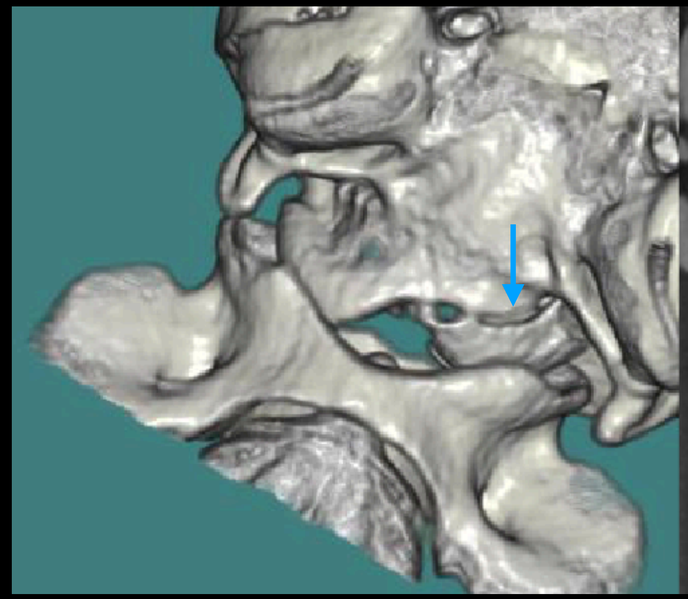

WL: 311 WW: 506
SP
PRI
IA

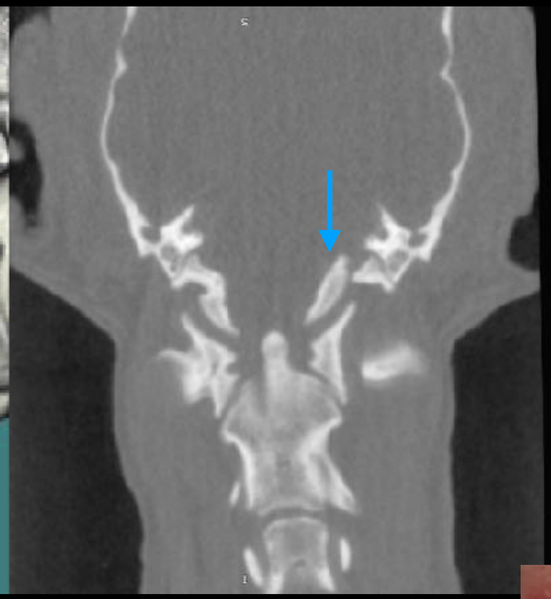

PLEXIGLAS

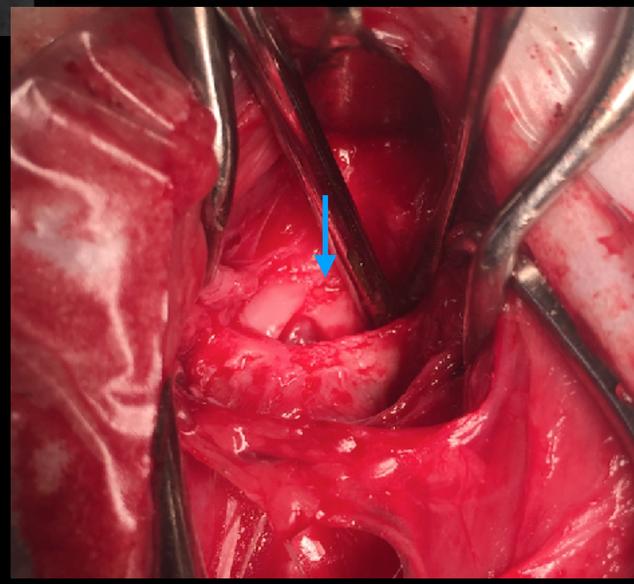


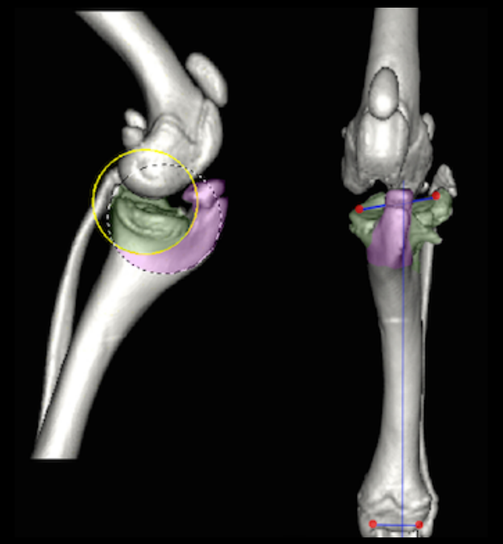
Spinal fractures



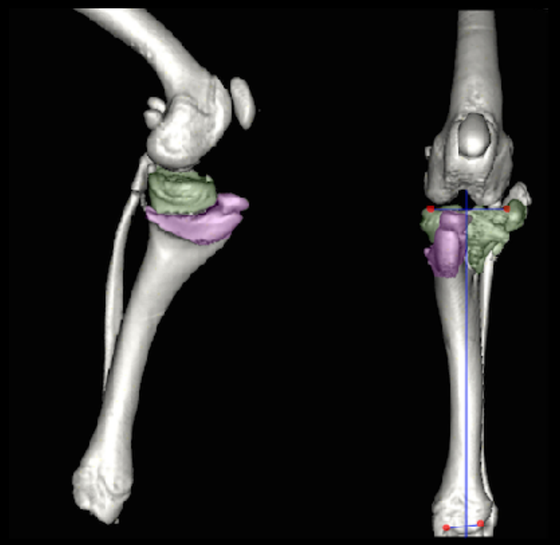


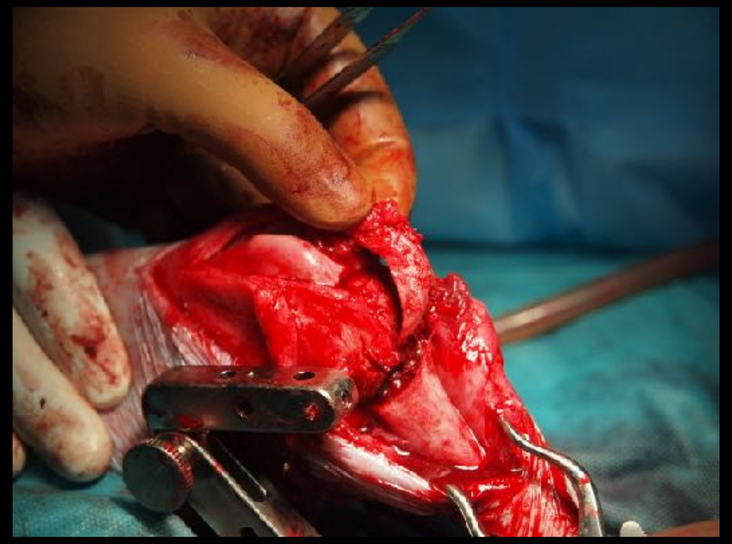


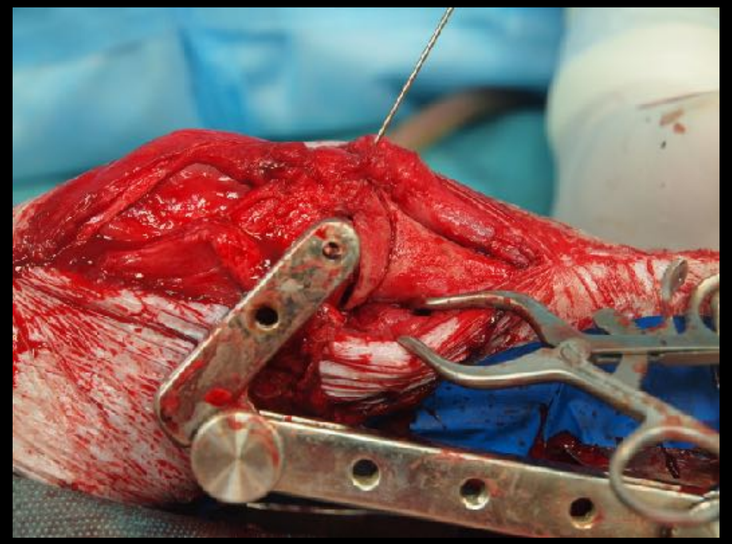
Bone deformation, reconstructions



3D simulation

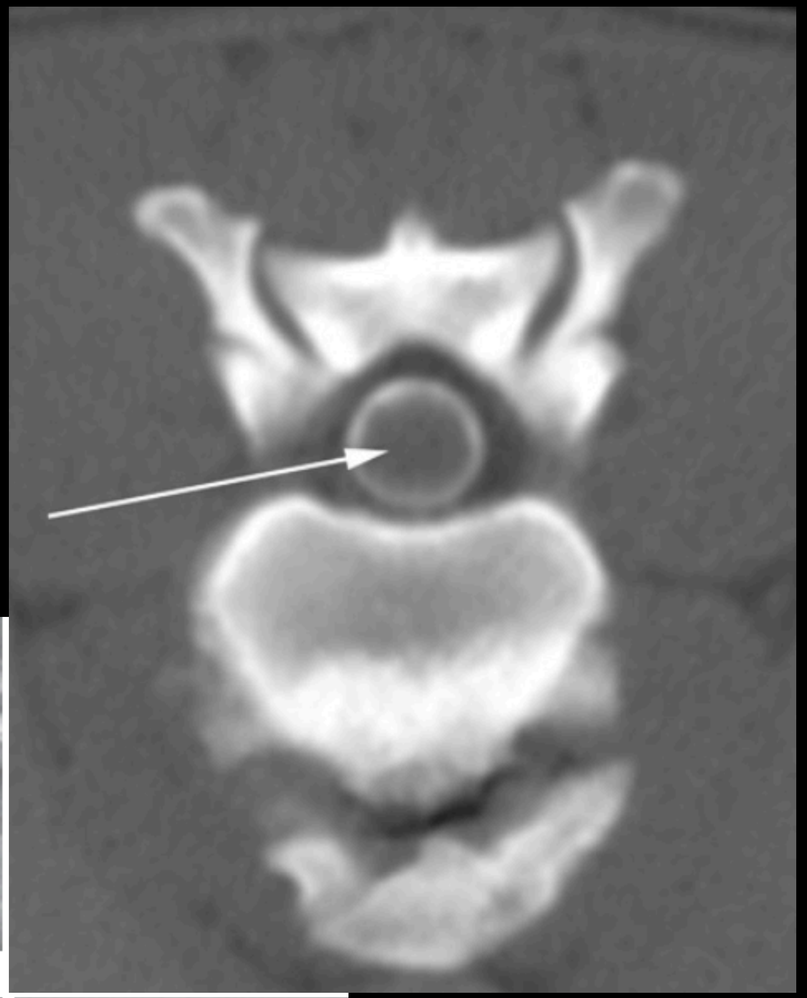


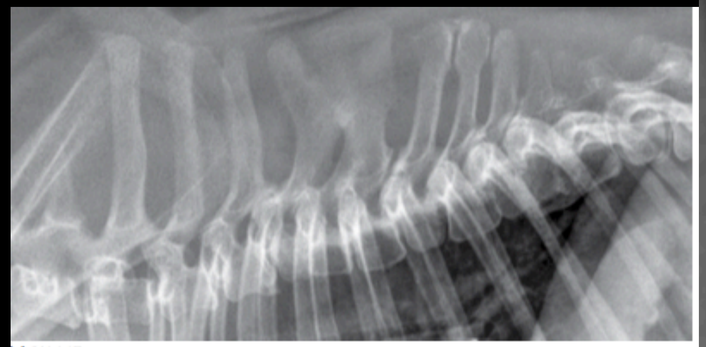




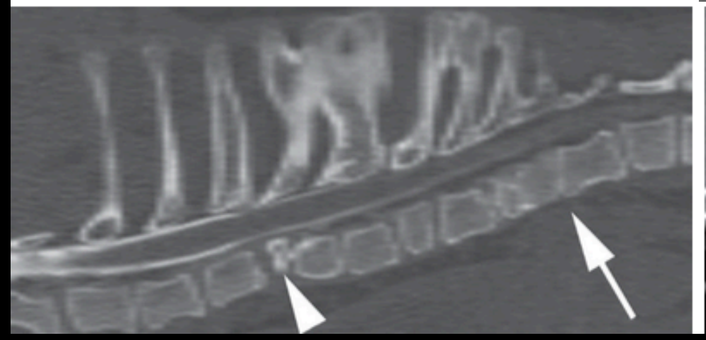
CT and myelography

Improved diagnostic value.

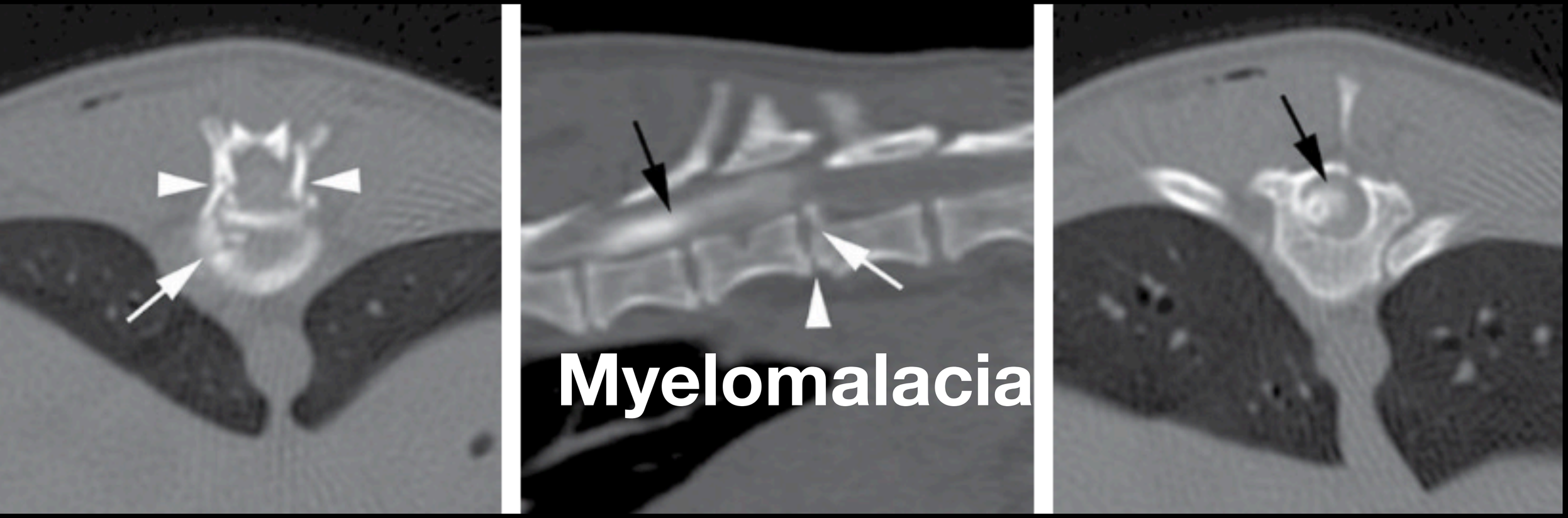




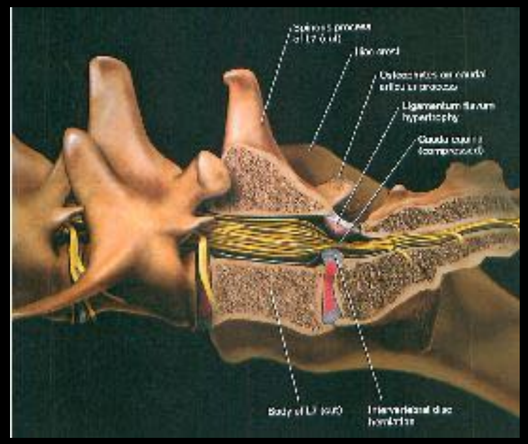
(a) DX, LAT

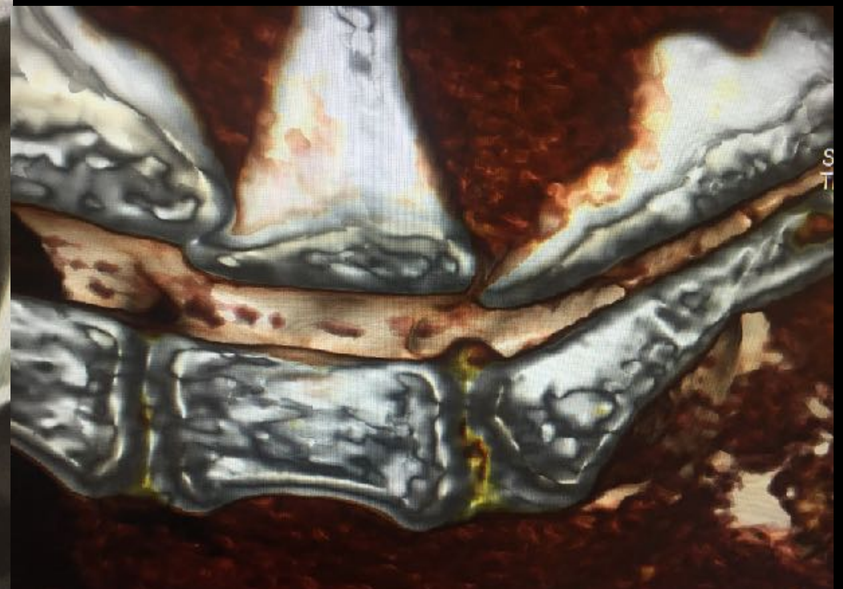


CT and myelography

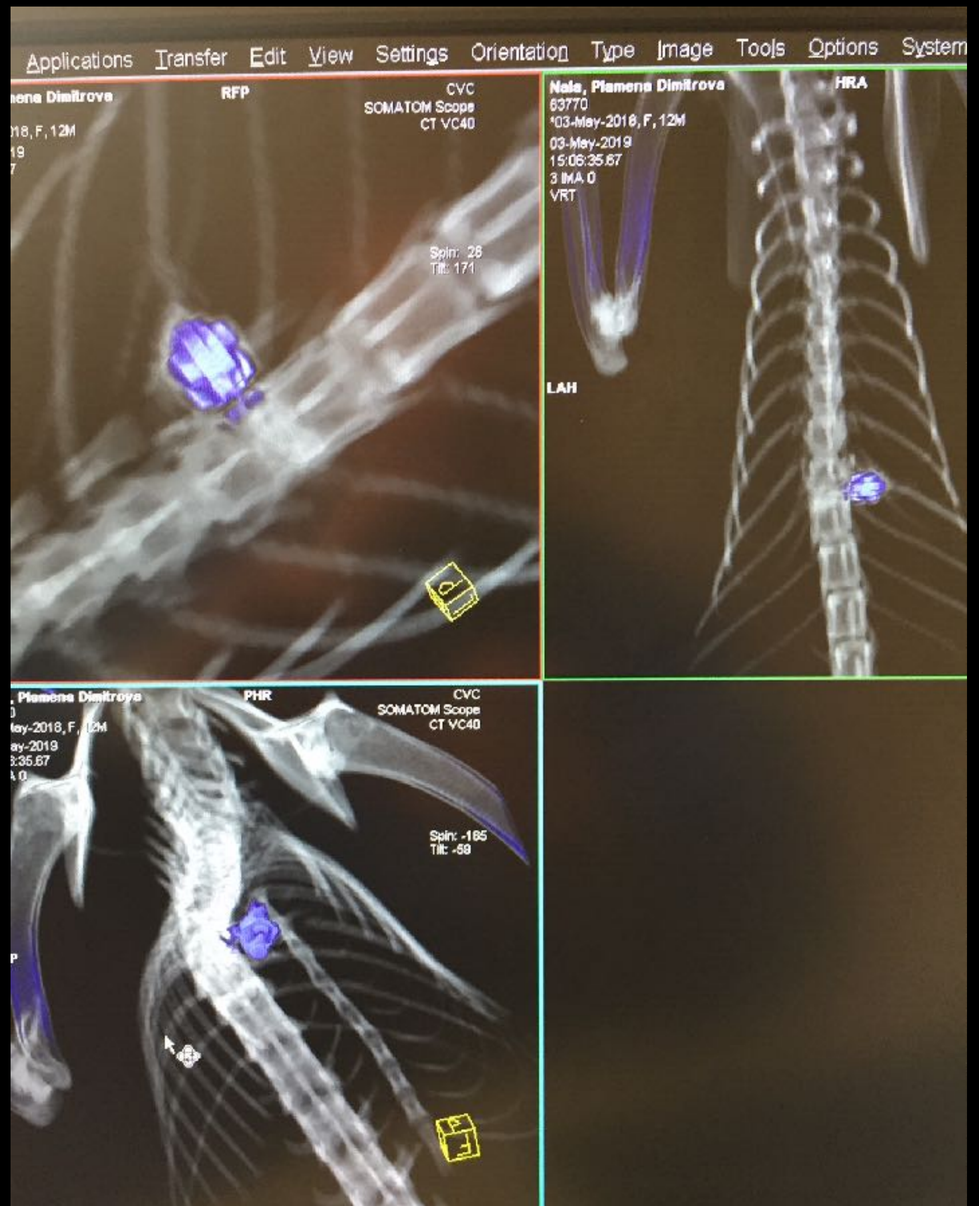


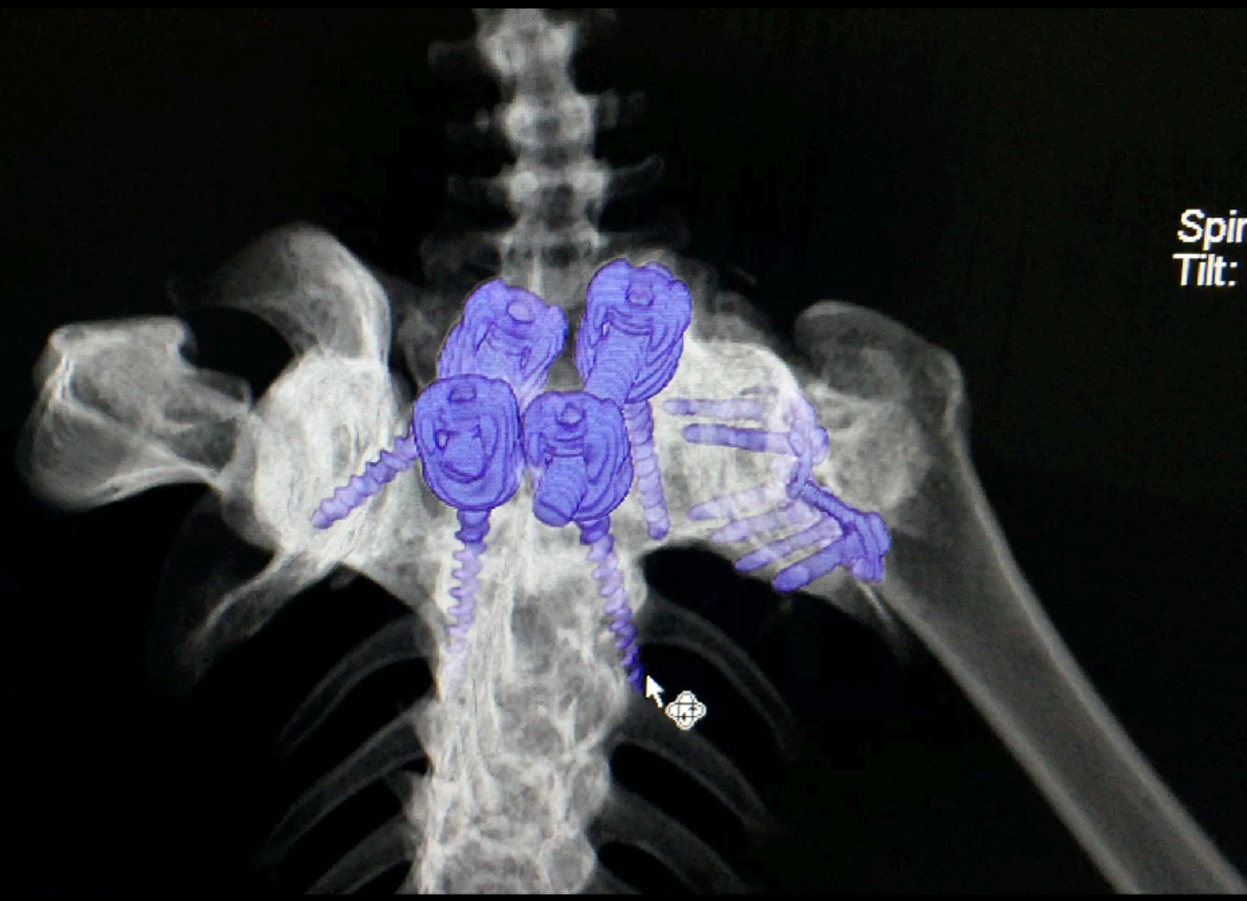
Lumbo-sacral space





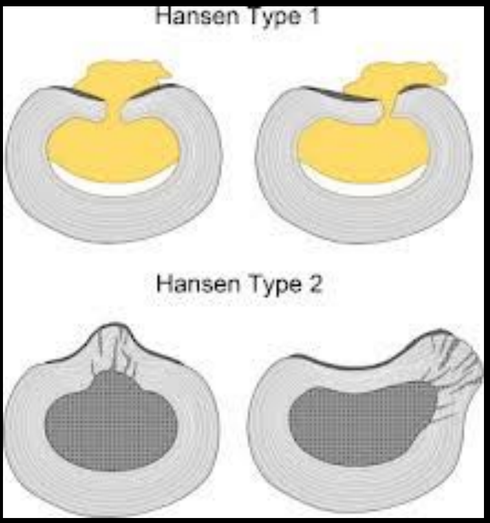
Special modes

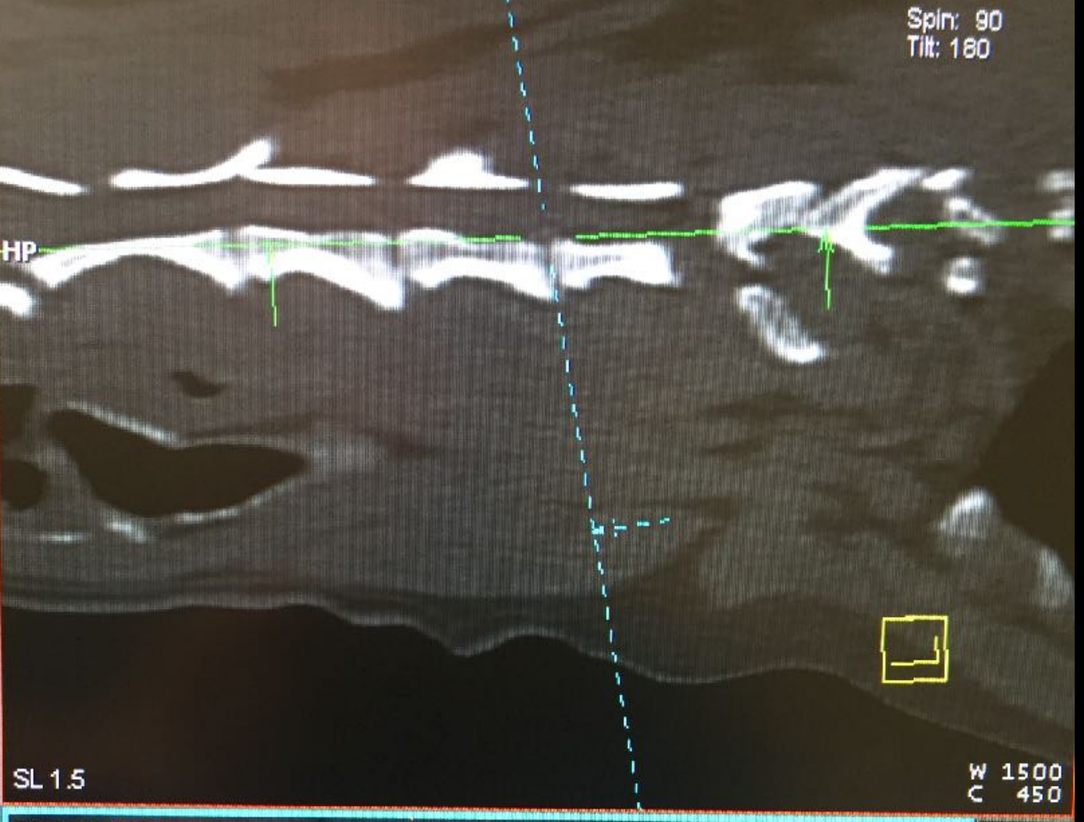




Acute disc hernias- sensitivity

- CT- 89-95 % accuracy
- CT with contrast > CT
- CT >myelogrpahy for large dogs
- Myelography >CT dogs **up tp 5 kg**
- MRI- most acccurate, minimal advanatge.



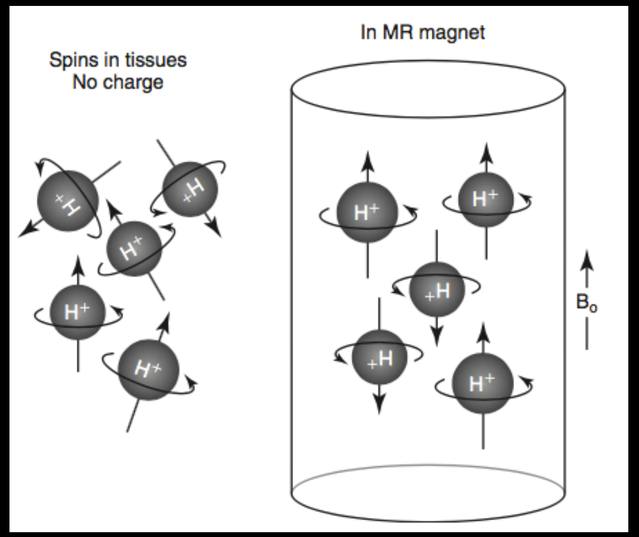

Spin: 90
Tilt: 180
HP
SL 1.5
W 1500
C 450

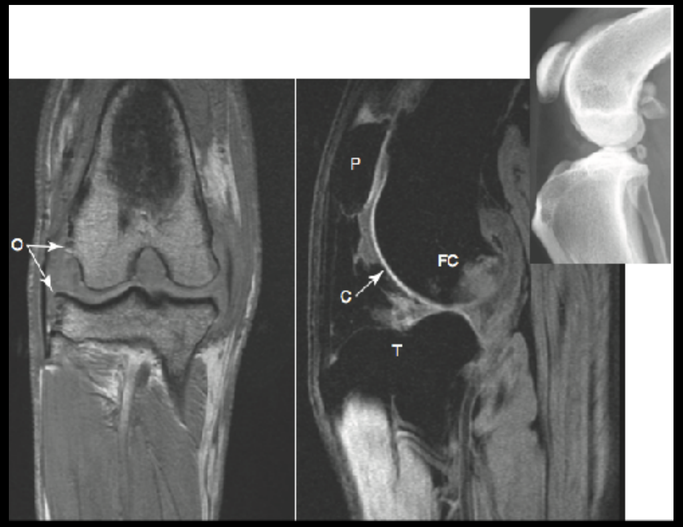

Djeimi, Malinov
63135
*04-Apr-2014, M, 5Y
04-Apr-2019
13:18:46.75
3 IMA 0
MPR
PLH
Central Vet Clinic
Ref.: 003
SOMATOM Scope
CT VC40
Spin: 128
Tilt: -77
LFA

Magnetic resonance investigation (MRI)

- MRI the most sophisticated method with huge potential (versatile soft tissue contrasting modes).

- Electromagnetic field, radio frequency transmitter.

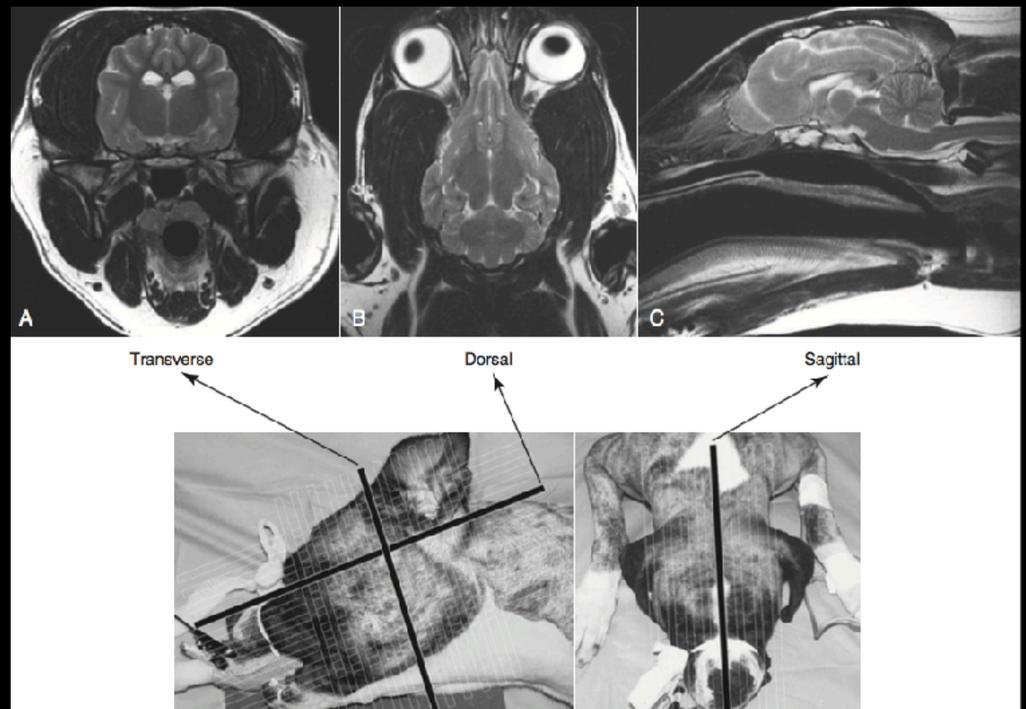




MRI

- Magnetic field with high frequency impulses
- Force positioning of hydrogen iones => repositioning and energy release
- Released enegy is tranformed into images.

<u>Three planes:</u>
-Transverse
-Saggital
-Dorsal



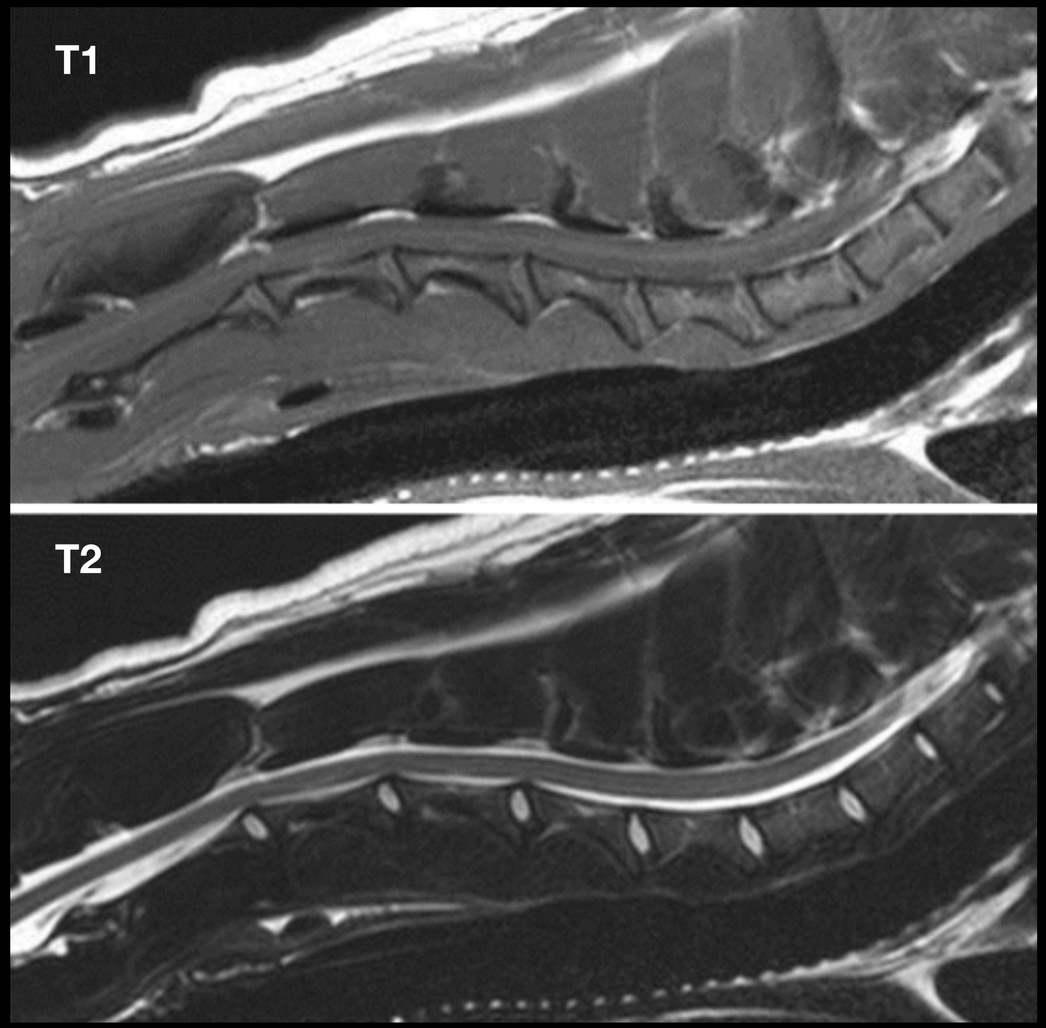
MRI

★ **T1 sequential**

- Fat tissue ->white color
- Fluids-> black color
- Normal anatomy

★ **T2 sequention**

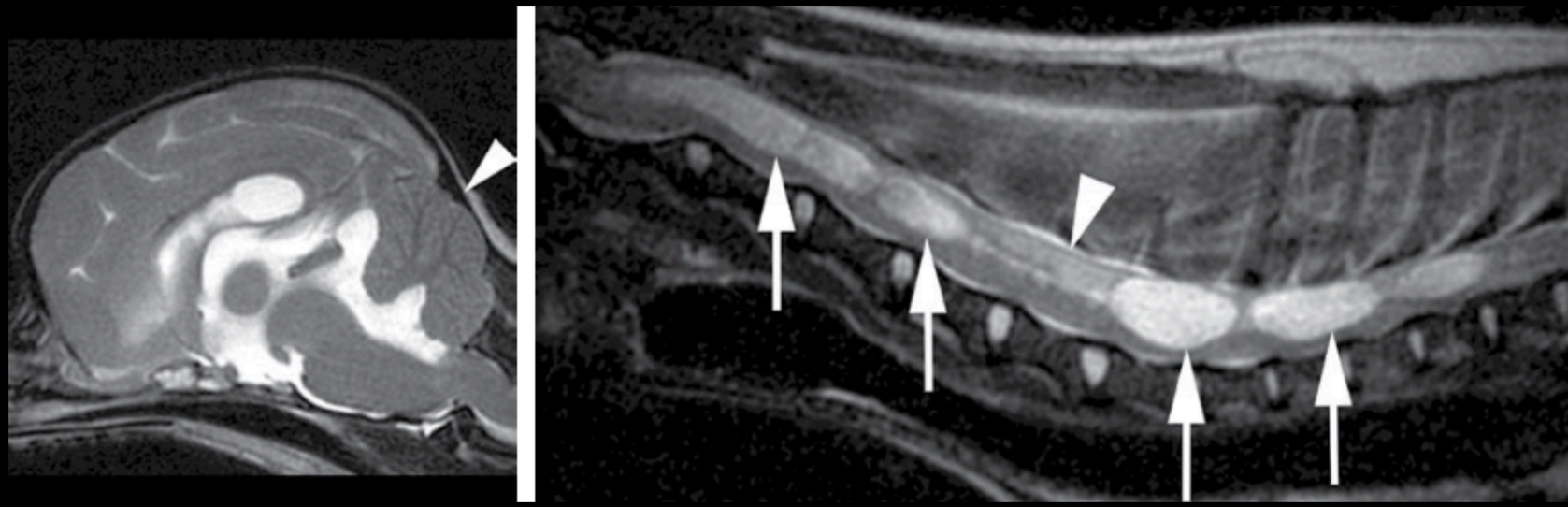
- Fat tissue->black color
- Fluids-> white color
- Pathologies- inflamation, neoplasia, edema.



MRI

- Signal enhanced tissues- white colour

- **Hyperintense**- fat
- **Hypointenese**- cortical bone, air, ligaments
- **Isointense**



MRI

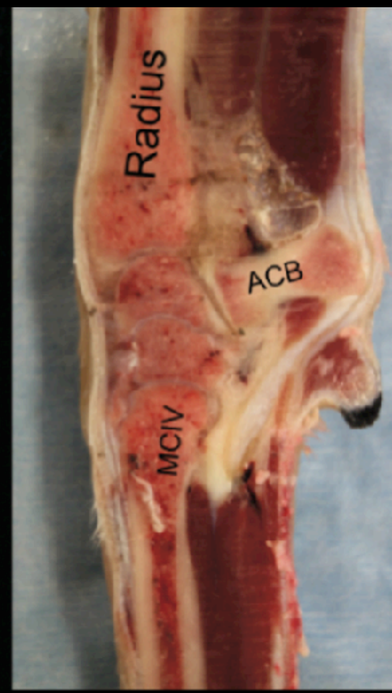
Advantages

- Perfect **soft tissue** visualisation
- No radiation hazards
- Potential for **contrast** enhancement

-Gadolinium

-Enhance T1 signal

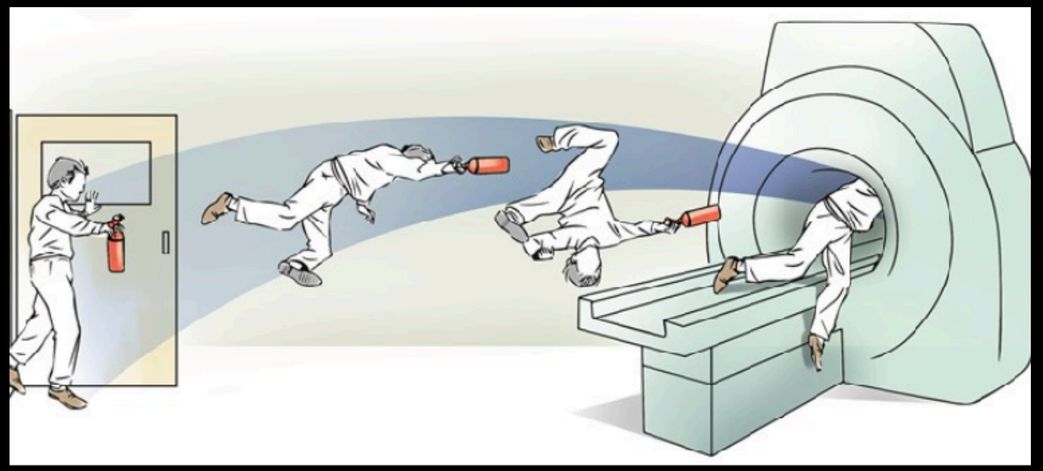
-Demonstrates changes in the brain circulation

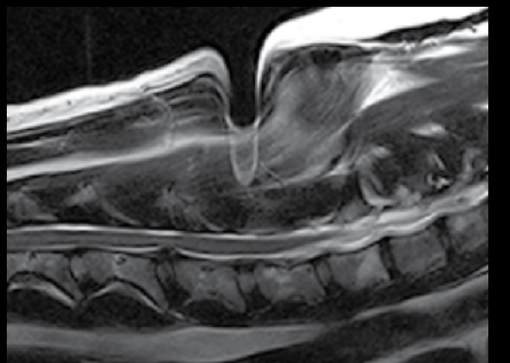


MRI

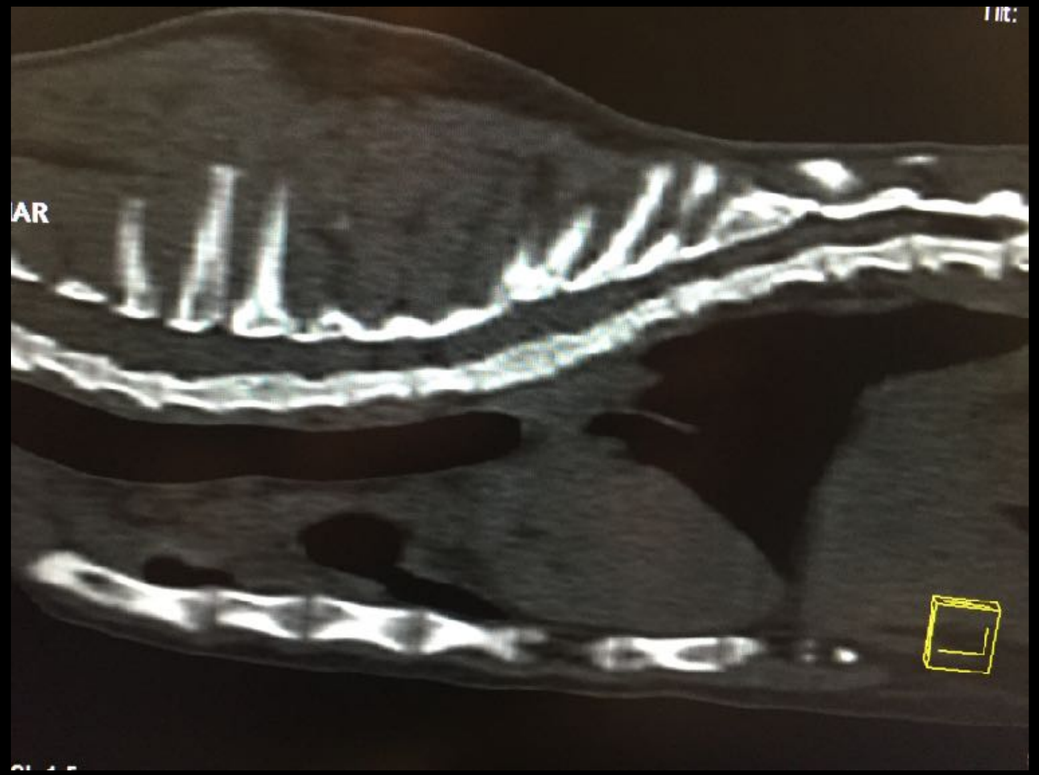
Disadvantages

- **Limited access** to equipment
- “time consuming”
- Very **small** animals?!
- Strong **metal** interference
- Bad **bone** details

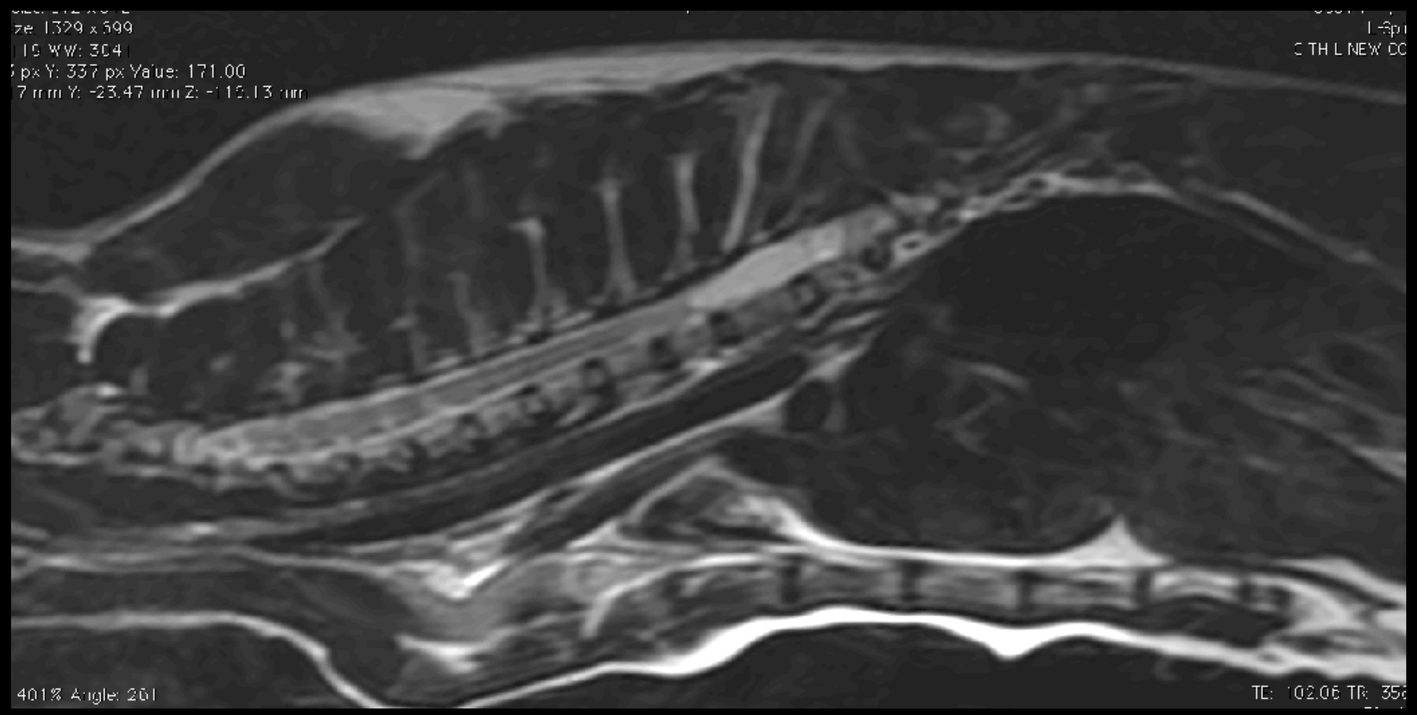




CT

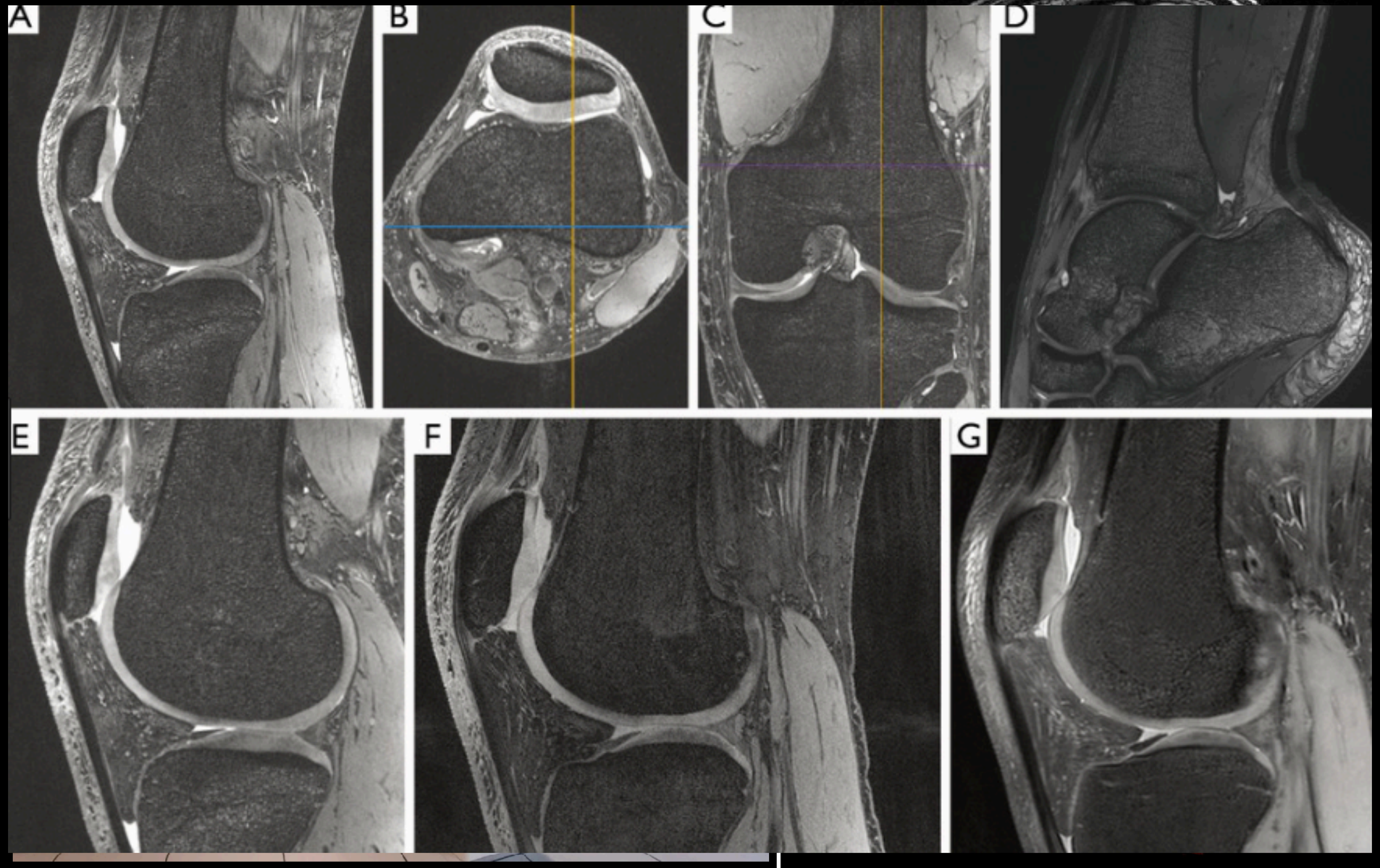


MRI



MRI scans

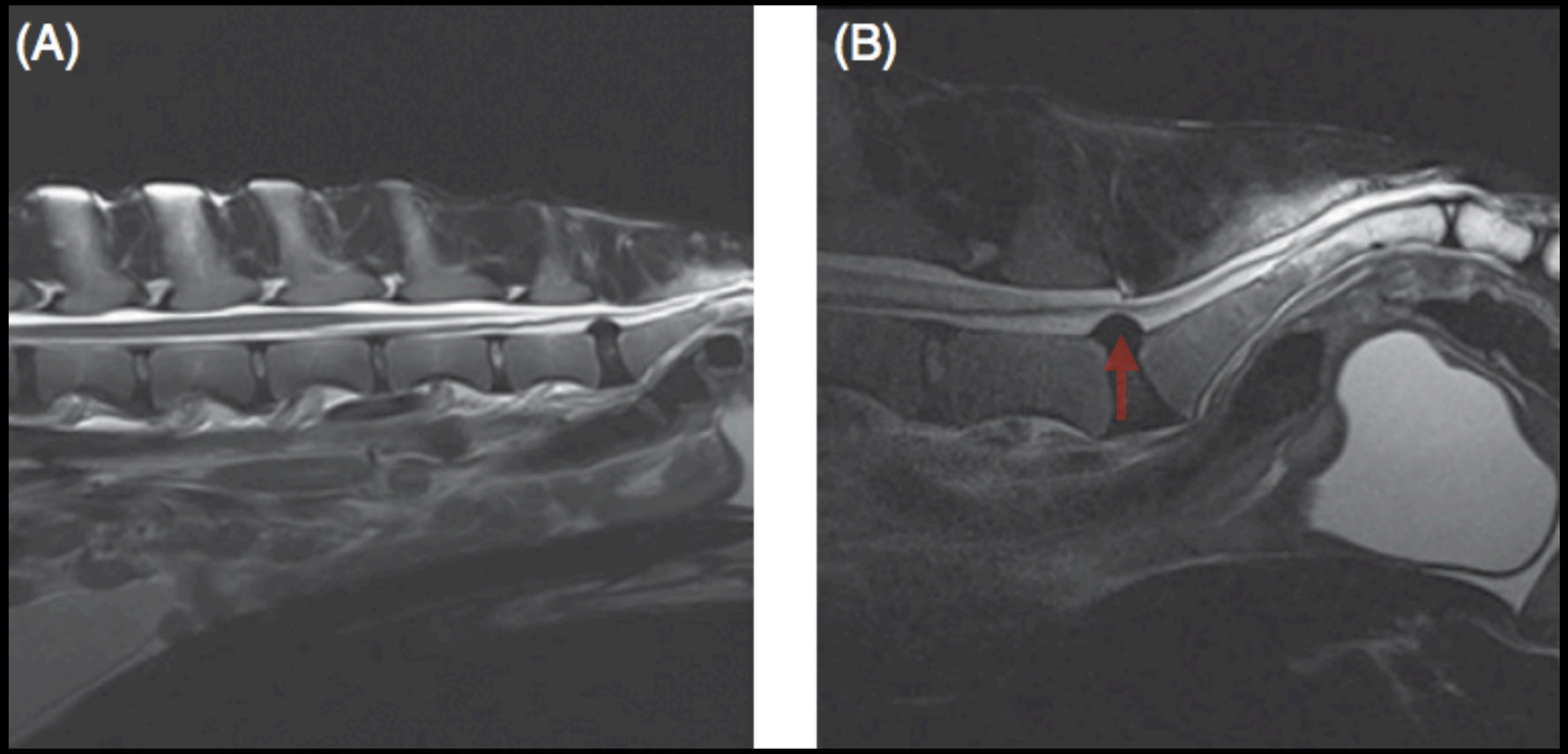
7 Tesla MRI machine



Cerebral blood vessels glow orange in this picture, generated by a 7-tesla magnetic resonance imaging scanner at The University of Queensland in Australia. Credit: Centre for Advanced Imaging, The University of Queensland

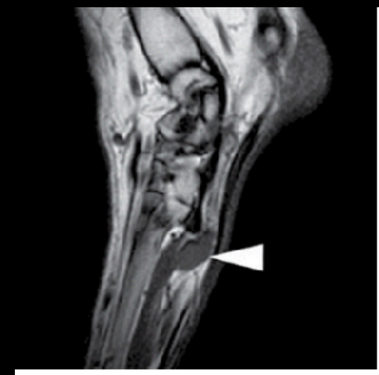
Nota bene

Disc protrusion- false signal intensification



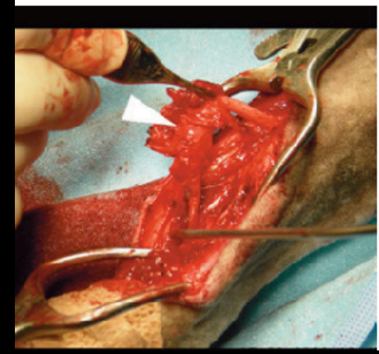
Indications

- CNS study- Parenchymal injuries in brain, spinal cord
- Peripheral nerves study
- Muscles, tendons pathologies

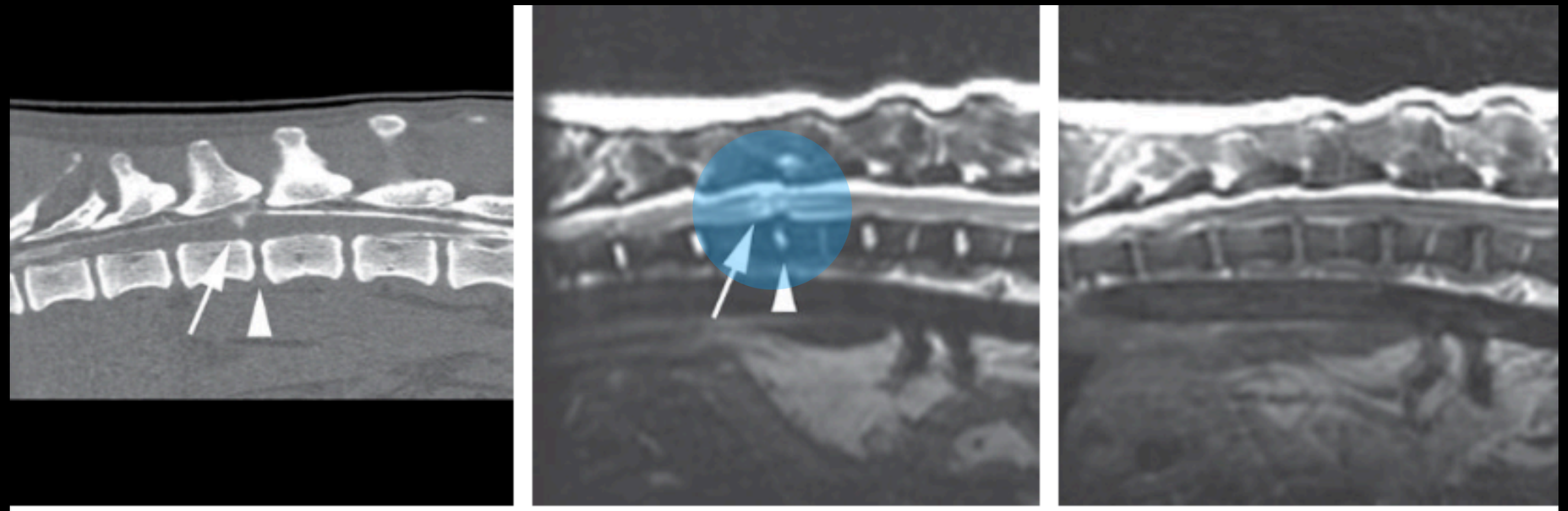


(a) T1, SP

(b) T2, SP



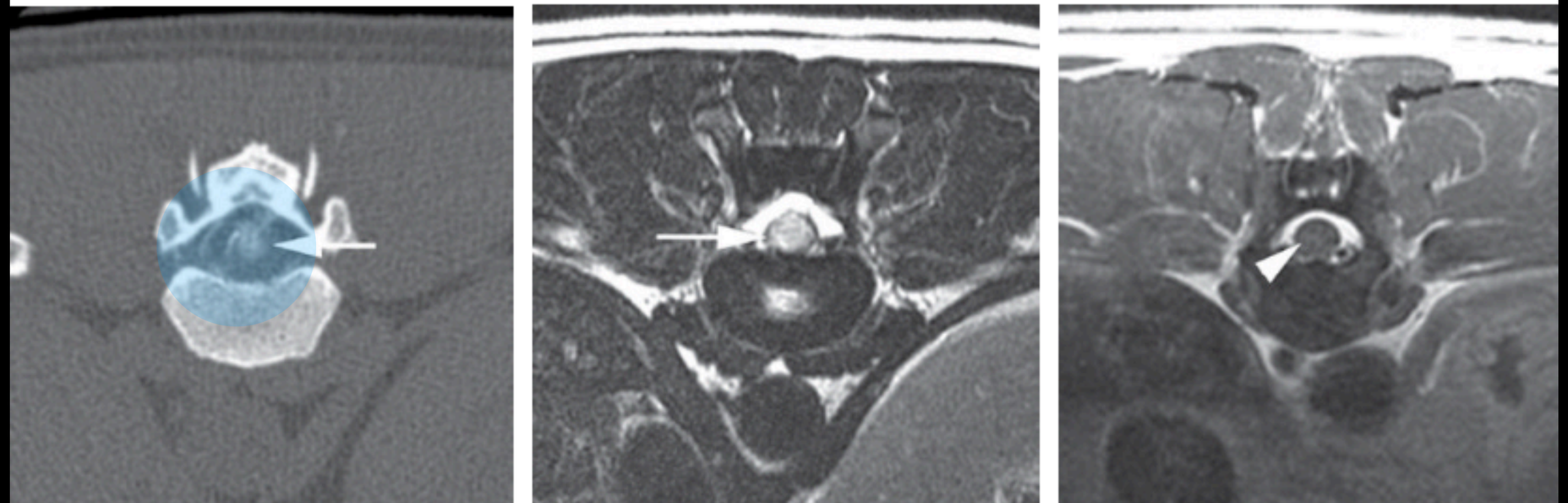
Traumatic disc hernia (Hansen III)

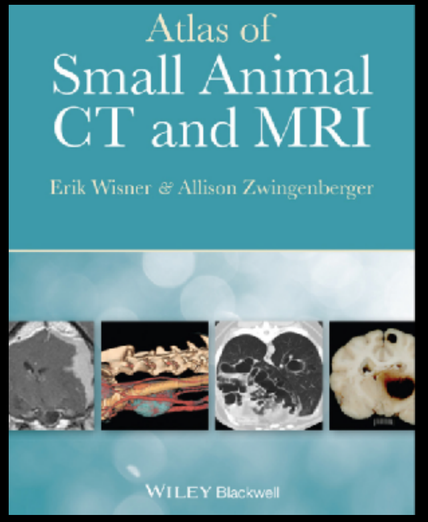


(a) CT+C, SP

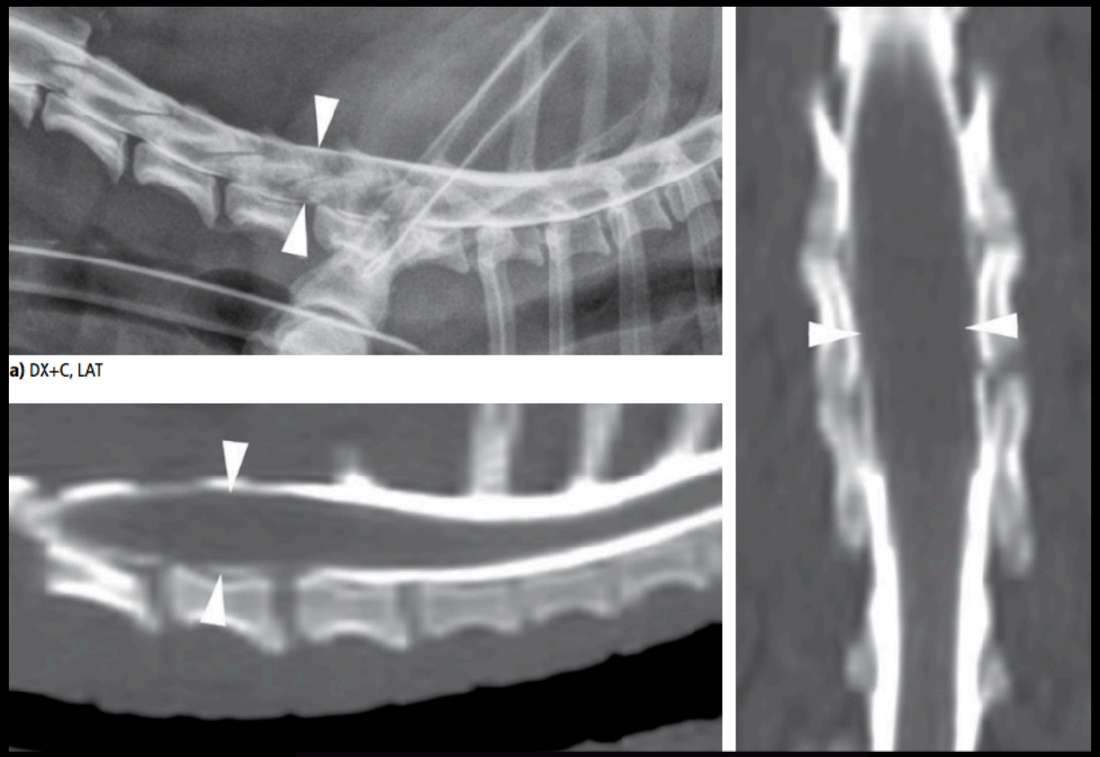
(b) T2, SP

(c) T1+C, SP

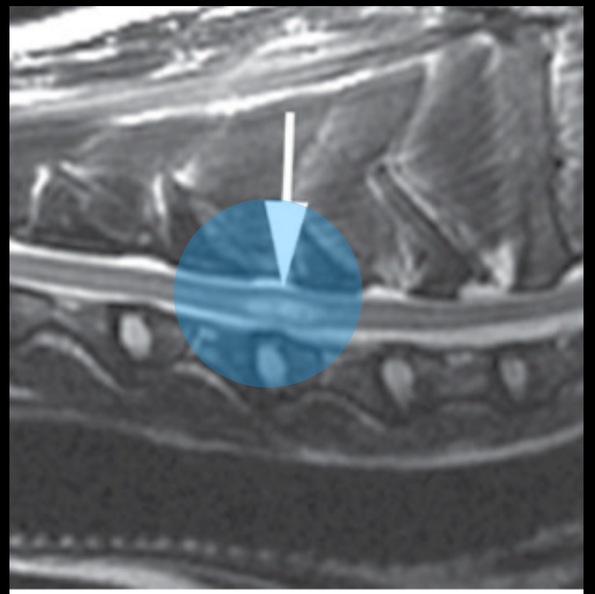




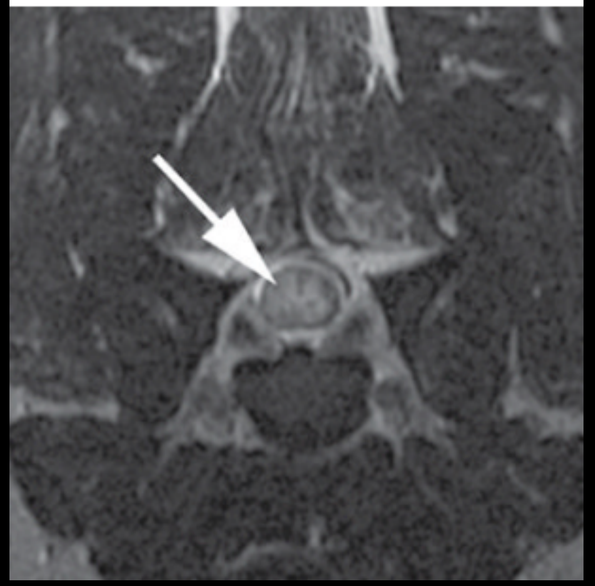
Fibrocartilaginous embolism

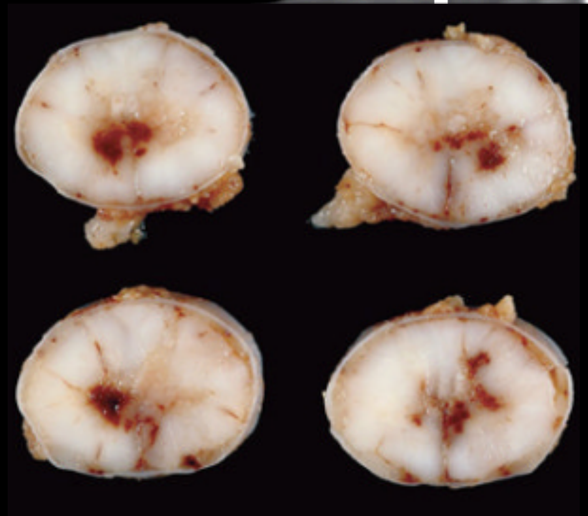


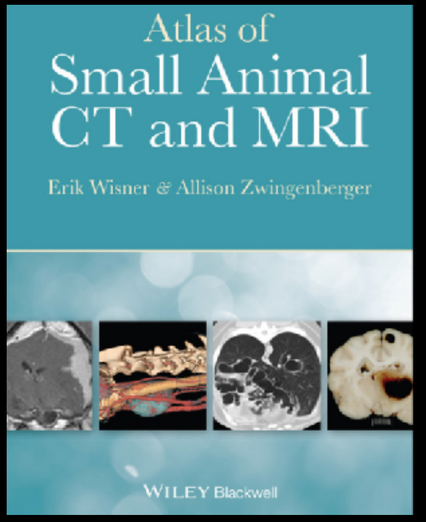
a) DX+C, LAT



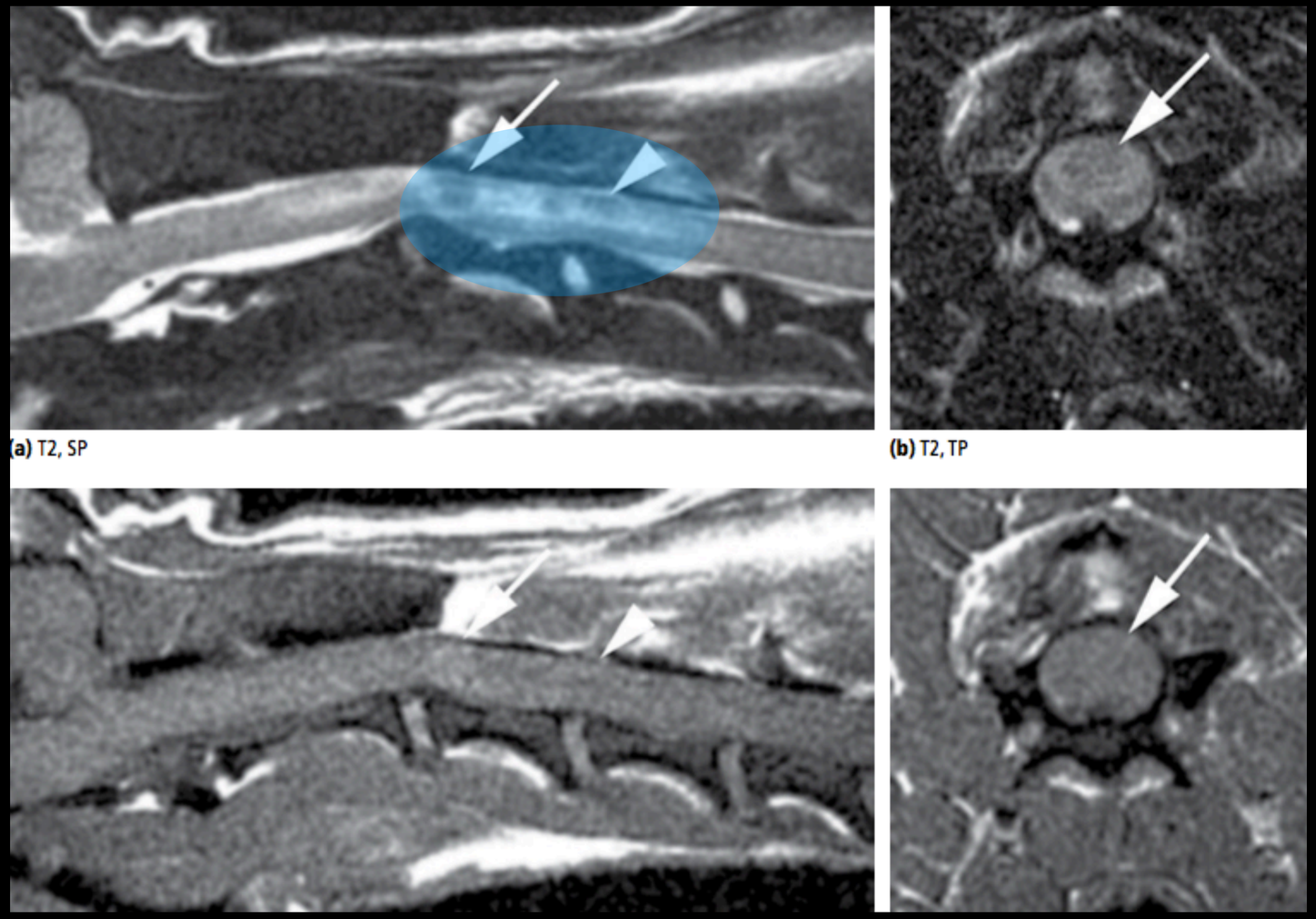
(a) T2, SP





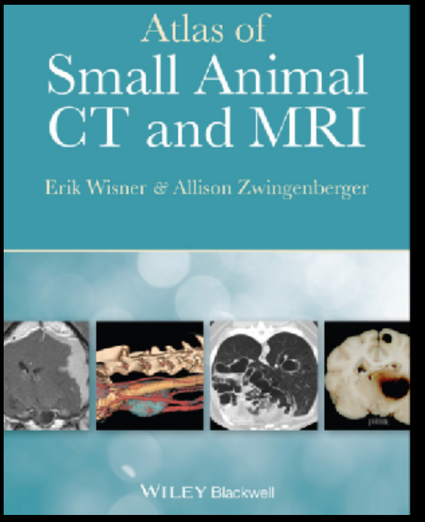


Granulomatous meningoencephalitis (GME)

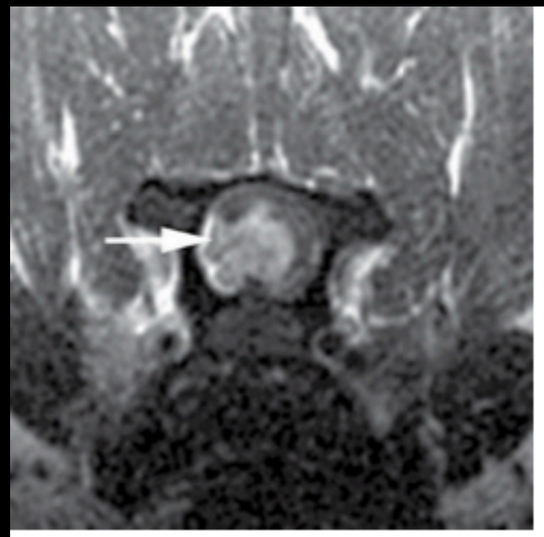


(a) T2, SP

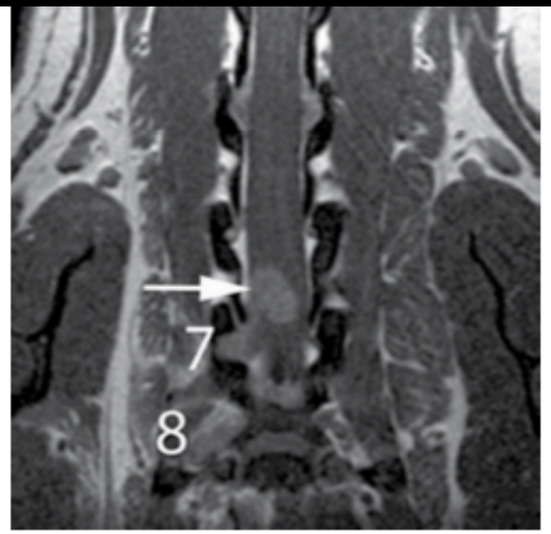
(b) T2, TP



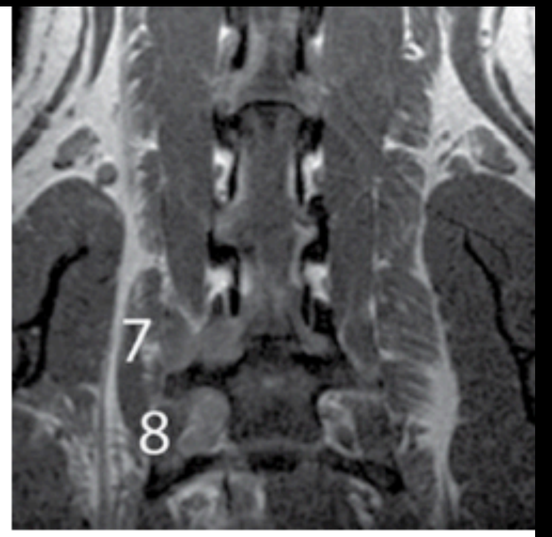
“Nerve sheath” tumor



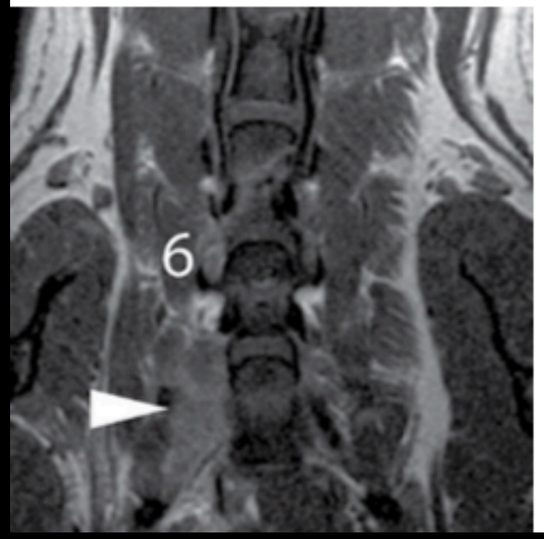
(a) T1+C, TP

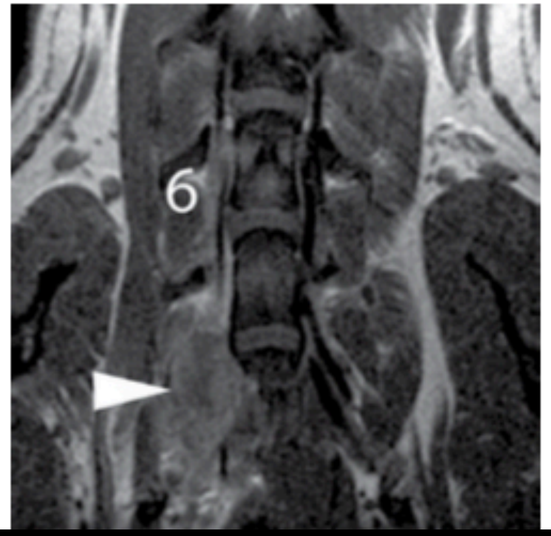


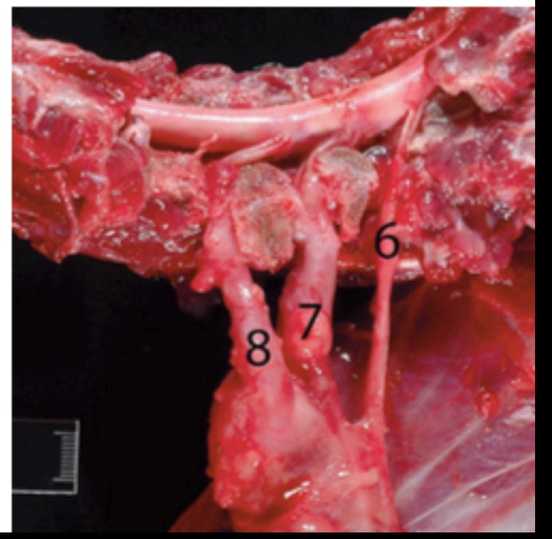
(b) T1+C, DP

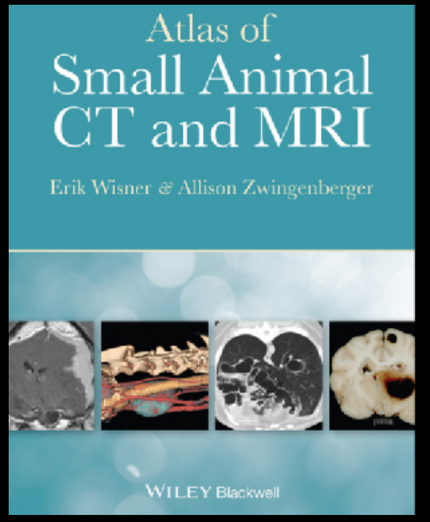


(c) T1+C, DP

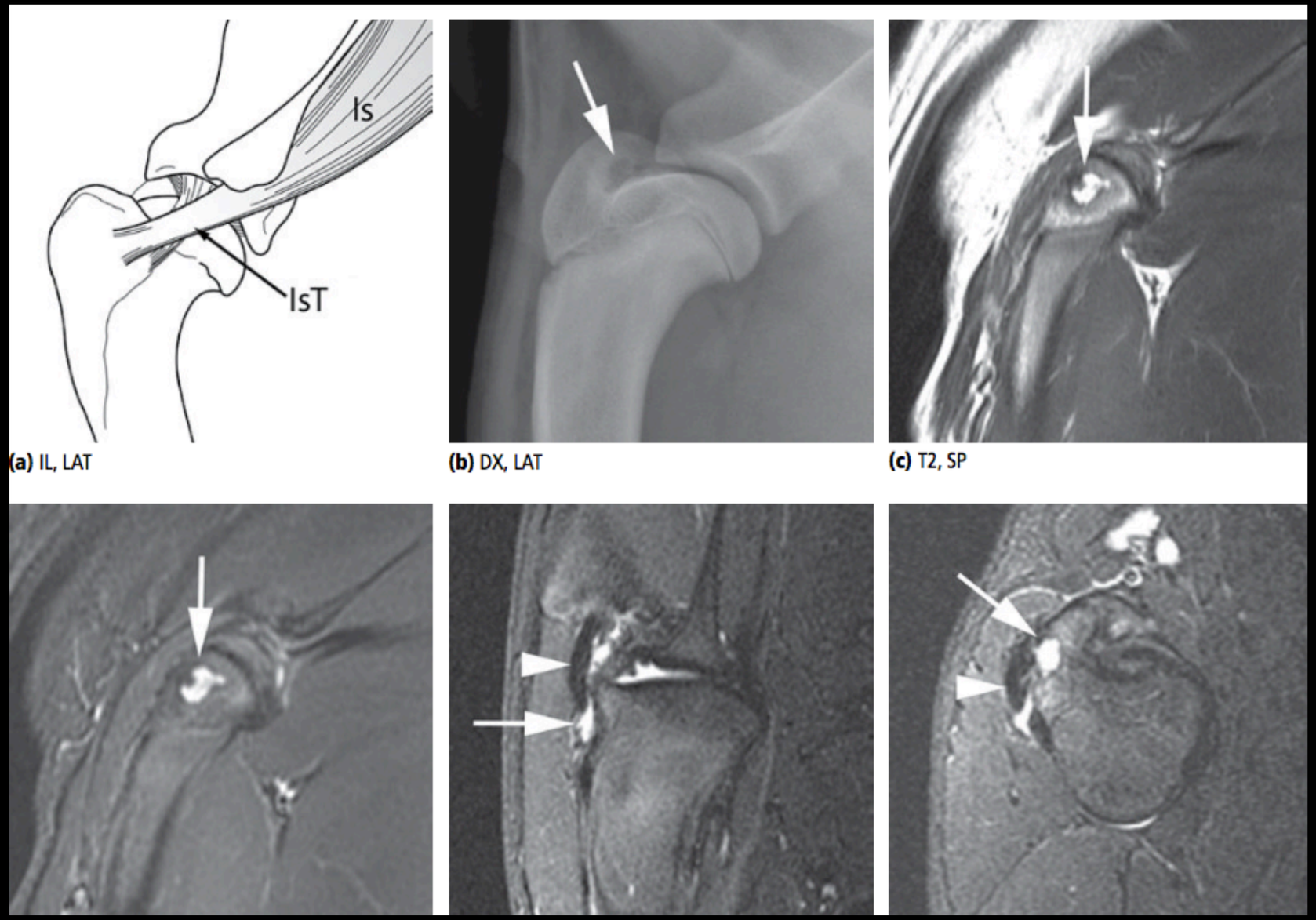


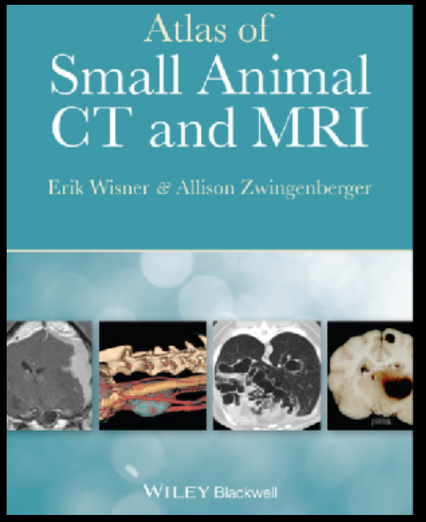






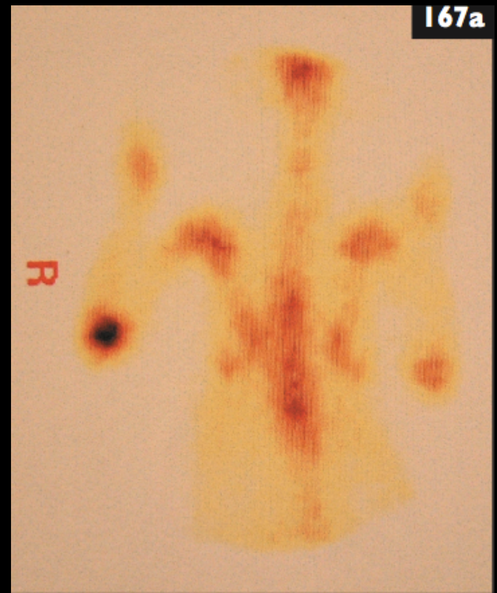
M. Infraspinatus insertionitis





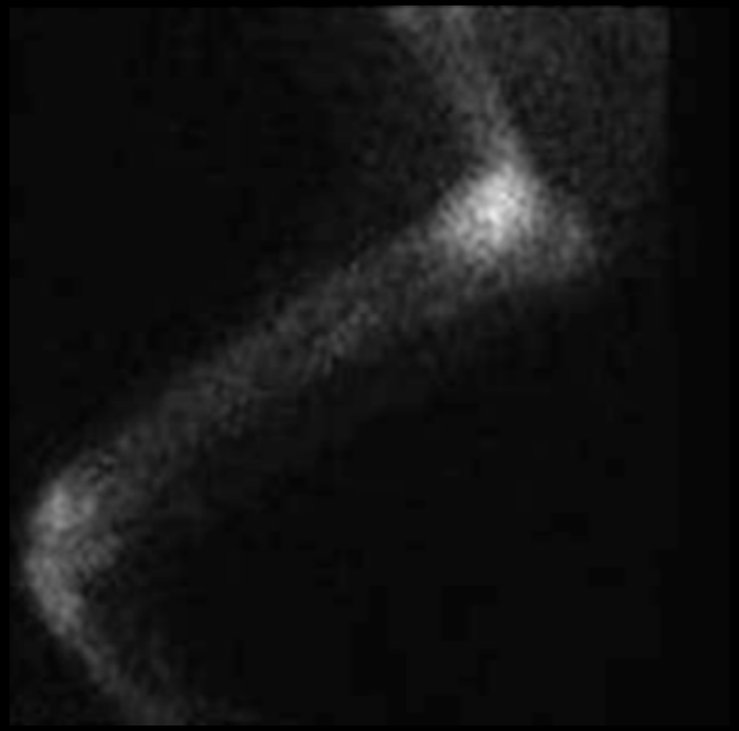
Scintiography

- Nuclear imaging technique to study bones.
- PET (positron emission tomography) CT analogy, but much cheaper.
- More sensitive than Ct and MRI , but less specific.



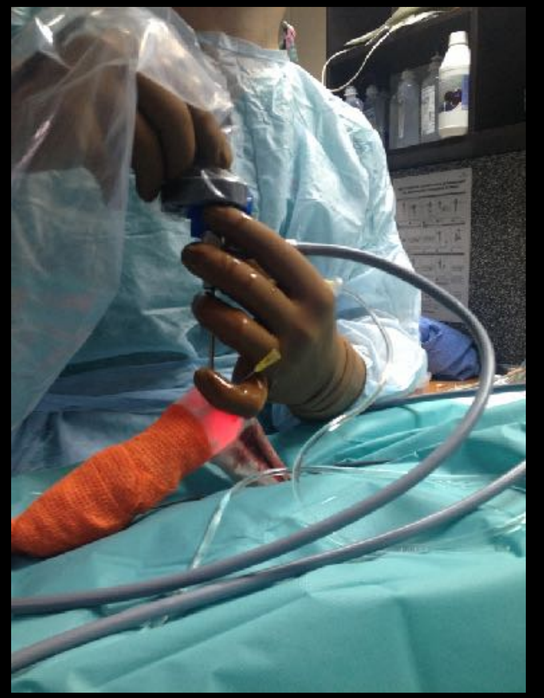
Application

- Localising bone neoplasia, metastatis, inflammation, bone fracture



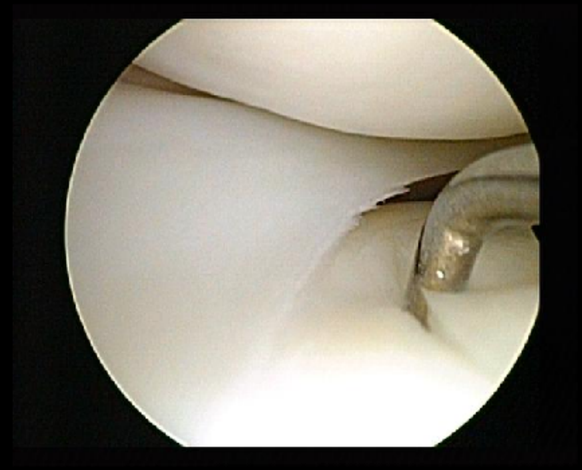
Arthroscopy

- Minimaly invasive surgical imaging technique.
- Visualasation, diagnostics, therapy.



Advantages

- Magnification, light enhancement, irrigation.
- Prefect articular surface/structures visualisation.
- Pathology treatment.
- Fast clinical recovery
- Minimal infection risk.

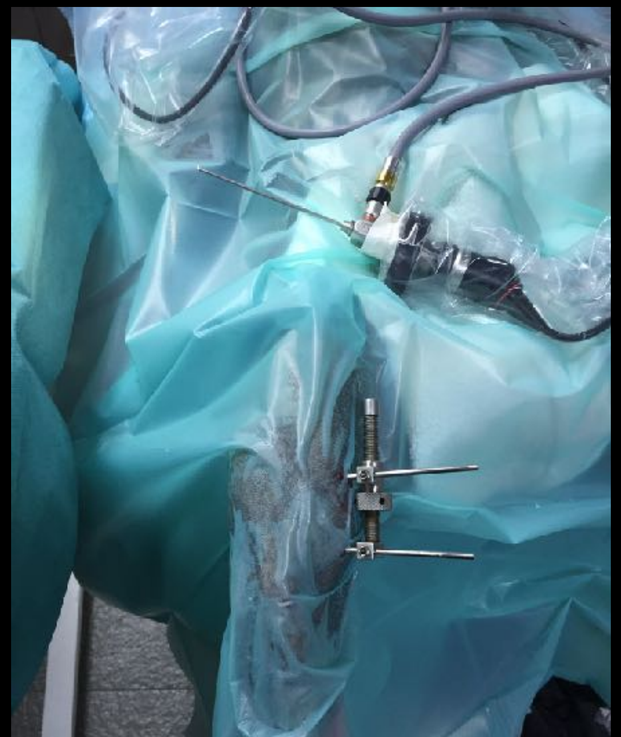


Disadvantages

- “Learning curve”
- Equipment?
- Anaesthesia, invasiveness.
- Laborious procedure

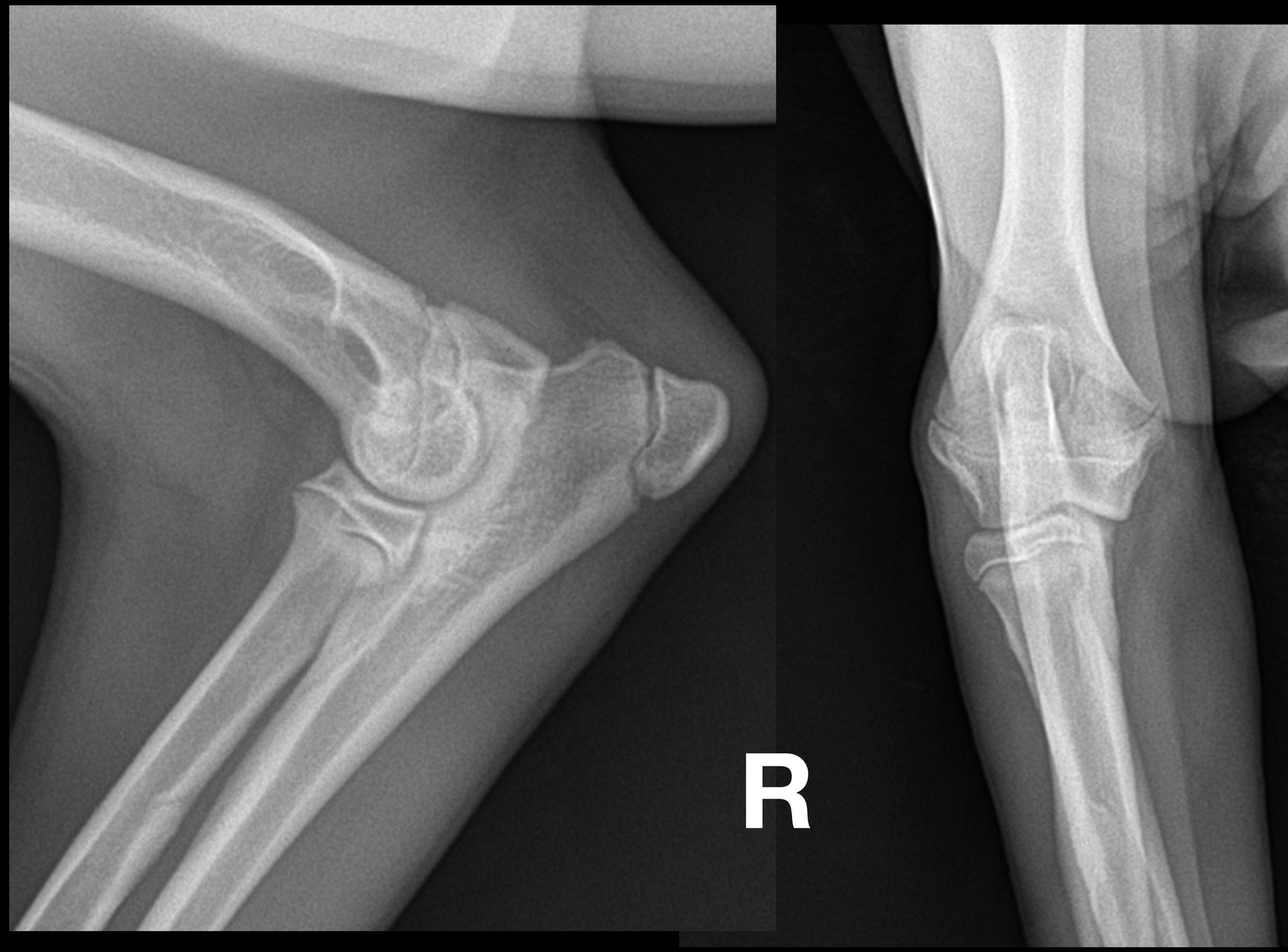
Indications

- Elbow dysplasia - fragmented medial coronoid.
- Osteochondrosis- shoulder, elbow.
- Stifle inspection- cruciate ligaments, meniscuses.



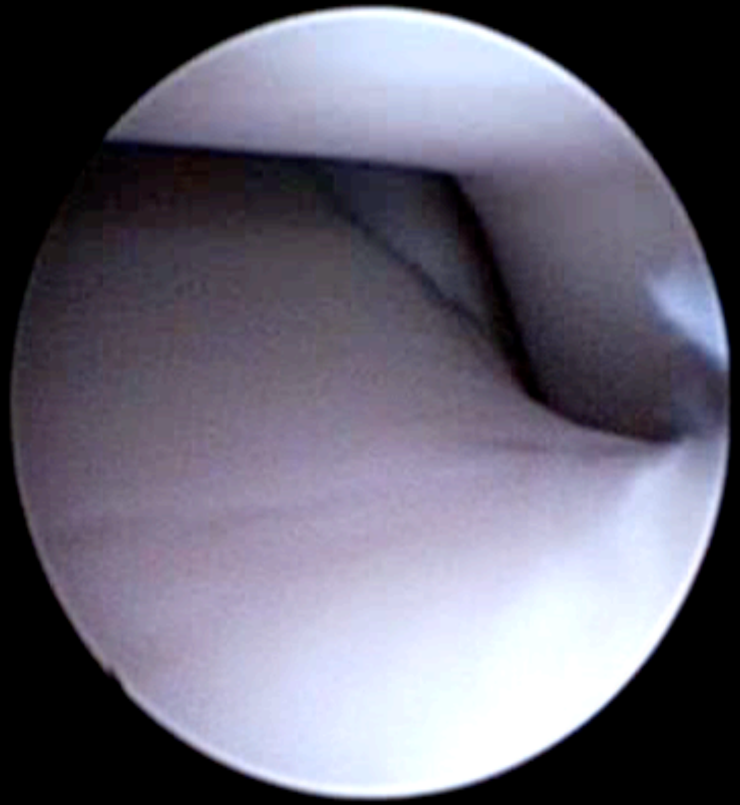
6 months old labrador.

Moderate intermitting lameness- right front.

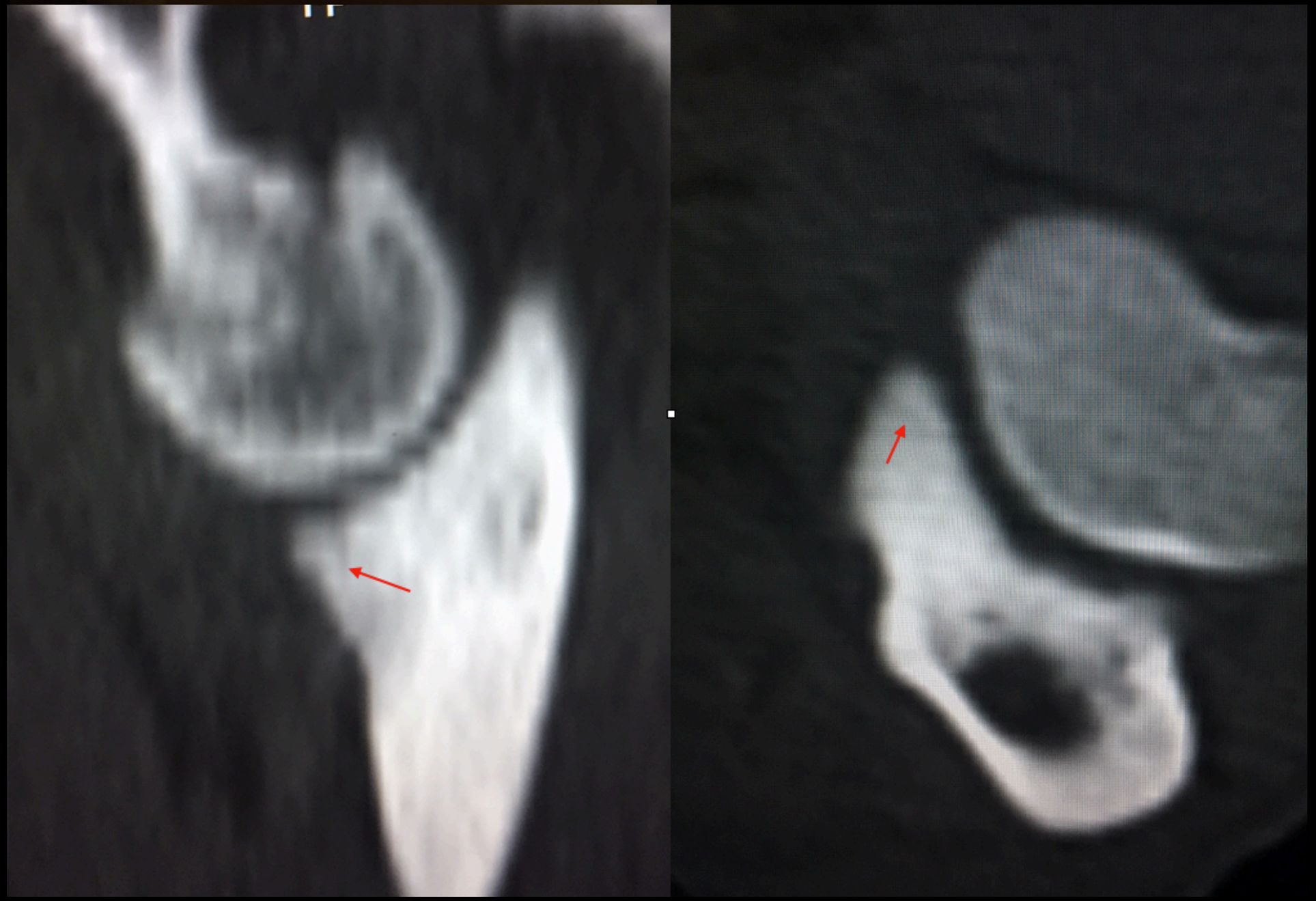


60809
Mailo

M 5
03/03/2014
09/03/2019
13:25:44
Cr:H EH:A1

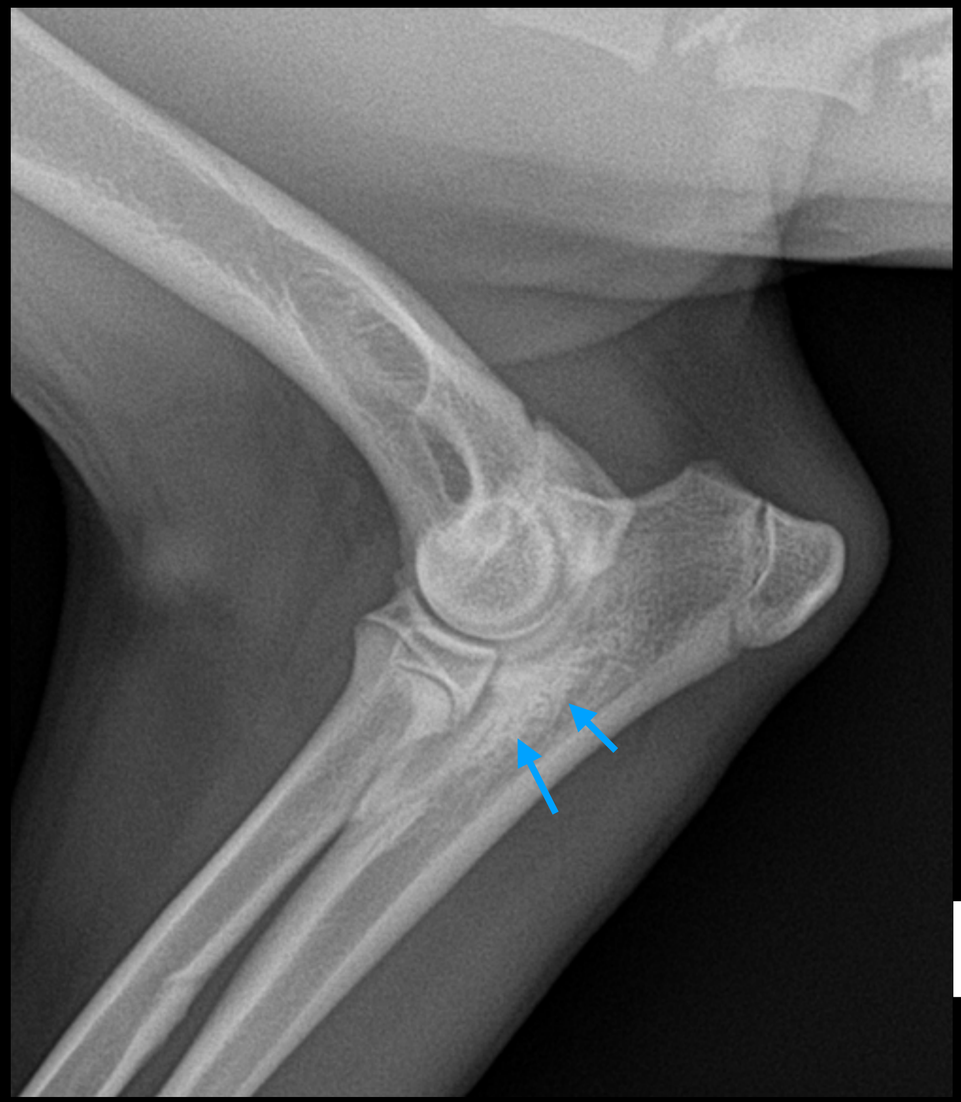


003
golden retriever



2 m f up

Permanent high degree lameness.



Second look arthroscopy

Fragmented medial coronoid

4 hours post arthroscopy

Thank you!