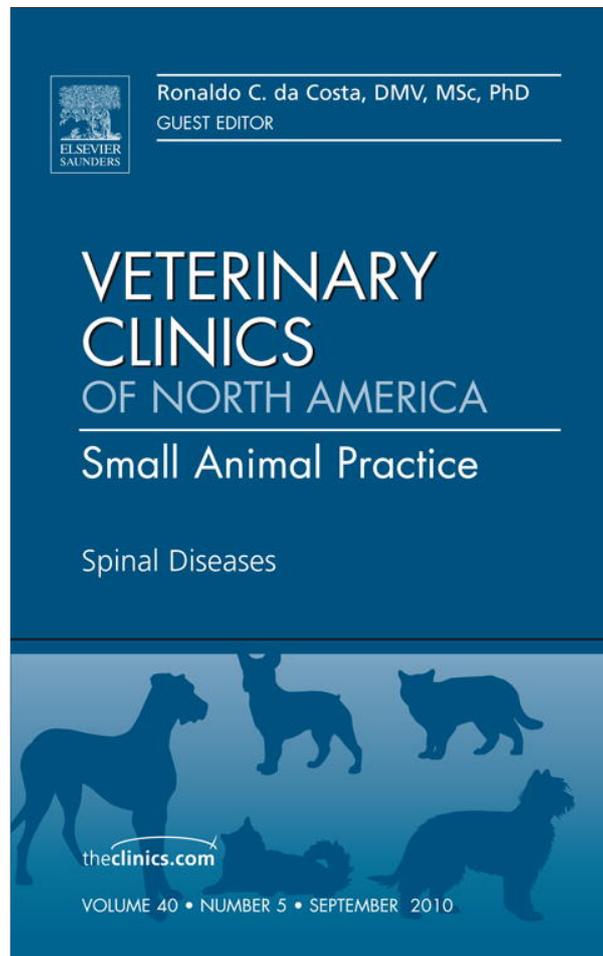


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# Differential Diagnosis of Spinal Diseases

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## KEYWORDS

- Spine • Spinal • Spinal cord • Nerve roots • Meninges
- Pain • Myelopathy • Radiculopathy

Neurologic diseases leading to gait problems are a common occurrence in small animal practice. Evaluating an ataxic, weak, or paralyzed patient can be an intimidating task, but a logical approach facilitates this process. A complete physical and neurologic examination enables the clinician to confirm that the patient has a neurologic problem and to localize the problem along the spine. The next step in the diagnostic approach is to develop a list of differential diagnoses. The patient's signalment and history often provide important clues to develop a logical list of differential diagnoses. This, in turn, provides the basis for developing a diagnostic plan. This article aims to facilitate the development of differential diagnoses lists for patients with spinal disorders. The authors' goal is to link the process of localizing a lesion with selecting the most likely diseases to develop a diagnostic plan. Detailed information about most of the differential diagnoses included herein can be found elsewhere in this issue.

## DIAGNOSTIC APPROACH

The approach to patients with spinal disorders includes a thorough physical and neurologic examination aimed at localizing the lesion. Proper lesion localization is paramount for the diagnostic approach, because differential diagnoses and ancillary diagnostic tests are dependent on it (**Fig. 1**).

Classically, the spinal cord is divided into 4 major segments. The spinal cord segments do not match up with the vertebrae in the cervical and lumbar regions, and there are 7 cervical vertebrae but 8 cervical spinal cord segments. The main spinal cord divisions in terms of lesion localization are C1 to C5, C6 to T2, T3 to L3 and L4 to S3. Also, there are 2 subdivisions that are clinically relevant and may assist the clinician in considering the appropriate differential diagnoses and in selecting the most indicated ancillary tests. These subdivisions are the T2-T10 and L6-L7-S1 vertebral regions.

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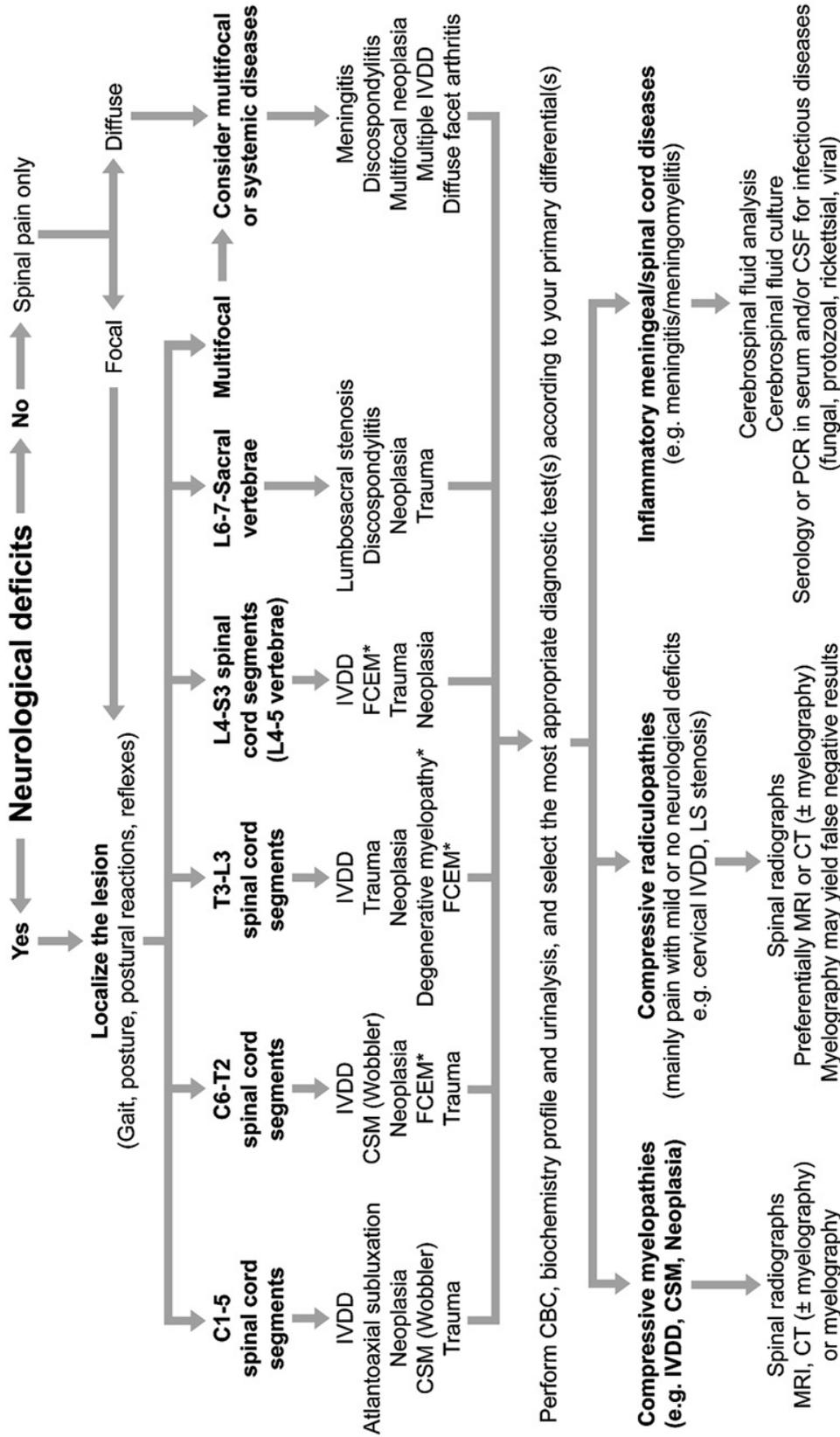
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**Fig. 1.** Algorithm presenting the differential diagnoses and diagnostic approach to spinal problems according to lesion localization. (\*), Nonpainful spinal cord diseases; CSF, cerebrospinal fluid analysis; CSM, cervical spondylomyelopathy; CT, computed tomography; IVDD, intervertebral disk disease; FCEM, fibrocartilaginous embolic myelopathy; MRI, magnetic resonance imaging; PCR, polymerase chain reaction.

The diseases presented in this article refer only to processes affecting the spinal cord or the vertebral column. Neuropathies, myopathies, and musculoskeletal conditions are not discussed. For specific information on the clinical features seen with lesions in each spinal cord segment or region, the reader is referred to the article on diagnostic approach and lesion localization of spinal disorders in this issue.

## DIFFERENTIAL DIAGNOSIS

When approaching a case with spinal problems, the simplest approach once the lesion is localized is to consider differential diagnoses using the acronym lists based on pathophysiologic mechanisms. These acronyms are called VITAMIN-D or DAM-NIT-V and are useful and practical ways to approach neurologic diseases. A list of common diseases according to the VITAMIN-D acronym is presented in **Table 1**.

<b>Table 1</b>	
<b>Common spinal diseases based on the VITAMIN-D acronym for dogs and cats</b>	
<b>Disease Mechanism</b>	<b>Specific Diseases (Common Conditions in Bold)</b>
Vascular	<b>Fibrocartilaginous embolic myelopathy</b> Epidural hemorrhage Spinal cord hemorrhage
Inflammatory/ Infectious	<b>Discospondylitis</b> (bacterial or fungal) <b>Meningitis</b> (steroid-responsive meningitis-arteritis or bacterial meningitis) <b>Meningomyelitis—</b> infectious (bacterial, fungal, rickettsial, viral), or <b>noninfectious</b> (unknown cause, granulomatous meningoencephalomyelitis) Spinal empyema Vertebral osteomyelitis
Trauma	<b>Spinal trauma</b> (fracture/luxations) Traumatic disk extrusion Traumatic atlantoaxial subluxation
Toxic	None
Anomalous	<b>Atlantoaxial instability</b> <b>Chiari-like malformation and syringomyelia</b> <b>Hemivertebra</b> Arachnoid cysts Multiple cartilaginous exostoses Spinal bifida Spinal dysraphism
Metabolic	None
Idiopathic <sup>a</sup>	Disseminated idiopathic skeletal hyperostosis
Neoplastic	<b>Primary or secondary spinal tumors</b>
Nutritional	Pathologic fractures because of metabolic bone disease Hypervitaminosis A (cats)
Degenerative	<b>Intervertebral disk degeneration</b> <b>Degenerative myelopathy</b> <b>Degenerative lumbosacral stenosis</b> Degenerative osteoarthritis of articular facets Extradural synovial cysts
Developmental	<b>Cervical spondylomyelopathy</b>

<sup>a</sup> Typically an incidental radiographic finding.

When using this acronym, it is useful to consider the signalment and history to develop appropriate differential diagnoses for the patient. For example, even though intervertebral disk disease is the most common spinal disease in dogs, it is not a reasonable differential diagnosis for a 6-month-old dog with chronic paraparesis. Some generalities should be considered when using the VITAMIN-D acronym. Young dogs are more likely to have congenital or inflammatory conditions. Acute presentations are usually caused by vascular or traumatic conditions. Chronic presentations are usually seen with degenerative or neoplastic processes. Another way to approach patients with spinal diseases is to develop a list of diseases that are known to affect specific spinal regions. This is useful because although many diseases affect several spinal regions (eg, intervertebral disk disease [IVDD], discospondylitis, fibrocartilaginous embolic myelopathy), many are region-specific (eg, atlantoaxial instability, cervical spondylomyelopathy, degenerative myelopathy). The primary differential diagnoses for the most common spinal diseases affecting each spinal region are presented in **Tables 2–5**. Some of the diseases listed are presented in only one table but can affect any spinal segment. For example, discospondylitis is more commonly seen in the lumbosacral area but can affect any vertebral region.

Once the list of differential diagnoses is prepared for the patient, the most probably causes should be ruled in or out based on appropriate diagnostic tests. The diagnostic approach exemplifying the diagnostic tests used to confirm common spinal diseases is presented in **Fig. 1**.

## **SPECIFIC SPINAL REGIONS**

### ***C1-C5 Spinal Cord Segments/Vertebrae C1 Through Mid-C5***

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Common diseases affecting the C1-C5 spinal cord segments in small breeds are atlantoaxial subluxation and cervical IVDD. Spinal pain is often present with these diseases. Primary differentials for large-breed dogs with C1-C5 lesions are IVDD, cervical spondylomyelopathy, and spinal neoplasia, mainly meningiomas. Trauma is also common and affects small and large breeds. Cervical pain without neurologic deficits affecting the C1-C5 regions is usually caused by steroid-responsive meningitis-arteritis, cervical IVDD, or discospondylitis. More information on the main clinical characteristics of each disease is presented in **Table 2**.

### ***C6-T2 Spinal Cord Segments (Cervical Enlargement)/Vertebrae C5 Through T1***

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Frequent conditions seen at this region are cervical IVDD in large- and small-breed dogs and cervical spondylomyelopathy in large- and giant-breed dogs. Neoplasia, discospondylitis, osteomyelitis, trauma, and fibrocartilaginous embolic myelopathy can also occur in this region (see **Table 3**).

### ***T3-L3 Spinal Cord Segments/Vertebrae T2 Through L3***

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Most spinal diseases in dogs and cats affect the T3-L3 spinal segments. IVDD (either extrusion or protrusion) is very common in this location. Other common diseases are degenerative myelopathy, spinal trauma, neoplasia, and fibrocartilaginous embolic myelopathy. If the lesion is localized to the mid-cranial thoracic region between the T2 and T10 vertebrae (based on the cutoff of the cutaneous trunci reflex and/or spinal pain), then a few diseases can be considered more likely. IVDD is rare at this region. The diseases that are more commonly seen between the T2 and T10 vertebrae are spinal neoplasia, discospondylitis, and hemivertebra. The differential diagnoses for the diseases affecting the T3-L3 spinal cord region are presented in **Table 3**.

Table 2 Differential diagnoses for common diseases affecting the cervical spine (C1-C5 spinal cord segments and cervical enlargement). These diseases cause proprioceptive ataxia, tetraparesis, and/or neck pain					
	Breeds	Age	Onset	Neurologic Deficits	Spinal Pain
Atlantoaxial Instability (Subluxation)	Mainly toy or small; Yorkshire terriers, Poodles	Typically younger than 2 y	Acute or chronic	Common; obvious ataxia and tetraparesis	Present in most cases
Cervical IVDD (Extrusions)	Any; mainly small	Usually older than 2 y	Acute	Typically mild or not present	Severe
Cervical IVDD (Protrusion)	Any; mainly large	Middle-aged to old	Chronic	Mild-to-moderate	Present, but mild-to-moderate
Cervical Spondylomyelopathy (Osseous-Associated)	Giant breeds; Great Danes, Mastiffs	Usually younger than 3–4 y	Usually chronic but can be acute	Common; obvious ataxia and tetraparesis	Usually mild; seen in 50% of cases
Cervical Spondylomyelopathy (Disk-Associated)	Large; Dobermans, Weimaraners	Middle-aged to old dogs	Usually chronic but can be acute	Common; obvious ataxia and tetraparesis	Usually mild; seen in 50%–70% of cases
Fibrocartilaginous Embolic Myelopathy	Any; usually large	Any; commonly middle-aged	Acute	Common; usually strongly asymmetric	Absent (after 12–24 h)
Spinal Trauma	Any	Any	Acute	Common	Common
Steroid Responsive Meningitis-Arteritis	Boxers, beagles, Berneses, English pointers, Golden retrievers	Young; usually younger than 2 y	Acute or subacute	Uncommon	Severe

Table 3

Differential diagnoses for common diseases affecting the thoracolumbar spine (T3-L3 spinal cord segments). These diseases cause proprioceptive ataxia, paraparesis, or paraplegia, with normal-to-increased pelvic limb reflexes

	Breeds	Age	Onset	Neurologic Deficits	Spinal Pain
Degenerative Myelopathy	Mainly large; German shepherds, Boxers, Pembroke Welsh corgis	Older than 5 y	Chronic (months)	Common; obvious ataxia and paraparesis	Absent
Fibrocartilaginous Embolic Myelopathy	Any; usually large	Any; commonly middle-aged	Acute	Common; usually strongly asymmetric	Absent (after 12–24 h)
Hemivertebra	Screw-tailed breeds, French bulldogs, others	Young; usually younger than 1 y	Chronic	Common; paraparesis and ataxia	Rare
IVDD (Extrusions)	Any; mainly small	Usually older than 2 y	Acute	Typically moderate-to-severe	Moderate-to-severe
IVDD (Protrusion)	Any; mainly large	Middle-aged to old	Chronic	Mild-to-moderate	Usually present but mild
Meningomyelitis	Any	Any	Usually subacute (few days)	Variable, but signs are often asymmetric	Variable; can wax and wane
Spinal Neoplasia	Any; usually large	Any; commonly middle-aged to older	Chronic or subacute (2–3 d)	Common	Variable, but usually present
Spinal Trauma	Any	Any	Acute	Common	Common

Abbreviation: IVDD, intervertebral disk disease.

<b>Table 4</b> <b>Differential diagnoses for common diseases affecting the lumbosacral (L4-S3) spinal cord segments or vertebrae L4 through L5. These diseases cause mild proprioceptive ataxia, paraparesis, or paraplegia, with decreased-to-absent pelvic limb reflexes</b>					
	<b>Breeds</b>	<b>Age</b>	<b>Onset</b>	<b>Neurologic Deficits</b>	<b>Spinal Pain</b>
Degenerative Myelopathy	Mainly large; German shepherds, Boxers, Pembroke Welsh corgis	Older than 5 y	Chronic (months)	Ataxia and paraparesis. The decreased patellar reflex is usually a manifestation of a dorsal (sensory) radiculopathy, and not a lower motor neuron sign	Absent
Fibrocartilaginous Embolic Myelopathy	Any; usually large	Any; commonly middle-aged	Acute	Common; usually strongly asymmetric	Absent (after 12–24 h)
IVDD (Extrusions)	Any; mainly small	Usually older than 2 y	Acute	Typically moderate-to-severe	Moderate-to-severe
IVDD (Protrusion)	Any; mainly large	Middle-aged to old	Chronic	Mild-to-moderate	Usually present but mild
Meningomyelitis	Any	Any	Usually subacute (few days)	Variable; but signs are often asymmetric	Variable; can wax and wane
Spinal Neoplasia	Any; usually large	Any; commonly middle-aged to older	Chronic or subacute (2–3 d)	Common	Variable, but usually present
Spinal Trauma	Any	Any	Acute	Common	Common

Table 5

Differential diagnoses for common diseases affecting the vertebrae L6 through L7 and sacrum. These diseases may cause paraparesis with or without proprioceptive deficits but without proprioceptive ataxia because the spinal cord is not affected. Lameness is also frequently observed with asymmetric lesions in this area

	Breeds	Age	Onset	Neurologic Deficits	Spinal Pain
Lumbosacral Stenosis (Cauda Equina Syndrome)	Usually large breeds; German shepherds are overrepresented	Middle-aged to old	Chronic	Typically mild-to-moderate; can be severe in late stages; lameness may be the only sign	Often present, but may only be elicited with deep spinal palpation
Spinal Neoplasia	Any; usually large breeds	Any; commonly middle-aged to older	Chronic or subacute (2–3 d)	Common	Variable, but usually present
Discospondylitis	Any; usually large and giant breeds	Any; commonly young to middle-aged	Usually acute	Usually not present initially	Severe pain, sometimes not localizable
Spinal Trauma	Any	Any	Acute	Common	Common

### ***L4-S3 Spinal Cord Segments (Lumbosacral Enlargement)/Vertebrae L4 Through L5 (Dogs)***

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This is a small spinal cord region, and most diseases affecting the T3-L3 spinal cord region can also affect this one (eg, IVDD, trauma, neoplasia). A disease that frequently affects this specific region is fibrocartilaginous embolic myelopathy. The main features of diseases affecting this region are shown in **Table 4**.

### ***Vertebrae L6 Through L7 and Sacrum in Dogs***

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Problems affecting the caudal-lumbar region are very common in large-breed dogs. Spinal diseases affecting this region can appear similar to musculoskeletal disorders, because lameness may be the only clinical sign. The primary differential diagnoses for diseases affecting this region are degenerative lumbosacral stenosis, discospondylitis, neoplasia, and extradural synovial cysts. Spinal pain is often a consistent feature of diseases affecting the caudal-lumbar/lumbosacral spine. The main clinical features of the diseases affecting this region are presented in **Table 5**.

## **SUMMARY**

A stepwise process facilitates the diagnostic approach to patients with spinal disorders. The VITAMIN-D system can be used to select the primary pathophysiologic mechanisms causing the patient's clinical signs. Using the acronym VITAMIN-D or the specific tables by lesion localization, the clinician may be able to go from a large list of diagnostic possibilities to a shorter list of diagnostic probabilities.

## **FURTHER READINGS**

- da Costa RC. Ataxia, paresis and paralysis. In: Ettinger SJ, Feldman EC, editors. Textbook of veterinary internal medicine. 7th edition. St Louis: Elsevier; 2010. p. 222–5.
- de Lahunta A, Glass E. Veterinary neuroanatomy and clinical neurology. 3rd edition. St Louis (MO): Saunders-Elsevier; 2009.
- Dewey CW. A practical guide to canine and feline neurology. 2nd edition. Ames (IA): Wiley-Blackwell; 2008.
- Evans HE. Miller's anatomy of the dog. 3rd edition. Philadelphia: Saunders; 1993.
- Lorenz MD, Kornegay JN. Handbook of veterinary neurology. 4th edition. St Louis (MO): Saunders; 2004.
- Platt S, Olby N. BSAVA manual of canine and feline neurology. 3rd edition. Ames (IA): Blackwell; 2004.
- Sharp NJH, Wheeler SJ, editors. Small animal spinal disorders diagnosis and surgery. 2nd edition. Philadelphia: Elsevier Mosby; 2005.