• 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
Vertebral Malformations

- Partial unilateral failure of formation (wedge vertebrae)
- Complete unilateral failure of formation (hemivertebra)
- Unilateral failure of segmentation (congenital bar)
- Bilateral failure of segmentation (block vertebra)
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

T6-7 T13
“Chewy”
Chewy’s 3D model
Post-op radiographs

Right lateral

VD
Vertebral Malformations

• The 4 Questions
  ▪ Onset?
    • Chronic
      – Months to years
  ▪ Progression?
    • Slowly progressive
  ▪ Symmetry?
    • Usually symmetric
  ▪ Painful?
    • No

The only disability in life is a bad attitude.
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
  - 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***
“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

Meningothelial 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

**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><strong>Totals</strong></td>
<td><strong>18/29</strong></td>
<td><strong>62%</strong></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><strong>Totals</strong></td>
<td><strong>44/48</strong></td>
<td><strong>92%</strong></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
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

[Images of dogs]
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!

---

*Doxycycline*
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, 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

References

Any Questions??