

Identification and effects of common errors and artifacts on the perceived quality of radiographs

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Objective—To identify common errors in film and digital radiographs provided by referring veterinarians and determine the effect of such errors on the perceived diagnostic quality of image sets.

Design—Prospective study.

Sample—135 sets of radiographic images acquired by referring veterinarians for client owned small animals evaluated at a university hospital.

Procedures—Sets of radiographs were prospectively collected and evaluated for proper performance of various radiographic technical variables including exposure, collimation, positioning, inclusion of all appropriate views, presence of artifacts, radiation safety, and labeling. Sets of radiographs were subjectively determined to be of diagnostic or nondiagnostic quality by 2 evaluators.

Results—The variables exposure, correct positioning, absence of artifacts, and acquisition of all appropriate views were significantly associated with a determination of diagnostic quality for radiograph sets. Correct patient labeling, radiation safety, and x-ray beam centering and collimation were not associated with a determination of diagnostic quality for radiograph sets. The number of categories with errors was significantly associated with identification of radiograph sets as having diagnostic or nondiagnostic quality. Digital radiographs had a significantly lower number of image artifacts and significantly higher frequency of proper labeling versus film radiographs.

Conclusions and Clinical Relevance—Results of this study suggested the technical variables proper exposure, proper positioning, absence of artifacts, and acquisition of all appropriate views were important for acquisition of sets of radiographs of high diagnostic quality. Identification of these errors and adjustment of radiographic technique to eliminate such errors would aid veterinarians in obtaining radiographs of high diagnostic quality and may reduce misinterpretation.

Essay to My Compatriots in the Struggle Toward Perfect Radiographs

By Lara Rasmussen, DVM, MS, DACVS (aka: Dr. Razz)

The taking of radiographs has haunted me since I was 17 or 18 years old and working as one of two veterinary technicians/assistants for a one doc shop in Northern California, back in the dark ages before schooling and certification and the standardization of quality those two things promise. We used dip tanks for processing, so the time it took to produce one films was considerable. When the quality (positioning, exposure) was inadequate for diagnostic purposes, it hurt on so many levels! And the anxiety created by that fear of failing on each exposure was considerable. That feeling remains with me to this day (don't ask me how long that has been!)

My dependence on radiographs to properly and effectively provide medical care to my patients, takes that fear of failing to a more profound level now in my current practice of veterinary medicine. When the rads are lousy, I cannot help my patient as well as I should be able to (if at all.)

I tell you about all of these deep dark anxieties to solicit your help. **As the above 2014 JAVMA article finds**, quality of radiographs (specifically, proper exposure, proper

positioning, absence of artifacts, and acquisition of all appropriate views) is instrumental in good diagnostic outcome, and by extrapolation, good patient care. We have come a long way since dip tanks, so I will not hesitate to say, in this day and age there is no excuse for crappy x-rays.

Now, I know there are MANY reasons for poor quality radiographs. I simply argue that they are (almost) all inexcusable. We (yes, the collective "we") *must take pride in the results of this diagnostic test*; only then will we achieve the goal of high quality radiographs. Do NOT deliver an inferior quality product, do NOT approve an inferior quality product. Just don't do it. Analyze why they are lousy and fix the problem, right then and there. Know the anatomy of what you are imaging. Know the breadth of visual subtleties a radiograph should be capable of portraying. Know what aspects are enhanced by multiple views. *Take pride in and responsibility for good work; it is helping the animals for whom you chose this job, this profession, this career.* (Melodrama intended!)

Ok, so enough of the peptalk! On to some specific radiograph issues and more specific issues related to orthopedic surgery...

Image making

- **True AP and lateral:** What does that mean? More importantly, what does it look like on a film? You MUST know the answer to both of those questions. X-rays 101! Then comes the finesse of making those images using a real patient on a table! It REALLY makes a difference when interpreting the films, really. (Think about how successful your texting would be if the "keyboard" was switched around every time you opened the app.)
- **Proper exposure:** Another "what should this look like" issue. You need to know this. If a stifle film is too hot to perceive joint effusion, *it is literally worthless.* It is a much more troublesome problem with hardcopy x-rays, but remains an issue with digital too. When a digital copy of a film is sent to be reviewed by someone else, half the time it comes as a PDF (i.e. not within the fancy x-ray software ya'll get to play with in the clinic) with very little room for successful image modification. Don't keep a black film; *it's just plain ridiculous.*
- **Cone down:** This is one of the most useful techniques for improving image quality, decreasing personnel exposure and assisting with image interpretation. When you have the collimator light opened up to the size of the plate (Who every told you to do that anyway? EVERYONE does it. It is wrong. Wrong, I say!), the machine is shooting out radiation to cover that area. The more radiation shooting out, the more scatter of the beam that happens. Scatter is random zings of radiation that has hit something (the patient) and ricocheted off to zing in another direction. That new direction can either be directly at YOU. (Scatter is the #1 source of personnel

exposure. Think about it.) Or it can be elsewhere on the plate or capture device, resulting in greying or fuzziness to the image.

The collimator was invented for a purpose, to collimate the beam of x-rays, to shoot them straight down and thru the body part of interest and then to the plate. Just the body part of interest. If the carpus on the Chihuahua is 2cm x2cm, then the collimator light beam should be about 3cm x3cm-- a cute little black square on the film with a nice white carpus in the middle.

- **Artifacts:** Keep the *penis, belly, tail, L/R marker* out of the way. If you are asked to take stifle x-rays and the os penis is "in" the stifle on the lateral view and the tail is "in" the stifle on the AP, *you have failed miserably*. Put yourself in that dog's shoes. How peeved would you be?
- **Animal pain:** This is one of the chief reasons for poor quality images.
 - 1) *Know the case* before you go take the radiographs; what is injured, broken, swollen, tumor-ridden?
 - 2) *Have a plan*, verbalize it clearly with everyone participating, steadily *work your plan* to get the films.
 - 2) Work with the animal, don't fight. You chose this job because you like animals.
 - 3) Use drugs as needed; *just a little* can go a very long way.
- **"True" sized digital images:** Below I mention this relative to the TTA procedure, but in general, there are times when it is very useful to have the ability to read the x-ray when the bones are actual size. See if you can make this option a reality for digital images on a routine basis.
- **Labeling:** And no discussion of medicine can be complete without a little legal stuff sprinkled in. Not only is an unlabeled film difficult to discuss intelligently ("Oh, I mean the one with the smudge on the left corner; was that the Jan 24th one?"), but they are not legal components of a medical record. Clinic name, patient name, and date all make everyone's lives easier.

Image Saving (unique to digital radiography)

- Digital imaging has brought benefits, but we actually have to bring those benefits along-- they don't just happen. One minor example-- we can save our images in their ideal form. A properly oriented, properly labeled image that is saved as such, that will then open the next time looking pristine and professional. (And easy to read and interpret.) So take 20 seconds when you are saving the images to the database, to click the button that puts the image in its correct orientation and confirm or add the correct label (L/R, VD or DV, R or L lateral, time (barium study, etc.), stressed location).

- I am remiss if I don't answer the question, "What is a correct orientation anyway?" Well, someone made up a standard convention, and the majority of us "see" things best in that orientation. Reading *an x-ray is all about noticing deviations from normal*; the more things we can do to make everything normal, the more likely it is that we will notice something out of whack. (So this "proper orientation" standard is actually about more than just someone "being anal"!)
 - Lateral limb-- top is the proximal aspect, left is the front of the leg, as if it is walking to the left.
 - AP (or cranial-caudal) limb-- top is the proximal aspect, left is lateral aspect of leg.
 - Lateral abdomen/thorax-- top is the dorsum of the patient, head is to the left.
 - VD or DV abdomen/thorax-- top is the head, and the left side of the image is the left side of the dog if it were "hung up" on the view box with the x-ray.
 - All positioning markers should be placed on the lateral or cranial/dorsal aspect of a limb.

Image viewing

- **Computer monitor/screen:** As a kid, did you ever take Silly Putty and press it on a newspaper to capture an image, then stretched the Silly Putty and made the image all wonky and distorted? (Wow, am I dating myself terribly? Silly Putty! Newspapers!) Well, my point is that the computer monitor settings, especially nowadays with huge monitors, can dramatically distort x-ray images. *Make sure all of your monitors are set-up for accurate viewing.*
- **Hoarding:** We don't like it happening with cats and dogs; it should not be happening with our x-rays in our clinics. Don't keep every single image you took, just because you took it. Save the images/films that have unique diagnostic value. *Throw/discard the blurry, burned out, pathetic ones that serve no purpose but to irritate viewers.*
- **CD copies:** *Do something for me.* Burn some x-rays to CD. Take that CD home and open the images. See what happens. If your software is good to you, it will open and run and all will be right with the world. If your software is F.U.B.A R., you will sit there for awhile, then you will knock on the screen, then you will eject and reinsert, then you will do a hard shutdown, then you will frisbee the CD across the room! (Ok, maybe that is just what I do 25% of the time with referred x-ray CDs.) But seriously, run them on a home computer and see if they work and what limitations will be experienced by the user you are sending them to.

Diagnostic interpretation

- **Who the heck are you?:** Now do something else for me. Close your eyes. Tie your hands behind your back. And plug your ears. Tell me what kind of animal just came into the exam room? This is what it feels like to get an x-ray with 1) no signalment, 2) no history, 3) no physical findings (and...what you will feel like when there is 4) no clinic or contact information!)

Cut and paste the following to a half sheet of paper (or to a blank email template), make copies and fill it in for every x-ray case you want reviewed.

Clinic and Doctor requesting opinion: _____

Patient Name: _____

Signalment (breed, age, body weight): _____

History (onset, duration, character of abnormality): _____

Physical findings

(specific body part, size, visual description, abnormal movement, lameness grade 1-5): _____

Laboratory findings: _____

Response to therapy to date: _____

Specific techniques

- **Stressed views:** This is a terribly under used x-ray technique. How many times have you had a dog come in with an acute lameness, take x-rays and see a little bit of carpal or hock swelling, and the patient is sent away with the diagnosis of "soft tissue injury". Stop for a moment and think about that that means. What soft tissues?

One type of tissue is the ligament. How do you take it one step beyond generic "soft tissue injury" to specific "medial collateral ligament injury" or other? The Stressed View. Take an x-ray while mechanically stressing the tissue you want to test. For example, the medial collateral ligament of the tarsus is tested by having the hock in an AP position, someone holds the foot and the shin and "bends" the hock like pencil trying to "break open" the medial side...snap the film. Label your film immediately to designate medial/lateral/cranial/caudal stress. To detect small amounts of abnormal laxity, it helps to have the normal leg stressed too, for comparison (it often helps to have the "normal" leg for comparison).

Preoperative Needs

- First, you need all radiographs that are needed to make the diagnosis. After that, to expressly plan the surgery procedure...
- **The TTA procedure needs** a true lateral (femoral condyles superimposed) stifle taken with the joint in a standing angle. (i.e. look at the dog when he/she is standing up and mimic that stifle angle when you are positioning the leg for the x-ray.)

The digital image MUST have a "true size" reference on it (or the computer program MUST have a "true size" button to select.) Nine times out of ten, *I get a really confused look from people when I ask for the image to be "true sized"*. We are not that far away from the time when we had hardcopy films. Those images were of the actual leg, "true sized". On a computer with a digital image, we can make a great Dane look like a Chihuahua and vice versa, right? Well, when we are making critical measurements for a procedure like a TTA, we need the actual size of the bones.

There are two solutions to this: 1) on every film, place a known marker (ex. a penny) and then we can use an actual penny held up to the screen to adjust the image to real size; or 2) talk to your digital image software people and tell them to

make it so and then confirm it several times with an actual item (i.e. penny) to make sure they did it right.

- **A fracture repair needs** two views, a *true* lateral and a *true* AP. (i.e. laying the leg on the plate and moving the animal's body to a different position, doesn't give you two leg views.) ***Compassionate Hint: Traction on a fractured limb (yes, pulling on it!)*** provides better pain and secondary trauma prevention than letting it flop around. *Be kind and utilize IV narcotics to help with broken patient x-rays.*

Thank you all for listening with open minds. I share your daily challenges in making perfect x-rays and interpreting them to the betterment of our patients. Little by little, year by year, my own anxieties will diminish as day by day perfect x-rays cross my viewbox/computer screen, and I am able to say "Voila! You are healed." Have a safe and perfect day, everyone!