Radiographic Positioning: Head, Shoulders, Knees, and Toes

PART 2

Part 1 of this article, published in the November/December 2016 issue of Today's Veterinary Technician, described radiation safety policies, personal protective equipment, and guidelines for positioning orthopedic radiography patients to obtain diagnostic-quality images of the skull, shoulders, and elbows. Part 2 gives a brief overview of the 3 forms of restraint commonly used when taking orthopedic radiographs and examines some positioning techniques for radiographic views of the stifles, pelvis, and lower extremities.

RESTRAINT TECHNIQUES
Milan Kundera said, “Humanity’s true moral test…consists of its attitude towards those who are at its mercy: animals.”1 The oath for veterinary technicians states, “I solemnly dedicate myself to aiding animals and society by providing excellent care and services for animals, by alleviating animal suffering…” Once in practice, it is important to remember this oath.

As veterinary technicians, we choose our profession because of our love and compassion for animals. Sometimes, however, we can get caught between doing what is best for the patient and working with limited monetary resources and time constraints. When positioning patients for radiographic studies, patient comfort should always be a priority, and injured or suffering patients should be made as comfortable as possible with analgesics or sedation.

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MEET THE AUTHORS

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Liane grew up in Valparaiso, Indiana, on a small hobby farm with horses, goats, pigs, chickens, geese, cats, a dog, and one duck named Daffy. A 10-year member of 4-H, she followed her continued on page 64

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Jeannine was born and raised in Logansport, Indiana, where she welcomed any opportunity to spend time with animals. In 2005, she earned a bachelor’s degree in English, in pursuit of her passion for reading and writing, but soon realized continued on page 64
Radiographs themselves are painless and noninvasive, but unsedated restraint can make the patient anxious, scared, and sometimes aggressive. This not only harms the patient, but also makes it more difficult to obtain diagnostic results in an efficient manner and can endanger team members.

Chemical
“Chemical restraint has contributed greatly to the progress made in radiology by allowing positioning that would otherwise be impossible to achieve.” Several types of sedation protocols can be used for patients, depending on the case (e.g., trauma, pediatric, geriatric). More information about sedation protocols can be found in the resources listed in BOX 1.

The following advantages of adequate sedation help the veterinary team achieve diagnostic-quality radiographs with minimal to no harm to the patient, greatly reducing the possibility of an inaccurate or inconclusive diagnosis:

- Chemical restraint reduces patient pain and anxiety. Imagine being in excruciating pain, scared, nervous, stressed, surrounded by strangers, and unable to communicate with anyone, all while being stretched out on a table in awkward and painful positions. Without sedation, this is the situation that many veterinary patients face.
- Sedated patients remain still during radiographic exposures, allowing fewer retakes of the same area of interest and therefore lowering radiation doses.
- Chemical restraint can increase efficiency in the workplace. A radiographic study can be done much more quickly when the patient does not struggle while being placed into multiple positions, allowing for more cases to be seen in a timely manner.
- Patient sedation can also help keep veterinary technicians healthy. A survey of more than 1200 NAVTA members found that sedation reduced the risk of on-the-job injuries, with 83% of respondents reported being injured while physically restraining a cat or dog, while only 9% reported being injured by a sedated animal. Even though the main focus of our profession is typically the patient, veterinary technicians should be cognizant of the care and attention we and our colleagues also need.

**BOX 1 Recommended Reading**

Manual
Although chemical restraint is the preferred option for orthopedic radiography, not all patients are medically stable enough to undergo heavy sedation. When manual restraint is needed, the minimum number of people needed to position and restrain the patient without compromising the safety of patient and other personnel should be in the room.

To prevent injury resulting from the patient jumping off the table, the minimum number of people performing restraint is usually two: one person to restrain the head and forelimbs, and one person to restrain the hind portion. If the patient is large and very anxious, up to 3 people might be needed to ensure the safety of all involved. In these cases, one technician, assistant, or other trained associate should be in charge of restraining the head and forelimbs, while another trained associate should be in charge of restraining the hindlimbs. The third trained associate should be focused on positioning the patient.

As discussed in part 1 of this article, it is imperative that anyone remaining in the room during an exposure be dressed in appropriate personal protective equipment (PPE), including lead gloves, a thyroid shield, a lead gown, and a dosimeter badge. To keep the radiation dose to a minimum for all involved, it is a good idea to keep a log of the number of times each person remains in the room during an exposure. The practice should always abide by the ALARA (as low as reasonably achievable) principle.

Some states have laws against anyone being in the room during an exposure. It is the responsibility of the practice and the team members to be aware of and follow state regulations on physical and manual restraint.

It is essential to keep in mind that patients undergoing orthopedic radiography are more likely to be in pain due to a recent traumatic event or chronic condition. This discomfort requires the team to work slowly and cautiously while positioning.

Mechanical
Mechanical restraint, or the use of positioning aids and devices, can be used in conjunction with chemical and/or manual restraint. Several commercially available devices can be used to aid in positioning, such as V troughs, sandbags, cotton, tape, radiolucent blocks and wedges made of foam, and immobilization blocks (BOX 2). However, many other items, such as compression bands, rope, and wooden spoons and cutting boards, can also be used. Some items are more cost-effective than others and can work just as well as more expensive options. Some companies may allow practices to test products for a short time to determine whether they are worth purchasing.

Some materials are radiolucent and some are radiopaque. Radiolucent substances absorb fewer x-rays than soft tissues and bone and appear black on radiographs. Radiopaque substances (e.g., metals) absorb more x-rays than tissue or bone and appear white on radiographs. At Purdue, we often use both radiolucent and radiopaque positioning aids. For example, when imaging a stifle, as described below, we use a radiopaque board under the pelvis, radiolucent cotton under the tarsus, and radiolucent tape around the opposing limb.

Mechanical restraint is very helpful and, when paired with chemical restraint, eliminates the need for a technician, assistant, or trained

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**BOX 2 Basic Positioning Aids**

- V trough
- Sandbags
- Cotton
- Tape
- Radiolucent blocks and paddles
- Foam wedges
associate to be in the room during a radiographic exposure. This should be the ultimate goal in obtaining diagnostic-quality radiographs.

**GENERAL GUIDELINES FOR DIAGNOSTIC RADIOGRAPHY**

One of the standards we follow at Purdue is to perform a complete radiographic series, no matter what is being imaged. Providing the most information we can to obtain the best possible diagnosis or outcome for the patient is our primary goal! Although certain circumstances (e.g., patient stability) may allow only one radiographic image to be obtained, it is possible to miss metastasis, disease processes, or even fractures based on a single radiograph. Therefore, taking at least two orthogonal views is of critical importance when trying to get diagnostic-quality images. Orthogonal views are images that are taken at 90° to each other. The below tutorial includes positioning instructions to obtain two orthogonal views for the stifles, pelvis, and lower extremities.

The terms used to describe radiographic positioning can be confusing and depend on the area being imaged. When describing the way the beam enters and exits the limb distal to the carpus and tarsus, it is appropriate to use the terms dorsopalmar and palmarodorsal for forelimbs or dorsoplantar and plantarodorsal for hindlimbs. The terms caudocranial and craniocaudal are used to describe the way the beam enters and exits a forelimb or hindlimb above the carpus and tarsus. Markers should always be placed to indicate patient position and/or beam direction.

Many of the images in this article contain a magnification or calibration marker (FIGURE 1). These markers are primarily used in orthopedic views and are designed for use with digital hardware templates to allow surgeons to determine the exact size of the patient's bone. In any radiographic study, especially digital studies, magnification resulting from patient size and exposure technique can be an issue. Using this marker allows the veterinary team to adjust for magnification by calibrating the radiograph with a known value: the size of the metal ball at the end of the flexible arm. For example, the ball in the marker shown in FIGURE 1 is 25 mm in diameter. The ball should be positioned next to the bone or joint being imaged and appears in the resulting radiograph as a radiopaque or bright circle.

To reduce the amount of equipment in the images, most of the following photographs feature cadavers or well-trained...
healthy dogs that could be taped and positioned without sedation. Sedated patients should always be appropriately maintained with oxygen and monitoring.

**POSITIONING THE PATIENT: STEP BY STEP**

**Stifles (Knees)**

**Mediolateral View**
The patient is positioned in lateral recumbency with the affected limb closest to the plate or cassette. For example, if the left stifle is affected, position the patient in left lateral recumbency. The goal of this view is to superimpose the condyles of the femur. Therefore, start by placing 1 to 2 inches of padding under the patient’s pelvis to aid in rolling the stifle down toward the table to be parallel with the table (FIGURE 2). If the patient weighs <20 kg, only 0.5 to 1 inch of padding will likely be needed. At Purdue, we typically use a plastic cutting board under the pelvis, but when using a device like this, ensure that it does not show up in the collimated view.

Abduct the opposing limb and secure it with tape to the table. If needed, place some cotton padding under the tarsus to lift it and aid in superimposing the femoral condyles (FIGURE 3). In some cases, if the condyles are not superimposed, the cotton under the tarsus can be removed and placed under the stifle. (FIGURE 4) Similarly, the thickness of the padding under the pelvis may need to be increased or decreased to superimpose the condyles. Center the primary beam over the stifle and collimate to include approximately one-third of the femur and one-third of the tibia. The marker should be placed on the cranial aspect of the stifle (FIGURE 5).

**Caudocranial View**
The patient is positioned in sternal recumbency. Sedation is very helpful for this view, which can be painful and awkward for a nonsedated patient. Place a triangular wedge under the caudal abdomen, close to the pelvis. Tape around the metatarsus of the affected limb and completely extend the leg and tape it to the table (FIGURES 6 and 7). Use foam padding or cotton to lift the unaffected limb and roll the affected limb medially or laterally based on the position of the patella. The primary goal is to center the patella. The fabellae may or may not
appear symmetric; however, the diagnostic view should show fabellae that are bisected symmetrically by the epicondyles of the femur. You may have to palpate the patella to find the center. Center the primary beam over the stifle. Collimate to include approximately one-third of the femur and one-third of the tibia (FIGURE 8). The marker should be placed on the lateral aspect of the stifle.

Tibial Plateau Leveling Osteotomy Views
Radiographic studies to assess the cranial cruciate ligament and aid in planning for tibial plateau leveling osteotomy (TPLO) are common in orthopedics. The series consists of 2 views: mediolateral and caudocranial.

Mediolateral view. For this view, it is necessary to include the entire tibia, from the stifle to the tarsus, to calculate the slope of the tibial plateau. The reference line for this calculation is the mechanical axis of the tibia, which is defined by drawing a line through the talus and the intercondylar spines, then identifying the cranial and caudal edges of the medial part of the tibial plateau. The difference between that angle and a perpendicular line to the mechanical axis is the tibial slope.¹

The patient is positioned in lateral recumbency with the limb of interest closest to the plate or cassette. Place some padding under the pelvis with the goal of superimposing the condyles of the stifle (FIGURE 2). Abduct the nonaffected limb out of the view by taping it to the table. Angle the affected tibia so that the femorotibial (stifle) joint and the tibiotarsal (tarsus) joints are at 90° angles (FIGURE 10). If needed, tape can be applied around the tarsus to pull the femur down to get the femorotibial slope.¹

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Orthogonal views are images that are taken at 90° to each other.

joint at a 90° angle. Use some cotton or a radiolucent wedge under the tarsus to aid in superimposing the femoral condyles. Center the primary beam over the tibia and collimate to include the stifle and the tarsus (FIGURE 11). The marker should be placed on the cranial aspect of the tibia (FIGURE 12). Again, in some cases, if the condyles are not superimposed, the cotton from the tarsus can be removed and applied under the stifle. Similarly, the padding under the pelvis may need to be increased or decreased to superimpose the condyles.

Caudocranial view. The patient is positioned in sternal recumbency with a triangular wedge under the abdomen and pelvis. Tape around the tarsus of the limb of interest, extend the limb completely, and secure it to the table. Lift the unaffected limb to roll the patella of the affected limb medially to center it (FIGURE 13). Secure this limb with tape or another positioning device. Again, the fabellae may or may not appear symmetric; however, the diagnostic view should show fabellae that are bisected symmetrically by the epicondyles of the femur. Center the primary beam in the middle of the tibia (FIGURE 14) and collimate to include the stifle and the tarsus. The marker should be placed on the lateral aspect of the tibia (FIGURE 15).

Tibial Tuberosity Advancement Views
Radiographic studies to assess the cranial cruciate ligament and aid in planning for tibial tuberosity advancement (TTA) are also common in orthopedics. Again, the series consists of 2 views: mediolateral and caudocranial.

Mediolateral view. The patient is positioned in lateral recumbency with the affected limb closest to the plate or cassette. If needed, place some padding under the pelvis to rotate the affected stifle down toward the table to be parallel to the table (FIGURE 2). Abduct the nonaffected limb out of the view and tape it to the table (FIGURE 16). For this view, position the affected tibia to be at a 135° angle with the stifle. This angle can be measured by using an instrument called a goniometer; however, if a goniometer is not available, the limb can
be positioned at a normal walking angle, which is typically close to 135°. There is no specific angle for the tarsus. Use some cotton or a radiolucent wedge under the tarsus to aid in superimposing the femoral condyles (FIGURE 17). Center the primary beam over the tibia and collimate to include the stifle and the tarsus (FIGURE 18). The marker should be placed on the cranial aspect of the tibia. If the condyles are not superimposed, alter the padding under the tarsus, stifle, or pelvis as needed to superimpose them.

**Caudocranial view.** The patient is positioned in sternal recumbency with a triangular wedge under the abdomen and pelvis. Tape around the tarsus of the limb of interest, extend the limb completely, and secure it to the table. Lift the unaffected limb to roll the patella of the affected limb medially to center it (FIGURE 13). Secure this limb with tape or another positioning device. Center the primary beam in the middle of the tibia (FIGURE 14) and collimate to include the stifle and the tarsus. The marker should be placed on the lateral aspect of the tibia (FIGURE 15).

**Pelvis**

*Lateral View*
The patient is positioned in right lateral recumbency. The goal of this view is to superimpose the wings of the ilium and hemipelvis. Place a foam wedge between the hindlimbs and use the wedge to push the right hindlimb cranially (FIGURE 20). Positioning the patient this way ensures that the left hindlimb is “left behind” to delineate which femur is which on the radiograph.

*Sedated patients remain still during radiographic exposures, allowing fewer retakes of the same area of interest and therefore lowering radiation doses.*
Center the primary beam over the pelvis and palpate the wings of the ilium as the cranial landmark and the caudal border of the ischium as the caudal landmark. Collimate over just the pelvis (FIGURE 21). The marker should be placed dorsal to the pelvis.

**Extended View**

This view of the pelvis is considered the most diagnostic view. The patient is positioned in dorsal recumbency with the help of a V trough or other positioning device to get the pelvis straight. Tape around the tarsus of each leg, extend the hindlimbs completely, and secure the tape to the table (FIGURE 22). Go under the hindlimbs, just above the stifles, with tape, then bring the tape up and crisscross it above the stifles to rotate the hindlimbs medially so that the femurs are parallel to each other. A diagnostic view of the extended pelvis shows the patellas centered, the femurs parallel to each other, the tuber ischia equally overlapped by the femurs, a symmetric obturator foramen, and the tail between the femurs (FIGURE 23). Center the primary beam just cranial to the ischium (FIGURE 24). Collimate to include the wings of the ilium and a small portion of the proximal tibias, just caudal to the femorotibial joints (FIGURE 25). A marker should be placed on one side of the patient to denote the right or the left side.

For patients that are not medically stable enough for this view, such as those with a fracture or unsedated patients, a frog-leg ventrodorsal view can be taken by letting the hindlimbs rest naturally. Collimate over the pelvis to include the wings of the ilium and the ischium.

**Phalanges (Toes)**

**Front Foot Views**

**Mediolateral view.** The patient is positioned in lateral recumbency with the affected limb closest to the plate or cassette. Tape around the foot, extend the forelimb cranially, and secure it to the table (FIGURE 26). Cotton padding may be needed under the carpus or foot to get the limb in a true lateral position. Center the primary beam over the metacarpal bones and collimate to include the carpus and all of the phalanges (FIGURE 27). The marker should be placed on the cranial aspect of the foot.

**Dorsopalmar view.** The patient is positioned in sternal recumbency. Tape around
the foot, extend the forelimb cranially, and secure it to the table (FIGURE 28). To get the forelimb in a straight cranio-caudal position, the patient’s head and body may need to be rotated left to right (FIGURE 29). This can be achieved by using a positioning device to prop the patient’s head to the lateral side or, if needed, having a team member in PPE hold the head out of the primary beam. Center the primary beam over the metacarpal bones and collimate to include the carpus and all of the phalanges (FIGURE 30). The marker should be placed on the lateral aspect of the foot.

**Mediolateral view (splay toe).** The patient is positioned in lateral recumbency with the affected limb closest to the plate or cassette. To separate the phalanges, take a 0.5-inch wide piece of tape, wrap it around P2, and pull the toe cranially. Take another 0.5-inch wide piece of tape, wrap it around P5, and pull caudally (FIGURE 31). This should separate the toes enough to visualize each toe. Center the primary beam over the metacarpal bones and collimate to include the carpus and all of the phalanges (FIGURE 32). The marker should be placed on the cranial aspect of the foot.

**Dorsopalmar view (splay toe).** The patient is positioned in sternal recumbency. Tape around the foot, extend the forelimb cranially, and secure it to the table. As with the regular cranio-caudal view, the head and body of the patient may need to be rotated left to right to get the forelimb in a straight cranio-caudal position, using a positioning device or a team member wearing PPE. To separate the phalanges, place some cotton between each toe (FIGURE 33). This will help to visualize the toes individually on the radiograph. Center the primary beam over the metacarpals and collimate to include the carpus and all of the phalanges (FIGURE 34). The marker should be placed on the lateral aspect of the foot.
**Carpus Views**

**Medial stress view.** The patient is positioned in sternal recumbency. Tape around the proximal phalanges, extend the forelimb cranially, and secure it with tape to the table. Place another piece of tape around the metacarpus, above the first piece, distal to the carpus. Pull it laterally and secure it to the table. Press the edge of a wooden spoon or similar radiolucent device on the lateral aspect of the carpus, near the middle carpal joint. Hold the elbow of the patient in place with a lead-gloved hand, and gently press the spoon medially to stress the medial joint of the carpus (FIGURE 35). Collimate to include approximately one-third of the radius and ulna and, at minimum, one-third of the metacarpus (FIGURE 36). If the clinician prefers, all the phalanges can be included in this view. The marker should be placed on the lateral aspect of the carpus.

**Lateral stress view.** The patient is positioned in sternal recumbency. Tape around the proximal phalanges and extend the forelimb cranially. Secure it with tape to the table. Place another piece of tape around the metacarpus, just above the first piece, pull it medially, and secure it to the table. Press the edge of a wooden spoon or similar radiolucent device on the medial aspect of the carpus, near the middle carpal joint. Hold the patient’s elbow in place with a lead-gloved hand and gently press the spoon laterally to stress the lateral joint of the carpus (FIGURE 37). Collimate to include approximately one-third of the radius and ulna and, at minimum, one-third of the metacarpus (FIGURE 38). If the clinician prefers, all the phalanges can be included in this view. The marker should be placed on the lateral aspect of the carpus.

**Hyperflexion.** The patient is positioned in lateral recumbency with the affected limb closest to the plate or cassette. Flex the carpus so that the phalanges almost touch the distal aspect of the radius and ulna. Secure the foot either by taping in a figure 8 pattern proximal and distal to the carpus (FIGURE 39) or by using a heavy positioning aid against the distal portion of the foot to force the foot against the radius and ulna. Center the primary beam over the flexed carpus and collimate to include approximately one-third of the radius and ulna and one-third of the metacarpus (FIGURE 40). The marker should be placed on the cranial aspect of the foot.

**Hyperextension.** The patient is positioned in lateral recumbency with the affected limb
closest to the plate or cassette. Extend the carpus by placing a heavy positioning aid against the foot and pushing against the carpus (FIGURE 41). If this does not work, place a piece of tape around the metacarpus, pull cranially, and secure it to the table. Place another piece of tape around the middle of the carpus, pull caudally to extend the carpus, and secure it to the table. Center the primary beam over the extended carpus and collimate to include approximately one-third of the radius and ulna and one-third of the metacarpus (FIGURE 42). The marker should be placed on the cranial aspect of the foot.

CONCLUSION
Anthony Douglas Williams, spiritual author, once said, “When I look into the eyes of an animal, I do not see an animal. I see a living being. I see a friend. I feel a soul.” Many veterinary technicians can relate to this quote and see the truth behind it. We entered into this profession with a passion for animals and have gained an immense knowledge of veterinary medicine, but it is our responsibility to learn more. This 2-part article has given an overview of radiation safety, types of restraint for orthopedic radiography, and positioning techniques to obtain diagnostic radiographs of the skull, shoulder, elbow, stifles, pelvis, and feet. It is imperative to remember that obtaining a diagnostic-quality image aids in achieving the appropriate diagnosis for the patient.

References
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