Thoracolumbar Intervertebral Disk Disease in Dogs

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Thoracolumbar intervertebral disk disease (IVDD) is a broad term that encompasses disk degeneration and clinical neurologic disease caused by disk herniation. With accurate assessment and appropriate therapy, many dogs can make a complete recovery from disk herniation. The efficacy of many common therapies is unknown and controversial. In the majority of practices that do not perform spinal surgery, the decision of when to refer is of paramount importance. This article offers principles to help guide therapy, prognosis, and referral.

Disk degeneration precedes disk herniation in the vast majority of clinical cases. Different mechanisms of disk degeneration typically occur in chondrodystrophoid and nonchondrodystrophoid dogs. Disk degeneration, as measured by the number of calcified disks on myelography of surgical cases, has been reported to be significantly and directly related to the likelihood of recurrence of clinical signs caused by disk herniation.

Disk degeneration in chondrodystrophoid dogs typically occurs at a young age (<2 years) and is often the result of chondroid metaplasia. This process begins shortly after birth and is probably caused by early chondrocyte senescence within the nucleus pulposus, which leads to increased keratan sulfate content relative to chondroitin sulfate content, disk dehydration, and nuclear calcification. In turn, the abnormal nucleus possesses abnormal biomechanical properties that may allow for annular tearing when torsional and compressive forces are applied to the disk. In some dogs, the annulus is weakened enough to allow for disk herniation. Although chondroid metaplasia is most often associated with disk extrusion, protrusion and bulge are also possible.

Disk degeneration in nonchondrodystrophoid dogs occurs later in life. Repetitive microtrauma likely leads to fissuring of the annulus fibrosus, altered disk biomechanics, and secondary fibroid degeneration of the nucleus pulposus. Fibroid metaplasia of the nucleus is histologically defined by fibrous tissue deposition, increased keratan sulfate content relative to chondroitin sulfate content, and disk dehydration. The abnormal nucleus may then extrude through the damaged annulus or herniate into the annulus, resulting in disk protrusion. Disk bulge may also occur in dogs with fibroid disk degeneration.

Disk herniation is commonly manifested as three syndromes: disk extrusion, protrusion, and bulge. Disk extrusion (Hansen’s type I IVDD) is defined as rupture of the annulus fibrosus with translocation of the nucleus pulposus into the vertebral canal. Disk protru-
sision (Hansen’s type II IVDD) occurs because of rupture of the innermost layers of the annulus fibrosus, partial displacement of the nucleus into the disrupted annulus, and annular hypertrophy. In disk bulge, the nucleus is not displaced, but symmetric hypertrophy of the annulus fibrosus is present. Whereas disk extrusion is usually acute in onset, disk protrusion and bulge are usually chronic.

Disk herniation can result in acute spinal cord injury, which is usually divided into primary and secondary events. Primary injury is the initial mechanical insult to the spinal cord and consists of compression, concussion, contusion, and laceration. Secondary injury is the biochemical cascade that results from primary injury and includes excitotoxicity, inflammation, lipid peroxidation, neurogenic shock, and vascular injury. Although surgical intervention usually targets components of primary spinal cord injury and may prevent secondary processes, medical treatment is geared toward alleviating secondary injury.

About 10% of dogs with severe spinal cord injury (i.e., absent nociception) develop myelomalacia, which is gross softening of the spinal cord that is the result of necrosis and intraparenchymal hemorrhage. Myelomalacia may be focal or ascend and descend through the spinal cord parenchyma. Dogs with ascending and descending myelomalacia may develop decreased pelvic limb reflexes, anal and urethral sphincter hypotonia, cranial migration of panniculus reflex, flaccid abdominal muscles, and ultimately flaccid forelimb paralysis and respiratory arrest. Prognosis in these dogs is grave, and there is no known treatment.

**DIAGNOSTIC CRITERIA**

**Historical Information**

**Gender Predisposition**
None clear; some studies suggest a male predisposition.

**Age Predisposition**
- Disk extrusion in chondrodystrophoid breeds usually occurs between the ages of 4 and 6 years (range, <1–12 years). In nonchondrodystrophoid breeds, it usually occurs between the ages of 6 and 8 years (range, 2–15 years).
- Disk protrusion and bulge may be more common in older nonchondrodystrophoid breed dogs.

**Breed Predisposition**
- Dachshunds.
- Pekingese.
- Welsh corgis.
- Beagles.
- Lhasa apsos.
- Miniature poodles.
- German shepherds.

**KEY TO COSTS**

$ indicates relative costs of any diagnostic and treatment regimens listed.

$ costs less than $250

$$ costs between $250 and $500

$$$ costs between $500 and $1,000

$$$$ costs more than $1,000
• Labrador retrievers.
• Doberman pinschers.

**Owner Observations**
• Anorexia.
• Panting.
• Vocalizing.
• Reluctance to walk or jump.
• Pelvic limb ataxia.
• Paraparesis or paraplegia.
• Urinary or fecal incontinence.

**Other Historical Considerations/Predispositions**
• Clinical signs can come on quickly (<1 hour) or may take many years to develop.
• Progression of clinical signs is variable.
• Some owners report that the dog experienced a sudden painful episode after jumping off furniture.

**Physical Examination Findings**
• Paraspinal hyperesthesia.
• Pelvic limb general proprioceptive ataxia.
• Pelvic limb postural reaction deficits.
• Paraparesis or paraplegia: Motor function should be examined in nonambulatory dogs. The dog's weight should be supported (by the tail in small dogs and by the inguinal region in large dogs), and an assistant should leash walk the dog, looking for purposeful movement of the pelvic limbs.
• The urinary bladder may be distended.

**Spinal Reflexes**
Spinal reflexes assist with localizing the lesion.

• **Pelvic limb reflexes normal to hyperreflexic with postural reaction deficits:** The T3–L3 spinal cord segments may be affected. Clonus and crossed extensor reflex may or may not be present. Pseudo-hyperreflexia, in which the normal patellar reflex appears increased, an artifact caused by hypotonia of caudal thigh muscles, should be considered. This is seen in many dogs with lumbosacral disease; check for lumbosacral pain by rectal examination and palpation.

• **Pelvic limb reflexes hyporeflexic to areflexic with postural reaction deficits:** The L4–S2 spinal cord segments may be affected, or cauda equina syndrome may be present. The patient may have spinal shock (severe, acute lesion; see below) or a diffuse lesion (i.e., ascending and descending myelomalacia).

• **Thoracic limb reflexes** are usually normal.
• The panniculus reflex may be tested by lightly pinching the skin of the dorsal trunk cranial to the wings of the ilia with hemostats.

— The afferent limb of the reflex is composed of the dorsal cutaneous branches of the spinal nerves.
— The efferent limb of the reflex is the lateral thoracic nerve, which innervates the cutaneous trunci muscle.
— The observed outcome of the reflex is bilateral “twitching” of the skin by the cutaneous trunci muscles.
— Loss of the cutaneous trunci reflex in an animal with T3–L3 myelopathy usually implies a lesion located one to two vertebrae cranial to the cut-off point. Animals with a spinal cord lesion caudal to the cutaneous trunci muscle have a normal panniculus reflex. The location of the caudalmost extent of the cutaneous trunci muscle is variable.

**Nociception**
• Nociception helps characterize lesion severity. It does not need to be tested in dogs with voluntary motor function. Nociception is commonly confused with withdrawal reflex; however, although the withdrawal reflex may remain intact with functional cord transection, nociception is lost with functional cord transection.
• To test nociception, the dog should be observed for a response to stimulus, including biting the examiner, vocalizing, struggling, increased heart rate, altered expression, or mydriasis. Superficial nociception is assessed by pinching the interdigital webbing with fingers or forceps. If superficial nociception is present, deep nociception does not need to be tested. Deep nociception is assessed by clamping the bones of the toes, leg, or tail with forceps.

**Schiff-Sherrington Posture**
• This posture is exhibited in dogs with severe T3–L3 myelopathy. The Schiff-Sherrington posture includes increased thoracic limb extensor tone or normal thoracic limb postural reactions. Pelvic limb reflexes are classically decreased (which may relate to spinal shock) but may be normal or increased.
• The cause is damage to border cells or their ascending projections within the fasciculus proprius, resulting in disinhibition of thoracic limb extensor tone.
• The prognostic implications have not been rigorously studied; however, dogs with the Schiff-Sherrington posture can recover.

**Spinal Shock**
• Spinal shock is exhibited in dogs with severe myelopathy. Temporary hypotonia and hyporeflexia do not result from lower motor neuron injury; rather, they occur caudal to a severe spinal cord injury.
• Spinal shock may occur because of acute disruption...
Urinalysis: Urine specific gravity is often very high or low if the dog has received steroids. Urine sediment examination may reveal leukocytes, bacteria, and erythrocytes. A urine culture should be considered if there is evidence of urinary bladder dysfunction.

Other Diagnostic Findings

Survey Spinal Radiography
- Surgery should not be attempted based on survey radiographs alone.
- Survey radiography can be performed in patients that are awake or anesthetized. Survey radiography of an anesthetized patient allows for quality radiographs and proper positioning, involves anesthetic risk and cost, and is usually performed before myelography and surgery.
- Survey radiography is most useful in ruling out differential diagnoses involving bony abnormalities (Table 1).
- Radiographic signs of IVDD include narrowed disk space, altered shape of the intervertebral foramen, wedging of the disk space, narrowing of the space between the articular facets, and mineralized disk material in the vertebral canal or overlying the intervertebral foramen.

Cerebrospinal Fluid Evaluation
- Aids diagnosis of infectious, inflammatory, or neoplastic disease.
- Mild to moderate increases in protein and cell counts are seen with disk extrusion and protrusion.
- Markedly elevated protein and cell counts are unlikely with IVDD.

Myelography
- Myelographic diagnosis of IVDD correlates with surgical findings 86% to 97% of the time and identifies the site of extradural spinal cord compression. Imaging may show attenuation of dorsal subarachnoid contrast column on the lateral view, dorsal deviation of ventral subarachnoid contrast column over a disk space on the lateral view, or attenuation of one or both lateral subarachnoid contrast columns on the ventrodorsal view. Oblique and lateral views may help determine disk lateralization.
- Myelography with fluoroscopy is the modality of choice for confirming vertebral column instability.
- Side effects include anesthetic complications (bradycardia, hypotension, cardiac arrest), seizures (transient), or worsening neurologic function (usually transient).
- Dogs with spinal cord swelling, as seen by attenuation of the dorsal contrast column (lateral view) for a length of five times the length of the L2 vertebral body, may have a poorer prognosis.

Laboratory Findings
- Complete blood count: Stress leukogram, hemocoagulation.
- Chemistry panel: Nonspecific changes; possible prerenal azotemia.

CHECKPOINTS

- Fenestration is removal of nucleus pulposus through a surgically created rent in the annulus. This can be done at the site of extrusion or at many sites. The amount of disk material removed depends on patient factors and surgical technique.

Argument for: Decreased likelihood of recurrence at the site of extrusion. (In many dogs, euthanasia is the consequence of recurrence.)

Arguments against: Recurrence rates are similar; increased operative time; increased cost; amount of nucleus removed is highly surgeon dependent; fenestration may alter vertebral column biomechanics, predisposing the dog to herniation at the next unfenestrated disk space.

Experts also disagree on the use of high-dose methylprednisolone sodium succinate (MPSS).

Arguments for: Improved short-term outcome shown in two large-scale human spinal trauma studies; improved histopathologic, electrophysiologic (spinal evoked potentials), and clinical outcome in animal models of acute spinal cord injury: limits lipid peroxidation and stabilizes cell membrane.

Arguments against: Gastrointestinal side effects; immune suppression; delayed wound healing; possible increased risk of infection, including pneumonia, urinary tract infection, and sepsis; impairment of neuronal glucose uptake. Also, the two large-scale human spinal trauma studies cited are imperfect; many other studies showed no benefit.

of upper motor neuron input. Some reflexes may return in minutes (patellar), but others may take hours (flexor withdrawal). With time, adaptations (including altered excitatory neurotransmitter levels and receptor modifications) allow for the returned function of lower motor neurons caudal to the injury.

The prognostic implications have not been rigorously studied in dogs.

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Myelographic findings suggestive of myelomalacia include spinal cord swelling and contrast media infiltration into the spinal cord parenchyma.

**Computed Tomography $$$**
- Provides a three-dimensional radiographic reconstruction; provides both transverse and sagittal views.
- IV contrast studies may clarify findings.
- May be combined with myelography to increase diagnostic yield.
- Provides excellent detail of bony structures and excellent agreement with myelography and surgical findings for the identification and localization of disk herniation.
- It is best for extradural lesions.

**Magnetic Resonance Imaging $$$$**
- This is a sensitive method for detecting early degenerative changes of the disks. It provides excellent detail of soft tissue structures, including the spinal cord, spinal ligaments, and intervertebral disks. It provides both transverse and sagittal views.
- Provides prognostic information for dogs without deep nociception. Dogs without an area of spinal cord hyperintensity (T2-weighted images) greater than the length of the L2 vertebral body have an excellent prognosis.

### TABLE 1 Common Diagnostic Differentials for Thoracolumbar Myelopathy

<table>
<thead>
<tr>
<th>Differential Diagnosis</th>
<th>Onset</th>
<th>Paraspinal Hyperesthesia</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Extradural</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diskospondylitis</td>
<td>Variable</td>
<td>Usually</td>
<td>—</td>
</tr>
<tr>
<td>Intervertebral disk herniation</td>
<td>Variable</td>
<td>Usually</td>
<td>—</td>
</tr>
<tr>
<td>Synovial cyst</td>
<td>Chronic</td>
<td>Usually</td>
<td>Usually occurs in the cervical region</td>
</tr>
<tr>
<td>Vertebral body neoplasia</td>
<td>Variable</td>
<td>Usually</td>
<td>Rule out with survey radiography</td>
</tr>
<tr>
<td>Vertebral fracture or luxation</td>
<td>Acute</td>
<td>Usually</td>
<td>Rule out with survey radiography</td>
</tr>
<tr>
<td>Vertebral malformation</td>
<td>Variable</td>
<td>Variable</td>
<td>Young to adult screw-tailed breeds</td>
</tr>
<tr>
<td><strong>Intradural–Extradural</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arachnoid cyst (diverticulum)</td>
<td>Chronic</td>
<td>Unlikely</td>
<td>Older small-breed dogs are most likely to have thoracolumbar arachnoid cysts</td>
</tr>
<tr>
<td>Meningioma</td>
<td>Variable</td>
<td>Usually</td>
<td>Usually occurs in the cervical region</td>
</tr>
<tr>
<td><strong>Intradural</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Degenerative myelopathy</td>
<td>Chronic</td>
<td>No</td>
<td>Older (&gt;5 years) dogs; German shepherds and boxers are predisposed</td>
</tr>
<tr>
<td>Fibrocartilaginous embolism</td>
<td>Acute</td>
<td>Unlikely</td>
<td>Asymmetric paresis is often present</td>
</tr>
<tr>
<td>Myelitis or meningitis</td>
<td>Variable</td>
<td>Usually</td>
<td>Consider infectious disease serology</td>
</tr>
<tr>
<td><strong>Variable Location</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lymphoma</td>
<td>Variable</td>
<td>Variable</td>
<td>—</td>
</tr>
<tr>
<td>Nerve sheath tumor</td>
<td>Variable</td>
<td>Variable</td>
<td>Often first manifests as chronic monoparesis that then progresses to myelopathy</td>
</tr>
</tbody>
</table>

The severity of IVDD ranges from subclinical to life threatening.

Presumptive diagnosis is based on clinical signs, physical examination findings, and spinal radiography.

Definitive diagnosis is based on advanced imaging (myelography, computed tomography, or magnetic resonance imaging) and gross and micro-
scopic surgical or necropsy findings. (Advanced imaging is commonly performed in surgical candidates, in cases in which the client wishes to exclude medically treated diseases, and under the same anesthetic episode as surgery.) Neuroanatomic localization should correlate with imaging studies.

**Diagnostic Differentials**

See Table 1.

**TREATMENT RECOMMENDATIONS**

**Initial Treatment**

The initial treatment includes surgical versus medical problem solving (also see Prognosis section).

- The severity of clinical signs is important. Although surgery offers a better outcome in nonambulatory dogs, many ambulatory dogs respond to medical therapy.
- The duration of absent nociception should be noted; the duration is usually not known. Some authors suggest that surgery beyond 48 hours of absent nociception is not beneficial; however, recovery after more than 48 hours of absent nociception has been reported.
- Owner considerations are also important. Potential surgery should be discussed with the owner at the time of the initial evaluation. The owner’s finances and attitudes toward surgery may impact the medical therapy administered and the timing of referral.
- Surgery may be indicated in dogs that do not respond to medical therapy.

**Emergency Treatment**

- The goal is to improve outcome with surgical or medical therapy.
- No specific medical therapy has been consistently proven to improve clinical outcome.
- IV fluid therapy is provided because many dogs are dehydrated at presentation. Acute spinal cord injury involves dysfunction of local blood flow regulation, ischemia, and hypoxia. IV fluid replacement therapy should be implemented in dehydrated dogs. Normally hydrated dogs may benefit from 1.5 to 2.0 times maintenance fluid rates (90–120 ml/kg/day).
- Also see the Supportive Care section regarding analgesia and urinary bladder management.

**Surgical Management**

- The current cost of diagnostics, anesthesia, surgery, and postoperative care (without complications) at one veterinary teaching hospital ranges from $2,500 to $5,000, depending on the patient’s size, lesion severity, and length of hospital stay (range, 3 days to many weeks).
- Techniques include a dorsal or dorsolateral approach to the vertebrae, including hemilaminectomy, pediculectomy, or dorsal laminectomy.
- The goals are to decompress the cord and remove herniated disk material.
- Successfully treated dogs are usually discharged from the hospital when they are ambulatory and urinary continent and have an acceptable pain level on oral medications. The duration of hospitalization is related to age, weight, lesion severity, and use of perioperative corticosteroids.

**Medical Management**

- Strict cage rest for 4 to 6 weeks. The cage should be just large enough to allow the dog to stand and turn around.
- The dog should be carried outside and leash walked to urinate and defecate as needed.
- The dog must have absolutely no off-leash activity, such as running, jumping, climbing stairs, or playing.

**Alternative/Optional Treatments/Therapy**

- Methocarbamol: 15–20 mg/kg PO q8h.
- High-dose MPSS:
  - 30 mg/kg IV bolus within 8 hours of acute spinal cord injury.
  - Then continued as a continuous-rate infusion (CRI) of 5.4 mg/kg/hr for 24–48 hours.
- Low-dose prednisone: Many dosing regimens are commonly used. An example is:
  - 0.5 mg/kg PO q12h for 5–7 days.
  - Followed by 0.5 mg/kg PO q12h every other day (i.e., skip a day) for 5–7 days.
  - Followed by 0.5 mg/kg PO q48 hours for 5–7 days.
- NSAIDs:
  - Carprofen: 2.2 mg/kg PO q12h.
  - Deracoxib: 1–2 mg/kg PO q24h.
  - Etodolac: 5–15 mg/kg PO q24h.
- Gastroprotectants:
  - Famotidine: 0.5–1 mg/kg PO, SC, IM, or IV q12–24h.
  - Ranitidine: 0.5–2 mg/kg PO, IV, or IM q8–12h.
  - Omeprazole: 0.7–2 mg/kg PO q12–24h.
- Acupuncture should be considered for patients with persistent pain.

**Supportive Treatment**

**Analgesia (after Neurologic Examination)**

- Hydromorphone: 0.1–0.2 mg/kg IM, IV, or SC q2–4h.
• Oxymorphone: 0.05–0.2 mg/kg IM, IV, or SC q1–3h.
• Morphine: 0.5–2 mg/kg IM or SC q3–4h.
• Fentanyl: 5 µg/kg IV plus 3–6 µg/kg hr IV CRI.
• Buprenorphine: 0.01–0.015 mg/kg SC, IM, or IV q6h.
• Tramadol: 1–4 mg/kg PO q6–8h.

Urinary Bladder Management
• Bladder expression or catheterization: The bladder is generally expressed every 6 to 8 hours or as needed to prevent distension and overflow.
• Monitor for urinary tract infections with cultures and urinalyses.
• Medical therapy:
  — Phenoxybenzamine, a nonspecific α-adrenergic antagonist, decreases internal urethral sphincter tone. Clinical effects take days. Dosage: 5–15 mg (total dose) PO q12h.
  — Prazosin, an α₁-adrenergic antagonist, decreases internal urethral sphincter tone and may cause marked hypotension. Dosage: 1 mg/15 kg body weight PO q8–24h.
  — Bethanechol, a cholinergic (mostly muscarinic) agonist, enhances detrusor muscle contraction. Dosage: 2.5–25 mg (total dose) PO q8h.

Postoperative Care
• Ice packs should be used for incisions.
• Postoperative physical rehabilitation: Standing exercises, passive range of motion, water treadmill, swimming.

Patient Monitoring
• Serial neurologic examination.
• Serial pain scores.
• Serial bladder management.

Home Management
• Behavior modification (e.g., discourage jumping).
• Obesity management.
• Monitor for progressive walking difficulties, urinary incontinence, failure to urinate, pain, vomiting, and anorexia.

Milestones/Recovery Time Frames
• Surgery should be considered if the dog remains in pain after 10 to 14 days of strict cage rest.
• Advise clients of the possibility of recurrence.
• Most dogs that do not recover deep nociception by 1 month after surgery will never recover it.
• Spinal walking: It has been reported that seven of 18 dogs without deep nociception that did not regain deep nociception after surgery and were maintained for at least 3 weeks regained partial ambulation. This involves the use of pelvic limb reflexes, trunk muscles, and any remaining upper motor neurons. Spinal walkers probably will not develop urinary and fecal continence.

On the News Front
— Medical therapies for minimizing spinal cord injury are being studied. These include sodium channel blockers, various receptor antagonists, systemically administered synthetic surfactants, antioxidant therapy, and stem cell therapy.
— The role of postoperative physical rehabilitation is being examined in dogs with IVDD.

Treatment Contraindications
• Aspirin (especially for surgical candidates).
• Corticosteroids in combination with NSAIDs.
• Corticosteroids other than MPSS for acute, severe myelopathy.
• High-dose MPSS for more than 8 hours after acute spinal cord injury.
• Overzealous physical rehabilitation.
• Dog that bolts or falls from the cage.
• Failure to comply with instructions for strict cage confinement.

Prognosis
Most studies define success as return to ambulation with urinary continence. Outcome is related to:
• Severity of myelopathy: In patients with paraspinal hyperesthesia alone, surgical treatment is successful in 95% of cases. Medical treatment is successful in an unknown percentage of cases, but most dogs recover.
  — In patients with paraparesis, surgical treatment is successful in 90% to 95% of cases. For medical treatment, one report described a successful outcome in about 61% (14 of 23) of nonambulatory paraparetic dogs.
  — In patients with paraplegia and intact deep nociception, surgery is successful in more than 80% of cases.
  — In patients with paraplegia but absent deep nociception, surgery is successful in about 50% (range, 25% to 76%) of cases. With medical treatment, one report described success in about 51% (21 of 41) of conservatively treated
nonambulatory dogs. (Nociception was not indicated, and this study included both paraplegic and paraparetic dogs.) Another report described success (ambulation alone) in about 40% (19 of 52) of paraplegic dogs with absent nociception. Spinal walking was not described. All of the patients with unsuccessful treatment died or were euthanized.

- **Onset and duration of clinical signs:** It has been reported that dogs that become nonambulatory in less than 1 hour have poorer outcomes than dogs that progress more slowly.

- **Imaging findings.**

**Recurrence**
- Early reports probably underestimate the recurrence of disk herniation.
- Recurrence typically occurs because of disk herniation at another site.
- A recent report suggests that about 20% of dogs treated surgically for IVDD develop paraspinal hyperesthesia and neurologic deficits at some point after surgery.
- Dachshunds may have higher recurrence rates than other breeds.
- The number of calcified disks on myelography of surgical cases has been reported to be significantly and directly related to the likelihood of recurrence.
- Conservatively managed dogs have recurrence rates as high as 40%.

**Favorable Criteria**
- Ambulatory.
- Presence of voluntary pelvic limb motor function (assess by tail walking a nonambulatory dog).
- Presence of superficial nociception.
- Presence of deep nociception.
- Dog with no previous IVDD.

**Unfavorable Criteria**
- Loss of deep nociception.
- Evidence of myelomalacia.
- Incomplete recovery from previous IVDD.
- Multiple mineralized disks on radiographs.
- Area of hyperintensity longer than the length of the L2 vertebral body on T2-weighted magnetic resonance imaging study.

**RECOMMENDED READING**


