The Neurological Examination: Pearls and Pitfalls
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The neurological examination is used to determine the most likely location within the nervous system for a patient’s neurological abnormalities and to aid in determining appropriate diagnostic testing or therapy. The neurological examination should be a systematic process. The use of a standardized form will allow the clinician to follow a set protocol and to thoroughly evaluate the nervous system. When one is first gaining proficiency with the neurological examination, it is important to complete the neurological exam form. Next, each abnormality should be listed and a neuroanatomic localization made. Taking this localization into account with the signalment, history, physical exam, and other information will allow the veterinarian to generate an appropriate list of differentials and a diagnostic and therapeutic plan.

Tools that are helpful for the neurological examination:

- Neurological Examination Form- this allows the veterinarian to follow a set protocol and not forget aspects of the neurological exam. It also permits the veterinarian to list all the abnormalities that are present and then to determine an anatomic localization.
- Pleximeter- to evaluate spinal reflexes.
- Light Source- a light with a strong beam for evaluation of the pupils.
- Hemostats- to evaluate sensation.

Neurological Evaluation:

Watch the animal: Much of lesion localization can be made prior to actually touching the animal. Allow the animal to move around the room.

Watch - Mental status, posture and gait

Mental Status
Before actually touching the animal, watch it as it walks around the room. This is particularly useful for cats. Does the animal respond appropriately? Does it pace continuously? Does it circle? Does it get lost in corners? Does it head press? The animal’s mental status may suggest a lesion localization (cerebrum). Generally, animals are classified as Normal (Alert, Responsive), Obtunded (Dull, Excessive sleepiness), Dementia/delirium (Paces, Agitated, Difficult to restrain), Stupor (Semicoma- Will respond to a noxious stimulus), Coma (Non-responsive).

Posture:

Head position: Abnormal head positions: head-turn (yaw), tilt, ventroflexion, torticollis. A head turn (without a tilt) may indicate a cerebral lesion. Head tilts are usually due to vestibular dysfunction. The head position is evaluated by looking at the eyes and the ears.

Body position: Changes in posture may suggest the type of lesion present, particularly with vestibular or LMN diseases. A lowered head may indicate neck pain or neuromuscular weakness. Kyphosis (arched back) may also indicate weakness or spinal pain. Changes in individual limbs are also important to evaluate. Holding one limb up intermittently can signify nerve root impingement. A classic sign of this problem is nerve-root signature.
With this sign, an animal will intermittently hold the limb up due to irritation/compression of the nerve root. This is most often caused by a lateralized intervertebral disc and is more common in the forelimbs. A normal animal should stand with the forelimbs spread about even with the shoulders and the pelvic limbs equal with the hips. They should distribute weight on the limbs fairly evenly (front 60%, back 40%).

Schiff-Sherrington posture is due to a T3-L3 spinal cord lesion. These animals have forelimb rigidity and dorsiflexion of the head and neck (opisthotonus). Decerebrate rigidity (opisthotonus and extension of all four limbs), Decerebellate rigidity (extension of the forelimbs, flexion of the pelvic limbs and trunk and opisthotonus).

Gait Analysis:
Watch the animal walk. For non-ambulatory animals, help the animal walk. For an animal to ambulate, motor and proprioceptive systems must be functional. Ataxia is a lack of motor coordination and is not due to weakness, an orthopedic problem, or abnormal movements (like tremors). There are three types of ataxia: sensory ataxia, cerebellar ataxia, and vestibular ataxia. Dysmetria refers to abnormal stride length. Hypometeria means that stride movements are too short while hypermetria indicates stride movements are too long. Paresis is the condition where voluntary motor deficits or weakness are present, while plegia is a complete loss of voluntary movement. Lameness may indicate an orthopedic condition, but can also be the result of nerve root compression.

Gait alterations can be divided into three types: Orthopedic, UMN, and LMN. During gait assessment, watch the animal move while walking and running. A non-slippery surface such as cement, grass, or carpet should be used. Slippery surfaces may exacerbate gait deficits. While evaluating gate, watch the animal’s length of stride, control of the limbs, and placement of the limbs relative to body position.

With UMN disease, the animal tends to have an overly long stride and abnormal placing of the feet (ataxia). There may be truncal ataxia (swaying from side to side), and there is generally a lack of coordination. The animal may cross its feet when walking or turning corners. Also, the animal may scuff its toes, and the stride length is erratic.

LMN diseases result in a short, choppy gait. Some animals may appear to be painful, but may actually be weak. Exercise-associated fatigue may occur with some diseases (Myasthenia gravis, myopathies). Also, there may a stiff, stilted gait with some LMN diseases. Some animals with LMN disease may “bunny hop”, as also seen with some orthopedic diseases. A special situation may occur in the animal with a caudal cervical spinal cord lesion; these animals may show a short choppy, stiff-legged gait in the forelimbs and an UMN type of gait in the pelvic limbs - the so called “Two Engine Gait”.

With orthopedic disease, the animal may have a short, choppy gait if more than one limb is involved, for instance with bilateral cranial cruciate ligament disease. Or, there may also be a noticeable lameness in one limb. With orthopedic disease, the animal should not scuff its nails or crossover. Each step taken should be similar in length. With orthopedic lameness, the affected limb bears weight as short as possible and is quickly replaced in weight bearing by the other limb. If more than one leg is involved, the animal may not get up.

Cranial Nerve Examination
The evaluation of cranial nerves allows a more precise localization of possible abnormalities within the brain.

Vision: CN II, Forebrain - Can the animal see? Can it navigate a room?
Fundic exam: CN II – Does the fundus appear normal? This is the only nerve that can be visualized.
Menace: CN II, CN VII, Forebrain - Does the animal blink when a menacing gesture is made?
Pupil Size: CN II, Symp, ParaSymp – Are the pupils symmetrical? Are there primary ophthalmologic
abnormalities present? Is Horner’s Syndrome present? Is there lack of Sympathetic nerve supply to the eye (ptosis, miosis, or enophthalmos)?

**Pupil Reflex:** (CN II, III) - Do the pupils respond to a light? Use a strong light source. Does the opposite pupil constrict as well?

**Muscle Mass/Jaw Tone:** CN V (muscles of mastication) - Does the animal have atrophy on one side of its head? Can the animal close its mouth? Can it open its mouth?

**Facial Symmetry:** Palpebral, Lip, Ear: CN V and VII – Does the animal have function of the muscles of facial expression, blink (palpebral is most helpful)? Touch the medial and lateral aspects of each eye, the nose, and lower jaw to elicit movement/twitch.

**Cochlear:** CN VIII – Can the animal hear? This can be difficult to evaluate especially for unilateral deafness. Avoid vibrations – stand behind animal and clap or jingle keys. This may require BAER testing.

**Nystagmus:** CN VIII (also CN III, IV, VI) - Is there spontaneous movement of the eyes (usually a fast and slow phase for abnormal nystagmus)? Evaluate the animal in an abnormal position (on its back). Characterize the type of nystagmus: rotary, vertical, or horizontal. Characterize the direction of the fast phase.

**Strabismus:** CN III, IV, VI, VIII – Does one eye deviate when the animal’s head is lifted? This is usually a vestibular abnormality.

**Oculocephalic (Doll’s Eye):** CN III, IV, VI, VIII - Is there normal physiologic nystagmus (“Doll’s Eye”)? Move the head through back and forth. Bilateral vestibular disease or severe brainstem disease will cause this to be absent.

**Swallow/Voice:** CN IX, X – Can the animal swallow? Does it gag? Has it had a change in voice?

**Trapezius:** CN XI – Does the animal have atrophy of these muscles?

**Tongue:** CN XII – Can the animal use its tongue? Does it have a deviation of the tongue, or atrophy on one side?

**Postural Reactions**

Postural reactions are a group of responses that the clinician evaluates by putting the animal through specific motions. These tests evaluate large portions of the nervous system. To properly interpret postural reactions, spinal reflexes need to be evaluated for complete localization of a lesion. Most postural reactions require intact sensory and motor function. In particular, conscious proprioception differs from other postural reactions in being predominately a sensory test. This can be useful if a disease of the neuromuscular junction or muscles is suspected. The examiner should be careful to support the weight of the animal when performing this test. False deficits may be present if the animal is too weak to turn the foot over, such as with muscle disease or myasthenia gravis. With other postural reactions, the examiner should watch for two components of the test: the initiation and the follow through. Differences may be apparent for different types of diseases. Also, inability to hold the head up during this exam may signify muscular weakness.

During the neurological exam of a patient with an orthopedic disease, there should be no deficits in postural reactions, especially conscious proprioception. However, if the animal is painful, this may make interpretation difficult. With an orthopedic disease, usually the animal will try to replace the foot during conscious proprioception unless it is extremely painful. This portion of the exam is predominately sensory and requires minimal motor function. Be sure to provide adequate support for the patient while testing conscious proprioception.

**Key points:**

- Not all postural reactions need to be evaluated for each patient. Try to do at least conscious proprioception and
- Postural reactions should be done on a floor with adequate traction (carpet, grass, rubber mat).

**Proprioceptive Positioning** (Conscious Proprioception) - Support the animal while doing this test – this is predominately an evaluation of sensory function (although it does require some motor function). Turn the paw over so that the dorsal surface comes into contact with the floor. Normal response is a quick return of the paw to the normal position. Repeat this a few times to verify a consistent response. Most animals with only orthopedic disease are normal if they are well supported. This test is fairly sensitive for subtle abnormalities in the CNS.

**Hopping** - Hold the animal so that all the weight is on one limb. Move the animal laterally. This test evaluates sensory and motor function. Animals with deficits tend to be slow or uncoordinated (spastic).

**Hemistand/Hemiwalking** – On one side of the body, push the front and back legs up towards the animal’s body and then push the animal laterally. Useful for large animals that are difficult to lift or to identify subtle abnormalities on one side of the body (hemiparesis).

**Wheelbarrowing** – Thoracic limb function - Support the abdomen, elevate the pelvic limbs, and push the animal forward. This test evaluates thoracic limb strength and coordination. Lifting head may take away animals ability to visually compensate and worsen deficits. Evaluate the animal with, and without, the head extended. This test is useful for large animals or to differentiate subtle abnormalities in the forelimbs.

**Extensor postural thrust** - Pelvic limb function assessment. Lift the animal (small animal) by the thorax just underneath the front legs and then lower them to the ground. As the animal touches the ground it should walk backwards a few steps. This is helpful to differentiate subtle abnormalities in the back legs.

**Placing** – Helpful for small animals (cats). This should be performed nonvisually (tactile) and visually. Animal should reach for the table when the feet contact the edge.

**Spinal Reflexes** (Segmental Spinal Reflexes – spinal cord segments, nerve roots, peripheral nerves)

Segmental spinal reflexes aid in determining the site of a suspected neurological abnormality. Interpretation of the spinal reflexes becomes more important when postural reaction deficits have been found. With an orthopedic disease, the animal should have normal reflexes and muscle tone. In some cases, this may be difficult to determine, as occurs with chronic cranial cruciate ligament disease when trying to elicit the patellar response. In this situation, the clinician should take the orthopedic exam into account as well as the tone of the muscle being evaluated (should be normal, not decreased). In LMN diseases, the reflexes will be decreased around the area of the lesion. The flexor withdrawal may be incomplete. An incomplete response, or a “kick back”, may indicate LMN disease. In UMN lesions, the reflexes will be normal to increased. There may also be crossed extensor reflexes present.

While evaluating reflexes, assess the tone of the limbs. This may be done by putting the limbs through a complete range of motion while assessing resistance. Also palpate the muscles of the limb for muscle mass. Changes in tone may indicate UMN disease (increased tone) or LMN disease (decreased tone). Severe muscle atrophy may indicate a loss of innervation. Denervation atrophy of a muscle takes place quickly and may be quite severe. It is not always possible to tell the difference between this and disuse atrophy. Denervation atrophy may be seen within about a week and there is generally a loss of muscle tone in the limb. Disuse atrophy occurs after about a month, but muscle tone should not be severely diminished.

The two most reliable reflexes are the flexor withdrawals and patellar reflexes! Do not let the other reflexes cause confusion/frustration.

Spinal Reflexes: Should be done with animal in Lateral recumbency

**Flexor** - Gently pinch the toes with a noxious stimuli (just enough to elicit a response) - Flexor Forelimb (C6-T2 spinal cord segments) and Flexor pelvic limb (L6-S1) - Assess the strength of the withdrawal and how complete
the withdrawal is (i.e. does the animal pull back completely?).

*Patellar reflex* (Quadriceps, “Knee Jerk”) – Myotatic Reflex – This assesses the integrity of the Femoral Nerve (L4-L6 spinal cord segments). With the animal relaxed, tap the patellar tendon with a pleximeter. A brisk response (extension of the stifle joint) should occur rapidly. Assess strength and evaluate muscle tone.

*Crossed Extensor* – Pinching one limb causes the other limb to extend. The presence of this reflex is abnormal and indicates an upper motor neuron abnormality (loss of inhibition).

*Cutaneous Trunci Reflex* - Segmental reflex that evaluates the Afferent cutaneous thoracic nerves and Efferent Lateral thoracic nerve located at C8-T1. The expected response is twitching of the cutaneous trunci muscle. Stimulation of skin on one side should cause twitching of the skin on both sides. Best response in the “saddle” area, absent in sacral and neck regions. Will not be present caudal to a lesion in the spinal cord that disrupts the superficial pain pathway. A C8-T1 lesion may also disrupt this pathway. A lesion at the T13 spinal cord segment results in a disruption of the cutaneous trunci reflex below the vertebral segment L1 or L2.

*Perineal Reflex* (S1-2 region) – Stimulation of the perineal region should cause contraction of the anal sphincter and flexion of the tail.

Other reflexes that may be evaluated to localize a lesion to a more precise level within the nervous system: *Cranial Tibial Reflex* (L6-7), *Extensor Carpi Radialis Reflex* (C7-T1), *Biceps Reflex* (C6-8), *Triceps Reflex* (C7-T1).

*Bladder function* - Characterize the size and tone of the urinary bladder. Is there evidence of incontinence (dribbling)?

*Rectal tone* - Is there pain with rectal exam or reduced rectal tone?

**Pain Evaluation**

The final portion of the neurological exam should evaluate for pain and areas of diminished sensation (if peripheral nerve disease is suspected). Hyperaesthesia or anesthesia in a limb may be due to a neurological problem. Evaluate each portion of the spine and head. Palpate just lateral to the midline of the spinous processes along the spine. When palpating along the thoracic and lumbar spine try not to put any pressure on the abdomen in case the animal actually has abdominal pain. Sometimes the animal’s response to pain may be very subtle such as tensing the abdomen or a change in respiratory rate.

In cases of generalized weakness or reluctance to walk, check for pain in the muscle bellies by squeezing the muscles in each limb. Isolate the long bones to see if pain is present, which may occur with panosteitis or multiple myeloma. Check for joint effusion and crepitus that may occur with polyarthritis. With more focal diseases, such as pelvic limb lameness, do a rectal exam to evaluate for rectal tumors and pain at the lumbosacral joint. In cases of forelimb lameness, palpation of the axillary region may elicit a pain response in an animal with a nerve sheath tumor.
Pain Perception

Superficial pain - Superficial pain pathways are disrupted about the same time as motor function (proprioception should be absent as well). To evaluate superficial pain, pinch skin (toe) caudal to the site of the suspected lesion.

Deep Pain – This should be last so that the animal will not resist the rest of the neurological examination. Deep pain perception can be difficult to evaluate. To evaluate this function, pinch the bone or joint of a digit (or the tail) caudal to the site of the lesion. It is important to use a sturdy instrument such as large hemostats to test deep pain. Remember that deep pain recognition involves such events as having the animal turn and look at you (and maybe bite), a change in heart or respiratory rates, or even something as subtle as a dilation of the pupils. A cry or turning of the head indicates central recognition of the noxious stimulus. Deep pain perception is not withdrawal of the limb.

Common Mistakes

-Not getting the dog up and evaluating gait (especially in big down dogs). For this, use two or more people. Also it may be helpful to use a towel to provide sling support

- Reflexes: Not evaluating reflexes or over interpreting reflexes. If there are no deficits, increased reflexes are usually not significant.

Neuroanatomic Localization

The goal of performing the neurological examination is to determine a probable location for a lesion within the nervous system. In some cases, the animal’s problem is not located within the nervous system. Distinct regions of the nervous system are differentiated. A basic division is intracranial versus spinal cord disease. Consideration should also be given to motor unit or multifocal diseases. Once anatomic localization is made, consider the following: What is the signalment (Age, Breed, Sex) of animal? Is the disease Progressive or Nonprogressive? Is the animal painful or not painful? All of this information can be used to determine a list of likely differentials, appropriate diagnostic testing, and therapeutic recommendations. Division of the nervous system into basic divisions makes lesion localization more simple. The major divisions are: Forebrain (cerebrum, diencephalon-thalamus, hypothalamus), Brainstem (midbrain, pons, medulla), Vestibular System (peripheral vestibular and central vestibular components), and Spinal cord segments (C1-C5, C6-T2, T3-L3, and L4-S2).

Intracranial Divisions

There tend to be characteristic clinical signs that occur for different regions of the brain. These 4 general regions are what we will use to localize intracranial lesions: Brain Stem, Vestibular System, Cerebellum, and Cerebrum/Diencephalon.

Cerebrum and Diencephalon (Cerebral hemispheres, Basal Nuclei, Thalamus, Hypothalamus)

Clinical signs associated with cerebral lesions are dependent on the location of the lesion within the cerebrum. Behavior changes are seen sometimes with a cerebral lesion. Seizures most often are a cerebral sign. Visual deficits or central blindness may result from a lesion in the occipital cortex or the optic tracts. Generally, the animal will have normal pupillary light responses, but the menace response and the ability to track objects is decreased to absent. Signs may be variable. Clinical signs with cerebral lesions include: Alterations in behavior/mental status, Seizures, Visual deficits with intact pupils, Contralateral decrease in facial sensation, Mild hemiparesis, Contralateral deficits in postural reactions, Compulsive pacing, Circling (large circles),
Hemiparesis (when this is present secondary to a cerebral lesion it is mild in comparison to lesions involving pathways located more caudally, i.e. in the brainstem or spinal cord). Animals may walk continuously without purpose. They may walk into a corner and not be able to get out. Circling tends to be towards the side of the lesion. Hemi-inattention is a syndrome in which the animal has a forebrain lesion that results in deficits on one side of the body, for instance eating out of one side of a food bowl.

Clinical signs associated with diencephalon lesions include: UMN signs, tetraparesis or hemiparesis, Gait may not be affected, Postural reaction deficits contralateral to lesion, Cranial nerve deficits ipsilateral to lesion, May have CN II involvement, CN III, IV, VI, and Hypothalamic dysfunction, and Alteration in consciousness with RAS involvement.

**Brain Stem (Midbrain, Pons, Medulla oblongata)**

UMN signs – Tetraparesis, Hemiparesis, Motor deficits (Ipsilateral or contralateral) depending on level of the brain stem lesion, Multiple cranial nerve deficits (CN III-XII and Ipsilateral to lesion), Mental Status may be altered depending on Reticular Activating System involvement. The Ascending Reticular Activating System (RAS) is very important in maintaining consciousness.

**Vestibular System (vestibular nuclei, cerebellum, internal ear)**

Clinical signs include: Falling, Rolling, Head tilt, Nystagmus, Positional strabismus, and Asymmetric ataxia. Vestibular lesions may be central or peripheral. Central lesions involve the vestibular nuclei in the brain stem. Some cerebellar lesions may also contribute to central vestibular signs.

**Cerebellum**

Clinical signs may be unilateral or bilateral and include: Cerebellar ataxia, Wide based stance, Lack of menace response but animal remains visual, Dysmetria, and Intention tremors. Little weakness is evident if cerebellum is affected only.

**Multifocal Disease**

Presence of multiple signs, such as nystagmus and seizures, suggests more than one location for lesion. Inflammatory, infectious diseases most likely.

**Spinal Cord Divisions**

Spinal cord compression usually results in predictable neurological abnormalities. Proprioceptive deficits are usually first to develop with compressive lesions of the spinal cord. This may be evident as abnormal positioning of feet and ataxia. After this the animal may then lose voluntary motor activity. The next abnormalities to develop are the loss of superficial pain sensation and voluntary motor function which are lost at about the same time. Finally, with severe lesions, deep pain perception is lost.

**C1-5 spinal cord segments**

For C1-C5 lesions there are UMN signs in all four limbs: decreased postural reactions and normal to increased spinal reflexes in all four limbs. Cervical pain may be present, however there are no cranial nerve deficits. If the animal is ambulatory, there may be a gait abnormality with generalized ataxia. No cranial nerve abnormalities should be present.

**C6-T2 spinal cord segments**
C6-T2 (cervical intumescence) spinal segment lesions cause LMN signs in the thoracic limbs and UMN signs in the pelvic limbs. There may be Horner’s syndrome (T1-T3 lesion). Cervical hyperesthesia may also be present. Dogs with caudal cervical lesions may have a short choppy gait in the forelimbs and an ataxic gait in the pelvic limbs.

**T3-L3 spinal cord signs**

Clinical Signs of a lesion in this location include paraparesis, pelvic limb ataxia, decreased or absent postural reactions, and normal to increased pelvic limb spinal reflexes. There may be a loss of normal urinary or bowel function. Pain sensation may be absent caudal to the location of the lesion. With some lesions in this location Schiff-Sherrington posture may be present. Animals with this posture present with the head extended and forelimbs extended (with increased tone). While this posture indicates a severe lesion, it is not prognostic. Cutaneous Trunci Reflex may be absent to the site of the lesion.

**L4-S2 spinal cord signs**

Lesions in this portion of the spinal cord may cause paraparesis, an ataxic gait, and urinary or bowel control abnormalities. The pelvic limb reflexes may be depressed or absent and muscles may be hypotonic/atrophic. Rectal tone may be reduced or absent.

**Motor Unit Disease (myopathies, neuropathies, neuromuscular junction)**

In diffuse LMN diseases, all four limbs may be flaccid and spinal reflexes depressed with generalized muscle weakness.

- Paraparesis: bilateral motor dysfunction of the pelvic limbs, deficit of voluntary movements involving both pelvic limbs
- Paraplegia: Complete loss of voluntary movements in both pelvic limbs

Changes in pain perception: Anesthesia (complete lesion), Hypoesthesia (decreased sensation), Hyperesthesia (increased pain sensation, irritation)

Tetraparesis (all four limbs)

Hemiparesis (thoracic and pelvic limbs on one side)

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