



RADIOGRAPHY OF THE SMALL ANIMAL SKULL: TEMPOROMANDIBULAR JOINTS & TYMPANIC BULLAE

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Imaging Essentials provides comprehensive information on small animal radiography techniques. The following anatomic areas have been addressed in previous columns; these articles are available at tvpjournal.com (search “Imaging Essentials”).

- Thorax
- Elbow and antebrachium
- Abdomen
- Carpus and manus
- Pelvis
- Tarsus and pes
- Stifle joint and crus
- Cervical, thoracic, and lumbar spine
- Scapula, shoulder, and humerus
- Nasofacial and frontal sinuses

The anatomy of the skull, temporomandibular joints (TMJ), and region of the tympanic bullae in the dog and cat is complex because of superimposition of cavities, sinuses, mandible, maxilla, dental arcades, and neurocalvarium. Radiography of specific areas requires close attention to the details of normal anatomy that will aid in proper positioning for each image, based on the type of study being done.

Improperly positioned radiographs can lead to anatomic distortion of the skull anatomy, resulting in potential false positive diagnoses.

RADIOGRAPHIC EXPOSURE

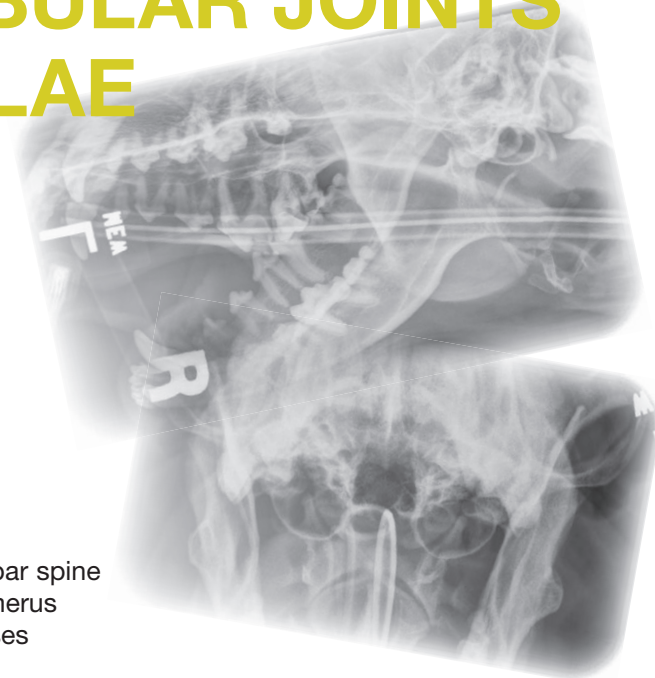
Exposures should be made using:

- **High mAs:** Lowest mA that, if there is an option, allows use of a small focal spot in order to improve geometric

THE NEED FOR ANESTHESIA

Although some basic skull views may be obtained with heavy sedation, general anesthesia is required to obtain diagnostic skull radiographs for several reasons:

- During each imaging series of the skull, one of the projections requires the mouth of the dog or cat to be open when an exposure is made.
- The oblique and skyline projections require exact positioning that is not possible in an awake dog or cat, even if heavily sedated.



sharpness and, thus, ability to see fine osseous detail.

- **Grids:** Use if areas thicker than 10 cm are being imaged; otherwise, **tabletop technique** is recommended.

ROUTINE PROJECTIONS:

SKULL, TMJ, & TYMPANIC BULLAE

LATERAL PROJECTION (Figure 1, page 54)

Positioning

1. For the right lateral projection, place the patient in right lateral recumbency, with the nose and skull in an extended position.
2. In dolichocephalic and mesaticephalic dog breeds, place a small rectangular sponge under the tip of the nose to keep it parallel with the table. For brachycephalic dog breeds and cats, use a 45-degree oblique sponge (wide end away from the head).
3. Place the cervical spine, thoracic limbs, and thorax in a lateral straight position relative to the skull.
4. Pull the thoracic limbs caudally.

To ensure the patient is straight in a lateral position:

- Place your hand along the ventral mandibles, positioning your hand perpendicular to the table and the mandibles.
- Feel for the external occipital protuberance along the caudodorsal margin of the skull (not as prominent in brachycephalic breeds).
- Compare the relative level with the middorsal aspect of the nasal cavity; this imaginary line should be parallel to the table.

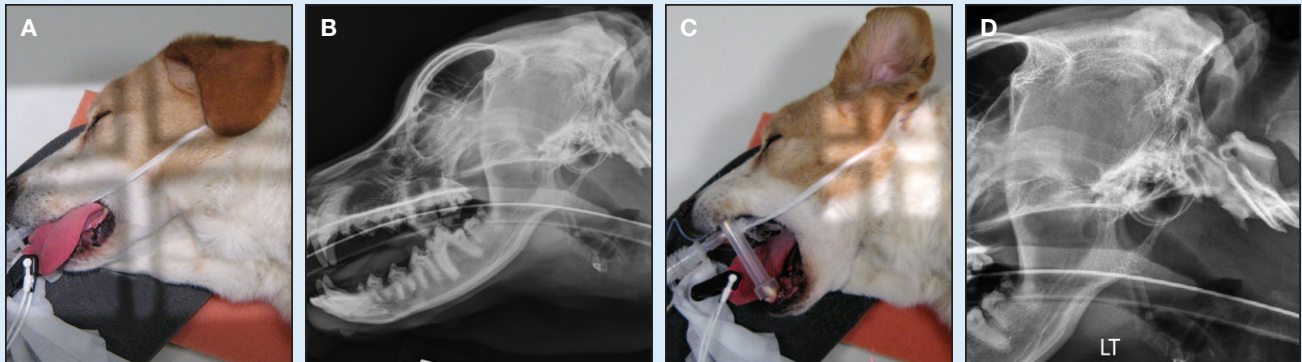


Figure 1. Dog positioned for a right lateral radiograph of the caudal skull centered over the TMJ and tympanic bullae (A) and corresponding radiograph (B). Collimated radiographs can be obtained if the area of interest only includes the TMJ and tympanic bullae (C and D). A syringe case can be used to open the mouth for the lateral or the oblique projections to ensure separation of the maxillary and mandibular dental arcades.

Collimation

1. Set the central beam to the mid cranium, with the collimator opened to just include the cranium and nasal cavity (cross hairs just caudal and ventral to the eyes).
2. Place an external radiopaque marker ventral to the caudal mandible on the table or radiographic cassette.
3. If the area of interest is lateralized to one side, place the side of interest closest to the detector, in which case, the marker indicates which recumbency the patient has been placed.
4. If the area of interest is at the level of the maxilla or mandible, the upper and lower jaw can be separated (opened) by placing a syringe case between the mandibular and maxillary canines.

Ensuring Image Quality

The lateral projection of the skull should extend from the rostral end of the nose (nasal planum) through the first cervical vertebra (C1). The wings of the atlas and C1 should be even and superimposed, and all aspects of the skull should be superimposed, such as the zygomatic arches, mandibles, and tympanic bullae.

Superimposition is more difficult in brachycephalic breeds because their skulls are much wider—geometric distortion from the divergent nature of the x-ray beam may make superimposition of all structures impossible.

VENTRODORSAL/DORSOVENTRAL PROJECTION (Figure 2)

Ventrodorsal (VD) or dorsoventral (DV) positioning is dependent on the breed of dog or cat; while deep-chested dogs are better imaged in VD position, brachycephalic and small breed dogs and cats may be better imaged in a DV position.

The area of interest should be as close to the film/cassette/detector as possible for the best overall

detail and to reduce geometric magnification. The radiograph should be reviewed to ensure that the right and left sides of the skull are symmetrical for evaluation.

Positioning

To obtain the **VD projection**:

1. Place the patient in dorsal recumbency.
2. Extend the skull, with the external occipital protuberance resting on a thin sponge.
3. Ensure the ventral aspect of the mandibles and the hard palate, which cannot be visualized because the animal's mouth is closed, are parallel to the table.
4. Use a V-trough to help maintain the patient in a straight position.

To obtain the **DV projection**:

1. Place the patient in ventral or sternal recumbency.
2. Extend the skull, with the mandibular rami placed on the table/cassette/detector.
3. To ensure stabilization, place a thin radiolucent sponge between the patient's ventral skull and the table/cassette/detector.

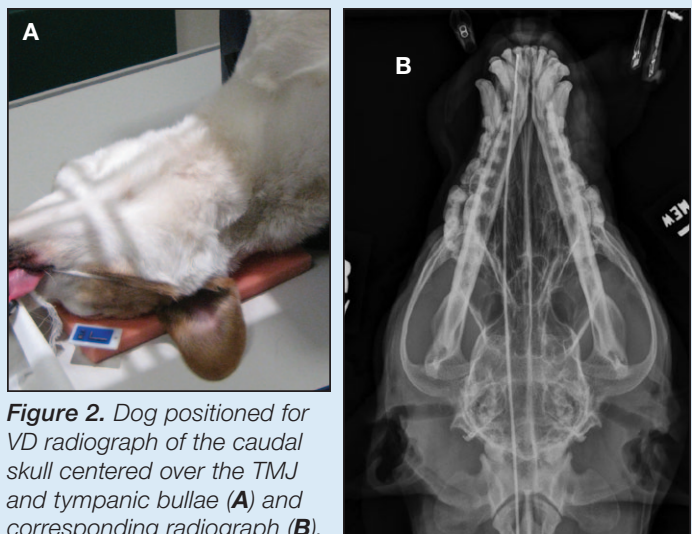


Figure 2. Dog positioned for VD radiograph of the caudal skull centered over the TMJ and tympanic bullae (A) and corresponding radiograph (B).

tor, as needed.

To ensure the patient is properly positioned, place your hands:

- On either side of the skull, feeling for the symmetry of the mandible and/or zygomatic arches.
- Relative to either anatomic location to be equidistant from the table on the right and left sides.

Collimation

1. Set the central beam to the level of the caudal zygomatic arch (at a level just caudal to the eyes) with the collimator opened to include C1/C2, the neurocranium, and the caudal portion of the nasal cavity (approximate level of maxillary premolar 3).
2. Place the radiopaque marker on the right side of the dog or cat, taking care to avoid superimposition of the marker over any part of the skull.

Ensuring Image Quality

For VD or DV images of the skull, the rostral extent of the image should be the nasal planum, while the caudal extent is C1. Make sure the various parts of the skull are symmetrically positioned right and left, and not obliqued. This may be impossible in patients that have skull trauma with multiple fractures.

BREED-BASED POSITIONING

Although positioning for many of these projections is similar, use of sponges and tape will vary based on skull size and shape:

- **Dolichocephalic** breeds (eg, Doberman pinscher) have long, narrower heads
- **Mesaticephalic** breeds (eg, beagle) have medium sized and shaped heads
- **Brachycephalic** breeds (eg, bulldog) have short, wide heads, with foreshortening of the nasal cavity and absence of frontal sinuses
- **Cats** have more standard sized and shaped heads; however, some brachycephalic cat breeds (eg, Persian) require the same considerations as brachycephalic dog breeds.

Figure 3. Dog positioned for an open-mouth rostrocaudal oblique radiograph of the TMJ and tympanic bullae (A) and corresponding radiograph (B).



SPECIFIC PROJECTIONS: TMJ & TYMPANIC BULLAE OPEN-MOUTH ROSTROCAUDAL OBLIQUE PROJECTION (Figure 3)

Positioning

1. Place the patient in dorsal recumbency.
2. Flex the neck, positioning the hard palate and mandibles perpendicular to the table and x-ray collimator system.
3. Place small triangle sponges under the external occipital protuberance to help maintain a symmetric position on the table.
4. Place tape—starting from one side of the table at the level of the abdomen—and pass it around the patient's nose, fastening it to the other side of the table at the same level.
5. Angle the hard palate approximately 10 degrees rostral to the perpendicular plane of the body.
6. Extend the mandible caudally (open mouth) with the endotracheal tube secured to the mandible, taking care to avoid kinking the tube and stopping the flow of oxygen/inhalation of anesthetic agent.

Collimation

1. Set the central beam through the open mouth at the level of the soft palate.
2. Take care to ensure the cranium is straight, without lateral rotation.
3. Assess this positioning by standing at the patient's head and placing your hands on either side of the cranium, at the level of mandibular rami, verifying both rami are equidistant to the table.

Ensuring Image Quality

The open-mouth projection should include both TMJ and tympanic bullae without rotation or superimposition of the endotracheal tube. Collimation should extend caudally from C1 to include the full tympanic bullae rostrally.

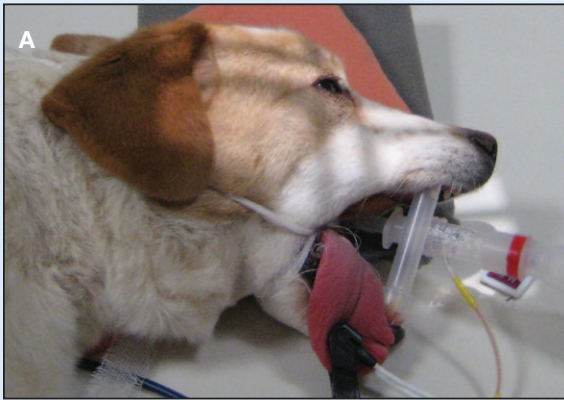


Figure 4. Dog positioned in left lateral recumbency for a 30-degree oblique radiograph of the nonrecumbent, right tympanic bulla and TMJ (A) and corresponding radiograph (B). **Note:** A roll of tape or a syringe case can be used to keep the mouth open.

LATERAL 30-DEGREE OBLIQUE PROJECTION (Figure 4)

Positioning

For a complete study, both right lateral and left lateral oblique projections are needed.

1. Place the patient in lateral recumbency, with the nose and skull in an extended position.
2. Ensure the mouth remains open, which can be accomplished with a syringe case, and secure the endotracheal tube to the mandible.
3. Place a 30-degree wedge sponge under the maxilla to ventrally oblique the skull.

When the initial projection is finished, take the opposite oblique projection by:

1. Rolling the patient over, with the original nonrecumbent side now on the table.
2. Placing a wedge sponge under the maxilla to ventrally rotate the head by 30 degrees.

Collimation

1. Position the central beam just ventral to the nonrecumbent external auditory canal (that closest to the tube head).
2. Adjust collimation to include only the tympanic

bullae and TMJ from the level of the third maxillary premolar to C1/C2.

3. If the patient is in right lateral recumbency, for example, the left TMJ, tympanic bulla, and ear will move ventrally when positioned correctly.
4. Place the radiopaque markers outside soft tissue structures: For the right lateral projection, place the right marker ventral to the oblique, recumbent bulla and the left marker just dorsal to the skull. For the left lateral projection, the opposite is true, with the left marker placed ventral to the oblique, recumbent bulla.

Ensuring Image Quality

The lateral oblique projection should extend from mid mandible to C1. One of the TMJs and tympanic bulla should appear ventral but without superimposition of the cranium. Care should be taken to avoid over rotating the patient, causing foreshortening of the vertical mandibular ramus and tympanic bulla.

LATERAL 25- TO 30-DEGREE ROSTROCAUDAL OBLIQUE PROJECTION (Figure 5, page 57)

Positioning

For a complete study, both right lateral and left lateral oblique projections are needed.

1. Place the patient in lateral recumbency, with the cranium and nasal passages in true lateral position.
2. Place a triangular- or wedge-shaped radiolucent sponge under the rostral aspect of the nose and mandible, which lifts the nasal planum, nasal cavity, and mandible 25- to 30-degrees away from the table.
3. Ensure the mouth remains open, which can be accomplished by placing a syringe case between the upper and lower canines.

When the initial projection is finished, take the opposite oblique projection by rolling the patient over, with the original, nonrecumbent side now on the table.

It is important to note that, in left lateral recumbency, the:

- Right TMJ and tympanic bulla are caudal and, therefore, best visualized by this projection
- Left TMJ and tympanic bulla appear superimposed over the caudoventral aspect of the skull.

The opposite is true for right lateral recumbency.

Collimation

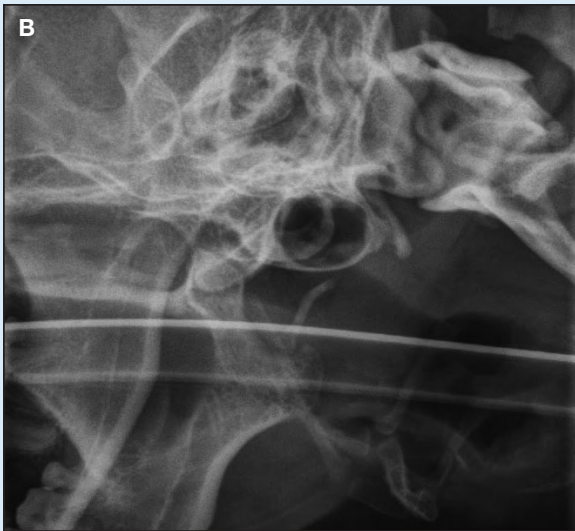
1. Direct the central beam just rostral to the TMJ (that closest to the tube head).
2. Adjust collimation to include only the tympanic bulla and TMJ.
3. Mark the recumbent side, which will appear *more rostral* on the radiograph.

Ensuring Image Quality

The rostrocaudal oblique projection should extend



Figure 5. Dog positioned in left lateral recumbency for a 30-degree rostrocaudal oblique radiograph of the nonrecumbent, right tympanic bulla (A) and corresponding radiograph that depicts caudal position of the nonrecumbent tympanic bulla, which is best visualized in this position (B).



The marker in this image denotes that, despite the left lateral recumbency position of the dog, the right tympanic bulla is caudal and, therefore, better visualized in this projection.

ing from one side of the table at the level of the abdomen, pass it around the patient's nose, fastening it to the other side of the table at the same level.

5. Secure the endotracheal tube rostrally to the maxilla, keeping the mouth closed.

Collimation

1. Direct the central beam to the tympanic bulla.
2. Take care to ensure the cranium is straight, without lateral rotation.
3. Assess this positioning by standing at the patient's head and placing your hands on either side of the cranium, at the level of mandibular rami, verifying both rami are equidistant to the table.

Ensuring Image Quality

This closed-mouth rostrocaudal oblique projection should include the tympanic bullae without rotation or superimposition of the endotracheal tube.

from mid mandible to C1. One of the TMJs and tympanic bulla should appear rostral to the other; the more rostral structures should be those on the recumbent side of the patient.

CLOSED-MOUTH ROSTROCAUDAL OBLIQUE PROJECTION (Figure 6)

This projection is used for rostrocaudal evaluation of the tympanic bulla in brachycephalic dogs and cats, and replaces the open-mouth rostrocaudal projection described earlier.

Positioning

1. Place the patient in dorsal recumbency, supporting the body in a V-trough, as needed.
2. Flex the neck, tilting the hard palate and mandibles 10- to 15-degrees rostral to the perpendicular plane of the table and x-ray collimator system.
3. Use small triangle sponges under the external occipital protuberance to help maintain symmetry of the skull on the table.
4. Flex the skull—then take tape, and start-

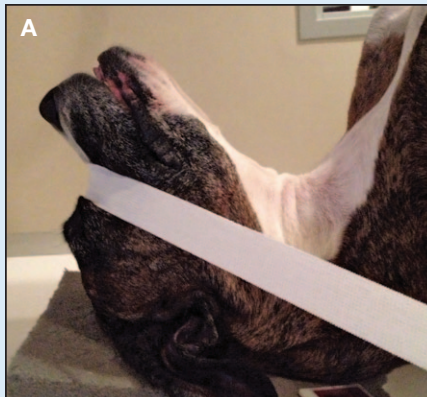


Figure 6. Positioning for a closed-mouth 10- to 15-degree rostrocaudal oblique radiograph of the TMJ and tympanic bullae in a boxer/mixed breed dog (A) and corresponding radiograph (B). This view can be used for brachycephalic dog breeds and in cats for evaluating the tympanic bullae.



QUALITY CONTROL

For quality control of any diagnostic image, use a simple 3-step approach.

1. Is the technique adequate, with appropriate exposure and development?
2. Is the correct anatomy present within the image? Compare the images you obtain with the images in this article.
3. Is positioning anatomically correct? Was correct anatomic coverage obtained?

Once it is determined that the technique is adequate, make sure the appropriate anatomy is present and positioning is correct, straight, and symmetric. Symmetry of the skull for VD/DV images is critical when evaluating all structures and osseous anatomy.

Use the figures in this article as a guide as well as the information provided in the **Ensuring Image Quality** sections.

SUMMARY

Radiographs of the skull allow evaluation of a number of clinical signs related to the skull, TMJ, and tympanic bullae. The images included in this article illustrate how to produce and evaluate the quality of these radiographs. High-quality, correctly positioned and collimated radiographs are required in order to accurately assess the TMJ and tympanic bullae. ■

C1 = first cervical vertebra; DV = dorsoventral; TMJ = temporomandibular joint; VD = ventrodorsal

Suggested Reading

- Burk RL, Feeney DA. *Small Animal Radiology and Ultrasonography: A Diagnostic Atlas and Text*, 3rd ed. Philadelphia: Saunders Elsevier, 2003.
- Kealy JK, McAllister H, Graham JP. *Diagnostic Radiology and Ultrasonography of the Dog and Cat*, 5th ed. Philadelphia: Saunders Elsevier, 2011.
- Sirois M, Anthony E, Mauragis D. *Handbook of Radiographic Positioning for Veterinary Technicians*. Clifton Park, NY: Delmar Cengage Learning, 2010.
- Thrall DE (ed). *Textbook of Veterinary Radiology*, 6th ed. Philadelphia: Saunders Elsevier, 2012.
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