The Neurologic Examination

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Objectives:

1. Review the six main parts of the neurologic exam and appreciate tips for how to perform these tests successfully
2. Understand the difference between LEVEL of mentation and QUALITY of mentation
3. Be able to identify the different types of postural and gait abnormalities
4. Identify the afferent and efferent components to each cranial nerve test
5. Understand the concept of the "reflex arc" in leg reflexes
6. Understand the difference between voluntary motor, withdrawal reflex, and deep pain sensation

Terms and definitions:

General:

Ipsilateral: On the SAME side as the lesion
Contralateral: On the OPPOSITE side of the lesion
Reflex: An automatic response (that occurs through a reflex arc) to a stimulus that does not receive or need conscious thought.
Reflex arc: The essential anatomic parts of an unconscious reflex. For example, the reflex arc for the patellar reflex includes the thigh muscles, femoral nerve, and L4-6 spinal cord segments.
Response: A conscious response to a stimulus. Because this is a conscious reaction, it needs to be LEARNED before it becomes a consistent response.

Mentation and behavior:

Obtundation: Decreased responsiveness to normal stimuli
Stupor: Decreased responsiveness that is only responsive to strong stimuli
Comatose: Unconscious and not responsive to any stimuli
Dementia: Animals that respond unusually to normal stimuli
Hemi-neglect/hemi-inattention: Animals with focal, lateralized forebrain lesions may develop a syndrome in which they are unaware of sensory information from one side of their 'world' and so tend to walk in circles (towards the lesion), bump into things on the side of their body contralateral to the lesion, have central vision loss contralateral to the lesion, and have contralateral postural reaction deficits

Gait and posture and proprioception:

Ataxia: Poor muscle control that leads to incoordination.
Vestibular ataxia: Occurs with a problem in the vestibular system. Results in incoordination characterized by wide-based stance, head tilt, leaning, and drifting. Severe cases may also include rolling.
Cerebellar ataxia: Occurs with a problem in the cerebellum. Results in incoordination characterized by dysmetria, tremor, wide-based stance.
Proprioceptive ataxia: Occurs with a problem affecting an animal's ability to sense body position. Results in incoordination characterized by wobbly gait, stumbling, swaying, dragging the limbs between steps, and sometimes having the feet knuckled under.
Dysmetria: Improper rate and distance of body movements. Hypermetric can be exaggerated, spastic movements. Hypometric can be under-reaching.

Titubation: Swaying of the trunk and head from side to side.
Paresis: Weak but still able to move the muscles. When related to leg weakness, we see a delay in onset of protraction (swing phase) which results in the stride being *longer* than normal.
Plegia: Completely paralyzed and unable to move the effector muscle.
Di-paretic: Weak in only the front legs
Hemi-paretic: Weak in the front and rear limbs of one side of the body (right or left)
Paraparetic: Weak in both back legs
Mono-paretic: Weak in one leg
Tetraparetic: Weak in all four limbs
Upper motor neuron: Upper motor neurons (UMNs) connect the brain to various spinal cord segments.
Lower motor neuron: Lower motor neurons (LMNs) act as intermediaries between UMNs and muscle fibers to coordinate muscle contraction.
Nerve root signature: A leg lameness (limping and holding up the leg) caused by nerve root irritation.
Two-engine gait: A gait abnormality caused by a lesion in the C6-T2 spinal cord that is characterized by short, choppy front leg steps and long uncoordinated back leg steps.

Head tilt: Rotation of the median plane of the head
Head turn: Rotation of the nose with the transverse plane of the head remaining perpendicular to ground
Pleurosthotonus: Head and body turn
Kyphosis: Dorsal curvature of the spine (arched back)
Lordosis: Ventral curvature of the spine (sway back)
Scoliosis: Lateral curvature of the spine (like an "s" shape when looking down over the top of the pet)
Torticollis: Twisting of the neck, sometimes with dorsal extension
Opisthotonus: Dorsal extension of the head and neck
Decerebrate rigidity: Opisthotonus with extensor rigidity of all limbs
Decerebellate rigidity: Opisthotonus with extension of the front limbs and active flexion of the rear limbs. Posture can persist from lateral recumbency to standing position.
Schiff-Sherrington posture: Opisthotonus with extension of the front limbs and loose pelvic limbs in lateral recumbency. Front limb and head posture improves with standing position, but back legs will still be loose and usually paraplegic.
Plantigrade: Weakness causing a low stance in the distal pelvic limbs with the heel on or closer to the ground compared to normal.
Palmigrade: Weakness causing a low stance in the distal thoracic limbs with the wrist on or closer to the ground compared to normal.

<u>Palpation</u>:
Nociception: Ability to feel a painful stimulus. To be unable to feel nociception is termed "absence of deep pain sensation".
Hyperesthesia: Sensation of discomfort. For example, appearing uncomfortable with palpation over the spine is termed "spinal pain" or "spinal hyperesthesia"

<u>Cranial nerves:</u>
Miosis: Smaller than normal pupil
Mydriasis: Larger than normal pupil
Internal ophthalmoplegia: Related to oculomotor nerve function. Paralysis of the muscles that control pupil size

External ophthalmoplegia: Related to oculomotor nerve function. Paralysis of the muscles that control eyeball movement

Reflexes:
Clonus: Involuntary and rhythmic muscle contractions resulting from normal leg reflex testing. Usually indicative of a chronic UMN lesion.

The focused neurologic exam can be broken up into six main components: mentation, gait and posture, cranial nerve testing, postural reaction testing, segmental reflexes, and palpation. We will cover each of these in detail including advice on how to get the best responses in normal patients as well as how to look for subtleties in your examination.

Observation of Mentation

This is one of the two portions of the neurological exam that you can be conducting during your owner interview. You should be observing how the patient interacts with the owner, you, and the environment. This might also include asking the owner if these observed responses are normal for that pet in this circumstance (ie. "Is the dog usually this calm while at the vet?"). You should also question the owner for any observed changes in sleep habits, interactions with the owner or other animals, or changes in normal habits.

Mentation can be described in terms of level of mentation as well as quality of mentation. To describe variable levels of alertness we use the terms normal, obtunded, stuporous, and comatose. A ***comatose*** dog is one in which there is no conscious response even to deep pain type stimulus. A ***stuporous*** dog is one who prefers to sleep when left alone and requires a more noxious stimulus to rouse. While these terms have clear definitions, obtundation covers the entire range in decreased alertness from normal to near stupor. I personally use ***mild obtundation*** to describe a dog who is a little quieter than normal but who may still appear relatively normal to an outsider. ***Moderate obtundation*** might be used for a dog who is clearly mentally altered but is not yet close to stupor. ***Severe obtundation*** might be used to refer to a dog who is very poorly responsive but not quite stuporous. ***Dementia*** describes a change in the quality of mentation. A demented animal may not necessarily be sleepier, but instead is acting very differently from normal - this can mean a calm animal who is now anxious, a nice dog who is now aggressive, or a normally fractious cat who is now purring and friendly.

Changes in the level of mentation can come from any part of the brain except the cerebellum. The reticular activating system (RAS) helps to keep an animal properly alert, and this system runs diffusely through the forebrain and brainstem structures. Changes in the quality of mentation (dementia) will come from forebrain pathology.

Observation of Gait and Posture

This is the second portion of the neurological exam that you can be conducting during your owner interview. The first question you must ask is, "Is this pet ambulatory?" If not, then is there paraparesis, tetraparesis, extreme postures like Schiff-Sherrington posture? If the pet can walk, is there any sign of ataxia, paresis, weakness, lameness, or abnormal body movements like tremors? While much of this information can be appreciated from your observation in the exam room, you can also take the pet out for an extended walk outside on a non-slick surface like a sidewalk. The dog should be walked on a leash at a controlled pace; some more subtle changes in gait are seen more easily when the animal is moving more slowly. The dog should be observed from the front, the rear, and the sides. The dog can also be walked in tight circles to the right and left to further challenge coordination and strength. If you have stairs, you can lead the dog up or down steps to get an idea of whether or not forelimbs (trouble

going down) or hindlimbs (trouble going up) are more involved. A cat can be lured to walk with a pet carrier and gentle encouragement. Some cats may attempt to jump up onto furniture in the room or navigate around obstacles. However, many cats can be quite uncooperative in the veterinary clinic, so videos from the owner of the cat's gait at home can be very helpful. Sometimes a low, crouching gait is just a nervous cat rather than true weakness.

There are three types of ataxia that can be seen during movement: proprioceptive, vestibular, and cerebellar. A ***proprioceptive ataxia*** is seen in a dog who has lost the sense of foot or body position in space. These may stagger as though intoxicated, may have a wide-base stance, and crossing over of the limbs. Proprioceptive ataxia can be seen with lesions affecting the spinal cord and nerves, the brainstem, and the forebrain (all part of the proprioceptive pathways). ***Vestibular ataxia*** can involve leaning and falling to one side. This may be very extreme in some animals with rolling and flailing of the limbs with handling while others may be more subtle. If you have a pet frequently leaning or drifting to one side while walking, you should start to look for other signs of vestibular disease like head tilt, nystagmus, and positional strabismus. ***Cerebellar ataxia*** reflects trouble with control over the rate and range of movement. A pure cerebellar lesion should not cause paresis and proprioceptive deficits, but can cause hypermetria with exaggerated or bouncing gait, truncal sway, and an intention tremor. This tremor may range from very obvious as with cerebellar hypoplasia cats or can be a subtle head bobble with intentional movement. While we describe 3 different types of ataxia, many patients will exhibit a mixed ataxia (ie. A dog with leaning, head tilt, and proprioceptive knuckling from a brainstem lesion affecting the vestibular nucleus).

Paresis indicates reduced ability to initiate movement. This will manifest in signs ranging from a dog who has more trouble jumping up onto furniture or going up stairs to one who cannot support weight to walk and only has minimal motor function to the limbs. Paresis can be seen in one limb (monoparesis) as with nerve tumors or can be seen on one side of the body (hemiparesis), just the back legs (paraparesis), or all four limbs (tetraparesis). Rarely a dog may show exclusively bilateral forelimb paresis with normal back legs as seen in brachial plexus neuritis. Remember that a dog who is truly paraparetic should have normal thoracic limb function including being able to walk without exhaustion in the front end while the rear is supported. If the dog is laterally recumbent or at least cannot walk far in the front legs, then you must look closely for thoracic limb involvement as well. For most lesions, the pelvic limbs will be affected first and more severely compared to the thoracic limbs.

Plegia refers to the total loss of voluntary movement. Do not confuse withdrawal as voluntary movement. Withdrawal of a limb in response to a noxious stimulus is instead a segmental reflex that is not under cortical (conscious) control.

Weakness is sometimes used interchangeably with paresis. It is also sometimes differentiated from paresis to refer to the loss of tone and the loose quality we can see with lower motor neuron disease. For example, a pet with a polyneuropathy like coonhound paralysis or tick paralysis can have a very loose floppy gait and may tire very easily with exercise. Other manifestations of generalized neuromuscular disease can include a stiff and stilted gait with exercise intolerance like that seen in polymyositis and other myopathies, or we can see a more dramatically waxing and waning weakness associated with exercise like with the myasthenia gravis junctionopathy. In the context of this course, we will use “weakness” as a general term that can include both UMN and LMN loss of strength.

There may be some clues to an ***orthopedic lameness*** in your exam and history. A dog will often demonstrate a reluctance to bear full weight while standing so may off load to a more-sound limb. This is sometimes obvious with the limb held up, but can often just be a very subtle shift in weight to one side. You may see a typical head bob or hip hike in forelimb and pelvic limb lameness. This can be supported if a painful area is appreciated on your thorough orthopedic exam (don't forget to check each digit!). Owners might also tell you about the dog having significant trouble rising and walking immediately after rest, but then will "work out of it" with more activity. Most neurologic problems will

be more static through the day rather than waxing and waning like we can see with arthritis and other joint problems. Don't be fooled by a "down dog" who has bilateral cruciate tears or a dog with pronounced coxofemoral subluxation. Similarly, a dog holding up both limbs or demonstrating a bunny-hopping forelimb gait may have bilateral elbow disease rather than a more unusual spinal cord dysraphism.

Cranial Nerve Testing

There are 12 cranial nerves:

CN I, Olfactory

This nerve is responsible for the ***sense of smell***. At home, animals might demonstrate poor appetite (especially cats) or might have trouble locating food on the floor. Owners might notice that the animal may not be as attentive to food odors at home. In the exam room, the best way to test for olfaction is to bring a pungent warmed food into the room where the animal cannot see it. Look for sniffing behavior to indicate intact olfaction sense. You cannot use irritating chemicals like ethanol or ammonia because this will stimulate the ophthalmic branch of the trigeminal nerve when senses irritation to the olfactory mucosa. This is not one I intentionally test for unless it may be related to the presenting complaint.

CN II, Optic

This nerve is responsible for ***transmitting visual input***. Vision not only involves the optic nerve, but also involves the rostral brainstem (mediates reflexes like PLRs) and the occipital lobe of the cerebrum (for conscious visual processing). There are a number of ways to test for vision during your exam:

1. Observe the animal ***navigating*** in the exam room. An animal with reduced vision might be able to avoid larger obstacles but often will get very close to obstacles before moving away. A pet with ophthalmic blindness should be cognitively aware of when it bumps into things. You will see a quick response and withdrawal from an object when that happens. A pet who has central blindness (cerebral pathology) might also bump into objects, but will not respond normally. Animals with central blindness might be driven to try to walk stubbornly through obstacles, might head press, and might get confused or lost in corners.
2. During your hands-on evaluation, you will test ***menace***. This will test a ***behavioral response*** rather than a true reflex. This means that this is a conscious response that an animal must learn. Most animals older than 10-12 weeks old will have this response intact. As stated above, this response depends on normal function of the eye, optic nerve, rostral brainstem, and occipital lobe. There must also be normal facial nerve function as well as the part of the brainstem from which the facial nerve originates. In a way not fully understood yet, there must also be normal cerebellar function. Your menacing gesture is translated through the retina to the optic nerve. Then from the optic nerve to the optic chiasm just at the rostral aspect of the brainstem. From here the information goes up to the cerebrum for visual processing before communicating fibers dive through the cerebellum to the brainstem again to trigger blinking via the facial nerve.
   To test menace, I will usually cover one eye and test the other independently. I will wave my hand toward the eye and watch for the animal to blink. You must be careful not to touch the whiskers, wave too much air over the eye, or make too much noise when making your menacing gesture. Some people will wave with fingers spread apart or just use one finger to limit airflow. Because this is behavioral, a very fearful, brave, or obtunded animal may not respond easily to menacing gestures. I will often gently pat the animal over the eyelids to demonstrate that I may make contact. After doing this, most animals will blink to protect the eye if they can see.
3. ***Pupillary light reflexes (PLRs)*** also require intact optic nerve function. The first portion of this pathway is the same as that for menace. However instead of traveling to the cerebrum for

conscious perception of vision, the PLR pathway remains subcortical with the motor effector portion involving the rostral brainstem and the oculomotor nerve for pupil constriction.
To look at the pupils, I will preferentially turn off the lights. You can first shine a light right in between the eyes. This will reflect off the fundus and give you an immediate idea if there is anisocoria. I then move the light closer to one eye and look for good constriction. Once constriction is observed, I then quickly swing the light to the other side to see if that eye is also constricted (intact consensual PLR) or if it has remained dilated (absent consensual PLR).
A lack of constriction can occur for several reasons:

a. Weak light stimulus - Many of our animals are fearful and under stress in the hospital. This increases sympathetic tone and therefore pupil dilation. Some animals require a light brighter than the typical yellow light penlight. I will use an irritatingly bright LED light if there is any question - if an animal does not constrict with this type of light then that animal has something other than simple stress driving this lack of constriction.
b. Ophthalmic disease - Iris atrophy or similar iris defects can alter normal PLR responses. Additionally diseases affecting the retina, glaucoma, uveitis, etc can also affect PLRs with either mydriasis or miosis depending on the disease.
c. Drugs - Some medications and toxins can cause mydriasis with sluggish pupil responses. This is important to remember when testing pupil function after CPR in animals who have received atropine and epinephrine.
d. Non ophthalmic prechiasmal diseases - Any disease affecting this portion of the visual pathway (optic nerves and chiasm). This generally results in blindness and mydriasis.

4. As mentioned earlier, some animals might have cerebellar disease contributing to poor menace. These animals are still visual, are still able to blink properly, and have normal PLRs. They just do not menace reliably during testing. In these cases, I will test ***visual tracking***. To do this, I will cover one eye and then drop a cotton ball (this is large enough to see, but quiet enough to land silently) on the side of the uncovered eye. I will look for eyeball or head tilt to indicate visual tracking of the dropped cotton. Sometimes I will let an animal walk while I drop the cotton on either side of its head so that only one eye is being tested at a time. Some animals do not care much about cotton balls, so I will first offer a smelly treat by the animal's nose. I will then hide the treat and drop the cotton ball. This might help an otherwise uninterested animal focus on your tracking object.

In summary: If I have a dog who does not menace, I must ask myself the following questions:

1. How old is this patient? Old enough to have a menace? This may be normal in a very young patient.
2. Can the patient blink? Are palpebral reflexes normal? If not, then we think of facial nerve paralysis. We then look for other signs of vision like globe retraction during menace, navigation ability, and visual tracking.
3. Can the patient navigate around obstacles? If not, does it seem more consistent with ophthalmic or central blindness?
4. Are the pupils and PLRs normal? If not, look for evidence of prechiasmal disease. What does the fundic exam look like?
5. Is the patient older than 12 weeks and visual with normal blinking and PLRs? Look for signs of cerebellar disease like head tremor, vestibular signs, and dymetria.

CN III, Oculomotor

This nerve is responsible for ***eyeball position*** and ***pupil constriction***. You can evaluate the first part by just observing the dog's face. A resting ventrolateral strabismus is seen with oculomotor dysfunction. If

you see this, make sure you are ruling out other reasons for strabismus like traumatized extraocular muscles, retrobulbar masses, etc. You might also see mydriasis in the affected eye.
If I see mydriasis, I must first look for the ability to constrict the pupil and whether or not that eye can transmit information for a consensual response. In PLR testing, the sensory input comes from the optic nerve as previously described. This means, an animal with mydriasis only from oculomotor dysfunction should still have an intact optic nerve. That animal will be visual and can still transmit a consensual PLR to the other eye. However when testing the opposite eye, a consensual response will not be seen in the affected eye, because the end effector muscle for pupil constriction does not work.
***I encourage you to review PLR testing and anisocoria for more detail on the pathophysiology and interpretation of abnormalities. I will soon have this posted in the "pathways link" for www.neurologynetworks.com if you do not have alternative easy access.

CN IV, Trochlear
This nerve is also responsible for eyeball position. This one is trickier to evaluate because it causes a ***rotation of the globe*** rather than an overt strabismus. This can be evident in cats and other animals with slit or diamond-shaped pupils. However, dogs and other animals with round pupils are not easy to appreciate from simple observation. Instead you must do a fundic exam to look for rotation of the retinal vessels. This nerve is so rarely affected by itself that I will not typically make the effort to assess trochlear function if the rest of the cranial nerve exam is relatively normal.

One additional test that I perform to assess eyeball position and movement is a ***test of physiologic nystagmus. To do this, you will hold the head level and move the nose back and forth. A normal animal should have normal type-writer-like eyeball movements as you smoothly move the head back and forth. Some lesions might reduce the nystagmus going in one direction over the other (very lateralized lesions) and some might reduce or obliterate the movement entirely. This tests the function of CNN III, IV, VI, VIII, and the brainstem. I will most often find absent physiologic nystagmus with brainstem lesions and very rarely neuromuscular disorders.

CN V, Trigeminal
This nerve has both motor (***muscles of mastication and the ability to close the jaw***) and sensory (***sensory to the entire face, inside the nostrils, oral cavity, and the corneas***) functions. I will usually tickle the whiskers at the medial canthus (ophthalmic branch), lateral canthus/near the base of the ear/over the muzzle (maxillary branch), and over the mandible (mandibular branch). I will cover the eyes (so there is no anticipatory retraction) and gently insert hemostats into the nostril. This assesses both the ophthalmic branch as well as conscious awareness. This is a very noxious stimulus, so most normal animals should resent this maneuver. An animal with ophthalmic branch dysfunction should have no response to this test because that animal cannot feel it. An animal with forebrain disease might twitch the muzzle or pull back a little (intact reflex because the ophthalmic branch is working), but will not have the robust withdrawal of the nose (a diminished behavioral response due to diminished conscious awareness).
I will observe the dog's face for asymmetry and palpate over the masticatory muscles. A dog with mandibular branch dysfunction will have muscle atrophy developing within a few days of injury and progressing to be quite severe if injury is persistent. I will also try to open the jaw to assess for tone (mandibular branch - the only motor portion). A dog with unilateral trigeminal nerve dysfunction might have dramatically decreased muscle mass on one side of the face but still can retain the ability to close the jaw because the nerve and muscles on the other side of the face is working. If you see a ***dropped jaw*** (and you have ruled out fracture, luxation, and other problems), then you must consider bilateral

mandibular branch dysfunction. *Do not confuse this with masticatory muscle myostis in which the dog cannot open its jaws from a muscle disease.*

CN VI, Abducens

This nerve will ***retract the globe*** and is most easy to appreciate during corneal reflex testing. To test the corneal reflex, I will soak a cotton tipped applicator in saline and gently touch the globe. A normal dog will retract the globe and may also show a behavioral response of wanting to pull away. A dog with intact sensation (trigeminal nerve) will feel the irritating sensation of having the cornea touched but will not be able to retract the globe during abducens dysfunction. You can also observe the eye for a ***resting medial strabismus***.

CN VII, Facial

This is the primary motor influence of the muscles of facial expression. You will often appreciate this initially from observation of the face. You will look for asymmetry, eyelid and lip droop, and a drooping ear. You might also appreciate food, water, or saliva matted into the muzzle on that side and have a history of dropping food while eating. Some dogs might have a deviation of the muzzle slightly to one side. In the acute phase of facial nerve weakness, the deviation is away from the affected side. This is because the muscles on the affected side are weak and cannot oppose the stronger muscles on the other side. Later, as the lesion becomes more chronic, the weak muscles will atrophy and contract. This contraction will now cause the muzzle deviation to orient toward the affected side. Muzzle position therefore may sometimes be an indication of chronicity. For dogs with facial nerve paralysis, you should also look at Schirmer tear testing. Branches of the facial nerves innervate the lacrimal glands and sometimes this might be dysfunctional leading to red eyes and corneal disease.

CN VIII, Vestibulocochlear

This nerve is responsible for ***hearing*** and ***balance***. A unilateral lesion should not cause deafness as the other side compensates and often makes hearing loss unrecognizable. Bilateral nerve lesions might be associated with deafness. This is unlike brainstem disease (from which the vestibulocochlear nerve originates) in which it is highly unlikely for an animal to be functional but to still have enough brainstem disease to cause bilateral deafness.

We are usually assessing for signs of vestibular dysfunction for CNVIII. A head tilt is the cardinal sign of vestibular system involvement. Do not be fooled by more subtle head tilts as they are not always very obvious! In cases of a more subtle tilt, I will also straighten the head so it is level and raise the nose to the ceiling (cervical dorsiflexion). This will induce a positional ventral strabismus on the side of the tilt. When you see this, it can be supportive of vestibular dysfunction. ***Be mindful of how you hold the head for this maneuver as pulling the skin can pull the eyelids giving the appearance of strabismus in a normal dog.

You can also see vestibular ataxia as previously described, nystagmus (horizontal, rotary, vertical, dysconjugate, inducible, positional). Some dogs might also walk in circles and may have increased extensor limb tone. Vestibular disease caused by cerebellar lesions might also have poor menace with intact vision, tremors, and dysmetria. Vestibular signs caused by thalamic lesions might also have forebrain signs like confusion, seizures, or compulsive pacing.

CN IX, Glossopharyngeal

This nerve is responsible for sensation and motor of the pharynx for the ***gag reflex***. You may appreciate poor gag on your exam and the owners will usually describe signs of dysphagia at home.

CN X, Vagus

This is tested along with the glossopharyngeal nerve in the ***gag reflex***. You might also see laryngeal dysfunction with ***raspier breathing and a change in voice***. This nerve also affects esophageal function, so you might also have varying degrees of ***dysphagia, regurgitation, and megaesophagus***. Autonomic functions are broad with ***parasympathetic input*** (slowing the heart rate, increasing GI motility, etc).

CN XI, Accessory

Innervates some ***cervical muscles*** (trapezius is the most significant) and can cause varying degrees of muscle atrophy. This nerve is rarely affected on its own and also rarely investigated if all else is normal.

CN XII, Hypoglossal

This nerve is motor to the tongue. In acute stages, you might see a limp tongue or a deviated tongue with difficulty pulling to one side. In chronic stages, you might see scalloping and atrophy of the tongue. You can test by pulling on the tongue to one side then the other and observing for the ability to pull away from you. You might also watch an animal try to eat to see if there is trouble with prehension relating to the tongue. This can include placing a small amount of food on the nose and watching the dog try to lick it off.

****Cranial nerves generally originate from along the brainstem. With cranial nerves III-XII, you might therefore also have signs of brainstem involvement if the problem is central. This can include varying levels of obtundation and long tract signs like knuckling and paresis.*

Although it takes time to discuss and to thoughtfully test each nerve, in practice it should only take 1-2 minutes to test cranial nerves. Instead of checking for function of each nerve from I to XII, I will instead test functional regions. I usually begin with observation of the head and face, looking for any drooping or the ear or lip, head tilt, strabismus, atrophy of the muscles of mastication, anisocoria, tongue atrophy, etc. I also listen for any stridor suggestive of laryngeal paralysis. I then test menace, palpebrals, facial sensation over the medial canthus, lateral canthus, muzzle, and over the mandible on each side. I will cover the eyes and gently insert a hemostat into the nostril. I will open the jaws to test tone, observe the tongue, and I will use my finger to stimulate the gag reflex or massage the pharyngeal area to induce a swallow. I use my penlight to look at PLRs. I then move the head back and forth to observe for physiologic nystagmus and then raise the head to the ceiling to look for a positional strabismus. This sequence of testing is rapid and allows you to test all but CNN I, IV, and XI. These nerves are so rarely a solitary neurologic lesion that I rarely make an effort to evaluate these more closely if the exam is otherwise normal.

<u>Postural Reaction Testing</u>

Proprioception is the sense of position in space. It is what allows you to know where your left big toe is without you having to move it or look for it to find out. There are many tests of proprioception including foot placement, hopping and wheelbarrowing. You will already have an idea of proprioception just from watching an animal move in the exam room. A dog who is knuckling or tripping over obstacles will be very likely to have deficits on your hands-on exam.

Performing so-called ***conscious proprioception*** (CP) is not an easy test. You will probably have 3 neurologists in a room all perform the test differently and all get different results! I will give you my method and rationale for testing and you can decide with practice what methods you prefer. To perform CP testing, I like to have the animal standing squarely on a ***non-slick surface***. I will examine animals outside on the sidewalk or inside on a yoga mat. During testing, the animal must be ***standing still***. Any wiggling will cause the animal to wobble and sway which will more likely stimulate

unconscious balance responses (from the cerebellum) to result in proper foot placement even when the animal truly has some difficulty with proprioception. This is the difference between you intentionally placing your foot forward (conscious movement and awareness of position) versus correcting your foot position after you trip on a curb to prevent a fall (unconscious correction mediated by your cerebellum). You will ***support the animal*** with one hand. I will support right under the belly for pelvic limb testing and just under the chest for thoracic limb testing. Make sure the animal has enough support to not feel as though it will fall, but is not so supported that it is floating off the ground. You will take the foot and turn the paw over onto the dorsal surface. A normal animal should replace the foot within 1-2 seconds. Be sure to ***hold the foot until the animal is no longer pulling away from you***. Some animals are very sensitive to foot manipulation and will place the foot from handling alone - this might cause you to miss a more subtle lesion. I generally feel that if foot placing is absent in an otherwise orthopedically intact dog, then the CP is truly absent. This is not always the case with intact foot placing considering how many little factors can affect this test.

Hopping is another easy test of proprioception and another test that can have variable results depending on how it is performed. In a small animal, you can do this test on a table using a yoga mat for traction. You can hold the animal's body under one arm and lift one thoracic limb with the other. Let us say I am holding the pet under my right arm and I have picked up the animal's left thoracic limb with my left hand. I will now be sure the animal is ***bearing good weight*** on the right thoracic limb and then carry it horizontally to the right. A normal animal will want to reposition the limb (hop) as soon as it is crossing midline under the chest. You must use a non-slick surface to prevent slipping. You must also be sure you are always pushing/ carrying the animal toward the limb that is bearing weight (or away from the carried leg). This puts the animal in a position of feeling as though it will fall and therefore triggers automatic positional correction reflexes in the form of hopping. If you were to do the opposite and pull the animal toward the carried limb (toward your body), there is a false sense of security and stability that will sometimes inhibit an animal from corrective limb placement. Additionally if the animal is not made to bear much weight, this has the same effect of feeling secure and not having the automatic drive to prevent falling. You should ***move in a smooth, fluid motion*** - not too fast or too slow. Keep the same pace as you test to better assess differences in placement rhythm for each side. You can test the pelvic limbs in a similar fashion.
You can do hopping in a ***huge dog*** that you can't carry. To do this I will pick up the right thoracic and pelvic limbs and then push the dog to the left. You will first evaluate the front right compared to the front left, then the rear right compared to the rear left. Again, be sure this is done on a non-slick surface to prevent falls.
Wheelbarrowing can be used to look more specifically at the front legs and to compare one side to the other. You will again be sure you are on a non-slick surface and pick up the animal under the belly and push forward. A normal animal should be able to walk forward to keep from falling. To uncover more subtle lesions, you might extend the neck dorsally to reduce stability from visual input. A similar test for the rear legs (***extensor postural thrust***) is to pick up the animal under the shoulders so the legs are hanging toward the table. Then in a smooth motion, lower the animal so the pelvic limbs touch and bear weight on the mat, then pull the animal toward you (backwards for the animal). A normal animal will step backwards rapidly. Use this to assess the back legs and look for asymmetry in response.

***For all of these, you will look for signs of presence or absence of placing. For present limb corrective responses, are they normal or more weak? Is there asymmetry to tell you that one side is worse? Do you have exaggerated movements (as you might see with cerebellar disease)? Which limbs are affected?

Segmental Reflex Testing

You will already have a good feeling for reflex function from watching the animal move. If the animal can support weight well and pick up each limb well, then reflexes are expected to be relatively normal. However, if you see that the animal can support weight well but cannot pick the limb far from the ground (more of a shuffling gait), then you might expect to see some alteration in flexor function. Similarly if the animal can pick up the limbs well, but will collapse down into the planted foot during weight-bearing, then you might expect to see some alteration in extensor function.

Limb myotatic reflexes are best performed with the animal restrained in lateral recumbency. I use this opportunity to do a thorough orthopedic palpation exam before reflex testing as many orthopedic conditions also contribute to gait abnormalities (especially in our older patients). You will generally be testing patellar, cranial tibial, and gastrocnemius reflexes in the pelvic limbs and biceps and triceps reflexes in the thoracic limbs. For all limbs, I first flex and extend the limb a few times to get a feel for overall limb tone. Upper motor neuron cases will still generally have some degree of tone, even when paralyzed. Lower motor neuron cases can feel very loose and floppy in comparison.

The ***patellar reflex*** tests extensor function and is innervated by the femoral nerve and spinal segments L4-L6. To test this reflex, the limb should be supported under the thigh so the limb below the stifle can swing freely. The leg should start out in a near 90-degree position. This is in order to create a stretch or tension in the tendons and muscle. You should feel that the patellar tendon feels very firm compared to the soft, flexible tendon you can feel when the leg is more straight and the tendon has "slack". This tension is essential to successful stretch reflex testing in all limbs, and without it you will certainly have a more weak or absent reflex even in very normal dogs. Once the limb is in position, you will administer a sharp percussion to the central portion of the patellar tendon with the wide rubber end of your pleximeter (oriented perpendicularly to the direction of the patellar tendon). While it seems as though this should be a very easy reflex to do, improper limb position, weak percussion, or a tense dog can all make it difficult to get a clear reflex in a normal dog. Additionally some dogs naturally do not kick well when you are testing patellar reflex in the "up" position, but if you test that same limb when the leg is now on the recumbent side, the patellar reflex is induced easily. We do not know why this may be the case for some dogs, but the same limb should be tested in both up and recumbent positions before determining that the reflex is truly reduced or absent. Finally some older dogs (especially larger breeds) may have a poor patellar reflex without signs of other significant pathology. The specific cause for this is also unknown.

The sciatic nerve and the spinal cord segments L7-S2 help with limb flexion. The flexor myotatic reflex tests include the cranial tibial (peroneal branch) and gastrocnemius (tibial branch) tests. To test the ***cranial tibial reflex***, you should support the leg so the lower limb can swing freely. The leg should be in a similar position to that used for patellar reflex testing. You will then put your thumb into the center of the cranial tibial muscle belly. Sharply percuss your thumb with the wide rubber end of your pleximeter. Alternatively you can use the pointed side of the rubber end of your pleximeter to sharply percuss the muscle belly directly. A normal dog will kick the foot dorsally.

You can test the ***gastrocnemius reflex*** in a couple of ways. One way involves holding the limb with your thumb over the lateral aspect of the center of the muscle belly. Be sure the knee is bent and the foot is lightly dorsiflexed. Then sharply percuss your thumb with the flat rubber end of the pleximeter. You should elicit a downwards kick of the foot at the tarsal joint (toe-point). You can alternatively firmly hold the metatarsal region in one hand and position the limb in a "Z" formation so the knee and tarsus are both bent. This will apply tension to the calcaneal tendon. Then sharply percuss the tendon between the tarsal bones and muscle belly (use the flat of your wide rubber end of the pleximeter oriented perpendicularly to the tendon as done for the patellar test). A normal dog will briefly contract the flexor muscle groups - you may see this in a thin dog and feel the "kick" in your hand that is holding the dog's foot.

Withdrawal is a test of femoral (at the hip) and sciatic (stifle and tarsus) nerve groups. You will touch or pinch the foot (only enough to elicit a withdrawal) and hold the irritating stimulus until you have observed the animal withdrawal at each joint. A normal dog should be able to pull fully away from you. This is in comparison to a dog with sciatic dysfunction who cannot flex the stifle and tarsus but may still pull away at the hip joint enough to pull from your fingers due to normal femoral nerve function. Some dogs can be stoic and may not pull the foot back without a very irritating stimulus. I do not say that withdrawal is absent until I have witnessed the dog objecting to me handling the foot without being able to withdrawal. Sometimes this means I have to pinch meanly as for deep pain testing (though do not start with the level of stimulus!!).
REMEMBER: Withdrawal is a segmental (local spinal cord-mediated) reflex. ***A dog who simply pulls away from you does not necessarily have voluntary motor function***. A UMN plegic dog who will not move the limbs when supported to try to walk will still have withdrawal reflexes if the local reflex arc in the spinal cord is intact. Additionally, ***simple withdrawal is NOT a sign of deep pain sensation***. Deep pain is a conscious response that needs to involve some sign that the animal can feel the stimulus. This is usually an animal who turns to look at you, tries to bite, or may just change the respiratory pattern or show pupil dilation. An animal who shows no conscious response is therefore determined to have absent deep pain, even if the leg is able to withdrawal. So, an animal might have withdrawal and no deep pain just as an animal might have the ability to feel pain without being able to withdrawal the limb - it all depends on the location and severity of the lesion.

Thoracic limb testing will focus on the biceps, triceps, and withdrawal. The ***biceps reflex*** tests flexor function and is innervated by the musculocutaneous nerve and spinal segments C6-C8. To test this reflex, you should put your finger over the tendinous insertion of the biceps just proximal to the elbow. Pull the elbow caudally to stretch the muscle and put tension on the tendon. Then sharply percuss over your finger using the pleximeter. In a normal dog, you should see contraction of the biceps muscle.
The ***triceps reflex*** tests extensor function and is innervated by the radial nerve and the spinal segments C7-T2. To test this reflex, you will grasp the antebrachium, flex the elbow to 90 degrees, and rotate the limb so the elbow is angled up toward the ceiling. Sharply percuss the triceps tendon proximal to the olecranon using the wide end of your pleximeter oriented perpendicular to the tendon. In a normal dog, you will see the triceps muscle contract. You may also feel the limb "kick" in your hand.
Withdrawal is performed similarly to the pelvic limbs. For both thoracic and pelvic limbs, watch the other limb for extension as the animal withdraws the tested limb. This is called "***crossed extensor reflex***" and is abnormal when an animal is in recumbency. This is seen in subacute to chronic upper motor neuron disease.
The ***perineal reflex*** is innervated by the perineal and caudal rectal nerve branches (both from the pudendal nerve) and the S1-S3 and caudal spinal cord segments. You should lightly touch or stroke the perineum on each side. The anal sphincter should contract and tail tuck down. This is especially important when evaluating patients for incontinence complaints.
The ***cutaneous trunci (panniculus) reflex*** can help to more specifically localize lesions within the T3-L3 spinal cord segments. This reflex is innervated by the lateral thoracic nerve and the C8-T1 spinal cord segments. A lesion at these spinal cord segments or near the nerve root (in the brachial plexus) can eliminate the reflex along the entire ipsilateral side. To test this reflex, you should lightly pinch the skin 1-2cm lateral to midline along the spine starting near L5 (most caudal extent of the reflex). In a normal animal, there will be bilateral twitch of the skin in segments tested up to the T3-4 area (most cranial extent of the lesion). At the level between intact and absent twitch reflex, a lesion can be found 1-3 spinal cord segments cranially.

<u>Palpation</u>

You will want to feel over the entire animal. You will palpate the head - I usually test one side, then the other to look for asymmetry. I will palpate the masticatory muscles, the jaw joint, the otic canal and over the bulla, over the muzzle, and over the gum line. I will open the jaw fully to test for tone, resistance, and pain. You can gently push in over each eyeball to look for ocular pain. I will squeeze gently over the temples (in the depression just in front of the ears) to look for general head pain. **While head pain is often a signal to me for intracranial diseases like tumors or meningitis, occasionally I have dogs who may be sensitive and react even with an otherwise normal exam. For this reason, I see this as a supportive sign in the face of other abnormalities, but don't necessarily order a big MRI workup if this is my only finding.

You will also do a thorough orthopedic exam to look for joint and long bone pain that might be affecting gait (old dogs with arthritis or bone tumors). If you have concerns for myositis, you can also palpate over the muscle bellies to look for muscle pain (this might mimic bone pain as you squeeze the muscle over the bone while palpating).

You will palpate the abdomen for belly pain. If an animal cries out while it has a very full bladder, you can walk them to urinate outside then re-palpate afterwards - many dogs are very comfortable after they have an empty bladder! Likewise if you are evaluating a patient for urinary complaints, be sure you are assessing bladder size, tone, and ease of expression. Feel the organs, feel for tumors, effusion, etc. Feel along the neck for any masses or asymmetry. Feel the lymph nodes. Do a rectal exam to feel the anal sacs, the prostate, the urethra, and the ventral surface of the LS area and sacrum. What is the rectal tone like around your finger? You will also feel pulse quality, especially for each femoral pulse. Are the feet warm?

You will finally palpate over the spine. I usually use my right hand with the patient in the same position every time. I have "calibrated" my hand to apply a similar degree of pressure for each patient so I have a decent idea of what may be normal vs abnormal. I usually start at the end opposite to which I expect to find pain. Often once a dog feels pain, it will be very sensitive to the rest of the palpation. You will want to dorsiflex the tail then flex the tail base to the right and left to look for pain or restricted range of motion. Dogs with lumbosacral disease are often painful with this maneuver. I then start palpating with relatively firm pressure over each dorsal spinous process moving forward. As you get to the cervical region, you will shift to palpate over the lateral processes. I will also take the head and move the nose to the ceiling, then to the floor, then to touch the right lateral thorax, then the left lateral thorax. Most healthy young dogs should have this excellent cervical range of motion without pain. It is not unusual for geriatric dogs to have some reduction in willing cervical range of motion due to spinal arthritis. Likewise, many larger middle age to older dogs have some relatively mild lumbosacral discomfort. You must therefore interpret these findings with caution in these populations. If you have a very stoic dog or a dog who is more prone to a dynamic lesion in the lumbosacral area, you can also support the lumbar region, then lift both pelvic limbs caudally and dorsally to tip up the sacrum at the LS joint. For any patient in which there is a possibility for an atlantoaxial subluxation (ie a young yorkie with neck pain), I will not ventroflex the neck because of the potential to traumatize the spinal cord and caudal brainstem.

This is a summary of tips for performing the neurologic exam. The next step is to take the information you get from your exam and integrate the information into a lesion. The lesion localization will help you narrow down differentials and help you direct specific testing for your patient.

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