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SKILLS CHECK

Radiographic Soft Tissue Positioning: Part 2

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Abstract

Proper patient positioning helps achieve optimal radiographs while minimizing radiation exposure. Following a checklist helps ensure that images meet the required standards. A checklist with the acronym CALIPER involves collimation, artifacts, landmarks, identification, patient positioning, exposure techniques, and radiographic presentation. Failure to follow the items on the checklist could lead to nondiagnostic images or their inaccurate interpretation by the veterinarian.

Take-Home Points

- Collimate the beam to the area of interest (AOI).
- Be aware that external objects on the patient and positioning devices can create artifacts.
- Use landmarks to ensure that the entire AOI is included in each image.
- Have a standard procedure for placing directional markers.
- Position the patient to avoid artifacts and errors that can lead to misinterpretation.
- Adjust milliampere-seconds and kilovoltage peak for proper density and contrast.
- Present lateral views with the cranial aspect of the patient to the viewer's left and the patient's dorsal aspect directed upward.
- Present ventrodorsal/dorsoventral views with the patient's cranial aspect directed upward, the caudal aspect downward, and the patient's left side on the viewer's right.

Most everyone is familiar with the phrase "if at first you don't succeed, try, try again," but when working with radiographs, it is critical to keep the number of attempts to a minimum. Well-positioned radiographs are necessary not only to be of diagnostic quality for the veterinarian to interpret but also to minimize the number of retakes to avoid unnecessary exposure to the patient and personnel. Good positioning can be achieved by using a diagnostic quality checklist to ensure that all images meet the standard required to enable the veterinarian to make an accurate diagnosis and therefore prescribe appropriate treatment for the patient.

Part 1 of this series, published in the *Today's Veterinary Nurse* Summer 2023 issue, reminded the veterinary team of the value of patient positioning for thoracic and abdominal radiographs. In Part 2, the veterinary team will learn to use a diagnostic imaging quality checklist to produce radiographs that will lead to proper diagnostic interpretation and patient treatment.

BOX 1

The CALIPER Checklist for Optimizing Radiographs

Collimation
Artifacts
Landmarks
Identification
(legal and true directional markers)
Patient positioning
(superimposition)
Exposure techniques
Radiographic presentation

DIAGNOSTIC QUALITY CHECKLIST: CALIPER

Even if the full area of interest (AOI) is included in the radiographic series, it is imperative that each image be evaluated for diagnostic quality to aid in proper interpretation. The Purdue University diagnostic imaging team has developed a checklist for optimizing all images and assigned it the acronym of CALIPER: collimation, artifacts, landmarks, identification, patient positioning, exposure techniques, and radiographic presentation (**BOX 1**).

Collimation

Collimation is the process of narrowing the x-ray beam to the AOI. Collimation reduces scatter radiation, not only producing a clearer, more detailed image but also reducing the amount of radiation exposure for the patient and veterinary personnel.[1]

Artifacts

Many materials can create artifacts that obscure parts of the image or affect image quality. Before imaging, all external objects such as leashes, collars, and harnesses must be removed from the patient. Some positioning aids (e.g., troughs) will also leave radiographic artifacts on the image and should be accounted for when positioning the patient (**FIGURE 1**).

Landmarks

For each AOI, there are specific landmarks that can be used to help optimize image quality. Including the full AOI for each image in the series will maximize the chances of a proper diagnosis. When the full AOI does not fit in 1 view (as often occurs with large patients), then overlapping cranial and caudal images for each view in the series will ensure that the full AOI is covered.

Identification

Radiographs are part of the medical record and remain the property of the veterinary hospital. Images are legal documents and must be labeled appropriately with the name of the veterinary practice, exposure date, and the patient's first and last name.[2]

Directional markers (left or right) must also be part of every image. Labels and directional markers must be applied during exposure and before processing (or image reveal on the computer screen). It is not best practice to use digital markers after the exposure has been made as human error can lead to misdiagnoses or misinterpretations.

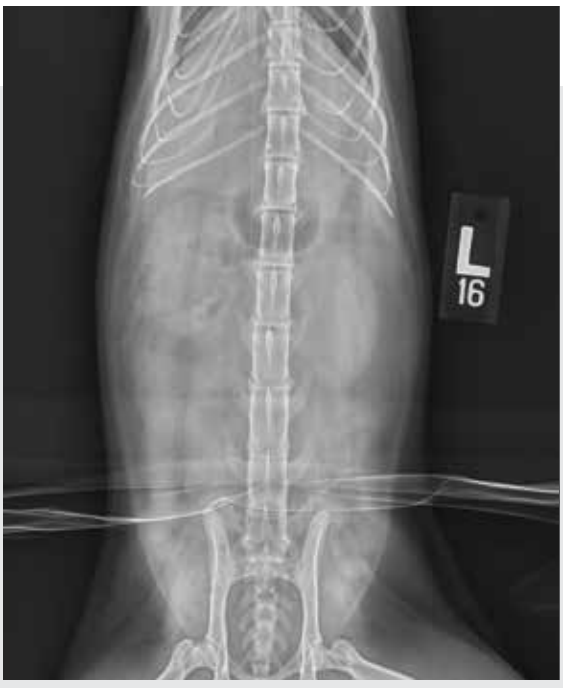

FIGURE 1. Artifacts obstruct the view of the area of interest; commonly, the edge of the positioning trough will appear in the radiograph. To avoid a trough line, ensure that the patient is in the middle of the trough and not on the edge.

Having a standard procedure for placing directional markers will help reduce the chances of omission. For thoracic radiographs, the marker should be placed in the axillary region outside the body wall. For lateral thoracic projections, the marker should be placed cranially and ventrally to the axillary region. For dorsoventral or ventrodorsal thoracic projections, the marker should be placed lateral to the patient (right or left) in the axillary region. For lateral projections of the abdomen, the marker should be placed caudally and ventrally to the inguinal region. For dorsoventral or ventrodorsal projections of the abdomen, the marker should be placed lateral to the patient (right or left) in the inguinal region.

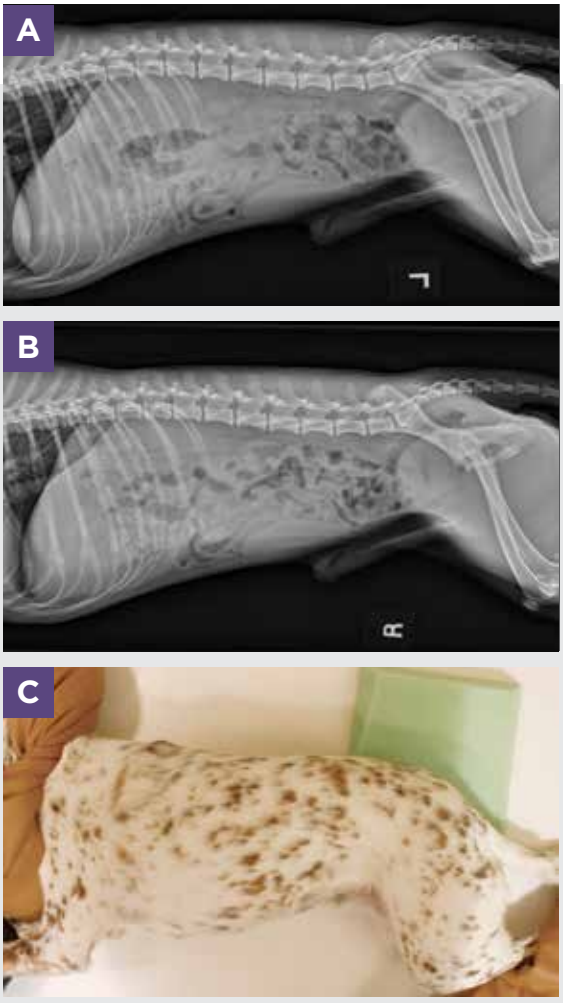

FIGURE 2. Lateral abdominal radiograph positioning. **(A)** Obliqued left lateral; note the lack of superimposition of the wings of the ilium and the ischiatic tuberosity. **(B)** Straight right lateral image. **(C)** Patient positioning for straight right lateral radiograph; adding some dorsocaudal padding helps prevent obliquing by ensuring that the patient (and thus the pelvis) is parallel to the table.

Patient Positioning

Many factors can affect patient positioning, and the veterinary team must familiarize themselves with the common positioning artifacts and errors that can result in a misinterpretation. To optimize image quality and diagnostic accuracy, consider the effects of magnification, elongation, foreshortening, obliquity, and superimposition when positioning patients.

Magnification

Magnification can affect image quality and occurs when the object–film distance (the distance from the AOI to the recording surface detector or cassette) is increased.[3] To maximize image resolution (detail), the AOI should always be as close to the recording surface as possible. Poor resolution results in a grainier image and thereby affects image interpretation.

Elongation and Foreshortening

Elongation and foreshortening can occur when the AOI is not parallel to the recording surface and the size and shape of objects are not accurately represented on the image. Elongation and foreshortening are most commonly encountered with radiographs of limbs but can also be evident on radiographs of other AOIs.

Obliquity

Obliquity is a very common artifact that is simple to correct, but if left uncorrected, obliquity can lead to interpretation errors. When radiographing the thoracic and abdominal cavities of a patient in lateral recumbency, the sternum and dorsal spinous processes (for the thorax) or transverse processes of the lumbar vertebrae (for the abdomen) should be parallel to the recording surface, which is often achieved by placing a small amount of padding ventrally or dorsally while extending the cranial and caudal limbs out of the view (**FIGURES 2 AND 3**). For the thorax, true representation is accomplished when the sternum and spine are superimposed over each another. When the patient is in dorsoventral or ventrodorsal recumbency, the spine must be straight to ensure true representation of the heart, lungs, and abdominal organs.

Superimposition

Sometimes superimposition of structures can lead to radiographic misinterpretation. When taking thoracic radiographs, it is best to extend the thoracic limbs cranially to prevent the brachial muscles from being superimposed over the cranial aspect of the thorax. Superimposition of the thoracic limbs significantly hampers interpretation of the cranial mediastinum and cranial lung lobes.[4]

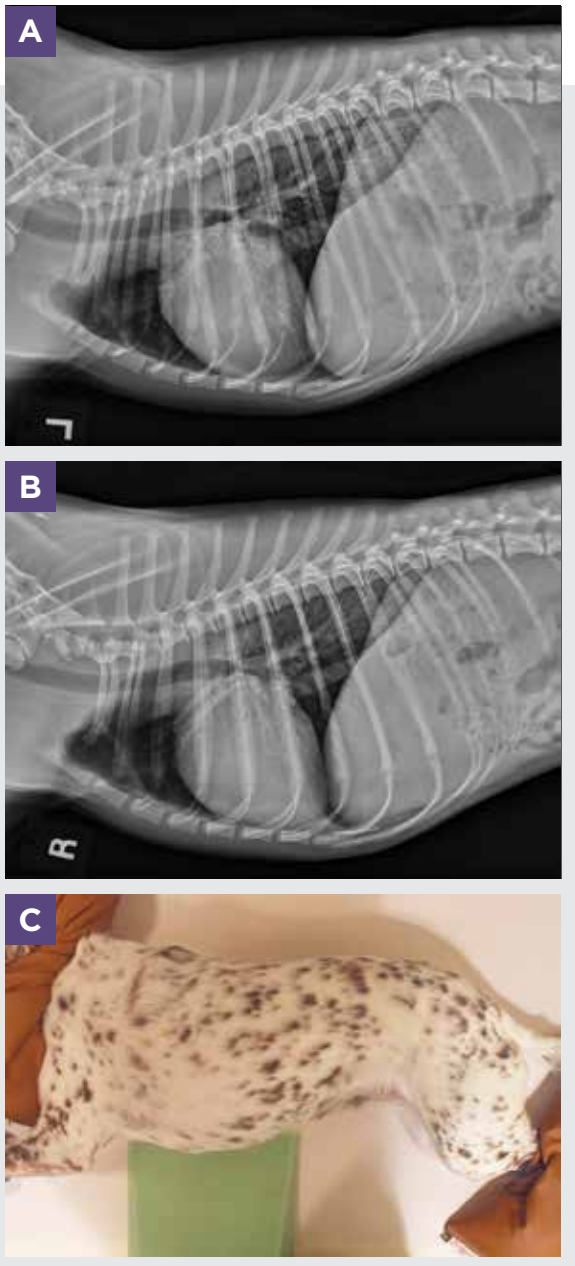

FIGURE 3. Lateral thoracic radiograph positioning. **(A)** Obliqued left lateral; when the patient is not parallel to the table, arching of the ribs may be seen with lack of pairing in the costochondral junctions. **(B)** Straight right lateral image. **(C)** Patient positioning for straight right lateral radiograph; adding some ventral padding helps ensure that the spine and sternum are parallel to the table and prevents arching (obliquing) of the ribs.

Changing the FFD affects image quality because of the inverse square law, which states that the intensity of the x-ray beam is inversely proportional to the square of the distance from the source.[6]

maintained at the manufacturer's suggested distance to ensure use of the x-rays at their peak power (typically 36 to 42 inches for small animal imaging).[6] Changing the FFD affects image quality because of the inverse square law, which states that the intensity of the x-ray beam is inversely proportional to the square of the distance from the source.[6] A short FFD results in greater x-ray beam intensity and therefore a darker image; conversely, a long FFD will result in lesser x-ray beam intensity and a lighter image. Doubling the FFD requires 4 times the quantity of x-rays to maintain detail.[4]

Exposure Techniques

Proper radiographic exposure techniques are vital for producing diagnostic radiographs. Blurry or distorted images are difficult to interpret, which can result in a misdiagnosis or delayed treatment. Image quality is dependent on spatial resolution (detail), density, and contrast resolution.

Detail

Image detail refers to the degree of sharpness of the image.[5] Detail is affected by object–film distance and focal film distance (FFD; the distance from the release of the x-rays to the recording surface). FFD should be

Density

The degree of blackness (density) is in large part affected by the thickness of the AOI and the quantity of x-rays produced, or the milliampere-second (mAs; milliamperage of radiation produced over seconds). If the image is overexposed or too dark, decrease the mAs by about 30%. If the image is underexposed or too light, increase the mAs by 30%.[5]

The darkness of an image is also influenced by the quality (energy) of the x-rays or the kilovoltage peak (kVp; maximum voltage applied to produce the x-rays). If an image is overpenetrated or too dark, decrease the kVp by about 15%. If the image is underpenetrated or too light, increase the kVp by 15%.[5]

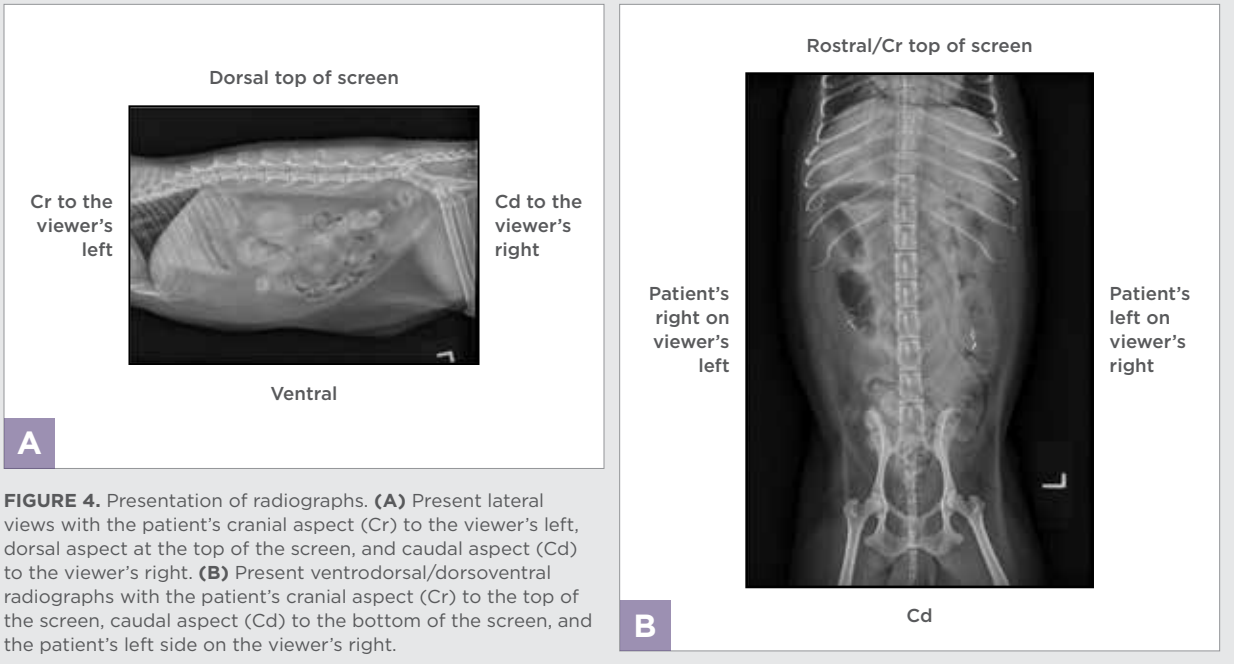

FIGURE 4. Presentation of radiographs. **(A)** Present lateral views with the patient's cranial aspect (Cr) to the viewer's left, dorsal aspect at the top of the screen, and caudal aspect (Cd) to the viewer's right. **(B)** Present ventrodorsal/dorsoventral radiographs with the patient's cranial aspect (Cr) to the top of the screen, caudal aspect (Cd) to the bottom of the screen, and the patient's left side on the viewer's right.

Contrast

Contrast resolution is the difference in opacities of the structures in the AOI of a radiograph. Contrast resolution depends on exposure technique but also on the contrast of the AOI. Contrast in the thorax is naturally high due to the air in the lungs (gas opacity); therefore, exposure techniques for the thorax use higher kVp and lower mAs.[5] Conversely, contrast in the abdomen is inherently low because almost all of the structures being imaged are of the same opacity (soft tissue); therefore, exposure techniques for the abdomen use higher mAs and lower kVp.[5]

Radiographic Presentation

To aid with radiographic interpretation, radiograph presentation is standardized.[4] When presenting a lateral image (left or right) of the thoracic or abdominal cavity, present it with the patient's cranial aspect to the viewer's left and the patient's dorsal aspect directed upward. Or, think of it as the patient walking out the door to your left. Ventrodorsal and dorsoventral views should be presented with the patient's cranial aspect directed upward and the patient's left side as the viewer's right (i.e., a mirror image) (**FIGURE 4**).

SUMMARY

Radiographic interpretation relies heavily on the accuracy of patient positioning and use of appropriate exposure techniques. The CALIPER radiographic quality checklist will aid in assessment of the final image. The veterinary team should use their radiographic positioning skills to generate proper images as only then will a proper diagnosis for the patient be achieved. Poor attention to detail will result in either nondiagnostic images or images that suggest an incorrect diagnosis. **TVN**

References

1. Sirois M, Schlote JM. Radiation safety. In: Sirois M, Schlote JM, eds. *Diagnostic Imaging for Veterinary Technicians*. 2nd ed. Bluedoor-Top Hat; 2021:21-25.
2. Sirois M, Schlote JM. Radiographic equipment. In: Sirois M, Schlote JM, eds. *Diagnostic Imaging for Veterinary Technicians*. 2nd ed. Bluedoor-Top Hat; 2021:11-20.
3. Han CM, Hurd CD. Achieving radiographic quality. In: Han CM, Hurd CD, eds. *Practical Diagnostic Imaging: for the Veterinary Technicians*. 3rd ed. Elsevier Mosby; 2005:10-21.
4. Thrall DE. Principles of radiographic interpretation of the thorax. In: Thrall DE, ed. *Textbook of Veterinary Diagnostic Radiology*. 7th ed. Elsevier; 2018:568-582.
5. Sirois M, Schlote JM. Quality assurance. In: Sirois M, Schlote JM, eds. *Diagnostic Imaging for Veterinary Technicians.* 2nd ed. Bluedoor-Top Hat; 2021:45-52.
6. Han CM, Hurd CD. Exposure variables. In: Han CM, Hurd CD, eds. *Practical Diagnostic Imaging: for the Veterinary Technicians*. 3rd ed. Elsevier Mosby; 2005:22-24.

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Liane is a 2003 graduate of the veterinary technology program at Purdue University, where she earned an associate and a bachelor's of applied science degree with a minor in organizational leadership and supervision. She recently earned a master's degree in higher education with Purdue University Global. Liane is a senior instructional technologist with specialties in radiology, dentistry, and learner-centered classrooms. Liane has been teaching since 2008 and is always evaluating how to improve the students' learning experience. She has received awards for excellence in teaching from Purdue University and Elanco Animal Health in 2011 and 2018. Liane stays busy by spending her evenings with her husband and 2 sons on their small hobby farm in Indiana, home to horses, dogs, cats, and a donkey named Shrek!