Diagnosing and Treating the Five Disk Diseases: Why is MRI so Important?

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The spinal cord connects the brain to the neuromuscular system which is responsible for locomotion and respiration. The spinal cord is protected by a long bony box that is segmented to allow for improved axial movements. The segments of the bony box (vertebrae) are cushioned by the intervertebral disk. The intervertebral disk (IVD) contains a jello-like substance called nucleus pulposus (embryonic notochord) that is wrapped by concentric layers of ligamentous material (annulus fibrosus). The IVD is located below and adjacent to the spinal cord and pathology of the IVD puts the spinal cord at risk for infection, infarction, and compression all of which can lead weakness, paralysis, ataxia, pain, and incontinence.

Role of magnetic resonance imaging (MRI)

MRI characteristics are based on the proton or water content of different tissue allowing for detection of even mild pathology in the soft tissue and to a lesser extent bone. Because MRI directly images the spinal cord it is superior to X-ray based technology like radiography, myelography and CT scanning. MRI consistently demonstrates superior accuracy in the diagnosis of spinal cord disease. Additionally, MRI is better at predicting outcome than assessment of neurological function at presentation. MRI is currently essential to the practice of high quality veterinary neurology.

Hansen type I disk disease

Hansen Type I disease occurs when the degenerated annulus fibrosus loses tensile strength and tears allowing the degenerated, dehydrated nucleus pulposus to extrude or herniate and co-occupy the spinal canal with the spinal cord. The stretching of the meninges, nerve root and annulus fibrosus tear generating pain and the spinal cord compression can cause weakness, paralysis and incontinence. Prognosis and the choice of medical vs. surgical management is made by combining information about the neurological grade and MRI findings. This disease is prevalent in 3-6 year-old dachshunds and many other small breed dogs and 6-9 year-old large breed dogs like the German Shepherd, Rottweiler, Dalmatians and mixed-breeds. Type I disk disease has a very good to excellent prognosis but surgery is often required when there is persistent pain and/or weakness with significant spinal cord compression. Remarkably, in paraplegic dogs with Type I disease that have hemilaminectomy, MRI is a greater predictor of outcome than nociceptive or deep pain status.

Hansen type II disease

Hansen Type II disease is present when there are micro-tears and bulging of the annulus fibrosus and compression of the spinal cord, meninges and nerve roots. The disease is most common in larger breed dogs in the low cervical spine and lumbosacral junction. In the low cervical spine, Type II disk extrusion is an important factor in cervical spondylomyelopathy and is also known by disk associated wobbler's syndrome (DAWS). In DAWS the outcome with surgery is better than with medical management although there is no significant difference in life expectancy with these 2 treatments. Lumbosacral disk disease can mimic hip or stifle disease but unlike these other conditions, it can lead to urinary or fecal incontinence. Success rates with surgery are generally with LS surgery unless incontinence is already present. Therefore the distinction between lumbosacral Type II disk extrusion and orthopedic disease is an important. Nerve pain (and not orthopedic disease) can be distinguished from orthopedic disease via palpation of lateral muscles just cranial and lateral to the wings of the ilium, between the L7 and S1 dorsal spinous process, ventral surface of L7 and S1 via rectal, or with elevation of the tail. Pain with hip extension can indicate nerve compression or joint pain. However, hip pain can be discerned by slowly elevating the femoral head about 3-5 mm from acetabulum by lifting up on the medial surface of the femur while the patient is laterally recumbent

Acute non-compressive nucleus pulposus extrusion (ANNPE)

ANNPE is sometimes referred to as Type III disk disease or low volume high velocity disk extrusion. In this disease a small amount of nucleus pulposus (NP) ruptures at a high velocity through a small tear in the dorsal annulus fibrosus leading to edema, malacia, and/or hemorrhage of the spinal cord and epidural fat but minimal to no compression of the spinal cord. ANNPE has a peracute onset and associated with activity or a traumatic event and seen more commonly in medium to large breed, male dogs, especially Labrador retrievers and mixed breeds. About 2/3 of the patients in one study returned to walking and when the T2 weighted cross sectional MRI showed less than 90% of the spinal cord to be affected, 93% of the dogs regained function. Similar to Type I disk disease, the prognosis is more strongly correlated to MRI findings than admission neurological grade or nociceptive status. Many patients have difficulty urinating over the short-term and are treated with phenoxybenzamine or prazosin and diazepam to reduce smooth and skeletal muscle tone, respectively. Urinary catheterization can be a useful way of managing these patients in the first 2-3 days while

the disease improves and the phenoxybenzamine has time to take maximal effect. Monitoring the urinalysis and bacterial culture and sensitivity are advised because the resulting urethral inflammation can frustrate useful urination. Exercise restriction, rehab therapy and pain medication as indicated are hallmarks of therapy. Pain medication in the short term and rehab therapy may improve outcome.

Fibrocartilaginous emboli (FCE)

FCE or ischemic myelopathy occur when the NP obstructs blood flow within a spinal cord arteriole leading to necrosis of the spinal cord from loss of blood flow (infarct). The onset and progression of clinical signs are very similar to ANNPE although dogs with FCE are rarely painful. The middle aged Miniature Schnauzer, Shetland sheepdog and Labrador are at higher risk for FCE. The overall recovery rate is about 84% but 100% of dogs will improve if the T2 weighted MRI cross sectional lesion is less than 67% and the length of the lesion is less than 2 vertebral bodies. Despite the fact that the MRI can be normal about 20% of the time, MRI is the most accurate test and the strongest predictor of outcome in dogs with FCE. The same concerns exist for micturition with ANNPE and FCE. Rehab therapy instituted early in disease process may improve recovery rate.

Diskospondylitis

Diskospondylitis is an uncommon infectious and therefore inflammatory condition of the intervertebral disk and surrounding bony endplate, soft tissue, and meninges. Increasing age, male, large breed dogs are at higher risk and the Great Dane, Boxer and Labrador are thought to be predisposed to this disease. Pain, lethargy, not eating well and low grade fever are often noted. This can progress to weakness, paralysis and incontinence if there is spinal cord compression from empyema, disk extrusion, fracture or subluxation. Diagnostic evaluation can be frustrating as neutrophilia, monocytosis and hyperglobulinemia are inconsistently elevated – a C reactive protein maybe a sensitive indicator of inflammation from diskospondylitis. Radiographic are often initially normal in this disease, MRI far more sensitive and can help determine degree of spinal cord compression and requirement for surgery. The typical bacteria implicated are *Staphylococcus*, *Streptococcus*, *E.Coli* and less commonly the zoonotic agent *Brucella canis* or fungal agents. Antimicrobial therapy is ideally based on a culture from the urine, blood, and/or affected interspace or spinal canal. However, even this combination of testing does not always produce a specific pathogen and sensitivity profile. Empiric therapy often recommended with cephalosporin, fluroquinolone or/and clindamycin. Pain management is often with NSAIDs, however, despite the concern for immune suppression, the author prefers a tapering course of anti-inflammatory doses of glucocorticoids plus pain modulators. Surgery to decompress the affected spinal cord and nerve roots is often very useful in improving outcome, perhaps by enhancing the delivery of antibiotic to the nervous tissue and surrounding structures. The overall prognosis for this disease is thought to be fair to good with mortality rates of about 30%. Early detection, absence of systemic disease, a better neurological grade, non-fungal and non-*Brucella* cases, and a good response to initial therapy are positive indicators for surviving this disease.

Conclusion

Pain, weakness and ataxia are common presenting complaints in veterinary medicine. IVD pathology is commonly implicated as the cause of the clinical signs. A presumptive diagnosis can often be established by considering breed, age of onset, progression but MRI is best test for establishing definitive diagnosis, prognosis and the requirement for surgery.

Table 1. Clinical features of 5 disk diseases

	Type I	Type II	ANNPE	FCE	Diskospondylitis
Definition	Annulus tear, nucleus pulposus in spinal canal	Annulus bulge, microtears	Small annulus tear, low volume, high velocity	Spinal cord stroke	Infection vertebral endplate, disk, soft tissue
Signalment	3-6, Chondrodystrophic 6-8, Large Breeds	>6 yrs Large Breeds	6 yrs, medium to large, Lab, Border collie	6 yrs, Sheltie, Schnauzer, Lab	Male, Great Dane, Boxer, Labrador, risk up with age
Onset Progress	Sudden, progressive with periods of rapid progression	Slowly progressive	Peracute, can progress in first 24 hours	Peracute, can progress in first 24 hours	Progressive, wax and wane
Painful	Yes, episodically very painful, muscle spasm	Mild pain, limits mobility	Moderate pain, improves in 24 hours	No	Painful to episodically very painful

Preferred Location	Neck, TL junction	low neck, low back	Over disk space	Intumescence	C6-7, Mid-thoracic, LS
Signs	Paresis to paralysis	Weak, incontinent, tail down (LS)	Paresis to paralysis, often one side worse	Paresis to paralysis, often one side worse	Painful, sick, weak
Diagnosis	MRI especially in deep pain negative	MRI	MRI required	MRI required	MRI most sensitive, CRP
Treating	Surgery often required, exercise restrictions, NSAIDs	Exercise restrictions, surgery, NSAIDs	No surgery, NSAIDs, exercise restrictions	No surgery, NSAIDs, exercise restrictions	Long term antibiotics, surgery, pain meds, NSAID >Steroid
Prognosis	Dependent on neurological grade and MRI findings but generally good to excellent				

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