Radiology Review

- **Technique**

- Radiation safety: Time, distance and shielding. Short time, distance from the x-ray source and patients and shielding by using the proper gloves, thyroid protectors and aprons.

- Key components of x-ray exposure include: focal-film distance, Milliampere-seconds and kilovoltage.

- **X-ray films** should be **storage** at vertical position, in a cold room with low humidity (Very low humidity lead to **artifacts** on film (liner dots tree pattern))

- Radiographic density from the least sent to most dense: air, fat, water, bone and metal. From least dense (Black on x-ray) to most dense (white on x-ray)

- **The focal-film distance (FFD)**:
  - Is the distance between the tungsten target in the x-ray tube and the surface of the x-ray detector
  - **The tungsten target is** contained within the **anode**, which is the **positive** side of the xray tube. **Tungsten is used because** it absorbs electrons (produced on the cathode side) without overheating.
  - The **FFD influences** on x-ray beam intensity and the detail of the Bottom image
    - Doubling the FFD (distance between the film and x-ray source) decreases the x-ray intensity **by a factor of four. In other words, doubling the FFD will decrease the x-ray beam intensity by ¼. So to keep x-ray exposure the same *4**
    - **If you Halves distance**, you must decrease mAs to 1/4, that means
    - If distance 100 cm and mAs 10, and distance become 50 so mAs =2.5 to take same result and

vise versa

- **If radiograph comes out too darker**: Halve mAs or subtract 10 KVp
- **If radiograph com too light (not dense enough)**: double mAs or add 10 KVp

- **Milliampere-seconds (mAs):**
- Have more **effect on the film density** (**darkness**), Milliamperes divided by the time.
  - **Milliamperes (mA)** are the **QUANTITY of electrons** produced by the x-ray machine
  - And **exposure time** (**sec**) is how LONG you expose the animal to these rays.
  - **Milliampere-second=**MA*Sec=Mas. Example: 300milliamperes for 1/20th of second. Milliampere-seconds equal: 300* (1/20) = 15mAs. **Usually we need high MA and Short exposure time.**
  - **Moving nervous animal x-ray must use high milliamperage (mA) and sort time (seconds) like 1/20**

- **Kilovaltage (kV):** has the **greatest influence on radiographic contrast**. **Controls** the **penetrability** of the x-ray.

- Soft Tissue x-ray: high kVp and low mAs setting. That is due to relatively low contrast between viscera and adipose tissue.

- Thorax x-ray: high kVp

- Bone x-ray: lower kVp and higher Mas setting, which bone has a lot more natural contrast as it is so hard

- Make an x-Ray film lighter and vies versa

1-**Decrease** (Kvp) so decrease **photon** energy (**ability of penetration power of x- Ray** to tissue)

2-**Decrease** milliamp (mA) is the **quantity** of electron produced by x-ray machine
3-**Decrease** time by seconds generates fewer electron
4-**Decrease** the number of photon hitting the film

- Overexposed radiograph (very dark): occur if milliampere-seconds (mAs) or kilovoltage (kVp) are set to high or if the speed of an intensifying scree is too **fast**.

Overexposure causes **disappearance of the soft tissues surrounding bone**.

Overexposure or **plate saturation: cause Planking artifact** results **in linear striations in the background of the image.**

- Tree partner: (**linear dots):** caused by **static electricity production** due to low **humidity**.

Temperature in the tanks is **uneven static electricity** production (due to very low humidity) lead to artifacts on film (**line dots, tree pattern**)

- Underexposed radiograph (**very light/ very white/ pale**): long distance between the x-ray tube to the patients, low mAs or low kV.

Remember that the patient's body stops some x-rays from penetrating all the way to the x-ray film, which lies UNDER the patient. Wherever the body is, the underlying film is whiter, paler, and lighter. Wherever there is no body in the way, the radiograph will be very dark or black, because the x-rays penetrate and expose the film without any tissues to stop them.

- Severe underexposure: can result in an image with a **grainy** (granular) appearance, also **called** "**noise" or "quantum mottle**".

- Blurring: might be caused by poor film-screen contact, patient movement or poor centering of primary x-ray beam.

To minimize blurring use high mAs and low time.

- Grey/fogged/ Blurry Films: too much scatter radiation, or if light are turned on while undeveloped films are out, or ight leak into the dark room, or **overdeveloping** can also interfere with radiographic contrast.

- Elongation artifact: when the x-ray **beam** is **not centered** on the structure being imaged

- **Foreshortening** occurs when the structure being radiographed is **lifted off the table** (The structure being radiographed is not in contact with the table)

- **The heel effect** occurs when the x-ray **beam** is **more intense** at the **cathode** side compared to the **anode** side, resulting in uneven x-ray photon distribution. **Improper use** of the "heel effect" will **cause a non-uniform appearance** of the image

- Distortion: if the distance between the object and the film is increased

- Magnification: when the focal-film distance is too short or when the patient is too far from the image receptor.

- Black Spots: appear if the developer solution fall on an undeveloped x-ray film, or Films are stacked together touching in the fixer solution

- White Spots: appear on developed film from defective cassette screens and the presence of dust or grit on the film surface.

- Yellow film: if the fixation is too short or if the fixer solution is exhausted.

- Reduction in image sharpness: due to an increase in the angle of the anode target

-Uberschwinger artifact: results in a lucent **halo** around metal implants. This can be mistaken for bone lysis around an implant.

- **Gridlines:** occur if the **lead strips** in the grid are too thick, causing them to appear in the image.

- **A ghost imag**e: occurs when a second image is taken too quickly after a previous image that required a very high exposure.

- Radiographic Landmarks: of the left side include gas bubble in stomach fundus, caudal kidney, descending colon and the apex of the heart.

- Anticlinal vertebra: anatomical landmark usually at **T11** in dogs where the **spinous process is** upright or vertical. It is the vertebra where the incline of the **spinous processes change** from caudal-pointing to cranial-pointing

- Hair clip: should be done to **decrease ultrasound reflection,** because hair traps air and rflect sound so image will be poor quality.

- **Machinery**

  - **Screen films** are not very sensitive to x-rays (but are sensitive to visible light) and require SHORT exposure time than non-screening films. Good choice for intra-oral exam, dental, nasal radiograph, bone extremities x-ray

  - **Non-screen films** require LONG exposure times and produces radiograph with superb detail being great for dental studies. They are sensitive to X-rays!

  - **Faster x-ray film** is less exposure time needed, some loss of details, has large silver bromide

  - **Slower x-ray film** is more exposure time, more details can be visible, small silver bromide crystal

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- **Digital radiography** (DR):

When a detector panel converts x-rays into electrical signals; an analog image is created which is then digitalized

- **Direct DR** has **no light intermediate** and x-rays are directly converted by semiconductors.
- **Indirect DR**, the X-ray results in a light flash from a **scintillation plate** that is then **registered** into an electrical signal.
- **Foam wedges**: are a type of mechanical restraint used to position patients for a radiograph.
- **Digital images are stored on** a **remote hard drive** called the Picture Archival Computing System (**PACS**)

- **Ultrasound mode**:
- A transducer emits a short pulse of sound into the patient. When the sound wave hits an echogenic structure, some of the sound is reflected back to the transducer, creating an image.
- **A mode/ amplitude mode** is for one-dimensional display and shows returning echoes as spikes/peak on screen.
- **B mode/brightness mode** or 2 dimensional imaging.
- **Motion/M mode** ultrasonography the motion of the organs is displayed as wave line across the screen, is used for echocardiography as Cardiomyopathy.

- **Linear array transducers:**
- Ultrasound probe for rectal palpation for **transrectal examination** (pregnancy checking and ovary exam) and **tendon examination**. It produces a rectangular cross section image

- **Fluoroscopy**:
- is used to evaluate **dynamic processes and moving structures (**A continuous x-ray image that evaluates

anatomic structures in real-time)

- The x-ray beam is directed through the patient onto an image intensifier continuously and the **images are videotaped** for analysis
- It is **used** for **gastrointestinal motility studies** (such as evaluating an animal with **regurgitation**), **tracheal studies**, **cardiovascular imaging**, and **some myelograms**

- **Doppler:** Is a monitor used to measure blood pressure detects blood flow using ultrasonic waves

- **Myelography:** is used to diagnose diseases of the spine and spinal cord.

- **Computed tomography (CT scans):**
  - An x-ray beam **passes transaxially** through a small segment of the patient; an image is created by measuring x-ray attenuation (drop off) at sequential sites**.**
  - is best for imaging the internal architecture of the nasal cavity

- **Magnetic resonance imaging(MRI):** is superior to computerized tomography in the **diagnosis** of **brain tumors, central nervous system.**

- **Nuclear medicine; technetium 99:**
  - Is administered to a patient; photon emission is detected and **recorded** with a **gamma scintillation camera**.
  - used to detect tumor metastasis to bone, Also called a "bone scan"

- **Ionizing radiation:** is **used** in **CT, radiography, and fluoroscopy** and it **is not** used in **MRI**

- **Dosimetry:** is a measurement of personal radiation exposure. The maximum permissible dose (MPD) is 0.05 Sv (Sievert) per year.

- **The equine embryo** can first be seen **via transrectal ultrasound** at **day 9-10**, it would be ~4 mm in diameter.

first ultrasound to determine **pregnancy** is performed at **day 14-18**.
The equine fetal heart beat is **ultrasonographically** apparent by **day 25**

- **Developing order/process**: developing solution, rinse baths, fixer and wash bath.
  - **Developing solution**: converts silver halide crystals exposed to x-rays in the film to black metallic silver (Metal associated with **Light** and x-ray **sensitive** granules in x-ray film).
  - **Rinse bath:**
    - **First wash bath**: Stop the film developing process
    - **Second wash bath**: prevent contamination of the fixer.
  - **Fixer solution**: removes and cleans away the unexposed silver crystals and hardens the film. The film should soak in the fixer bath for twice as long as it was in the developer.
  - **Wash bath**: removes processing chemicals from the film and prevents film discoloration.

- **Grid**: like the **focusing** in a **camera**. **High-ratio grid**
  - **A gridprevents scattered radiation**
  - permits fewer x-rays to pass through it from the animal and fewer x-rays reach the film
  - Needing **longer exposure time**, **but** you get a better (**high-resolution**) radiograph.
  - **Use** a grid between a patient and x-ray film cassette

when a body part x-rayed **more than 10 cm thick. like thorax, abdomen, skull and joints**
- **Grid lines that are too far apart result in an increase in the amount of scatter radiation**
- **If the x-ray was shot with a grid under the dog:** you will see many regularly-spaced alternating **light and dark lines** on the radiograph

- **Potter Bucky**: diaphragm is a **moveable x-ray grid**.
  - It moves in time with a particular x-ray exposure setting, **so** that gridlines from the lead strips in the grid **do not show** up on the x-ray film.
  - When using it increase the kVp by 20% or increase exposure by a factor of 4.

- **Collimator**: beam-restricting device that decreased production of scatter radiation. It improves safety and image quality.

- **Low voltage electrical circuits**: provide electricity needed to heat the filament.

- **Glass and aluminum filters**: removes less-energetic x-ray from primary beam

- **Intensifying screen**: Is smooth white plastic lining insides and x-ray cassette. Decreased the amount of radiation needed for a diagnostic radiograph

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- **Terminology**

Teleradiology: digital data is transmitted between hospitals via the Internet

Digital Imaging and Communication in Medicine (DICOM): is a universal digital image format that allows sharing of electronic images with hospitals, specialists and

other locations. **DICOM** is the standard image format for medical image generation and storage

Anechoic/**sonolucent**: structures that produce **few** or no echos. Both are **dark** on ultrasound

Echogenic/**sonodense**: structures produce **strong** echoes so these are **bright** on the ultrasonic image. **From most to least bone, spleen, liver, and urinary bladder** filled with water

Echogenicity: refers to the strength of the echoes that return to the transducer after passing through the patient. **Echogenicity is a relative term:**

- **Hyperechoic**: structure that produced **more** echoes than nearby structures.
- **Hypoechoic**: structure that produces **fewer** echoes than nearby structures.
- **Isoechoic:** structure that produces the **same** echogenicity as nearby structures.

Through transmission (**Acoustic enhancement**): when the ultrasound **hits non-attenuating** structures. Emerging ultrasound beam will have high intensity (and image will be brighter). Usually happens in the gallbladder and **in contrasr Liver**

Acoustic shadowing is a dark area distal or beyond the highly dense material as stones, bone

Which **blocking** the ultrasound

Reverberation artifact (**Comet tail**): occurs when ultrasound meets **strong reflector** like bone or gas **(**in lungs**)**

Shadowing artifact: occurs when ultrasound hits highly reflective structures like uroliths.

Radiolucent: means clear and appear **black** in the radiograph. Air is radiolucent.

- **Soluble nonionic radiopaque contrast materia: Iohexol**, **iotolan** and **lopamidol**.

It used in blood vessels, draining wounds (**fistulography**), salivary ducts (**sialography**), in the urinary tract, intraarticularly, **and intrathecally myelography (intrathecally is the space under the arachnoid membrane of the brain or spinal cord intrathecal)**

They can also be **administered orally** for gastrointestinal (GI) studies. These contrast agents **have a lower osmolarity and less risk** of adverse effects **compared to soluble ionic organic iodides**

- **Soluble ionic organic iodides** (**iothalamate**, **diatrizoate**):

Can be used orally for gastrointestinal studies; intravascularly; in joints, the urinary tract and the abdomen; in wounds; and in salivary ducts. **They should NOT be used intrathecally for myelography. The absorbed dose of ionizing radiation** by a unit mass of irradiated material is **measured in Gray (Gy) unite**

- **Insoluble inert radiopaque contrast/Radiopaque positive contrast media** (**Barium/iodine**) **appear white** in the radiograph.

It **used** almost exclusively for **upper and lower GI motility studies**.
It should NOT be used if an upper or lower bowel perforation is present and severe constipation

Aspiration pneumonia is a potential **complication** of barium sulfate administration for gastrointestinal studies

- **Radiolucent gases** (e.g., nitrous oxide, air, and carbon dioxide): can be **used for double-contrast cystograms and gastrograms**

Radiology Finding and Treatment

- **Thorax**

Alveolar pattern: characterized by "**air bronchograms**".

- Bronchial pattern: irregularly thickened walls of bronchioles that look like donuts. End-on bronchioles are **normal in the hilar region**, **unless** there is abnormal thickening of bronchiole walls. **Feline asthma classically demonstrates a bronchial lung_pattern**

Lung patterns:

1- - Bronchial pattern: irregularly thickened walls of bronchioles that look like that **look like "donuts" end-on or "tram tracks" side**-onbronchioles are **normal in the hilar region**, **unless** there is abnormal thickening of bronchiole walls. **Feline asthma classically demonstrates a bronchial lung_pattern**

2- Interstitial pattern: decreased visualization **of pulmonary vessels, cardiac and diaphragm silhouettes.**

3- Vascular pattern: can suggest either **hypervascularity or hypovascularity**.

Hypovolemia: heart is small and lifted off the sternum. The **pulmonary** vasculature as well as the **aorta and caudal vena cava** may also be **reduced in size**. The lungs will also appear darker.

Pneumothorax: notice dark airspace below the lungs, between them and the chest wall**. Heart is not touching the sternum**. **Decreased to absent lung sound** are also characteristic.

Aspiration pneumonia: radiographic changes in dependent lung fields (**cranio-ventral**).

Heartworm (BCSE): Radiographically, look for right ventricular enlargement and bulging of the main pulmonary artery. The pulmonary knob sign in the VD view is present in 60-0% of cases. A severe case may exhibit the "reverse D" signs on VD view.

http://www.merckvetmanual.com/multimedia/v4730657 : Shows tortuous pulmonary arteries and increased sternal contact.

http://www.merckvetmanual.com/multimedia/v4730666 : Reverse D

- **Abdomen**

Peritoneal effusion: distended abdomen with poor peritoneal detail throughout the abdomen.

Foreign body: multiple loops of enlarged small intestine associated with loops filled with gas and fluid.

Linear foreign body: plicated loops of bowels with eccentric comma-shaped gas bubbles.

Determine pregnancy in mare by ultrasound after 11 day of gestation with using 3-5 MHZ

- **Skeleton**

- Ringbone: is exostosis (bone growth) in the pastern or coffin joint of a horse, associated with periostitis and osteoarthritis. **High ringbone** occurring on the lower part of the large pastern bone or the upper part of the small pastern bone. **Low ringbone** occurs on the lower part of the small pastern bone or the upper part of the coffin bone. Low ringbone is harder to see as it occurs in the hoof of the horse.

- Cortical Stress Fracture: Common in young racing horses. Treatment is screw fixation (+/- osteostixis).

Hemivertebra: a wedge-shaped vertebra, which can be an asymptomatic finding or may present with scoliosis, kyphosis, paresis and ataxia. Typically thoracic.

- Avascular/Aseptic necrosis of the femoral head (Legg Perthes):

- Salter Harris: fractures involving the physis (growth plate).

S	Straight	Fracture straight across cartilage of physis. Also known as capital physeal fracture.
A	Above	Fracture above physis
L	Lower	Fracture bellow physis in the epiphysis
T	Through	Fracture through metaphysis, physis and epiphysis
R	Rammed	Crushed physis

Radiograph is very light and washed out/ Blurry ضبابی x-ray / X-ray film comes out black along the top
1-**Too long a focal distance from x-ray tube to patient** (Fewer x-rays reach the film), also you May get distortion or magnification of the image
2-Patient movement, poor centering of primary x-ray beam, poor film screen contrast
3-light exposure across top of storage box
4-A defective cassette that does not close properly
5-The speed of an intensifying screen is too slow
6- Kvp or MAs are set too low