Spinal Cord Diseases

Part 2

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Neurology/Neurosurgery
8/20/17
• V – Vascular
• I – Infectious / Inflammatory
• T – Trauma
• A – Anomalous
• M – Metabolic
• I – Idiopathic
• N – Neoplasia
• D – Degenerative
Anomalous

- Vertebral malformations
- Cysts / Diverticula
- Cervical spondylomyelopathy (Wobbler)
Vertebral Malformations

- Variety of neurologic symptoms
  - Myelopathy
  - Radiculopathy

- However...
  - VAST majority are incidental findings / clinically insignificant
Vertebral Malformations

- Generally breed-associated
- Exception
  - Mucolipidosis
- Bulldog overrepresented
  - Also...
Vertebral Malformations

• Many different classification systems
  ▪ Stage of development
    • Embryonic
      – Hemivertebrae
      – Wedge vertebrae
      – Butterfly vertebrae
    • Fetal
      – Block vertebrae
      – Articular process hypoplasia
Articular Process Hypoplasia

• Hypoplasia or aplasia
• Pugs
Articular Process Hypoplasia

• “Pug Myelopathy”
• Hypoplasia / aplasia of caudal articular facets
  ▪ Thoracolumbar region
• Leads to chronic instability and secondary fibrous band
  ▪ → Constrictive myelopathy

Vertebral Malformations

• Diagnostics
  - Radiography
    • Most are easily identified
  - MRI
    • Cross-sectional analysis
    • Spinal cord compression
    • Other abnormalities
      – Disc
      – Cyst / diverticula
Vertebral Malformations

- Treatment
  - Dependent on...
    - Significance
    - Type
    - Number
    - Severity
    - Stability
Vertebral Malformations

• Treatment
  ▪ Medical management
    • Strict confinement
    • NSAIDs vs. steroids
    • Analgesic therapy
  ▪ Surgery
    • Rarely performed...
Vertebral Malformations

- Surgical Management
  - More common to address secondary disease
    - Block vertebrae
      - Disc
    - Hemivertebrae
      - Cyst / diverticula
Vertebral Malformations

• Surgical Management
  ▪ Simple
    • Dorsal laminectomy
    • Hemilaminectomy
  ▪ Complex
    • Requiring stabilization
“Chewy”

- 4 month old Chihuahua mix
- Weak / wobbly in PL since adoption
“Chewy”
“Chewy” MRI
“Chewy” CT
“Chewy”
Chewy’s 3D model
“Chewy”
Post-op radiographs

Right lateral

VD
Vertebral Malformations

- **The 4 Questions**
  - **Onset?**
    - Chronic
      - Months to years
  - **Progression?**
    - Slowly progressive
  - **Symmetry?**
    - Usually symmetric
  - **Painful?**
    - No
Spinal Arachnoid Diverticula

- Focal dilations of the subarachnoid space
- Formerly known as cysts
- More common in brain
Spinal Arachnoid Diverticula

• Compressive myelopathy
• Most common symptom
  ▪ Proprioceptive ataxia
• Two groups of dogs
  ▪ Cervical
    • Large breed dogs
      – Rottweiler
  ▪ Thoracolumbar***
    • Frenchies and Pugs
Spinal Arachnoid Diverticula

- Corkscrew tail breeds
- Very common to have concurrent disease adjacent to SAD
Spinal Arachnoid Diverticula

• Diagnostics
  ▪ CT / myelogram?
  ▪ MRI!!

• Diagnosis
  – FLAIR

• Also...
  – Cord changes
    » Edema,
    gliosis
  – Concurrent
diseases
“Francisco”
“Francisco”
Spinal Arachnoid Diverticula

- Treatment
  - Medical management
    - Prednisone (low dose)
    - Omeprazole
    - +/- furosemide, acetazolamide
  - Surgery
    - Laminectomy
    - Durotomy
    - Marsupialization
Spinal Arachnoid Diverticula

• Prognosis
  ▪ Medical therapy
    • Unknown – no studies to date
    • “Guarded”
  ▪ Surgery
    • ~63% - improved
    • ~37% - worsened
Spinal Arachnoid Diverticula

• **The 4 Questions**
  - **Onset?**
    - Chronic
      - Months to years
  - **Progression?**
    - Slowly progressive
  - **Symmetry?**
    - Usually symmetric
  - **Painful?**
    - No
Cervical Spondylomyelopathy

• “Wobbler syndrome”
• Condition of large and giant breed dogs
• Static or dynamic compression
  ▪ Spinal cord
  ▪ Nerve roots
  ▪ → pain and spinal cord dysfunction
• Causes
  ▪ Genetic, congenital, conformational, nutritional
Cervical Spondylomyelopathy

• Breeds
  ▪ Great Dane, Doberman, Basset

• Pathogenesis
  ▪ Multifactorial
  ▪ Canal stenosis from disc, ligament, joint capsule, bone, vertebral instability, among others...
Cervical Spondylomyelopathy

- Two forms
  - Doberman
    - Older dogs (6.8 years)
    - Caudal cervical
    - Disc-associated
  - Great Dane
    - Younger dogs (3.8 years)
    - Cranial-to-mid cervical
    - Osseous-associated
Cervical Spondylomyelopathy

• Basset hound
  ▪ Unique form of disease
  ▪ JVIM, 2012, De Decker et al.
  ▪ Dorsal lamina & spinous process hypertrophy
  ▪ $\rightarrow$ leads to ligamentum flavum hypertrophy
Basset Spondylomyelopathy
Basset Spondylomyelopathy
“George” – 5 mo Basset Hound
Cervical Spondylomyelopathy

- **Diagnostics**
  - CT / Myelography
  - MRI
    - Diagnosis
    - Dynamic vs. static
    - Cord changes***

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[Image: MRI scan showing cervical vertebrae labeled as C5, C6, and C7.]
“Fitz” – 2 yo MN Great Dane

C2-C3

C5-C6
Cervical Spondylomyelopathy

- Treatment

- Medical
  - Prednisone
  - Gabapentin
  - Controlled exercise

- Surgery
  - Dependent on type, extent, severity
  - Ventral slot, dorsal laminectomy
  - +/- stabilization
  - Disc replacement??

Cervical Spondylomyelopathy

• The 4 Questions
  ▪ Onset?
    • Chronic, Acute-on-Chronic
  ▪ Progression?
    • Progressive
  ▪ Symmetry?
    • Usually symmetric
  ▪ Painful?
    • Osseous-associated
      – 50/50
    • Disc-associated
      – Yes!
• V – Vascular
• I – Infectious / Inflammatory
• T – Trauma
• A – Anomalous
• M – Metabolic
• I – Idiopathic
• N – Neoplasia
• D – Degenerative
Neoplasia

- Primary
  - Arising from the spinal cord or meninges

- Secondary
  - Adjacent

- Intramedullary
  - Intradural, Extramedullary

- Extradural
Primary SC Neoplasia

- Can be broken into 2 categories
  - Intramedullary
  - Intradural, extramedullary

http://sevneurology.com/lupa-spinal-tumor/
Intramedullary SC Neoplasia

• Uncommon
  ▪ ~15% of spinal cord tumors

• 2/3 are primary
  ▪ Neuroepithelial
    • Glial cells
    • Ependyma

• 1/3 are secondary
  ▪ Metastatic
Intramedullary SC Neoplasia

- **Primary tumors**
  - More common...
    - Young dogs
    - Cervical spinal cord

- **Secondary**
  - More common...
    - Older dogs
    - Thoracolumbar spinal cord
Intramedullary SC Neoplasia

• **Primary tumors**
  - Mean age is 5.9 years
  - Most common is ependymoma
    • Followed by
      – Astrocytoma
      – Oligodendroglioma
Intramedullary SC Neoplasia

- Secondary / metastatic tumors
  - Mean age is 10.8 years
  - Most common...
    - Hemangiosarcoma
    - TCC
    - Prostatic carcinoma
    - LSA?
Intramedullary Neoplasia

• The 4 Questions
  ▪ Onset?
    • Acute-to-chronic
  ▪ Progression?
    • Progressive
  ▪ Symmetry?
    • Often symmetric
  ▪ Painful?
    • Nope!!
Intradural, Extramedullary

Intradural, Extramedullary

- **Meningioma**
  - Most common in dogs
  - Arises from arachnoid granulation of meninges
    - Locations
      - Cervical most common
  - Grades
    - I-III
  - Types
    - Numerous!!
Transitional Meningioma

Angiomatous Meningioma

Microcystic Meningioma
Meningioma

- **Treatment**
  - Palliative care
  - Oral chemotherapy
    - Hydroxyurea
  - Surgery alone
    - 1410-1440 days (Levy et. al 1997)
    - 19 months (Petersen et. al 2008)
  - Surgery + Radiation
    - ??? Likely longer...
Intradural, Extramedullary

• Nerve sheath tumors
  ▪ Types
    • Schwannomas
    • Neurofibromas
    • Neurofibrosarcomas
Nerve Sheath Tumors
Nerve Sheath Tumors

• Treatment
  ▪ Palliative care
  ▪ Radiation
    • 371 ± 30 days
  ▪ Surgery alone
    • 6-9 months
  ▪ Surgery + Radiation
    • ??? Likely longer…
Nephroblastoma

• “Thoracolumbar tumor of young dogs”
• Embryonal tumors of the kidneys
• Neoplastic transformation of blastemal cells
  ▪ Retroperitoneal → primary renal tumor
  ▪ Within dura → spinal tumor
• T10-L3
• GSD, Golden retrievers
Nephroblastoma

• Age at onset
  ▪ 5-48 months
    • Median 14 months
• Progressive symptoms
  ▪ T3-L3
  ▪ Paraparesis / ataxia to paraplegia
Nephroblastoma
Nephroblastoma

• Treatment
  ▪ Medical management
  ▪ Surgery
    • Dorsal / hemilaminectomy
    • Durotomy

• Prognosis
  ▪ Poor
    • MST 30 days in all dogs
    • Surgical resection
      – MST 70.5 days
Extradural Tumors

• Vertebral tumors
  ▪ Osteosarcoma
  ▪ Fibrosarcoma
  ▪ Chondrosarcoma
  ▪ Multiple myeloma
  ▪ Lymphoma
  ▪ Metastatic...
Extradural Tumors

• Other sites
  ▪ Soft tissue
  ▪ Abdominal
  ▪ Retroperitoneal
  ▪ Esophageal
ID-EM and Extradural Tumors

- The 4 Questions
  - Onset?
    - Acute-to-chronic
  - Progression?
    - Progressive
  - Symmetry?
    - ED → Symmetric
    - ID-EM → Asymmetric
  - Painful?
    - Most are...
      - Meninges, nerve, muscle
• V – Vascular
• I – Infectious / Inflammatory
• T – Trauma
• A – Anomalous
• M – Metabolic
• I – Idiopathic
• N – Neoplasia
• D – Degenerative
Degenerative

- Intervertebral disc disease (IVDD)
- Degenerative myelopathy (DM)
Max,
7 yr, MN Dachshund
Max – The Situation

- 2 days ago – sudden onset not walking, painful
- 1 day ago – pcDVM - paralyzed and no deep pain
- Your exam – quite the same

- Diagnosis? Prognosis?
Max – The truth

- Came in through ER (~8PM)
  - Plegic, DPP (NEGATIVE)
- Advised to wait til AM to have MRI

- 8AM
  - Exam unchanged.
Outcome

- Left hemilaminectomy at T12-T13 with removal of massive amount of paste-like disc
- Grossly normal spinal cord
- Weakly ambulatory at discharge 2 ½ days later
Deep Pain Negative & Hemilaminectomy

<table>
<thead>
<tr>
<th>T2 Signal Changes</th>
<th>Number Recovered</th>
<th>Success Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>None noted</td>
<td>13/13</td>
<td>100%</td>
</tr>
<tr>
<td>&lt; 3x length L2</td>
<td>4/6</td>
<td>66%</td>
</tr>
<tr>
<td>&gt; 3 x length L2</td>
<td>1/10</td>
<td>10%</td>
</tr>
<tr>
<td>Totals</td>
<td>18/29</td>
<td>62%</td>
</tr>
</tbody>
</table>

Deep Pain Positive & Hemilaminectomy

<table>
<thead>
<tr>
<th>T2 Signal Changes</th>
<th>Number Recovered</th>
<th>Success Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>None noted</td>
<td>31/31</td>
<td>100%</td>
</tr>
<tr>
<td>&lt; 3x length L2</td>
<td>11/12</td>
<td>92%</td>
</tr>
<tr>
<td>&gt; 3 x length L2</td>
<td>2/5</td>
<td>40%</td>
</tr>
<tr>
<td>Totals</td>
<td>44/48</td>
<td>92%</td>
</tr>
</tbody>
</table>

• MRI findings best predictor of outcome in paraplegic dogs

• Generally success rates are 92% and 62%, in DPP+, DPP – respectively

MRI as predictor of outcome

- Allows for evaluation of SC health
- Without MRI
  - Prognoses range from 10-100%
    - “50/50”
- MRI allows for...
  - Establishment of diagnosis
  - Accurate prognosis!
Why wait??

• Our beliefs
  ▪ Diagnostic and prognostic value of MRI is worth the wait
  ▪ CT / myelogram??
  ▪ Little harm in waiting

• 2 components of injury caused by disc rupture
  ▪ 1) Concussive internal injury sustained at moment of impact
    • Most important / fate is sealed at time of rupture
  ▪ 2) Ongoing compression
Why MRI for Type I Disc Disease?

• MRI consistently superior to myelography for determining lesion localization and lateralization (Bos)

• Correlation between MRI and surgical findings is 100% for lesion localization and lateralization (Besalti, Naude)

• Superior to deep pain status in determining outcome in paraplegic dogs

Bos AS. University of Guelph. 2008: 113-49
No harm in waiting...

- **JAVMA 2016**
  - *Jeffery et. al*

- **Goals of study**
  - Identify factors associated with recovery of locomotion

- **78 dogs that underwent spinal surgery for IVDD**
  - Iowa State, TAMU, UK
• Results
  ▪ No evidence that prognosis for recovery of ambulation was related to time from onset of non-ambulatory state or loss of DPP

• Conclusion
  ▪ “Immediacy of surgical treatment had no apparent association with outcome”
  ▪ Rather, the prognosis strongly influenced by nature of initiating injury
Further Evidence...

- JAVMA 2003
  - *Olby et. al*
  - Study on spinal trauma
    - Including IVDD, HBC, etc.
  - Outcome was not associated with duration of paraplegia
  - Additionally, 0% of DPP(-) dogs recovered that had suffered “trauma” (fracture, subluxation, etc.)
Further Evidence...

- **JSAP 1999**
  - *Scott, McKee*
  - No statistical significance to show duration of loss of DPP impacted the prognosis

- **JAVMA 2005**
  - *Ito et. al*
  - Duration of clinical signs
    - Not associated with outcome
However....

• We do still recommend prompt establishment of diagnosis and prognosis
• Surgical intervention (if indicated)
  ▣ Sooner rather than later.
Type I Disc Disease
Intervertebral Disc Degeneration

Type I - Breeds

- Overall prevalence = 2% (Bray, 1998)
- Dachshunds (20%), Pekingese, beagle, cocker
Type I – Age

• Chondrodystrophic: 3-7 years
• Non-chondrodystrophic: 6-8 years
  - Large breed dogs: mixed, German Shepherd, Labrador, Rottweiler, Dalmatian, Doberman
Surgery vs. Medical Management?

- In general with an isolated disc rupture...
  - Surgery
    - Prognosis with surgery is >95%
    - Quicker recovery
    - Low recurrence with fenestration
      - ~8%
  - Medical management
    - Fair prognosis
    - Recurrence rates
      - 30-50%
Medical

• What are we trying to accomplish?
• Rest is key!!!!
  ▪ All medically managed cases will be more likely to fail if not rested.
• So, rest (not medication) is more important!
NSAIDS > Steroids

• NSAID therapy associated with higher satisfaction (better pain control, fewer side effects) via questionnaire (Levine)
• Administration of steroid is associated with higher rate of GI and urinary complications causing increased hospital stay
• NSAIDS lower recurrence rate than prednisone (Mann)
• Steroids impair healing (annulus)

Medical

• My preference
  ▪ NSAID
    • Meloxicam, Carprofen
  ▪ Gabapentin
  ▪ Tramadol
  ▪ Muscle relaxer

• Other
  ▪ Urinary status
Surgery

• Best if done sooner...
• If delayed
  ▪ >2 weeks
  ▪ Prognosis could worsen
  ▪ Why?
    • Disc material analogy
    • If delayed...
      – Adhered to dura, vessels
      – More challenging
      – More dangerous
Type 1 Disc Summary

• Not as time sensitive as once thought.
  ▪ Down ≠ Down n’ Out

• Recommend referral in all dogs with suspected disc disease
  ▪ Establish diagnosis and PROGNOSIS

• Educate owners of risks associated with medical management
  ▪ Recurrence
  ▪ Surgery for chronic discs
Type 1 Disc

- **The 4 Questions**
  - **Onset?**
    - Peracute-to-acute
  - **Progression?**
    - Progressive
  - **Symmetry?**
    - Often subtly asymmetric
  - **Painful?**
    - Yes!
Disc Disease – Type 2

• Signalment
  ▪ Large breed dogs
  ▪ 6-8 years
  ▪ GSD, Lab, Golden
Disease Physiology

- Disc degeneration
- Fibrous form of metaplasia
  - nucleus pulposus replaced with fibrocartilage
  - weakening of the dorsal annulus
  - protrusion, bulging of annulus
Type 2 - Signs / Progression

- Lumbosacral (L7-S1) disc protrusions
  - Slow to rise / sit
  - Paraparesis
  - Poor reflexes
  - Incontinence
  - Tail abnormalities
  - Pain

- Low cervical disc protrusions (Disc associated Wobbler’s syndrome or DAWS)
  - Tetraparesis
  - Tetra-ataxia
  - Pain
Surgery and L7-S1 Type II Disc

• Dorsal laminectomy with fenestration
  • 131 cases, GSD, painful / reluctant to jump, rise, climb stairs, 93% improved, 17% recurrence rate (Danielsson)
  • 69 cases, various grades, 78% good outcome (De Risio)
- Urinary or fecal incontinence has a worse prognosis
- Chronic urinary incontinence predicts poor outcome

Do NOT confuse with orthopedic disease and wait to address the problem until incontinent

Type 2 Disc

• The 4 Questions
  ▪ Onset?
    • Chronic
  ▪ Progression?
    • Progressive
  ▪ Symmetry?
    • Usually symmetric
  ▪ Painful?
    • Yes
IVDD in Cats??

- Yes!
- Far less common
- Older
- Lumbar disc disease
  - L4-L5
- Type 1 > Type 2
- Outcome similar to dogs
“Amy” – 11 yo FS Balinese
Degenerative Myelopathy

- First described in 1973
  - Non-specific degeneration
- Most dogs in initial reports were GSD
- However, common in several other breeds
  - Overall prevalence of 0.19%
Degenerative Myelopathy

• Cause
  ▪ Mutation in superoxide dismutase 1 gene
    • SOD1
    • Antioxidant / free radical scavenger
  ▪ Amyotrophic lateral sclerosis
    • ALS / Lou Gehrig’s disease
    • Differences
      – Neuron vs. axon
Degenerative Myelopathy

- Progressive disease in older dogs
  - 8-14 years
- Large breed dogs
  - GSD, Boxer, CBR
  - Mean age of 9 yo
- PWC
  - Mean age of 11 yo.
Degenerative Myelopathy

• Clinical Progression
  ▪ Spectrum of symptoms
    • Proprioceptive ataxia, paraparesis
      – T3-L3 spinal cord segments
    • Progress to non-ambulatory state (6-20 months)
      – LMN paraplegia
      – → tetraplegia
      – → brainstem signs
Degenerative Myelopathy

• Antemortem Diagnostics
  ▪ MRI
    • Diagnosis of exclusion / presumptive diagnosis
      – Normal MRI
      – Cord atrophy
  ▪ CSF
    • Normal
    • High protein
Degenerative Myelopathy

- Genetic test
  - Mizzou
  - OFA
- Samples
  - Cheek swab
  - Whole blood
- Results

G/G – Normal
A/G – Carrier
A/A – Affected
Degenerative Myelopathy

- Treatment?
  - No definitive treatment
  - Supportive care
    - Exercise/physical therapy
    - Vitamin supplementation?
  - Good nutrition
  - Weight control
Degenerative Myelopathy

- **The 4 Questions**
  - Onset?
    - Chronic!
  - Progression?
    - Progressive
  - Symmetry?
    - Often symmetric
  - Painful?
    - No.
Take Home Points

- MRI is the best diagnostic modality to evaluate spinal cord health, determine an accurate prognosis and to plan appropriate therapy.
- Not everything is a disc!!!
References


• Dolera M¹, Malfassi L¹, Bianchi C¹, Carrara N¹, Finesso S¹, Marcarini S¹, Mazza G¹, Pavesi S¹, Sala M¹, Urso G¹,². Frameless stereotactic volumetric modulated arc radiotherapy of brachial plexus tumours in dogs: 10 cases. Br J Radiol. 2017 Jan;90(1069).


References


Any Questions??