



# SMALL ANIMAL SPINAL RADIOGRAPHY SERIES

## CERVICAL SPINE RADIOGRAPHY

Danielle Mauragis, CVT, and Clifford R. Berry, DVM, Diplomate ACVR

**Imaging Essentials** provides comprehensive information on small animal radiography techniques. This article is the first in a 3-part series covering **cervical, thoracic, and lumbar spine radiography**.

The following anatomic areas have been addressed in previous columns; these articles are available at [todaysveterinarypractice.com](http://todaysveterinarypractice.com) (search “Imaging Essentials”).

- Thorax
- Scapula, shoulder, and humerus
- Abdomen
- Elbow and antebrachium
- Pelvis
- Carpus and manus
- Stifle joint and crus
- Tarsus and pes

**S** **pinal radiographs** are indicated for:

- Evaluation of traumatic injuries
- Neck and back pain
- Pain or neurologic issues associated with thoracic or pelvic limb lameness isolated to these regions.

Each radiographic projection is a separate study and should be radiographed as such. High quality, correctly positioned and collimated radiographs are required in order to provide an accurate assessment of the area of interest, especially for surgical planning.

As a general rule, general anesthesia or heavy sedation is necessary to evaluate the spine because, in most cases, spinal images taken in nonsedated patients are nondiagnostic. In addition, the presence or absence of disk space narrowing cannot be determined from a nonsedated animal's radiographs due to unavoidable positioning artifacts.

### MEASURING THE CERVICAL SPINE

**Measure the thickest portion of the neck** that is within the area of collimation.

Due to thickness differences of the *cranial and caudal parts of the neck* in large-breed dogs, such as Doberman pinschers, Great Danes, or mastiffs:

- For *lateral imaging*, measure mid cervical and at the level of the shoulder.
- For *ventrodorsal imaging*, measure mid cervical and at the level of the manubrium.

These techniques result in 2 separate radiographic images—cranial and caudal radiographs of the cervical spine.



## ROUTINE VIEWS

**Lateral and ventrodorsal views** are considered the minimum orthogonal radiographs for the spine. Due to the angled, divergent nature of the x-ray beam, the area of the spine in the center of the field of collimation will be the area that provides the correct anatomic detail and intervertebral disk space widths.

If there is a **suspected abnormality** at the edge of the image, a repeat collimated image centered at the area of interest is required for complete evaluation. Recollimated images are important because they depict common areas of disease (ie, intervertebral disk spaces) that are typically at the edge of the film/image, which could be misinterpreted as narrowed due to the divergent nature of the x-ray beam.

A routine cervical spine study includes:

1. Open **lateral** image of entire cervical spine
2. Open **ventrodorsal** image of entire cervical spine
3. Collimated image of **lateral cervicothoracic** spine
4. Collimated image of **ventrodorsal cervicothoracic** spine.



**Figure 1.** Dog positioned for lateral projection of the cervical spine (A) and corresponding radiograph (B).

### Lateral Projection: Cervical Spine

For the lateral projection, position the patient in lateral recumbency (**Figure 1**).

- Tape the thoracic limbs together evenly and pull caudally.
- Tape or sandbag the thoracic limbs in this caudal position, which places the humerus and glenohumeral joint below the cervical spine, eliminating superimposition. There will always be some degree of superimposition of the scapula.
- Move the lumbar area of the dog dorsally, allowing the cervical spine to align with the horizontal collimation light.
- Place the skull in lateral position; then extend the skull and spine naturally and pull them straight cranially.

If the patient is a large-breed dog, place a sponge under the cervical spine and skull cranial to the shoulder. The sponge elevates the cranial portion of the cervical spine, making it level and lateral with the caudal portion of the cervical spine.

### Collimated Projection: Cervicothoracic Spine

The collimated lateral image is centered over the cervicothoracic spine, and extends from the mid cervical spine (cranial limit of field of view [FOV]) to just caudal to the scapulohumeral joint.

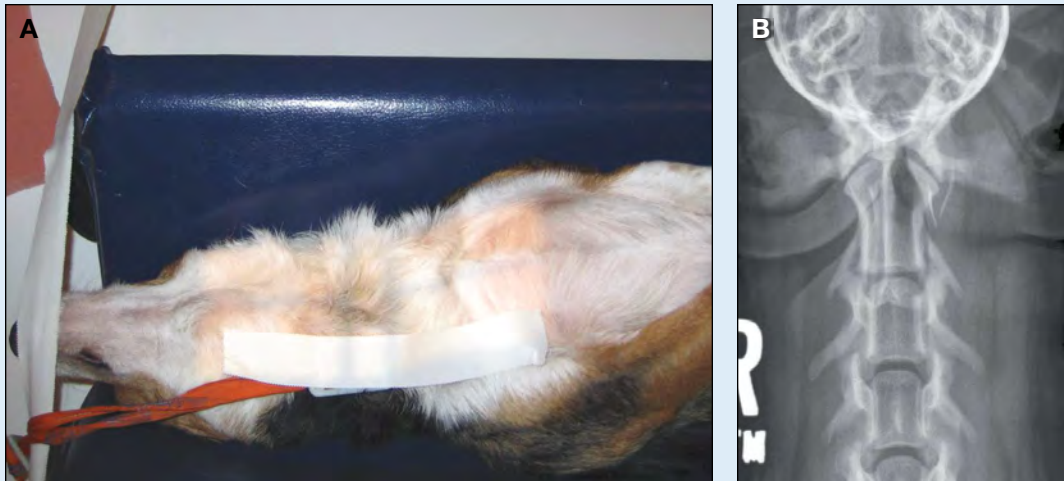
### Lateral Collimation

For the lateral projection, the FOV *excludes* the ventral and dorsal soft tissues of the neck, only *including* the cervical vertebral bodies and immediate soft tissues adjacent to the spine.

For all patients:

- Palpate the vertebrae of the cervical spine and place the horizontal line of the FOV at this plane.
- **For smaller patients**, collimate the FOV to include the caudal portion of the skull (cranial limit) to just caudal of the scapulohumeral joint (caudal limit).
- **For larger patients** (cranial and caudal images):
  - » The **cranial projection FOV** should include the caudal portion of the skull to just cranial to the level of the scapulohumeral joint.
  - » The **caudal projection FOV** is centered just dorsal to the humeral scapular joint and first rib; it should extend cranially to the mid cervical spine and caudally to approximately the third rib.

The radiographic marker is placed along the dorsal and cranial aspect of the collimated FOV.



**Figure 2.** Dog positioned for ventrodorsal projection of the cervical spine (A) and corresponding radiograph (B).

#### Ventrodorsal Projection: Cervical Spine

Position the patient in dorsal recumbency (Figure 2).

- If a positioning trough is used, place the entire cervical spine within the trough to eliminate any edge artifacts associated with the imaging tray.
- Extend the skull and neck and align them with the manubrium.
- Pull the thoracic limbs caudally and either tape together or individually.



#### Collimated Projection: Cervicothoracic Spine

The caudal ventrodorsal projection used for large-breed dogs (see **Ventrodorsal Collimation**) also serves as the collimated cervicothoracic image for all dogs and cats.

#### Ventrodorsal Collimation

For the ventrodorsal projection, the FOV *excludes* the lateral soft tissues of the neck, only *including* the central cervical vertebral bodies and immediate soft tissues adjacent to the vertebral column.

For all patients:

- Palpate the vertebrae of the cervical spine and place the horizontal line of the FOV at this plane.
- **For smaller patients**, collimate the FOV to include the caudal portion of the skull and caudal to approximately the third rib.
- **For larger patients** (cranial and caudal images):
  - » The **cranial projection FOV** should include the caudal portion of the skull to just cranial to the manubrium.
  - » The **caudal projection FOV** should extend to mid cervical spine cranially and extend caudally to approximately the third rib. If allowable, the tube head should be angled approximately 10° toward the dog or cat's head, which aligns the angle of the x-ray beam with the angle of the caudal cervical intervertebral disk spaces, eliminating superimposition of the vertebral body over the intervertebral disk space.

The radiographic marker is placed along the right cranial aspect of the image in the collimated FOV.

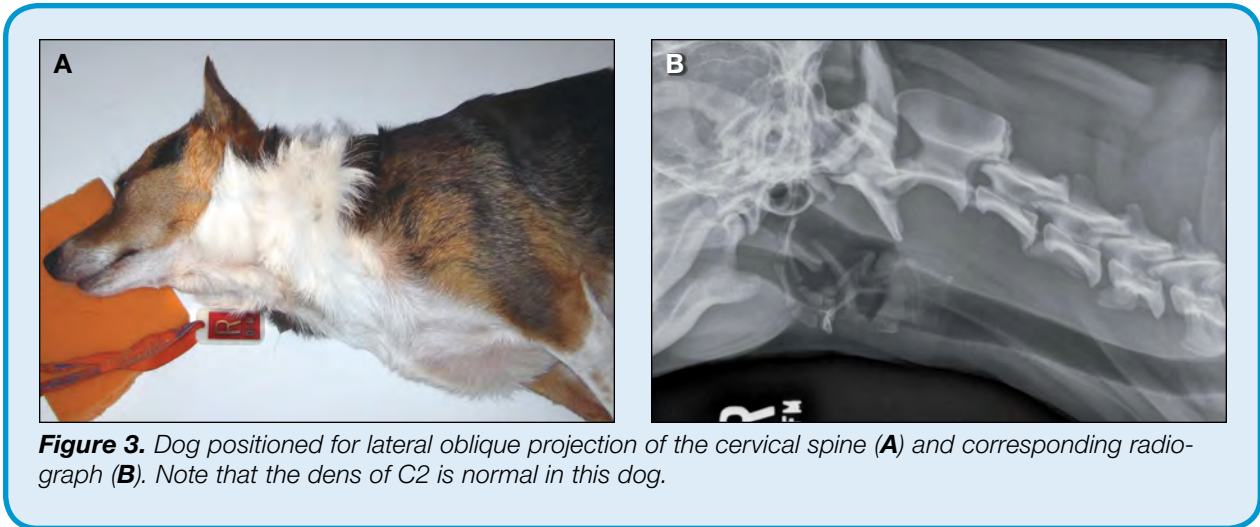
**ADDITIONAL VIEWS**

**Lateral Oblique Projection: Cervical Spine**

Trauma or congenital malformation may cause atlantoaxial luxation or instability of the joint between cervical vertebra 1 and 2. To visualize the dens, an oblique projection from the lateral position is obtained.

If an atlantoaxial instability is suspected, it is imperative that care be taken not to luxate the vertebra further, resulting in spinal cord trauma. Sedation is highly recommended for these patients to avoid additional movement.

- Position the patient in lateral recumbency (**Figure 3**).
  - Tape the forelimbs and pull caudally with gentle pressure.
  - Obliquely angle the spine in a ventral direction, which is achieved by placing a sponge under the dorsal skull and shoulder.
- For collimation**, the FOV is centered at the atlantoaxial joint. The cranial border is at mid skull, while the caudal border includes cervical vertebra 3 and 4.




**Figure 3.** Dog positioned for lateral oblique projection of the cervical spine (A) and corresponding radiograph (B). Note that the dens of C2 is normal in this dog.

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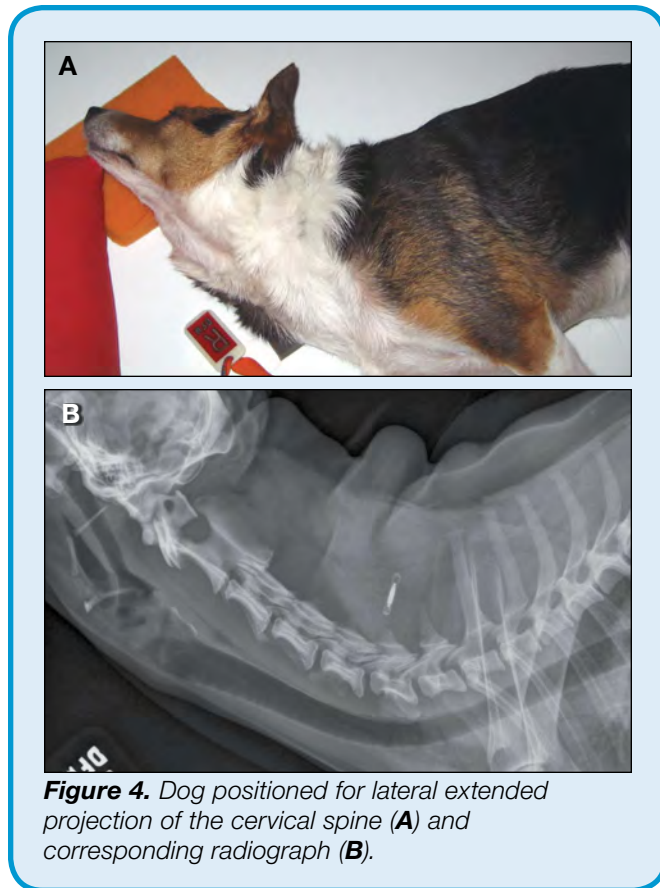
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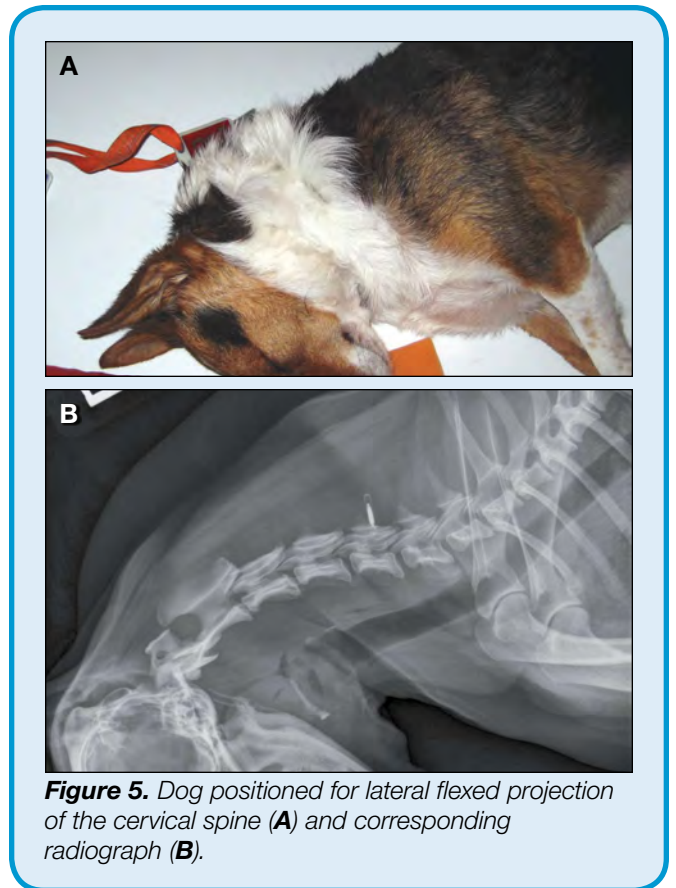
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**Figure 4.** Dog positioned for lateral extended projection of the cervical spine (A) and corresponding radiograph (B).



**Figure 5.** Dog positioned for lateral flexed projection of the cervical spine (A) and corresponding radiograph (B).

### Lateral Flexed & Extended Projections: Cervical Spine

Flexed and extended projections are used for cervical vertebral malformation (CVM) or Wobbler's syndrome.

Compression of the spinal cord due to abnormalities occurs mainly in large-breed dogs and affects the caudal cervical vertebrae and their articulations, resulting in paraparesis, tetraparesis, or ataxia. The large-breed dog will need a cranial and caudal projection as with a naturally positioned cervical spine projection.

**For both projections**, position the patient in lateral recumbency, with the forelimbs taped and pulled caudally.

**For the extended projection (Figure 4)**, push the skull and cervical spine dorsally.

- Ensure that the caudal cervical vertebra are angled dorsally, not merely pivoted at the mid cervical spine.
- Hold the skull in place with a sandbag or tape.

**For the flexed projection (Figure 5)**, pull the skull and cervical spine ventrally toward the forelimbs.

- Ensure that the cervical spine is flexed at the level of the caudal cervical vertebra and not merely arched at the mid cervical spine.
- Hold the skull in place with a sandbag or tape.

**For collimation**, due to the flexion and extension of the cervical spine, the FOV includes most of the soft tissues of the neck.

### Ventrodorsal Oblique Projection: Cervical Spine

Subtle lesions, fractures, and intervertebral disk disease are a few of the conditions that may require a ventrodorsal oblique projection of the spine.

From the straight ventrodorsal position of the cervical spine, obliquely rotate the patient to the left approximately 10° to 15°; then take the radiograph. Then rotate the patient to the right approximately 10° to 15° and take another radiograph.

**Set the collimation** of the oblique ventrodorsal projections as described for the ventrodorsal projection of the cervical spine.

### QUALITY CONTROL

To make certain the desired technique has been achieved, use the following guidelines to determine whether the appropriate anatomy is included in the images.

### For both lateral and ventrodorsal projections of the cervical spine:

- The **cranial border** should include the caudal aspect of the skull.
- The **caudal border** should, at least, include T1.

### For the lateral projection of the cervical spine:

- The wings of the Atlas (C1) should be even and superimposed.
- Each cervical vertebral body should be even with the superimposed transverse processes.

For quality control of any diagnostic image, follow a simple 3-step approach:

1. Is the **technique** adequate (appropriate exposure and development factors)?
2. Is the correct **anatomy** present within the image?
3. Is the **positioning** anatomically correct and straight?

- On a straight cervical spine, the wings of C1 will overlap each other and be superimposed over the dens, which is not visualized.

#### For the ventrodorsal projection of the cervical spine:

- The spinous processes should be superimposed over the vertebral bodies.
- The spinous process over the Axis (C2) should resemble a thin line bisecting the vertebral body. ■

#### Suggested Reading

- Burk RL, Feeney DA. *Small Animal Radiology and Ultrasonography: A Diagnostic Atlas and Text*, 3rd ed. Philadelphia: Saunders Elsevier, 2003.
- Keely 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*, 5th ed. Philadelphia: Saunders Elsevier, 2008.
- Thrall DE, Robertson ID. *Atlas of Normal Radiographic Anatomy and Anatomic Variants in the Dog and Cat*. Philadelphia: Elsevier Saunders, 2011.



**Danielle Mauragis, CVT**, is a radiology technician at University of Florida College of Veterinary Medicine. She teaches veterinary students all aspects of the physics of diagnostic imaging, quality control of radiographs, positioning of small and large animals, and radiation safety. Ms. Mauragis coauthored the *Handbook of Radiographic Positioning for Veterinary Technicians* (2009) and was the recipient of the Florida Veterinary Medical Association's 2011

Certified Veterinary Technician of the Year Award. This award recognizes an individual for the many outstanding contributions that person has made to the overall success of a veterinary practice operated or staffed by an FVMA member veterinarian.



**Clifford R. Berry, DVM, Diplomate ACVR**, is a professor in diagnostic imaging at the University of Florida College of Veterinary Medicine. His research interests include cross-sectional imaging of the thorax, nuclear medicine applications in veterinary medicine, and biomedical applications of imaging in human and veterinary medicine. Dr. Berry has been a faculty member at North Carolina

State University and University of Missouri. He received his DVM from University of Florida and completed a radiology residency at University of California–Davis.

#### TRIFEXIS®

(spinosad + milbemycin oxime)

#### Cheewable Tablets

Before using TRIFEXIS chewable tablets, please consult the product insert, a summary of which follows:

**Caution:** Federal (USA) law restricts this drug to use by or on the order of a licensed veterinarian.

#### Indications:

TRIFEXIS is indicated for the prevention of heartworm disease (*Dirofilaria immitis*). TRIFEXIS kills fleas and is indicated for the prevention and treatment of flea infestations (*Ctenocephalides felis*), and the treatment and control of adult hookworm (*Ancylostoma caninum*), adult roundworm (*Toxocara canis* and *Toxascaris leonina*) and adult whipworm (*Trichuris vulpis*) infections in dogs and puppies 8 weeks of age or older and 5 pounds of body weight or greater.

#### Contraindications:

There are no known contraindications to the use of TRIFEXIS Chewable Tablets.

#### Warnings:

Not for human use. Keep this and all drugs out of the reach of children.

Serious adverse reactions have been reported following concomitant extra-label use of ivermectin with spinosad alone, one of the components of TRIFEXIS Chewable Tablets (see **ADVERSE REACTIONS**).

#### Precautions:

Treatment with fewer than 3 monthly doses after the last exposure to mosquitoes may not provide complete heartworm prevention (see **EFFECTIVENESS**).

Prior to administration of TRIFEXIS, dogs should be tested for existing heartworm infection. At the discretion of the veterinarian, infected dogs should be treated with an antihelminthic to remove adult heartworms. TRIFEXIS is not effective against adult *Dirofilaria immitis*. While the number of circulating microfilariae may decrease following treatment, TRIFEXIS is not indicated for microfilariae clearance. Mild, transient hypersensitivity reactions manifested as labored respiration, vomiting, salivation and lethargy, have been noted in some dogs treated with milbemycin oxime carrying a high number of circulating microfilariae. These reactions are presumably caused by release of protein from dead or dying microfilariae.

Use with caution in breeding females. The safe use of TRIFEXIS in breeding males has not been evaluated. Use with caution in dogs with pre-existing epilepsy. Puppies less than 14 weeks of age may experience a higher rate of vomiting.

#### Adverse Reactions:

In a well-controlled US field study, which included a total of 352 dogs (176 treated with TRIFEXIS chewable tablets and 176 treated with an active control), no serious adverse reactions were attributed to administration of TRIFEXIS chewable tablets. All reactions were regarded as mild.

In some cases, dogs vomited after receiving TRIFEXIS. To ensure heartworm prevention, observe your dog for one hour after administration. If vomiting occurs within an hour of administration, redose with another full dose.

Reactions that occurred at an incidence  $\geq 2\%$  (average monthly rate) within any of the 6 months of observation are presented in the following table:

Average Monthly Rate (%) of Dogs With Adverse Reactions

Adverse Reaction	TRIFEXIS Chewable Tablets <sup>a</sup>	Active Control Tablets <sup>a</sup>
Vomiting	6.13	3.08
Pruritus	4.00	4.91
Lethargy	2.63	1.54
Diarrhea	2.25	1.54

<sup>a</sup>n=176 dogs

In the US field study, one dog administered TRIFEXIS experienced a single mild seizure 2½ hours after receiving the second monthly dose. The dog remained enrolled and received four additional monthly doses after the event and completed the study without further incident.

Following concomitant extra-label use of ivermectin with spinosad alone, a component of TRIFEXIS, some dogs have experienced the following clinical signs: trembling/twitching, salivation/drooling, seizures, ataxia, mydriasis, blindness and disorientation. Spinosad alone has been shown to be safe when administered concurrently with heartworm preventatives at label directions.

In US and European field studies, no dogs experienced seizures when dosed with spinosad alone at the therapeutic dose range of 13.5–27.3 mg/lb (30–60 mg/kg), including 4 dogs with pre-existing epilepsy. Four epileptic dogs that received higher than the maximum recommended dose of 27.3 mg/lb (60 mg/kg) experienced at least one seizure within the week following the second dose of spinosad, but no seizures following the first and third doses. The cause of the seizures observed in the field studies could not be determined.

For technical assistance or to report an adverse drug reaction, call 1-888-545-5973. Additional information can be found at [www.TRIFEXIS.com](http://www.TRIFEXIS.com).

#### Post-Approval Experience (March 2012):

The following adverse reactions are based on post-approval adverse drug event reporting. The adverse reactions are listed in decreasing order of frequency: vomiting, depression/lethargy, pruritus, anorexia, diarrhea, trembling/shaking, ataxia, seizures, hypersalivation, and skin reddening.

#### Effectiveness:

##### Heartworm Prevention:

In a well-controlled laboratory study, TRIFEXIS was 100% effective against induced heartworm infections when administered for 3 consecutive monthly doses. Two consecutive monthly doses did not provide 100% effectiveness against heartworm infection. In another well-controlled laboratory study, a single dose of TRIFEXIS was 100% effective against induced heartworm infections. In a well-controlled six-month US field study conducted with TRIFEXIS, no dogs were positive for heartworm infection as determined by heartworm antigen testing performed at the end of the study and again three months later.

##### Flea Treatment and Prevention:

In a well-controlled laboratory study, TRIFEXIS demonstrated 100% effectiveness on the first day following treatment and 100% effectiveness on Day 30. In a well-controlled laboratory study, spinosad, a component of TRIFEXIS, began to kill fleas 30 minutes after administration and demonstrated 100% effectiveness within 4 hours. In field studies conducted in households with existing flea infestations of varying severity, flea reductions of 98.0% to 99.8% were observed over the course of 3 monthly treatments with spinosad alone. Dogs with signs of flea allergy dermatitis showed improvement in erythema, papules, scaling, alopecia, dermatitis/pyodermitis and pruritus as a direct result of eliminating the fleas.

##### Treatment and Control of Intestinal Nematode Infections:

In well-controlled laboratory studies, TRIFEXIS was  $\geq 90\%$  effective in removing naturally and experimentally induced adult roundworm, whipworm and hookworm infections.

NADA #141-321. Approved by the FDA

Manufactured for Elanco Animal Health

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Lilly Corporate Center, Indianapolis, IN 46285

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