“BACK DOGS”: EXAMINATION AND DIAGNOSIS

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Introduction

Veterinary practitioners commonly encounter pets with various neurological diseases. Sorting through these neurological problems can be challenging. The following discussion will provide a review of general principles that aid developing the proper diagnostic and treatment plans for small animals presenting with signs of spinal disease. Important aspects that should be considered by the clinician include clinical features and signalment and neuroanatomic localization. Properly recognizing these clues will help develop an appropriate list if differential diagnoses.

Accurate lesion localization is imperative to clinical case management. Distinct regions of the nervous system include intracranial [supratentorial (prosencephalon), infratentorial (mesencephalon, metencephalon, myelencephalon)], spinal [C1 – C5, C6 – T2, T3 –L3, L4-S1, S1 – Cd5) and peripheral nervous system locations. Accurate lesion localization also enables the clinician to interpret diagnostic tests, especially regarding diagnostic imaging. In the era of advanced imaging, such as MRI, the significance of a structural abnormality can only be ascertained based on the clinical examination. In other words, the neurological examination and the MRI findings should be compatible.

Neuroanatomic Localization

Differentiating between upper motor neuron and lower motor neuron disease is often the first aspect of evaluating pets with spinal cord lesions. Lower motor neuron disease causes hypo- to atonia of the muscles, hypo- to areflexia of segmental spinal cord reflexes and can lead to neurogenic muscle atrophy. Hopping may be normal if voluntary movement is still present and weight support is provided. Pets with lower motor disease typically have decreased ability to bear weight due to muscle flaccidity. There is often a short-strided gait, bunny hopping of the pelvic limbs may be present, and fine muscle tremors may be seen when bearing weight. Importantly, when lower motor neuron disease is suspected problems of the neuron, nerve, neuromuscular junction, and muscle should be considered.

Lower motor neuron signs may be present focally or diffusely. If acute generalized lower motor neuron signs develop, botulism, tick paralysis, and coonhound paralysis should be considered. Pets in this category can easily mimic pets with acute spinal cord injuries, especially in the early stages. Repeated neurological assessments are required to differentiate between these cases.

Pets with upper motor neuron signs have a distinct clinical picture that differs from pets with lower motor neuron signs. Typically, proprioception is altered causing knuckling and hopping to be decreased. The muscles will often be contracted (spastic) and more extended than normal. This results from hypertonia of the muscles. Reflexes are normal to increased and an abnormal crossed extensor reflex may be present. Gait may demonstrate proprioceptive ataxia, spasticity, and/or elongated strides. Dragging of the dorsal aspect of the paws is also commonly observed.

Spinal cord signs explainable by a focal lesion are usually caused by lesions that disrupt the integrity of the spinal cord parenchyma. These could be compressive, inflammatory, and/or ischemic lesions. Differentials include intervertebral disk disease, neoplasia of the spinal cord or surrounding structures, vascular accidents (ischemia), vertebral fracture or luxation, diskospondylitis, or inflammatory disease (myelitis/meningitis). Neurodegenerative diseases such as degenerative myelopathy should also be considered depending on the clinical history and signalment.

Vertebral column trauma

Dogs or cats presenting with acute vertebral column trauma should be managed cautiously. Worsening of clinical signs due to movement of an unstable spinal fracture or luxation can lead to irrecoverable spinal injury. Immediate external splinting of any patient with acute vertebral column injury is recommended. This should be done on a case-by-case basis as some patients, especially cats, may struggle during the procedure, mitigating any benefit from it. Spinal splinting can be done by securing a patient to a spinal board. A lightweight firm board that allows radiographic beam penetration is optimal (plexiglass). With the patient in lateral recumbency on the board, white tape is placed across the point of the shoulder and hip. If a cervical vertebral column fracture is suspected, the head should also be secured. It is important to firmly secure the patient cranially and caudally to the site of suspected trauma. Sedation should be used cautiously as muscle relaxation can allow movement of an unstable fracture or luxation. With the patient on a spinal board, only a partial neurological examination can be performed. In many instances, survey radiographs may be taken prior to a complete examination to screen for obvious unstable conditions prior to manipulating the patient as is required for a complete neurological examination. Deep nociception and voluntary movement can still be evaluated while the patient is taped to a spinal board. (Appendix 1)

Diagnostic imaging

Diagnosing structural lesions of the spinal cord requires diagnostic imaging. Radiography allows assessment of the vertebral column and is sensitive in the diagnosis of diskospondylitis, luxations, fractures, and aggressive osteolytic or osteoproliferative disease. It can also provide “footprints” of intervertebral disk disease, such as narrowing of the disk space, mineralization of the nucleus pulposus (intracanicular or in situ), narrowing of the intervertebral foramen, or changes in the articular facet spacing. It is important to note that radiography is relatively insensitive in diagnosing interverbral disk disease compared to advanced cross sectional imaging modalities. Radiographs also allow “indirect” assessment of the patient. For example, chest radiographs in older dogs allows screening for pulmonary metastatic and cardiovascular disease.

Advanced imaging tests for CNS evaluation include computed tomograqphy (CT) and magnetic resonance imaging (MRI) studies. Ultrasound and nuclear scintigraphy play only a limited role. Technological advancements will enable the clinician to order “functional” tests such as the functional MRI and PET CT images. However, currently, these are not practical due to the limited availability and high cost. Advantages and disadvantages of CT and MRI are important to consider. Various clinical scenarios will dictate which test is more appropriate. Some basic knowledge regarding these imaging studies will allow the clinician to better facilitate the timing and selection of the most appropriate test.

Important to note is that survey radiography is considerably less sensitive in detecting vertebral column fractures and luxations in veterinary patients compared to CT. (Kinns and others, 2006) Important criteria in detecting trauma, such as changes in spinal canal diameter and identifying bone fragments within the CNS, are difficult using radiographs alone. However, a combination of survey radiographs and CT can much more definitively rule out vertebral trauma. Computed tomography also allows identification of acute hemorrhage within the CNS – something radiography does not permit. Computed tomography also requires relatively short acquisition time (compared to MRI). In people that have suffered acute trauma, CT is routinely performed from head to toe as a way to screen for problem areas.

Computed tomographic images are created using x-rays. Therefore, evaluating CT images is very similar to evaluating radiographs – bone is white, soft tissue is grey, fluid/air is black. The major advantage, however, is that

CT images are cross-sectional and have very good contrast resolution. This reduces the problem of superimposition of structures. Greater sensitivity in lesion detection is, therefore, possible. Lesions that are not apparent on survey radiographs often stand out on CT. Also helpful is that some lesions "contrast enhance" after administration of an IV contrast agent. This is particularly helpful in diagnosing certain inflammatory and neoplastic conditions. Contrast can also be injected into the subarachnoid space to "outline" the spinal cord. This is particularly helpful in locating extradural compressive lesions and lesions in the subarachnoid space.

Many soft tissue abnormalities, however, cannot be detected using CT. For instance, non-mineralized, non-contrasting enhancing lesions are difficult to visualize. An example would be a non-mineralized disk extrusion - which happens with some frequency in dogs that have suffered trauma. Many of the CNS lesions that occur in veterinary medicine involve neural tissue; these types of lesions are nearly impossible to appreciate on CT alone. A recent investigation by Levine and others (2009) found that spinal cord hyperintensity seen on MRI in dogs with cord injury induced by disk extrusion had an association with outcome. Since CT is not capable of determining parenchymal hyperintensity, this important clinical information may be missed if CT is performed alone. The take home message regarding CT is that is a speedy, relatively low-cost test, for broad screening evaluation of skeletal and soft tissue structures and to screen for CNS hemorrhage.

Magnetic resonance imaging offers the best contrast resolution when compared to other imaging tests. This allows differentiation between soft-tissue and detection of abnormalities within the same tissue. Edema, hemorrhage, and ischemia can therefore readily be detected via MRI. It also permits multi-planer imaging without having to "reformat" images – this means that images are created in the transverse, sagittal, and dorsal planes. This greatly improves lesion detection and characterization. Another advantage of MRI is that patients and personnel are able to avoid ionizing radiation.

Acquisition time for MRI is relatively longer than for CT. For instance, a routine MRI of a patient's spine may take up to an hour; although the introduction of higher field magnets, such as the 1.5T MRI, is reducing scan times. Naturally, poor anesthetic candidates may not tolerate lengthy anesthesia. Other contraindications for MRI include various medical devices such as pacemakers, vascular clamps and stents, and some orthopedic implants. Any fragment or implanted metal can create an artifact obscuring image quality. Clients should be questioned carefully about the possibility of a contraindication in their pet. Additionally, survey radiographs to screen for metal can be performed. Overall, the expense is much greater for MRI relative other imaging modalities, however, in general, the information is much more detailed.

This report is not intended to cover such topic as PET CT and fMRI. However, it is prudent to point out that most of the imaging tests used in veterinary medicine currently only evaluate structural integrity of tissue. They do not permit "functional" evaluation. The most common "functional test used is the clinical examination. [Electrodiagnostics are another example of functional testing, however, these are limited to specific neurological diseases beyond the scope of this discussion.] In the future, diagnostic tests that evaluate tissue function will greatly aid in lesion characterization and localization. For the most part, both PET CT and fMRI have the capability of determining tissue metabolism, hemodynamic response, tissue oxygenation, and other important clues as to the function of neural tissue. Unfortunately, structure and function are not always correlated. This is particularly frustrating when various advanced imaging tests are normal despite a very abnormal clinical examination.

Test selection

Choosing which neuroimaging test to use can be challenging, especially in traumatized patients. Often, limited clinical examination precludes accurate lesion localization. Pragmatically, diagnostic imaging that screens for pathology is extremely helpful in determining appropriate patient management. For instance, the decision to remove a patient from a backboard could be made after screening for spinal fractures. With this in mind, radiography and CT are the tests of choice for skeletal injuries and space occupying hemorrhage. Some advocate CT scans of the entire vertebral column of humans with severe trauma. (Hutchings and others, 2009) Heavy sedation or short anesthesia is all that is necessary to perform a CT scan. Most clinically stable patients can tolerate this level of sedation with minimal risk.

Importantly, a normal CT does not exclude soft tissue injuries that may be clinically important. For example, a non-mineralized disk extrusion in a dog acutely traumatized, could be overlooked with CT, even though it may require surgical intervention. Severe contusion of neural tissue may also be missed. For these cases, MRI may be the better choice. When it is determined that better soft tissue detail is warranted and accurate knowledge of lesion location is known, MRI is the most appropriate test selection. Another common indication for MRI is for further evaluation of a specific area within the CNS after a normal CT scan. This is when neuroanatomical localization is of the utmost importance.

In some trauma scenarios, MRI may be the test of choice based on the prioritized list of differential diagnoses. For instance, if a chondrodystrophic breed of dog presents after relatively minor trauma (falling out of stationary pickup truck, etc), the clinician may still suspect a disk extrusion as the cause of acute paraparesis. It should also be noted that MRI is capable of diagnosing very subtle osseous lesions. Therefore, is some situations, MRI is selected for evaluation of both soft tissue and bone so that a patient can avoid undergoing both imaging modalities.

Conclusion

Neurologic examination of small animals provides important diagnostic and prognostic information to the clinician. Neuranatomical localization is prerequisite to determining an accurate list of differential diagnoses. Once this has been established selecting the appropriate diagnostic tests is much easier. Naturally, some clients will be unwilling or unable to permit advanced imaging tests or spinal surgery. Additionally, even though advanced imaging centers are more widely distributed, geography will preclude many patients from expedient access. In these situations the “best fits” diagnostic and treatment plan may have to suffice. In all instances, however, accurate diagnosis is important in providing a treatment plan and prognosis.

Appendix 1. Vertebral column/spinal cord Emergencies

Atlantoaxial instability

- Small/toy breed dogs
- Acute cervical pain with or without ataxia, paresis, plegia, respiratory difficulty
- Survey radiographs typically diagnostic
- MRI, CT often used to screen for concomitant pathology
- Conservative vs. surgical treatment
    - Less severely affected may benefit from pain medication, cage-rest, neck bandage
    - Surgical stabilization/decompression for more severely affected patients

Intervertebral disk disease

- Varying degrees of dysfunction and pain, upper vs. lower motor neuron signs, focal spinal pain, cutaneous truncii cutoff – help in lesion localization
- Presence/absence of voluntary motor/nociception helps prognosticate
- Schiff-Sherrington: extended front limbs secondary to T3-L3 lesion: helps localize, but not prognosticate
- Common causes of neurosurgical emergencies
- Chondrodystrophic breeds most commonly affected, other can be affected as well

- Diagnosis based on structural imaging, myelogram, CT, **MRI**
- Imaging should be performed in the entire region of localization
- Patients scoring helps categorize patients and assess changes
    - Modified Frankel score
        - 5- pain only
        - 4- paresis, ambulatory
        - 3- paresis, non-ambulatory
        - 2- Plegic, nociception positive
        - 1- Plegic, superficial nociception -, deep nociception +
        - 0- Plegic, deep nociception –
            - < 48 hours
            - > 48 hours
- Generally, acutely and severely affected patients are surgical candidates
    - MFS < 1 should have surgical intervention immediately
        - Patients with score of 0 > 48 hours have very poor prognosis (< 10%) therefore some pet caretakers decline surgical intervention
    - MFS 1 – 3 benefit from surgery as soon as is reasonable possible
    - MFS 4 – 5 individual case basis
        - Chronic pain (refractory to medication or requires constant medication) is considered a valid surgical indication

Spinal Fracture/Luxation

- Address life-threatening emergencies first
- Immobilize spine
- Survey radiographs to assess vertebral column
- Varying degrees of dysfunction and pain, upper vs. lower motor neuron signs, focal spinal pain, cutaneous truncii cutoff – help in lesion localization
- Presence/absence of voluntary motor/nociception helps prognosticate
- Schiff-Sherington: extended front limbs secondary to T3-L3 lesion: helps localize, but not prognosticate
- Assessment of nociception
- Trauma related vs. pathologic fracture (metabolic bone disease, neoplasia, osteomyelitis/diskospondylitis)
- Methylprednisolone sodium succinate (SoluMedrol®) – 30mg/kg IV at time 0, 15mg/kg IV at 2 hours, 6 hours, give this drug slowly
    - Not proven beneficial in dogs
    - < 6 hours post injury in dogs
    - < 2 hours post injury in cats
- Appropriate analgesia
    - Muscle relaxation can "destabilize" the spine
- Advanced imaging to determine spinal compression, concomitant diseases
- Non-surgical vs. Surgical treatment
    - Non-surgical
        - Ventral compartment and articular facet intact
        - Less severely affected (pain or mild paresis only) patients may not require surgery
    - Surgical
        - > 2 compartments of vertebral column affected considered unstable
    - Case-by-case
        - Articular facet fractures: rotationally unstable
        - Ventral compartment fractured: unstable in bending

Suggested reading:

1. Bagley RS: Clinical Neurology in Small Animals: A guide to the diagnosis and treatment of animals with neurological disease. Washington, RS Bagley Productions, 2002.

2. Dewey CW: Brain Trauma. In Wingfield WE: Veterinary ICU Book. Teton New Media, 2002, p911.

3. Dewey CW: emergency management of the head trauma patient. Vet Clin North Amer sm Animl Pract. 2000;30:207

4. Kapatkin AS, Vite CH. Neurosurgical emergencies. Vet Clin North Amer Sm Anim Pract. 2000;30:617-641.