

Radiography

X-Ray the AAVEC Way!

Brief History of X-Radiation

- A penetrating form of high-energy electromagnetic radiation
 - Shorter than UV rays, longer than gamma rays
 - Discovered in 1895 (German scientist Wilhelm Röntgen)
 - Within first year, excitement about benefits and applications, but also discovered hazards
- Photons carry enough energy damage tissue = ionizing radiation
 - Ionize atoms
 - Disrupt molecular bonds
 - This is why we use protective gear and do what we can to reduce exposure



What exactly is a radiograph?

Projection radiography produces a two-dimensional image using x-ray radiation

- Beam of radiation is projected at a target to image
- A radiograph of nothing would appear black; solid objects appear grey/white based on density
 - Bones
 - High in calcium
 - Absorb radiation efficiently
 - Appear white (their shadow on the X-ray field)
 - Lungs/trapped gas
 - Very little absorption
 - Appear dark/black
 - Tissues
 - Mixed density
 - Absorb *some* radiation
 - Appear various shades of grey



Radiograph Terminology

Functional / Technical

Radiograph Terminology

- **kVP** - kilovoltage peak (tube voltage)
 - Highest voltage between the anode and cathode that will be produced during exposure
 - Measure of the energy/penetrating strength of an x-ray beam
 - Higher value can penetrate denser material/tissue, but also produces more scatter radiation
 - As kVP *increases*, contrast *decreases*
- **ma** - milliamperage (tube current)
 - Number of x-ray photons released from filament
 - As ma *increases*, the amount of radiation *increases*
- **mAs** - milliamperere-seconds
 - Measure of the radiation produced (**ma**, or number of photons) over a set amount of time
 - As time *increases*, the amount of exposure *increases in quantity*, not quality



Radiograph Terminology - REVIEW

- **kVP** - kilovoltage peak
 - STRENGTH of x-ray
- **ma** - milliamperage
 - NUMBER of x-rays
- **mAs** - milliamperere-seconds
 - EXPOSURE TIME of x-ray

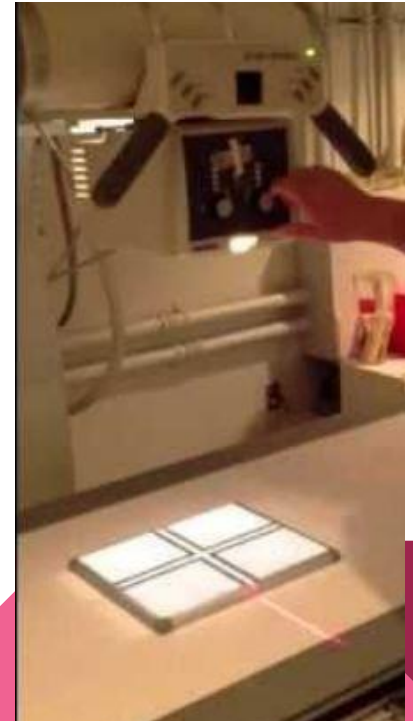
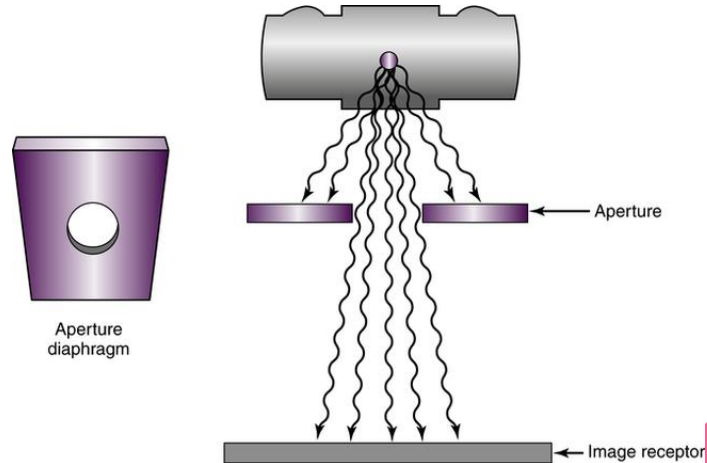


Radiograph Terminology

- **Scatter** - secondary radiation resulting from beam interacting with tissue
 - When the x-ray beam hits tissue, bone, or the table, it bounces off in various directions
 - Larger areas of tissue imaged results in more scatter
 - Increased scatter *reduces* detail and *increases* patient dose
 - It can darken the radiograph = “film fog”
- **Collimator** - metallic (lead) barrier to control the size & shape of the x-ray beam
 - *Increasing* collimation (making your field smaller)
 - *Reduces* scatter radiation
 - *Increases* contrast and *improves* image quality
 - *Reduces* patient exposure/dose (and staff exposure/dose)
 - AAHA (American Animal Hospital Association) guidelines:
 - You must show collimation on four sides

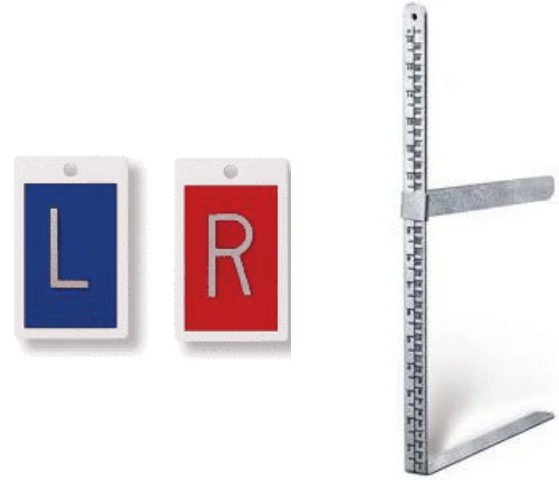
Radiograph Terminology - REVIEW

- **Scatter** - radiation from bounced beams
- **Collimator** - controls shape and size of beam



Radiograph Terminology

- **Markers** - Indicate anatomical side of patient
 - Use these every time you take a radiograph
- **Calipers** - Tool to measure the thickness of the body part being imaged
 - Measure at widest area to be imaged
- **Dosimeter** - Measures absorbed dose of ionizing radiation (individual badges per person)
 - Kept by each of the 3 Radiology Suites
 - AAVEC's dosimetry badges are kept outside of Radiology 2
 - They should be worn at collar level, outside of any PPE
 - They should be worn every time you take radiographs
 - Monthly reports provided show cumulative radiation exposure of all staff



Radiograph Terminology

- **PPE - Personal Protective Equipment**

- Lead Apron
 - Reproductive organs
- Thyroid Shield
 - Thyroid
- Gloves/Mitts
 - Hands/fingers
- Eyeglasses
 - Eyes



Directional Terminology

Directional Terminology

Dorsal

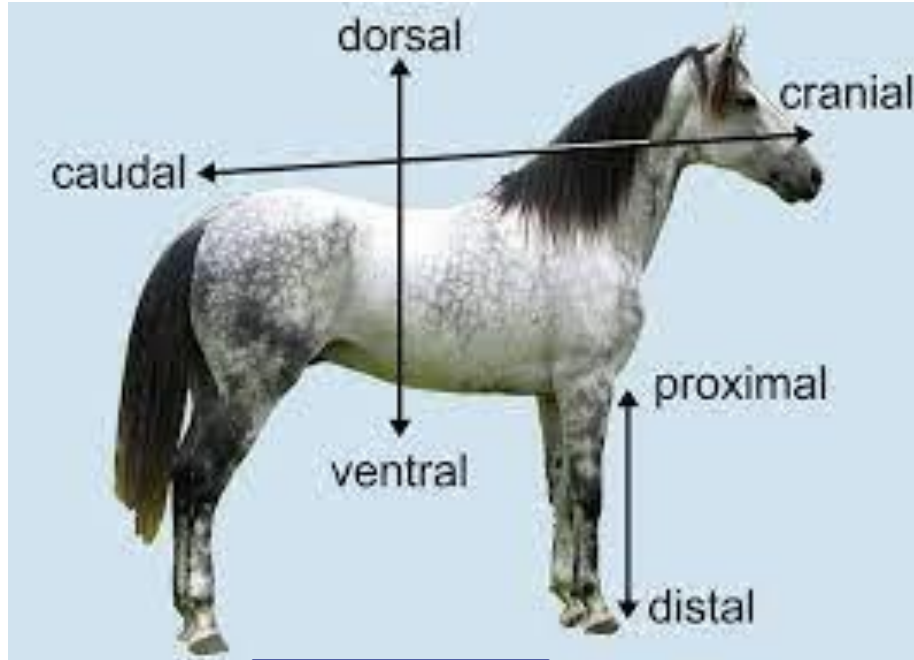
Toward the back

Caudal

Toward the tail

Posterior*

Toward the back



Cranial

Toward the head

Anterior*

Toward the front

Proximal

Closer to the center/heart

Distal

Farther from the center/heart

Ventral

Toward the belly

Dorsal

Toward the back

Cranial

Toward the head

Rostral

Toward the nose

Proximal

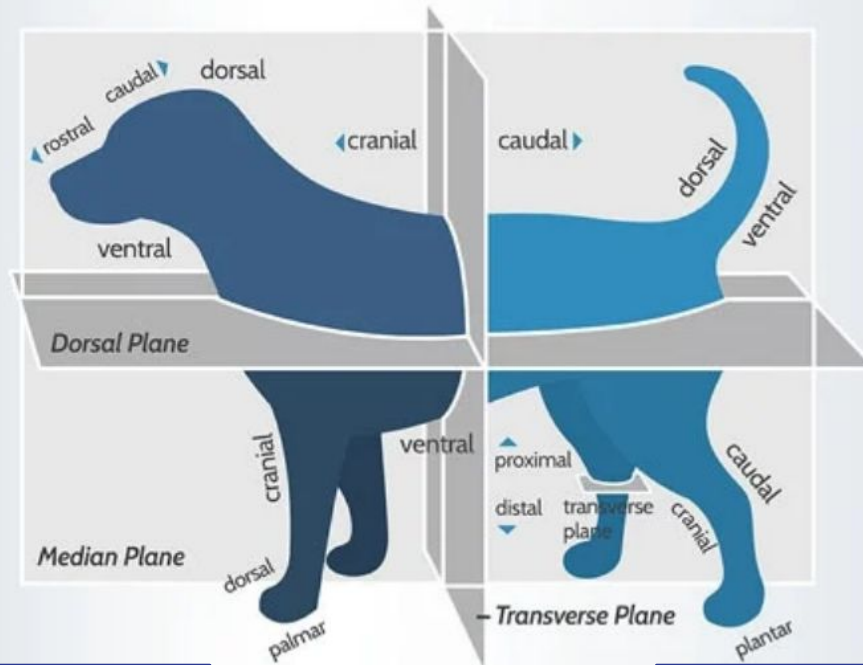
Closer to the center/heart

Distal

Farther from the center/heart

Caudal

Toward the tail



Palmar

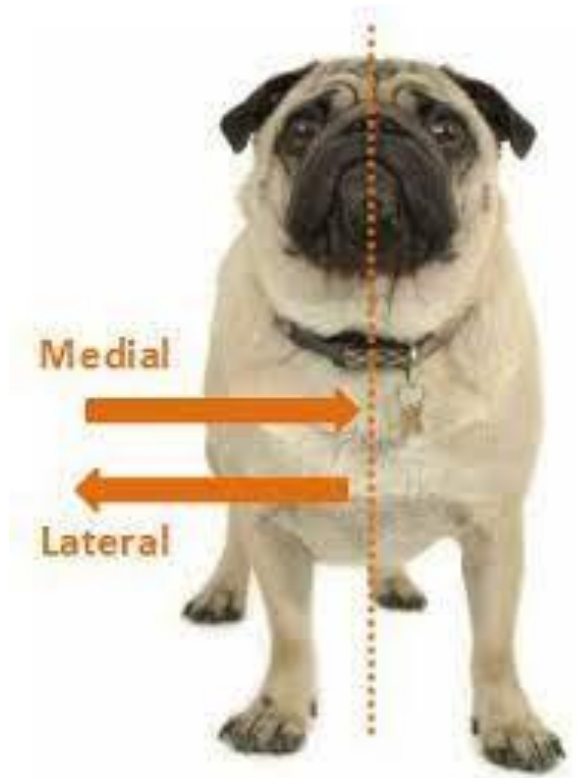
Bottom surface
of the front
paw/foot

Ventral

Toward the belly

Plantar

Bottom surface
of the rear
paw/foot



Dorsal
Toward the back

Ventral
Toward the belly

Lateral
Away from midline

Medial
Toward the midline

Radiograph Terminology

Images / Techniques

Radiograph Terminology

- **Right or left lateral** - lateral view of animal
 - Animal is positioned lying on its side on the X-ray table
 - The **DOWN** side is the one that will be labeled
 - Right lateral = right side DOWN
 - Can be for trunk of body or extremities
- **V/D** - ventrodorsal view of animal
 - Animal is positioned lying on its back, belly up
 - Use a V-tray to help keep spine straight
 - Beam passes through **VENTRAL** aspect first, then **DORSAL** aspect
- **D/V** - dorsoventral view of animal
 - Animal is positioned lying with its belly on the table
 - Beam passes through **DORSAL** aspect first, then **VENTRAL** aspect
- **CrCd (A/P)** - craniocaudal (anterior-posterior) view
 - Variety of positions possible for patient comfort, depending on body part
 - Usually a limb
 - Beam passes through **CRANIAL** aspect first, then **CAUDAL** aspect
- **CdCr (P/A)** - caudocranial (posterior-anterior) view
 - Variety of positions possible for patient comfort, depending on body part
 - Usually a limb
 - Beam passes through **CAUDAL** aspect first, then **CRANIAL** aspect

Radiograph Terminology

- **Right or left lateral** - lateral



- **V/D** - ventrodorsal



- **D/V** - dorsoventral



- **CrCd (A/P)** - craniocaudal (anterior-posterior)

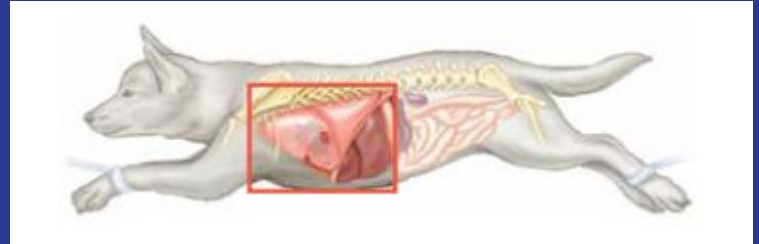
- **CdCr (P/A)** - caudocranial (posterior-anterior)



Common Radiographs

Thoracic: Lateral

- Center on heart
 - Use elbow as approximate
- Border landmarks:
 - Cranially, up to manubrium to include thoracic inlet
 - Caudally, include all lung fields (up to diaphragm) by measuring to halfway between xiphoid and last rib
- Pull forelimbs forward as much as patient allows
 - Helps avoid triceps/tissue from superimposing on thorax
- Allow neck to remain in neutral position
- Capture image at peak inspiration for expanded lungs and best image

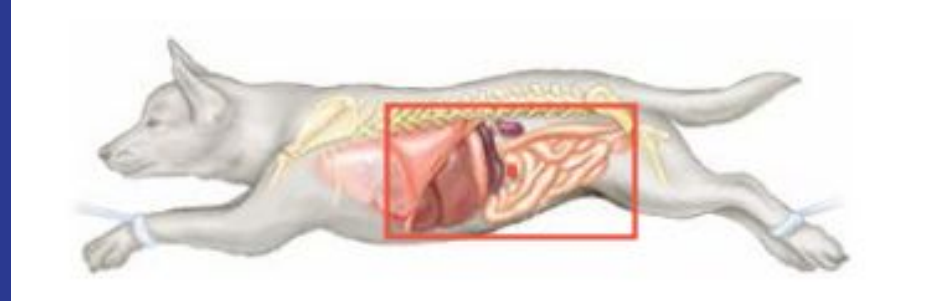


Thoracic: V/D



Abdominal: Lateral

- Center on last (13th) rib
 - Palpate to align correctly
- Border Landmarks:
 - Cranially, 3 intercostal spaces cranial of xiphoid process to (include entire diaphragm)
 - Caudally, the greater trochanter of the femur
- Extend hindlimbs as much as patient allows
- Capture image at peak expiration (breathing out) - allows diaphragm to move cranially, reducing compression of abdominal organs



Abdominal: V/D



Pelvic: Lateral

- Center on greater trochanter of femur
- Position target limb/affected side DOWN
- Superimpose hemipelves so that femoral heads line up
- Border landmarks:
 - Cranially, the iliac crest
 - Caudally, the ischiatic tuberosity or perineal skin margin
 - Dorsally, the pelvic skin margin
 - Ventrally, the stifle joints
- Pull **down** leg cranially and **up** leg caudally



Pelvic: V/D

- Use V-trough to stabilize thorax & align spine
- Position entire pelvis **outside** of V-trough
 - Avoids superimposed artifact
 - Decreases geometric magnification
- Border landmarks:
 - Cranially, the iliac crest
 - Caudally, the stifle joints
 - Laterally, the left and right skin margins
- With extended pelvic limbs, internally rotate femurs
 - Femurs should be parallel to each other
 - Femurs should be parallel to table
 - Proper alignment centers each patella within its trochlear groove



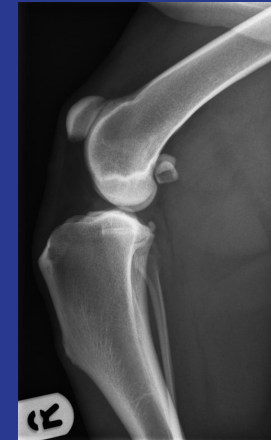
Pelvic: Frog-Leg

- Use V-trough to stabilize thorax & align spine
- Position entire pelvis **outside** of V-trough
 - Avoids superimposed artifact
 - Decreases geometric magnification
- Border landmarks:
 - Cranially, the iliac crest
 - Caudally, the ischiatic tuberosity
 - Laterally, to mid-femur
- Good for
 - DJD
 - Pelvic fractures
 - Femoral head/neck fractures
 - Extended can reduce fracture
 - “Distraction” = widening



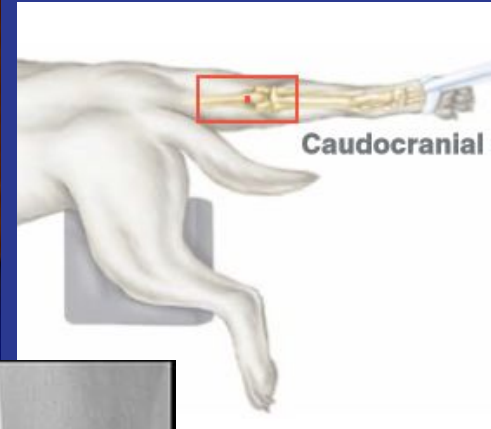
Extremity: Stifle

- Center on stifle joint = knee joint
- Target limb/side should be DOWN
- Border landmarks:
 - Include up to mid-femur
 - Include down to mid-tibia/fibula
- Femoral condyles should be superimposed
- Relaxed or slightly flexed joint
 - For TPLO, 90° is ideal
- Top leg needs to be pulled out of field
 - Usually laterally/dorsally
 - May be able to pull cranially



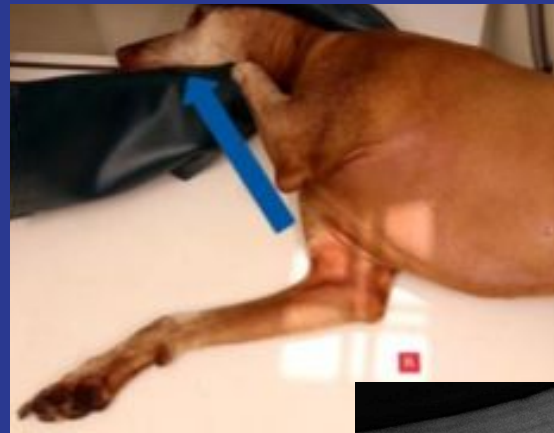
Extremity: Stifle

- Center on stifle joint = knee joint
- CdCr (caudo-cranial) technique
- Border landmarks:
 - Include up to mid-femur
 - Include down to mid-tibia/fibula
 - Skin margins on both sides
- Can use V-trough to support and keep thorax straight
- CrCd (craniocaudal) technique results in the most magnification and geometric distortion
 - Patient is in dorsal recumbency in V-trough
 - Target limb is not as close to table



Extremity: Elbow

- Center on medial epicondyle/joint space
- Target limb/side should be DOWN and parallel to table
- Border landmarks:
 - Include up to $\frac{1}{4}$ of the humerus
 - Include down to $\frac{1}{4}$ of the antebrachium (forearm)
- Humeral epicondyles should be superimposed
- Relaxed joint
 - Also include a flexed view
- Top leg needs to be pulled out of field
 - Can be pulled cranially if out of field
 - Can be pulled caudally along thorax



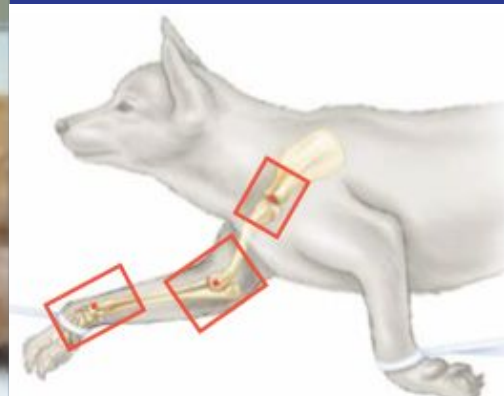
Extremity: Elbow

- Center on medial epicondyle/joint space
- Limb should be parallel to table
- Need good forelimb extension, pull cranially
- Border landmarks:
 - Include up to $\frac{1}{4}$ of the humerus
 - Include down to $\frac{1}{4}$ of the antebrachium (forearm)
- Ensure true CrCd (craniocaudal) positioning
 - Roll patient's body slightly TOWARD target elbow
 - Rotate carpus externally to shift elbow under limb
- Head and neck should be turned to be out of field



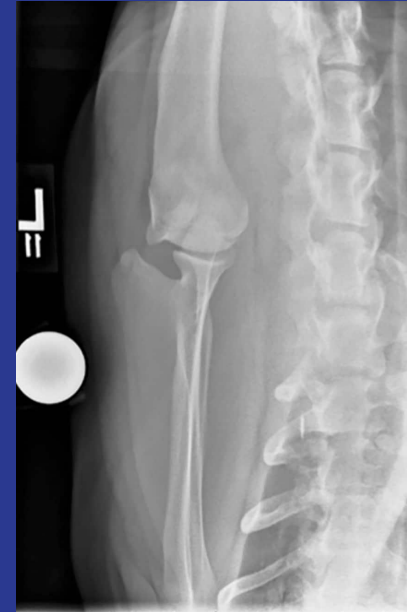
Extremity: Shoulder

- Center on shoulder joint cranial to thoracic inlet
- Target limb/side should be DOWN and parallel to table
- Border landmarks:
 - Include distal $\frac{1}{3}$ of the scapula
 - Include proximal $\frac{1}{3}$ of the humerus
- Head and neck should be extended dorsally
 - Prevents superimposition of C-spine
- Pull target/affected limb cranially and distally from neck
- Top leg needs to be pulled out of field
 - Should be pulled caudally along thorax



Extremity: Shoulder

- Caudocranial (CdCr) technique
- Center on axillary joint space
- Target limb/side humerus should be parallel to table
- Border landmarks:
 - Include half of the scapula
 - Include half of the humerus
 - Thoracic inlet = medial border
 - Skin margin = lateral border
- Use tape or gentle limb rotation to ensure elbows are pointing up
- Other leg and head/neck should be out of field
 - May need bilateral shoulders



Extremity: Antebrachium

- Center midway between elbow and carpus
- Target limb pulled cranially and away from thoracic cavity
- Border landmarks:
 - Distal humerus
 - Digits, or at least entire carpal joint
 - Skin margin on both sides
- **Lateral** - head extended dorsally and top limb pulled caudally
- **CrCd** - unaffected limb bent naturally with head resting on top
- Can use a V-trough to stabilize lower body, but limb should not be in trough.



Spinal Rads

- Spine is composed of three parts
 - Cervical spine (cranial section)
 - C₁ - C₇ vertebrae
 - Atlas & axis = top two vertebrae
 - Thoracic spine (middle section)
 - T₁ - T₁₃ vertebrae
 - Vertebrae articulate with ribs
 - Lumbar spine (caudal section)
 - L₁ - L₇ vertebrae
 - Sacrum and coccygeal vertebrae caudal to L-spine



Spinal Rads: Cervical

- Cervical spine - lateral
 - Neck in neutral position
 - Center at C₃-C₄ vertebrae
 - Borders:
 - Cranially, base of skull
 - Caudally, T₂ vertebrae
 - Extend forelimbs caudally (don't rotate thorax)
 - Transverse processes should overlap
- Cervical spine - V/D
 - Neck in neutral position
 - Straight, not rotated (spinous processes should be equal size)
 - Avoid hyperextension
 - Center at C₃-C₄ vertebrae
 - Borders:
 - Include entire C-spine
 - V-trough to stabilize thorax
 - Foam under neck to support



Spinal Rads: Thoracic

- Thoracic spine - lateral
 - Center at T₆-T₇ vertebrae
 - Borders:
 - Cranially, just cranial to the manubrium
 - Caudally, ~2" caudal of xiphoid
 - Dorsally, the spinous processes
 - Ventrally, only include the dorsal half of thoracic cavity
 - Pull forelimbs cranially & hindlimbs caudally
 - Use foam wedges = prevent thoracic rotation
- Thoracic spine - V/D
 - Center at T₆-T₇ vertebrae
 - Use a V-trough for spinal alignment
 - Entirety of thoracic spine should be in V-trough
 - Borders:
 - Cranially, just cranial to the manubrium
 - Caudally, ~2" caudal of xiphoid
 - Pull forelimbs cranially & hindlimbs caudally
 - Extend and align the head and neck
 - Sternum should superimpose thoracic spine



Spinal Rads: Lumbar

- Lumbar spine - lateral
 - Center at midpoint of lumbar vertebrae
 - Borders:
 - Cranially, thoracolumbar junction
 - Caudally, iliac crest/greater trochanter of the femur
 - Dorsally, the spinous processes
 - Ventrally, only include the dorsal half of abdominal cavity
 - Pull forelimbs cranially & hindlimbs caudally
 - Use foam wedges to prevent rotation
- Lumbar spine - V/D
 - Center at midpoint of lumbar vertebrae
 - Use a V-trough for spinal alignment
 - Entirety of thoracic and lumbar spine should be in V-trough
 - Borders:
 - Cranially, cranial to xiphoid of sternum
 - Caudally, caudal to the iliac crest
 - Pull forelimbs cranially & hindlimbs caudally
 - Sternum should superimpose thoracic spine



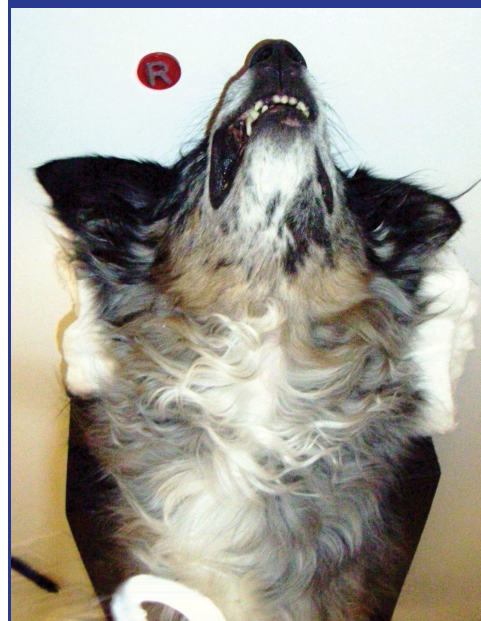
Extremity: Digits

- Digits - lateral
 - Center at middle of metacarpal bones
 - Borders:
 - Proximally, include the carpus
 - Distally, include the nails
 - Lateral recumbency
 - Extend limb with stretch gauze or tape
 - Spread phalanges to avoid superimposition of digits
 - Use cotton balls between toes
 - OR
 - Use stretch gauze around nail & pull
 - Pull digit II dorsally & digit V palmar
- Digits - A/P or CrCd
 - Center at center of digits/mid-paw
 - Borders:
 - Proximally, include the carpus
 - Distally, include the nails
 - Sternal recumbency
 - Extend limb cranially



Extremity: Skull

- Skull - lateral
 - Superimpose mandibular rami
 - Use padding under nose and mandible
 - Include entire head
 - Borders:
 - Tip of the nose
 - Skull base
- Skull - V/D
 - Dorsal recumbency, V-trough to align
 - Head should not be in V-trough
 - Forelimbs pulled caudally
 - Nose parallel to table
 - Can use stretch gauze behind maxillary canine teeth to position
 - Include entire head
 - Borders:
 - Tip of the nose
 - Skull base



Extremity: Skull

- Skull - Open Mouth Tympanic Bullae View
 - Dorsal recumbency, rostral-caudal view
 - Head should not be in V-trough
 - Nose pointing upward
 - Use stretch gauze behind maxillary canines to pull nose 10°-15° cranially
 - Use stretch gauze behind mandibular canines to open mouth wide
 - Include entire nasopharyngeal region
- Skull/Jaw - Open-Mouth Maxilla
 - Dorsal recumbency, rostral-caudal view
 - Head should not be in V-trough
 - Maxilla parallel to table
 - Can use stretch gauze across hard palate to position
 - Use stretch gauze behind mandibular canines to open mouth wide
 - Requires angling tube head of X-ray about 20° to direct beam inside mouth



Extremity: Skull

- Maxillary Obliques
 - Lateral recumbency
 - Head rotated to $\sim 45^\circ$ ventrally
 - Affected maxillary side closer to table
 - Mouth propped open by radiolucent object
 - Syringe casing
 - Tongue depressor
- Mandibular Obliques
 - Sternal or lateral recumbency
 - Head rotated to $\sim 45^\circ$
 - Affected mandible closer to table
 - Mouth propped open by radiolucent object
 - Syringe casing
 - Tongue depressor





Special Circumstance Radiographs

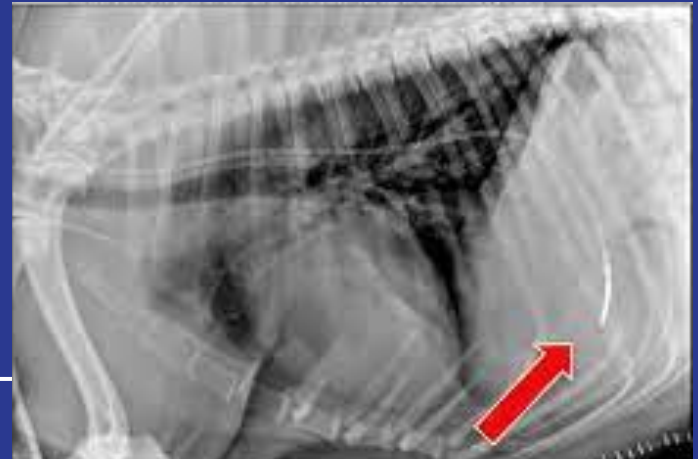
Urinary Catheter Placement

- Want to visualize entire urethra
- Hind limbs extended allows best visualization of bladder
- DVM may ask for hind limbs to be pulled cranially
 - May help visualize distal urethral stone(s) that would otherwise be obscured



NE/NG tube

- Want to get thoracic image, but include neck
- Confirms appropriate placement
 - In esophagus not trachea
 - Correct insertion distance



Barium Studies

- Determine obstruction in esophagus, stomach, or intestines
- Speed is key
 - Administer barium dose orally
 - Rapid imaging to get best images, especially of cranial structures



Other Contrast Studies

- Barium or other radiopaque medium
 - Positive contrast
- Determine urinary bladder leakage, urethral tears
 - Use urinary catheter to inject solution
 - Do NOT use Barium in bladder
- Determine lower GI/large bowel conditions and the ileo-ceco-colic junction
 - Give as enema
- Speed is key





Bad Rads!

Top 4 “Rad” Crimes

Don't Be Guilty of Committing These Crimes!

Fingers/Human Anatomy in Image

- OSHA Violation
- Personal Safety/Radiation Exposure
- Unprofessional Radiograph

Mislabeled Image or Wrong Patient Info

- Diagnostic errors, may have severe repercussions
- Misidentified limbs/sides, incorrect patient info
- Unprofessional Radiograph

Extraneous Items in Image

- Collars, tags, harnesses, etc.
- May be unavoidable in some cases (aggressive animal)

Patient Motion

- A moving target causes blurry images
- Diagnostically useless
- Don't be afraid to communicate with DVMs, ask for sedation, or additional help with restraint



How to Set Up for Rads

Setting Up Radiographs - Search Screen

Search:

- By name

- By Pt. ID

Search

1 Day 2 Days 1 Week 2 Weeks 1 Month All

Patient: CP(CLEOPATRICK) **ID:** AAVEC_147825 **Owner:** RAUSCHER **Total Studies:** 1

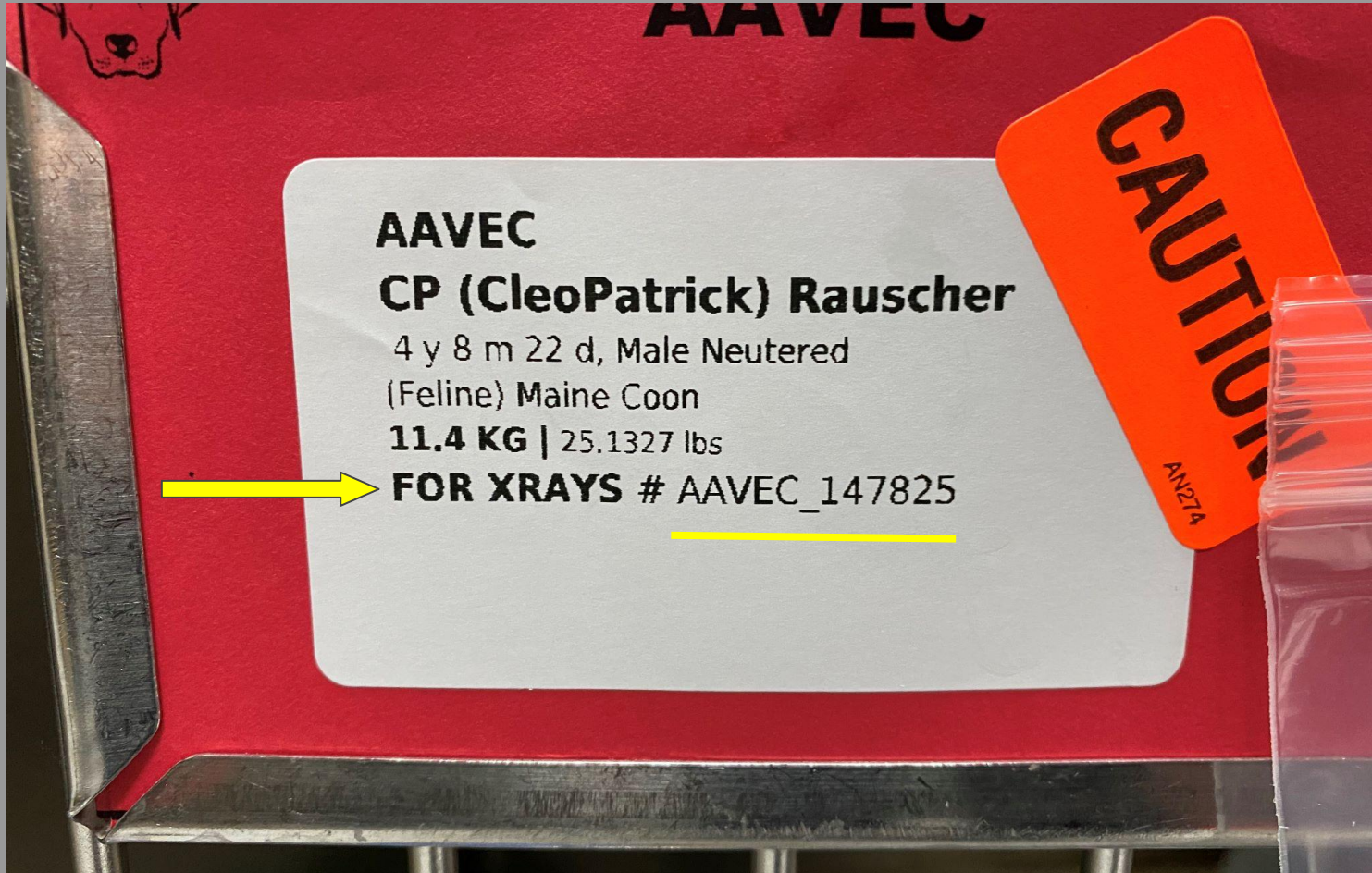
Species: Feline Breed: Weight: 11.400 kg Sex:

tube placement - LR/

Date: 10/18/2021 Sent: 3 of 3

Patient: FINN	ID: 360857	Total Studies: 1
Patient: SANDY PAW	ID: 356756	Total Studies: 3
Patient: LUKE	ID: 355121	Total Studies: 1
Patient: LEO	ID: 360846	Total Studies: 1
Patient: LEA	ID: 360837	Total Studies: 2
Patient: TATERTOT SCHLOBOHM	ID: AAVEC_134936	Total Studies: 1
Patient: BLU	ID: 360841	Total Studies: 1

Setting Up Radiographs - Animal ID Card



Setting Up Radiographs - Patient Information Screen

REQUIRED:

- Pt. name

- Pt. ID
(entire ID)

- Weight

- Species

- Owner last
name

- Other fields
optional

Edit Patient Information

Patient First Name: CP(CLEOPATRICK)

Patient Last Name:

Patient ID: AAVEC_147825

Weight: 11.400 kg

Species: Feline

DOB: Years: Months:

Breed:

Sex:

Secondary Patient ID:

Edit Owner Information

Owner Last Name: RAUSCHER

Owner First Name:

Email Address:

Cancel Save

Right Forelimb

Right Hindlimb

Setting Up Radiographs - X-Ray Selection Screen

Protocols

CP(CLEOPATRICK)
ID: AAVEC_147825
Study Description: THORAX - LR

Select Region

- Body
- Left Forelimb
- Left Hindlimb
- Right Forelimb
- Right Hindlimb

Select Anatomy

- Abdomen
- CSpine
- Pelvis
- Skull
- Spine
- Thorax**
- Whole Body

Select Shots

- DV
- DV Obl Left
- DV Obl Right
- Lat Left
- Lat Right
- VD
- VD Obl Left
- VD Obl Right

Shotlist

- Body Thorax Lat Right

Navigation: ← →

Choose rads:

- Region

- Anatomy

- Shots

Description:

- Anatomy

- Initials



Setting Up Radiographs - X-Ray Labeling Screen

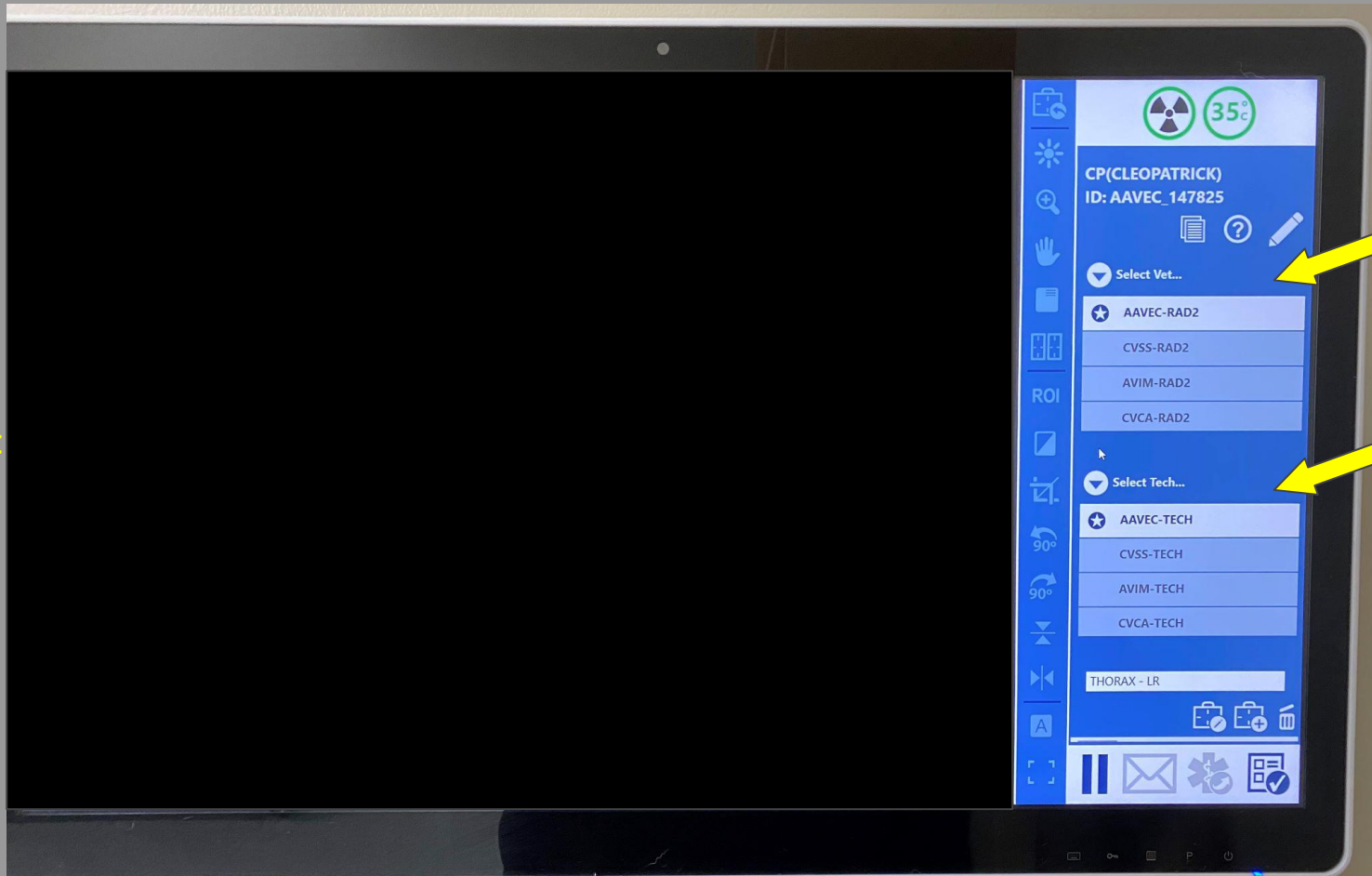
Select Vet:

- AAVEC

- 1, 2, 3
= suite

Select Tech:

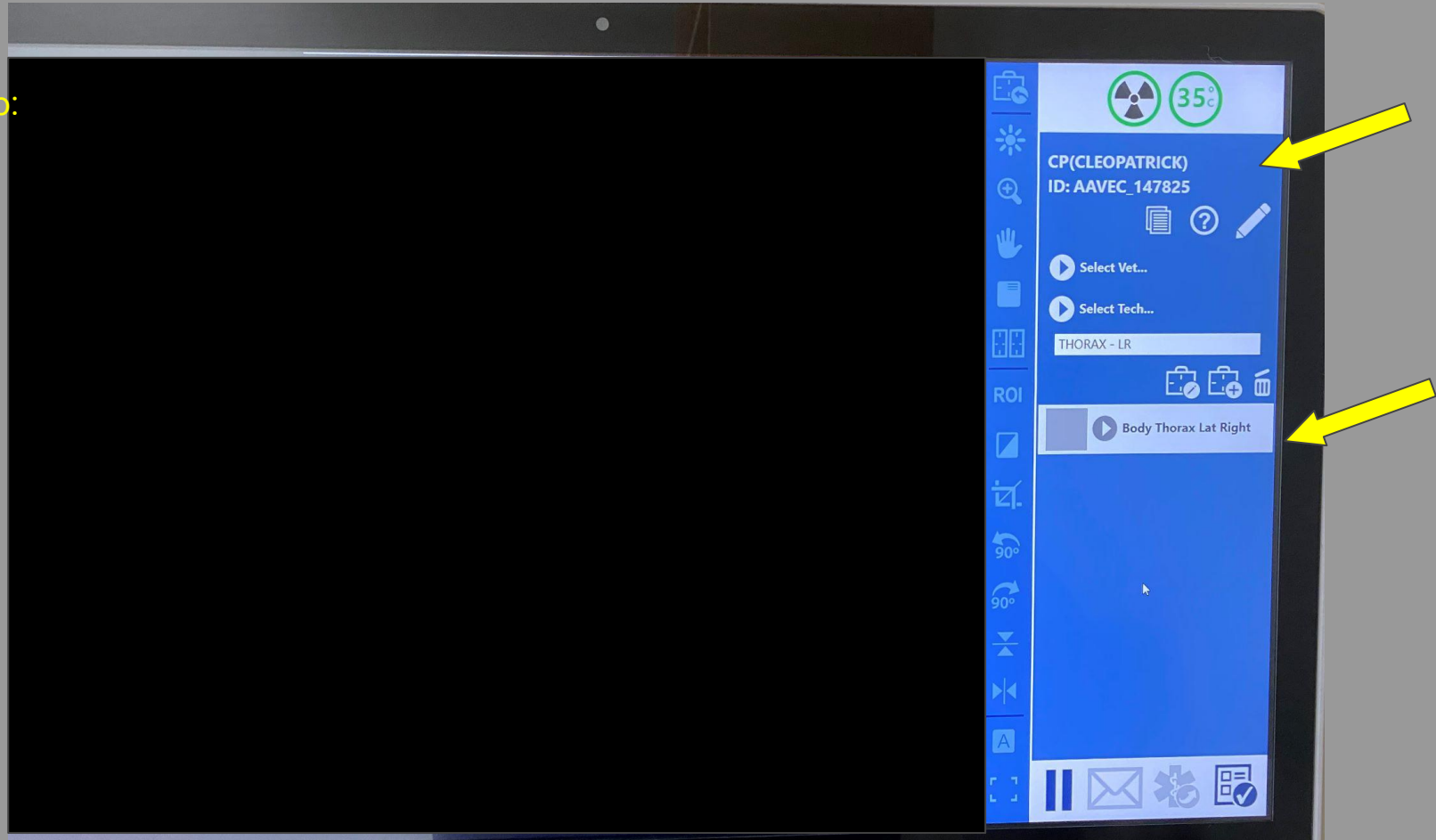
- AAVEC



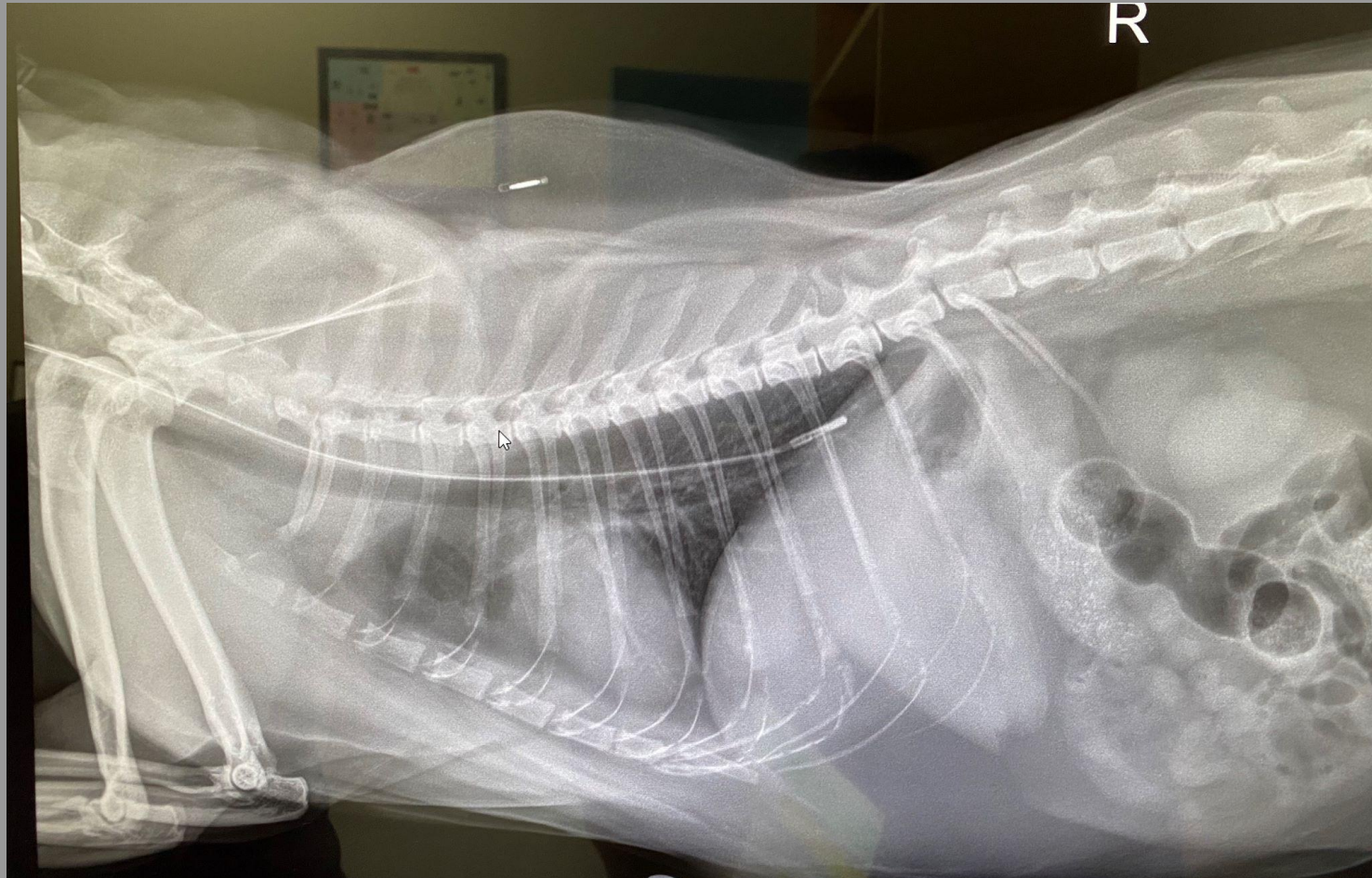
Setting Up Radiographs - X-Ray Labeling Screen

Confirm Info:

- Pt. name
- Pt. ID
- Vet
- Tech
- Anatomy/
Initials
- Desired
views



Setting Up Radiographs - Result





Thanks!