A complete neurologic examination should be done in all animals presenting with suspected neurologic disease. Abnormalities found during the neurologic examination can reflect the location of the lesion, but not the cause, requiring further tests, such as blood analysis, electrodiagnostic tests, and advanced imaging, to determine a diagnosis.

The neurologic examination evaluates different parts of the nervous system; the findings from the examination help localize the lesion to the:

- Brain
- Spinal cord
- Peripheral nervous system
- Cauda equina.

A fundic examination is recommended, especially in patients with brain disorders. Repeat neurologic examinations are helpful to discover subtle abnormalities and assess progression of disease.

THE BRAIN
Lesions in the brain can be localized to the:

- Cerebrum and thalamus (ie, prosencephalon)
- Brainstem
- Cerebellum.

In order to localize the lesion to a specific part of the brain, an understanding of the anatomy and function of the brain is necessary (see Brain Anatomy & Related Functions).

Ataxia
A patient with ataxia may have a lesion in the proprioceptive pathways (peripheral nerves, spinal cord, or cerebrum), vestibular system, or cerebellum. Ataxia can be described as an uncoordinated gait, with crossing of the limbs and, sometimes, listing or falling to 1 or both sides. Ataxia can be further characterized as:

- Proprioceptive: Mild, usually bilateral ataxia
- Vestibular: Moderate, asymmetric ataxia
- Cerebellar: Symmetric, truncal ataxia.

Circling
The direction of circling is usually toward the side with the lesion. The circles tend to be larger with lesions in the prosencephalon than with lesions in the vestibular system.
Cranial Nerve Abnormalities
Cranial nerve abnormalities are signs of either a peripheral neuropathy or brainstem lesion. Brainstem lesions can be localized to the part of the brainstem where the cranial nerve nucleus is located. Peripheral neuropathy may affect only 1 nerve (eg, idiopathic facial palsy) or be part of a polyneuropathy.

Decerebellate Posture
This rare posture is seen with a severe lesion in the cerebellum. Findings include:
• A mentally alert patient
• Opisthotonus (dorsiflexion of the head and neck)
• Increased extensor tone in the thoracic limbs due to loss of inhibition from the cerebellum to the extensor muscles
• Pelvic limbs with reduced muscle tone that are usually flexed.

Decerebrate Posture
This rare posture is seen with a severe lesion in the midbrain or pons.
• The mentation in these patients is severely affected (stupor or coma).
• Opisthotonus may be present if the animal has a cerebellar lesion in addition to the brainstem lesion.
• Increased extensor tone in all limbs is a result of loss of inhibitory function from the pontomedullary reticular formation (RF or RAS), which affects extensor tone of the limbs.

Hemineglect (Hemiinattention)
Hemineglect is a reduced reaction to a stimulus (body or head) contralateral to a lesion in the cerebrum. To test for hemineglect observe the patient’s reaction (turning the head around, whining, trying to bite) while pinching the side

BRAIN ANATOMY & RELATED FUNCTIONS
Cerebrum & Thalamus
The cerebrum initiates movements; the thalamus executes movements.
• A common finding in cats with a large meningioma compressing the cerebrum is difficulty initiating movements and continuous, aimless walking in large circles.
• A patient with a thalamic lesion may have a compulsive behavior: if restrained, the patient may struggle, vocalize, and try to keep walking.

Brainstem
The brainstem connects the cerebrum with the spinal cord and body. All information to and from the body (which is examined by postural reaction assessment) passes through the brainstem and thalamus to leave or reach the cerebrum.

The brainstem includes the midbrain (mesencephalon), pons, and medulla oblongata. Localizing to one specific part of the brainstem is often not possible; however, cranial nerve deficits may help pinpoint the lesion.

The brainstem contains the cranial nerve cell bodies (except CN I and II).
• The midbrain contains the reflex center for vision and hearing (colliculi) and the nuclei of CN III and IV.
• The pons lies between the midbrain and medulla oblongata and contains the nucleus of CN V. In addition, some of the vestibular nuclei are partially in the pons.
• The medulla oblongata, the most caudal part of the brainstem, contains the respiratory and blood pressure regulation centers, nuclei of CN VI to XII, and the vestibular nuclei (4 vestibular nuclei on each side).

Cerebellum
The cerebellum adjusts and moderates all movements initiated by the cerebrum and executed by the thalamus. Clinical signs that may indicate a cerebellar lesion include:
• Cerebellar ataxia
• Variable and intermittent loss of the menace response
• Ipsilateral postural reaction deficits and/or hypermetria
• Intention tremor.

Lisa Wirth, VMD

Cross-section of cerebrum and thalamus and lateral aspect of brainstem.
of the trunk with hemostats. Compare reactions when pinching the other side.

**Mental Status**
A change in mental status is caused by a lesion in the prosencephalon or brainstem (the reticular activating system is diffusely spread in the brainstem and responsible for our awareness and arousability).

- Owner’s knowledge of his or her pet’s personality plus observations at home are essential to assess the patient’s mental status, especially when there are subtle mentation changes.
- Repeat examinations and observation of the animal over a longer time period and in different surroundings are also helpful.

**HORNER’S SYNDROME & ANISOCORIA**
Horner’s syndrome is caused by a lack of sympathetic innervation to the eye. In patients with other neurologic dysfunction, it is most commonly seen with peripheral vestibular dysfunction, C6 to T2 myelopathy, or brachial plexus injury (ie, outside the spinal canal). Clinical signs include:

- Miosis (constricted pupil)
- Enophthalmia (sunken eye)
- Ptosis (drooping eyelid)
- Protrusion of the third eyelid.

Anisocoria refers to pupils of unequal size.

- Loss of sympathetic tone (ie, Horner’s syndrome) results in one pupil failing to dilate (remaining constricted) in darkness.
- A parasympathetic lesion (ie, deficit of the oculomotor nerve CNIII) results in one pupil failing to constrict (remaining dilated) when exposed to light.
- Brain edema and brain herniation may cause compression of the CNIII nucleus in the midbrain, resulting in anisocoria, pinpoint pupils that do not dilate in the dark or respond to light, or fixed and dilated pupils. In these patients mental status is also altered (stuporous or comatose). This is a serious finding that requires immediate attention and treatment.

**Figure 1.** Myotatic and withdrawal reflex pathways; thoracic and pelvic limbs

**Figure 2.** C1 to C5 myelopathy: Postural reactions are delayed or absent in all limbs (red lines); spinal reflexes are normal or increased (green lines)

**Figure 3.** T3 to L3 myelopathy: Postural reactions and spinal reflexes in thoracic limbs are normal; postural reactions are delayed or absent (red lines) but spinal reflexes are normal or increased (green lines) in pelvic limbs

**Figure 4.** C6 to T2 myelopathy: Postural reactions are delayed or absent in all limbs; spinal reflexes are reduced or absent in thoracic limbs (red lines) and normal or increased in pelvic limbs (green lines)

**Figure 5.** L4 to S3 myelopathy: Postural reactions and spinal reflexes in thoracic limbs are normal (green lines); postural reactions are delayed or absent and spinal reflexes are reduced or absent in pelvic limbs (red lines)
Paresis
A patient with a cerebral lesion usually has mild, almost unnoticeable paresis. Patients with brainstem lesions have more pronounced paresis and ataxia ipsilateral to the lesion.

Seizures
If there is a history of seizures, the lesion can be localized to the prosencephalon, even if the neurologic examination is normal.

THE SPINAL CORD
Patients with spinal cord lesions have normal mental status and cranial nerves. Spinal cord lesions can be localized based on:
- Gait abnormalities
- Postural reaction deficits
- Spinal reflex abnormalities.

The spinal cord is divided into 4 functional regions: (1) C1 to C5, (2) C6 to T2, (3) T3 to L3, and (4) L4 to S3.

- A lesion in the C1 to C5 or C6 to T2 spinal cord segment results in tetraparesis and often postural reaction deficits in all limbs. Sometimes the pelvic limbs are more affected than the thoracic limbs.
- A lesion in the T3 to L3 or L4 to S3 spinal cord segment results in paraparesis and postural reaction deficits in the pelvic limbs. The C6 to T2 and L4 to S3 spinal cord segments are anatomically enlarged (thus, cervical and lumbar intumescences) because they contain the nerve cell bodies of the peripheral nerves to the limbs and tail. It is important to understand that these enlarged spinal cord segments are normal anatomy when evaluating images of the spinal cord.

SIGN OF VESTIBULAR SYSTEM DYSFUNCTION
Spontaneous nystagmus, vestibular ataxia, positional strabismus, head tilt, and circling are all signs of vestibular system dysfunction. The lesion may be in the inner ear or eighth cranial nerve (peripheral vestibular system) or in the brainstem or cerebellum (central vestibular system). Additional signs of brainstem dysfunction that are used to localize the lesion to the central vestibular system include:
- Ipsilateral postural reaction deficits
- Changes in mental status
- Deficits in other cranial nerves.
In addition to postural reaction assessment, these areas are also evaluated by testing the spinal reflexes (Figure 1).

- A lesion in the C1 to C5 or T3 to L3 spinal cord segment results in normal (sometimes increased) spinal reflexes (upper motor neuron signs) (Figures 2 and 3).
- A lesion in the C6 to T2 or L4 to S3 spinal cord segment results in reduced muscle tone and reduced spinal reflexes in the thoracic limbs (C6–T2) or pelvic limbs (L4–S3) (lower motor neuron signs) (Figures 4 and 5).

**Paresis**
Tetraparesis without cranial nerve deficits or other brainstem signs suggests a cervical myelopathy; paraparesis is suggestive of a thoracolumbar myelopathy.

**Schiff-Sherrington Posture**
This posture is seen with severe spinal cord injury between the T3 and L4 spinal cord segments. There is increased tone in the thoracic limbs, and normal or reduced tone with paralysis of the pelvic limbs; the prognosis is guarded but not hopeless.

The posture results from loss of normal inhibition of the thoracic limb extensor muscle tone, which is normally controlled by the border cells in the lumbar spinal cord. Axons of these cells ascend the spinal cord to reach the cervical intumescence, where they inhibit the thoracic limb extensor motor neurons.

**THE PERIPHERAL NERVOUS SYSTEM**
The peripheral nervous system includes the:

- Neuromuscular system (peripheral motor nerves, muscles, and neuromuscular junctions)
- Sensory nervous system
- Autonomic nervous system

Peripheral nervous system diseases can be difficult to diagnose, with signs of neurologic dysfunction being vague or nonexistent. The following information does not pertain to diseases of the autonomic nervous system.

- Patients with neuromuscular disease can have both paresis and muscular weakness as well as exercise intolerance.
- Sometimes muscle pain is present.
- Postural reaction deficits and reduced spinal reflexes may be present.
- The history may reveal signs of neuromuscular disease, such as exercise intolerance, generalized weakness, voice change, and neurogenic muscle atrophy; these signs may be intermittent.

**THE CAUDA EQUINA**
The cauda equina are the spinal nerves (L6–L7, S1–S3, and Cd1–Cd5) caudal to the spinal cord in the lumbar vertebral canal.

- Compression of the cauda equina initially results in pain, followed by paraparesis and postural reaction deficits.
- Later in the disease, reduced spinal reflexes to the pelvic limbs, anus, and urinary sphincter are present.
- A history that includes slowly progressive paraparesis (over many months) and pain on palpation of the lumbosacral area can help localize a lesion to the cauda equina.

**FURTHER DIAGNOSIS**
Once the lesion is localized to a specific area of the nervous system, a list of differential diagnoses can be made. Based on lesion localization and differential diagnoses, appropriate diagnostic tests can be chosen.

**Suggested Reading**


**Helena Rylander**
DVM, Diplomate ACVIM (Neurology), is a clinical assistant professor in the Department of Medical Sciences at University of Wisconsin–Madison’s School of Veterinary Medicine.

Her clinical interests include spinal surgery, electrophysiology, and diagnostic imaging. Dr. Rylander has published several articles and a book chapter as well as presented at national and international meetings. She received her veterinary degree from University of Agricultural Sciences in Uppsala, Sweden. After 10 years in private practice in Sweden, Dr. Rylander completed a residency in neurology/neurosurgery at University of California–Davis. She also completed the Educational Commission for Foreign Veterinary Graduates (ECFVG) certification program and received her DVM.